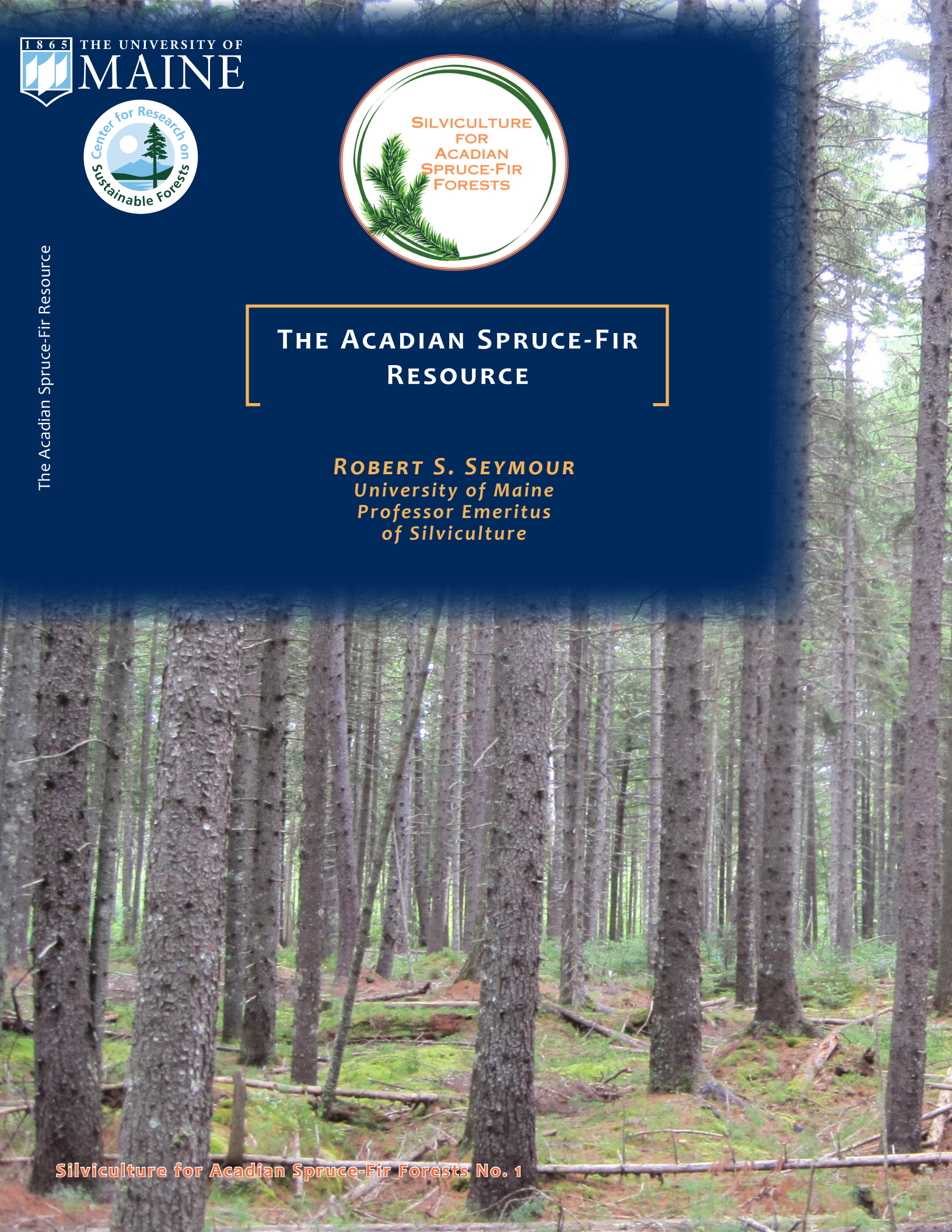
The Acadian Spruce-Fir Resource

The Acadian Spruce-Fir Resource

Robert S. Seymour
University of Maine
Professor Emeritus
of Silviculture



Silviculture for Acadian Spruce-Fir Forests No. 1

The Acadian Spruce-Fir Resource

The Acadian Forest covers nearly 67.7 million acres and extends over most of northern New England, northwestern Massachusetts, a section of southern Quebec, and all but the highlands of Nova Scotia and New Brunswick (Fig. 1.1). The term was first used by Halliday (1937) to describe the Canadian portion of the region, then by Loo and Ives (2003) in a detailed ecological characterization. European settlement began during the early 17th century; the region is named after early French settlers of Nova Scotia who migrated up the St John River Valley after being displaced by the British ca. 1760. Although large areas were once cleared for subsistence farms, much of the region was never settled by Europeans and remains as a virtually unbroken block of contiguous forest stretching from Cape Breton, Nova Scotia, to the Green Mountains of Vermont and southward to the Berkshires. Large areas of publicly owned forest in Canada (crown lands) are leased to forest industry. Forests in the United States are mostly in private ownership by large forest investment companies but also include the White Mountain and Green Mountain National Forests.

