HISTORY OF THE PENOBSCOT EXPERIMENTAL FOREST, 1950-2010

Laura S. Kenefic and John C. Brissette

Abstract.—Though the U.S. Department of Agriculture, Forest Service has been studying the forests of the northeastern United States since the late 1800s, long-term studies were not common until experimental forests were introduced in the 20th century. These forests were established for long-term experimentation, and research questions were defined by local forest management needs. The Penobscot Experimental Forest (PEF) in east-central Maine is an example of the success and evolution of the experimental forest model. The PEF was purchased by forest industry for research by the Forest Service, and later donated to the University of Maine Foundation. Throughout its history, the PEF has been defined by successful collaboration in research. Today, the PEF is known for world-class research on northern conifer silviculture and ecology, and work continues to evolve to address research questions beyond the scope envisioned by the original proponents of the site.

INTRODUCTION

The conifer-dominated forests of northern New England (Fig. 1) and adjacent Canada have long been critical to the region's economy. The northeastern United States was a leader in softwood lumber and pulpwood production by the mid- to late-1800s (Whitney 1994, Wilson 2005), and the region's heavily utilized northern conifer forest was largely cut over by the early 20th century (Irland 1999). Widespread cutting of progressively smaller trees caused forest degradation and led to concerns about resource sustainability (Judd 1997), yet demand for wood products continued to grow.

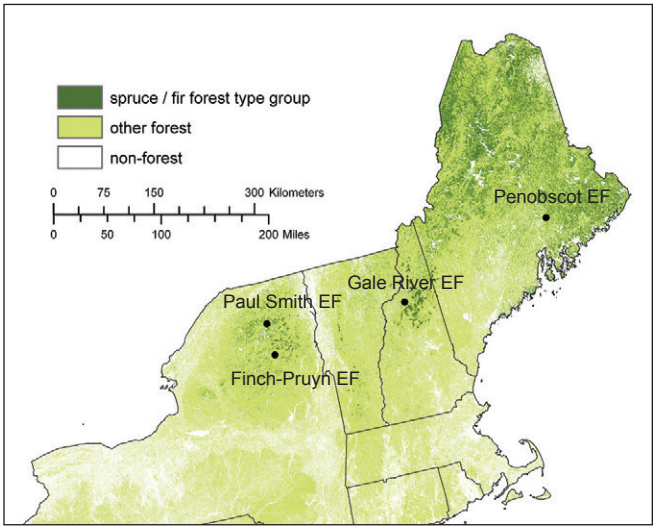

Figure 1.—Location of the northern conifer (previously called spruce-fir) forest in the northeastern United States, courtesy of B. Tyler Wilson, U.S. Forest Service, Forest Inventory and Analysis.

Though the U.S. Department of Agriculture (USDA), Forest Service had been conducting observational studies in the northern conifer (previously called spruce-fir) forest type since the 1890s (e.g., Graves 1899, Hosmer 1902, Murphy 1917, Zon 1914), manipulative research did not begin until experimental forests (EFs) were established in the 1920s. Establishment of EFs in the Northeast occurred shortly after the Forest Service formalized its research program in that region with the creation of the Northeastern Forest Experiment Station (now the Northern Research Station) in 1923 (Kenefic et al., in press). At that time, the northeastern pulp and paper industry manufactured more than half the nation's wood pulp and contributed substantially to the region's social and economic welfare (Meyer 1929, Westveld 1938).

The Forest Service's silvicultural experimentation in northern conifers began in 1926 at the Gale River EF (44°51′ N, 68°37′ W) in the White Mountains of New Hampshire. Research there was conducted under the direction of Marinus Westveld, the "Father of Spruce-Fir Silviculture." Additional experiments in northern conifer silviculture were initiated in 1934 and 1945, respectively, at the Finch-Pruyn (44°00′ N, 74°13′ W) and Paul Smith (44°26′ N, 74°14′ W) EFs in the Adirondacks of New York. Studies demonstrated the importance of establishing advance softwood regeneration prior to removing the overstory (Westveld 1930, 1931, 1938), using mechanical and chemical treatments to release overtopped softwoods (Curry and Rushmore 1955, Westveld 1933), and retaining sawtimber in managed stands (Recknagel et al. 1933). Despite these accomplishments, all three EFs were closed by the middle of the 20th century. The Gale River EF was destroyed in the New England Hurricane of 1938 (U.S. Forest Service 1939), and changes in research priorities and staffing led to closure of the Finch Pruyn and Paul Smith EFs (Berven et al. 2013).

Industrial use of the northern conifer forest continued to be heavy, particularly in Maine, where large acreages were owned by forest industry (Whitney 1994). Without Forest Service research, forest product companies would have had little scientific basis for their management (Kenefic et al., in press). Prior to the McIntire-Stennis Act of 1962, the capacity of university faculty to conduct forestry research was limited (Thompson 2004). As a consequence, the Forest Service was the sole source of information about many forest management topics, especially in the northern conifer forest.

