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Soil-Woodland Correlation in Northern Idaho[1]

Approximately two-fifths of Idaho's land is forested (Wilson, 1962). More than 25 million acres need to be restored or improved (Idaho Conservation Needs Committee, 1963). Often it is difficult to recommend specific tree species for reforestation because of the absence of adapted trees by which to measure potential site quality.

Through soil-woodland correlation, site quality may be estimated by identifying the soil in question and relating it to similar soils of known productive capacities. The objective of this study was to formulate regression equations from previously collected data to predict site quality in areas which have been burned or otherwise disturbed.

Methods

Over the past 14 years data from over 200 plots in northern Idaho have been collected by a team consisting of a soil scientist and woodland specialist of the Soil Conservation Service. Each plot represents a soil series with a normally stocked overstory of measurable trees.

The soil scientist described the soil profile in accordance with standard nomenclature (Soil Survey Staff, 1951). The woodland specialist recorded height and age of four to five dominant and/or codominant trees, stand density, and composition of both overstory and understory. These data were used in this study.

One hundred forty-four plots (Fig. 1) were eventually selected: 47 plots of ponderosa pine (*Pinus ponderosa*), 24 plots of lodgepole pine (*Pinus contorta*), 25 plots of western white pine (*Pinus monticola*), and 48 plots of western larch (*Larix occidentalis*). The soil profile at each plot was classified in accordance with the Soil Survey Staff (1967). Site index was computed based on tables by Meyer (1938), British Columbia Forest Service (1947), Haig (1932), and Cummings (1937).

Regression analyses were used. Since much of the data was discrete (discontinuous), a choice had to be made; either the data must be split so that discrete variables in one half could be coded and used in regression to test the other half, or the authors' knowledge of the area must be relied on to establish codes for the discrete data to test the entire 144 plots. Splitting the data would result in increasing sampling error. The results of using data coded by the authors would, in part, be a reflection of the authors' knowledge

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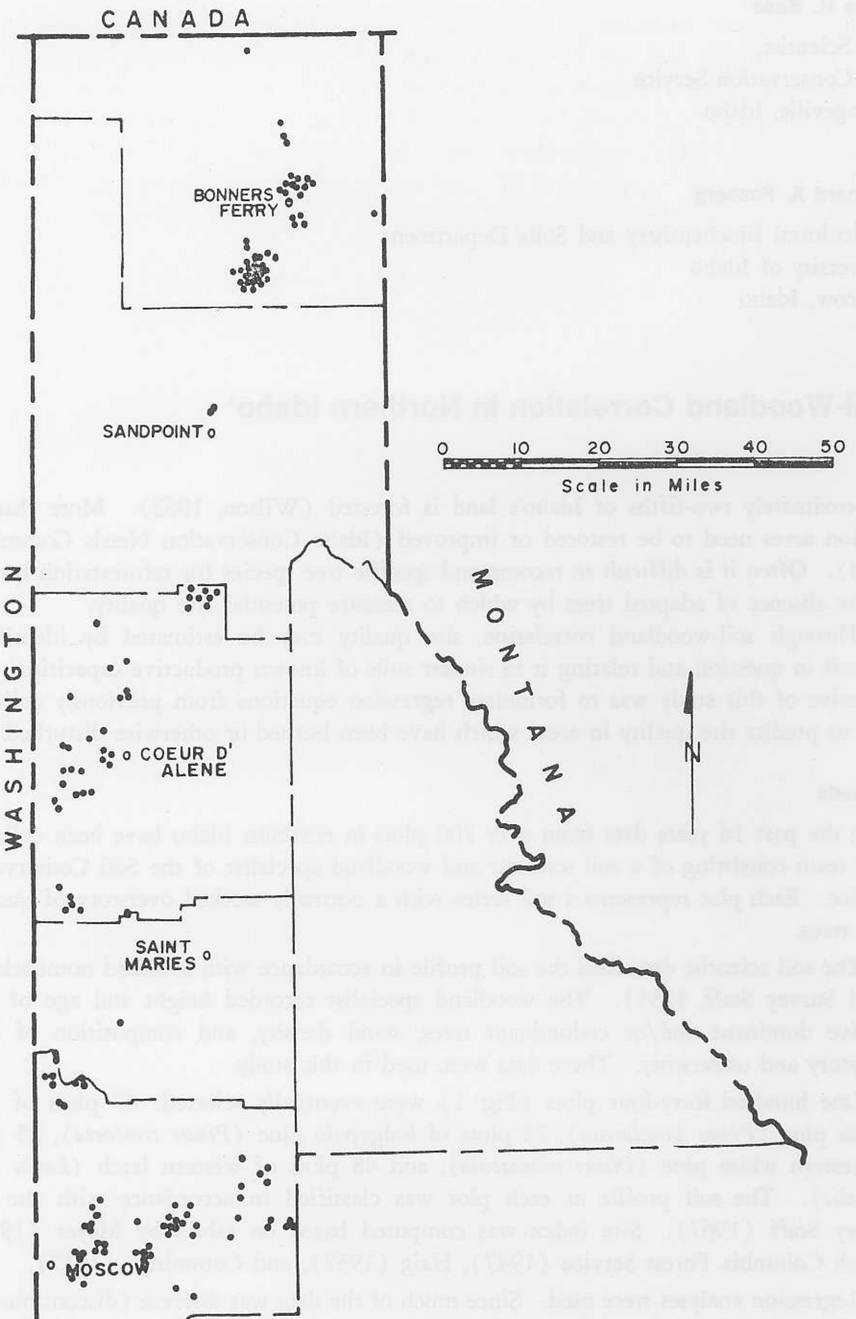

