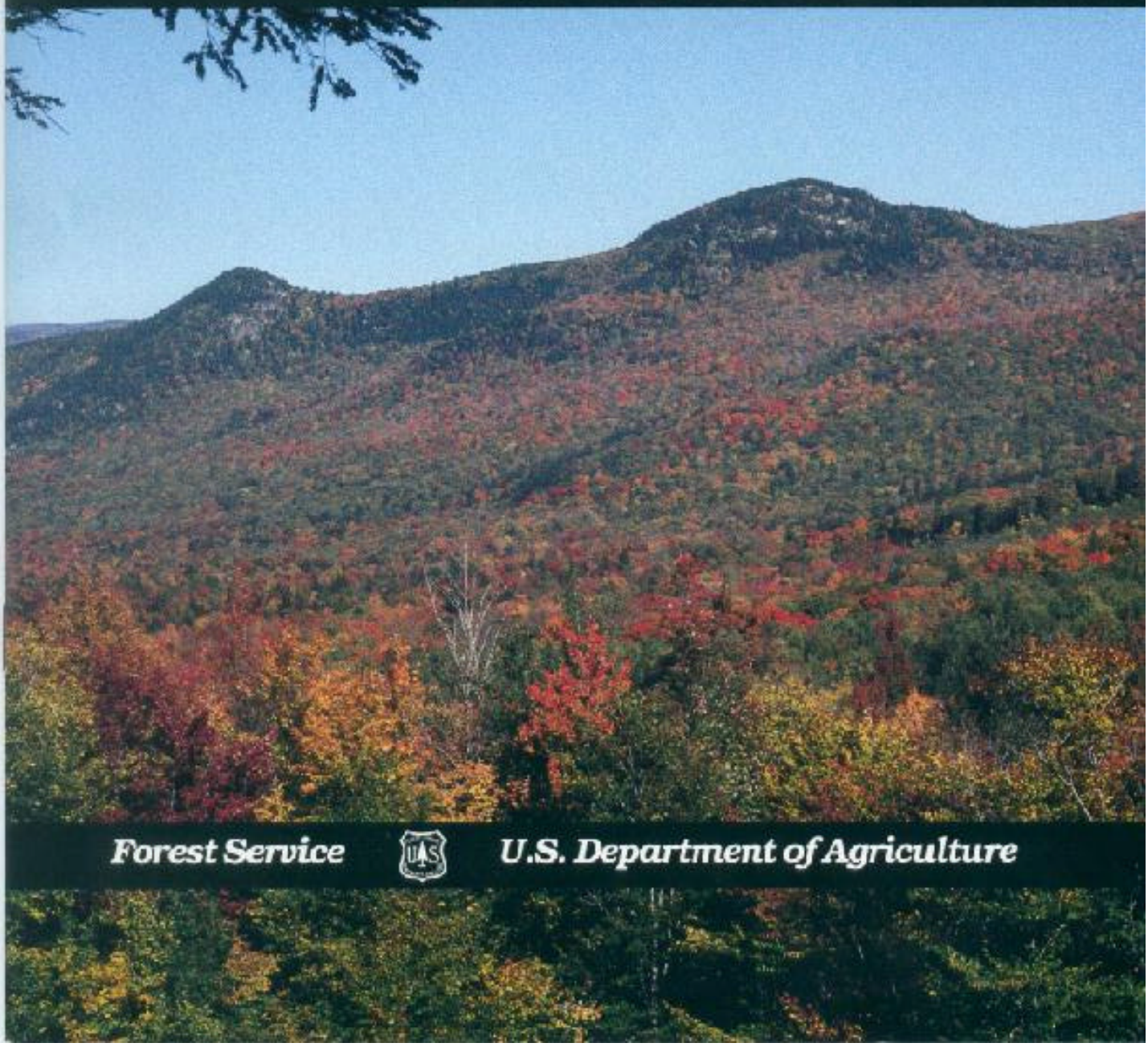
USDA

Bartlett Experimental Forest

Ensuring the future of the forests



Forest Service *U.S. Department of Agriculture*

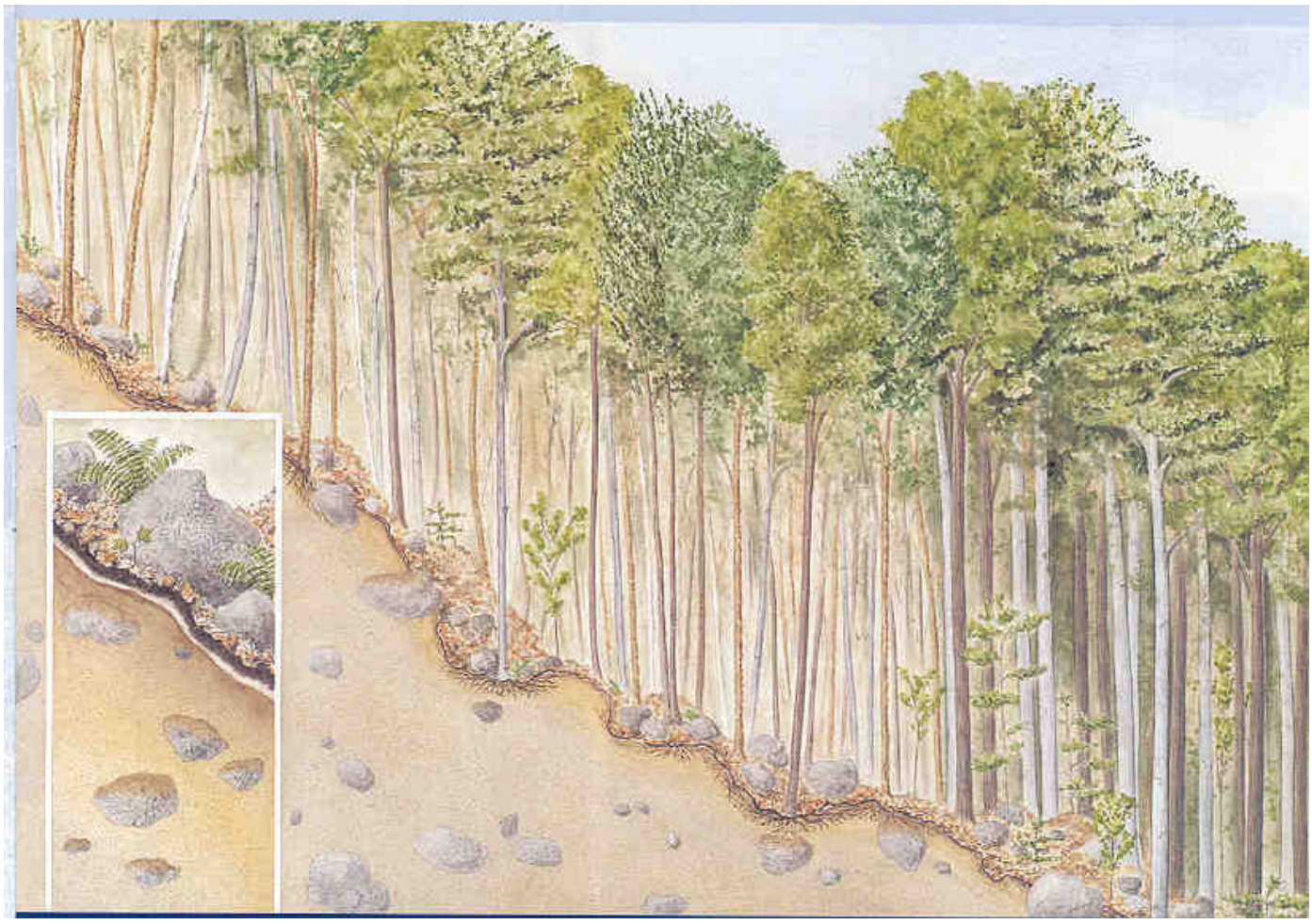
Bartlett: A Research and Demonstration Forest

The Bartlett Experimental Forest is a field laboratory for research on the ecology and management of northern forest ecosystems. Research on the Bartlett includes: 1) extensive investigations on structure and dynamics of forests at several levels, and developing management alternatives to reflect an array of values and benefits sought by users of forest lands, 2) a better understanding of ecological relationships between wildlife habitats and forest management at various levels in order to integrate wildlife habitat maintenance and improvement with other forest management goals, and 3) preservation of undisturbed areas in the Northeast to study natural succession and anthropogenic impacts.

Research activities at the Experimental Forest began in 1931, when the U.S. Forest Service set aside 2,600 acres (1,052 ha) on the White Mountain National Forest in New Hampshire for experimental studies, as part of the then Allegheny Forest Experiment Station (1927-45). This particular site was chosen because it represented conditions—soils, elevation, climate, and tree species composition—typical of many forested areas throughout New England and northern New York.

The soils at the Bartlett Experimental Forest are spodosols, developed on glacial till derived from granite and gneiss. The black humus layer of the soil is nutritionally rich for plant growth, while lower mineral soil layers are nutritionally deficient. In many places the soil mantle is very shallow; boulders and rocks are common.

The climate in the Bartlett area, where elevation ranges from 680 feet to 3,000 feet at the summit of the Upper Haystack, includes warm summers and cold winters. During the summer, daytime temperatures sometimes run into the 90's; winters are rigorous with temperatures often reaching -30°F. Individual snow-

