The Bartlett Experimental Forest

ITS FIRST 75 YEARS

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Abstract

The Bartlett Experimental Forest in central New Hampshire, now administered by the U.S. Forest Service's Northern Research Station, was formally established in 1932 as a 2,600-acre tract set aside for research within the White Mountain National Forest. This paper traces the activities, people, and personal insights that shaped the research program on this experimental forest over its first 75 years.

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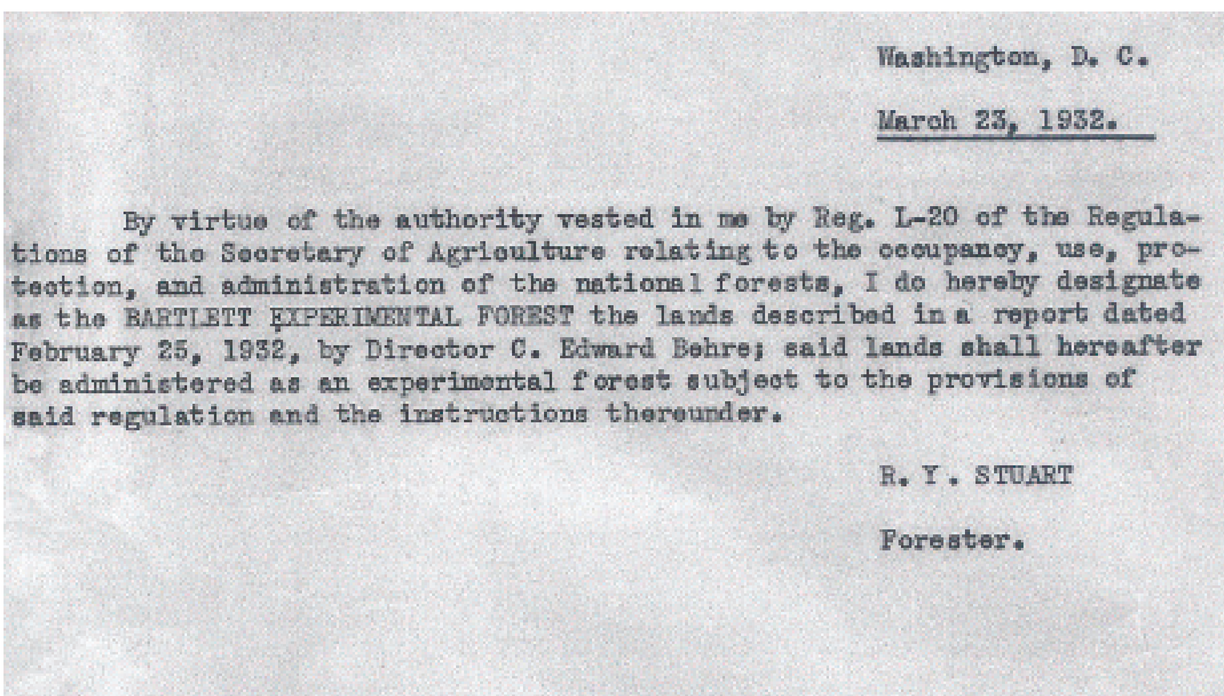
INTRODUCTION

As part of the 75th anniversary of the Bartlett Experimental Forest (BEF), it seemed fitting to assemble some photos, records, and personal recollections of work on the forest since its formal establishment in 1932 (Fig. 1) as part of the White Mountain National Forest (WMNF). Progress was slow and sometimes interrupted by events such as the 1938 hurricane and World War II, but it is surprising how much was accomplished by the small staff with even smaller budgets in the early days.

An early annual report states that the forerunner of the Northern Research Station, the Northeastern Forest Experiment Station (NEFES), was established in 1923, with headquarters in New Haven, CT, in cooperation with Yale University. It had a total budget of $22,500. Even by 1935, there were only 13 permanent employees at NEFES, including seven professionals, and a total budget of about $69,000 (Northeastern Forest Experiment Station 1940).

NEFES covered all of New England plus New York and included activities on four experimental forests: Bartlett, Gale River (Bethlehem, NH), Chenango (near Norwich, NY), and Finch Pruyn (near Newcomb, NY). Negotiations also were underway to use or acquire the Hopkins Memorial Forest (owned by Williams College, Williamstown, MA) and the Massabesic Forest in southwestern Maine (owned by Bates College). NEFES research program areas (including those of collaborators) were spruce and northern hardwood silviculture, mensuration (form class tables), fire, pathology (*Nectria* canker, pruning injury), entomology (balsam wooly aphid), and biology (grouse populations). All this research was undertaken by a total of 13 employees plus cooperators! No computers, GPS units, or electronic measuring devices! Not much bureaucracy! Just hard work! There's a lesson in there somewhere!

The policy for experimental forests was established early on: *"…NEFES aims to concentrate its work to a large extent on experimental forests, set aside especially for the purpose. …a wise policy not only because it safeguards longtime experiments, but also because it permits accumulation of more detailed information…leads to greater efficiency .. and better correlation of different lines of investigation…"* (Northeastern Forest Experiment Station, Annual Report 1935).



Washington, D. C.

March 23, 1932.

By virtue of the authority vested in me by Reg. L-20 of the Regulations of the Secretary of Agriculture relating to the occupancy, use, protection, and administration of the national forests, I do hereby designate as the BARTLETT EXPERIMENTAL FOREST the lands described in a report dated February 25, 1932, by Director C. Edward Behre; said lands shall hereafter be administered as an experimental forest subject to the provisions of said regulation and the instructions thereunder.

R. Y. STUART

Forester.

Figure 1.—Signature block of the 1932 establishment report. U.S. Forest Service, Northern Research Station, Durham, NH.

Early History

The early history of the Bartlett Forest is not well documented. The town began to be settled in about 1769 and was incorporated in 1790. There is some evidence of clearing and short-term agriculture on the northern half of the BEF including one old foundation and well in Compartment 15 (current compartment numbers) and maybe another old camp site along the Shannon Road in Compartment 15 or 16. Also, some word-of-mouth stories about stagecoach roads, way-stations, and somewhat mysterious dwellers including army deserters were passed along by V.S. (Vic) Jensen, founder of the BEF.

But the major influence was the logging by means of the Bartlett and Albany Railroad (1887-1894) that connected with the Maine Central Railroad in the Saco Valley, extended up what is now the Bear Notch Road, and wound down along the Douglas and Rob Brooks into the Passaconway Valley – an area later (1906-1916) accessed by the Swift River Railroad (Belcher 1980). The old railroad grade leaves the Bear Notch Road about halfway down the hill toward Passaconway.

The need for wood fuel for the engines contributed to the almost complete clearing of the lower half of the BEF around the late 1800s. One estimate (Hale 1958) says that 4,100 New Hampshire acres were cleared each year in the later 1800s for the wood-burning engines. This area is now occupied by evenaged stands 100 to 120 years old. The upper, more mountainous half of the Bartlett was picked over for softwoods during the railroad era, leaving stands of old-growth hardwoods. A few piles of disintegrating hemlock bark may still be found (current Compartment 36), probably dating back to the late 1800s when the bark was still being used for tanning leather.

Fire apparently was never a dominant historical feature in the area that became the Bartlett. Partly due to heavy concentrations of slash, there were years in New Hampshire when burn acreages reached 84,000 acres (1903) and 59,000 acres (1911-12) with fires of up to about 2,000 acres (Natti 1975). But the largest documented fire on the Bartlett (in the expansion area described later) was the 100-acre Table Mountain fire in 1984.

The Busy 1930s

Activities on the Bartlett began in 1929-31 before its formal establishment in 1932; one early type map dates back to 1929. Vic Jensen (Fig. 2), never one to wait around for formal paperwork, was responsible for the early development of northern hardwood research on the Bartlett Forest while his senior compatriot, Marinus Westveld, handled spruce-fir management on the Gale River Forest. Vic is the father of northern hardwood silviculture in New England and Marinus occupies a similar position with spruce-fir.

Figure 2.—Vic Jensen, founder of the Bartlett Experimental Forest, seldom appeared in photos, but here he is on the left with a group of students (D. Gates, J. Miller, W. Schwacke, and D. Lewis) at the upper BEF overlook in 1951. U.S. Forest Service, Northern Research Station, Durham, NH.

