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Good Rocks/ Bad Rocks: The Latest Piece in the Puzzle of Natural Forest Fertility

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Those of us that spend part of every day in the quest for new information and new ways to analyze it are constantly discovering scientific facts and processes that, as far as we can determine, no one else knows. We also find that people seem to know a lot of things that just aren't true. This is a story about discovery and changing what we thought we knew to be true.

Imagine that you are the new owner or manager of a tract of forestland, about 60 acres sloping moderately to the northeast. The forest had been logged twice in the past 50 years, most recently about 10 years ago. Currently there is about 40 acres of mostly second growth grand fir and Douglas-fir with scattered western red cedar in the draws. The stumps show that ponderosa pine and western larch were the species removed along with some larger Douglas-fir. The remaining 20 acres was clearcut and broadcast burned 10 years ago, and planted to ponderosa pine and Douglas-fir.

The site is a cedar/pachistima habitat-type located in the northern Idaho panhandle. This habitat type is about as good as you can get for the species present, as the even more moist hemlock series of habitat-types is usually a little cooler with a shorter growing season. Sounds pretty good so far, right? Well actually, your first impression is that this is the skankiest, skuzziest, beat-up ragpatch of an excuse for a forest you have ever seen. Subsequent impressions as you examine tree conditions more closely are that your first impression was too generous. Most of the second-growth has chlorotic, yellow-green foliage, abnormally short needles, thin crowns with poor needle retention, and evidence of current or past bark-beetle attacks. Many trees are dying from the top down, and 5-10 trees per acre have died in recent years. Many of the dead trees have toppled and show evidence of advanced root disease. In the adjacent plantation, survival is only about 35% and mostly ponderosa pine. The Douglas-fir that didn't die are stunted, yellowish, and poorly formed. The pine are little better, with short, yellowed needles and an average height of only 2 feet in 10 years (one might expect at least 12-18 feet of growth in these conditions). There is no evidence of animal damage, and competing vegetation is sparse. In fact, it seems that the grasses and shrubs are not doing any better than the trees. Now remember, this is considered a premium growing site based on habitat-type, with lots of precipitation. And we all know that water is the most important limiting factor in tree survival and growth in summer-dry Idaho.

Next, you look at several road cuts to see if there are any hardpans, shallow soil, or other soil factors that may limit water availability. You find a shallow alluvial layer of mixed loess and volcanic ash over a base soil with some sort of hardened, layered "parent material" rock that is well fragmented. Exposed tree roots show deep penetration, and the soil generally appears to have adequate soil moisture conditions for trees based on what we learned in our college courses. *Most foresters would conclude that poor forestry and logging practices are at fault,* but that would be incorrect based on recent scientific discoveries.

In work done by the the Intermountain Forest Tree Nutrition Cooperative (IFTNC), directed by UI Professor Jim Moore, it was recognized that nitrogen fertilization alone sometimes increased mortality from root disease and that adding potassium to nitrogen

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fertilization had a dramatic, positive effect on growth and mortality reduction. They began experiments to examine the effect of fertilization on root chemistry, because mortality was primarily due to fungal root disease infections. Significant reductions in root-sugar concentrations were found at one location when combinations of potassium and sulfur were combined with nitrogen, whereas nitrogen alone increased root-sugars and the incidence and spread of root disease infections. While root-sugars increased at many locations, it did not happen at all sites. Current research includes increasing the number of test locations and testing fertilizer blends that include micronutrients. The IFTNC also studied the nutritional ecology of commercial tree species and found that shade-tolerant trees such as grand fir and Douglas-fir, which are more prone to root disease, have higher nutrient demands. Other scientists have shown that firs produce higher sugar ratios than intolerant species such as ponderosa pine and western larch.

These discoveries helped explain the mortality and other health effects of various fertilization applications, and the susceptibility of firs and resistance of pines and larch to root disease. It did little to explain the apparent nutritional deficiency and poor health of forests such as the one described earlier, especially where general site conditions all seemed so favorable. The IFTNC research staff began to suspect that some natural soil nutritional factor must be limiting. About this time, Professor Moore and his colleagues were studying soil maps of the region and noticed that many of the soil types characterized by a surface layer of loess (windblown deposits of silty soil; the Palouse region is typical) were classified as the same soil type but were actually underlain by several different, buried parent material rock types. Jim was discussing this with a geologist who noted that base-rock types were mapped and available. Jim took several geologic maps and, as suggested by several cooperators, overlaid them with large scale maps of root disease “hotspots” in northern Idaho. BINGO! Highly infected areas corresponded closely with areas of sedimentary rocks such as sandstones, low infections generally matched areas of basalt parent material ,and moderately infected forests were underlain with granitic parent materials. A closer look showed that the variations in these matches could be accounted for by looking at the potassium content within these basic rock types. Furthermore, the depth and nature of loess or volcanic ash depositions generally influences the timing and extent of root disease and other ill effects of inadequate soil nutrition. *NEW CONCLUSION: Bad Rocks!! The nutritional deficiencies of the soil are the primary factor underlying the increasingly poor health of the forest tract described earlier.*

The general, rather than absolute, essence of the initial and new conclusions is while parent material rocks have a pervasive and overriding effect, silvicultural practices can accelerate or diminish this effect. In this instance, stand composition changed due to selective harvests that cut less nutrient demanding, and more resistant, pines and larch and left high nutrient demanding, susceptible firs. Additionally, the clearcut was broadcast burned, reducing organic matter and depth to the nutrient-deficient parent material, and exporting nutrients via smoke and erosion. Retention of intolerant pines and larch, plus conservation of organic matter might have moderated the effect of subsoil nutritional deficiencies.

Many resource agencies, private industries, and individual landowners have struggled to renovate degenerated forest stands, with mixed results. We now know that while management and logging practices have an influence, situations with “bad rocks” need to be identified before we have costly, repeated planting and stand improvement failures. Ongoing fertilization trials will test whether forest health and productivity can be dramatically improved in these situations. Preliminary results are encouraging, but not enough time has passed for scientific conclusions. Understanding the nutritional status of forestlands is also critical to management planning including decisions to purchase or retain forests where health and productivity are primary objectives.

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