According to the most recent data from the U.S. Forest Service Forest Inventory and Analysis (FIA) program, Acadian spruce-fir forest types comprise a total forestland area (including reserves) of 6,361,705 acres, virtually all occurring in four states: Maine (79%), New York (10%), New Hampshire (7%), and Vermont (4%). About 680,000 acres (11%) are classified as reserved from harvesting, leaving 5,680,392 acres of FIA-defined timberland that is subject to commodity extraction, 83% of which is in Maine. FIA recognizes four sub-types within the umbrella forest type code of 120: balsam fir (code 121), red spruce (123), red spruce-balsam fir (124), black spruce (125), and white spruce (121). Data in this section exclude two wetland conifer subtypes of northern white-cedar (127) and tamarack (126); silviculture of these forests is quite different and covered elsewhere (Boulfroy et al. 2012).

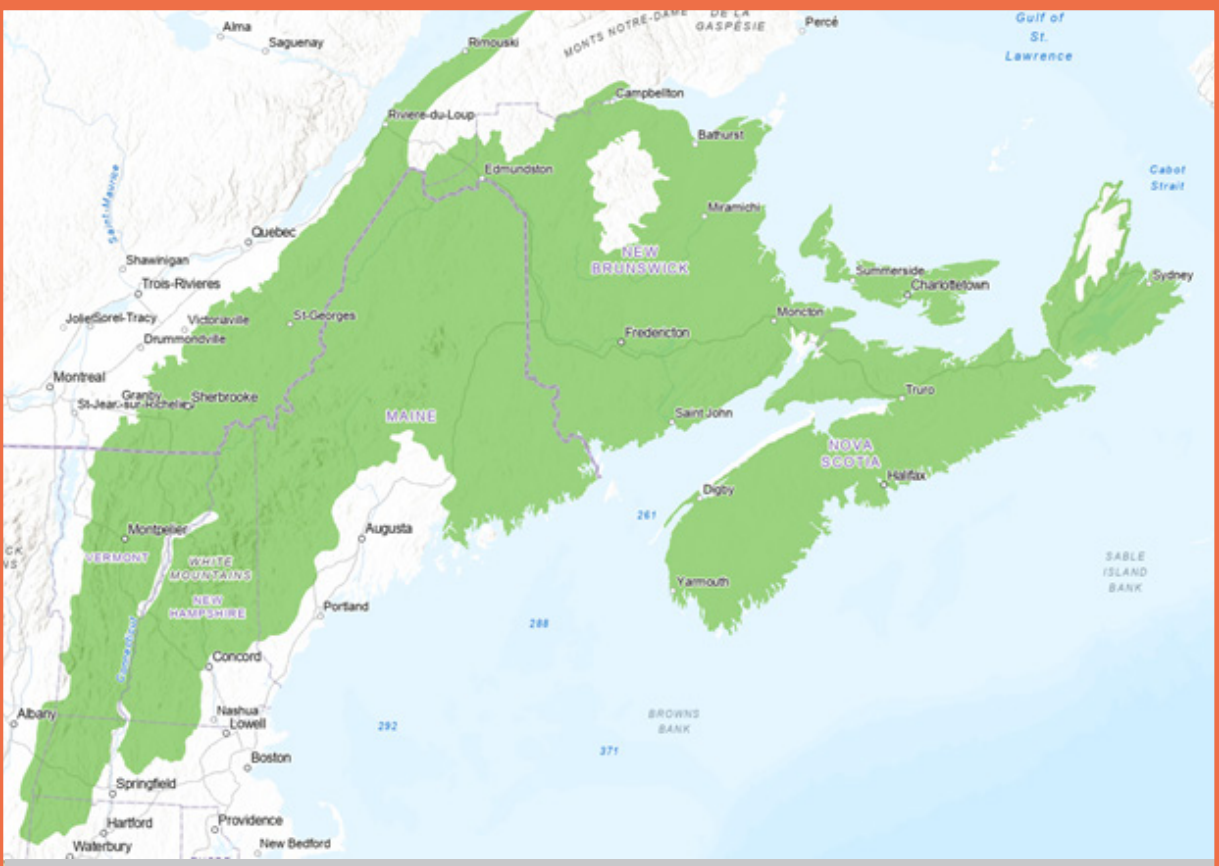


Figure. 1.1 Extent of the Acadian Forest, including the New England-Acadian Forest and Gulf of St. Lawrence Lowlands Forest as mapped by the World Wildlife Fund.