A NEW EXPERIMENTAL FOREST

Louis Freedman, woods manager and superintendent of the Penobscot Chemical Fibre Company, suggested that forest industry purchase land for a new Forest Service experimental forest. The search for a suitable area in Maine began in earnest in the late 1940s. A number of criteria were specified for the property: 2,500 to 4,000 acres of land, all-weather road access, and location within 30 to 35 miles of a town. Though more than 20 areas were considered, one was deemed "superior in every respect."[1] The selected tract consisted of 3,800 acres owned by the Eastern Land Company in the towns of Bradley and Eddington on the east side of the Penobscot River (Fig. 2).

Repeated partial cutting had occurred on this parcel, but the forest contained large acreages of operable red spruce (*Picea rubens* Sarg.), balsam fir (*Abies balsamea* [L.] Mill.), and eastern hemlock (*Tsuga canadensis* [L.] Carr.), as well as hardwood and mixedwood stands dominated by red maple (*Acer rubrum* L.) and birch and aspen (*Betula* and *Populus* spp.). Two maps and unpublished reports[2] describe the forest land prior to the establishment of the experimental forest. A survey of the property in 1929 reports:

> The greater part of this area is second growth caused by an old burn and now has a growth of spruce, fir and poplar 5-8" dbh.[3] The balance of the area is old growth[4] having a stand of spruce, fir and hemlock, some pine and cedar. This area has all been cut off in [the] past five years for a mark of rather small saw logs, some as recent as last year, and there is now left standing spruce, fir and hemlock 5-8" [dbh] with a few trees of larger size. All of this land has a good growth of soft woods, spruce, fir and hemlock also poplar seedlings and saplings. A very thrifty stand.

An unpublished, undated report, "Statement Regarding a Proposed Experimental Forest, Bradley and Eddington Townships, Maine," further describes the land. Reference to a cruise by the Sewall Company in 1947 suggests that the report was written after that date, but before the experimental forest was established in 1950. The site is described as follows:

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[1] Unpublished reports are on file with the U.S. Forest Service, Northern Research Station in Bradley, ME.

[2] Unpublished reports are on file with the U.S. Forest Service, Northern Research Station in Bradley, ME.

[3] Diameter at breast height.

[4] The term "old growth" refers to older trees, not old-growth forest.