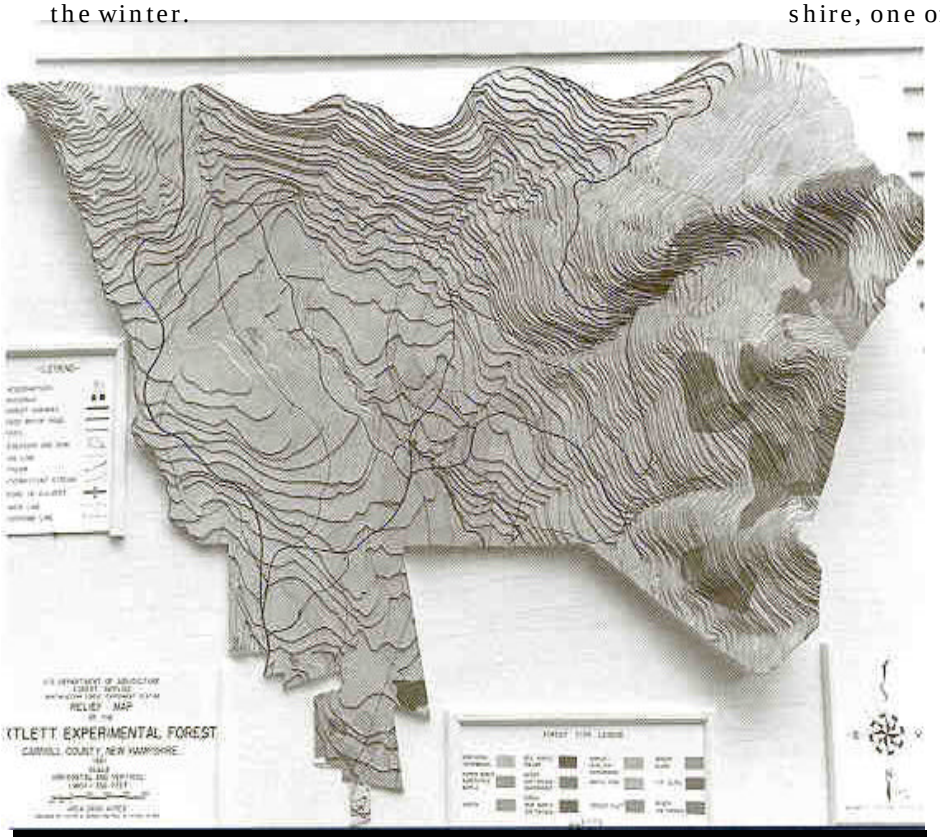


Glacial till, the most common soil type here, is ideal habitat for northern hardwoods.

storms often deposit more than 2 feet of new snow, and snow accumulates to depths of 5 or 6 feet. Average annual precipitation at Bartlett is 50 inches, distributed throughout the year. Severe winters limit most field work at the Experimental Forest to the period between May and November, although some wildlife studies (raptors and fur-bearers) continue throughout the winter.

Bartlett is located in the heart of the New England tourist and ski country. Many hiking trails of varying lengths wind throughout the area, along with several rivers where canoes can be rented for a day or longer, rock ledges for climbers of every skill level, lakes for swimming, public golf courses, and all the usual tourist attractions. North Conway, New Hampshire, one of the leading tourist attractions in the Northeast with many local shops and factory outlet stores, lies about 12 miles east on Route 302.

The headquarters for the Bartlett Experimental Forest is located on Rte. 302 in the town of Bartlett. Housing is available for approximately 25 researchers at the present time, with plans to add additional space in the near future. Additional housing is available in area cabins and motels which tend to be expensive in this tourist region. A number of people working on the Bartlett for a few



Topographic map shows the Bartlett in relief.

View of the Haystacks, Bartlett's highest elevation, from Bear Notch Road.

The laboratory includes research and conference facilities.

days or weeks erect tents on the grounds and use facilities in the various buildings.

A large laboratory building with computer room, balances, drying ovens, bench, and desk space can accommodate a wide range of research activities. In one end of this building is a fully equipped conference room with seating for 50-60 people, and in the other end, a large room for storage and construction activities.

Showers, laundry, kitchens and a residential wing are on-site.

RESEARCH ACTIVITIES

In contrast to cellular studies of energy and nutrient flows, the existing work on this Forest looks at the organism as the lowest common denominator for ecological studies. The approach is to observe how distinct ecosystems —units of land defined by biota, soils, and climate—differ in their productivity, bio-diversity, dynamics (e.g. successional patterns), and response to disturbances of various kinds.

This guide describes some of the studies being carried out on the Experimental Forest by Forest Service scientists stationed at Bartlett and in Durham, New Hampshire, part of the Northeastern Research Station, which is headquartered in Radnor, Pennsylvania. Additional studies are being conducted by other Northeastern Station units located in Amherst, Massachusetts, and Hamden, Connecticut. Non-Forest Service groups such as universities and the Audubon Society of New Hampshire also conduct research on the Experimental Forest on a regular basis.

SILVICULTURE / ECOLOGY RESEARCH

In 1931-32, the Bartlett Forest was gridded with 500 permanent 0.1-hectare square cruise plots spaced 200 by 100 meters apart. After an initial measurement of all woody stems larger than 3.8 centimeters in diameter, a majority of the plots (441) were remeasured by 1-inch (2.54 centimeters) diameter classes and species in 1939-40 and again in 1991-92. This 60-year data set includes areas (55 percent) that were cut for experimental purposes using single-tree selection, diameter-limit cutting, group selection, clearcutting, shelterwood, and thinning. Another 45 percent of the Forest has not been harvested since at least 1890. The Forest has no history of recent fires, but a 1938 hurricane did substantial damage, particularly at the higher elevations, and the area sustained severe damage from beech-bark disease in the early 1940's. Two other natural disturbances may be occurring on this Forest: red spruce decline associated with acid deposition and migration of tree species upslope as a result of climatic warming.

Long-term Succession

Thirty quarter-acre plots were established and measured in 1931-32. Scientists have remeasured these to observe changes in tree species, sizes, and regeneration. This is a continuing study but some interesting observations are already apparent. Species changes are related to soil conditions. On wet, shallow, or rocky soil, the long-term trend is toward dominance of softwood such as hemlock and spruce. On deeper and more fertile soil, the trend is toward hardwoods such as beech and sugar maple. These plots have also allowed prediction of how long it takes to develop an old-growth forest composed of large trees and very shade-tolerant species: about 250-300 years.

Patch cutting encourages regeneration of desirable species.

The same patch-cut area, several years later.

Habitat Studies

Tree species composition varies widely over the Bartlett Forest. Historically, these species' differences were thought to be caused mostly by accident or past timber harvesting practices. Studies of natural habitats or site conditions have shown, however, that much of the variation in species mix corresponds to site conditions. Researchers have mapped the entire Experimental Forest into habitats based on soils, landform or topography, and tree vegetation. Habitat classification allows forest managers to regenerate and culture the tree species that will grow best in each area, instead of trying to encourage species that grow poorly or not at all.

