Forest Regeneration Handbook

A guide for forest owners, harvesting practitioners, and public officials

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Introduction

Forests are dynamic. Seedlings germinate, grow, compete with each other and with larger trees. Some survive for hundreds of years. Change will happen. Which species will be predominant in the future forest depends not only on climate and soils, but also on management decisions made today. Changes in forest composition will affect the quality and variety of forest resources available to future generations and wildlife.

This handbook was developed to provide an appreciation of how our forests developed and an understanding of forest regeneration concepts, including the importance of disturbance. This information will help landowners and public officials, in concert with professional foresters, make informed decisions about forest regeneration options tailored to their management objectives.

This handbook is divided into five sections.

• The first section provides a short history of the forest from the period of European colonization and large scale land clearing through the present suburban forest. It concludes with the challenges (fragmentation, parcelization, deer, invasive species) that must be met to maintain a healthy and vibrant forest for future generations.

• The second section explains basic concepts in forest regeneration. The importance of different combinations of light, moisture, and soil in determining success or failure of regeneration is discussed. It then details the adaptations of different species to distinct combinations of light, moisture, and soil conditions. The section concludes with an examination of competitive interference among trees striving to form part of the upper canopy.

• The third section examines the role of disturbance in maintaining habitat and species diversity. The influence distinct disturbance regimes have on forest composition is also explored.

• The fourth section introduces different methods (prescriptions) of forest management. The influence of each management style on the availability of light, moisture, and growing space for new regeneration is discussed. Because the primary reason for harvesting is often either income or a non-commodity amenity such as wildlife, the economic and esthetic considerations of each management method are also presented.

• The handbook concludes with a section detailing requirements to successfully regenerate specific species. As with the other sections, this section is not intended to be an authoritative reference, but rather to provide readers with sufficient information to make informed decisions about forest management options.

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Connecticut's Forest

Viewed across the landscape, the forests covering our hillsides and valleys seem as though they have always been there. A different story emerges, however, when walking along a trail and evidence of human impact on the land from earlier generations is discovered. Overgrown stone walls outline old pastures and grain fields. Occasionally, the outline of a charcoal mound or a sunken cellar of a farmhouse can be found. The landscape has undergone dramatic changes since European settlement including large-scale land clearing for agriculture, wildfire, hurricanes, and repeated harvesting. The following pages chronicle the dynamic and resilient nature of the Connecticut forest over the past 400 years with a special emphasis on disturbances and changes in land use patterns.

A Short Account of a Long History. When the Dutch and English began to settle in Connecticut around 1633, it is estimated that 90-95% of Connecticut was covered with forest. The colonists gradually cleared the land to plant their crops and orchards, create hayfields, and develop towns. In addition, they harvested the virgin forests to provide timber and firewood for domestic use and export. In 1710, the English Parliament passed the *White Pine Act* to protect the large white pines needed for masts for the royal fleet. It is interesting to note that an act about forest use was one of the first to contribute to the dispute between the colonists and the British Empire, that led to the American Revolution. It may be hard to believe, but by the mid-1800s, 75% of the state had either been converted to pasture or was plowed for food production.

The remaining quarter of the state that was forested was not like the forest we know. The forest provided wood for homes, furniture, wagons, tools, and fuel. Hickory was prized for tool handles, and hickory smoke added a distinctive taste to cured meats. Rot-resistant chestnut poles were used for fences and buildings. Sassafras was used as a teak substitute on ship decks, and, because of its reputed power to repel insects, was used to make beds and chicken coops. An even larger part of the forest was cut for wood to cook meals and heat houses through the cold New England winters. Undoubtedly, many early Americans supplemented their diets with foods from the forest such as American chestnuts, maple syrup, blueberries, and game. These foods added variety to their diets and helped them survive the long New England winters.

In the mid-to-late 1800s, many farm families moved west to

establish new farms on the more fertile soils, leading to the abandonment of many Connecticut farms. Other families moved to the mill towns to earn a higher income than could be gained on hardscrabble and overworked farmlands. The abandoned farms quickly converted to young forests of hardwood and pine.