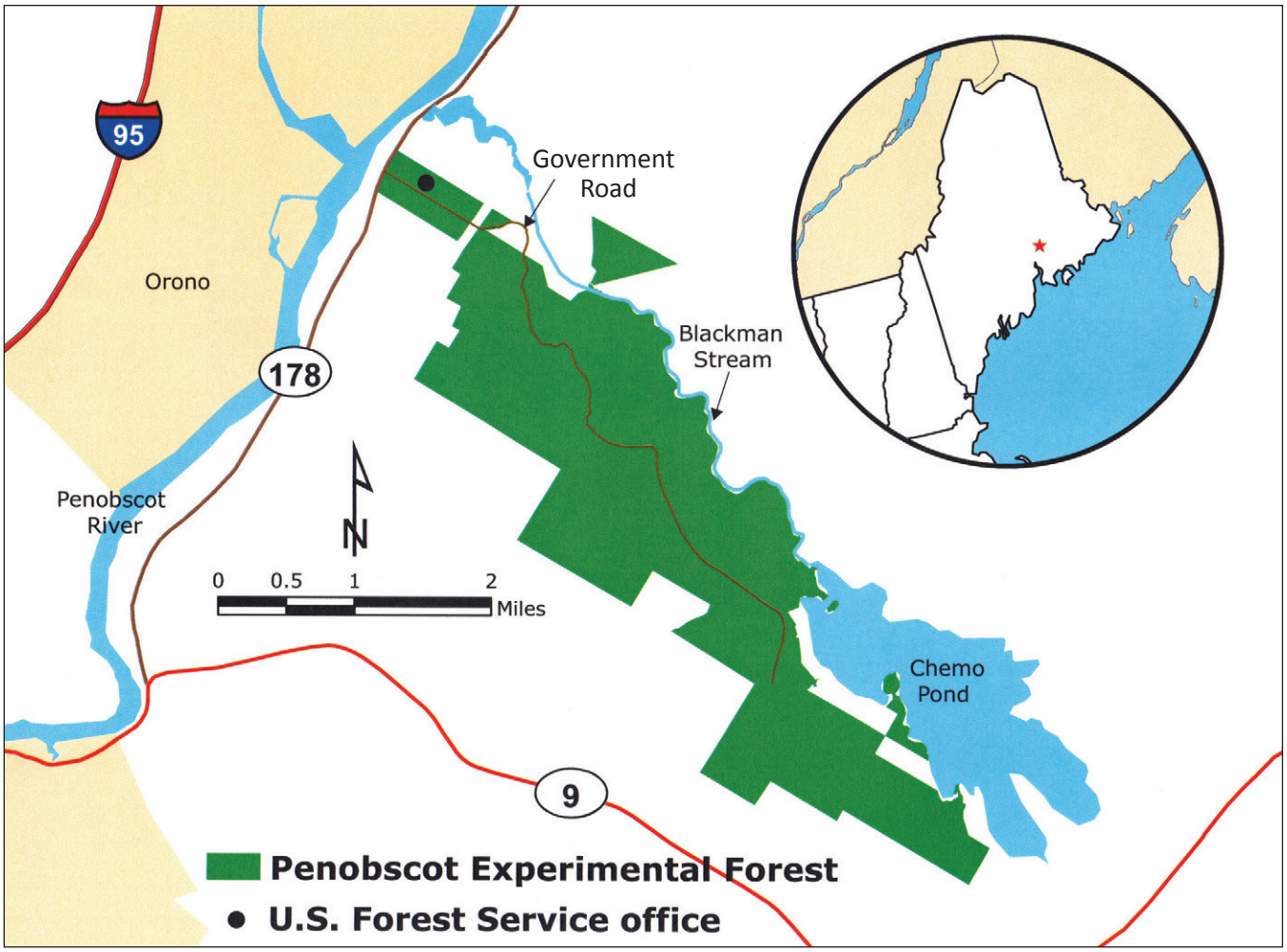


Figure 2.—Location of the PEF; map by Dale Gormanson, U.S. Forest Service, Forest Inventory and Analysis.

Practically all the area is well suited for growing spruce and fir. Heavy cutting and fires in the past have reduced the softwood types to their present distribution but the presence of spruce and fir reproduction throughout is evidence that these species are on their way back. The growth rates of spruce and hemlock are very good. Indications are that balsam fir makes very rapid growth for a short period—perhaps 40 years—then gradually goes into a decline.

The timber is all fairly young second growth, i.e. no overmature stands, in good condition, except for the fir which is showing signs of decay. One feature of the softwood stands which makes the tract particularly adaptable for research is the all-aged nature of the forest. This will permit immediate harvest cuttings on an experimental basis without the necessity for waiting until satisfactory stand conditions develop. A wide range of operating conditions is represented, from barely operable stands up to some carrying 10 or 12 cords per acre. Similarly, the non-operable portions range from young softwood stands which will be ready to cut in eight or ten years, to sprout hardwood stands where cutting will not be possible for 25 years or more.

The Penobscot Experimental Forest

The Eastern Land Company tract was selected for a new experimental forest and purchased in common and undivided ownership by nine industrial and land-holding companies: Great Northern Paper, Hollingsworth & Whitney, Oxford Paper, Eastern Corporation, S.D. Warren, Penobscot Chemical Fibre, International Paper, St. Regis Paper, and Dead River.

The land was leased to the Forest Service, which established the Penobscot EF (PEF, 44°53′ N, 68°39′ W) (Fig. 3). An American Forest Products Industries, Inc., press release at the time stated that this was "the first instance in the annals of American forestry in which a group of wood-using industries have united to purchase a large tract of timberland solely for lease to the federal government for experimental work" (Fig. 4).

Figure 3.—Sign on the PEF listing names of the landowners, circa 1950s. Photo by U.S. Forest Service.

Figure 4.—Photograph taken on September 26, 1952 of representatives of the nine companies that purchased the land for the PEF, with U.S. Forest Service staff and cooperators. In 2010, Forest Service, industry, and university retirees identified the following: Robert I. Ashman (University of Maine, 2nd from left), Louis J. Freedman (Penobscot Chemical Fibre Co., 3rd from left), Dwight B. Demeritt (Dead River Co., 6th from left), and Ed Giddings (Penobscot Chemical Fibre Co., 11th from left). Also: Robert True (S.D. Warren, 2nd from right), Gregory Baker (University of Maine, 7th from right), Art Randall (University of Maine, 9th from right), Paul Patterson (Great Northern Paper Co., 11th from right), and Henry Plummer (University of Maine, 13th from right). Photo by U.S. Forest Service.

The PEF is located south of the large industrial ownerships of northern Maine, on the southern edge of the Acadian Forest (Braun 1950, Rowe 1972). It has a much larger component of eastern hemlock than forests to the north. To increase the relevance of the study to the industrial landowners, the long-term Forest Service experiment was established in the portions of the PEF with the most spruce and fir; these sites were also more poorly drained and less productive than the portions of the forest supporting northern hardwoods (Fig. 5).

When the long-term experiment began, species composition across the study area was (in terms of basal area) 30 percent hemlock; 20 percent fir; 16 percent spruce; 12 percent northern white-cedar (*Thuja occidentalis* L.); 9 percent red maple; and 4 percent each eastern white pine (*Pinus strobus* L.), paper birch (*B. papyrifera* Marsh.), and "other." Diameter distributions (graphs of number of trees per acre by diameter class) were reverse-J shaped, with few if any trees per acre in the large sawtimber classes. These distributions reflect the presence of scattered older residuals from past cutting in otherwise aggrading stands composed of released advance and new regeneration. The forest age structure was irregularly uneven-aged.