Clearcutting

In a study designed to encourage regeneration of light-demanding birch, 7 acres of the Experimental Forest were clearcut in 1968. Slash was removed and the site scarified to approximate site conditions that follow full-tree chipharvester operations. Seeded and unseeded control plots were included. Stocking of birch on the control plots suggests that clearcuts of this size can be reseeded naturally from birch in surrounding stands.

In 1975, scientists thinned the seeded plots for a study on the growth of released birch trees. They selected crop trees at a uniform spacing and removed all other trees. After 10 years, the diameter of released stems was nearly twice that of the unreleased controls.

Shelterwood and Clearcutting

Clearcutting and shelterwood harvests stimulate the regeneration of a variety of tree species. Studies on the Bartlett Experimental Forest compare revegetation after clearcutting and shelterwood cuttings on several habitat (soil-site) types so that regeneration methods and habitat can be matched to produce desired tree species.

Seed Rain

Studies of forest regeneration are often focused on natural seed supplies. A long-term collection of seed from plots throughout the Experimental Forest provides new insights into forest reproduction dynamics. The amount

A clearcut area, in its first growing season after the removal cut.

The same clearcut area 20 years later.

of seed produced in the best years was 2,000 times that produced in the poorest years. This year-to-year variation in seed supply has a major impact on wildlife populations which use the seed for food and on foresters who attempt to time harvest cuts to coincide with seed availability.

Thinning to Improve Composition, Quality, and Growth Rate

A 22-acre area of the Bartlett Experimental Forest was completely clearcut in 1934. By 1959, a potentially valuable stand had developed on this site. At that time (25 years) researchers established three different thinning treatments and an untreated control. After another 25-year period, results indicated that thinning–especially heavy thinning around crop trees–could double growth on birch while maintaining a good proportion of slower growing, longer lived maple and beech.

Stocking Level

One consideration in managing forests is to regulate density so that individual trees can develop satisfactorily. In 1964, part of the Experimental Forest was used for a stocking level study in which 48 one-third acre plots were cut to four levels of stem density. Scientists have monitored the growth and development of entire stands and individual trees in these stands since the study was installed. They found that lower density stands grow nearly twice as fast per acre as higher density stands, and that average diameter growth of individual stems was about twice as fast in the lower density stands as well.

Group Selection

Group selection is merely clearcutting on a small scale, usually no more than two-thirds of an acre, often within the boundaries of larger, mature, or young stands. This method produces stands with a greater proportion of mixed tree species than would be obtained by clearcutting. Studies on the Bartlett show that regeneration of yellow and paper birch is possible in these small clearcuts made by group selection harvests.

A shelterwood cut on the Experimental Forest.

Selection Cutting

Selection cutting is the removal of individual trees comprising only a small proportion of a stand during each cutting cycle. This method maintains a vigorous stand of high quality trees in all size classes (uneven-aged management). Selection cutting is often preferred for aesthetic reasons because evidence of logging is hardly visible. While clearcutting and group selection favors light-demanding species, selection cutting favors growth of shade-tolerant beech, sugar maple, hemlock, and spruce.

Tree Quality Development

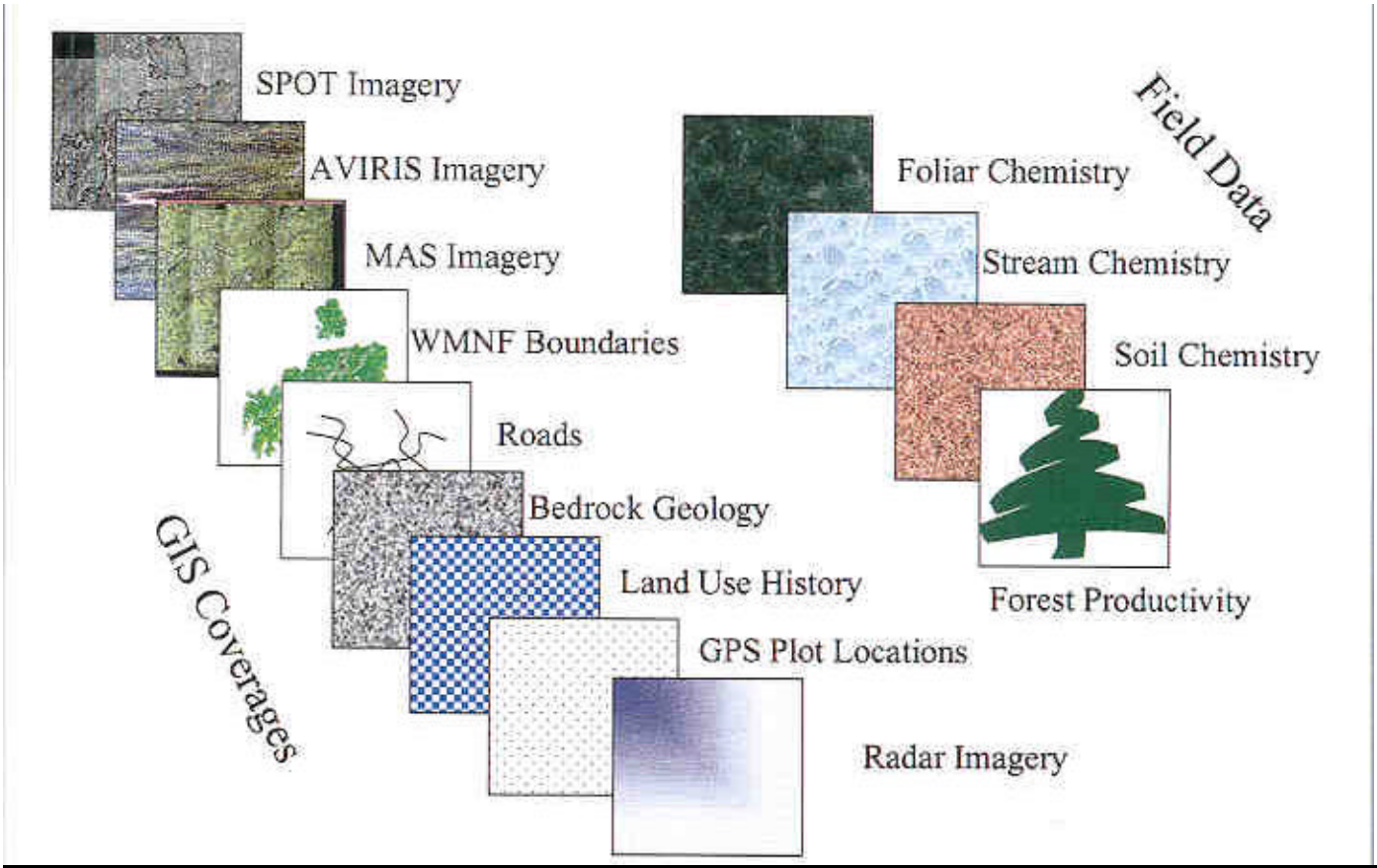
As hardwood trees mature into larger diameter classes, the potential for quality development increases. Quality in hardwoods is a reflection of the proportion of lumber sawn from a log that can be classed in the higher lumber grades—the higher the proportion, the higher the quality. Scientists are studying silvicultural systems used to manage hardwoods to determine their effect on tree quality development. Individual trees in nine compartments on the Experimental Forest initially graded in the 1950's were evaluated again in 1996. Changes in quality over that 40-year period, and in future periods, will be measured and reported.

