The Importance of Forest Research to the USDA Forest Service: An Essay[1]

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Introduction

In his 1976 book[3], *The U.S. Forest Service: a History*, Harold K. Steen wrote, "*It may be said that the Forest Service started as a research agency.*" My remarks today hope to put a bit more flesh on that bare-bones assertion by outlining the hereditary bases for Steen's assertion.

Early forest research in the U.S. came from a mixture of naturalists, federal agencies, and educators in academia. Their reports and findings, interwoven over decades, along with a few crucial decisions and laws, created what is today one of the top 10 forest research institutions in the world. This essay describes a few of the seminal activities that I think were most important in creating the forest research enterprise we are today blessed with in the U.S.

My Thesis

The knowledge base for early forest researchers was a blend of European ecological knowledge from multi-generational experiences of living in and managing conifer and hardwood forests there as well as place-based observations and experiences of people[4] living in North America—both colonists and Native Americans.

Colonists from Europe brought with them traditional ecological knowledge (TEK) from centuries of living in and using forests in post-Roman Europe. Some of this TEK—how to manage beech, oak, chestnut, and hazel forests—was adaptable to similar tree species in North America. Other forest genera and species were new to colonists.

Native Americans taught early settlers much about North American forests. In the 1600s, Native Americans taught the colonists how to:

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[1] Remarks at the 2026 Board Meeting of the National Association of Forest Service Retirees (NAFSR).

[2] Guldin was the Board's member representing the USDA Forest Service's Research and Development mission area from 2016 to 2026.

[3] Steen, H. K. (1976). The U.S. Forst Service: A history. Seattle, WA: University of Washington Press. 356 p. ISBN: 9780295983738.

[4] The word "people" used here includes both indigenous peoples and early colonists and immigrants. Some anthropologists have narrowed the definition of *Traditional Ecological Knowledge (TEK)* to mean knowledge only held by indigenous peoples, such as Native Americans in North America. Other anthropologists have hewn a broader definition of TEK to mean the cumulative knowledge held and shared by local populations that over generations have developed a deep understanding of specific local ecosystems. Examples can be found throughout history in Europe, ranging from the Etruscans in Tuscany in 900s BCE to present-day peoples such as the Sámi in the Nordic North and rural civilizations in Poland, the Carpathian Mountains, the Swabian Alb of Germany, the Doñana region of southwestern Spain, and in other cultures across Africa and Asia. These remarks take this broader view.

- *Identify edible and medicinal plants*. Chestnuts and beech nuts were well-known in Europe, where they had been a staple food for poor people and livestock. But Native Americans taught colonists about other edible North American nuts (e.g., pecans and some other hickory nuts, black walnuts, hazelnuts, and selected oak acorns), fruits (e.g., pawpaw, persimmon, wild plum), boiling maple sap into syrup, and medicinal uses (e.g., slippery elm for sore throats, witch hazel for reducing inflammation, willow bark for pain relief).
- *Use specific tree species for construction*. Examples include bald cypress for canoes and flexible bark for shelters.
- *Use fire to clear under underbrush and encourage the growth of berries and grasses*. Early records from Georgia, the Carolinas, and Virginia describe extensive use of fire in February and March to improve forage for free-roaming livestock; a practice whose timing was learned from Native Americans.
- *Practice "Three Sisters" agriculture and use fish as fertilizer*. Native Americans showed colonists how to clear small forest plots for agriculture and plant together maize (corn), beans and squash in mounds using fish for fertilizer was vital to early New England settlers.[5]

The shared learning and TEK of both settlers and Native Americans were the earliest examples of what I consider forest research in what would become the U.S. In its broadest sense, I think of forest research as the systematic investigation/exploration of a topic/issue that has several sequential steps:

- Collection and documentation of data/information, followed by
- Analysis and interpretation of the data/information, that
- Expands present knowledge about a topic, solves problems, and supports actions.

Against this background, my thesis is that forest research in the U.S. developed along three pathways:

1. ***Learning about the location, composition, and condition of North American forests***—an inventory of what was where.
2. ***Adapting previous multigenerational knowledge learned in other places to North American forests*** (e.g., managing conifers in Scandinavia and the Baltics; managing hardwoods (beech, oaks, chestnut, birch, alder and other related species) in central and northern Europe to conditions[6] and similar species in North America.
3. ***Creating educational programs*** that brought together what was known about managing forests from multiple sources and multiple generations to accelerate inter-generational learning and equip students with broader and deeper knowledge about forests.

[5] In 1632, Thomas Morton reported that one acre of maize fertilized with alewives (an anadromous species of herring) would product as much as three acres where alewives weren't used. Over-fishing for herring and shad during their spring spawning runs to use as fertilizer led the Plymouth Colony to enact the first fishery regulation in North America to protect them.

[6] I define "conditions" broadly, to include ecological conditions, economic conditions, and socio-political conditions. That panoply of conditions, their interactions, and their changes had influenced forests and their uses in western civilizations for millennia.

The Three Pathways That Set the Stage for Forest Research in the 20th Century

Path 1: Learning about the location, composition, and condition of North American forests

The beginnings of forest inventories. Inventory processes of learning the location and composition of forests began the late 1500s as British, Spanish, French, and Dutch mariners surveyed the Atlantic coast and made initial forays up bays and rivers inland. Their favorable reports stimulated formation of companies to colonize North America and build wealth from trade[7]. The companies were primarily English, Dutch, and Swedish joint-stock ventures.[8]

Earliest inventory workers were the King of England's naval surveyors. They were seeking mast-quality eastern white pine[9], which they marked with the "Broad Arrow," naval stores (e.g., pitch, turpentine, and tar) and quality oak for boat-building. They were also mapping coastlines and bays for potential fortifications.

The Influence of naturalists and botanical explorers. The focus of the naturalists can best be described as botanical reconnaissance. Where did trees exist? What genera and species were at places they visited? How dense were the trees? How tall were they? Then, what economic utilitarian goal could be posited, based on the facts they gathered. Their sole focus was the present, or at best, the coming decade.

From the early 1700s to 1850, a coterie of botanical explorers in North America began identifying new flora and shared specimens—dried foliage, dried flowers, and seeds with European botanists. The most prominent among them were John Bartram and his son William, Jane Colden, David Douglas[10], André Michaux and his son François, Thomas Nuttall, John Torrey, and Almira Phelps. Their explorations, writings, and specimens collected throughout North America and Hawaii did two things. First, cataloging species and identifying timber resources, they laid the foundation for scientific research about ecosystems in North America and how flora and fauna might be used. Second, when their reports were shared with colleagues in Europe—notably Carl Linnaeus—they introduced scientists on other continents to the rich diversity of American forest ecosystems.

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[7] Their objectives included searching for gold and other ores (e.g., iron, lead) and producing commodities for export to homelands and other colonies (e.g., wood, naval stores, furs, dried fish, tobacco, rice, indigo, wheat).

[8] The Virginia Company of London (1607), The Plymouth Company (New England, 1607), The Massachusetts Bay Colony (1620), The Dutch West India Company (New Amsterdam, aka New York, 1621), the New Sweden Company (Delaware Valley, 1630s), Trustees for the Establishment of the Colony of Georgia (1732).

[9] By the end of the 1500s, England had no more mast-quality conifers and very little ship-building oak. Their only source of masts was Scots pine from eastern Baltic forests, but Hanseatic League traders demanded payment in gold, not raw wool or woolen cloth that were England's primary trade goods. Henry VIII's gold coffers were nearly empty from the Anglo-Dutch wars. His naval architects searched for alternative sources of wood and North American Atlantic coastal forests were newly explored and ripe for development. See Guldin (2026).

[10] Douglas was a Scot and Head Gardener at Scone Palace, the ancient place where Scottish kings were crowned. On his two botanical reconnaissance voyages along the Pacific Coast (1824-1827 and 1829-1833), he gathered seeds and specimens of many conifers and brought them back to Scone to add to its arboretum. I've walked through the stand of Douglas-fir and other western species that Douglas planted and are still growing there.

Two botanists who epitomized this early focus were Andre Michaux and his son François Andre Michaux. From 1785 to 1796, the elder Michaux traveled throughout eastern forests in North America. He was responsible for nurturing a nursery in Charleston, South Carolina.[11] Later, the son extended and deepened his father's work. François Andre was especially interested in silvics of North American oaks. He also established a forest tree nursery at Bergen, New York.[12] They pointed out one driving detail in the history of American forests—consumption of the continent's forests was proceeding at an alarming rate with no thought for the future. The father wrote in 1803 that "*neither the federal nor state governments were reserving forest lands to safeguard the nation's future economy*."[13] Fifteen years later, the son warned of the *"… alarming destruction of trees proper for building."*[14] However, prior to the Civil War, the common belief was that the country's forests were inexhaustible, despite the fact that some 100 million acres had been cleared for agriculture by 1850.

The 1810 Census: Beginning of censuses of manufacturers. The 1810 census added information collection about manufacturers to the collection of population data. The wood products data from this census documented the locations and sizes of wood-based industries. They can be sorted as primary manufacturers (sawmills, tie hackers), secondary manufacturers (cabinet and furniture makers, barrel and stave makers, and potash producers for tanneries and glass-makers), and home industries (producing wooden tools[15]). This 1810 census data enabled forest analysts to identify regions with extensive timber resources, and as mills disappeared in subsequent censuses or new mills opened, census data began to chart the decline in forests in some areas and expansion into new forest areas. Then analysts pondered the implications for counties, states, and regions.

The 1870 Census: Schedule 3, Agriculture. For the first time, the census specifically requested data on the acreage of woodland per farm and the total value of forest products produced. The results were used to create a map in the 1870 statistical atlas illustrating the relative proportion of surface area with woodlands, although it did not account for species, density, or condition of the forests.

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[11] Andre Michaux introduced many old-world species to America, including the tea olive, crape myrtle, Chinese tallow, mimosa, camellia and gingko. Michaux came to Charleston in 1786 as the Royal Botanist under French King Louis XVI, to study plants that could be useful in France for construction, medicine and agriculture. From the mid-1700s to mid-1800s, Charleston was home to several prominent botanists. Not surprisingly, Andre established the French Botanic Garden there where he grew plants to send back to France. That experiment station still exists today. For example, Michaux introduced camellias to the Lowcountry by presenting plants to Henry Middleton for his Middleton Place plantation gardens. Today, Middleton Place has over 3,500 camellias including one of the original Michaux plants. See https://charlestonlivingmag.com/early-charleston-gardeners

[12] Located between Buffalo and Rochester, this area originally had oak savannas. Nurseries established in this area in the mid-1800s led to it being the center of the 19th century tree nursery industry, supplying saplings to many New England and mid-Atlantic cities.