Forest Service Research on the PEF

Station employees held different opinions about the direction that Forest Service research should take in Maine. Westveld was nearing retirement, but continued observational studies of silvics and fundamental silviculture. New silviculturist Thomas F. McLintock

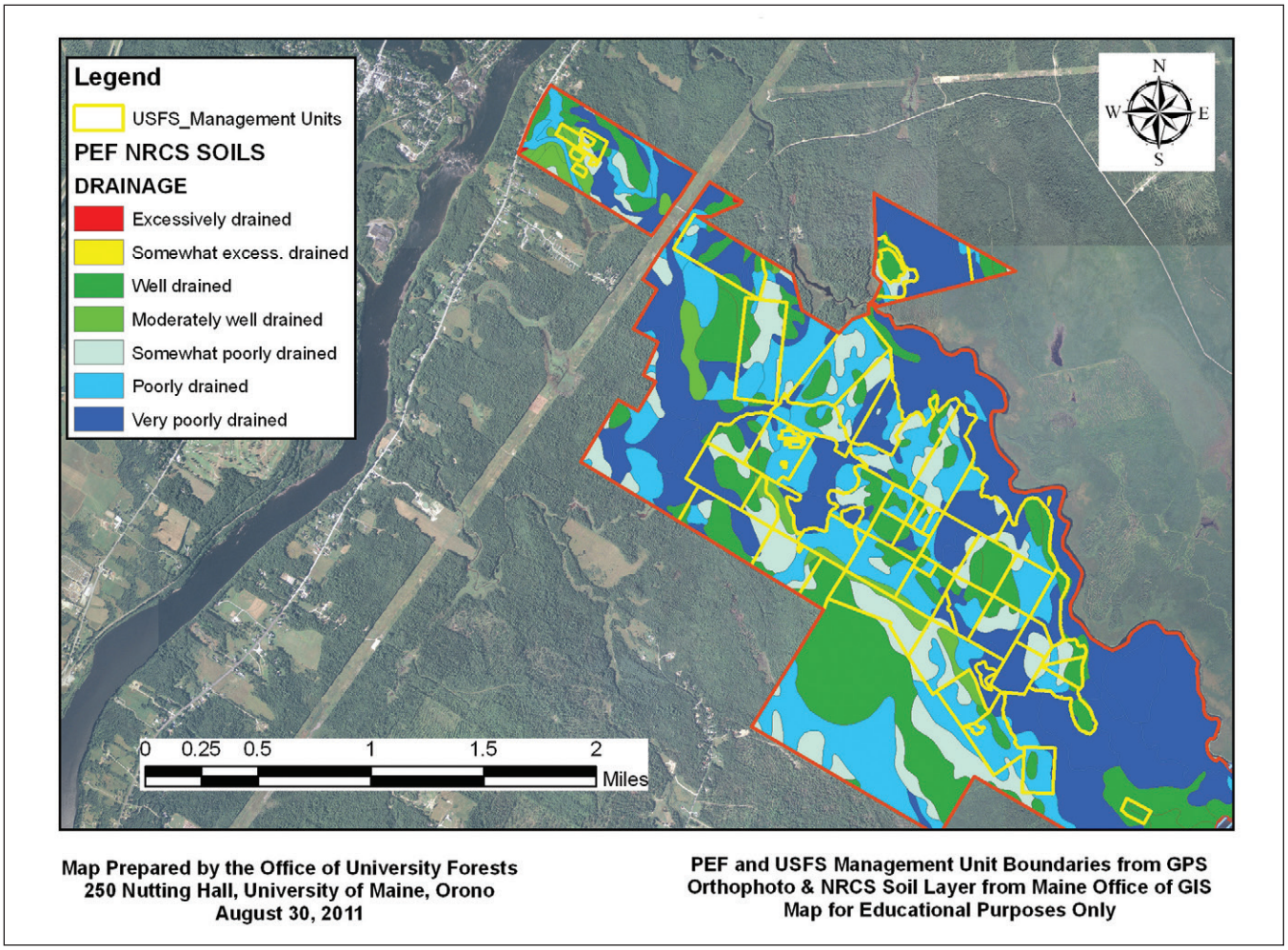
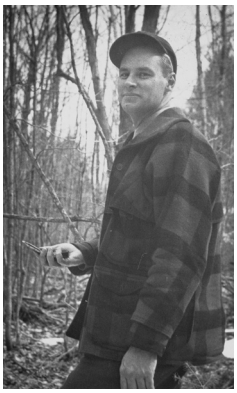


Figure 5.—Location of the U.S. Forest Service management units and soil drainage on the PEF, courtesy of Alan Kimball, University of Maine.

(Fig. 6) was focused on specific management problems, such as determining cutting cycle length and marking guidelines from growth and yield assessments. Though industrial support for forestry research was growing, the approach the Station would take in the future was not clearly defined. Ultimately, McLintock's emphasis on growth and yield was adopted and served as the basis for experiments at the PEF; this decision was a turning point for the Forest Service's research program in Maine.