The initial work included establishment of exterior and compartment boundaries, laid out with transit, staff compass, and chain – no small feat in rocky, steep, forested country. Although he was the in-charge guy, Vic was right there when it came to this type of field work. Sometimes Vic wore moccasins instead of field boots. His field efforts slackened in later years, but he always kept close track of what transpired on the BEF. I (WBL) can recall scraping red paint off a few trees that, in his and Andy Gilbert's opinion, were not the proper ones to mark for harvesting. Although early annual reports describe the Bartlett as about 3,500 acres in size, the final size was about 2,600 acres. There was some indication in early reports that portions of the acreage below Table Mountain (now part of the Bartlett Expansion described later) were considered for inclusion, but that didn't happen initially. So the original boundary followed Bartlett Brook on the east, the Bear Notch Road on the south, and the ridge line of the Upper, Middle, and Lower Haystacks on the west (Fig. 3). Elevations ranged from about 700 feet at the administration site to about 2,980 feet at the tip of the Upper Haystack.

Early on, names were attached to certain BEF features (Fig. 4). Jensen Brook and Jensen Brook Spur were of obvious origin. Nearby there is Neuts Brook and Neuts Brook Spur, apparently named for Neut Howard, who owned the gas station in the middle of the Bartlett and was a longtime friend of Vic's. Early maps also show an Upper and Lower Neuts Trail. Stanley Road, named after Stan Filip, was constructed somewhere around the early 1950s. Other names are of unknown origin: Shannon Road, Spot Mountain Trail, McKeils Pond (the Ice Pond on early maps), and Louisville Brook. Bear Mountain and Bear Notch reflect the rather high level of bear activity in the area, probably due to the high proportion of beech. In the early 1930s, the Civilian Conservation Corps (CCC) cut a ski slope from the top of Bear Mountain, along the upper bank of the Albany Brook in Compartment 27, and then down to a point near the present-day town reservoir. The trail was used by expert skiers, sometimes for ski races, and then abandoned in the 1940s. Quite evident on early aerial photos, the trail is barely noticeable today.

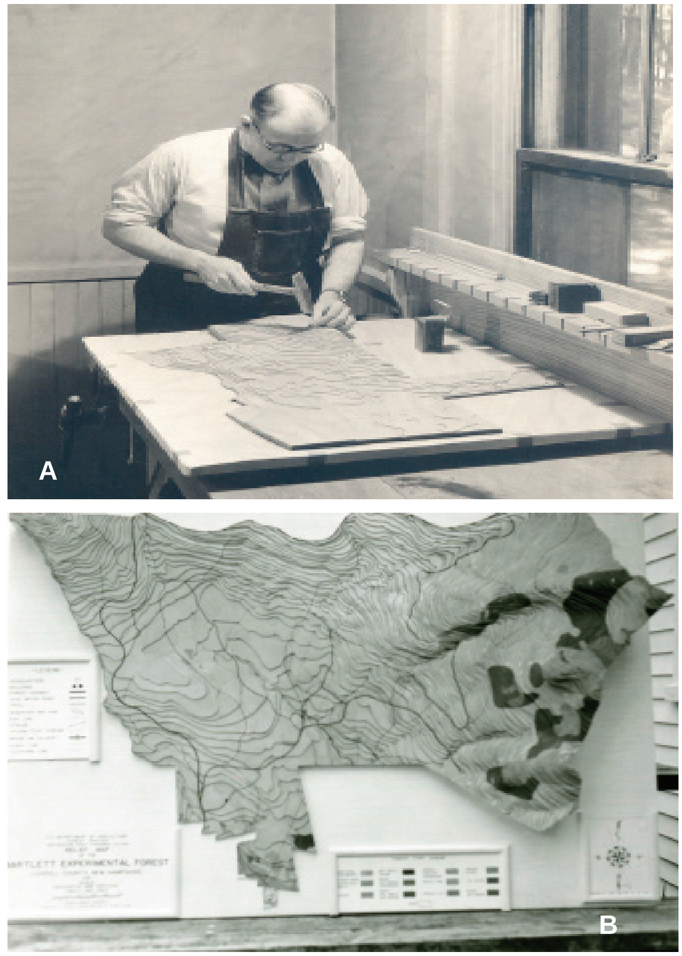


Figure 3.—A BEF fire researcher in the 1930s (Paul Stickel) constructing a 3-D model of the experimental forest (A) with sheets of cardboard carefully cut out and assembled to represent the contours (B). U.S. Forest Service, Northern Research Station, Durham, NH.

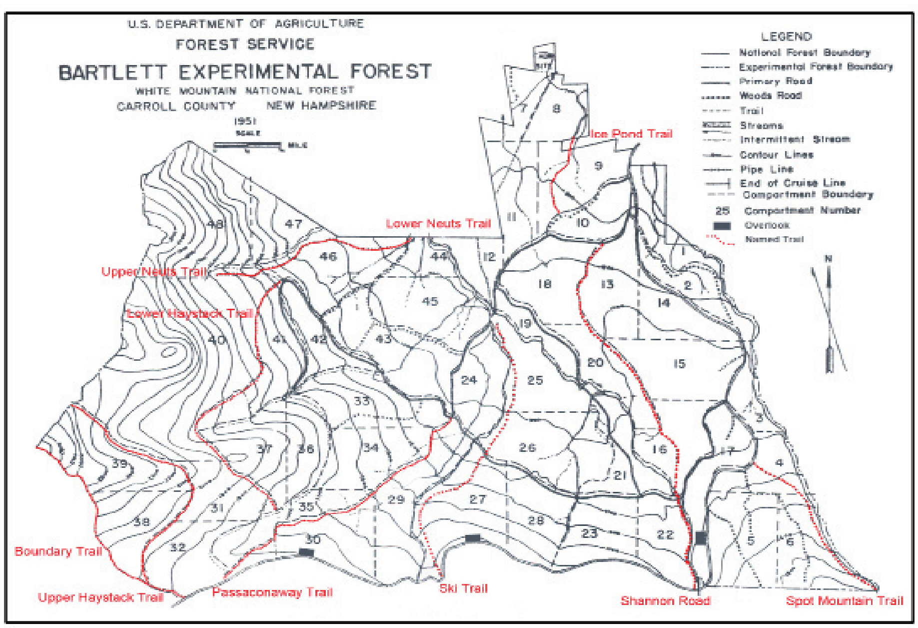


Figure 4.—Map of the Bartlett Forest with notations on historical features. U.S. Forest Service, Northern Research Station, Durham, NH.

When the exterior boundaries were settled, the next major effort was layout of the cruise-plot grid, a series of about 500 mostly 1/4-acre cruise plots along a grid measuring 5 by 10 chains. The major grid lines went north/south on the eastern portion of the forest and east/west on the western portion (Fig. 5). There was no obvious reason for the change in direction on each half of the forest except perhaps to orient the grids at right angles to the contours—i.e., up and down slope to better sample the elevational gradient.

The blazed gridlines, including some of the original yellow paint, are still maintained today, and a few of the original cedar stakes marking the four corners of the plots also may be found. The original measurements were taken in 1931-32, with a followup in 1939-40 (after the 1938 hurricane). Since then, there were partial remeasurements in the 1950s and 1960s of the compartments scheduled for harvesting treatment followed by complete remeasurements in 1991-92 and 2001-03. It is hard to imagine the amount of work required to grid and stake out about 500 plots in that rough country using basic surveying equipment, and to complete the job—along with all the other work—in about 2 years!

