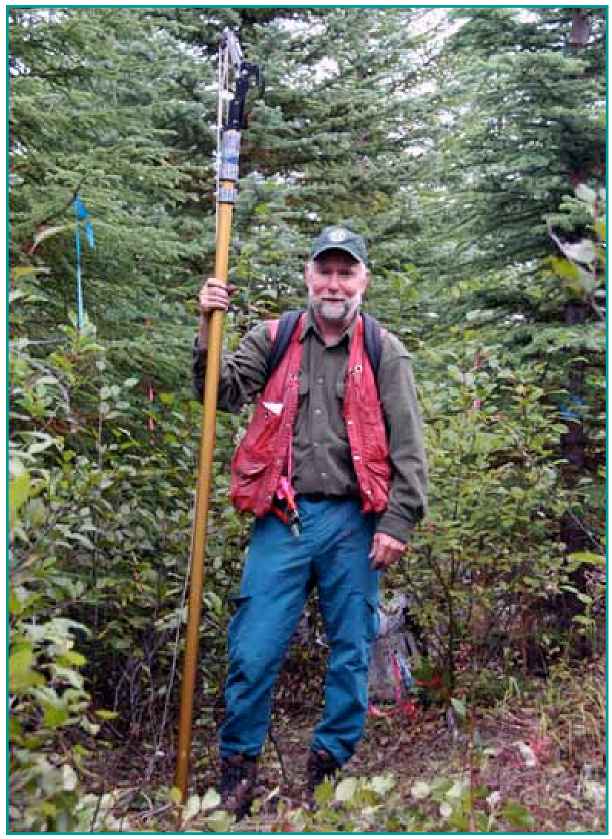
Q&A with Rob Brockley

Thirty years of lessons learned from forest fertilization research in the British Columbia Interior

Kathie Swift

In June 2010, **Rob Brockley**, Research Silviculturalist, Forest Productivity for the Ministry of Forests and Range, retired *(see right)*. Rob planned and implemented the forest fertilization program for the BC Interior since 1980, using the various funding avenues that have existed over the past three decades (Forest Resource Development Agreement Forest Renewal BC, and the Forest Science Program). Forest fertilization is one of the few forest management tools that can directly affect timber supply, and it has been identified as a key tool to help address mid-term timber supply issues resulting from the mountain pine beetle infestation. After 30 years of research in this area, here are some of Rob's interesting stories and important lessons learned.



Rob Brockley—pole-pruning career complete.

Q *Your government job title describes you as "Research Silviculturist, Forest Productivity." How did you get started in this area of research in British Columbia?*

A In 1980, I was working on my master's degree at the University of British Columbia under **Tim Ballard** (forest soils) when a job was advertised by the Ministry of Forests Research Branch for a scientist to design and implement a forest fertilization research program for the Interior. I applied for the job and surprisingly, the gig has lasted for 30 years.

Q *Implementing a forest fertilization program for the Interior is quite a large project. What has been the focus of your research?*

A The research initially focussed on lodgepole pine fertilization. The species is widespread throughout the Interior, and there was a lot of operational thinning undertaken in young, fire-origin stands in the 1970s. Dr. Tim Ballard and **Dr. Gordon Weetman** had previously done some preliminary foliar nutrition and fertilization research with lodgepole pine, so the next logical step was to establish area-based fertilizer trials in thinned, fire-origin stands across a range of interior biogeoclimatic zones. A technical advisory committee was formed to help design the project, and the first trial was established in a 20-year-old stand at Lac Le Jeune (south of Kamloops) in 1981. All of the early research trials were established in fire-origin stands. Later trials included naturally regenerated harvest-origin stands and plantations.

We established several interior spruce, Douglas-fir, and western larch fertilizer screening trials in 1987–1988 to identify specific nutrient deficiencies and to quickly assess fertilization growth response potential. Larger, area-based spruce and Douglas-fir fertilizer trials were established in the early 1990s.

Nitrogen was the only nutrient applied in early lodgepole pine fertilizer trials, since nitrogen is commonly deficient in temperate and boreal forests; however, we quickly found that the growth response was quite variable—some stands responded very well and others responded poorly. Further foliar analysis and fertilizer screening trials indicated that nitrogen fertilization induced sulphur deficiencies in many stands. We subsequently found that large incremental growth gains could often be achieved by adding sulphur in combination with nitrogen. Sulphur deficiencies appear to be most prevalent in lodgepole pine stands, especially in the Sub Boreal Spruce and Sub-Boreal Pine Spruce biogeoclimatic zones.