The last great cut of our forests came in the late 1800s. Entire hillsides were cut to produce charcoal and fuelwood, not only for home use, but also for the local brick, brass, and iron industries. Stands were typically cut every 20-40 years when the trees were still small enough to be handled manually. Charcoal production fell dramatically in the early 1900s with the advent of cheap coal and petroleum. Most of the forest we see today has its origin in the charcoal-production era and consists of even-aged stands.

During the early 1900s, immense fires, covering up to 20,000 acres, regularly roared over the countryside. Some of these were accidental, caused by escaping sparks from railroads, homes, and industry. Records from the early 1900s indicate 15,000 to over 100,000 acres (in 1915) of forest fires in Connecticut. This wanton destruction of forest resources spurred the legislature to create the position of State Forest Fire Warden in 1905 to coordinate fighting of forest fires. The efforts of state and local fire fighters has reduced the annual amount of forest damaged by wildfires to an average of 1,300 acres in recent years.

Impacts to the forest have not been limited to clearing, cutting, and burning. Prior to the importation of the chestnut blight fungus, upwards of 25% of our forest was comprised of American chestnut trees. Gypsy moth outbreaks defoliated large swaths of the state between 1960-1990. Another species that has also been affected by insects and disease include eastern hemlock, currently threatened by the hemlock woolly adelgid.

Historical records suggest that severe hurricanes strike Connecticut every 100-150 years. It was estimated that the 1938 hurricane destroyed over 100,000 public shade trees, every mature white pine stand east of the Connecticut River, and almost one-fifth of the timber in the state. Nearly 55,000 acres of forest were flattened and 45 miles inland near Putnam, salt damage was observed. Other weather events that have caused widespread forest destruction include ice storms (1898 and 1921), microbursts, and tornados such as the one that destroyed the Cathedral Pines in 1988.

Connecticut's Forest

The Forest Resource. A significant local forestry products industry has developed in the past several decades to utilize our maturing, but renewable, forest resource. Steve Broderick of the University of Connecticut Cooperative Extension System has reported that there are over 350 forest product firms in Connecticut employing approximately 3,600 people. These companies harvested an average of nearly 90 million board feet of timber annually between 1985 and 1998. Connecticut companies manufacture products ranging from fine furniture to shipping pallets, from cabinets to charcoal, and from doors to wood mulch. In addition, each year the Connecticut forest yields 15,000 gallons of maple syrup and almost all of the world's supply of witch hazel extract.

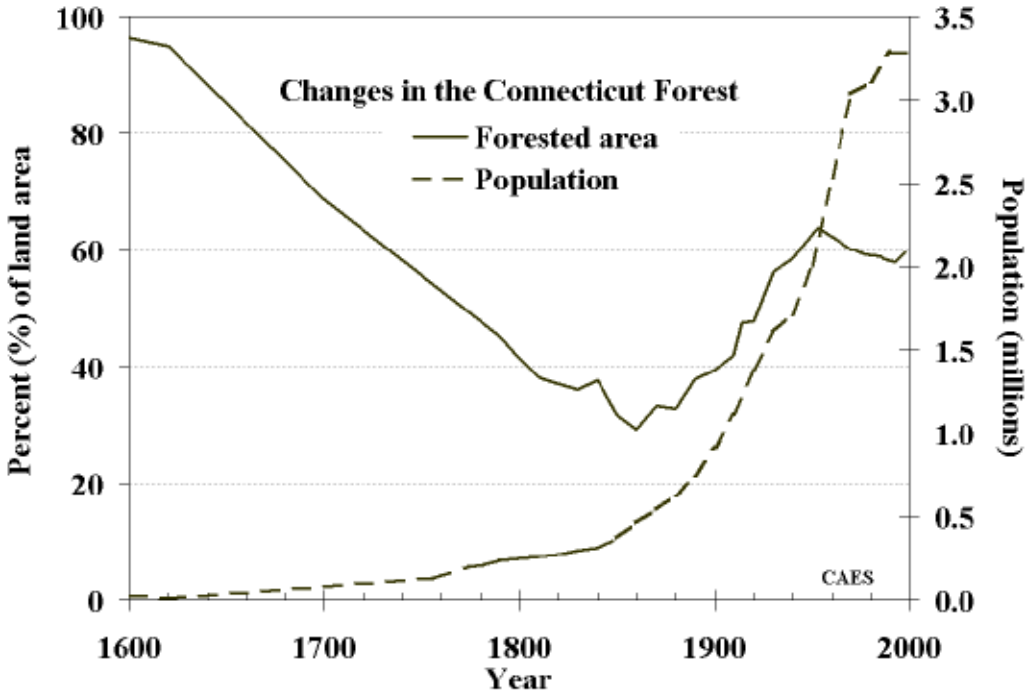
The value of the forest to Connecticut is much more than simply the timber and other forest products. First and foremost, forests protect watersheds, aquifers and groundwater supplies that provide the bulk of our clean drinking water. Trees can also provide air pollution control, acting as giant sponges to remove dust, particulates, and some airborne chemicals. In addition, trees cool our environment in the summer by recycling water and reflecting sunlight.