[13] Michaux, A. (1803). *Flora borealis-americana: sistens caracteres plantarum quas in American septentrionali collegit et detexit Andreas Michaux*. Volumes 1 and 2. Paris, France: Fratres Levrault. 680 pages with 51 plates.

[14] Michaux, F.A. (1819). The north American sylva: a description of the forest trees of the United States, Canada, and Nova Scotia. Volumes 1-5. Paris, France: C. d'Hautel.

[15] Examples are wooden rakes, pitchforks and flails for threshing; axe and shovel handles; bowls, spoons, butter churns, laundry washboards, and spinning wheels; and wood-bodied hand planes, spokeshaves, and clamps.

Franklin B. Hough used the 1870 census data to prepare a paper that he presented in 1873 to the American Association for the Advancement of Science, *"On the Duty of Governments in the Preservation of Forests."* This led AAAS to ask Congress to fund a position and authorize a study of the situation in further detail. On August 15, 1876, Congress appropriated $2,000 to USDA and authorized USDA to pursue investigations and inquiries—to conduct research—into the protection, production, and utilization of timber. Fifteen days later, Hough was hired by USDA as "special forest agent" to fulfill this Congressional mandate. Thus began an uninterrupted 150 years of forest research in USDA. **That makes 2026 the Sesquicentennial of forest research in USDA!**

Hough's detailed *Report on Forestry* was published in 1878[16]. It criticized both contemporary practices and attitudes about forest harvesting and lack of management. In 1881, the position of federal forestry agent was elevated in USDA to the Division of Forestry, Hough at the helm. Today, he is regarded as the first federal leader of the American forestry movement and is called by some "the father of American forestry."

The 1880 Census: Volume 9: Report on the Forests of North America[17]. Charles Sprague Sargent, a Harvard University botanist and director of Harvard's Arnold Arboretum for 54 years, was asked to compile forest data collected by the 1880 Census. Published in 1884, this 612-page report was the first comprehensive report detailing the nature, condition, and distribution of U.S. forests. It included important data on lumber industries, timber resources and the extent of forest fire damage. The report outlined the economic value of forests that covered saw logs, fuel for domestic, industrial, and railroad use, and charcoal production (critical for metallurgy). It provided in-depth regional analyses of forest types for four regions: North Atlantic, South Atlantic, North Central, and South Central. The report contained detailed maps, such as distribution of pine, spruce, and hardwood forests. It also documented the destruction of timber due to fires, often attributed to land clearing and railroad operations.

In the spring of 1891, when Congress was debating the issue of land fraud (the illegal purchase or deceit in the homesteading of Federal land) related to the Timber-Culture Act of 1873 and several other homestead laws, a rider was attached to a bill to revise a series of land laws. This small, one-sentence amendment (Section 24) allowed the President to establish forest reserves from public domain land:

> "SECTION 24—The President of the United States may, from time to time, set apart and reserve, in any state or territory having public land bearing forests, in any part of the public lands, wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations; and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof."

[16] Hough, F.B. (1878). Report upon forestry. Washington, DC: Government Printing Office. 632 p. See: https://archive.org/details/reportuponfores00houg/page/632/mode/2up

[17] Sargent, C.S. (1884). *Report on the Forests of North America (Exclusive of Mexico)*. Washington: Government Printing Office. 612 pages plus maps. 47th Cong., 2d sess. House. Mis. doc. 42, pt. 9). https://doi.org/10.5962/bhl.title.22935

For weeks after passage of the law on March 3rd, President Benjamin Harrison set aside the first reserve—the Yellowstone Park Timberland Reserve. By the end of his term in 1893, he had created 15 reserves totaling 13 million acres. Shortly after being inaugurated in 1893, President Grover Cleveland added 2 more, an additional 5 million acres.

The original intent of Section 24 of the 1891 act[18] was for the forest reserves to be managed, specifically to protect watersheds from erosion and ensure a sustainable supply of timber. But the question of ***how*** the reserves should be managed and the explicit authority to do so did not exist. Scientists and the American Forestry Association advocated for better management of the reserves.

In 1896, Sargent led the National Forest Commission, sponsored by the National Academy of Sciences. The commission was tasked by the Secretary of the Interior to survey western forests and assess how best to manage them to ensure they survived into the future. The commission had seven members; six of whom were NAS members. Thirty-one-year-old Gifford Pinchot—the only non-member and the only trained forester—wrangled his way onto the commission as its secretary. John Muir, Henry S. Graves, and Pinchot's brother Amos tagged along as advisors.

In July, the commission members headed West. By the end of the summer, Pinchot wrote[19] that this survey was the *"… first time any forester had ever looked this region over, and the same was true of most of the country I saw that summer."* (page 126). By the end of the four-month tour of the reserves, consensus on recommendations about how to manage the reserves had not been reached. Sargent, Muir, and some others believed that western forests needed to be protected—from fire, from vandals, from timber thieves. They advocated deploying the U.S. Army to provide that security[20]. Pinchot and Arnold Hague[21] believed that the forests needed to be managed as a renewable resource that produced economically valuable outputs. They advocated for a trained group of professional foresters, a forest service. At the end of the commission, Pinchot backed off his criticism so that the commission's report could be unanimous in its recommendations. But he regretted that later.

After returning to Washington, DC, in autumn 1896, Pinchot began to prepare the 159-page report of the commission's survey. The winter and spring of 1897 was an active year on Capitol Hill. The 2nd Session of the 54th Congress was ending on March 4th, inauguration day for President William McKinley.[22] Recognizing the importance of the commission's

[18] Section 24 became known as the Forest Reserve Act of 1891 or the Creative Act of 1891.
[19] Pinchot, G. (1947) Breaking new ground. Seattle, WA: University of Washington Press Edition (1972). 510 p. ISBN: 0-295-95181-8
[20] The U.S. Army had already been dispatched to protect the Yellowstone Park Timberland Reserve in 1886 to protect its natural features and wildlife from poachers and vandals after civilian administration had failed. They built Fort Yellowstone at Mammoth Hot Springs in 1890-91. The Army managed the park for 32 years until 1918.
[21] Hague was a geologist. He joined the U.S. Geological Survey in 1879, became geologist of the Yellowstone Park division of USGS in 1883, and was elected to the National Academy of Sciences in 1885. He worked closely with Pinchot to draft plans for creating a specialized corps of trained experts to manage the reserves.
[22] Before the 20th Amendment to the Constitution, March 4th was the traditional, fixed date for presidential inaugurations and the seating of a new Congress.

recommendations and the time pressures, Sargent presented a draft report to President Cleveland on January 29th. The commission recommended that Cleveland create 13 more forest reserves covering 21 million acres. Cleveland hadn't added any new forest reserves since shortly after his inauguration, awaiting legislation on how they were to be managed. But on February 22nd, less than two weeks before the end of his presidency, Cleveland issued an executive order adding 13 new forest reserves totaling 21 million acres

President Cleveland's executive order set off a controversy that eventually led to Congressional passage of laws that strengthened instructions for managing the nation's forests. After the McKinley inauguration, Sargent and the other commissioners were very active and influential personally with members of Congress during the ensuing months.[23] The final report of the commission was published in May 1897. Beyond recommending additional forest reserves, the report also noted that good forest management required continuity of ownership and management, and good forest management required technically-trained foresters.

On June 4, 1897, President McKinley signed the appropriations bill that included language on the purposes of the forest reserves and funded a more detailed inventory and survey by the U.S. Geological Survey.[24] That same day, Pinchot received letters from the Director of the Geological Survey Charles Walcott and his associate Arnold Hague both inviting Pinchot to come to Washington, DC to talk to the Secretary of the Department of the Interior Cornelius Bliss. Bliss and Walcott offered Pinchot the position of Confidential Forest Agent for the Department of the Interior with the task of making recommendations on how the 21 million acres of forest reserves should be managed. In response to Secretary Bliss' request, Pinchot described the bureau needed to take charge of the forest reserves, proposing a decentralized regional management structure because of the diversity of forest conditions and markets. A decade earlier Fernow had proposed the same thing, as Dietrich Brandeis had implemented decades earlier in Burma and India.

See Appendix 1 for a description of the network of influence that Fernow, Brandeis and William Schlich had on the views of Pinchot and Graves—both in creating and organizing an agency and creating educational programs to train the corps of experts needed.

Although few may remember Sargent's name, he served as one of the most influential conservationists as the idea of conserving forests emerged. The maps he made, and the census report he wrote meant that Sargent spoke with authority atop a mountain of data just being compiled.[25]

Main Point: Inventory field work—conducting surveys and collecting data—followed by data-driven analyses ALWAYS has been the first and most important foundation for developing forest

[23] See Steen (2001).
[24] Later, this section of the appropriations bill would become known as the Forest Service Organic Act.
[25] This paragraph comes largely from Adam Soward's 2025 article at https://www.adamsowards.net/tracking-forests/

policies and forest management. Further, subsequent re-inventories are essential to determine whether the policies and management actions are in fact delivering desired results.

Path 2. Adapting previous multigenerational knowledge learned in other places

European TEK about forest management. By the Middle Ages (1000s to 1200s) in Europe, generations of villagers had learned how to balance their immediate wood needs with future wood needs. A prominent forest management approach was "coppice with standards." This traditional two-tiered forest management system combined

- Regular cutting of understory trees (coppicing) on a 7 to 10-year cycle to produce small-diameter fuelwood and fencing. Hazel, willow, linden, maple, and alder—all highly prolific sprouters—were desired underwood species and cut on 5–7-year cycles
- Longer-rotation coppicing species included hornbeam, oaks, and sweet chestnuts. They were coppiced on longer 15–25-year cycles .
- Overstory trees of selected form and species—oaks, beech, ash, hornbeam, sweet chestnut—were the standards, managed on an 80–100-year cycle to produce the timber needed for construction and nuts for panage[26].

Coppicing with standards is among the earliest examples of sustainable forest management practices based on TEK. Included in the coppicing with standards method was management of woodland grazing/silvopasture. Rotational grazing throughout a woodlot and livestock fencing were often used to prevent the animals from eating all the fresh sprouts for a year or two after coppicing. Other TEK-based forest management practices were gathering leaves for fodder and gathering fruits and nuts for human and animal consumption. Leaves and other green foliage were often gathered for over-winter fodder[27].