Thomas F. McLintock
1945-1956

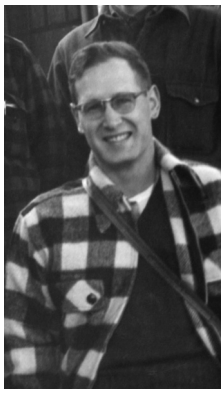
Research Center Leader (1945-1956)

Expertise: silviculture

Arthur C. Hart, Sr.
1948-1969

Project Leader (1958-1969)

Expertise: silviculture



Grant Davis
1955-1958

Expertise: silviculture

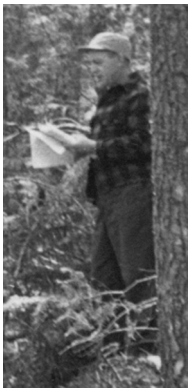
Franklin R. Longwood
1956-1961

Research Center Leader (1956-1961)

Expertise: silviculture

John C. Bjorkbom
1961-1970

Expertise: silviculture



Francis M. Rushmore
1962-1972

Expertise: silviculture

Lawrence O. Safford
1962-1970

Expertise: soils

Robert M. Frank, Jr.
1963-1996

Expertise: silviculture

Carter B. Gibbs
1971-1972

Project Leader (1971-1972)

Expertise: silviculture

Figure 6.—U.S. Forest Service, Northeastern Forest Experiment Station (now Northern Research Station) scientists assigned to the PEF, 1950-present. Dates research scientists were assigned to the PEF and served as Research Center or Project Leaders are shown, as determined from memos in the PEF archives, Forest Service Organizational Directories, published biographies, and personal communication with retirees. There may be slight errors (i.e., ± 1 to 2 years), particularly regarding earlier staff. Photos by U.S. Forest Service.

Dale S. Solomon
1971-1988

Expertise: growth and yield modeling

Barton M. Blum
1971-1991

Project Leader (1972-1991)

Expertise: silviculture

Miroslaw M. Czapowskyj
1973-1986

Expertise: soils

Hewlette S. Crawford, Jr.
1975-1991

Expertise: wildlife biology

Daniel T. Jennings
1976-1988

Expertise: entomology

John C. Brissette
1992-present

Project Leader (1992-present)

Expertise: silviculture

Laura S. Kenefic
1994-present

Expertise: silviculture

Figure 6 (continued).—U.S. Forest Service, Northeastern Forest Experiment Station (now Northern Research Station) scientists assigned to the PEF, 1950-present. Photos by U.S. Forest Service.

The core experiment proposed for the PEF was a "Compartment Study" of forest management options with different silvicultural treatments applied to replicated stand-level management units (MUs) (see Brissette and Kenefic, this volume). Described as "the heart of the research program," this experiment would document tree growth, mortality, logging costs, and change in forest condition through frequent inventories. This large-scale (called "pilot plant" at the time) approach to experimentation was advocated within the Forest Service, and allowed assessment of forest management alternatives at an operational scale.

In addition, though earlier studies were unreplicated, advances in statistics (i.e., Fisher 1925a,b) led to at least minimal replication (n=2) in studies established on many mid-century EFs. On the PEF, researchers also set aside a small portion of the forest (less than 50 acres) as an undisturbed area "closed to all operations and experiments, except those of an observational nature." Though not intended as such, this area would later serve as an important reference for the long-term study, against which the outcomes of management could be evaluated.

In 1946, a national assessment of forest resources divided management practices into five categories, based on what was being done relative to what was deemed the most appropriate practice for the local forest type (Harper and Rettie 1946). These categories were: "high-order," "good," "fair," "poor," and "destructive." The Northeastern Forest Experiment Station further promoted this categorization as a basis for research (U.S. Forest Service 1948). Many experimental forests in the Station established "cutting practice level" (CPL) studies which compared categories (usually the first four) of management, and served as demonstrations.

A 1952 article in "Pulp and Paper Magazine" (Anonymous 1952) described the early stages of the research on the PEF. Work was initiated by McLintock with the objective of determining what types of forest management were economically practical for the spruce-fir-hardwood region of Maine. The first step was to establish a CPL (also called management intensity demonstration, MID) area on the forest; this 40-acre area was divided into 10-acre MUs representing high-order, good, fair, and poor management, as described above. These treatments, which have since been redefined as selection cutting on 5- and 15-year cycles, fixed diameter-limit cutting, and commercial clearcutting, mirrored those on many other EFs throughout the Station. They were initially intended to serve as demonstration areas, but have since allowed comparison of similar treatments across forest types, thus expanding the scope of the local studies to a regional scale (Kenefic and Schuler 2008).

