Potential Conflict between Future Development of Natural Resources and High-Value Wildlife Habitats in Boreal Landscapes

Biodiversity and Conservation

Nobuya Suzuki[1], Katherine L. Parker[1]

[1]Natural Resources and Environmental Studies Institute, University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9, Canada

Nobuya Suzuki (Corresponding Author)
Email: nobi.suzuki@unbc.ca

Online Resource 2. Forest Resource Potential

We created a GIS raster layer of forest resource potential across the Muskwa-Kechika Management Area (hereafter referred to as the Muskwa-Kechika) using Vegetation Resource Inventory (VRI) data for British Columbia (British Columbia Ministry of Forests, Lands and Natural Resource Operations, Forest Analysis and Inventory Branch 2013). To develop the forest potential layer, we selected 4 forest stand variables that are routinely used to assess timber production: site index, basal area, quadratic diameter, live stand volume. These 4 variables were correlated with each other (all $P < 0.0001$, Table S2.1). Basal area and live stand volume had the highest correlation ($r = 0.823$); quadratic diameter and site index had the lowest correlation ($r = 0.381$).

Table S2.1 Pearson's correlation matrix of stand structure variables from vegetation resource inventory (VRI) data in the Muskwa-Kechika Management Area showing moderate to strong correlations between variables ($P < 0.0001$)

	Pearson's Correlation Coefficient (*r*)			
	Quadratic diameter	Basal area	Stand volume	Site index
Quadratic diameter	--	0.413	0.618	0.381
Basal area	0.413	--	0.823	0.491
Stand volume	0.618	0.823	--	0.592
Site index	0.381	0.491	0.592	--

As a summary of our general approach, we used a principal component analysis to reduce the 4 correlated stand variables to a single principal component variable that served as a measure of forest resource potential for planning units (Fig. 1b, main text) across the Muskwa-Kechika. We tested both untransformed original stand variables and natural-log transformed stand variables for normal distribution using normal probability plots and histograms. We ran the principal component analysis separately for untransformed stand variables and transformed stand variables, tested principal component scores from both variable sets for normal distribution and linearity, and selected the best-performing principal component variable from either untransformed or transformed stand variables.

Specifically, we focused our assessment on forested areas of the Muskwa-Kechika by limiting our analysis to polygons of VRI in the Muskwa-Kechika where basal area > 0, quadratic diameter > 0, and site index > 0. There were 112,516 polygons in the Muskwa-Kechika that met these criteria. A number of polygons, each of them having unique values of stand variables, partitioned a 500-ha planning unit. Because some polygons extended across more than one planning unit, we generated a point at the center of each polygon to assign polygons to specific planning units within which center points of polygons were located. We randomly selected approximately 50% of polygons that had their center points within a 500-ha planning unit across all planning units in the Muskwa-Kechika. This process precluded selecting the same polygons more than once during the random sampling and also allowed randomly sampled polygons to be spatially spread across the landscape. We analyzed the 4 stand variables from the randomly selected polygons (n = 55,210) in a principal component analysis to formulate a measure of forest resource potential, which is a principal component axis based on a linear combination of the original 4 variables. In theory, the first principal component axis should explain the highest variability expressed by the original variables; therefore, it has the potential to serve as the best measure of forest resource potential. This measure of forest resource potential formulated by the principal component analysis was used to score forest resource potential for all VRI polygons in the Muskwa-Kechika. To validate, we used data from polygons (n =57,306) that were not used in the principal component analysis to assess scores of the forest resource potential measure (the principal component axis) relative to the 4 stand variables using Pearson's correlation coefficients. We presumed that the higher the correlations, the better the performance of the principal component axis as a measure of forest resource potential.

As expected, results of the principal component analysis indicated that the first principal component (PC1) explained the majority of the total variation (Table S2.2, 68%), and all 4 stand variables were highly correlated with PC1 (Table S2.3). Herein, results were based on natural-log transformed variables, which better met the assumption of normal distribution and produced principal component scores that were closer to normal and more linear than those produced by the untransformed variables.

Very slight differences in component weights among the 4 variables suggested all variables were well taken into account for the principal component scores without 1 or 2 variables over-influencing the scores. Live stand volume and basal area had only slightly higher component weights than site index and quadratic diameter. The second principal component was mainly a measure of increasing quadratic diameter where basal areas and site index were decreasing, which did not serve the purpose of an index of forest potential. We only retained the first principal component, which explained 68% of the variability and was positively correlated with the 4 stand variables.

Principal component scores (PC1) and values of the 4 variables from the validation data showed strong correlations (Table S2.3), confirming that VRI polygons with high principal component scores tended to have high values for the 4 stand variables and providing support for the use of PC1 as an index of forest potential. Because principal component scores are negative below and positive above mean = 0, we added a constant value (5.43) to PC1 so that all values are positive with base value of 1.