Remote Sensing of Forest Ecosystem Composition and Function

Human land-use activities have dramatically altered vegetation and soils across much of the globe, including northern New England. Disturbances such as plowing, logging, grazing, and burning deplete nutrient pools important for forest growth and cause substantial changes in the composition of forests and other ecosystems.

Most traditional forest ecosystem research on these and other issues has been conducted at the stand or small watershed level. Though results from such studies have provided much basic information on important forest processes, it is difficult to extrapolate such information with much confidence to larger landscapes. In a new approach, scientists use a combination of airborne and spaceborne remote sensing technology to assess both ecosystem function and composition across wider areas.

Cooperative research among Forest Service, University of New Hampshire, and NASA scientists on the Bartlett Experimental Forest, and on the adjacent White Mountain National Forest, is addressing these issues through a combination of field-data collection, high spectral resolution remote sensing, and ecosystem modeling analyses. Field and remote sensing data is being combined to derive spatially extensive data layers for forest composition and nutrient status. These data are used as input into a geographic information system (GIS) based forest ecosystem model that allows estimates of current ecosystem condition and function at broad scales and allows any number of "what if" scenarios (acid deposition, climate change, etc.) to be evaluated for this region.



Remote sensing, maps, and field data aid in managing ecosystems at a landscape scale.

WILDLIFE RESEARCH

Wildlife species found on the Bartlett Experimental Forest depend on the array of surrounding forest and riparian habitats on the extensively forested mountain slopes. Nonforested and aquatic habitats are minor components of the overall landscape. At least 15 species of amphibians and reptiles, 90 bird species, and 35 mammalian species have been known to occur in the area throughout the year. Charismatic megafauna like moose and black bear can be seen; redback, spring and two-lined salamanders and wood frogs are also found, as well as a number of raptors (red-tailed hawk, goshawk, barred owl, and saw-whet owl), a variety of neotropical migratory birds, permanent residents (pileated woodpecker, ruffed grouse), winter residents (crossbills and redpolls); and an array of bats, small mammals, forest carnivores (weasels, fisher, bobcat), snowshoe hare, and white-tailed deer.

The most serious problem facing woodland managers in the Northeast is a lack of knowledge about the ecological relationships between wildlife habitat and forest management in northern hardwoods and associated ecosystems at various levels. This information is essential for integrating wildlife habitat maintenance and improvement with other forest management goals including timber production and maintenance of aesthetic qualities.

The primary objectives of wildlife research at Bartlett include: refining and expanding the ecological classification to better define vertebrate species concerns; evaluating silvicultural effects on various wildlife species that use the northern hardwood/mixedwood types; improving and developing silvicultural prescriptions that effectively integrate timber production and wildlife habitat improvement; and extending wildlife habitat investigations into forested wetlands, riparian and aquatic systems typically associated with the northern hardwood and associated types in this region. With numerous ongoing studies of traditional game species being conducted elsewhere in the country, research on the Bartlett has concentrated on amphibians, birds, and small mammals. Habitat research on forest carnivores and moose are future research areas.

The existing long-term and large-scale investigations of various harvesting treatments on the Experimental Forest provide ideal sites to study the effects of management practices on wildlife abundance and diversity under controlled conditions. Emphasis to date has been to establish some baseline habitat information regarding stream-dwelling and terrestrial salamanders, breeding birds, raptors, and small mammals.

