Predicting site series for the John Prince Research Forest

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Introduction

Before commencing a typical day in the field, resource managers are often limited by the maps they hold for making in-house decisions. A prime example of this problem relates to the Biogeoclimatic Ecosystem Classification (BEC) maps of British Columbia. The BEC system is a hierarchical classification scheme that combines three classifications: climatic, vegetative, and site. At the broadest scale, the biogeoclimatic zone is a class based on the prevailing regional climate. For example, the Sub-boreal Spruce (SBS) zone within the central interior plateau is typified by hot dry summers and cold snowy winters. Underlying this broad class is the subzone. The subzone is the product of dividing the biogeoclimatic zones based on the variation in the prevailing climate. For example, the Dry Warm Sub-boreal Spruce (SBSdw) zone lacks the major influence of the orographic lifting of the McGregor Mountains foothills or the Coast Mountain rain shadow. Within each subzone is the biogeoclimatic variant. Each variant encompasses the considerable geographic variation between subzones. For example, the Stuart Dry Warm Sub-boreal Spruce (SBSdw3) zone defining the geography of Fort Saint James and the surrounding areas. Finally, the site series is the finest resolution of class, and the most commonly used in regards to on-the-ground decision making. Each site series is based upon relative soil moisture regimes (SMR) and soil nutrient regime (SNR). This level of classification is often used in silvicultural applications and site selection for ecological research. Site series maps, however, do not exist in most cases and require field diagnosis. Variant maps are the only level of ecosystem classification that exist for all of British Columbia, and they are only reconnaissance level maps, ignoring vast levels of variation

With such coarse ecosystem classification it is difficult to apply one's intuition as to where a particular wet or dry, rich or poor site may occur on the landscape. Pending the quantity and quality of geographically referenced ecological data, it is possible to build a GIS to predict site series. This would enable the resource manager to pin-point candidate sites based on some predefined objective that requires knowledge about the site series.

Study Area

The John Prince Research Forest (JPRF) was selected to test the feasibility site series prediction using GIS technologies. This area is ideal considering previously attained ecological knowledge of the area and access to the spatial data required to build the predictive models.

The JPRF is 50km northwest of Fort St. James, British Columbia. Specifically, the JPRF is bound within zone 10 of the Universal Transverse Mercator projection from 6050654 N to 6068452 N, and 396683 E to 418453 E. The majority of the JPRF land base is represented by the Stuart Dry Warm Sub-boreal Spruce Biogeoclimatic Variant (SBSdw3). Other variants exist but are not included in the model due to time constraints.

Spatial Data

To predict the SMR at a given location the spatial data used included: slope; solar incidence; soil type; and vegetation. To predict the SNR of a given location the spatial data used included: vegetation; site index; and soil type. Vegetation was limited to the primary and secondary tree species and their relative percent in composition. Ideally, many plant species should be used in site series identification; however, the spatial data was limiting in this respect. The soil type was used to make inferences about soil biochemistry and resultant soil fertility.

The JPRF digital elevation model (DEM) was used to create a lattice of slope values (degrees) and solar incidence values (degrees). These provided spatial data about the tendency for moisture to move away or evaporate from a given point. The soil coverage for the JPRF was used to indicate the innate soil moisture holding capacity. The primary and secondary tree species from the forest coverage were used to indicate soil moisture based on the given vegetation association and plant indicator values (Beaudry et al 1999).

Primary and secondary tree species and their relative composition from the forest coverage were also used to indicate the soil nutrients based on the given vegetation association and plant indicator values (Beaudry et al 1999). Site index, another attribute within the forest cover coverage, was used to further pin-point the SNR.

All spatial data was fit to a common map-extent using the John Prince Research Forest DEM coordinates. The DEM was then imported into PCIWORKS. Slope and solar incidence channels were calculated within PCIWORKS. Vector data was converted into grid data using Arc/Info. These grids were imported into PCIWORKS as channels under the original DEM. This produced common grid points between the explanatory variables for modelling between channels.

Site-Series Modelling

PCIWORKS was used because of ease in modelling between channels. The EASI modelling panel in PCIWORKS allows the user to compose modelling equations and procedures in a simple editor window using basic logical expressions and apply these to IMAGEWORKS. Three individual models were created to predict site-series for the SBSdw3 portion of the JPRF. First, a model was created to predict the soil moisture regime (SMR) for each grid point. Second, a model was created to predict the soil nutrient regime (SNR) for each grid point. Finally, the resultant channels of SMR and SNR where used to assign the site series for each grid point based on a SMR x SNR matrix for the SBSdw3. The models created are similar to, and based upon, a dichotomous method found in the Field Guide for Site Identification and Interpretation for the Southwest Portion of the Prince George Forest Region (1993).