My recent research has focussed on the effects of different regimes and frequencies of fertilization on the growth and development of young interior spruce and lodgepole pine forests, studying the potential long-term effects of large nutrient additions on ecosystem health and sustainability. I've collaborated with several scientists to examine the effects of repeated fertilization on things such as soil biota, forest health, understorey biomass and diversity, carbon sequestration, and green house gas emissions.

Q *What are some of the unexpected surprises you have discovered through your work?*

A I've certainly had a few surprises over the past 30 years. The first surprise occurred shortly after I established my first fertilizer trial near Kamloops in 1981. The fertilizer was applied in the fall to a thinned, fire-origin lodgepole pine stand, and I was shocked to see that red squirrels had stripped most of the bark from fertilized trees when I returned the next year to collect foliage samples. There was virtually no damage to trees in the unfertilized treatments. During my initial inspection of the site, I had obviously failed to properly assess the risk of fertilizing a stand with an active red squirrel population. This is when I first met Dr. Tom Sullivan, a well-known small mammal researcher. He taught me a lot about squirrel nesting and feeding habits and suggested that I should avoid fertilizing fire-origin stands with previous signs of red squirrel damage. I pass along his sage advice to others.

Another surprise occurred when I returned to a study site near Burns Lake 1 year after fertilization to discover that the upper crowns of the fertilized trees were dead. Foliar nutrient analysis indicated that we had induced a severe boron deficiency by fertilizing with nitrogen. Further research indicated that boron deficiencies could be easily avoided by adding 2–3 kg/ha of boron to the fertilizer mix.

Q *What are some of the key principles forest managers need to consider when they apply some of the tools you have worked with? For example, where can fertilization be applied most effectively? Based on your research, does fertilization work better on some species than others? What are some of the benefits achieved through the use of fertilization and when could they be realized? What are some of the risks associated with using this tool?*

A Here are some key points that will help forest managers use fertilization effectively.

You need to do a good job of diagnosing the nutritional status of candidate stands before applying fertilizer. Simply put, a growth response won't occur unless the stand is nitrogen deficient. In many cases, other nutrients (e.g., sulphur or boron) must be included in the fertilizer prescription to maximize growth response. We've published guidelines for collecting foliage samples and interpreting analytical results (***http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En52.htm***). However, it's generally not practical to develop specific fertilizer prescriptions for individual stands. Rather, an appropriate fertilizer prescription should usually be developed based on the "average" nutrient conditions of candidate stands. In many cases, it may be best to avoid fertilizing stands with complex nutritional problems. Also, other factors that affect fertilization growth response potential (e.g., crown vigour, forest health, stand density, soil water availability) must be carefully evaluated. Fertilizers should only be applied to stands in which nutrition is the most important growth-limiting factor.

The purpose of fertilizing is generally to accelerate growth so that the fertilized stands can be harvested sooner, mitigating future timber supply challenges. Therefore, fertilization should be used strategically to address specific pinch points in the timber supply. For example, it makes sense to target younger stands if you're faced with a mid-term timber supply issue, and older stands if harvestable wood is required sooner. In both cases, the intention is to accelerate the development of the treated stands so that they attain harvestable size when the timber supply deficit occurs. Nevertheless, both younger and older stands must have stand structures and current growth rates that are conducive to utilizing the applied fertilizer and to producing reasonable amounts of stand volume.

Fertilizing older stands tends to be economically more attractive since the investment time frame is shorter. On the other hand, younger stands may provide excellent re-fertilization opportunities. Our research has shown that intensive fertilization of young interior spruce plantations may offer particularly good opportunities for increasing fibre yield and (or) reducing rotation length. At one spruce study site, two applications of nitrogen and sulphur (at 6-year intervals) more than doubled volume growth compared to the unfertilized stand after 12 years. When combined with other nutrients, yearly nitrogen additions almost quadrupled growth. Periodic re-fertilization of lodgepole pine also produces solid volume gains, but growth may be adversely affected when nitrogen is applied too frequently.