Cavity-Dweller Habitat

Providing cavity-dwelling habitat for all wildlife species needing cavity sites for denning, nesting, and roosting depends on site capability, the normal mortality associated with managed stands, the longevity of standing dead cavity trees, and the patterns of cavity use among cavity dwellers. Northern hardwood and mixedwood types are home to a variety of cavity dwelling species including primary excavators such as the pileated woodpecker, hairy woodpecker, and yellow-bellied sapsucker; and secondary cavity users such as the black-capped chickadee, red-breasted nuthatch, fisher, flying squirrels, white-footed mice, and various bat species. Researchers installed plots in several compartments on the Forest and check them periodically to obtain information on the probability that a cull tree will be used by cavity dwelling wildlife and the length of time dead trees of various species and sizes remain standing. Knowledge of animal behavior will help in developing guidelines for selecting cull trees and criteria for preserving cavity-dwelling habitat.

Presence and Habitat Use of Bats

Determination of species/habitat associations is fundamental to the maintenance of biological diversity and provides baseline data vital to management and conservation activities. Studies of species communities lead to better understanding of the northern hardwoods ecosystem and provide some insight into the likely consequences of habitat alteration or environmental change. Bats are heterothermic mammals, and, as such, possible early indicators of climatic change. Knowledge of summer forest habitat associations of the nine listed bat species in northern New England was nonexistent until studies were initiated on the Bartlett Experimental Forest. Researchers conducted systematic surveys of flight and foraging bat activity in four age classes of northern hardwood and spruce/fir stands. They used Anabat II ultrasonic detectors and locally developed software to analyze search phase echolocation sequences across the Experimental Forest and surrounding White Mountain National Forest.

In a second study, they explored the summer maternal roosting preferences of two bat species—northern long-eared and little brown myotis—in forested stands. Adult females were mist-netted, fitted with radiotransmitters, and tracked to day roosts where cavity tree and surrounding stand characteristics were recorded. Researchers also placed ultrasonic detectors at randomly selected cavity trees to monitor potential roosting sites. Roost characteristics of suitable snags and stands were identified for use by land managers interested in developing silvicultural prescriptions that provide maternal bat roosting habitat in managed forests.

Songbird Response to Group Selection Harvests and Clearcuts

Past research has shown that clearcutting creates breeding habitat for many early successional neotropical and short-distance migrants, as well as for resident bird species. However, little information was available on bird communities utilizing smaller forest openings created by other silvicultural practices such as group selection in northern hardwoods. Information was also lacking on bird communities that occupy the forested areas between group openings. With the potential elimination of clearcutting on public lands and a greater use of group selection, this information gap becomes important. To determine if species richness and composition differs between areas managed by these methods, researchers selected a number of study blocks, each consisting of a clearcut stand, group selection stand, and a mature stand in northern hardwood stands on the Forest. Breeding season point count surveys are conducted on these study blocks. Early data suggest that small group selection openings do not provide habitat similar to that created by clearcuts in extensive northern hardwood stands. Group selection appears to retain much of the mature forest bird community while providing for a small number of early successional species. These studies can assist forest managers in decisions surrounding the further development of forest interior habitat or the maintenance of a diversity of structural vegetative conditions for a diverse array of avian species.

Checking for salamanders.

Cavity trees: habitat for birds and bats.

Researchers study songbirds, such as the chestnut-sided warbler (l), and raptors, like the barred owl (r).

Small Mammals Response to Habitat Alteration in Northern Hardwoods and Mixedwood

Long-term studies of small mammal occurrence and abundance are important to any understanding of vertebrate dynamics in northern hardwood and mixedwood types. Dramatic year-to-year fluctuations in species occurrence and abundance can influence the availability of potential prey for forest carnivores and raptors. Small mammals are also potential predators of some forest birds, tree seed/nut crops, and forest insects; thus providing yet another source of variation in any periodic assessment of silvicultural practices. Habitat alteration through silvicultural treatment can change the vegetative structure and species composition of the subsequent stand. Forty small mammal trap sites have been placed in each of four compartments under different silvicultural treatments—shelterwood, individual tree selection, and unmanaged. The shelterwood treatment has had more impact on habitat alteration than individual tree selection with respect to canopy closure, shrub, and ground vegetation layers. Preliminary data suggest similar species composition between treatments but very different year-to-year results.

Small mammal studies across landscapes of similar management (active vegetation management, adjacent unmanaged vegetation, and remote unmanaged vegetation) are important to understanding the vertebrate dynamics and site differences across larger areas than those undertaken by traditional stand studies of small mammals. Researchers placed 119 snap trap grids and 120 pitfall trap arrays across the Experimental Forest and surrounding White Mountain National Forest to evaluate small mammal species occurrence and abundance across three broad levels of vegetation management. They then measured various habitat and site variables. Preliminary results showed that all small mammal species expected in the White Mountain Section were represented in the sample.

Salamander Occurrence in First Order Streams

First order streams at Bartlett provide habitat for both terrestrial salamanders such as the redback salamander and some of the stream-dwelling salamanders such as the two-lined, dusky, and spring salamander. These habitats are subject to local seasonal flooding and scouring actions. Researchers have established transects perpendicular to stream channels to sample the occurrence of salamanders across these narrow riparian corridors. They have also conducted timed searches in selective 100-foot stream reaches to quantify instream salamander abundance.

Examining a meadow vole.

A spotted salamander found on the forest.