Forests contribute to the character of Connecticut and the $3.9 billion tourist industry. People come from all over the country, from all over the world, to view the kaleidoscope of fall colors that we sometimes take for granted. Healthy forests add to our enjoyment during other times of the year. We mark the end of winter by noting the first pussywillow flowers. Trees shade our homes and picnics in the summer while white pines amplify the whistling of the wind. Massive oak and yellow poplar tree trunks lend a sense of wilderness to modest urban parks.

The Changing Forest. The past 300 years has seen the many changes in the landscape: from a sea of forested hills to a quilt of agricultural fields and woodlots, from abandoned farms to short-rotation forests cut for firewood and charcoal, from burned over stands to mature forests increasingly fragmented by encroaching suburban development.

In Connecticut forests and in many northeastern and Appalachian forests, we are at the beginning of a second major successional change in forest composition in 100 years. Since the loss of American chestnut in the early 1900s, the Connecticut forest has been dominated by oak. A gradual conversion of our forest from oak to other species, such as maple, birch, and beech has taken place at a rate of approximately 5% every decade since 1938. Connecticut's oak forests could slowly disappear in the next 100 years if this trend continues.

As with the shift from chestnut to oak forests at the beginning of the century, the emergence of a forest dominated by northern hardwoods will alter the economic, ecological, and esthetic values of our forest. The consequences of these changes will last well into the 21st Century. Oak is more economically important than maple and



birch for its higher value, lower cull rates, and higher per acre volume growth. The shift from oak will also affect many wildlife and insect populations -- discriminating against those species dependent on oak and favoring those species associated with northern hardwoods.

Changes in esthetic values are important because of increased public utilization of the forested landscape for both home sites and recreation. The leaves and flowers of maple and birch are more colorful than oak. However, faster -growing oaks and pines are more likely to have the "big tree" characteristics that the public associates with mature forests. Changes made to the land by modern society tend to be much more permanent than those made in the past. Cut-over, burned, or converted to pasture, the forest always grew back. The same cannot be expected from the conversions made to other land uses today. As an ever-growing population demands an ever-increasing array of benefits from a continually shrinking forest land base, careful stewardship, including the need to be able to successfully regenerate the forest with desirable species, becomes ever more critical. Our society is poised at a unique moment in history, with respect to the future of the forest resource, and the decisions we make today will affect whether many future generations will continue to enjoy the vast benefits our forest resource provides.

Challenges Today and Tomorrow

Whether landowner, professional forester, or concerned citizen, we must remain united in our commitment to sound forest management based on the best available science to avoid a return to the sad state of our forests during the mid-1800s. Five major challenges to forest management at the landscape level can be recognized in Connecticut. These are: fragmentation and parcelization, coping with deer, maintaining habitat diversity, invasive species, and the stewardship of private forestlands.

Alien (Non-native) Invasive Species. Alien invasives have interrupted natural plant associations and ecology since the time of European settlement. Settlers imported these species from their homelands for their one or two desirable characteristics. They were unaware of or did not consider their invasive potential.

The introduction of alien plants has not only caused the displacement of native plants but indirectly caused problems by bringing in alien fungi and insects.

Coping with Deer. White-tailed deer are very adaptable, and can survive in forest stands in all stages of development. The current high deer numbers have significantly altered the forest structure in Connecticut. Deer browsing affects regeneration, abundance and distribution of species. Forage is best from stands in early stages of succession, where the forest floor is open to sunlight.