Table S2.2 First principal component axes (PC1) explained more than 4 times as much variability as the second or third principal component axes and was therefore used as an index of forest potential

	Eigen value	Proportion of variance explained (%)	Cumulative proportion of variance explained (%)
PC1	2.720	68.0	68.0
PC2	0.641	16.0	84.0
PC3	0.582	14.5	98.5
PC4	0.057	1.4	100.0

Table S2.3 Relationship between variables of forest structure and the first principal component (PC1), indicating that the 4 variables similarly contributed to produce the PC1 and each variable showed a strong correlation with PC1

Stand variable[a]	Component weight[b]	Standardized coefficient[b]	Correlation with PC1 (r)[c]
Quadratic diameter	+0.716	+0.263	+0.720
Basal area	+0.880	+0.324	+0.882
Live stand volume	+0.957	+0.352	+0.958
Site index	+0.718	+0.264	+0.719

[a] Values in the table are based on the natural logarithms of the stand variables
[b] Component weights and standardized coefficients from the principal component analysis were based on 50% random selection (n=55,210) of all forest-based pixels
[c] Pearson's correlation coefficients were obtained for principal component scores and values of stand variables from validation data (n=57,306) that were not used in the initial principal component analysis

After the scores of forest resource potential were assigned to all polygons, we converted polygons into 0.25-ha pixels (50-m cell size) of forest resource potential scores and also assigned 0 to non-forest pixels across the Muskwa-Kechika. Scores of forest resource potential for 500-ha planning units (Fig. 1b, main text) were determined by calculating a mean forest resource potential score of approximately 2000 pixels in each planning unit across the Muskwa-Kechika (Fig. S2.1).

Reference

British Columbia Ministry of Forests, Lands and Natural Resource Operations, Forest Analysis and Inventory Branch (2013) Vegetation Resource Inventory (VRI) - Forest Vegetation Composite Polygons and Rank 1 Layer. http://www.for.gov.bc.ca/hts/vridata/. Accessed 10 November 2013. Data currently available at: http://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer

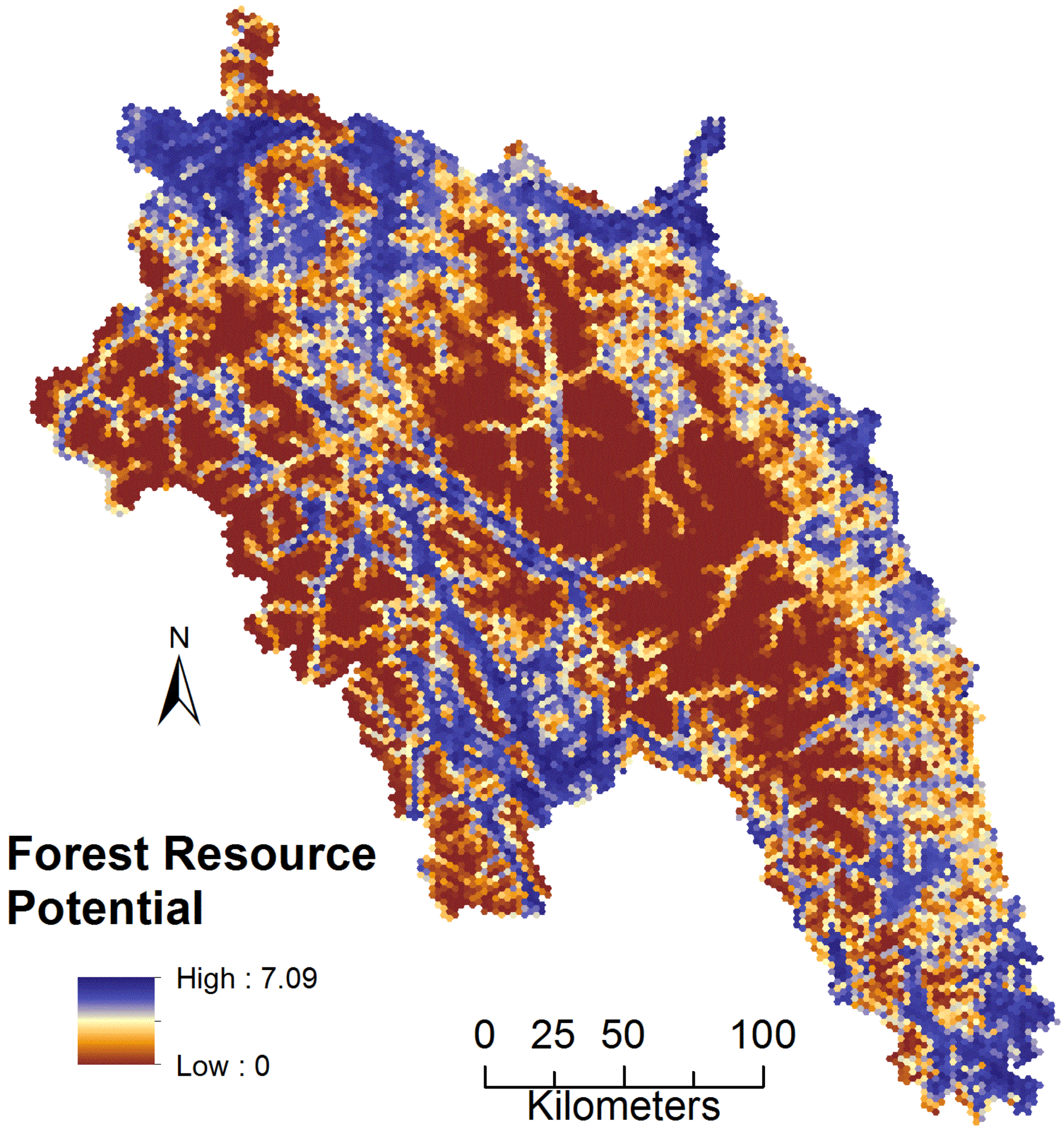

Fig. S2.1 Forest resource potential for 500-ha planning units across the Muskwa-Kechika Management Area in northeast British Columbia, Canada derived from a principal component of 4 stand variables: basal area, quadratic diameter, live stand volume, and site index