In the 1700s and early 1800s, a typical New England small homes (450-600 ft^2) required 15-20 cords of wood annually to heat one or two rooms (40s^o – 50^o) and fuel cooking fires while larger, draftier homes (800-1,200 ft^2) required 30-40 cords. A typical farm dedicated a 20-acre woodlot to ensure sustainable fuelwood and fencing supplies. Towns and villages were surrounded by a ring of woodlots actively coppiced.

European progression of forest knowledge integration and adaptation to forest policies and management. A detailed recounting of how multigenerational knowledge was integrated across European forests and used by governments to create forest inventories, management policies, and a new forestry profession is beyond the scope of this paper. See Guldin (2026) for details. Suffice it to say that events in the U.S. followed much the same pattern, though lagging behind 80-100 years.

[26] Panage refers to letting animals feed on the nuts produced by older oaks, beech, and chestnuts. Acorns and beechnuts were especially valuable for fattening pigs and feeding wildlife; chestnuts (aka "bread of the forest") for humans' winter subsistence.

[27] The Roman historian Cato (100 BCE) recorded the Teutons, a Germanic tribe, creating sileage by preserving green fodder in pits covered with dung.

Advances in understanding the essential role that forest conditions played in human welfare, economic vitality and generating wealth emerged first in Europe and Asia largely after the fall of the Roman Empire in 476 CE, forests were clearly seen as finite at all levels of society—villages, regions, duchies and principalities, kingly realms. The finiteness of forests had been confronted on other continents[28] repeatedly for millennia. Thus, the socio-economic and socio-political importance of forest governance was recognized earlier in Europe.

European progress was vitally important globally because several new disciplines were created. Advances in mathematics led to developing forest mensuration and valuation procedures and statistical applications to sampling for inventories The first formal forestry schools in Europe emerged in the Germanic duchies (Prussia, Saxony, Hesse) in the late 1700s. Initially, these were led by notable foresters who were already employed by sovereigns and practicing as professionals.[29] The curriculums blended recent advances in mathematics, statistics, cartographic surveying, inventory, mensuration, valuation, silvics, soils, writing forest plans and management prescriptions, and governance (aka, fostering interpersonal relations with political leaders and roles in community life). Inculcating practical experience through field work—learning by doing with a more experienced mentor—was a critical part of integrating all the new knowledge being developed and passing it on to trainees.

Main Points: When colonists arrived in North America, they brought their TEK about forest management with them and began testing whether their knowledge would also apply here. Much of it did. They also blended their TEK with TEK taught by Native Americans.

European rulers and governments recognized the need for forest management, supported by research and professional education, earlier than in the U.S. because they understood that the goods and services their forests provided were essential to social and economic sustainability and well-being, yet their forest area was finite. Therefore, forests had to be managed and regenerated using the best science to meet both society's present needs as well as the needs of future generations. Government agencies staffed by professionally educated experts were needed because private interests often conflicted with public interests.

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[28] Assyrian and Babylonian civilizations waned (900-600 BCE) due to plundering of Taurus Mountain watersheds in the headwater of the Tigris and Euphrates rivers. The Carthaginian civilization (900-200 BCE) and the Roman Empire waned in large part due to overcutting of forests for trade and war. England, Germany and France faced periodic, sever, localized wood shortages between 1200 and 1600 CE driven by rapid population growth, expansion of agriculture, mining, and shipbuilding. Fuelwood shortages hindered industry (glassmaking, metallurgy).

[29] Gamekeepers are another earlier example of professionals employed by sovereigns as early as the 1400s-1500s who managed landscapes—including forests—for wildlife habitat. Often, they wrote the permits allowing serfs and tenants to gather down wood for fuel, cut trees for fencing, and open lands at certain times of the year for livestock grazing and panage. Another example from Switzerland is the role of the forster or forstmeister (e.g., forest ranger, forest superintendent) in mountain villages. The top three Swiss village leaders were the mayor (burgemeister), the priest, and the forstmeister. The forsters and forstmeister had two roles: assuring that all families, but especially widows, had sufficient firewood for cooking and heating and manage the forests upslope from the village to protect the village from avalanche damage.

Path 3. Creating educational programs in forestry

There we no forestry schools in the U.S. until the 1890s. For the first 27 decades of North American colonization, forest management—in the limited places that it existed—was fragmented and based on TEK. The coppice and standards approach dominated, adapted to North American species.

By 1800, there were roughly 25 colleges in the U.S. Most were private and sectarian--chartered or affiliated with religious denominations. Curricula were focused on religion, the classics, liberal arts, and law. Science curricula were limited to mathematics, physics, astronomy, and medicine, with a few courses teaching "natural history" (today called biology). In the early 1800s, the few natural history courses included botany and rudimentary ecology, some horticulture and a bit of practical agriculture.

The industrial revolution in the 1840s radically transformed both the nation's economy and collegiate education. Interest in religion, the classics, and liberal arts waned, replaced by increased interest in science as a tool for both social progress and personal success. Advocates of science emphasized that truth does not come from the past, but from relentless investigation of present reality. ***Note that this new emphasis devalued TEK***.

The new emphasis on science led to numerous discoveries in medicine, engineering and machinery (adaptations of steam to power factories and railroads), and agriculture. Agricultural advances in the 1840s included mechanized harvesting and planting (shifting from hand tools to animal-powered wheeled machines) and introduction of chemical fertilizers to improve fertility. Wealthy farmers formed local groups to share knowledge. A few groups built experimental farms where they applied rudimentary scientific methodology to study the complex processes of plant physiology, nutrition, soils, and genetics. They were on the right track, but their limited local resources hindered progress. They lobbied state legislatures for money to support agricultural science. But during this same time, state legislators with farming backgrounds were being replaced by legislators who represented oil, steel, coal, railroad, and manufacturing interests. Legislators backed by agricultural interests in their districts lost political influence.

Against this background of turbulent economics, politics, and the outbreak of the Civil War, Justin Smith Morrill, a U.S. Congressman from Vermont, authored the Morrill Land Grant Colleges Act of 1862,[30] signed by President Lincoln on July 2, 1862. The Morrill Land-Grant Act of 1862 not only led to creation of land-grant colleges, but it also funded these new state institutions of higher learning to teach practical agriculture, including horticulture and pomology.[31]

[30] Before the end of Morrill's political career as a U.S. Senator in 1898, he authored the Second Morrill Act of 1890 which supported historically Black colleges.

[31] Pomology is a specialized branch of horticulture focused on the scientific study, cultivation, and production of fruits and tree nuts. It involves breeding, managing, and improving crops including tree crops (apples, pears, peaches), small fruits (blueberries, raspberries), and nuts (pecans, walnuts) to increase yields and the quality of fruits and tree nuts that landowners could offer in markets.

Twenty-five years later, the Agricultural Experiment Stations Act of 1887 and the Hatch Act of 1887 authorized creation of state agriculture experiment stations to conduct scientific research and appropriated $15,000 per year to each state and territory to fund their research. These acts laid the groundwork for adding forest research to the portfolio of state experiment stations a decade later.

Main Point: Although collegiate education in forestry didn't emerge until the late 1890s, the foundations for scientific research to improve economic and agricultural productivity were laid from the 1840s to 1880s. They formed one part of a sturdy foundation for forestry research, but a second part was needed—elevating the importance of forests to the nation just as the importance of agriculture was elevated in the 1850s-1880s. This second part of the foundation story began in the early 1700s.

Forest conditions gained public attention after the Civil War.

George Perkins Marsh's 1864 book, *Man and Nature: Or Physical Geography as Modified by Human Action,* described the history of the ravaging of European forests by the late 1700s. The most effective response to these crises, according to Marsh, was developing forestry as a science whose solutions would stabilize deteriorating forest and socio-economic conditions and the necessity of academically-trained experts in the management and recovery of forests. This book influenced naturalists and educators in the U.S. who witnessed the Civil War's devastation of forests and were led to the same conclusions.

The work by Hough and Sargent in the two decades after the Civil War, described earlier, also elevated public attention to forest conditions, especially within the scientific community. But the attention of the broader public also surged. The prime example is the founding of the first forest-focused NGO—the American Forestry Association—on September 15, 1875. AFA's purpose was to collect and disseminate information on forests and the practices of protecting, conserving, and managing forests via its meetings and publications, thereby fostering the conservation of existing forests. It published annual reports, occasional bulletins, and press releases. Concurrently with AFA's development as a national organization, it also helped start and support creation of state forestry associations. The Minnesota Forestry Association was organized in 1876 and the Pennsylvania Forestry Association in 1886. The PFA's magazine "Forest Leaves" was the early official organ of AFA.

Early USDA forestry activities. After its founding in 1826, USDA began to publish annual reports whose main focus was disseminating fresh agricultural and horticultural science to farmers and statistics about crop production and prices. It also contained essays by outside individuals on contemporary issues. USDA's 1865 annual report contained an essay by the Reverend Frederick Starr, a Presbyterian minister from St. Louis and a proponent of forestry. Starr documented the rapid destruction of American forests, particularly during the Civil War. He listed numerous causes, including military necessity, accidents, and wanton destruction. He concluded by predicting a **timber famine** by 1895; Starr coined that term. To prevent this, Starr called for

planned forest management research done by a federally funded private organization. He considered USDA to be farmer-focused. His additional essays and writings in 1866 and 1867 are considered early foundational texts on American forest conservation and the pioneering look at the need for sustainable forestry in the U.S.

USDA forest research activities expanded after the Hough report

By 1881, forest-related research in USDA had been consolidated in a Division of Forestry led by Franklin B. Hough (see page 5, above). The research focused on gathering facts about forests—where they were located, species and sizes, how forests were being used—a federal extension of the work of the early naturalists and analysts of census data. Although Franklin Hough was the first chief of the Division of Forestry, Secretary of Agriculture George Loring replaced him in 1883 with Nathaniel Egleston.

Nathaniel Egleston, 2nd chief of the USDA Division of Forestry. Egleston The second chief of the Division of Forestry was Nathaniel Egleston. He rose to forestry prominence in 1882, when he became a vice-President of the American Forestry Association. He served as the second chief of the Division of Forestry from 1883 to 1886. See Char Miller's article[32], titled, "*Amateur Hour: Nathaniel H. Egleston and Professional Forestry in post-Civil War America*." Egleston loved trees as an asset to community life. His views launched a planting frenzy of American Elms; at its peak, 25 million elm seedlings were produced annually. He advocated tree planting as the first necessity of every village or town cropping up across the Great Plains, regardless of climate, rainfall, or soil type. After the 1884 presidential election won by Grover Cleveland, Secretary Loring was replaced and the new Secretary ignored Egleston. Two years later, Bernhard Fernow was hired; the first professional forester in the U.S.