Fragmentation and Parcelization. A major issue plaguing the forest resource of southern New England is population growth and the associated loss of forested open space to residential development. In a steadily suburbanizing region, privatly-held land can be subject to change in ownership and use at any time. Change in use and ownership can affect all members of the community and should be planned, or at least anticipated, in order to minimize the impact to both human and forest communities. Through a detailed inventory and analysis of natural resources in a community and educational outreach, local planners and decision makers can obtain the data they need to make effective, high quality plans for conservation and development that will guide future growth in their towns.

In addition, by recognizing the importance of the upland forest resources in protecting water quality, wetlands and other habitat features, community leaders can justify the effort necessary to determine the extent and distribution of forested land and identifying areas most suitable for protection and sensitive areas that may be threatened by development.

Maintaining Habitat Diversity. The value of the early successional habitat found in seedling/sapling stands for a myriad of plant and animal species is not well appreciated. Unfortunately, Connecticut has been losing these valuable early successional habitats at an alarming rate attributable to three factors. 1) These habitats are ephemeral. The very nature of plant and tree growth causes them to change to more advanced successional stages. 2) Fewer farm fields are being abandoned and those that are abandoned are often converted to new development. 3) Partial cutting (uneven-aged) has become the dominant forest management practice. While it is unlikely that early successional habitat will completely disappear from Connecticut, it would be worthwhile to determine the critical minimum amount of early successional habitat required to maintain healthy populations of early successional species. Uneven-aged management often has significantly lower visual impact than even-aged management practices, but can accelerate the replacement of oak by birch, maple, and beech.

Private Lands Stewardship. The stewardship of forests on private lands needs to be a concern for landowners, local land-use officials and forest practitioners. Of the 60% of Connecticut that is forested, approximately 85% is in private ownerships. Some private lands are managed by land trusts, small water companies, camps, and sportsmen's organizations. However, the bulk of private landowners are individuals, families, and farmers. While forestland ownership patterns and owner's goals are varied, diverse, and complex, there are some emergent trends and identifiable patterns, which may provide an indication about the long-range future of the forest resource.

Forestlands are becoming increasingly parcelized: Although the amount of forested land has remained remarkably stable over the last 30 years, the number of different owners has increased dramatically. As ownership changes hands, large parcels are often divided into pieces that are still technically forest land, but are economically and logistically "unmanageable" for all practical purposes. Over 75% of forested properties in Connecticut are parcels less than 10 acres in size.

Landowners are aging and lots of land will change hands in the next 15 years: The average age of forest landowners, for parcels greater than 10 acres, is somewhere in the early 60s. As current owners approach the end of their tenure, property is often sold off or transferred to other family members.

This process contributes significantly to parcelization, leading to fragmentation of resource.

Demand for benefits from the forest will increase: A steadily increasing population will demand an ever-increasing supply of products and other benefits from a steadily decreasing forest land base. Benefits derived from private forests that contribute to the economy and the overall quality of life in our society include the following broad categories:

Recreation – access, sites, facilities, and diverse opportunities

Habitat – private holdings provide the bulk of necessary habitat

Watershed protection – private forests protect most of the source-water areas for surface waters, groundwater and aquifer-recharge areas

Forest Products – 75%+ of the raw material for a $700 million forest products industry comes from private forestlands

Aesthetics – the forest in Connecticut is considered to be the essential backdrop for the tourism industry

Landowners receive no benefit in return for many of the benefits they provide: The public enjoys many benefits derived from private forestlands that are public in nature, high quality water, cleaner air, wildlife habitat, and aesthetics, for example, and often take them for granted, at no cost. The people who own and manage the resource are not directly compensated for the public benefits to which their lands contribute.

Few, if any financial incentives exist for holding forestland, except forest products: Landowners often hold forest lands for reasons other than the promise of economic return, but often some economic return is necessary in order to keep the land "intact." Trees sold as raw material for forest products are often the only potential source of financial support for the land.

Managing the forest for periodic income from the sale of trees as raw material for forest products DEPENDS on being able to regenerate the forest successfully: When trees are harvested, the ability to replace them with a desirable mix of healthy and productive seedlings naturally maintains the value of the forest. Therefore, landowners who manage for timber income, loggers and other forest practitioners who depend on a gradually shrinking land base for their livelihood, need to be invested in the knowledge of how to insure successful, desirable regeneration.