

# **SILVICULTURE AROUND THE WORLD: PAST, PRESENT, AND FUTURE TRENDS**

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## **Summary**

Forests have played a major role in the development of human civilization. They have provided fuel, wood, protection, and food. As human populations have grown, the pressure on forest resources has increased, leading to the overexploitation and degradation of forests around the world. However, as forest resources dwindled, management techniques arose that enabled resources to be more sustainably utilized. The most effective of these methods were developed and refined into widely applied silvicultural systems. The application of such silvicultural systems is inherently tied to the stand scale; however, the past century has seen advances in technology, transportation, communication, and knowledge that have expanded the demands on the

forest from the stand to the landscape, regional, and global scales. Linking stand scale operations to larger scale demands will be the future challenge for the field of silviculture. Concepts, methods, and tools that enable forest managers to link stand and landscape scale management for multiple forest resources have been recently developed.

## **1. Introduction**

Forests have played a central role in the development of human civilization. They have provided timber, fuel, food, forage, shelter, and a host of minor forest products such as bark, baskets, dyes, and beeswax. Since their earliest days, humans have depended upon this bounty. However, over the course of the last several millennia, rising population densities have made overexploitation and degradation of forests around the world increasingly common. As civilizations blossomed and forests dwindled, forest management techniques have been needed to regulate exploitation and improve the forest's productivity. Eventually, unbridled exploitation has given way to more structured silvicultural practices, although in many regions of the world this transition has yet to occur. Recently, however, demands on the forests have changed because of advances in knowledge, technology, communication, and transportation. Increasing demands at broader spatial and temporal scales have challenged our ability to manage forests.

In this paper, we consider several trends in the development of silviculture. In so doing, we seek to place contemporary silviculture within its historical context and identify future directions. The paper is organized into three sections. In the first section, we present an abridged history of forest exploitation and the eventual emergence of silviculture. In the second section, we identify three components of the modern silvicultural decision-making process and examine the influence of scale on each. In the third section, we identify future trends in silviculture, focusing in particular on improved links between scale (that is, stand, landscape, or forest levels) and silvicultural manipulations. A review of these broad topics is necessarily subjective and general. We use examples from around the world to highlight themes, although we realize that silviculture is at different stages of development and implementation in different parts of the world.

## **2. Where Are We Coming From? An Abridged History of Silviculture**

### **2.1 What is Silviculture?**

Silviculture is the theory and practice of controlling forest establishment, composition, structure, and growth. The existence of predefined goals for the remaining or future stand distinguishes the practice of silviculture from simple exploitative manipulation. Nonetheless, forest manipulations range across a continuum from simple exploitation (for example, removing a few or many trees without any consideration of impacts) to the cultivation and tending of stands. While the origins of silviculture may be found in exploitative forest manipulations, increased demands on forests caused a shift to more cultivation-oriented management and the advent of modern silviculture.

## 2.2 Aboriginal Silviculture

Indigenous people across much of the earth have depended upon forests for their survival. The forests have provided food, fuel, tools, and shelter. This dependence caused early cultures to develop forest management practices based on observation and experience. Such management practices spanned a broad range of intensity and scale. Low intensity management included such activities as cultivation and protection of fruit or nut tree species like mango (*Mangifera sp.*) and durian (*Durio zibethinus*) in South and Southeast Asia, avocado (*Persea americana*) and brazil nut (*Bertholettia excelsa*) in South and Central America, and chestnut (*Castanea sp.*), apple (*Malus spp.*), and olive (*Olea europaea*) in Europe. More intensive early forest management practices included prescribed burning. During the late Holocene, Australian Aborigines began to manage their food resources actively through the widespread application of fires. Native American populations in North America used fires to promote the growth of certain edible plants and berries, to flush game, and to clear underbrush from the forest.

Throughout history, wood has been harvested from forests to make tools, implements, bridges, boats, and shelter. There is evidence of such uses from many areas of the world. In northern India, two large caches of wooden tools have been discovered that date back approximately 5000 years. The range of tree species used for these tools suggests that the early inhabitants of the region had developed substantial familiarity with the characteristic properties of wood of different species. Archaeological evidence has shown that the Mesolithic hunter-gatherers of Ireland were sophisticated woodworkers, making boats capable of carrying several tons of food and people 8000 years ago. Neolithic farmers in Ireland 3000 years ago made dugout boats, plates, utensils, and house frames from wood and cultivated ash and holly wood for weapons and domestic building purposes. Prehistoric cultures used wood extensively and had enough knowledge of the forest to influence production of lumber, thatching, staves, weapons, and so on; however, due to the low human population densities and vast expanses of forests, degradation of forests by aboriginal cultures was minimal or localized. Consequently, it was not imperative to manage the resource sustainably. When the standing timber or productivity of a forest area waned, new unexploited areas could be sought out, colonized, and used.

