Long-Term Data from Silvicultural Studies: Interpreting and Assessing Old Records for Economic Insights

Paul E. Sendak[1], Robert M. Frank[2], William B. Leak[1]

[1]USDA Forest Service, Northeastern Research Station, Durham, NH
[2]USDA Forest Service, Northeastern Research Station, Bradley, ME

Abstract

Long-term silvicultural studies on the Penobscot Experimental Forest in Maine and Bartlett Experimental Forest in New Hampshire offer opportunities for the patient financial analyst. The economist working with carefully collected growth and yield data can increase the value of these studies to other researchers and ultimately to forest managers. Issues related to data transparency and availability from long-term studies established decades ago are discussed.

Introduction

Silvicultural research on the Penobscot Experimental Forest (PEF) in Maine and Bartlett Experimental Forest (BEF) in New Hampshire has included designed experiments and case studies, some going back 50 or more years. When these studies were planned and initiated, mostly in the 1950s, researchers collected detailed and accurate information to facilitate economic analysis. Improved economic outcomes often were included among study goals, though mostly as secondary ones. In some studies, detailed plot data were collected regularly and stored in electronic files. In others data were neither collected regularly nor stored electronically but entered on field data sheets. The rewards and pitfalls encountered when attempting financial analyses of these long-term studies are discussed.

Studies on the Penobscot Experimental Forest

An experiment on spruce-fir silviculture (now recognized as northern conifers) was established on the PEF from 1952 to 1957 (Sendak et al. 2003). Replicated treatments included the selection system, uniform shelterwood, unregulated harvesting, and diameter-limit cutting. According to the study plan the objectives were to evaluate “the efficacy of certain silvicultural techniques and to determine the relations between these techniques and the growth and yield and changes in stand attributes resulting from them.” Under the growth and yield objective, it was stated; “Although costs and returns have been eliminated from formal analyses, values can be determined by applying appropriate dollar figures (emphasis added) to the volume and product data at the time of analysis." With that limited guidance, a financial analysis was desired that compared nine treatments in the study for approximately the first 35 years of the experiment.

Typically, financial analyses of silvicultural treatments require growth and yield data (the economist's production function), as well as data on costs incurred in applying the treatments and revenues received. This is simple in concept but somewhat complicated in application. The original stands were natural stands, irregularly uneven-aged in structure, of mixed, mostly shade-tolerant species, and even-aged, two-aged, and uneven-aged after treatment. There are no specific models to project the growth and yield of such stands, though several models exist that can be adapted for this purpose. Cost and revenue data by treatment were not collected but detailed harvest data were. The paper files contain records of various cultural activities carried out on compartments, such as timber stand improvement, that included labor hours expended and materials and equipment used, which were used to estimate cost of these activities. Stumpage prices received by product and species were reported annually for the PEF averaged over all stands where harvesting occurred, but prices were not specific to treatment.

Logging methods and products produced changed during the first several decades of the study. Markets expanded in the region and created additional opportunities for products on the PEF, and changing technology increased the efficiency of logging. Although it is possible to recreate the historic cash flow for the experiment, applying current costs and revenues to historic yields is more useful to land managers.

Treatments were applied to stands or "compartments" (averaging about 25 acres) to be commercially operable. This approach required a large total area for each complete replication of the experiment—more than 200 acres. And as total area increased, site differences increased. Each treatment was replicated twice and randomly assigned to a compartment. Extraneous, uncontrolled variables were treated as randomized errors, so that the more heterogeneous the compartments, the larger the error and the more difficult it was to detect statistical differences, particularly with only two treatment replications. Not surprisingly, discounted cash-flow analysis applied to growth and yield data gathered to date on the PEF favored those treatments with early heavy volume removals. We used FIBER to simulate growth and yield through a full even-age rotation (80 years for second-growth spruce (Meyer 1929) for each treatment (Solomon et al. 1995). Results were presented in posters and in several poster papers at professional meetings and in workshops (see Sendak et al. 1996a, b). This work is ongoing.

Forest inventory data collected in the PEF silvicultural experiment have been meticulously recorded and entered into electronic files. However, the paper files contain much more information that can be helpful in estimating costs of cultural activities applied to compartments, for example, estimating the cost of marking trees to cut in partially harvested stands (Sendak 2002). Data stored in paper files is not as accessible as data stored electronically, and one can spend a considerable amount of time digging through file drawers. Some of these records were scanned recently and are available in electronic format.

Studies on the Bartlett Experimental Forest

The BEF has a long history of silvicultural research in northern hardwoods. Set aside for research in 1931, the Forest was divided into 48 management compartments averaging approximately 50 acres. The BEF has been the site of research by many scientists both within and outside the USDA Forest Service. Most of what has been accomplished by Forest Service researchers fills several file cabinets and consists of study plans, field data collection sheets, study establishment and progress reports, and related information. Few of the older long-term records have been entered into electronic format. A major exception is the periodic inventory of approximately 450 permanent plots (0.25 acre) distributed on a 5- by 10-chain grid over the entire Forest. Since 1995, the BEF has become a test site for emerging remote sensing technology because of the availability of these inventories (Smith et al. 2002; Ollinger and Smith 2005). As with the PEF, and perhaps more so, the paper files are a challenge to navigate without help from someone who is knowledgeable about past studies and/or where information is filed. Currently, past and present studies are being catalogued in an electronic database for use by future researchers.