Centuries of human exploitation, first for large sawlogs and later (ca. 1900) for smaller-diameter pulpwood, have radically changed the forest from its presettlement multi-aged structure (Seymour 1992; Noseworthy and Beckley 2020). Remnants of the primary, old-growth forest are very rare, and most have been reserved from logging and studied intensively by ecologists (Fraver et al. 2009). The commercial forest landscape is dominated by stands that are much younger and more even-aged than during presettlement. Typical stand compositions have shifted from the slower-growing late-successional species to those that are favored by frequent harvest disturbance, such as red maple, paper birch, aspen, and balsam fir. Legacies of the presettlement forest, such as large cull trees and small, long-suppressed saplings of late-successional species rare in the overstory, remain in many stands and offer opportunities for restoration with appropriate retention prescriptions.

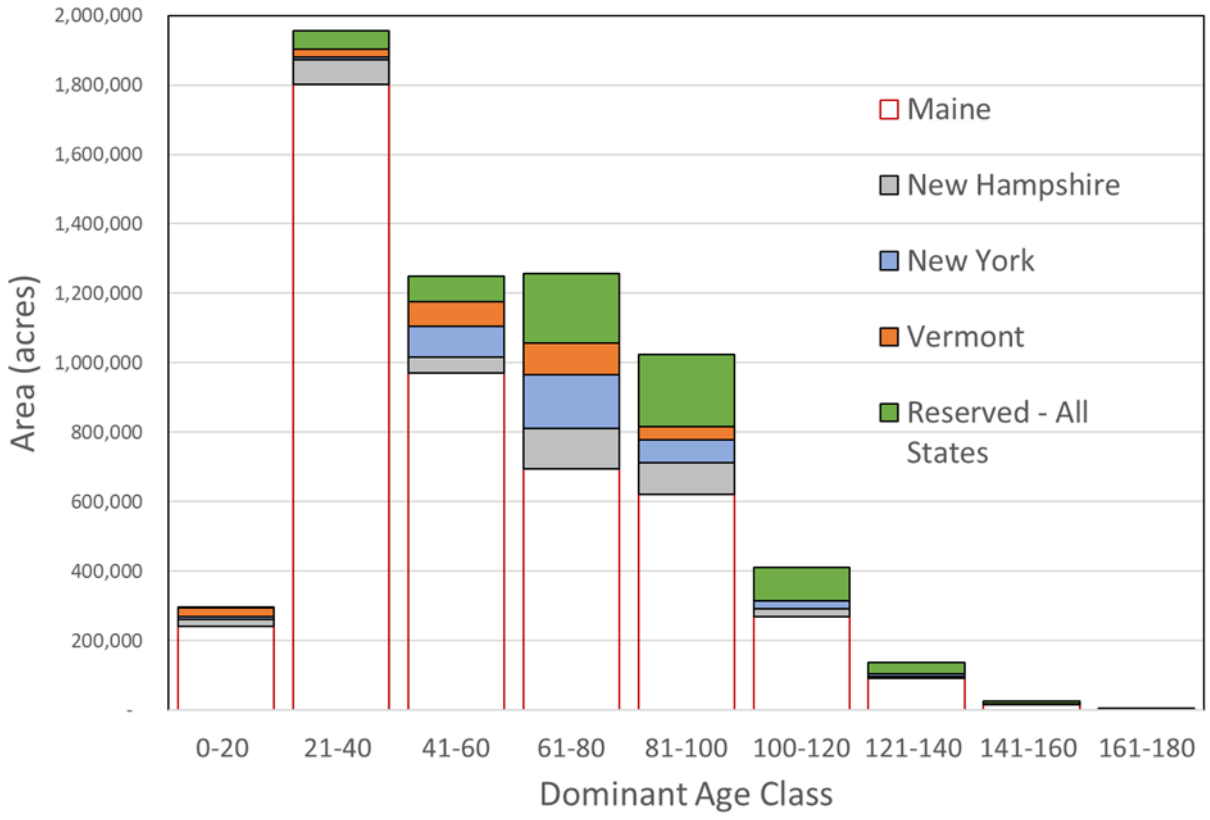


Fig. 1.2. Age structure of the northern conifer resource by state and reserve status. State-labeled bars are timberland only; reserved lands include all states. The FIA protocol classifies stand age only by the dominant age class, so this figure does not mean that all stands are even-aged.