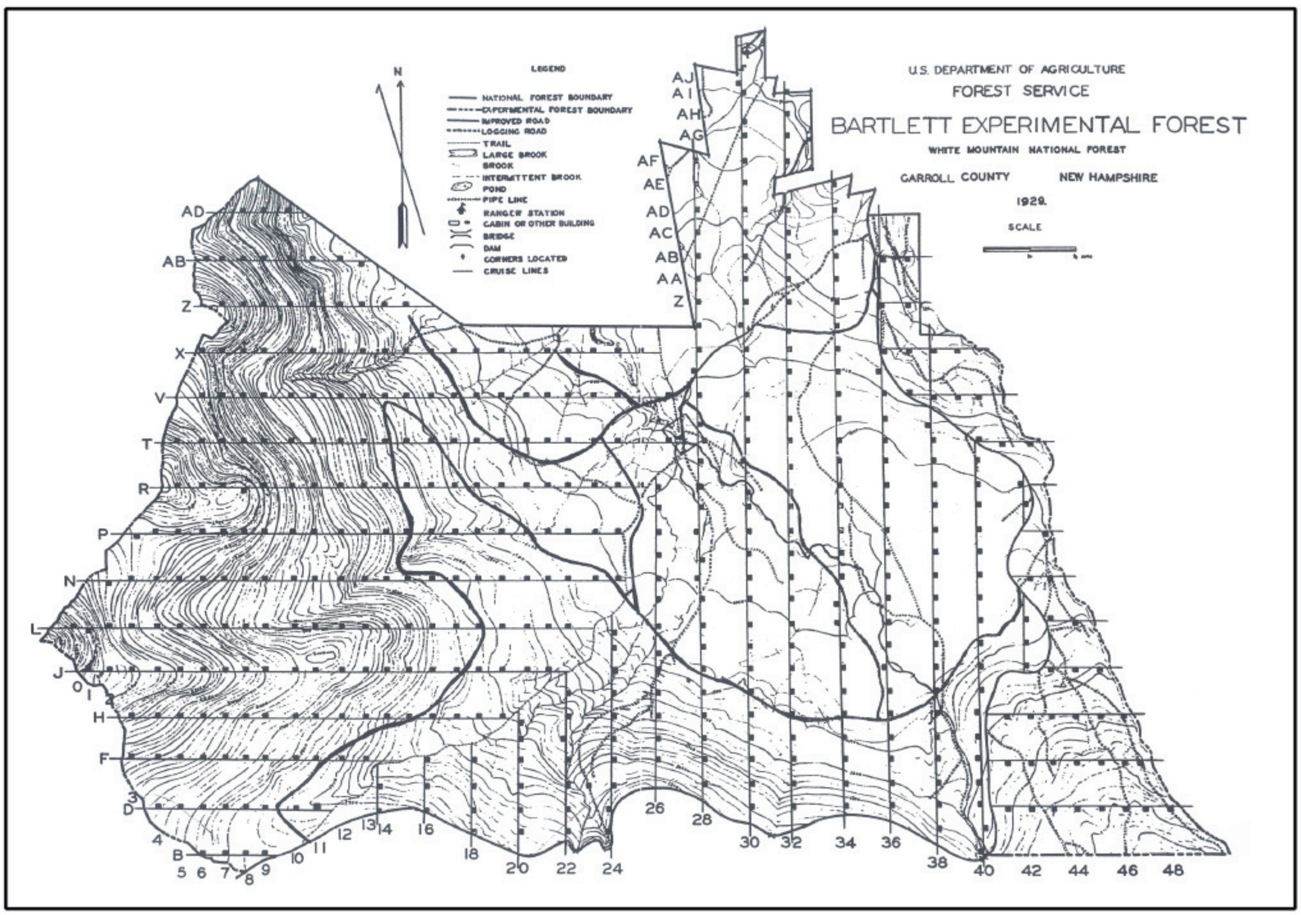


Figure 5.—Layout of permanent plots on the Bartlett Forest as established in 1931-32. U.S. Forest Service, Northern Research Station, Durham, NH.

The pencil-dot tally sheets from the early measurements are still legible, although the information has now been transferred to databases (Fig. 6). These are interesting historical documents containing the names/initials of well-known folks. Between 1931-32 and the early 1950s, we see initials such as VSJ (Victor S. Jensen), GRT (George “Dick” Trimble, who along with Vic Jensen, co-founded the Hubbard Brook Experimental Forest and served as a longtime, well-known project leader on the Fernow Experimental Forest, (Fig. 7)), AG (Al Gottlieg, an early State Forester in Vermont), TN (Ted Natti, longtime State Forester in New Hampshire), RJH (Russ Hutnik, an NEFES employee who then became professor at Penn State, now retired), GED and RW (George Doverspike and Bob Wilson, field project leaders at Bartlett), and, oh yes, WBL (in his student days). Many other names/initials occur of others whose careers are unknown: K. Maki, G.M. Day, J.W. Hendrix, E. Williams, etc.

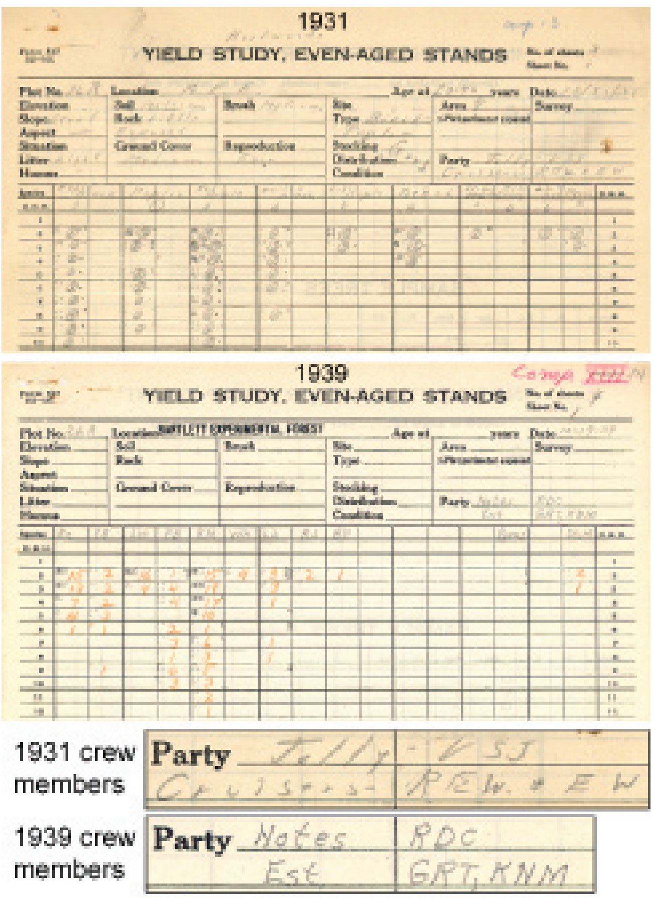


Figure 6.—Examples of 1931 and 1939 cruise-plot tallies showing initials by Vic Jensen (VSJ). George “Dick” Trimble (GRT), Robert Wilson (REW), and others. U.S. Forest Service, Northern Research Station, Durham, NH.

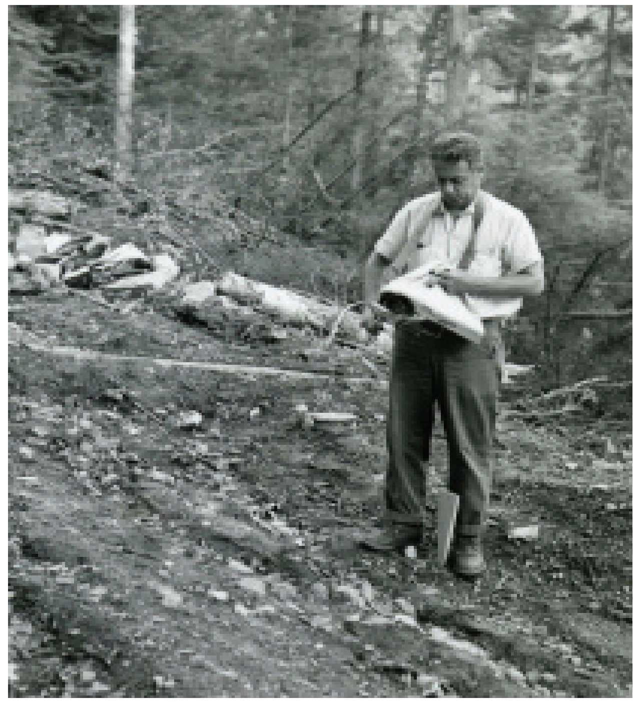


Figure 7.—George “Dick” Trimble assisted with early cruise-plot measurements, helped initiate Hubbard Brook Experimental Forest, and later ran the Fernow Experimental Forest. U.S. Forest Service, Northern Research Station, Durham, NH.