Results

Figures 1, 2 and 3 describe the output of the SMR, SNR, and site series models respectively.

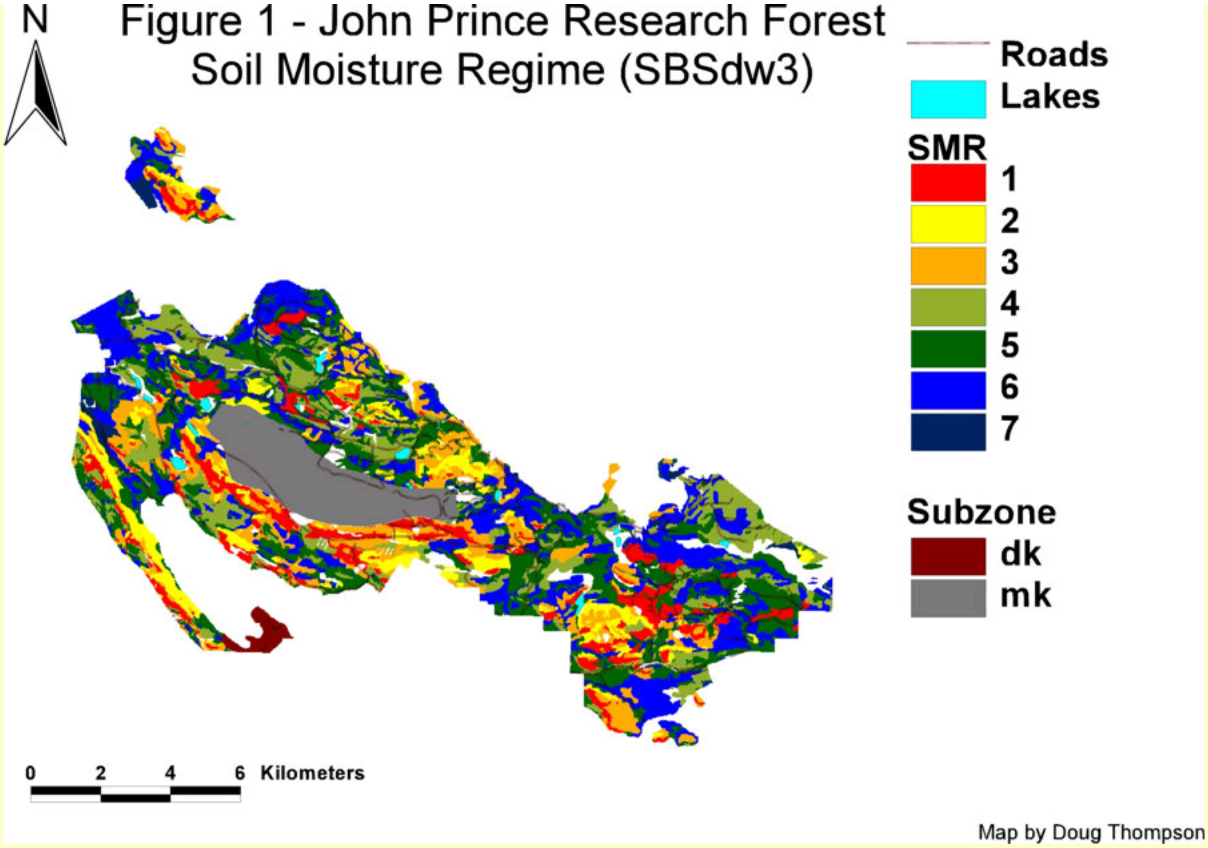


Figure 1 - John Prince Research Forest
Soil Moisture Regime (SBSdw3)