Age Structure

The age structure is quite unbalanced, with one-third of all timberland in a single 20-year cohort originating between 1980 and 2000, mostly in Maine (Fig. 1.2). This cohort is the legacy of widespread regeneration cutting in response to extensive spruce budworm defoliation during the late 1970s and early 1980s. If Maine were excluded from Fig. 1.2, the forest would appear to be older, because the budworm had much less influence on harvesting in the other states. Without early density management, northern conifer stands do not reach commercial size until the 40+ age classes; such stands comprise 62% of the timberland area.

This structure is quite different from its condition 50 years ago when the first spruce-fir silvicultural guide was published (Frank & Bjorkbom 1973). At that time, the forest was dominated by mature, fully stocked 50–90-year-old, single-canopied stands that originated from heavy cuttings of the old-growth forest and spruce budworm mortality during the 50-year period between 1880 and 1930 (Seymour 1985, 1992).

Species Composition

The balsam-fir subtype dominates overall composition (46%), especially in the younger age classes (Fig. 1.3). Mixed red spruce-fir and red spruce types are equally represented and together comprise 43% of all timberland. Black spruce, typically a wetland species, accounts for 8%, and white spruce (mostly old-field origin stands) only 2%. Planted stands cover 240,000 acres (2%), composed mainly of white and black spruce in northern Maine. In Maine, nearly two million acres have been lost from the resource over a 47-year period (Fig. 1.4). This change occurred largely between 1980 and 1995, caused by two factors. Many heavy salvage harvests during the budworm era were true clearcuts (no advance regeneration) and either did not regenerate to spruce-fir species or became so overwhelmed with competing vegetation that the conifers succumbed. These areas are now largely in the intolerant hardwood (aspen-paper birch) forest type. Other softwood-dominated mixedwood stands were harvested selectively for conifer species only, owing to the need to capture dying fir and the lack of markets for hardwoods. These areas are now mainly in the northern hardwood forest type which has grown significantly in area over this same period. Spruce-fir area has remained largely stable since the late 1990s but has not returned to its former status.