Along with development of the cruise-plot grid was the establishment of compartments, a crucial step in the evolution of the BEF because the entire research program, initially and in the future, would hang on these compartment delineations. In addition to providing the basis for the planning and conduct of the large-scale harvesting experiments, the compartments would provide an organizational (and locational) framework for smaller scale studies. I’m (WBL) sure that Vic gave it the most careful thought. And, although never written down, we can imagine the criteria he developed. First, the units needed to be large enough for commercial timber operations, so that the research results would have practical application. Additionally, they needed to be logical harvesting units. They had to have distinct boundaries (roads, trails, brooks, ridge tops) that would be recognizable forever even if boundary maintenance wavered. Stand condition and topography also were important—old growth vs. evenaged second growth, hardwoods vs. softwoods, inoperable steep slopes, wetlands, etc. By 1934, the first map appeared containing 27 compartments, averaging a little less than 100 acres apiece, numbered with Roman numerals. Boundaries were surveyed, blazed, and painted (two blue dots), and some of the upper compartments (now numbers 39, 40, and 48) as well as one lower compartment (now numbers 25 and 26) were designated as reserved from harvest treatments. These compartment delineations lasted until the early 1950s, when the compartment management era descended on the BEF. One notable study area from this early period was the clearcutting in Compartment 22 during 1933-35 (Fig. 8), which later was the site used for Dave Marquis's (Fig. 9) precommercial thinning study and later (2003) for a commercial thinning study (Fig. 10).

Figure 8.—About 22 acres of Compartment 22 were clearcut harvested in 1933-35. Clearcutting was considered a poor practice at the time, but as the stand developed, that point of view changed radically. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 9.—Dave Marquis joined the project in about 1958 and later became project leader for Allegheny hardwoods in Warren, PA. U.S. Forest Service, Northern Research Station, Durham, NH.

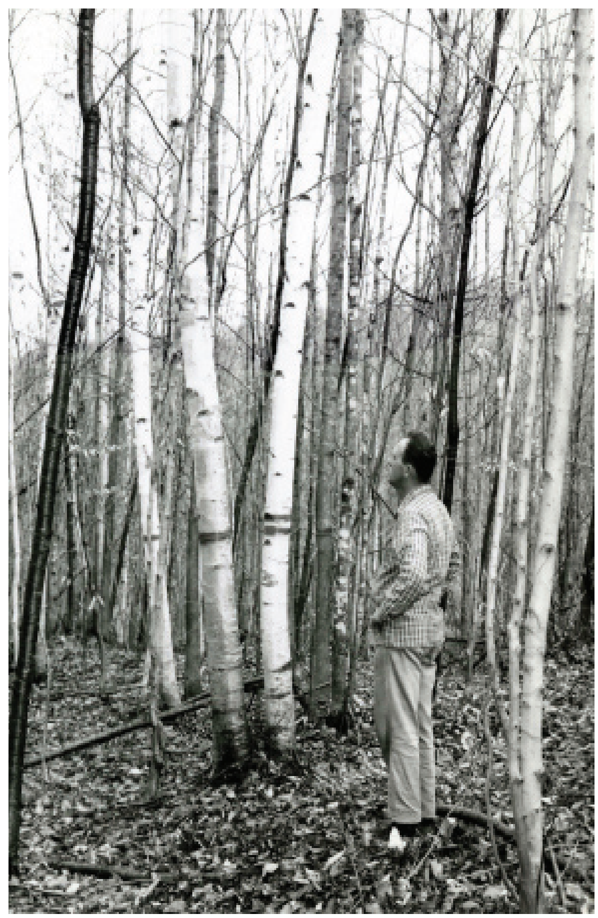


Figure 10.—Merle Grant, forest technician beginning in the mid-1950s, sizing up the stand in Compartment 22 in preparation for precommercial thinning that took place in 1959 (stand age about 25). U.S. Forest Service, Northern Research Station, Durham, NH.

The building program also was in full sway in the early 1930s. By 1934, the CCC crew at Bartlett had built the lodge and cottage, as well as several garages; the office may have been there before Forest Service acquisition. A small office (origin unknown) apparently designed for a district ranger was being used as a tool shed (and still is today); there is some indication from early annual reports that this ranger's office was built there—perhaps the first building on the administrative site (Figs. 11, 12).

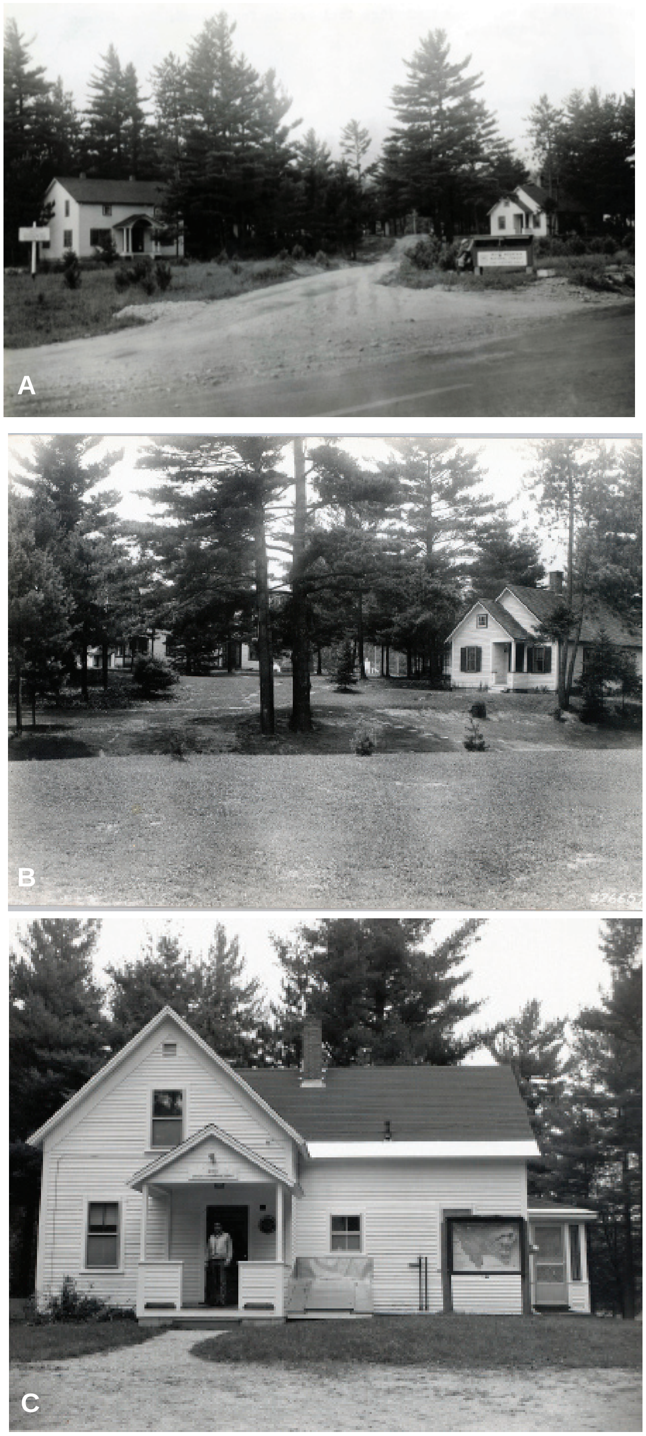


Figure 11.—Early views of the buildings on the BEF headquarters site: the lodge and cottage in 1934 (A) and 1936 (B) and office in 1962 (C). U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 12.—The Bear Notch Road (A) was gravel until the 1950s; previously, it was the site of the Bartlett/Albany railroad track. The BEF interior roads (B) and bridges (C) were well developed by about 1934. U.S. Forest Service, Northern Research Station, Durham, NH.

The 1940s

There is not much to report about Bartlett activities during the 1940s. Assessments of the 1938 hurricane (Fig. 13) were drawing to a close with the result that research on the heavily wind-thrown Gale River Experimental Forest began to close down although activity did not cease until the early 1950s. Another major disturbance first discovered on the BEF in the late 1930s was the beech-scale *Nectria* complex, an exotic disease from Europe that infected most of the beech on the Bartlett and is still spreading throughout the range of beech in the United States (Fig. 14).

