

# THE ORIGINS OF FOREST OPERATIONS: THE ROLE OF PRESCRIPTION AND PRACTICE

Bob Rummer

**ABSTRACT.** The Darwinian concept of evolution provides a useful theoretical construct to consider the ongoing development of forest management and forest operations. For example, changing environments, “survival of the fittest”, and random mutation are processes, which have analogs within the forestry arena. The success and survival of any forest operations technology is determined by how well it meets the demands of its operating environment. Examples of evolutionary processes in forest operations are presented. Selection pressures on forestry operations are not entirely derived from silvicultural needs. This presents the possibility of divergent development. In order to influence the evolution of forest operations, silviculture must define future operational constraints and support the survival of technology, which exhibits value for forest management practices of the future.

**KEYWORDS.** economics, harvesting, impacts, prescription

---

## INTRODUCTION

Forestry is changing. New scientific knowledge emerges, social values change, and global market shifts affect supply and demand for forest products. Non-consumptive uses of forests are becoming more important. Responding to these changing demands and using new knowledge, silviculture is changing. Modern prescriptions call for treatments such as natural regeneration, partial cutting, stewardship treatments, and restoration. While prescriptions have evolved, will the tools available to managers be capable of achieving the desired outcomes?

Manipulating the resource to develop desired future conditions and produce value for society requires effective tools. Forest operations are the tools to “do” forest management. Current forest operations employ computerized technology, incorporate safety features to protect operators, and can operate with minimal site impacts. These operations are certainly different than their predecessors, but what forces have shaped their development? This is not an idle question. The better we understand the processes that have shaped the world we live in, the better we can anticipate the environment of the future. If we can understand the forces that have shaped forest technology to the present day, we may be able to predict whether forest operations and silviculture are converging or diverging.

Charles Darwin was a student of change. He examined change in the natural world and sought to understand the processes that promoted or impeded the development of biological diversity. The field of evolutionary biology builds on the work of Darwin and others to explain change in the natural world. Basic principles of evolutionary biology provide an informative construct used to examine change over time in many applications unrelated to biology. Evolution can even be applied to the development of forest technology.

## EVOLUTION OF TECHNOLOGY

Evolution is a change in the relative abundance of genetic types in a population over time. A classic example is the development of the English moth from light to dark coloring associated with the impact of the industrial revolution. Both light and dark colorings were inherent in the original population. In response to the selection pressures of predation, the dark coloring became more common as the environment was darkened by soot.

We can view forest operations technology as the population of interest. This population contains a wide diversity of traits, ranging **from** manual technologies (pruning, planting, chainsaw work) to high-technology systems such as helicopters and computerized harvesting machines. The relative abundance of technology types within this population has changed over time. In the U.S. South, for example, the most common forest operation in the 1960's was the shortwood system of pulpwood production with **manual** felling, processing, and loading. In the last 40 years, responding to the selection pressures of cost, labor availability, and markets; and the development of new technology, shortwood systems have become practically extinct (Greene et al 200 1). Forest operations technology evolves.

Evolutionary biology posits several processes that add variation to the genetic pool of a population. Mutation is a change in a genetic **type**. Mutations occur as a single instance of a random variation that may or may not **offer** some advantage. In forest technology, mutation occurs as innovators consider, "What if . . . ?" These trials lead to never-seen-before methods or equipment. Early developments of forest mechanization were clear examples of trying new configurations of functions. Feller-bunchers, feller-buncher-processors, **feller-buncher**-processor-forwarders were all developed and tested. Many of these equipment innovations were discarded, however some ideas were found to be effective and have led to modern equipment designs.

Recombination of genes takes existing traits and creates new variations of the organism. Generally, in forest operations, this takes the form of new combinations of functional operations. Wetland loggers in the southeastern U.S., for example, combined shovel logging pre-bunching with multi-span cable systems. Toms (1999) reports on animal logging systems in **Alabama** that combined traditional animal logging with forwarder extraction.

Another process that adds variation to the gene pool is gene flow from disjunct populations of closely related species. Colby (1996) cites an example of two species of fruit fly sharing genetic material through a common contact. There are many examples of technology interaction among forestry and other sectors. Agricultural equipment has been commonly adapted for forest operations. Construction machines, particularly tracked excavators, have been modified to perform a variety of forest tasks. Land clearing equipment designed for right-of-way maintenance is being used for mechanical mid-story reduction. Gene flow also occurs among disjunct populations of forestry operators. Cut-to-length technology, highly developed in Scandinavia, is being examined in other parts of the world.