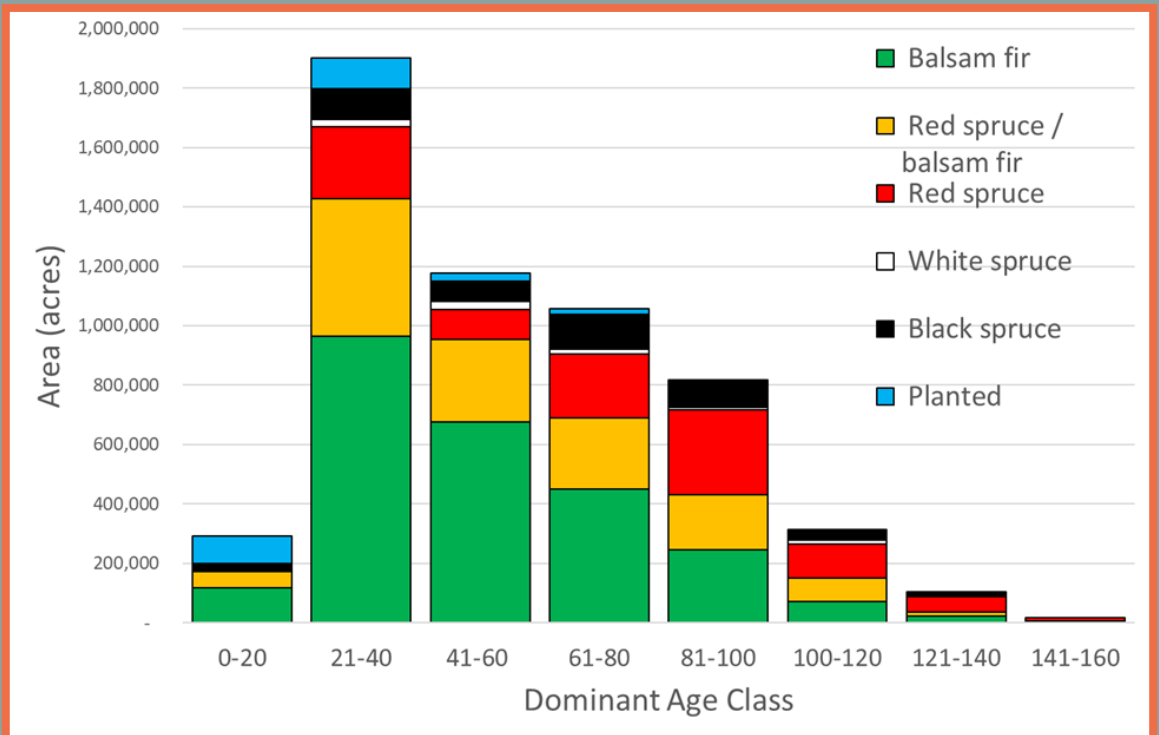


Fig. 1.3. Composition of the northern conifer resource by 20-year age classes, timberland only. Because the FIA protocol classifies stand age only by the dominant age class, so this figure does not mean that all stands are even-aged.