Co-author William Leak has been involved with silvicultural research on the BEF since the 1950s. When we had an opportunity to evaluate how cutting practices in northern hardwoods were related to improvements in timber quality, he recalled a study of individual tree selection cutting established in the 1950s. At the same time, three compartments were cut to various diameter limits. Due to personnel changes and budget constraints, the study was abandoned after the initial harvest. Because trees were graded by quality at the time of initiation, we were able to evaluate how cutting practices influenced tree quality over time and estimate the effect on stand value (Sendak et al. 2000). This discovery of an abandoned study also provided an opportunity to set aside two of the selection compartments to establish cutting on a regular cycle (15 to 20 years) to assess its effect on hardwood tree quality.

A study was established in 1959 to examine precommercial thinning (PCT) in a 25-year old, even-aged northern hardwood stand on the BEF. Among the published reports was one that examined the financial aspects of three levels of PCT on 0.25 acre plots, replicated 5 times (McCauley and Marquis 1972). This was based on actual growth 5 years after PCT; stand-table projections were made to 10, 15, and 20 years or a stand age of 45 years (an alternative to long-term data collection). Plots were measured in 1990 (56 years). In 2003 (69 years), a commercial thinning was applied and plots measured before and after. This presented an opportunity to evaluate the actual financial outcome of the PCT treatments in northern hardwoods using long-term data compared to the initial projections. Financial analysis of PCT in northern hardwoods is currently of interest in northern New England and adjacent Canada.

Discussion

There are a number of alternatives to long-term silvicultural studies, for example, retrospective analyses; substitution of space for time (e.g., the construction of normal yield tables) or what economists call cross-section analysis; simulation modeling; and analyses of hypothetical stands. These alternatives are not substitutes for long-term studies and by themselves have a number of shortcomings (Fleming 1999). However, if these alternatives are combined with information from long-term studies, the value of both approaches can be extended. It is the quality of the underlying biological data that determines the utility of financial analyses applied to growth response to silvicultural manipulation of stands.

Long-term studies on the PEF and BEF provide opportunities to answer important questions about managing forest ecosystems in New England. But they are also a source of the kind of empirical data needed to develop and validate growth and yield models. They also provide opportunities for financial analyses of the various silvicultural systems and cutting treatments applied in these studies. The data are stored in various formats. The easiest to work with are those stored as electronic files. It is important to have good metadata or information about variable names, dates of collection, conversion factors, etc. Study plans and revisions record study goals, treatments, design, and changes. Establishment and progress reports and reports of cultural activities and timing of cutting and silvicultural treatments are part of the files maintained on these studies. These documents also are required reading. For the paper files, the process is much the same except for the added step of data entry, and the data might be less accessible. Studies that have been abandoned or closed are more difficult to locate. It helps to have a good guide, someone who is familiar with the history of both inactive and active studies, and/or a well-organized catalog of documents filed by study. It is critical to capture this expertise at times of staff change and retirements.

Much work on financial analysis of silvicultural practices has been done with loblolly pine in the South—a single species cultured in even-aged plantations on short rotations. Fairly accurate information on cost and revenue is available, and accurate growth and yield models have been developed and tested (see Huang et al. 2005). Financial analysis applied to simpler systems, such as southern pine plantations, avoids many of the problems encountered on the PEF and BEF. Analyses of hypothetical stands can be devised that avoid these problems. However, unless they are used simply to demonstrate a principle, these analyses lack the reality of observable data and so are less credible to land managers.

Long-term data on growth and yield, such as those collected on many Forest Service Experimental Forests provide information needed to make stand management decisions. In the North where rotations are long, interim analyses using defensible assumptions provide useful guidance to land managers, but are verifiable only in the long run. We know this information delivers value because "show me tours" to visit the treatments usually are fully subscribed. One tour of the BEF for visiting scientists from the Forest Research Institute in Poland was held during a hurricane.

There are 77 active experimental forests and ranges within the Forest Service, and many include long-term studies of vegetative manipulation (Adams et al. 2004). Some, like the H.J. Andrews in Oregon, Crossett in Arkansas, Coweeta in North Carolina, and Hubbard Brook in New Hampshire are household names, at least in the households of many forest scientists and ecologists. There have been other applications of financial analysis to long-term data collected on many of these forests (see Niese and Strong 1992). A special issue of The Forestry Chronicle included papers on long-term silvicultural research sites presented in 1998 at a workshop in Victoria, BC. In the opening paper, Powers (1999) discussed the benefits of silvicultural research on permanent sites and the survival skills needed to sustain this research over the long term. He proposed ways to make long-term silvicultural research sustainable to "withstand the vagaries of politics and time."

At best, economic or financial analysis usually is a secondary goal of these studies, so an economist must accept the study design as given. Also, reasonable and defensible assumptions about costs and revenues are required, as treatments were not necessarily designed to be financially optimal. Long-term studies will provide the information that will allow future analysts and mangers to optimize treatments and to verify results from computer simulations. In this vehicle, the economist is a passenger rather than the driver, though ironically, the adoption of these practices is very much driven by economics. Long-term silvicultural studies offer opportunities to the patient financial analyst to work with carefully collected empirical data, thereby increasing the value of these studies to other researchers and ultimately to forest managers.

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