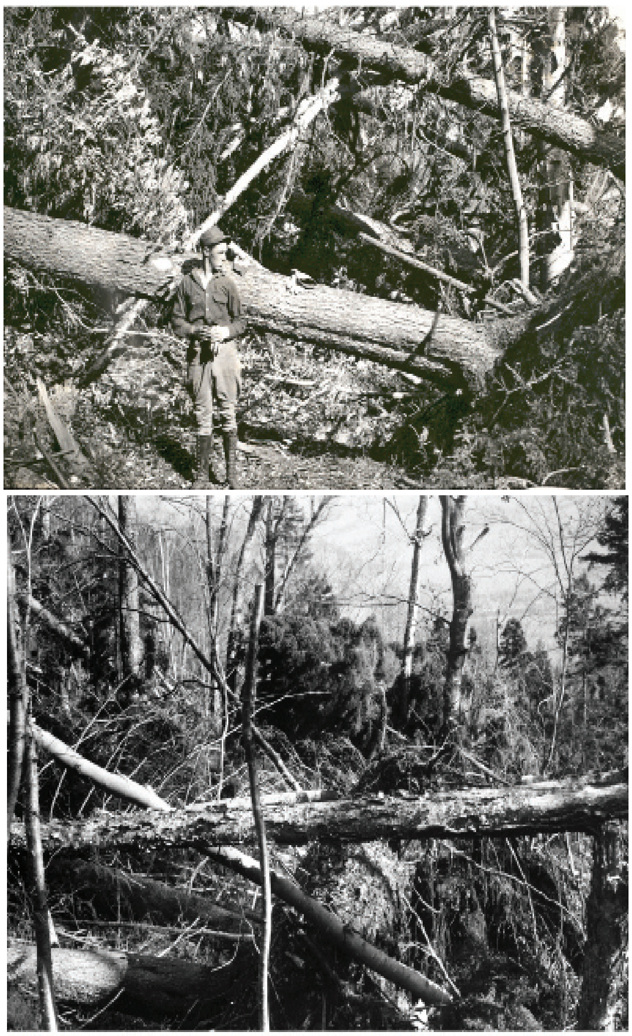


Figure 13.—Damage from the 1938 hurricane was severe in places, especially in the higher elevation softwood types (top photo), but the overall losses were only 14 percent of the stems (Jensen 1941). Hardwood types suffered less damage except in spots such as this stand (bottom photo). Hurricane Carol (1956) was a relatively minor disturbance. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 14.—Beech-scale *Nectria (*an exotic from Europe) was the most widespread disease encountered on BEF. Discovered in the late 1930s at BEF (by Dick Trimble we believe), the disease infected most beech trees (A). However, there was genetic resistance to the scale or the *Nectria* or both. Fifty years of single-tree selection on one compartment (42), where the diseased trees were periodically removed, resulted in a stand with about 70 percent of the sawtimber basal area showing resistance to either the scale or the *Nectria* disease or both (B) (Leak 2006). U.S. Forest Service, Northern Research Station, Durham, NH.

Between 1941 and about 1945-46, the field offices were essentially closed to concentrate personnel and funds toward the war effort. But there were some organizational changes. In 1945, the Allegheny and Northeastern Forest Experiment Stations were combined under the name of the latter and the headquarters moved to Philadelphia. By 1946, the field units were referred to as "branches" or research centers. The Upper Connecticut Branch or Winnipesaukee Branch was now located in Laconia under Vic's direction as center leader. Stan Filip and George Doverspike, who later both worked at Bartlett, joined the NEFES but at other field units.

Compartment Management —the 1950s and 1960s

By 1952, the white pine and hardwood research was combined into the White Pine-Hardwood Research Center under Vic, still housed in Laconia in the Federal Building along with the White Mountain National Forest under Forest Supervisor Gerry Wheeler. Relations were cooperative and productive, as they still are today. WBL can recall (in about 1956) discussions with both Gerry and Elmer Kelso (WMNF head of timber management) about forest management tactics. The WMNF Supervisor's Office was still located in Laconia until the move in 2009 to new quarters in Campton, NH. The Hopkins Forest in Williamstown, MA, under Frank Cunningham, and the Massabesic Forest under Tom McConkey were also part of this center (Fig. 15).

Vic's right-hand "man" was M. "Maggie" Stothart, who was in charge of all the office proceedings and clerks (Fig. 16). Maggie also took care of celebrations and miscellaneous personnel matters. Another stalwart was Robert W. Wilson who worked on hardwood regeneration and thinning studies in the early 1950s and later moved on to Forest Survey; he also served as station statistician for a while. Beginning in about 1950, the main activity at BEF and other experimental forests was installation of the large-scale compartment management studies. Small-scale (5-acre) examples of these compartment studies were known as the Management Intensity Plots and were located in Compartment 17.

Photo by Vic Jensen
U.S. Forest Service

Figure 15.—White Pine - Hardwood Research Center personnel and others in the mid-1950s in front of the lodge at Bartlett. In the front row (left to right): John Bjorkbom, Frank Longwood, Tom McConkey, Arthur Hart, and Grant Davis. In the back row (left to right): Stan Filip, Bill Leak, Frank Cunningham, Bob Curtis, Bob Pierce, Andy Gilbert, and Dick Sartz.

Figure 16.—Maggie Stothart, Vic Jensen's capable administrative support person. U.S. Forest Service, Northern Research Station, Durham, NH.

The compartment studies were designed to provide practical information on costs, yields, and stand development. Impetus for these studies came from Ralph Marquis, station director and economist who arrived in 1951 (Fig. 17). Later support came from Carl Stoltenberg (1956), division chief for economics and survey. Apparently to accommodate the many proposed treatments, the original 27 compartments were renumbered, and some were subdivided, to provide for 48 compartments averaging roughly 50 acres in size. The original study plan (1951) written by Vic Jensen included 27 compartments and about 19 proposed treatments. The treatments included three cutting cycles (5, 10, and 20 years), four levels of residual basal area (40, 60, 80, and 100 square feet/acre) in the selection compartments, four levels of cultural intensity (high order, good, fair, and poor), and a group/patch option (Fig. 18). Trying to schedule and administer the harvesting under this complicated regime was difficult. And the personnel requirements were high. Generally, the entire professional staff, plus a crew of summer students, moved up to Bartlett each summer and spent the entire season measuring compartments with 100-percent inventories partly under the direction of John Bjorkbom and others (Fig. 19). The differences among some treatments (the selection treatments especially) turned out to be

Figure 17.—Ralph Marquis, who became NEFES Director in 1951, at an advisory group meeting on the BEF. Ralph was an economist, who championed the economic aspects of the compartment studies and assembled a sizable group of economic researchers at the headquarters in Upper Darby, PA: Perry Hagenstein, Robert Marty, Robert Manthy, Neil Kingsley, and Barney Dowdle. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 18.—Russ Hutnik was silviculturist at BEF in the 1950s. He was involved in the group/patch selection studies (shown by a slash pile in one of the patches), beech-scale work, and the farm-forties studies—two compartments (1 and 21) set aside to mimic typical farm woodlot practices. Russ later worked on the Fernow and then became professor of silviculture at Penn State. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 19.—John Bjorkbom came from Forest Survey to join the project in the mid-1950s as silviculturist. He worked on skidroad erosion and control (shown here) as well as on all of the compartment studies. U.S. Forest Service, Northern Research Station, Durham, NH.

minimal. It probably was Andy Gilbert (Fig. 20), who became field project leader in the early 1950s, who said that if you had seen one individual-tree selection cut on the Bartlett you had seen them all.

Apparently, in the late 1950s, the headquarters office near Philadelphia also recognized the extreme effort and minimal output from these compartment studies. Stan Filip (Fig. 21), who arrived at Bartlett in the mid-1950s, took charge of field studies. He had the job of revising the management plan to include 12 compartments in a designed and replicated study of the selection system coupled with 6 compartments for case history studies of liquidation, diameter-limit, single-tree selection in evenaged stands, and group/patch cutting (Fig. 22). Stan wrote the designed plan (Filip 1961) and

Figure 20.—Adrian (Andy) Gilbert (center) took charge of the field studies at BEF in the early 1950s. George Yelenosky (right) was a physiologist at BEF for a few years; on the left is an unidentified summer student. Andy brought some traditional European views to the silvicultural program at Bartlett, wrote the first silvicultural guide with Vic Jensen (1958), later became project leader at Burlington, and then became economics division chief in Upper Darby. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 21.—Stan Filip (center) with Dale Solomon (left) and Merle Grant (right) doing a 100-percent tally on one of the single-tree selection (STS) compartments. STS was the core of the compartment studies at the outset, later becoming less popular due to its propensity to regenerate tolerant species (i.e., beech). Stan became project leader for a short time before he retired. Dale went to Orono and then returned to Durham as project leader for growth and yield research. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 22.—Group/patch selection (closeup (A) and aerial view (B) was part of the case-history compartment study. Vic Jensen always spoke highly of the group/patch approach, although the management/control of this system did not become evident until much later when it found a home as a legitimate unevenaged system. U.S. Forest Service, Northern Research Station, Durham, NH.