The PEF Compartment Study was also installed shortly after the PEF was established, with initial treatments applied between 1952 and 1957 to MUs averaging 25 acres in size. Though Westveld never worked on the PEF, the range of treatments there was greatly influenced by his earlier work in partial cutting (e.g., Belotelkin et al. 1942; Recknagel et al. 1933; Westveld 1938, 1953). The first draft of the study plan included variants of selection cutting, as well as common exploitative practices: diameter-limit cutting and commercial clearcutting (unregulated harvesting). This emphasis was consistent with broader trends in forestry research between 1925 and 1960, a period that has been called the "Selective Cutting Era" due to the national focus on selection and other forms of partial cutting (Seymour et al. 2006, Smith 1972). Though not initially included, variants of even-aged silvicultural systems (including shelterwood) were added to the study plan at the urging of cooperator David M. Smith, who was then a young faculty member at Yale.

Smith's suggestion proved to be an inspired one. In the 1960s, forestry nationwide shifted into what is now known as the "Production Forestry Era," during which the management paradigm was one of even-aged, high-yield, low-cost wood production (Seymour et al. 2006). Studies of planting, fertilization, thinning, strip clearcutting, and whole-tree harvesting were initiated by Forest Service scientists on the PEF, in direct response to industrial needs (Table 1, Fig. 7). Arthur C. Hart, Sr., a silviculturist who had previously worked with Westveld at the Gale River EF, took over leadership of the PEF study from McLintock; Hart and new scientist Robert M. Frank, Jr., expanded the research to include regeneration and recruitment.

Table 1.—Partial list of formal studies by U.S. Forest Service scientists on the PEF, 1950-present.

Year initiated	Study[a]	PI(s)	Study number	Status	Data available?[b]
1950	Cutting Practice Level Study (Management Intensity Demonstration)	McLintock	NE-1101-3	Active	Digital, online
1951	Small Woodland Management in the Spruce-Fir Region	McLintock, Hart	—	Closed	No
1951	Costs and Returns from Pruning Red Spruce Trees	McLintock	NE-1101-5	Closed	No
1952	Compartment Management Study (Spruce-Fir Silviculture)	McLintock	NE-1101-7	Active	Digital, local and online
1953	Effect of Seedbed Preparation on Spruce and Hemlock Reproduction	—	—	Closed	No
1954	Compartment Inventory Sampling Study	—	—	Closed	Unknown
1954	Volume Table Study	McLintock	—	Closed	Unknown
1954	Balsam Fir Mortality Study	—	—	Closed	Unknown
1954	Physical Properties of Forest Soils	McLintock	—	Closed	No
1955	White Pine Provenance Study	Schreiner, Wright	—	Inactive	Unknown
1955	Thinning Balsam Fir Thickets with Soil Sterilants	Hart	—	Closed	No
1958	Seedbed Preparation and Regeneration of Paper Birch	Bjorkbom	—	Closed	No
1958	Hybrid Spruce Plantations	Hart	NE-1101-10	Inactive	Unknown
1958	Balsam Woolly Aphid Occurrence on the PEF Compartments	Hart	NE-1101-13	Closed	Unknown
1959	Influence of Mice and Birds on Spruce-Fir Reproduction	Hart	—	Closed	No
1960	Rate of Growth of Heart Rot Fungi in Living Trees	Brandt, Shigo	—	Closed	Unknown

(Table 1 continued on next page)

Table 1 (continued).—Partial list of formal studies by U.S. Forest Service scientists on the PEF, 1950-present.

Year initiated	Study[a]	PI(s)	Study number	Status	Data available?[b]
1961	Growth Response of Released White Spruce	Hart	—	Closed	Unknown
1962	Revision: Compartment Management Study (Spruce-Fir Silviculture)	Hart	NE-1101-7	Active	Digital, local and online
1964	Amendment: Compartment Management Study (Regeneration)	Frank	NE-1101-7	Active	Digital, online
1964	Sapsucker Behavior and Feeding Habits	Rushmore	—	Closed	No
1964	Strip Clearcutting and Slash Disposal Methods	Frank	NE-1101-23	Inactive	No
1964	Production and Germination of Paper Birch Seeds	Bjorkbom	—	Closed	No
1966	Viability of Seeds in the Forest Floor After Clearcutting	Frank, Safford	—	Closed	No
1967	Nutrient Content of Red Spruce Foliage on Different Soil Series	Safford	—	Closed	No
1971	Effect of Fertilizer on Spruce Trees in a Thinned White Spruce-Balsam Fir Stands	Frank	NE-1101-41	Closed	No
1972	Height Growth Relationships Among Red Spruce, White Spruce, and Balsam Fir	Blum	NE-1101-43	Closed	Unknown
1973	Growth Response of Red Spruce, White Spruce, and Fir Along Edges of Strips	Frank	NE-1101-45	Closed	No
1973	Effects of Strip Harvesting and Slash Disposal Methods on Soils	Czapowskyj, Frank	NE-1101-46	Inactive	No
1975	Revision: Compartment Management Study (Spruce-Fir Silviculture)	Frank	NE-1101-7	Active	Digital, online
1975	Foliar Nutrient Concentrations of Young Balsam Fir Related to Soil and Slash Disposal Methods	Czapowskyj	NE1101-49	Closed	No

(Table 1 continued on next page)

Table 1 (continued).—Partial list of formal studies by U.S. Forest Service scientists on the PEF, 1950-present.