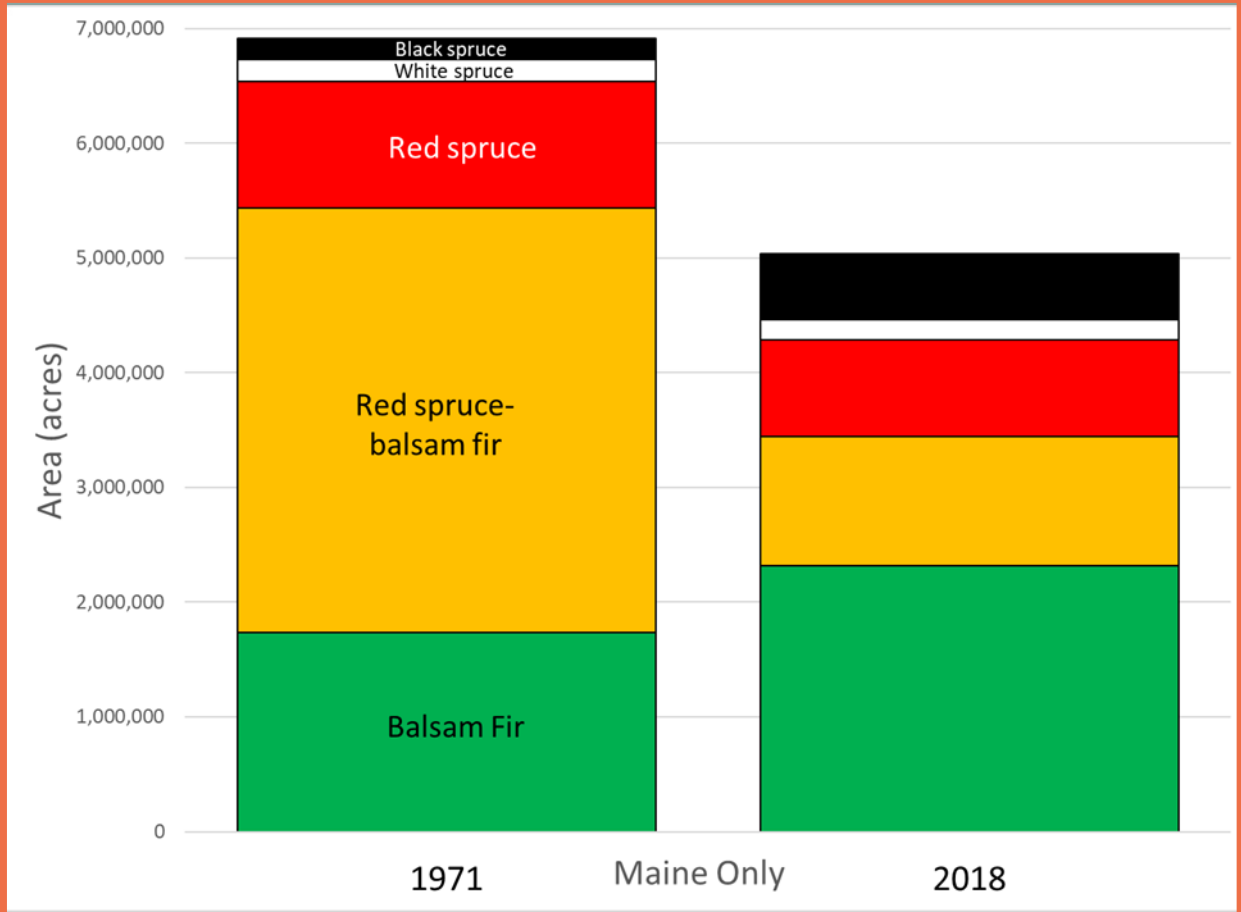


Fig. 1.4. Loss of northern conifer forest-type area over the 47-year period from 1971 to 2018 (1971 data from Table 40 in Ferguson & Kingsley 1972; 2018 data based on queries from the Evalidator 2.0.5, January, 2023).

Harvesting Patterns

In Maine, 370,049 acres were harvested during the most recent five years, a rate of 1.6% of all spruce-fir timberland per year. Only 14% (50,220 acres) of these stands were classified in the 1-20 age class after harvest (Fig. 1.5), and only 7 of 83 harvested plots had a residual basal area of zero (Fig. 1.6). Characterizing these patterns silviculturally is challenging. Many likely have little silvicultural intent, but do have defined stand development patterns and thus, silvicultural implications. The most dominant practice appears to be delayed overstory removal (extended shelterwood), releasing trees that are 21-40 years old (42% of all harvested area). Nearly half (48%) of all harvests did not change age class as a result of cutting. Over a third (34%) of

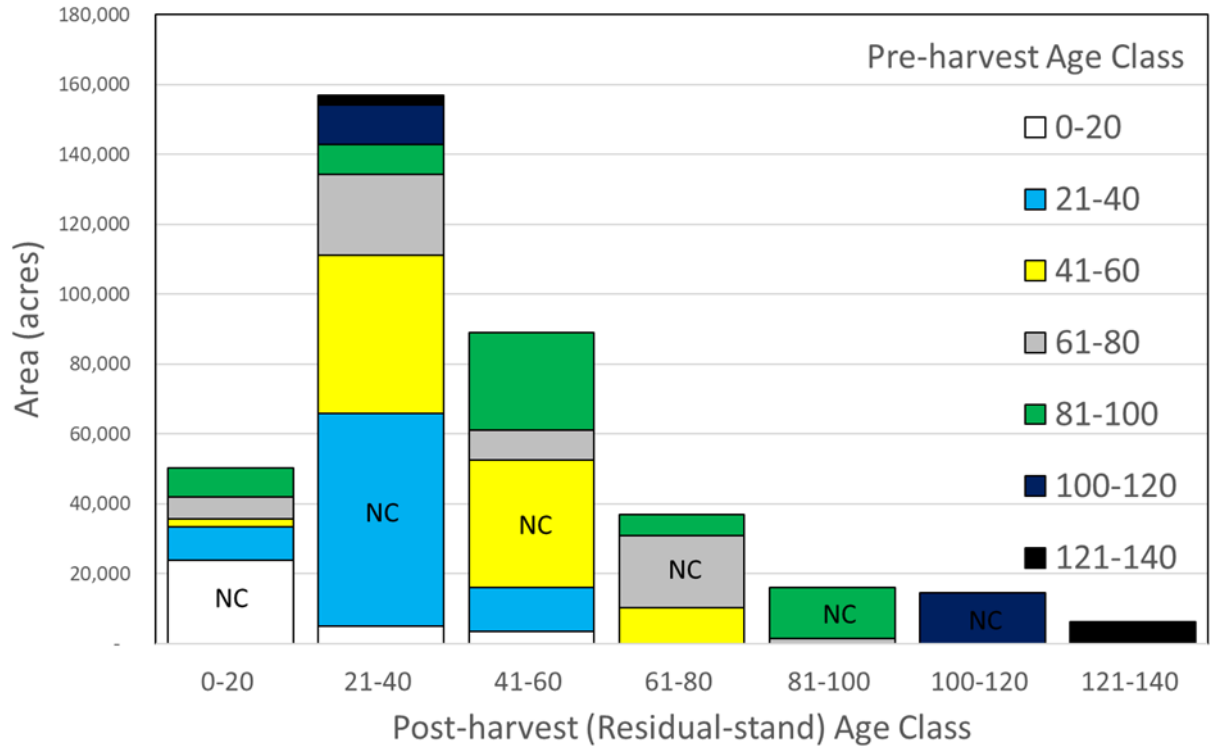


Fig. 1.5. Pre- and post-harvest age class of all areas harvested in Maine during the 2019 FIA remeasurement in the northern conifer subtypes. Represents 5 years of harvesting totaling 370,049 acres. Segments labeled "NC" did not change age class as a result of harvest. From C. Barnett, FIA Resource Analyst.