RESEARCH NATURAL AREAS

The Research Natural Areas (RNA) Program is a joint effort between the National Forests and Research. The Research unit responsible for the Bartlett is also responsible for the RNA Program in the Northeast. While there are no RNA's on the Bartlett, several exist nearby, and a large body of information on plant dynamics and diversity is being developed for these Areas. Several excellent botanical surveys have been completed and considerable work has been accomplished on "stubble lichens" as indicators of old-growth forest sites.

RNA's, as the name implies, are meant to be studied, and we encourage people to submit plans for non-destructive research in these Areas. Because these are essentially undisturbed sites, they provide opportunities to collect baseline data against which to judge effects of management activities and to study structure, function, and development of natural ecosystems. For example, undisturbed areas can be useful in studies of successional processes, effects of management on wildlife, soil, disease regimes, and impacts of global change and atmospheric deposition.

Sample List of Publications from Research on Bartlett Experimental Forest

Costello, C.A. 1995. **Songbird response to group selection harvests and clearcuts on the White Mountain National Forest.** Durham, NH: University of New Hampshire. M.S. Thesis. 94 p.

Crow, G.E., Ritter, N.P, McCauley, K.M., Padgett, D.J. 1994. **Botanical reconnaissance of Mountain Pond Research Natural Area.** Gen. Tech, Rep. NE-187. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 11 p.

Filip, S.M., Little, E.L. Jr. 1971. **Trees and shrubs of the Bartlett Experimental Forest, Carroll County, New Hampshire.** Res. Pap. NE-211. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 20 p.

Krusic, R. 1995. **Habitat use and identification of bats in the White Mountain National Forest.** Durham, NH: University of New Hampshire. M.S. Thesis. 86 p.

Leak, W.B. 1996. **Long-term structural change in uneven-aged northern hardwoods.** Forest Science 42(2): 160-165.

Leak, W.B., Smith, M-L. 1996. **Sixty years of management and natural disturbance in a New England forested landscape.** Forest Ecology and Management 81: 63-73.

Leak, W.B., Smith, M-L. 1996. **Long-term species and structural changes after cleaning young even-aged northern hardwoods in New Hampshire, USA.** Forest Ecology and Management 95: 11-20.

Royte, J.L., Sperduto, D.D., Lortie, J.P. 1996. **Botanical reconnaissance of Nancy Brook Research Natural Area.** Gen. Tech. Rep. NE-216. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 23 p.

Solomon, D.S., Leak, W.B. 1994. **Migration of tree species in New England based on elevational and regional analyses.** Res. Pap. NE-688. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 9 p.