Year initiated	Study[a]	PI(s)	Study number	Status	Data available?[b]
1975	Influence of Residual Basal Area Density on Growth of Spruce-Fir Stands	Solomon	NE-1101-56	Closed	No
1975	Cultural Treatments Designed to Reduce Spruce Sawlog Rotation Age	Frank	NE-1101-58	Active	Digital, online
1976	Seasonal Foods Selected by Tractable Deer in Spruce-Fir-Mixedwood Stands	Crawford	NE-1151-61	Closed	No
1977	Helicopter Propwash for Removal of Spruce Budworm	Jennings	—	Closed	No
1977	Measuring Plant Growth with Radio Link Attenuation	Crawford	NE-1151-73	Closed	No
1978	Attraction of Male Spruce Budworm to Pheromone Traps	Jennings	—	Closed	No
1978	Aspen and Red Maple Sprouting After Cutting	Blum	NE-1151-77	Closed	No
1978	Even-Aged and Shelterwood Regeneration of Residual Strips in Spruce-Fir Strip Harvests	Frank	NE-1151-83	Inactive	No
1979	Survival and Development of Advance Regeneration After Shelterwood Harvest	Blum	NE-1151-87	Inactive	Unknown
1979	Spruce Budworm Monitoring	Blum	NE-1151-89	Closed	Unknown
1981	Variation in Bud Flushing Among White Spruce Provenances	Blum	NE-1151-92	Closed	No
1981	Early-Larval Dispersal of the Spruce Budworm	Jennings	NE-1151-94	Closed	No
1984	Comparison of Whole-Tree and Conventional Logging Damage to Spruce and Fir Regeneration	Frank	NE-1151-100	Inactive	Unknown
1994	Irregular Shelterwood (New Forestry)	Frank	—	Active	Digital, local
1995	Age Structure of the Selection Compartments	Kenefic, Seymour	—	Inactive	Digital, local

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Table 1 (continued).—Partial list of formal studies by U.S. Forest Service scientists on the PEF, 1950-present.

Year initiated	Study[a]	PI(s)	Study number	Status	Data available?[b]
1995	Leaf Area – Growth Efficiency Relationships in Multi-Cohort Stands	Kenefic	—	Inactive	Digital, local
1995	Role of Fungi in Biotransformation and Nutrient Cycling in the Forest Ecosystem	Shortle, Jellison, Smith	NE-4505-95-2	Active	No
2001	Quantifying Carbon in Northern Forests (Emphasis on Soils)	Hoover	FS-NE-4152-177	Inactive	Digital, local
2001	Timber Marking Costs in Northern Conifer Stands	Sendak	—	Inactive	Digital, local
2005	Substrate Availability and Regeneration Microsites of Tolerant Conifers	Kenefic, Weaver	—	Closed	Digital, local
2006	Relationships Between Understory Vegetation and Soil, Site, and Silviculture	Kenefic, Bryce	—	Inactive	Digital, local
2008	Revision: Compartment Management Study (Northern Conifer Silviculture)	Brissette, Kenefic	NRS-07-08-01	Active	Digital, online
2008	Rehabilitation of Cutover Mixedwood Stands	Kenefic	NRS-07-08-01 Appendix	Active	Digital, local
2009	Effects of Silvicultural Treatment on the Dynamics of Eastern White Pine in Mixed Stands	Brissette, Seymour	—	Inactive	Digital, local
2010	Seedling Herbivory	Kenefic, Weiskittel, Berven	—	Inactive	Digital, local
2010	How Well Do the Permanent Sample Plots Represent Stand Conditions?	Brissette, Weiskittel, Kenefic	—	Active	Digital, local

— Indicates unknown (PI or study number) or unassigned (study number).

[a] This list includes studies conducted wholly or partly on the PEF and for which U.S. Forest Service scientists served as principal investigators. Active studies are ongoing with regularly scheduled treatments and inventories. Inactive studies are not being treated and/or inventoried at this time, but boundaries and/or plots are maintained for future remeasurement. Closed studies cannot be relocated or remeasured. This list is not complete; it includes only those studies for which documentation is on file.

[b] Data may be available for download (online) or in a locally stored digital format with limited accessibility (e.g., text, spreadsheet, or pdf). Availability of data from inactive or closed studies may be unknown due to the volume of records held by the Forest Service at the PEF; such data may be in paper or scanned (pdf) format or lost. Data that are not available are confirmed to be lost, with the exception of NE-4505-95-2, for which data are being processed at this time. Summaries of the data or results of analyses from most of the studies listed here have been published (see Kenefic and Brissette, "Publications," this volume).

a. 1968

a. present

b. 1976

b. present

c. 1984

c. present

Figure 7.—Examples of production forestry research on the PEF: (a) eastern white pine provenance plantation (1968 and present), (b) precommercial thinning (1976 and present, after commercial thinning), and (c) biomass operation with whole tree harvesting (1984 and present). Photos by U.S. Forest Service.