such stands (12,166 acres per year) fall in the 21-40 age class, and are thus likely to be commercial thinnings. The remaining areas could be later thinnings, shelterwood establishment cuttings, or some kind of multi-aged treatment such as irregular shelterwood that retained older trees as the dominant residual cohort. Stands of all ages appear to be targeted for harvesting, including the youngest class. The residual basal area of all live trees 1" dbh^{+} averaged 70 square feet per acre for all harvested plots, with no obvious pattern by age (Fig. 1.6). Clearly, the dominant paradigm is some kind of partial harvesting. Regeneration harvests that reset stand development to an early stage are the exception, not the norm. Nearly 91,000 acres (25%) of stands older than 40 are classified as 21-40 after harvest, likely overstory removal cuttings that leave tall saplings and small poles.

Landscape Patterns

Natural-origin spruce-fir forest types tend to dominate landscape positions that are too poorly drained or infertile to support tolerant northern hardwoods such as sugar maple and American beech (Seymour 1995). Planted spruce stands, where intensive silvicultural treatments are employed to cover hardwood competition, span the range of soil conditions. These patterns are covered fully in the section on soil-site assessment.

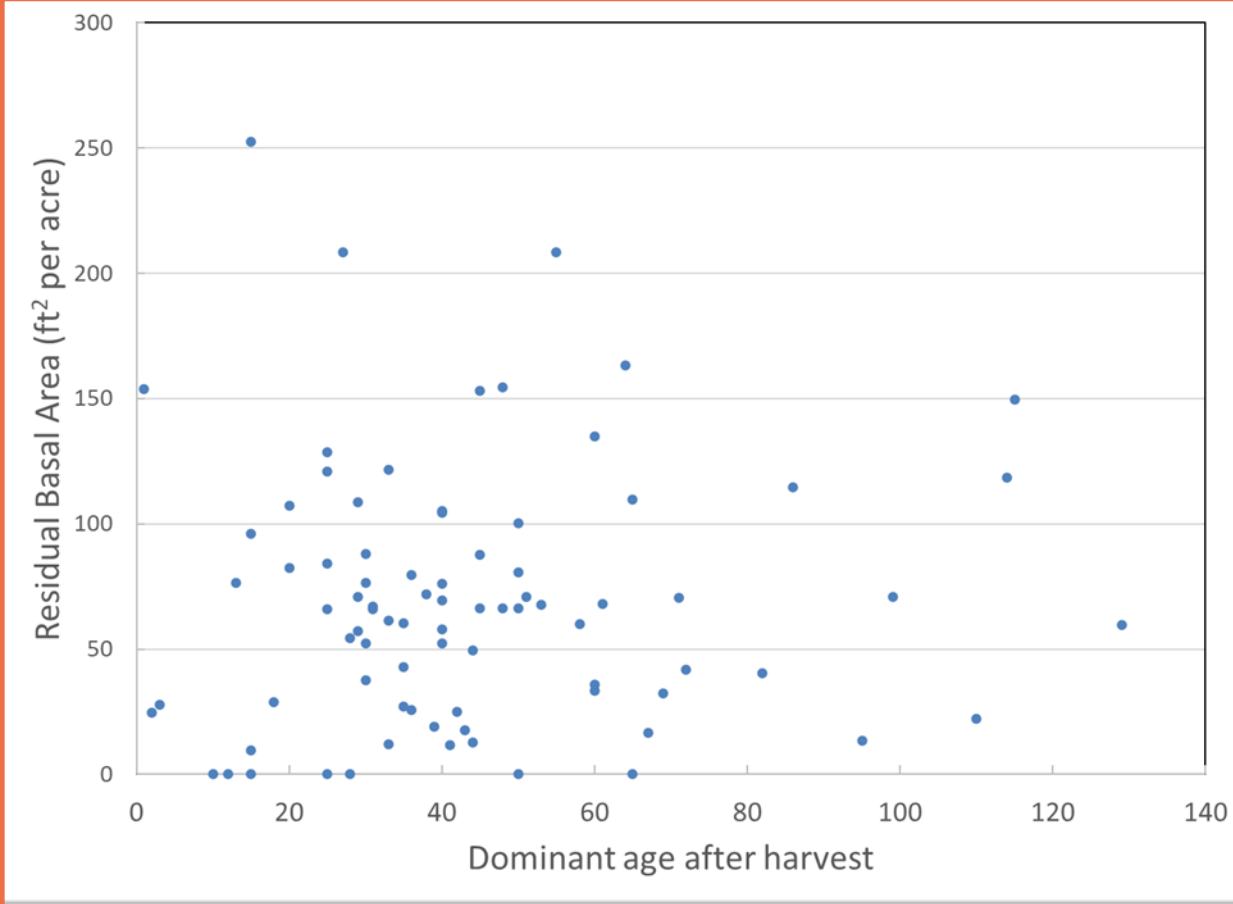


Fig. 1.6. Residual basal area of 83 northern conifer plots harvested over the period 2015-2019, over the post-harvest age-class assignment. From C. Barnett, FIA Resource Analyst.

Scientific Names

Balsam fir – *Abies balsamea*
Red spruce – *Picea rubens*
White spruce – *Picea glauca*
Black spruce – *Picea mariana*
Red maple – *Acer rubrum*
Sugar maple – *Acer saccharum*
American beech – *Fagus grandifolia*
Paper birch – *Betula papyrifera*
Yellow birch – *Betula alleghaniensis*
Aspen – *Populus tremuloides, Populus grandidentata*
Northern white-cedar – *Thuja occidentalis*
Tamarack – *Larix laricina*

References

Boulfroy, E., Forget, E., Hofmeyer, P. V., Kenefic, L. S., Larouche, C., Lessard, G., Lussier, J.M., Pinto, F., Ruel, J.C., and Weiskittel, A. 2012. Silvicultural guide for northern white-cedar (eastern white cedar). USDA Forest Service General Technical Report NRS-98. 74 p.