Bart Blum (Fig. 23) wrote the case history plan (Blum 1963); Bart later became project leader in spruce-fir at Orono. A compartment harvesting schedule up to 1990 was developed. However, only some of the early harvests were completed under this plan before the interest in these compartment studies waned (Fig. 24). The disinterest apparently was due to minimal differences in selection-system results, large areal requirements in view of the still inadequate replication, lack of technical help for the field tally work, and—possibly the major influence —interest in expanding the research program to include more special studies. The 1963 annual report (Northeastern Forest Experiment Station 1963) specifically mentioned the need for more evenaged management research. In about 1959, the thinning study in Compartment 22 was begun under Dave Marquis, and a few years later the stand density study under Dale Solomon was begun in Compartments 2, 3, and 14. Dale hired Sharon Perkins in the late 1960s, the first female summer student to work on the density study (Fig. 25). Alex Shigo also joined the center in about 1959, taking the place of Ken Bromfield who had returned, after a brief sojourn with the center, to biological control work at Fort Dietrick, MD. Alex later (1967) left the project (but not the location) to lead a pioneering project in wood decay and discoloration research.

Figure 23—Bart Blum came to BEF in the early 1960s, wrote the plan for the case-history compartment studies, and later went to Orono to become project leader for spruce-fir research. U.S. Forest Service, Northern Research Station, Durham, NH.

Figure 24.—Horse logging (A) was not uncommon on the BEF up through the 1950s. It was gradually replaced by (B) crawler tractors and finally by (C) rubber-tired skidders. U.S. Forest Service, Northern Research Station, Durham, NH.

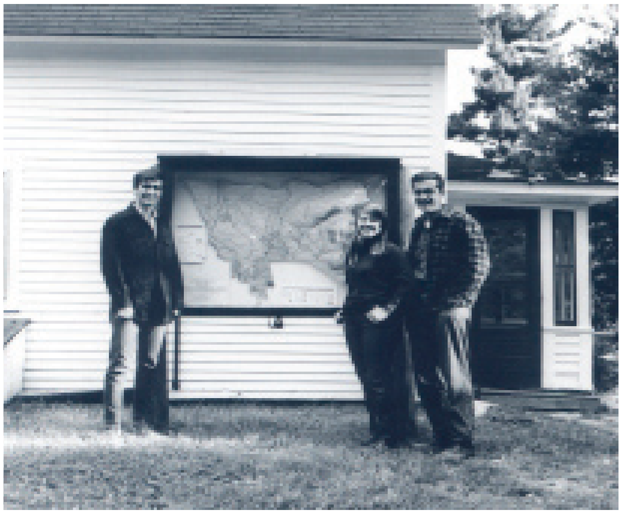


Figure 25.—Sharon Perkins, the first female summer forestry student at BEF, hired by Dale Solomon. U.S. Forest Service, Northern Research Station, Durham, NH.

More organizational changes took place in the early to mid-1960s. The genetics work at NEFES moved to the UNH campus in Durham under Ernie Schreiner. Frank Cunningham came to Durham as work on the Hopkins Forest began to close down, and Ray Graber and Don Thompson, the remaining people assigned to white pine work on the Massabesic, joined the genetics project. Vic Jensen retired and WBL became project leader, and the transition from center leaders to projects and project leaders was about complete. J. P. van Buitenen and Peter Garrett joined the genetics work; each took a turn as project leader, the former for only a year or two. Mike Hoyle joined the northern hardwood project as soil scientist and Larry Safford moved from Orono to Durham in 1970. Larry worked on soil fertility in young hardwood stands in Compartments 18 and 28 and later revised the paper birch guidelines (Safford 1983). These moves heralded the beginnings of a much closer look at soils than ever before, a trend that continued into the 1970s when longstanding cooperative work began with the WMNF on ecologic land typing.

The Durham Lab in the 1970s and 1980s

The new Durham Lab was dedicated in 1973 although the project had moved to rented quarters in Durham in the mid-1960s. Shortly after, Stan Filip took over from WBL for a year or two as project leader. Then Carl Tubbs was moved in from the Lake States as leader of the combined northern hardwood and genetics projects, including what little white pine work still continued. Carl brought some different ideas with him. The first shelterwood-system harvest on the Bartlett in Compartment 21 was Carl's idea. As an avid hunter, he also was very much interested in working on timber/wildlife relationships with Dick DeGraaf from the Amherst project. Then, he further developed the timber/wildlife potential of the project by hiring M. Yamasaki from the National Forest System. This not only heralded a continuing program of timber/wildlife endeavors, but also marked a return to compartment-level studies — areas large enough to have some impact on wildlife habitat conditions. In the mid-1980s, throughout the 1990s, and continuing to the present, compartment-size experimental harvests have included single-tree selection, group/patch harvests, clearcuts, a pine shelterwood, a deferred shelterwood in northern hardwoods, and three harvest systems in hemlock-spruce stands designed to regenerate softwoods: single-tree selection, a strip cut (Fig. 26), and a group shelterwood harvest. Areas of wildlife research associated with these harvests include small mammals, terrestrial salamanders, and of course, songbirds under the guidance of wildlife biologist and Bartlett site manager Chris Costello—of

Figure 26.—Frank Williams, forest technician during the 1970s and 1980s, in a strip cut about 3 years after harvest. It looks like pure pin cherry, but the mix improves greatly after a few years. U.S. Forest Service, Northern Research Station, Durham, NH.

particular and continuing interest because of their close relationship to forest structure and timber harvesting regimes. The latest endeavors include nesting habits and movements of northern goshawks.

Dick DeGraaf, project leader of the Amherst, MA, wildlife unit, moved his field operations from the Kilkenny Guard Station in northern New Hampshire to Bartlett in the late 1980s. Many University of Massachusetts wildlife graduate students found seasonal housing at the cottage and used various study sites on the Bartlett including Dave King and Carly and Richard Chandler.

Peter Garrett became project leader in 1989 after Carl Tubbs retired. Much of his effort had been directed toward genetic plantings on the Massabesic Experimental Forest. However, two of his major marks on the Bartlett were directing the building of the new office/bunkhouse, begun in 1994, and securing dry laboratory space in one of the WMNF construction and maintenance shop buildings south of the Bartlett administrative site. This lab and adjacent conference room were later rebuilt and further improved in 2005-06 (Fig. 27). Additionally, Peter encouraged some of the first forest bat habitat research work in New England done at BEF by University of New Hampshire wildlife students Rachel Stevens and Blake Sasse in the early 1990s.

Photo by Christine Costello U.S. Forest Service

Photo by Ken Dudzik U.S. Forest Service

Figure 27.—New bunkhouse/office building on the Bartlett administrative site (A) and renovated laboratory and conference room (B).

The 1990s and Beyond

History unfolds slowly, and we are sure there will be more to say about the 1990s and 21st century at some later date. But a few significant items deserve mention. In the 1990s, the research at BEF (in and beyond its borders) moved in new directions with remote sensing activities dealing with productivity and foliar chemistry under M.L. Smith, Jen Pontius, and Rich Hallett as well as carbon studies motivated by Dave Hollinger – who was responsible for erecting the Ameriflux tower to monitor CO^2 exchange in Compartment 18. The cruise-plot grid first established by Vic Jensen in 1931-32 proved invaluable in providing long-term productivity estimates as ground-truth for the remote sensing work. Peter Garrett was responsible for acquiring funds and personnel to remeasure the cruise plots in 1991-92 and encouraging a program of repeated measures on these valuable-long-term assets. Mike Medeiros led the 1991-92 inventory crew and provided considerable breeding bird inventory support in subsequent years.

Walter Shortle and Kevin Smith installed a long-term softwood rot study in the southern end of Compartment 15 in 1995 using oxen to move large, freshly cut red spruce logs to their final resting place (Fig. 28). After the ice storm of 1998, they installed a set of long-term decay plots on the upper part of the forest in Compartments 30 and 34.