It was toward the end of this period, in the late 1970s and early 1980s, that a severe spruce budworm (*Choristoneura fumiferana* [Clemens]) infestation spread through southeastern Canada and northern New England. During the budworm years, Forest Service staffing in Maine and related research activity on the PEF increased. Though less severe than in forests farther north, the spruce budworm infestation on the PEF generated an abundance of literature related to budworm impacts and control (e.g., Blum 1985; Collins and Jennings 1987; Houseweart et al. 1980, 1982; Jennings and Crawford 1983; Jennings and Houseweart 1983, 1986, 1989; Jennings et al. 1984; Kendall et al. 1982). In addition, heavy cutting throughout the region before and during the budworm era created large areas of naturally regenerated, softwood-dominated stands. Industrial landowners had questions about the best ways to manage these densely stocked stands, and whether early stand treatments were warranted. Some of the earliest studies on precommercial thinning in the region were conducted on the PEF, and would ultimately provide important information about the effectiveness of various operational methodologies and spacings (Brissette et al. 1999; Weiskittel et al. 2009, 2011).

Over the years, numerous studies have been conducted on the PEF, and close to 300 technical and scientific publications written (see Kenefic and Brissette, this volume). In addition to an abundance of research on forest ecology and silviculture, studies done by or in cooperation with Forest Service scientists have covered a range of topics, such as measurement techniques (Brissette et al. 2003, Kidd 1952, Lindemuth 2007), tree growth (Blum and Solomon 1980, Solomon and Frank 1983, Solomon and Seegrist 1983), leaf area relationships (DeRose and Seymour 2003, 2010; Gilmore and Seymour 1996; Kenefic and Seymour 1999; Maguire et al. 1998), root structure (Tian 2002), soils and site quality (Czapowskyj et al. 1977, McLintock 1959), wood properties and decay (Garber et al. 2005, Smith et al. 2007), genetics (Hawley et al. 2005), understory plants (Dibble et al. 1999, Olson et al. 2011, Safford et al. 1969), songbirds (Horton and Holberton 2009, Johnston and Holberton 2009), insects (Collins and Jennings 1987, Su and Woods 2001), spiders (Jennings and Houseweart 1989, Jennings and Sferra 2002), and wildlife (Abbott and Hart 1961, Crawford 1982, Crawford and Frank 1988, Grisez 1954). There has always been great potential for additional research, using the conditions represented within the long-term study to answer questions about ecology and management. In addition, many of the Forest Service's data from the long-term silvicultural studies on the PEF are available online, facilitating collaborative research (Brissette et al. 2012a, 2012b).

The University of Maine and the PEF

In the 1990s, forest product companies in the Northeast underwent profound changes involving consolidation, downsizing, and turnover in mill and forest ownership. Early mills had acquired large amounts of land and held it against wood shortages, but returns on investment were low. As long as timberland was cheap, the mills retained their forest property, but with land values rising and demand for pulpwood declining, many began to sell their property in the 1990s (Acheson 2000, Hagan et al. 2005). Frequent turnover of ownership within the forest industry, desire to increase university cooperation, and concerns about the Forest Service's long-term commitment to the PEF (Frank and Kenefic, this volume) motivated the industrial owners to donate the property to the University of Maine Foundation in 1994.

As a result of mergers and acquisitions of the original companies, the forest owners at the time of the donation were Boise Cascade, Champion International, Great Northern Paper, J.M. Huber, International Paper, J.D. Irving, James River Timber, Prentiss and Carlisle, Scott Paper, Seven Islands, and J.W. Sewall (Fig. 8). The Forest Service has continued its research under a memorandum of understanding since that time. In addition, University of Maine faculty and graduate students have expanded the research on the forest to include an additional 300 acres of forest

Figure 8.—Sign on the PEF listing names of the landowners, circa 1990s. Photo by U.S. Forest Service.

management experiments (see Nelson and Wagner, this volume; Saunders et al., this volume; Seymour et al., this volume), as well as 1,000 acres of wetlands and reserves and 1,500 acres of "working forest" managed by the University Forests Office for income generation, education, and research (see Kimball, this volume). The PEF is also open to many types of recreation.

CONCLUSIONS

One of the articles published at the time of the PEF's establishment concluded that "[t]here is every reason to think it [the PEF] should return rewards… It is a project established on a large enough scale, and to extend over a long enough period of time, to permit true scientific investigation" (Anonymous 1952). This prediction has proven to be true; the cutting practice level (MID) and large-scale Compartment Study have been continued by the Forest Service until the present day, making the PEF one of the oldest replicated, continuously operated and inventoried forest research sites in North America. The PEF studies provide invaluable information on the long-term consequences of various forest management alternatives. We give dozens of tours each year to landowners, researchers, forestry students, and land managers. Though visitors are usually from the Northeast and eastern Canada, we have had guests from throughout North America and as far away as Australia and Siberia. Perhaps most important, we continue to maintain and expand the research envisioned by our predecessors and in so doing, pay tribute to those Maine forestry pioneers.

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