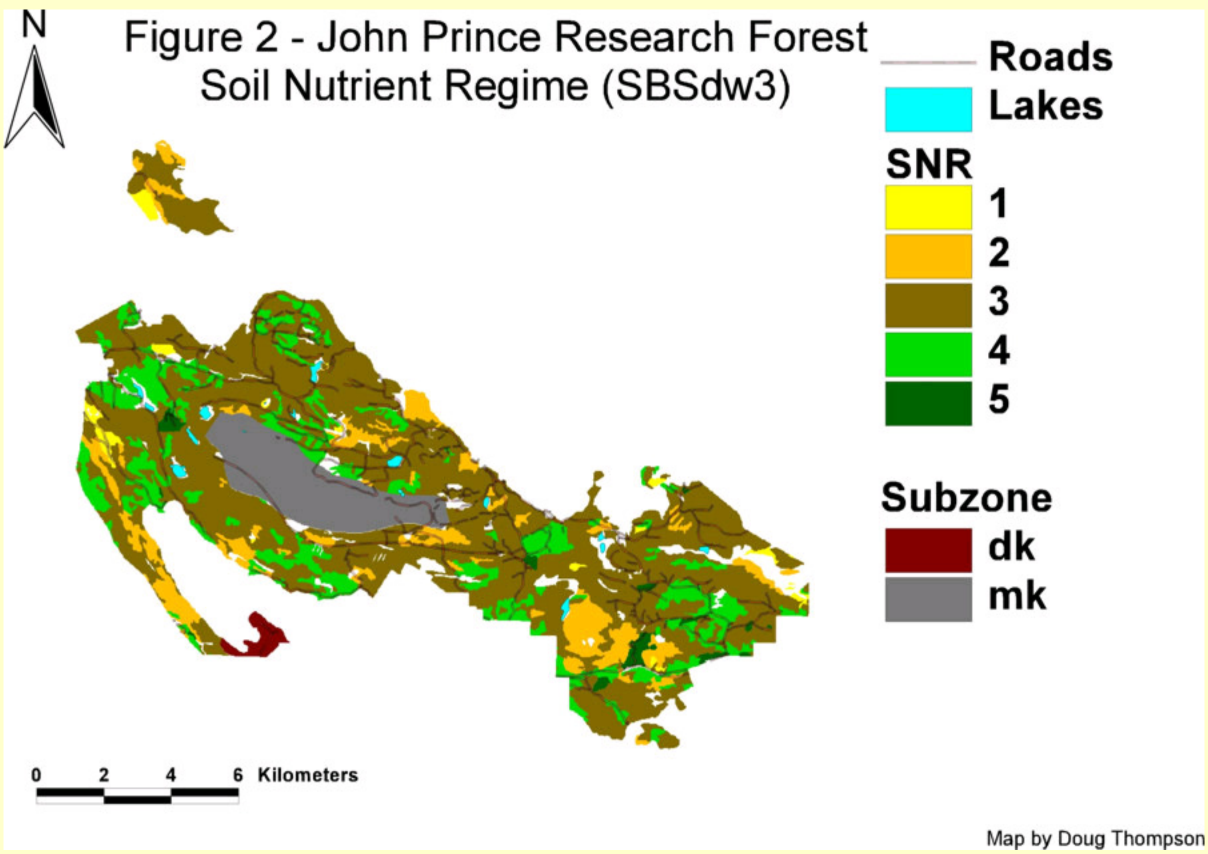
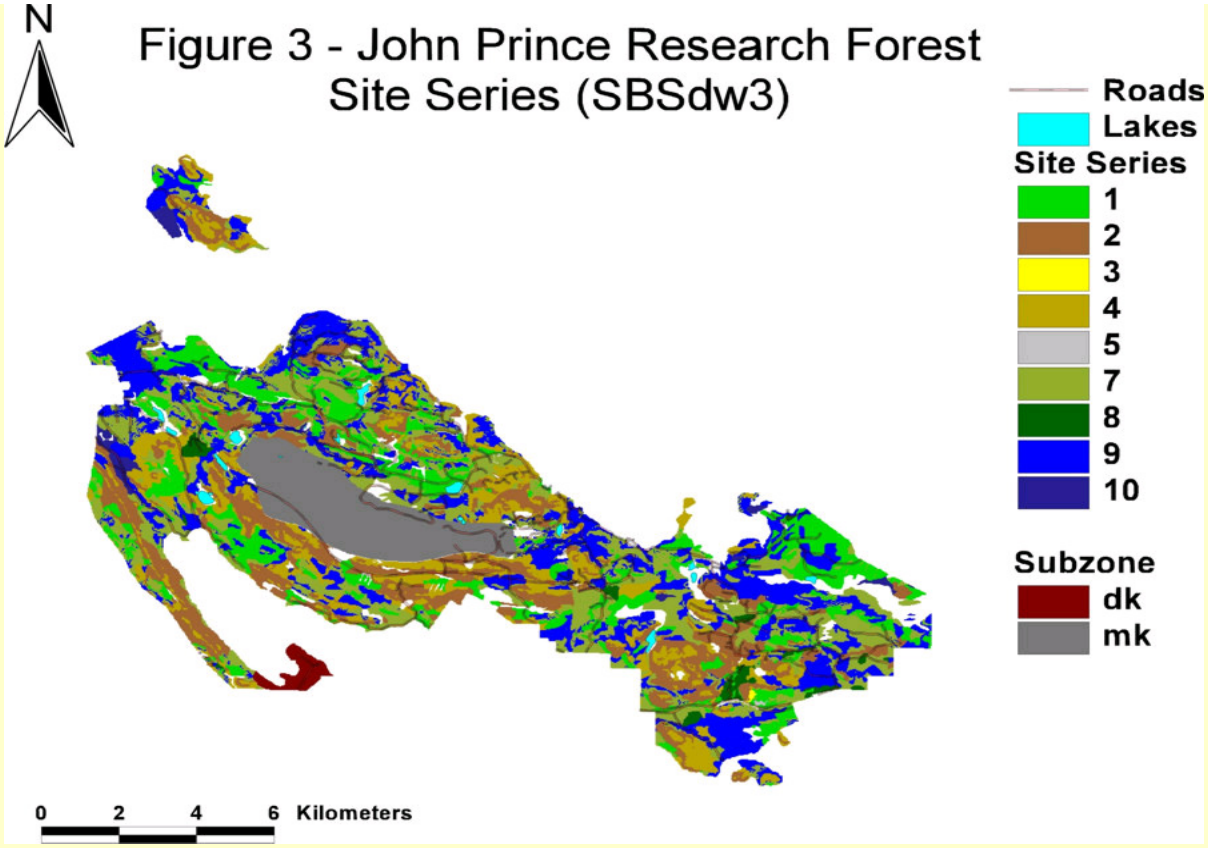