Bernhard Fernow, 3rd chief of the USDA Division of Forestry. Bernhard Fernow was a recent immigrant to the United States. He was born into a mid-ranking Prussian family. Raised as a ward on his uncle's estate, he was groomed for land management. His preparation for that role consisted of serving in the Prussian Forest Service for a year under the direction of a district officer before taking the entrance examination for the Prussian Forest Academy at Münden. After graduation, he returned to the Forest Service, working in Silesia, Brandenburg, and Eastern Prussia—three distinctly different forest ecosystems.

In 1876, Fernow traveled to the U.S., ostensibly to attend the Philadelphia Centennial Exhibition[33] and a meeting of the nascent American Forestry Association at the Judges Hall of the Centennial Exhibition on September 15th. But his unspoken reason was to reunite with his American-born fiancée, Olivia "Alice" Reynolds. From 1872-1876, she was keeping house for

[32] Miller, C. (2005). *Amateur Hour: Nathaniel H. Egleston and Professional Forestry in post-Civil War America*. Forest History Today. Spring/Fall issue. Pp. 21-26

[33] The centennial exhibition had a collection of woods, cones, and seeds of western and southern tree species assembled by leading botanists. Also on display were maps showing the distribution of America's forests vis a vis other land uses and statistics on enrollments and courses at American colleges. (Rodgers, 1951).

her brother John who was attending the University of Göttingen[34]. Fernow and John Reynolds had become acquainted, and upon being introduced to Ms. Reynolds, Fernow was smitten. They were married in 1879. In 1882, Fernow became a U.S. citizen.

Fernow's initial work in the U.S. was very practical. After a series of odd jobs—no one here really knew what a professional forester was—he was hired to manage 15,000 acres of oak and hemlock woodland in Pennsylvania that produced charcoal for the Cooper-Hewitt Iron Works, Trenton, New Jersey. The Works had several large iron furnaces that required immense amounts of charcoal for fuel. In 1871, 22 mining engineers—largely from eastern Pennsylvania—met in Wilkes-Barre, PA to form the American Institute of Mining Engineers. AIME members were increasingly worried about impending shortages of wood to produce the charcoal needed for iron blast furnaces and for the timbers and props needed for rapidly-expanding deep shaft mining for iron ore and coal.[35] The first three presidents of AIME were Raymond Rossiter (1872 to 1875), Abram Hewitt (1876-1890), and John Birkinbine (1891-1893). Birkinbine was also president of the Pennsylvania Forestry Association.

Fernow quickly came to the attention of these three AIME leaders when he began attending and speaking at AIME meetings about his experience as a forester from Europe, where similar concerns about shortages of wood for mining and metallurgical operations had led to forest management. These three men led the network of mining and forestry interests that supported Bernhard Fernow. In 1886, they approached President Grover Cleveland, with whom they were well-connected, urging the appointment of Bernhard Fernow as the third chief of the USDA Division of Forestry after Egleston's departure.[36]

Data and findings in Sargent's 1884 *Report on the Forests of North America* confirmed Fernow's view that the U.S. needed proper forest management. This report energized his advocacy for scientific forest management. He joined AFA, sought leadership roles, and became a driving force in the NGO. He helped organize the first American Forestry Congress in 1882. He served as AFA's executive secretary from 1883 to 1895 and also as a member of its committee focused on improving laws related to forest conservation.

When Fernow became Chief of the USDA Division of Forestry in 1886. He had three main policy goals:

- Establish a national forest system,
- Introduce scientific forest management, and

[34] The University of Göttingen, located in the Lower Saxony area of Prussia, was the world's premier research center for mathematics and natural sciences.

[35] The first main shaft for iron ore mining was sunk on Mount Penn in Reading, PA in 1843. Before that, mining was limited to large open pits or shallow shafts less than 75-100 feet deep. By the 1870s, deep shaft mining expanded to meet the demands of the iron industry once anthracite-fired iron furnaces technology developed in the Lehigh Valley of eastern Pennsylvania and along Delaware Rivers. m

[36] See Stanley Dempsey's paper, *"Cautious support: relations between the mining industry and the Forest Service, 1891-1991"* in Steen, H.K. (Ed.).(1992) The origins of the national forests: a centennial symposium. Durham, NC: Forest History Society. ISBN: 0-8223-1272-7. https://ppolinks.com/forestservicemuseum/1992_3_1_mine.pdf

- Create collegiate educational programs that would lead to creating the profession of forestry.

To support his first goal, he invested much time and energy in getting the Forest Reserve Act of 1891 passed. Fernow's political advocacy was through the AFA, where he was an active member of the forest laws committee that was urging creation of a national forest system, which resulted in the Forest Reserve Act of 1891. The act authorized the President to set aside public forestland in the west as forest reserves. Displays that Fernow prepared for the forestry exhibit at the 1893 Chicago World's Fair played a prominent role in generating public support for establishing national forests. The displays also created support for a Prussian-style national forest service and a collegiate system for training forestry professionals for the United States.

To support his second goal of introducing scientific forest management, he and his staff produced many scientific reports while working toward the creation of national forests. Among his objectives was to protect and carefully manage forested watersheds to better manage flow rates and water quality. Fernow also recognized that the scientific basis for American forestry needed to differ in some ways from European forestry. He was quoted as saying, *"… besides making propaganda (on the merits of forestry) we should … establish the principles upon which the forestry we advocate is to be carried on."*[37] His staff included George Bishop Sudworth[38], who authored several books, notably *A Check List of the Forest Trees of the United States*, and Raphael Zon, who pioneered studies of forest influences on watersheds and the economic benefits of forestry. Examples of USDA studies by its researchers during Fernow's tenure were studies of forest supplies for fuelwood and lumber, the impact of railroads on forests,[39] forest fires, and the benefits of tree planting in the Great Plains.

Fernow resigned as 3rd chief of the USDA Division of Forestry because Secretary of Agriculture James Wilson refused to increase the research budget of the Division. Fernow's most enduring contributions[40] as 3rd chief were his work on the Forest Reserve Act of 1891 and the Organic Act of 1897. Fernow left the USDA Division of Forestry for Cornell in 1898. It was time to put his energy into his third policy goal—creating professional forestry education in the U.S.

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[37] Storey (1975), p. 6. Quoted in West, T.L. 1990. Research in the USDA Forest Service: a historian's view. Third Symposium on Social Science in Resource Management. College Station, TX: Texas A&M University. 18 May.

[38] At the time of his death in 1927, Sudworth was Chief Dendrologist of the Forest Service.

[39] From 1865 to 1890, railroads transformed the U.S. Driven by government land grants and private capital, five transcontinental railroads were built by 1890, and existing rail networks grew denser. Between 1870 0and 1980 track mileage tripled, helping to boost track mileage from 35,000 miles in 1865 to over 200,000 miles by 1900. Locomotive emissions sparked forest fires. Building each mile of track took 2000 cross-ties. Ties needed to be replaced every 5 to 7 years due to lack of effective wood preservatives. Telegraph poles followed railroads; 40-50 per mile. Timber bridges and other wooden infrastructure—stations, sidings—added to railroad wood demands. Further, until the 1880s, wood was the predominate railroad fuel. Coal began replacing wood in eastern railroads during that decade because of wood shortages and climbing wood costs.

[40] A contribution not to be overlooked was Fernow's service as editor-in-chief of the *Journal of Forestry*, which he started at Cornell in 1892 (subsequently taken over by the Society of American Foresters in 1917), until his death in 1923.

While Fernow's desire to establish a Prussian-style vision for professional forestry in America weren't shared by Gifford Pinchot and others, nevertheless, Fernow was among the pioneers of forestry research in the U.S.

Gifford Pinchot, 4th chief of the USDA division of forestry. Gifford Pinchot replaced Fernow as the 4th Chief of the USDA Division of Forestry (1989-1901) and then served as the 1st Chief of the Bureau of Forestry (1901-1905) when it was elevated from a division to a bureau, and then 1st Chief of the USDA Forest Service (1905-1910).

Pinchot changed the Division's priorities and foci. He shifted the Division's focus toward active, practical management of forests, fire protection, and leveraging political influence. Pinchot led USDA into creating management plans for private timberland owners. He also had staff focus on fire prevention, fire effects, and grazing management—areas overlooked by Fernow. Pinchot redefined forestry as the sustainable, scientific use of both public and private forest resources ("Utilitarian" conservation) rather than just preservation. Pinchot's political savvy led to active use of print media and political influence to push for the transfer of forest reserves[41], created under the 1891 Forest Reserve Act yet held and managed by the Department of the Interior's General Lands Office under the 1897 Organic Act, to the Department of Agriculture. The Transfer Act of 1905 moved the reserves to USDA, transforming the USDA Division of Forestry into the U.S. Forest Service. Researchers employed by the USDA Division of Forestry became the core group of Forest Service researchers.

Early forest education in the U.S.

The earliest U.S. forestry schools didn't emerge until the late 1890s and early 1900s. European foresters were central to them.

Biltmore & Carl Alwin Schenck. The Biltmore Forest School (1898-1913) was founded by Carl A. Schenck, a German forester, on George Vanderbilt's estate in Asheville, North Carolina. It was the first forestry school in the U.S., offering hands-on training for practical work in the lumber industry. Entrance conditions were lenient—graduation from high school. But once accepted into the program, requirements were strict and those who couldn't make the grades were dropped.

Schenck viewed forestry as a science, balancing forest conservation and economic needs to create a sustainable system. Biltmore's program was an intensive 12-month program of classroom lectures on silvicultural theory and rigorous practical field training followed by a 6-month internship. Schenk's curricula and textbooks laid the foundation for practical forestry

[41] Forest reserves were created from public domain lands held by the Department of the Interior's General Lands Office. The Forest Reserve Act of 1891 empowered Presidents to set aside public domain forests to protect watersheds and timber and not transfer them to private landowners. The 1897 Organic Act directed the management and regulation of forest reserves.

education in the United States. The program was a "ranger school," designed to train forest workers rather than scientists, and modeled on programs of the German "Master Schools."

Today, Biltmore is known as "The Cradle of Forestry" and is part of the Pisgah National Forest. When the Biltmore School closed in 1913, it had graduated 365 students, representing about 70 percent of all foresters in America at this time. Among them were Overton Price[42] and Frederick E. Olmsted[43], both early hires of the USDA Division of Forestry and founders of the Society of American Foresters.