Ferguson, R.H., Kingsley, N.P. 1972. The Timber Resources of Maine. USDA Forest Service Resource Bulletin NE-26. 129 p.

Frank, R. M., Bjorkbom, J.C. 1973. A silvicultural guide for spruce-fir in the Northeast. USDA Forest Service General Technical Report NE-6. 29 p.

Fraver, S., White, A.S., Seymour, R.S. 2009 Patterns of natural disturbance in an old-growth landscape of northern Maine, USA. Journal of Ecology 97: 289–298.

Halliday, W.E.D. 1937. A forest classification for Canada. Can. Dept Mines Resources, Forest Service Bull. 89. Ottawa, Canada. 50 p.

Loo, J., Ives, N. 2003. The Acadian Forest: Historical condition and human impacts. Forestry Chronicle 79(3):462-474.

Noseworthy, J., Beckley, T.M., 2020. Borealization of the New England–Acadian Forest: a review of the evidence. Environmental Reviews, 28(3): 284-293.

Seymour, R. S. 1985. Forecasting growth and yield of budworm-infested forests. Part I: Eastern North America. p. 200-213 In: Recent Advances in spruce budworms research: Proc. CANUSA symposium, Bangor, ME, Sept 16-20, 1984. 527 p.

Seymour, R.S. 1992. The red spruce-balsam fir forest of Maine: Evolution of silvicultural practice in response to stand development patterns and disturbances. Ch. 12 (p. 217-244) In: Kelty, M. J., Larson, B. C. and Oliver, C. D., eds. The Ecology and Silviculture of Mixed-species forests. Kluwer Publishers, Norwell, MA. 287 p.

Seymour, R. S. 1995. The Northeastern Region. p. 31-79 In: Regional Silviculture of the United States, Ed. 3. Ed. J. W. Barrett. Wiley and Sons, N. Y. 643 p.

Robert Seymour is Professor Emeritus of Silviculture, School of Forest Resources, University of Maine, having retired in 2017 after 39 years of teaching, research and service to the forestry community. He writes a monthly column on silvicultural topics for Maine Woodlands and maintains a YouTube Channel devoted to hands-on silvicultural techniques and webinar presentations.
https://www.youtube.com/@tmimotf
https://www.researchgate.net/profile/Robert-Seymour

Silviculture for Acadian Spruce-Fir Forests

Center for Research on Sustainable Forests

Silviculture for Acadian Spruce-Fir Forests No. 1
2024

The Acadian Spruce-Fir Resource

Photographs by Robert S. Seymour, used by permission.