Figure 1. Location map of selected plots in northern Idaho.

of soil-woodland relationships in the area. Since many soil-woodland observations were made in this area, the latter was chosen.

Stepwise multiple regression analyses of the plot data were selected to obtain prediction equations. It was hoped the use of these equations would give a reliable measure of site quality in disturbed areas. Site indexes of the four tree species were used as dependent variables and 10 soil and site factors were used as independent variables. The independent variables, selected from the plot data to represent best soil classification, plot position, and physical soil characteristics, are:

X_1 elevation in feet
X_2 latitude in hundreds of degrees
X_3 soil drainage class
X_4 depth to C horizon in inches
X_5 moist soil color of upper 6-inch mineral horizon by Munsell color charts
X_6 texture of control section (Soil Survey Staff, 1967), field determination
X_7 moist consistence of the most developed horizon in upper 40 inches, field determination
X_8 soil subgroup
X_9 soil family
X_{10} soil series.

Seven of the 10 independent variables were discrete, so numerical codes had to be adapted for them. Latitude, a continuous variable, was recorded in units of degrees and minutes; therefore, minutes were converted to hundredths of a degree. Soil drainage, an important variable to Mader and Owen (1961), seemed to be a logical choice in this study. Depth to the C horizon was also considered by others (Myers and Van Deusen, 1960) to be an important variable. Moist soil color of the upper 6-inch mineral horizon is locally indicative of vegetative composition. Texture of the control section was selected to reflect the soils' available water-holding capacity. Moist consistence of the most developed horizon in the upper 40 inches was selected to reflect root penetrability. The three lowest categories of the soil classification system were selected as independent variables to establish the relationship between soil classification and site index in northern Idaho.

Results

The regression equations were selected on the basis of insignificant change in coefficients of determination with additional steps of regression. The following prediction equations, coefficients of determination, and standard partial regression coefficients for the four species are:

(ponderosa pine)

$$\hat{Y}=70.95137+1.26319X_9$$

$$R^2=0.45$$

Variable	*Standard partial regression coefficient*
X_9 (family)	0.66930

(lodgepole pine)

$$\hat{Y}=-48.03618+0.03715X_1+6.3169X_7$$

$$R^2=0.41$$

Variable	*Standard partial regression coefficients*
X_1 (elevation)	0.93992
X_7 (moist consistence)	0.75061

(western white pine)

$$\hat{Y}= -1.62242+15.28558X_3+0.62654X_5$$
$$R^2=0.64$$

Variable	*Standard partial regression coefficients*
X_3 (soil drainage)	0.64289
X_5 (soil color)	0.46585

(western larch)

$$\hat{Y}=77.26344+ -0.00657X_1+ -0.70319X_8+0.59386X_9$$
$$R^2=0.26$$

Variable	*Standard partial regression coefficients*
X_1 (elevation)	-0.41856
X_8 (subgroup)	-0.31534
X_9 (family)	0.55394

Discrete Variable Codes

The following discrete variable codes were used in the prediction equations:

Codes for soil drainage classes (X_3)

excessively drained	1	well drained	3
somewhat excessively drained	2	moderately well drained	4

Codes for moist soil color in upper 6-inch mineral horizon (X_5)

10YR 2/2	01	2.5YR 5/2	19
10YR 2.5/2	02	10YR 4/3	20
10YR 2/2.5	03	10YR 3/3.5	21
10YR 2.5/2.5	04	7.5YR 3/2	22
10YR 4.5/2	05	10YR 3.5/3	23
10YR 3/2	06	10YR 3/4	24
10YR 2.5/3	07	2.5YR 5/1	25
10YR 2/1	08	7.5YR 3/3	26
10YR 3/2.5	09	10YR 3.5/3.5	27
10YR 2/1.5	10	10YR 4/4	28
10YR 4.5/3	11	7.5YR 3.5/2.5	29
10YR 3/3	12	10YR 3.5/4	30
7.5YR 2.5/2	13	7.5YR 3/3.5	31
10YR 4/2	14	7.5YR 4.5/4	32
10YR 3.5/2	15	7.5YR 3/4	33
10YR 5/3	16	7.5YR 3.5/3.5	34
10YR 4/2.5	17	7.5YR 4/4	35
2.5YR 5.5/2	18	7.5YR 3.5/4	36