The New York *Times* described Schenck as *"… the most influential person in making forestry in this country a science and profession."* He also helped create the forestry school at The University of the South, Sewanee, TN, and was a visiting professor at the University of Montana, Missoula, MT from 1923-1937.

New York State College of Forestry & Bernhard Fernow. A few weeks after Biltmore began in 1898, The New York State College of Forestry was established at Cornell University, Ithaca, NY. It was the first professional forestry school in the U.S. offering a baccalaureate degree. Bernhard Fernow was its leader. A year later, a Ranger School offering a one-year training course in surveying, mapping, and timber cruising was established at Wanakena, NY.

In 1913, the college was shifted to 12 acres of land adjacent to Syracuse University, a private research institution established in 1870. Raphael Zon (1901) and Bob Marshall (1924) were notable graduates who joined the Forest Service.

Yale School of Forestry & Henry Solon Graves. When the U.S. Forest Service was formed, its new Chief Gifford Pinchot, realized that managing the new national forests required scientific information. Pinchot persuaded his father to endow a new forestry school at Yale[44] ($150,000) and then sent Henry Solon Graves to be its first director. Graves had a baccalaureate degree from Yale in 1892 and a master's degree in 1900. The Yale school was the first graduate school dedicated to forestry in the U.S. Graves' curriculum focused on silviculture and scientific management. After serving as the second Chief of the Forest Service (1910-1920), Graves returned to Yale and served as the Dean of the Forestry School (1923-1939) and University Provost (1923-1927).

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[42] Price was Associate Forester, Pinchot's second-in-command and instrumental in creating the Forest Products Laboratory. He also was lead author of Circular 171: Price, O.W., Kellogg, R.S., Cox, W.T. (1909). The forests of the United States: their use. Circ. 171. Washington, DC: U.S.G.P.O. 25 p. https://archive.org/details/forestsofuniteds17pric/page/n1/mode/2up

[43] Olmsted was the nephew of Frederick Law Olmstead, the noted landscape architect whom Pinchot had worked with earlier on George Vanderbilt's estate. After being hired by the Division of Forestry, he was a "boundary boy" because during field seasons, he located the boundaries of the forest reserves. In 1902, Pinchot put him in charge of the Subdivision of Forest Products. From 1902 to 1905, he supervised 15 "boundary boys" and led the identification of additional potential forest reserves. He also wrote the new *Use of National Forest Resources* (aka the *Use Book*) in 1905 and its revision in 1907, and was the first regional forester based in San Francisco.

[44] The initial endowment in 1900 was $150,000; about $5.8-$5.9 million in 2025$.

Other early forestry schools in the U.S. included: the University of Michigan whose Department of Forestry was established in 1903 (but had been offering forestry courses as early as 1881); the Pennsylvania State Forest Academy[45] (1903); Iowa State University (1904, but who had offered its first forestry course in 1877); the University of Georgia (1906); the University of Washington (1907) who created a forestry school to serve the needs of the Pacific Northwest timber industry; and the University of Montana who formed a Ranger School in 1908 and a four-year program in 1913.

Henry Solon Graves, James Toumey, Herman Haupt Chapman, and Ralph Hawley at Yale. Graves focused on forest management, including sustainable timber harvesting, forest mensuration and valuation, forest policy, and improving education standards. Toumey developed silviculture based on ecological principles and studied natural regeneration and tree nursery practices. Toumey established the school's research reputation, integrated ecological principles into forestry, and founded the Ecological Society of America. Together, Graves and Toumey created a curriculum that blended field experience (summer camp at Grey Towers (the Pinchot family's country estate in NE PA) and Yale's school forests in northeastern Connecticut and Keene, NH) Pinchot's father underwrote the costs of purchasing the Connecticut and New Hampshire properties to establish research and demonstration activities. Two 1904 graduates of the school—Herman Haupt Chapman and Ralph Hawley—joined the faculty in 1905-1906. Chapman taught forest management, especially fire ecology and management and initiated annual field trips in the South to study southern pines. He's considered the "father of controlled burning for silvicultural purposes." Hawley taught mensuration, surveying, and silviculture. Toumey and Hawley developed silviculture based on ecological principles and studied natural regeneration and tree nursery practices. Together, they developed the science of forest mensuration and created a curriculum that blended field experience (summer camp at Grey Towers, and Yale's school forests in northeastern Connecticut and Keene, New Hampshire). Pinchot's father underwrote the costs of purchasing the Connecticut and New Hampshire properties to establish research and demonstration activities.

Charles Sprague Sargent at Harvard. Sargent was Harvard's botanist and head of Harvard's arboretum for 54 years was mentioned earlier. He transformed the arboretum into a premier scientific research facility with a world-renowned botanical collection. Beyond the 1884 report, Sargent wrote *The Silva of North America* (1891-1902) whose 14 volumes were the first comprehensive compilation of trees' properties. Sargent also focused on the stocking density and location of various tree species and an economic analysis of forest utilization.

Iowa State's early forest education began in 1874 with a course, subsequently combined in the Department of Horticulture and Forestry established in 1877. A complete degree-track program in forestry was approved in 1904. Early forest research identified optimal tree species for

[45] An excellent history of the emergence of the forestry and forest education movement in Pennsylvania is Swanger, R. (2010). "Something akin to a second birth": Joseph Trimble Rothrock and the formation of the forestry movement in Pennsylvania, 1839-1922. Pennsylvania Magazine of History and Biography. Vol 134, No 4. Pp 349-363. https://journals.psu.edu/pmhb/article/download/60028/59846

windbreaks and shelterbelts to protect crops and farm steads. Early soils research began to link tree species performance with specific soil types. Early researchers were Louis H. Pammel, botanist, and Ada Hayden, who began her pivotal work in prairie and forest ecology in 1911. Among Pammel's early students was George Washington Carver, who completed his B.S. in 1894, then pursued graduate studies as Assistant Botanist at the College Experiment Station focused on plant pathology and mycology, completing his Master's degree in 1896. Pammel studied grazing conditions in the Uintah mountains for the Forest Service and did research on grasses of the plains for USDA.

Michigan's forestry program was a response to the devastating cutover land left by the late 1890s logging boom. The University of Michigan first offered offer forestry courses in 1881. Michigan State University—the land-grant college—established forestry education two years later. William James Beal championed reforestation, focusing on reforesting the "stump prairies" of northern Michigan. He established the Beal Pinetum (1896) to test alternative pine species' silviculture needs and serve as a long-term growth and yield research area. In 1925, program established a field station to study intensive management of northern hardwood and spruce-fir forests.

Pennsylvania State Forest Academy and Joseph Trimble Rothrock. In May 1903, the Governor of Pennsylvania created the Academy by proclamation. The impetus for his action was the barren lands that had been decimated by rampant cutting to serve the charcoal, iron and mining industries. George Wirt, first director of the academy patterned the curriculum after curricular in Germany. At that time, Germany was a leader in reforestation. Swanger (2010) is an excellent overview of Pennsylvania's forest history. [46]

University of Georgia focused on restoring the heavily harvested, fire-prone, and degraded forests of the South. Endowed by George Foster Peabody in 1906, Alfred Akerman was its first professor. In partnership with University of Georgia researchers, Forest Service researcher Philip Wakeley pioneered reforestation techniques for loblolly and longleaf pine, addressing millions of acres needing planting. The first forest tree nursery was established in 1916-1917, leading to early studies in seedling nursery production and management as well as planting techniques. Early studies in the 1910s and 1920s showed that fire, when controlled, could be used to suppress brown-spot disease in longleaf pine and aid in regeneration of that species. This contradicted earlier "fire is always bad" policies.

University of Montana. Joseph Kirkwood, Morton Elrod, L.C. Plant and J.P. Rowe were early faculty. A difference from the eastern schools was that six Forest Service employees, mostly supervisors, were engaged to teach courses too, as students were expected to join the agency upon graduation. Early research focused on fire management and timber management. In

[46] An excellent history of the emergence of the forestry and forest education movement in Pennsylvania is Swanger, R. (2010). "Something akin to a second birth": Joseph Trimble Rothrock and the formation of the forestry movement in Pennsylvania, 1839-1922. Pennsylvania Magazine of History and Biography. Vol 134, No 4. Pp 349-363. https://journals.psu.edu/pmhb/article/download/60028/59846

collaboration with the Forest Service researchers and its Fort Valley Experimental Forest on the Coconino National Forest, early studies dealt with the intense need for fire management and reforestation in the interior West. Silvicultural studies on the growth, regeneration, and management of ponderosa pine and other western species were critical, given the high-altitude, fire-prone nature of many Montana forests. Other early studies investigated how to protect young seedling regeneration from livestock grazing on national forests[47].

University of Washington. Early faculty were Francis Miller and Hugo Winkenwerder. Early research focused primarily on growing trees faster so that harvested sites could be replanted after logging. The concern was that early cutting rates had left many cutover areas in need of regeneration or else the new second-growth forests wouldn't grow big enough soon enough to be available to meet ongoing industry needs. After the U.S. Forest Service established the Wind River Experimental Forest in Skamania county in 1913, partnerships between university and agency researchers quickly bloomed. Douglas-fir and western hemlock were the two species of greatest interest.

Three salient points arise from enumerating these early schools and their research:

- **Curricula were needed and they were largely based on European textbooks and curricula**. Sir William Schlich's five-volume *Manual of Forestry*, first published in 1895 and based on existing European science, was the most comprehensive set of texts then available worldwide. Schlich taught and led forestry schools for the British Empire, first at Dehradun, India (1877-1885) and then at the Royal Indian Engineering College at Coopers Hill, Surrey, UK until it was closed (1885-1905), after which he moved to Oxford University and founded and led the Oxford Forestry Institute (1905-1920). Later work by Fernow in designing a curriculum for the New York State College of Forestry was based in part on his Prussian Forest Academy curricula and Schlich's *Manual*. Both influenced Graves' curriculum at Yale, which in turn, formed the foundation for curricula at other new U.S. forestry schools. Wirt's curriculum at the Pennsylvania State Forest Academy also was based on German texts.
- **When the new American forestry schools were created, research was a vital component supporting the education they provided**. The early U.S. university research was tightly focused on immediate, important, and therefore high-priority needs.
- **Collaboration between university and Forest Service scientists occurred very early in the histories of both the schools and the agency.** This set an important attitude for forest research in the U.S.—combining knowledge at sites where both university and agency scientists could partner was a strength.
- An excellent historical overview of forestry education in the U.S. is Green (2006)[48].