## 2.3 Unregulated Exploitation

As human populations increased, the availability of unexploited forests decreased. Human cultures became more sedentary and depended more heavily on agriculture. Consequently, forest exploitation became increasingly concentrated in areas close to population centers. This closeness placed unregulated pressure on the forests that often led to overexploitation of the resource. This pattern is often referred to as the “tragedy of the commons” and is lucidly described by F. C. Osmaston:

*In spite of the multiple use of forests, however, their vastness and apparent general indestructibility prevented man from conceiving ideas of possession until after he had cut most of them down and converted the land to tillage, pasture or wastes. The forests themselves remained a gift of nature for all men to use alike as they wished and were subject to unregulated use by means of uncontrolled selective cutting.*

At this point in the evolution of forest/human interactions, most societies chose one of two routes: seize new forested areas through warfare or regulate forest exploitation.

The Roman Empire provides a clear example of the expansionist approach. Early Rome was built on the bounty of its extensive forests. As Rome developed, however, the once thick forests of the Italian peninsula began to recede before a wave of urban expansion. By the third century BC, subsistence agriculture was being replaced by intensive agriculture and ranching, leaving the remaining forests increasingly farther away from the cities. Such leading citizens as Lucretius, Cicero, Pliny, Seneca, and Virgil discussed the dwindling forests and their effects on the state, the people, and the natural world. However, instead of adopting a policy of conservation, Rome chose to supplement its consumption of wood through conquest by annexing foreign timberlands. By about 300 BC, the Roman Empire had consumed much of Europe's wood supply, had become dependent on distant lands for basic foodstuffs, and was on the verge of economic collapse. The rise and decline of wood supplies closely paralleled the fortunes of the Roman Empire.

In contrast, other societies began to control forest exploitation through the development of rules and regulations limiting tree harvesting, grazing and foraging rights, and the collecting of minor forest products. The period in history at which this transition to regulated forest management occurred varies widely among cultures. In the United States, heavy exploitation of the forests began with the arrival of the first European settlers. The vast forest reserves of the North American continent supplied European and West Indian timber needs during the seventeenth and eighteenth centuries. The forests of New England were the first to be depleted. Westward expansion of the timber industry occurred as local timber supplies dwindled; however, not until the late nineteenth century did loggers and timber companies reach the Pacific Ocean. With the end of the frontier came the threat of a timber famine. Within a decade, the seeds of a federal forest service were sown and legislation and regulations to control and manage the timber flow were being devised.

In several instances, such as in India and Japan, the pattern of overexploitation of natural resources and subsequent conservation was repeated more than once because of major cultural shifts caused by invasion or rapid economic development. In India, historical records describe detailed measures to manage forests and wildlife during the Gupta period (320–800 AD). Subsequent invasion by the Mughals and, more recently, colonization by the British, led to renewed destruction of the Indian forests. In Japan, regulated forest management arose after 1200 AD following centuries of over-cutting. Near the end of the sixteenth century, the ruling elite initiated a century-long campaign of vast construction projects for monuments and cities. Improvements in transportation and communication allowed the exploitation of forests on a greater scale and at a faster pace than ever before and eventually left Japan with almost no remaining high forest. By the mid seventeenth century, the need for a well-developed forest management system had become urgent. Slope erosion and wood scarcity were having major socioeconomic impacts on the population. Within decades, local and provincial governments had established regulatory measures to counter the effects of overexploitation. In addition, a rich body of silvicultural techniques was developed and disseminated throughout the country.

In medieval Europe, the amount of forested land decreased because of unrestrained felling practices. In response, the ruling elite began to set aside land to be used for hunting. The establishment of these forests placed considerable power in the hands of royalty. Not only did this enable the king to control harvesting and extraction, but also it gave him the rights to grant concessions and assess fines. Control of concessions also provided a source of income as long as the forest was well stocked with timber and game. It is important to note, however, that the definition of forest did not necessarily require that the land be covered in trees. In England, for example, the Dartmoor forest was mostly peat bog land devoid of trees. Nonetheless, the restriction of use enabled trees to regenerate in those areas where climate and soils allowed.

## 2.4 Origins of Modern Silviculture

As forested lands became increasingly scarce and forest exploitation became increasingly regulated, attention turned to identifying and developing more sustainable and efficient methods to produce wood and other forest products. It is here that we find the origins of modern silviculture. One of the earliest documented silvicultural methods was the coppice system. It had been systematically practiced in France from the ninth century. Over the course of the next few centuries, coppice working would be applied to hardwood forests throughout much of Europe. Two notable variations on the coppice method existed: coppice and coppice-with-standards. Coppice originated from the simple process of felling an area of trees. If the cutting was timed correctly and the new sprouts were protected from grazing, the stand could produce a new crop of wood within 12–20 years. If the coppice area was divided into cutting blocks that would be entered a year at a time, the stand would produce a sustained yield and be a constant source of income. Coppice-with-standards developed from the recognition that two crops could be harvested from the same stand if some trees were allowed to grow over several coppice rotations. In England, as early as the mid sixteenth century, there was debate as to the appropriate number of standards to leave in a coppice stand. Some foresters suggested as few as 12 standards per acre, while others advised as many as 38 per acre.

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### Biographical Sketches

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