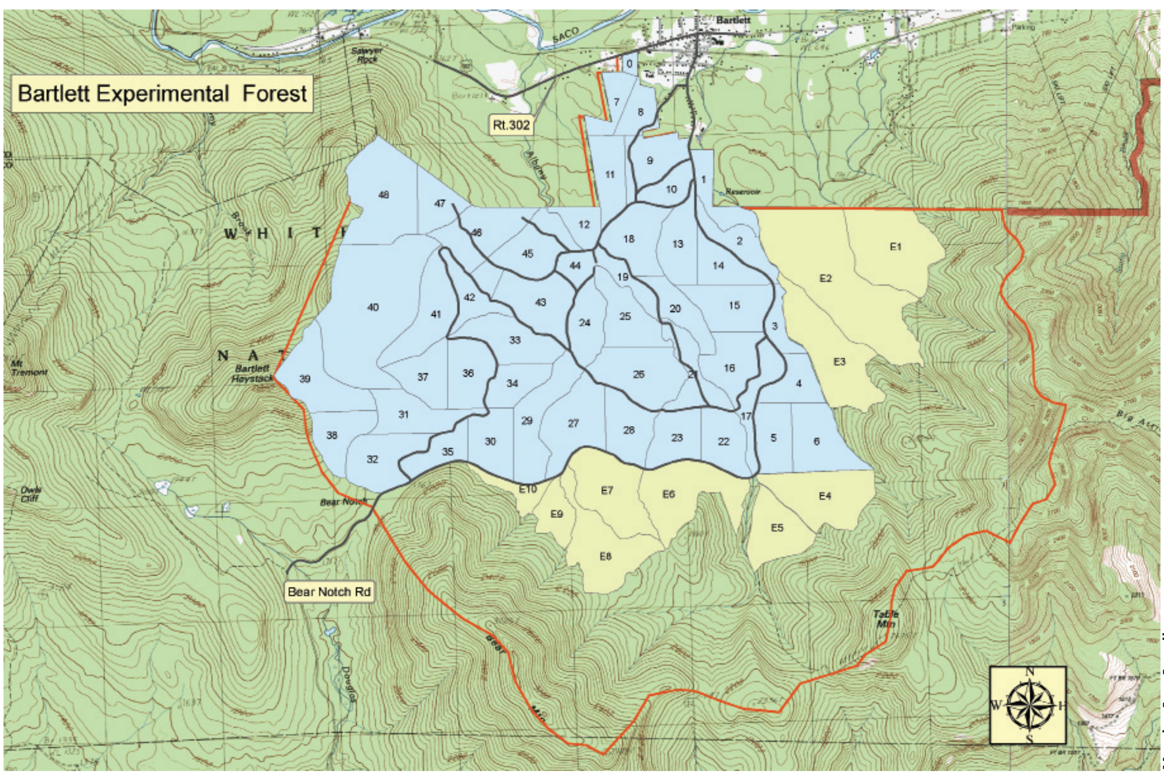
John Brissette took over as project leader in 1997, combining the Penobscot and Bartlett programs under one work unit. One major development during John's reign has been the Bartlett Expansion Area, a move facilitated by Steve Fay, soil scientist on the WMNF. The expansion area is a 3,189-acre addition to the existing BEF through the efforts of the WMNF and formalized through completion of the WMNF Plan in 2005. It lies to the south and east of the BEF (Fig. 29).

Photo by Ken Dudzik
U.S. Forest Service

Figure 28.—Nip and Tuck, the local oxen team that helped install the long-term red spruce decay plot in Compartment 15 in October 1995.

The upper boundary follows the ridgeline along Bear, Table, and Big Attitash Mountains. Together with the existing ridgeline boundary over the Haystack Mountains, the Bartlett now encompasses the entire watershed of the Bartlett, Louisville, and Albany Brooks and their associated streams and tributaries.

About half of the expansion area carries the Management Area designation of 6.1 lands, lands that are too high and steep to be suitable for timber harvesting. The highest peak is Bear Mountain at 3,217 feet. This nonharvest restriction remains in effect for any future harvesting proposals. During the summer of 2006, the lower portions of the expansion were divided into proposed compartments based primarily on physical features such as roads, trails, and brooks and secondarily on broad stand type/condition classes. The upper reaches of these compartments were determined by conditions of stoniness, shallow bedrock, and slope where harvest activity would be restricted; in all cases, the upper limits were below the 6.1 line. Ten compartments were established and the boundaries were designated by blue paint or recognizable physical features. The total area in these compartments is 908 acres—leaving nearly 2,300 acres in upper elevation forest. A number of large clearcuts (up to 40 acres and 30 to 40 years old) were in the expansion area, providing a diversity of stand conditions. Adding to the variability are the upper elevation stands, which include patches



Map by Jon Janelle
U.S. Forest Service

Figure 29.—Outline of the BEF Expansion Area, also showing the lower elevation compartments in the area.

of old-growth spruce. Work currently is underway to define upper elevation compartments.

Timber harvest studies already are operational in the expansion area. Current emphasis is on softwood regeneration, a new phase in BEF research. Although timber values in softwood (especially hemlock) are not high, the wildlife habitat values are unique – snowshoe hare, red squirrels, and related predators such as weasels, mink, fisher, goshawks, and even marten.

Major Bartlett Findings

Since its inception, the research findings from the Bartlett Experimental Forest have been conveyed to thousands of practicing foresters, forestry and wildlife students, land managers, and national and international visitors through combinations of show-me trips, educational tours, workshops, and conferences. Guest books recount visits by Forest Service chiefs (Ed Cliff, John McGuire), well-known foresters and silviculturists from the past (Dave Smith, Ernest Gould, Carl Arbogast), and international visitors interested in northern hardwood silviculture and wildlife habitat from numerous countries (Canada, China, Japan, South Korea, Poland, Ireland, France, Norway, Iran, Turkey, England, and Mexico among others).

In this publication, it would be difficult to list and cite all the work that has been done at Bartlett; a companion publication is currently underway to fulfill this need. So, this summary provides a very general overview of some of the findings that seem to have usefulness and lasting value with particular emphasis on northern hardwoods.

- **Regeneration**: Any form of harvest (or no harvest at all) results in regeneration and understory development. The real concern is species composition. In areas of granitic soils (the Bartlett condition), something more than tree-by-tree removal (e.g., patches, groups, strips, clearcuts) is generally needed to maintain a diverse component of valuable species.
- **Site**: Site conditions (soils, glacial deposit, and bedrock type) have important effects on the range of species that can feasibly be regenerated and grown. This seems to be a competitive thing, because most species grow best on good rich soils. However, it is difficult to regenerate nutrient-demanding species (white ash, sugar maple, basswood) on poor soils and, conversely, to regenerate non-demanding species (softwoods, oak, pine) on rich soils. Some species, beech for example, are aggressive on a wide range of sites; and pioneer species (pin cherry, quaking aspen, gray/paper birch, etc.) will regenerate on almost any open, disturbed site.
- **Intermediate Cuts**: The earliest commercial thinning study on BEF began in 1936. It showed, of course, that thinning improved diameter growth at breast height (d.b.h.) and increased total volume yields. More interesting, perhaps, is that the research writeup described the reverse J-shaped stand structure of evenaged northern hardwood stands due to species layers – intolerant/intermediate species in the overstory and midstory with tolerant species in the understory, which resulted in the reverse J-shaped condition. Another interesting development is that this study provided early d.b.h. response figures that could be compared with a very comparable thinning study in 2003. Essentially, released trees in 2003 grew at least as fast as those released in 1936 (except for paper birch), raising doubts about the presumed effects of nutrient depletion, acid rain, global warming, etc. This latter study was carried out in Compartment 22, where an early precommercial thinning study was installed in 1959. The precommercial work showed a d.b.h. growth increase of about 50 percent, but over time the effects of the thinnings were only moderate—possibly not enough to warrant the expense. Some years earlier, pruning studies showed that hardwood pruning was biologically feasible; due to potential increases in hardwood grade and value, it would appear that the practice would catch on, but it hasn't as yet.