[47] See Smith's history of the school at https://www.umt.edu/environment/files/montanas-school-of-forestry.pdf
[48] Green, C.C. (2006). Forestry education in the United States. Issues in Science and Technology Librarianship. Spring issue. DOI:10.5062/F4FX77CX

Emergence of research in the new USDA Forest Service

Raphael Zon: the driving force behind forest research.

Zon was born in the Russian Empire in 1874. A schoolmate of Lenin's, he fled Russia in 1896 while on bail following arrest for organizing a trade union. He and his wife emigrated to the United States in 1898. They quickly made their way to Cornell where Raphael studied forestry under Bernhard Fernow and Fibert Roth, earning a professional degree of Forest Engineer in the college's first graduating class in 1901. He immediately joined the Bureau of Forestry's Division of Forest Investigations, where he focused on research about eastern forests.

Pinchot understood the vital role that research could play in providing the science needed to practice sound forest management. Therefore, in 1902 he created the "Division of Special Investigations" within the Bureau. At that time, this component accounted for about one-third of the Bureau's budget. But Zon soon became convinced that the German methods of forest science taught by Fernow were not being properly followed by the Bureau. Zon had a blunt personality and argumentative nature; perhaps not unusual giving his earlier life in Russia. Richard's 1926 paper[49] said that "his ability to criticize searchingly was sometimes a bit overwhelming" yet led him to act forcefully on this concern. In a 1904 memo to Pinchot, Zon painted a dire picture of the state of forest research in the Bureau, "the need for silvical data upon which one can rely in making his practical recommendations … is felt by every member of the Bureau."[24] The solution Zon zealously advocated was creating a Section of Silvics with wide administrative independence that would serve as the source of information for all field foresters.

After the national forests were transferred to the new Forest Service in 1905, Pinchot's focus shifted heavily to establishing a land management organization and land management policies for the new national forests. But he made certain that researchers formerly in the Bureau's Division of Forest Investigations were transferred to the new Forest Service. Zon continued his forceful recommendations. In 1906, the previously named Division of Special Investigations was renamed the Office of Silvics with Raphael Zon as its Chief. In a memorandum the same year, Zon argued that the current lack of focus of research in the newly-minted Forest Service was unlikely to produce much useful research of regional or national scope, and neither were the forest research components of the state agricultural experiment stations or new university programs. Zon's solution was to put all the research money into a single pot to be spent on a series of well-thought-out lines of research under one head. Zon's reasoning convinced Pinchot, who returned the memo to Zon with a hand-written note at the top: "I have read this with great interest. Pls let me see a detailed plan." Thus, Pinchot tasked Zon with developing a plan for permanent experiment stations focused on scientific, field-based research. Zon had successfully argued that to practice scientific forestry, the agency needed rigorous long-term studies focused on key topics of regional and national importance.

[49] Richards, E. (1926). Raphael Zon–The Man. Journal of Forestry. 24(8): 850-857.

Now the primary architect of a national, organized, research program, Zon created a set of field stations dedicated to studying forest ecosystems, which led to establishment of experimental forests for field research. Zon envisioned that over the coming decades experimental forests would serve as "meeting grounds" for researchers and land managers, ensuring that scientific data and findings would directly inform silvicultural activities and forest management and conservation strategies. Zon also saw a corollary role for the experimental forests and ranges, that of "furnishing the most valuable, instructive, and convincing object lessons for the public in general."[24]

Zon and Pinchot decided to locate the first station in the Southwest. Zon's assistant, Samuel Trask Dana, canvassed New Mexico and Arizona looking at possible locations. In 1908, Zon personally chose the first location: Fort Valley on the Coconino National Forest near Flagstaff, Arizona. The new experiment station would focus on studying ponderosa pine. The Fort Valley station was the linchpin of Zon's bold plan. It also represented the beginning of a fruitful marriage between German and American methods of forestry.[50] Other early stations were the Fremont in Colorado (1909), Santa Rita experimental range (1915). Bent Creek in North Carolina was the first in the East in 1925. These were the foundations for the current network of 84 experimental forests and ranges in today's Forest Service. For a detailed recounting of highlights of the scientific advances accomplished on experimental forests and ranges in the first 100 years, see Wells et al. 2009.[51] For synopses of the research programs on each experimental forest and range, see Adams et al. (2008) [52] and Hayes et al. (2014)[53].

Short history of government-run research stations and networking in Europe. The history of government-run experiment forest experiment stations had its roots in Vienna, Austria, beginning in 1868. A group of German foresters and soil scientists attending a convention shared concerns about their country's lack of any comprehensive plan for forest research. Five were appointed to think about how to create an organized network of field stations. Their plan envisioned a network of government-operated field stations, associated with forestry schools and staffed by professors. The first two were established in 1870 in Baden and Saxony, with six more created in two more years. Then a Union of German Forest Experiment Stations was set

[50] Young, Jeremy C. (2008). Roots of research: Raphael Zon and the origins of forest experiment stations. In: Olberding, Susan D., and Moore, Margaret M., tech. coords. Fort Valley Experimental Forest-A Century of Research 1908-2008. Conference Proceedings; August 7-9, 2008; Flagstaff, AZ. Proc. RMRS-P-55. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 257-261.

[51] Gail Wells, Deborah Hayes, Katrina Krause, Ann Bartuska, Susan LeVan-Green, Jim Anderson, Tivoli Gough, Mary Adams, Thomas Schuler, Randy Kolka, Steve Sebestyen, Laura Kenefic, John Brissette, Susan Stout, Keith Kanoti, Fred Swanson, Sarah Greene, Margaret Herring, Martin Ritchie, Carl Skinner, Tom Lisle, Elizabeth Keppeler, Leslie Reid, Peter Wohlegemuth, Stanley Kitchen, Ward McCaughey, Jim Guldin, Don Bragg, Michael Shelton, David Loftis, Cathryn Greenberg, Julia Murphy. (2009). Experimental forests and ranges: 100 years of research success stories. Gen. Tech. Rep FPL-GTR-182. Madison, WI: USDA Forest Service. https://doi.org/10.2737/FPL-GTR-182

[52] Adams, M.B., Loughry, L., Plaugher, L. (comps). (2008). Experimental forests and ranges of the USDA Forest Service. Gen. Tech. Rep. NE-321 Revised. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 178 p. https://doi.org/10.2737/NE-GTR-321.

[53] Hayes, D.C., Stout S.L., Crawford, R.H., and Hoover, A.P. (eds). (2014). USDA Forest Service experimental forests and ranges: research for the long term. New York, NY: Springe. 659 p. ISBN: 978-1-4614-1817-7.

up to standardize and codify the experiments conducted at the locations. Their directors met annually to exchange ideas and recent results. This fledgling organization led to similar stations being created in France, Switzerland, and Austria. It created so much data useful for all Central European forest types that an international union of research organizations was formed in 1892 at the directors' meeting in Eberswalde, Germany. Today—133 years later—the International Union of Forest Research Organizations (IUFRO) has over 700 members with a global Secretariate in Vienna, Austria. The Forest Service has been an IUFRO member since before 1914, with its researchers serving in important leadership positions since the late 1940s.

Post-Pinchot expansion of forest research. After Gifford Pinchot was fired in 1910 and Henry Solon Graves was appointed the 2nd Forest Service Chief, Graves broadened the research assignment to address several urgent needs. After the "Big Blowup" of 1910, an aggressive long-term shift toward intensive research on fire suppression and post-fire reforestation studies were started at Wind River, Washington. Permanent growth plots were installed on the Willamette National Forest. Timber volume estimation studies were expanded. In a first for the agency cooperating with a land grant university, a national laboratory for forest products research was created on the campus of the University of Wisconsin in 1910.

The Week's Act of 1911 broadened Forest Service research by adding focus on rehabilitation of eastern forests, watershed protection, and fire management. Authorities in the Week's Act led the Forest Service to acquire 20 million acres of degraded, diverse eastern forests. The law mandated studies on how forests impact the navigability of rivers, leading to research on erosion control, soil health, and watershed management, especially in the Appalachians. Unlike western, mostly coniferous forests, the degraded condition of newly acquired eastern forests required new research into forest restoration, reforestation, and watershed protection. Further, the Act authorized $200,000[54] in matching funds for state-level fire protection, prompting research into fire behavior and prevention in eastern forests. Finally, the legislation enabled, for the first time, federal matching funds for state forestry programs, fostering collaborative research on private forests with both state forestry agencies and land grant universities. In 1920, Zon wrote, "there should always be the closest possible cooperation between the Forest Service and those groups."[55]

The broadened research assignments of the Weeks' Act led to the Office of Silvics being renamed the Office of Forest Investigations in 1913. The national network of experiment stations spawned by Zon and Pinchot and implemented by Zon and Graves would become the Forest Service's Research & Development mission area.

The McSweeney-McNary Act of 1928. The next vital legislation expanding Forest Service research was the McSweeney-McNary Act of 1928. It authorized two things: a comprehensive,

[54] $200,000 in 1911 is equivalent to $6.8 million in 2025 dollars.

[55] Zon, R.A. (1920). The Part of Public, Academic, and Private Organizations in the Promotion of Forest Research. U.S.
Forest Service: n.p. Available: National Archives and Records Administration, College Park, MD, Record Group 95, PI-18/Entry 15 (Research Compilation File), Box 186.

nationwide program of forest research; and a continuous survey of forest resources in the United States. Essentially, it affirmed Congressional approval of the nationwide network of experiment stations and experimental forests and ranges that had been created by Zon and Graves. The first authorization laid out five broad research portfolios: forest management (including silviculture and ecology), range management, watershed management, fire protection, and forest economics.

The second authorization in the Act–authorizing a continuous survey of forest resources—expanded the research portfolio. For the first time since the Hough and Sargent reports four decades earlier, Congress wanted to know the condition of *all* forests in the nation, not only the national forests. The Act directed the agency to implement *"… a comprehensive survey of the present and prospective requirements for timber and other forest products of the United States."* Although the new addition to the research portfolio was called Forest Survey in its early years, today its name is the Forest Inventory and Analysis (FIA) program.