Codes for moist consistence of the most developed horizon in upper 40 inches (X_7)

loose	1	soft	5
extremely firm	2	friable	6
very firm	3	very friable	7
firm	4		

Codes for soil subgroup (X_8)

Lithic Haploxeroll	01
Typic Haploxeroll	02
Typic Argixeroll	03
Aeric Argialboll	04
Typic Argiudoll	05
Glossoboralfic Argiudoll	06
Dystric Xerochrept	07
Mollic Hapludalf	08
Typic Cryorthod	09
Boralfic Cryorthod	10
Typic Fragiochrept	11
Typic Dystrochrept	12
Typic Hapludalf	13
Glossoboric Hapludalf	14
Alfic Fragiorthod	15
Typic Haplorthod	16
Alfic Haplorthod	17

Codes for soil family (X_9)

Lithic Haploxeroll loamy-skeletal, mixed, mesic	01
Typic Haploxeroll loamy-skeletal, mixed, mesic	02
Typic Argixeroll loamy-skeletal, mixed, mesic	03
Typic Argixeroll fine-loamy, mixed, mesic	04
Typic Argixeroll fine-silty, mixed, mesic	05
Typic Argixeroll loamy-skeletal, mixed, frigid	06
Typic Haploxeroll coarse-loamy, mixed, frigid	07
Aeric Argialboll fine-montmorillonitic, mesic	08
Glossoboralfic Argiudoll fine-silty, mixed, mesic	09
Dystric Xerochrept sandy, mixed, mesic	10
Typic Argiudoll fine-loamy, mixed, frigid	11
Glossoboric Hapludalf fine, montmorillonitic, mesic	12
Typic Argiudoll fine-silty, mixed, frigid	13
Dystric Xerochrept coarse-loamy, mixed, mesic	14
Mollic Hapludalf loamy-skeletal, mixed, mesic	15
Typic Haplorthod sandy, mixed, frigid	16
Typic Cryorthod loamy-skeletal, mixed	17
Typic Cryorthod coarse-loamy, mixed	18
Boralfic Cryorthod fine-silty, mixed	19
Typic Dystrochrept loamy-skeletal, mixed, frigid	20
Typic Hapludalf loamy-skeletal, mixed, frigid	21
Typic Dystrochrept fine-loamy, mixed, mesic	22
Typic Dystrochrept coarse-loamy, mixed, frigid	23
Typic Fragiochrept fine-silty, mixed, frigid	24
Typic Haplorthod loamy-skeletal, mixed, frigid	25
Typic Haplorthod coarse-loamy over sandy or sandy skeletal, mixed, frigid	26
Typic Haplorthod coarse-silty over sandy or sandy skeletal, mixed, frigid	27
Typic Hapludalf fine-silty, mixed, mesic	28
Mollic Hapludalf fine-loamy, mixed, frigid	29
Alfic Fragiorthod fine-silty, mixed, frigid	30
Typic Hapludalf fine-silty, mixed, frigid	31
Typic Haplorthod sandy over loamy, mixed, frigid	32
Typic Haplorthod coarse-loamy, mixed, frigid	33
Typic Haplorthod coarse-silty, mixed, frigid	34
Typic Haplorthod fine-silty, mixed, frigid	35
Alfic Haplorthod fine-loamy, mixed, frigid	36
Alfic Haplorthod fine-silty, mixed, frigid	37

Discussion

In the prediction equation selected for ponderosa pine, soil family accounted for 45 per cent of the variation in site index. An R^2 value of 0.51 was obtained when all 10 independent variables were introduced.

Elevation and the moist consistence of the most developed horizon in the upper

40 inches accounted for 41 per cent of the variation in site index of lodgepole pine in the prediction equation. Elevation is approximately 25 per cent more important than moist consistence. By using all 10 variables, an R^2 value of 0.62 was obtained.

In the equation selected to predict site index of western white pine, soil drainage and moist soil color of the upper 6-inch mineral horizon accounted for 64 per cent of the variation in site index. Soil drainage is approximately 33 per cent more important than soil color. Seventy-five per cent of the variation in site index is accounted for by using all 10 variables.

Elevation, subgroup, and family accounted for 26 per cent of the variation in site index of western larch in the prediction equation. Soil family is approximately 25 per cent more important than elevation and 75 per cent more important than soil subgroup. Thirty-seven per cent of the variation in site index is accounted for by introducing all 10 variables.

Conclusions

The regression equation for western white pine is a fairly reliable tool for determining site quality for this species in northern Idaho. Soil drainage and moist soil color of the upper 6-inch mineral horizon are the only determinations that need to be made. The equations for ponderosa pine, lodgepole pine, and western larch are less reliable. Use of these equations to determine site quality for these three species should be limited to northern Idaho areas with unknown soil-woodland relationships. More reliable equations for these species could be expected if additional plots were available. Discrete variables (soil color, drainage, etc.) from half of the plots could have been set in linear relationship with the actual site index values and regression equations derived from the other half.

The land manager who elects to use these equations will either require the assistance of a soil scientist to make the necessary observations or must have a good working knowledge of soil classification.

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