While some processes add genetic diversity, natural selection reduces genetic diversity. Natural selection, one of Darwin's primary theoretical contributions, has also been called "survival of the fittest." Conceptually, individuals who are best adapted to their environment have a competitive edge for survival. Through reproductive success, their genetic traits are promoted in the population. Obviously, successful forest operations contractors are more likely to be imitated by their peers and by new entrepreneurs. An important distinction in natural selection, however, is that the critical factor is reproductive success, not just survival. Animal loggers, for example, are in high demand by NIPF landowners. Toms' (1999) survey of animal logging contractors in Alabama found that 82 percent had no lack of business in the previous year. Yet, most also expressed concern about whether their business would survive them. Only one-third of the respondents had someone in line to perpetuate their business. The nature of the work is very specialized and physically demanding. While animal loggers may be successful in the economic survival sense, they are not broadly successful in attracting new people to that line of work.

If we consider natural selection to be the determination of whether a forest operations technology is adopted by new contractors or not, there are many factors which affect the outcome. At a basic level, technical feasibility is required. If an existing technology is not capable of meeting new performance requirements, it will not be copied. Similarly, social license is a basic requirement. If a technology is unacceptable to the public, it will not be promulgated. Economic viability is another factor. Greater returns on investment will tend to be favored over lesser. Labor requirements are also important. The availability of skilled, reliable labor to fill forest operations positions is a recurring concern of contractors. Market constraints such as distance to mills, product specifications, and pricing all differentially select among forest operations technologies.

Current forest operations are changing in response to these selection pressures. The pressure for economic viability, for example, is leading to the development of larger machines. Large-capacity skidders introduced in the last several years offer the potential of balancing a system with fewer employees, reduced maintenance and moving costs, and reduced interference delays. Increasing demand for products and the changing nature of the raw material is encouraging forest operations on more adverse sites such as steep slopes and wet areas. More emphasis on sustainability and best management practices leads to training, light-on-the-land equipment, and seasonal restrictions on operations.

Clearly, forest operations are changing. The central question of this session, however, is whether forest operations and silviculture are evolving together or heading in different directions. Silviculture, through the prescriptions developed by foresters, defines the operational requirements of forest technology. A prescription for a shelterwood, for example, establishes a piece size for removal, residual spacing, and extraction distance. Several systems may be equally capable of performing this type of task. Suppose a manual felling/cable skidder system is competing with a cut-to-length system. Each can meet the basic silvicultural requirements, but they are significantly different in features such as soil disturbance, residual stand damage, capital investment, and productivity. Considerations of factors such as tax effects, various government

regulations, and intangible values determine the cost structure and perceived return to the operations contractor. Thus, there is no guarantee that silvicultural considerations will naturally direct the development of forest operations technology.

In fact, some forces may preclude evolutionary development. For example, extirpation (the local elimination of a population) puts an end to technology development. In areas where forest products markets have been eliminated, foresters may have difficulty locating contractors to perform stewardship treatments. The elimination of forest operations technology for timber harvest in this case precluded its evolution into a technology for other silvicultural treatments. Wide variations in operating conditions can also impede development of new technology. If available silvicultural work one season focuses on small trees (e.g. thinnings), and the subsequent season prescriptions call for overstory removals, it is unlikely that selection will lead to constructive evolution. In fact, under such conditions, evolution likely favors generalist systems with low-capital investment.

## CONCLUSIONS

Evolutionary principles appear to provide a reasonable construct to consider the process of change in the population of forest operations technology. Our currently available technology represents a wide range of operations; each with its own set of capabilities, limitations, and cost structures. We can also be certain that new ideas and equipment configurations will develop. Over time, as the needs of silviculture and forest products evolve, some of these technologies will prove better adapted and will become more prevalent. Progress and technology march onward.

Although change will happen, we should also be aware of a fundamental precept: evolution is not progress. Natural selection may not lead to a population with an optimal set of traits. Evolution doesn't look into the **future** to position a population for success. Instead, change occurs in response to the selection pressures of the present. In addition, these selection pressures operate on a current population that is a limited expression of the possibilities of the past. Conceivably, the requirements of silviculture could change radically and the forest operations systems of today may not be capable of evolving to meet the needs.

To insure that we have the tools we need tomorrow, foresters and engineers must work together to define future operational requirements. Basic research is needed to define the nature of acceptable impacts, to develop new technologies for forest operations, and to forecast market and social constraints. By articulating future needs, we can guide the evolution of new technologies in productive ways. Guiding the process of evolution may also require intervening in the natural selection of systems, supporting the survival of technology for the future when it may not be competitive in the present.

## LITERATURE CITED

COLBY, CHRIS. 1996. *Introduction to evolutionary biology*.  
<http://www.talkorigins.org/faqs/faq-intro-to-biology.html> [8/10/00].

GREENE, W. DALE, BEN D. JACKSON, and JACK D. CULPEPPER. 2001. Georgia's logging businesses, 1987 to 1997. *Forest Products Journal* 51(1):25-28.

TOMS, CHRISTOPHER W. 1999. "Whoa, mule: "animal-powered logging in Alabama at the end of the twentieth century. Auburn, AL: Auburn University. 75 p. M.S. thesis.

#### ABOUT THE AUTHOR

Bob Rummer is Project Leader for the Forest Operations Research Unit of the USDA Forest Service, located in Auburn, Alabama.