The survey had four components addressing different aspects of forest management: complete an inventory of the nation's forests; assess forest growth phases; study forest depletion; and estimate requirements for forest products. The aspect about assessing forest growth phases led to quantifying forest structure by state, forest type group, size class--nonstocked; seedlings and saplings, pole timber, and saw timber—and stand age class. The aspect about forest depletion led to estimating net volumes of growing stock by ownership group, along with annual growth, annual removals, and annual mortality—all vital information for tracking forest depletion.

The survey began in 1929 in the Douglas-fir region of Oregon and Washington, led by Thornton T. Munger, a research scientist with the recently created Pacific Northwest Forest and Range Experiment Station. Other research stations began their surveys in individual states; the first state in the Northeast in 1930, 1932 in the South and the Lake States, and in the mid-1930s in the Rocky Mountains. Initially, these were periodic inventories, conducted every 10-15 years, state by state. In 2000, advances in statistical techniques enabled annual surveys to begin, first in the eastern half of the nation, with a subset of plots measured in each state every year.

Anchoring Forest Service research authorities in the post-World War II years

Immediately after World War II, the Congress asked the Forest Service to prepare a report of timber conditions in the U.S. Wartime needs had ramped up timber production, so a post-war assessment of forest conditions was sought to understand the war's effects on the nation's forest resources. After the war, Chief Lyle Watts called for a reappraisal of the nation's timber situation. In partnership with the American Forestry Association, the 1945-1947 reappraisal report showed a significant decline in sawtimber—18.6 billion board feet per year. Key factors were the burgeoning civilian demand for housing construction stimulated by the Servicemen's Readjustment Act of 1944 (the GI Bill), which offered no-money-down loans that allowed millions of veterans to purchase homes, and timber demands for reconstructing postwar Europe. The 1945-1947 reappraisal report also showed that a large proportion of the private

forestlands had no more timber as a result of high war demands. Therefore, the pace of logging on federal lands accelerated in the late 1940s and early 1950s. On its heels came the Korean War (1950-1953). There were concerns about the uncertain political future globally and what projected future conditions might mean for America's forests.

In 1952, Chief McArdle launched a comprehensive review of the nation's timber supplies and demands to provide actionable data for future forest management in an uncertain future. It was a massive collaborative effort involving state agencies and private industry, led by Ed Crafts, Assistant Chief for Program Planning & Legislation. It aimed to analyze the timber resource situation to identify development problems in time to adjust public and private forest policies. But it made no recommendations about what those adjustments might be. Craft's oral history is an excellent recounting of the history of this study and his other contributions.[56]

A preliminary draft of the *Timber Resource Review* (TRR)was published in 1955. It was intended as a document for review by advisors, collaborators, and agency employees who participated in assembling and analyzing the data. But public interest was so large that through several reprints to meet demands, 15,000 copies were ultimately printed. Two-thousand comments were received. The final report published in 1958 included both responses to the comments as well as fresh post-war forest inventory data.

This report was the 6th national report on the nation's forest resource situation, the initial ones dating back to Hough's 1878 and Sargent's report in 1884. The historical significance of this report is three-fold. First, it specifically cited the research authorities in the 1927 McSweeney-McNary Act when describing why the report was commissioned and extensive partnerships used. Second, it served as a foundational document for later periodic assessments required by the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974. The TRR called attention to the fact that it was limited to an assessment of the timber situation and did not include assessments of other important forest resources. That helped justify the broader scope of the RPA legislation. Third, the analytical techniques introduced for the first time in TRR served as the baseline for future 20th century assessments. For example, the research arm broke all statistics down by state, ownership category, and size of trees. It also introduced the use of growth-removals-mortality computations to determine net growth.

A side note: Examples of station directors becoming regional foresters and higher. In the mid-20th century, it was not uncommon for leadership career paths to include both working at research stations and in the national forest system. Some examples:

- **Ed Crafts**. From 1932-1939, he was a researcher at the Pacific Southwest Forest and Range Experiment Station and a research economist at the California Forest and Range Experiment Station (1941-1944) before becoming Division Chief of Forest Economics in the Research mission area.
- **John McGuire**, one of many experts working on the TRR, was research economist at Orono, ME, served 5 years in the headquarters of the Northeastern Forest Experiment

[56] https://foresthistory.org/wp-content/uploads/2022/05/Crafts_Edward_C.pdf.

Station, led economics research at the Pacific Southwest Station for 5 years, was later Director of the Pacific Southwest Station for four years before becoming Deputy Chief for Program Planning and Legislation in 1967.

- **Charles Connaughton's** early career spanned national forest system and research station appointments. He was Southern Forest Experiment Station Director (1944-1951) and later Regional Forester in Regions 5 (1955-1967) and 6 (1967-1971).
- **Richard McArdle** was Director of the Rocky Mountain Research Station and the Director of the Appalachian Research Station (aka Southeastern Forest Experiment Station) (1937-1944)
- **Ronald Stewart** was Pacific Southwest Research Station Director (1988-1990) before becoming Region 5 Regional Forester (1990-1994)
- **Kent Connaughton** had a long career in research before becoming Regional Forester in Region 9 (2007-2011) and Region 6 (2011-2014).
- **Jack Ward Thomas** was a senior research scientist, notably on elk habitat, at the Pacific Northwest Research Station before becoming Forest Service Chief.
- **John Phipps** was Rocky Mountain Research Station Director before becoming Deputy Chief of State and Private Forestry.

Forest and Rangeland Renewable Resources Planning Act of 1974 (P.L. 93-378). The Multiple Use-Sustained Yield Act of 1960 codified the various uses of national forests and that the combination of uses for particular forests would not necessarily be the combination that gave the greatest dollar return or greatest profit. But the bill did not assign any priorities amongst the uses mentioned. Public controversy erupted at the Fifth World Forestry Congress held in September 1960 in Seattle, WA. For these remarks, I'll go to skip over the various debates that erupted. Rather, I'll connect the dots between the list of potential uses and the expansion of forest resource assessment coverage.

The 1974 RPA legislation attempted to do three things.

1. It broadened forest resource assessment coverage beyond timber to cover all forests and forest uses; required forward looking projections of forest conditions, looking ahead 50 years under the assumption that existing forest management policies would continue unchanged; and required the Forest Service to send fresh assessments to Congress every ten years.
2. The RPA Act required a new and different report—a Renewable Resource Program—that provided options for management of national forests and delivery of state and private mission area programs, and for conducting research. Further, the Program was to include priorities, recommendations to address those priorities, the budget levels required to deliver the science needed to support the priorities and recommendations. The ideal vision was for the Program to focus on the undesirable conditions likely to prevail 50 years in the future if current policies went unchanged—identified in the Assessment—and figure out what policy changes were needed to mitigate or avoid the undesirable outcomes. That was tough enough without OMB and USDA budgeteers' involvement, which of course, overrode and attempted to constrain the "what" to do

and “how to do it” recommendations to conform to the current administration’s budget priorities.

3. The third attempt was to reform national forest planning process so that the cumulative outcomes for all forest plans achieved the goals and objectives set out on the Program document.

The public and internal debates about numbers 2 and 3, above, largely obscured the programmatic effects of the bill on the research mission area. Several effects emerged. First, the combined efforts of the FIA program to gather richer data on forest conditions and trends and the analytical power within the FIA program and also the forest economics and wood utilization research programs were strengthened. Second, experts within the research program on outdoor recreation, water, wildlife, fish, rangelands, urban forests, and forest products were tapped to participate as part of the regular research assignments. Third, partnerships with university experts in these and related areas (e.g., population demographics, socio-economic drivers) were cemented through multi-year cooperative research agreements that funded faculty and graduate students to add data collection and analytical capacity. For example, construction of a large, complex timber demand and supply model was the joint product of a team of both Forest Service and university researchers. Ditto for models of recreation demands, built on public surveys about outdoor recreation preferences and participation rates and the demographic driving forces for future preferences and participation rates. The recreation models and findings were particularly illuminating for national forest system recreation specialists and other public agency recreation programs because for the first time the models identified shifts in preferences in activities and participation rates as people aged and as new outdoor recreation technologies emerged to markets.

There were several net effects of the RPA assessments on research programs. First, funding was augmented for the team of 15-20 agency researchers and a similar number of university partners. That empowered many research advances. More detailed inventories and surveys emerged in a variety of new areas (e.g., outdoor recreation participation) to support the forward-looking resource projections. New models of markets for timber and other resources were developed, driven by census projections of demographics and other forces. These research accomplishments also enabled many of the RPA assessment experts to advance faster in their fields of research and increased the number of Ph.D. graduates experienced in these activities. Second, the RPA Assessment work broadened and deepened the interests of outside organizations—not only state agencies, but also NGOs whose membership and focus was on specific issues. The wildlife and fish assessment findings strengthened interests amongst a large number of regional and national groups, such as the Rocky Mountain Elk Foundation, National Wild Turkey Federation, and American Fisheries Society. Sometimes there were hiccups in developing relationships with certain groups, who had to learn how to simultaneously object strenuously to specific national forest system plans and proposals while fostering positive relations with the RPA experts in the research mission area. In one sense, such differences “kept the door open” for exchanges between the agency and organization where without the RPA work, relationships would have only been icy.

The National Forest Management Act of 1976 amended the RPA by mandating that the Forest Service develop comprehensive land and resource management plans for all national forests and grasslands, updated every 15 years. It emphasized sustainable, interdisciplinary resource management that maintains soil, water, and air quality, while protecting wildlife and fish habitat and ecosystem diversity. Further, it directed the Forest Service to limit the size of clearcuts, ensure prompt reforestation, and restrict harvesting on lands where it will not cause irreversible damage. Finally, it required public involvement throughout plan development. NFMA attempted to shift management toward a more balanced, science-based approach. Although many have written much about NFMA and debate continues about LRMP planning processes, the main effect on research programs was that existing research priorities in station territories shifted, with some growing in importance, new priorities emerging, and others declining in importance and/or agency support.

Forest and Rangeland Renewable Resources Research Act of 1978 (P.L. 95-307)

The principal purpose of this act was to replace the 50-year-old McSweeney-McNary Act of 1928. Section 3 expanded the scope of Forest Service research by broadening the authorized areas of research. It sharpened the focus of the Forest Inventory and Analysis program. I called for reports to Congress on various monitoring programs designed to better track effects of atmospheric conditions, climatological conditions, and forest health conditions and causes. It called for enhanced cooperation with Federal, state, and private agencies and entities and endorsed international collaboration. It updated authorities for research facilities and cooperation[57] with outside agencies, universities, and organizations. Further, it encouraged the development, employment, retention, and exchanges of scientists through post-graduate, post-doctoral, and other training of national and international scientists.