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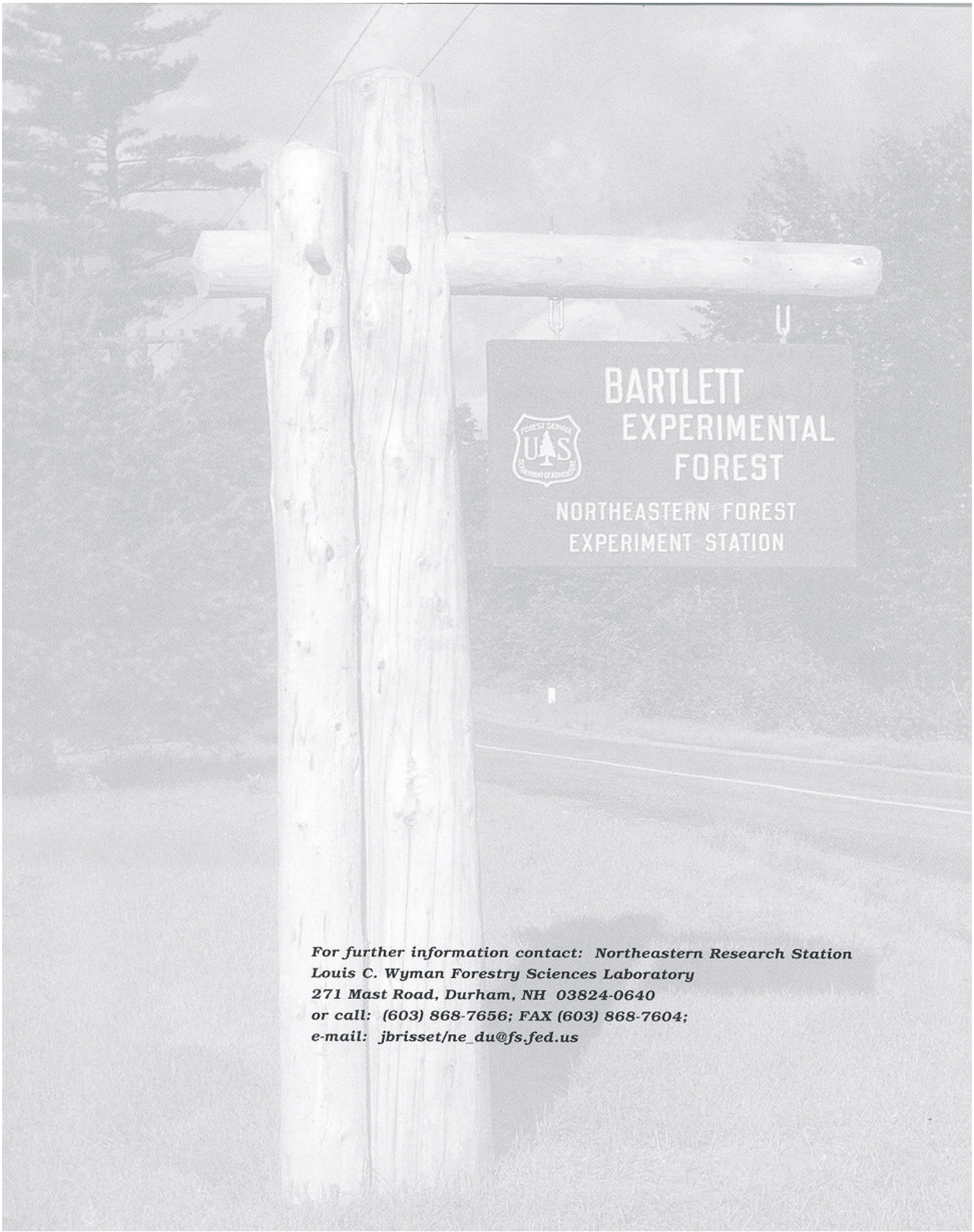
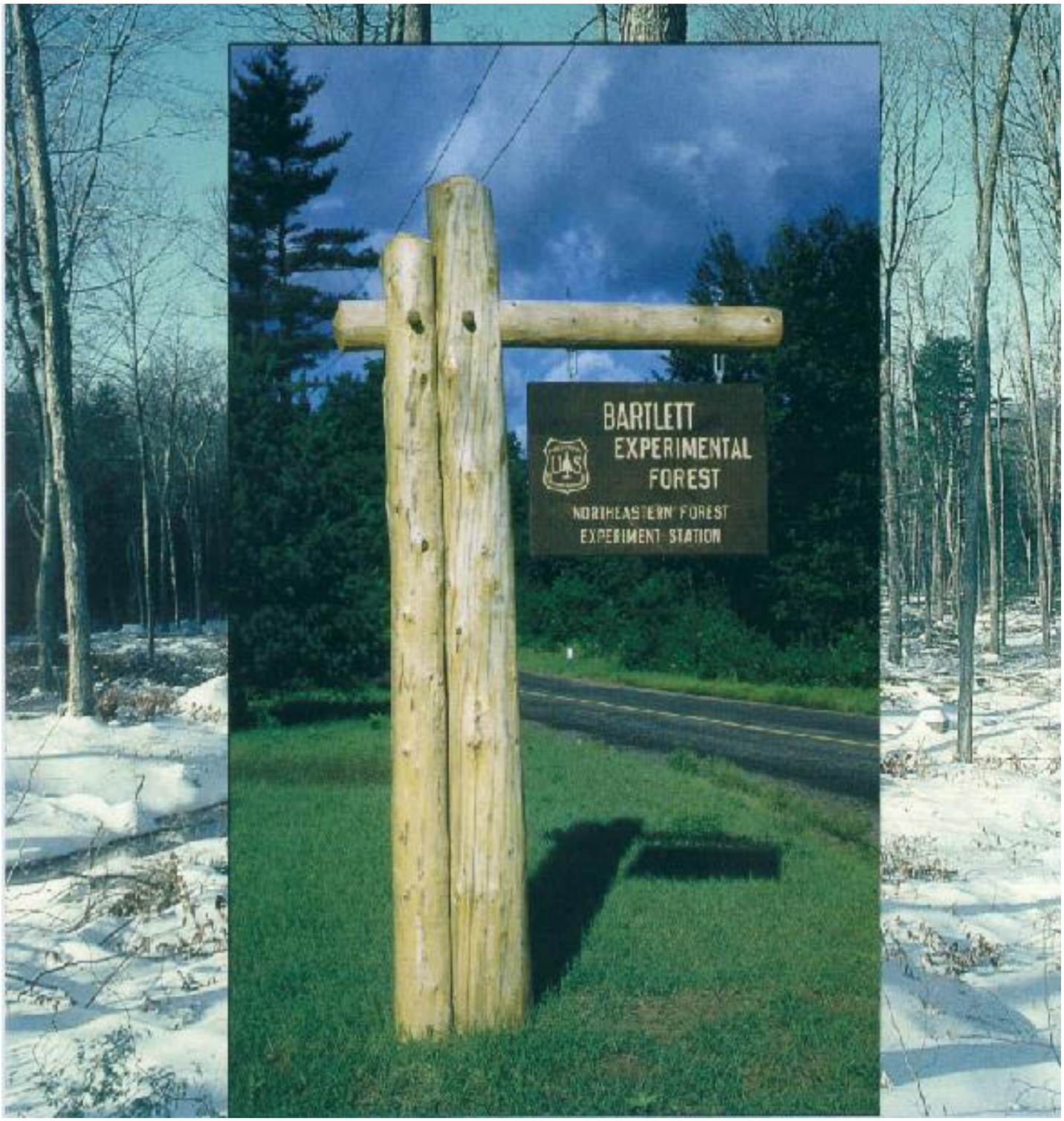


For further information contact: Northeastern Research Station
Louis C. Wyman Forestry Sciences Laboratory
271 Mast Road, Durham, NH 03824-0640
or call: (603) 868-7656; FAX (603) 868-7604;
e-mail: jbrisset/ne_du@fs.fed.us



PREPARED BY: Communications, Northeastern Research Station, Radnor, PA
(610) 975-4229; FAX (610) 975-4224; e-mail: jgamalel/ne@fs.fed.us

NE-INF-136-98 ***Printed on Recycled Paper***

*U.S. Government Printing Office:
605-439/1998