- **Growth**: A major growth study was established in 1964 by Dale Solomon comparing four levels of stand density and three stand structures measured in terms of percent sawtimber. Results showed that northern hardwoods grow about 1/2 cord per acre per year, and that best growth occurs with 60 to 80 square feet residual basal area with 25 to 30 square feet sawtimber, a much lower proportion of sawtimber than was previously thought acceptable. An added feature from this study was the finding that northern hardwoods develop a roughly reverse J-shaped/sigmoid-shaped diameter distribution following a wide variety of residual structures – indicating that following a rigid reverse J-shaped structure when marking is not required. More important are good marking practices, good growth response, and acceptable regeneration.
- **Harvest Systems**: Although individual-tree selection has long been touted as the superior harvesting system, there are concerns that it minimizes species diversity through encouragement of primarily tolerant species. Group selection counteracts this tendency and provides a means for efficiently harvesting patchy stands. Clearcutting also works well in northern hardwoods and provides needed early successional wildlife habitat.
- **Long-term Productivity**: As mentioned above, tree growth apparently has not declined over the 75-year history of the Bartlett. In addition, trends in species composition have followed the pattern of natural succession, which has proven to be the dominant agent of change. Elevational distribution of species has not changed materially. There is no indication as yet that the many environmental concerns – climate change, nutrient depletion, declines of species – have had any material effects. There are some indications that early successional species, initiated through patches or clearcuts, will maintain rich upper soil layers by means of nutrient-rich leaf-fall.
- **Songbird Breeding Habitat**: Breeding bird surveys conducted in managed forest openings of various sizes on BEF and adjacent WMNF have shown that regenerating clearcuts (15 to 20 acres), patch cuts (3 to 5 acres), group selection cuts (0.3 to 2.0 acres), and low density shelterwoods create ephemeral early successional or brushy habitat not typically found within older stands that are unmanaged or managed by single-tree selection. However, these surveys also suggest that the larger openings created by clearcutting or patch cutting accommodate a more diverse group of early successional birds than group selection or low density shelterwoods. This is of current interest for a couple of reasons. First, a large number of early successional bird species are showing declines due to habitat loss both here and on their wintering grounds. Secondly, despite the benefits of clearcutting as a management tool, its use continues to decrease due to public sensitivity to the appearance of larger forest openings and perceived detrimental effects on wildlife habitat and forest health. Partial cutting under both the group selection system and low density shelterwood cuts retain some of the mature forest bird community while providing for a limited number of early successional species. The proportion of the two communities depends on the amount of residual basal area.
- **Songbird Post-Fledging Habitat**: Results of mist-net captures in clearcut and patch cut openings during the migration period showed that these areas provide significant post-fledging habitat for mature forest birds in addition to early successional birds due to increased protective cover and high insect and fruit abundance. This study further highlights the importance of forested openings on the landscape.

  Post-fledging habitat selection and survival of ovenbirds was studied using radio telemetry during two breeding seasons. In the literature, ovenbird habitat is typically described as forests consisting of large deciduous trees and an open understory. These conclusions are based largely on results of point count surveys during the nesting season. However, this study noted a significant shift in habitat selection between the nesting period and the post-fledging period. Fledgling ovenbirds appear to use habitat characterized by few large trees and greater vertical structure than ovenbird nest sites. Furthermore, fledgling survival increased significantly with increased vegetative structure. These results suggest that current habitat relationships based on point count surveys alone may provide only a partial understanding of the habitat requirements of bird species that may alter their habitat use after nesting

- **Raptors**: Broadcast surveys using recordings of great horned, screech, barred, and northern saw-whet owls were conducted to determine the presence or absence of these species on the Bartlett. Surveys were conducted during the time period believed to coincide with pair formation and territorial establishment of individual species and confirmed the presence of barred and saw-whet owls. Barred owls were the most common species detected during the 16-year survey period. Yearly response rates are extremely variable and may be related to prey availability and winter severity.

  Northern goshawks have been breeding on the lower slope of the Bartlett since at least 1995. This nesting territory has been monitored during the last 15-year period and is a component of a larger study that describes goshawk nesting habitat characteristics and compares nesting habitat with available habitat across the WMNF and New Hampshire forest landscapes. A minimum of four adult females have occupied this nesting territory over the survey period.

- **Terrestrial Salamanders**: Sensitivity of northern redback salamander habitat to evenaged management was observed on cover board transects that bisected stand edges of mature northern hardwoods and three stages of evenaged stands (regeneration from 0 to 9 years, saplings, and poletimber). Redback salamander recovery rates even along edges post-harvest may take about 30 years. Salamander counts vary seasonally: early spring and late summer counts were higher than early- to mid-summer and fall counts, and yearly patterns of abundance were related to overall precipitation. Redback salamander distributions were not related to the percent cover of downed woody debris, different from findings in other parts of the range of redback salamanders.

- **Bats**: Broadband ultrasonic detection surveys revealed significantly higher rates of flight activity in regenerating hardwood and softwood stands and older hardwood stands than in other forest size classes. Bat foraging activity was highest in small regenerating softwood group cuts. Flight activity was highest along habitat features such as trails and still water; feeding activity was highest over still water. Little brown males and northern long-eared bats were the most commonly trapped bats.

  Female northern long-eared bats also were captured, radiotagged, and followed back to day roosts to learn about the type and condition of commonly used roost sites. Of the roost trees used by northern long-eared bat females, two-thirds were dead snags. Beech, sugar maple, yellow birch, and red maple were the most commonly used species. Roost snags were larger, had more remaining bark attached, and were less decayed than random snag samples in the surrounding area. Roost sites had larger live-tree diameters and more snag basal area than the surrounding forest.

- **Small Mammals**: Six species make up more than 90 percent of the small mammals trapped over a wide range of habitat conditions on the BEF: short-tailed shrew, red-backed vole, woodland jumping mouse, deer and white-footed mouse, and masked shrew. The less commonly seen small mammals (star-nosed and hairy-tailed moles; long-tailed, smoky, pygmy, and water shrews; meadow, rock, and woodland voles; southern bog lemming; and meadow jumping mouse), except for the northern bog lemming, have all been trapped at one time or another on the Bartlett. Both northern and southern flying squirrels, red and grey squirrels, and eastern chipmunk have also been observed on the Bartlett. Patterns of occurrence and abundance vary annually, quite likely in relation to the occurrence of large mast crops. Silvicultural treatment has minimal influence over small mammal populations.

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Scientific Names of Trees and Animals Mentioned in the Text

Trees

Common name	Scientific name
Balsam fir	*Abies balsamea*
Red maple	*Acer rubrum*
Sugar maple	*Acer saccharum*
Yellow birch	*Betula alleghaniensis*
Paper birch	*Betula papyrifera*
Gray birch	*Betula populifolia*
Beech	*Fagus grandifolia*
White ash	*Fraxinus americana*
Red spruce	*Picea rubens*
Eastern white pine	*Pinus strobus*
Quaking aspen	*Populus tremuloides*
Pin cherry	*Prunus pensylvanica*
Northern red oak	*Quercus rubra*
Basswood	*Tilia americana*
Eastern hemlock	*Tsuga canadensis*

Animals

Common name	Scientific name
Amphibians	
Northern redback salamander	*Plethodon cinereus*
Birds	
Northern goshawk	*Accipiter gentilis*
Eastern screech-owl	*Megascops asio*
Great horned owl	*Bubo virginianus*
Barred owl	*Strix varia*
Northern saw-whet owl	*Aegolius acadicus*
Ovenbird	*Seiurus aurocapillus*

Mammals

Masked shrew	*Sorex cinereus*
Water shrew	*S. palustris*
Smoky shrew	*S. fumeus*
Long-tailed shrew	*S. dispar*
Pygmy shrew	*S. hoyi*
Short-tailed shrew	*Blarina brevicauda*
Hairy-tailed mole	*Parascalops breweri*
Star-nosed mole	*Condylura cristata*
Little brown bat	*Myotis lucifugus*
Northern long-eared bat	*M. septentrionalis*
Snowshoe hare	*Lepus americanus*
Eastern chipmunk	*Tamias striatus*
Gray squirrel	*Sciurus carolinensis*
Red squirrel	*Tamiasciurus hudsonicus*
Northern flying squirrel	*Glaucomys sabrinus*
Southern flying squirrel	*G. volans*
Deer mouse	*Peromyscus maniculatus*
White-footed mouse	*P. leucopus*
Southern red-backed vole	*Clethrionomys gapperi*
Meadow vole	*Microtus pennsylvanicus*
Rock vole	*M. chrotorrhinus*
Southern bog lemming	*Synaptomys cooperi*
Northern bog lemming	*Synaptomys borealis*
Meadow jumping mouse	*Zapus hudsonius*
Woodland jumping mouse	*Napaeozapus insignis*
American marten	*Martes americana*
Fisher	*M. pennanti*
Ermine	*Mustela ermine*
Long-tailed weasel	*M. frenata*
Mink	*Neovison vison*

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