Our ability to diagnose nutrient deficiencies and to predict the fertilization growth response potential of 20- to 40-year-old lodgepole pine, interior spruce, and Douglas-fir (in the Interior Cedar–Hemlock biogeoclimatic zone) is reasonably good. Pre-fertilization foliar analysis is a useful tool for selecting responsive stands and for selecting appropriate fertilizers. Unfortunately, we don't have much growth response data for fertilized stands greater than 40 years old. The density, crown vigour, and health of older lodgepole pine stands are often poorly suited to fertilization, and most of the older pine stands have been killed by the mountain pine beetle. Also, we've found it difficult to find older spruce and Douglas-fir natural stands with sufficiently uniform conditions for research trial establishment. Fortunately, there has been a lot of fertilization research undertaken in older spruce and Douglas-fir stands in other jurisdictions.

We haven't conducted any fertilization research in dry-belt Douglas-fir stands. Firstly, the structure of these stands (age, size, density) is typically quite variable, so the likelihood of reliably detecting a growth response following fertilization is very small. Secondly, moisture limitations almost certainly reduce fertilization growth response potential in most Interior Douglas-fir stands. My belief is that fertilization investments are best directed toward higher-productivity sites where substantial growth responses have been previously confirmed.

As well as improving stand growth, fertilization can provide several other benefits. In the short term, fertilized stands provide more forage and enhanced habitat for wildlife and cattle. Also, studies generally indicate that fertilization increases above- and below-ground carbon sequestration. The higher costs associated with repeated fertilization (and increased cost per cubic metre of harvested volume) may be more practicable if the benefits of growth gains are combined with the benefits of increased carbon storage.

Most fertilization-related risks are associated with forest health. The growth benefits of fertilizing young lodgepole pine can be largely negated by red squirrel de-barking damage; however, the risk is minimal if candidate stands are carefully selected. Also, the incidence and severity of white pine weevil damage may increase in fertilized spruce plantations in some biogeoclimatic zones (Interior Cedar–Hemlock, Sub-Boreal Spruce warm cool variant [SBSwk]). On the flip side, the height losses caused by weevil attack are usually less than the height gains due to fertilization.

Q *What are some of the common misconceptions related to forest fertilization?*

A Fertilization is not a silver bullet. It's one of the only silvicultural treatments that can have a significant impact on short- to mid-term timber supply, but the magnitude of the impact will be directly proportional to the size of the fertilization program that you put in place. In other words, a large and sustained fertilization effort is needed to have a substantial impact on timber supply. Unfortunately, many Interior forest management units currently have rather limited fertilization opportunities. Most managed and unmanaged lodgepole pine stands greater than 30 years old have been killed by mountain pine beetle, and the risks may still be too high to fertilize surviving younger stands. Although they would be prime candidates for fertilization, the age-class profiles of most timber supply areas contain relatively few 40- to 80-year-old spruce and Douglas-fir stands. Young managed stands (20–30 years old) probably offer the greatest current fertilization opportunities. As previously mentioned, many of these stands can likely be re-fertilized in the future.

Q *Now that you are retiring, who should people contact for information related to forest fertilization?*

A Fortunately, several forest licensees have accumulated a lot of experience with forest fertilization during the past few years. Also, **Mel Scott** and **Ralph Winter** do an excellent job facilitating

Interior forest operations. However, I'm certainly interested in maintaining some involvement with fertilization after my retirement. I'll be the only Brockley on Gabriola Island, so I'm only a phone call away.

Q *What are some of the key sources of information you would pass on to practitioners? For example, are there any specific websites or documents you have found helpful?*

A Most of the research that I have completed has been published and is available online—see the Research and Knowledge Management Branch website: ***http://www.for.gov.bc.ca/hre/standman/trtfert.htm***. Forests for Tomorrow web pages also carry a lot of relevant information related to forest fertilization: ***http://forestsfortomorrow.com/fft/node/446***.

Q *Do you have any last comments or suggestions for our LINK readers?*

A Forest practitioners rely heavily on growth models and decision tools (e.g., TASS, TIPSY) to develop appropriate stand management prescriptions for achieving desired outcomes. However, the fact that growth models are based on incomplete knowledge of the growth, yield, and value impacts of stand management decisions is often not fully recognized. The available long-term database for calibration and validation of growth models is limited and fragmented, and much of the data have been obtained from sources outside of British Columbia. Further refinements and improvements in growth models will depend, to a large extent, on the availability of local, high-quality long-term growth and yield data. Over the last 30 years, the Ministry has made a significant investment in long-term growth and yield studies, testing a wide range of silvicultural treatments in managed forests. Unfortunately, it has become increasingly difficult to secure funding to maintain and re-measure these field studies. I feel strongly that a long-term funding commitment is required to protect this valuable investment.

Contact Information

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