Figure 2 - John Prince Research Forest
Soil Nutrient Regime (SBSdw3)



Discussion

At this time it is difficult to discuss the true applicability of the results. Ground checking using the output would be required to suggest where the strengths and weaknesses lie. From site series data collected in the previous summer field season - eight stands in total - the predictions were consistently within one unit of the true SMR and SNR values. However, with such a small sample size limited statistical relevance could really be attained. Furthermore, the variation present can lead to poor predictions of site series which is based upon a matrix of two variables.

Placing the model aside, there are three major sources of error that where either inherent in the spatial data from the start or introduced during data manipulation. The first source of error was introduced when converting the vector data to raster data to make all forms of data compatible within PCIWORKS (i.e. common grid centres). When converting vector data, grid size has to be defined. For this project, 20m grid cells were chosen. In the original vector data of forest cover there were polygons less than 400m2 and/or less than 10m in width. Numerous polygons were omitted from the original data set. This increased the overall homogeneity of the data set and decreased the predictive power of the model.

Second, error was introduced when overlaying data sources that came from vastly different scales. The forest coverage was created using air photo interpretation and is 1:20,000 in scale. The soil coverage for the JPRF is 1:100,000 in scale and literally, reconnaissance interpretations of the dominate soil types. If soil type is weighted heavily within the model then the model has dependence on this data type. Even if delineation between SMR values was possible the model does not pick this up due to the homogeneity in soil types

Third, error was introduced by relying too heavily on any one of the data sources. The soil nutrient variable that was created from soil type was too coarse to be introduced into the model. Site series was therefore relied heavily upon to delineate between the various levels of productivity for a given vegetative association. Site series, however, is based on photo interpretation with limited ground checks. Height and age are estimated from the air photos and in many cases the forest canopy masks the true nature of the underlying landscape, and therefore makes height interpretation difficult. This results in poor estimations of site index and ultimately leads to poor estimations of the site series.

In conclusion, predictions of site series, or any ecological variable, are dependent upon three things: the quality of spatial data, the quantity (types) of spatial data, and the modeller's ability to make sound judgments about how the explanatory variables work with one another to explain the real world.

Acknowledgments

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Sources

Beaudry, L., Coupe, R., Delong. and Pojar, J. 1999. Plant Indicator Guide for Northern British Columbia: Boreal, Sub-Boreal and Sub alpine Biogeoclimatic Zones (BWBS, SBS, SBPS, and northern ESSF). British Columbia, Ministry of Forests.

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