Disseminating science in the 21st century

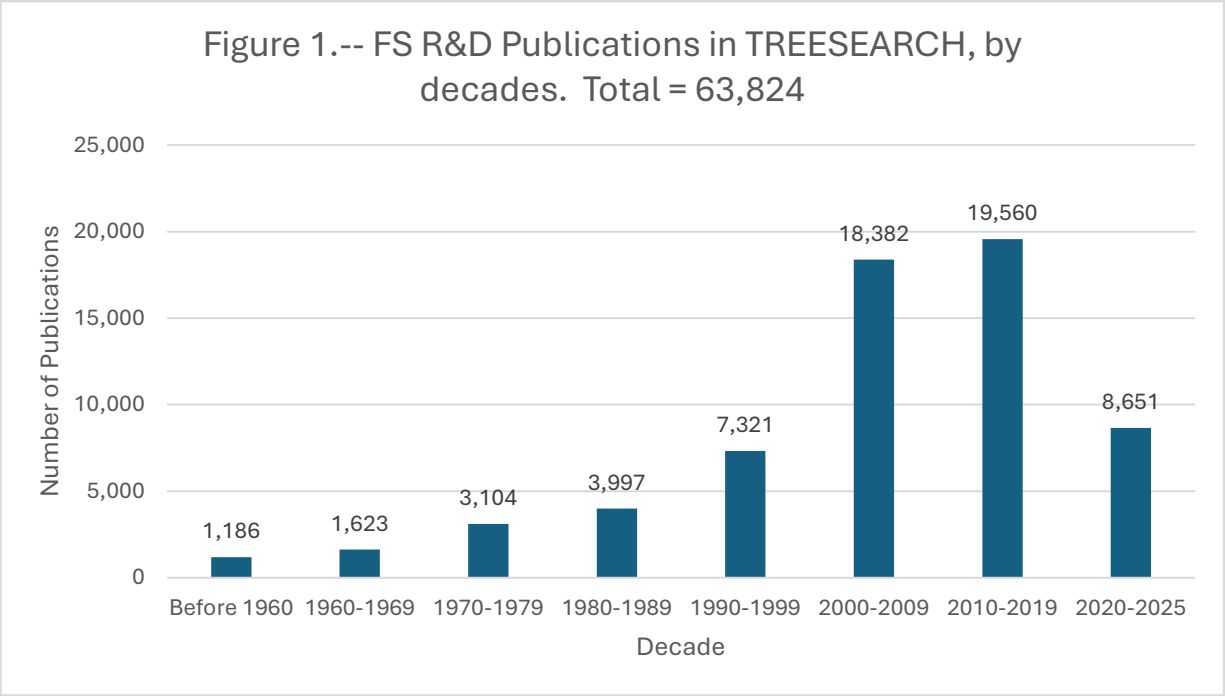
As research has expanded, the R&D mission area has confronted the issue of evolution in the ways that science is disseminated.

Until the late 1980s, each station had its own library. Further, paper copies of all printed reports were also sent to the National Agricultural Library in Beltsville, MD, and to NAL's specialty libraries (e.g., the University of Minnesota, St. Paul, MN, has a complete set of all FS R&D publications ever published). Further, Stations maintained mailing lists of universities and interested clients in their region. Through periodic (quarterly?) newsletters, recent publications in agency reports and peer-reviewed journals were shared with clients, who could then request paper copies be mailed to them.

[57] Cooperation was broadly defined as both financial (e.g., cooperative research grants and agreements issued by the agency as well as incoming money granted by entities or won in competitive grant programs funded by others (e.g., National Science Foundation) and sharing of research sites owned by others (e.g., Penobscot Experimental Forest in Maine, owned by the University of Maine Foundation, Baltimore Ecosystem Study).

Around 2005, FS R&D developed a web-based portal to provide digital copies of publications to anyone with online access. The portal is called TREESEARCH. Today, it's the largest global database of forest research publications. Once TREESEARCH was established, FS R&D librarians began digitizing key reports from prior years, Figure 1.

Today, TREESEARCH is one of the leading online repositories for forest research information. Public data are available on the annual number of TREESEARCH website hits or number of documents downloaded, it is widely known globally as a free source of forest science, maps, and data about U.S. forest science. Its web address is: https://research.fs.usda.gov/treesearch.



Final Thoughts

In his 1976 book, The U.S. Forest Service: a history, Harold K. Steen wrote, "It may be said that the Forest Service started as a research agency." A recent article[58] also called the Forest Service's Research & Development mission area "The brain of the agency."

This essay has taken a "30,000 foot " overview of the history of forest research in the U.S. Clearly the roots of today's R&D mission area are in the U.S. decennial censuses of the 1800s and the early botanical reconnaissance of early explorers. Their information prepared the ground—heightened public awareness of the importance of forests, stimulated Congressional action to inventory and report on forest conditions and trends. This validates Steen's assertion.

[58] Pattiz, W., (2026, Jan 10). *The U.S. Forest Service is Starving to Death in Real Time*. More than Just Parks. https:// https://morethanjustparks.substack.com/p/the-us-forest-service-is-starving

The creation of the land grant colleges in the 1860s and funding of state agricultural experiment stations in the 1880s likewise created opportunities for forest research to prosper once it got started.

The actual roots of forest research on North America came from Europe—for forest research, for forestry education, and for the profession of forestry in North America. By transplanting those roots to this country, with its evolving socio-economic and political conditions, early forest research activities took root.

First came inventory work to learn what forests existed, where they existed, and to some extent, what their condition was. Then came evolution of horticulture to include trees, along with increases in botanical and rudimentary ecological knowledge.

The arrival of Bernhard Fernow (America's first professional forester) altered the trajectory of developments in forest research, forest education, and the forestry profession. The mentoring of Gifford Pinchot, Henry Graves, and other early U.S. leaders by Sir Dietrich Brandeis and Sir William Schlich in the last decade of the 1800s and first couple of decades of the 1900s were extraordinarily valuable (Appendix A). They helped forest research and education—both with Germanic roots—to adapt to the unique North American forest conditions—botanically, ecologically, socially, economically, and politically—as did the emerging profession of foresters and forest management strategies.

Further, by joining the International Union of Forest Research Organizations before 1914, forest research in the U.S. benefitted from the networking opportunities with researchers and research leaders from Europe and elsewhere. Not only did IUFRO membership enable scientific advances in the U.S. to be widely disseminated and help inform scientists globally, it also enabled U.S. forest researchers to tap into the best emerging science in Europe, the British Empire, and elsewhere. Networking within and outside the U.S. accelerated.

After Bernhard Fernow, the second crucial person in the growth of forest research in U.S. was Raphael Zon. I believe he was a more important driving force to expand forest research than Gifford Pinchot. Thankfully, Pinchot could tolerate and appreciate Zon's brusk manner and come to share Zon's vision for a network of regional forest and range experiment stations, with many research sites on national forests focused on their needs. This accelerated knowledge discovery and application. The outcomes from applying early research findings and recommendations proved their worth. And not only for timber management, but just as importantly, watershed management, grazing management, and wildlife and fish management.

The third group of people vital to the growth of forest research were Henry Solon Graves and the early leaders of forestry education. As the number of college graduates with master's and Ph.D. degrees grew by the end of the 1920s[59], the pool of well-trained forest researchers grew.

[59] For the U.S. Endowment's *Blue-Ribbon Commission on Forest and Forest Products Research and Development in the U.S. in the 21st Century*, Terry Sharik (Michigan Tech) and I built a chronology of Master and Ph.D. graduates in

The role of land grant colleges and universities as partners with the Forest Service R&D mission area is sometimes not fully appreciated. FS R&D's 84 experimental forests are world-renowned as homes for long-term research. They are vital infrastructure for long-term research; a network unmatched globally and nearly all of them on national forests. For example, Hubbard Brook Experimental Forest , NH, has over 125 research studies installed, most from university partners, and serves as the center of New England's forest research consortium. Many other experimental forests and ranges are similar networks of university and agency researchers. Another valuable aspect of the partnership is the universities' abilities to accomplish short-term research, often through graduate students, and to share post-doctoral fellowships. These shared programs boost the talent pool of forest researchers, which is important for keeping research continually flowing.

Legislation pertaining to research in the 1970s continues to provide a rock-solid foundation for forest research in the Forest Service. The nation is lucky to have them. Although they are 5 decades old, any future proposals to amend or replace the 1974 and 1978 acts should absolutely demand NAFSR's careful and cautious attention.

In the next quarter century, continually integrating fresh research results with existing knowledge will be an essential activity for both Forest Service researchers and university faculty. Many times, this process of integration will be building upon what is already known. But sometimes, fresh research will mean discarding what we previously thought we knew and replacing it with something else. Therefore, *strengthening both* agency and university research programs is therefore critical to provide the breadth and depth of knowledge needed by current and future resource managers.

Because knowledge from research is proliferating, investing in expanded continuing education for mid-career and later-career agency employees is a compelling need. Better and more innovative ways are needed to provide continuing education to natural resource managers. Developing and testing such innovations are as much vital research activities as they are an important pursuit of educators.

Therefore, a vital goal for the next 25 years is to strengthen both research and education programs to broaden and deepen the information available for natural resource managers' continuing education and leadership development.

Finally, other Deputy Areas of the Forest Service besides Research and have benefited from people who have had R&D work and leadership experience. To me, the examples presented in the paper are outstanding examples of how the agency as a whole has benefited in the past from leaders who had experience in R&D.

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forestry for the 1900s to 2015. Sharik was the NAUFRP leader on educational statistics. https://www.usendowment.org/wp-content/uploads/2019/07/blue-ribbon-commission-on-forest-and-forest-products-research-and-and-development-in-the-united-states.pdf

I hope that as I look back at NAFSR's positions and policy papers over the next 10 -15 years, I will see a group that advocates for the nation's forest research needs. To me, that not only will be a focus on advocating for the intellectual capacity and financial health of the R&D mission area, but also be supportive of university research programs and capacity-building forest education.

The old chestnut is that the Forest Service is a sturdy three-legged stool because it has 3 mission areas. Weakening any of those legs will make the stool unstable. I'd like to adapt that analogy to a three-legged forest **research** stool for the nation whose legs are: (1) a robust Forest Service R&D mission area; (2) a robust university research partner network; and (3) the network of experimental forests and ranges on the National Forests and Grasslands where long-term research studies by both agency and university researchers occur. Weakening any one of those legs will result in an unstable national program of forest research. From my vantage point, weaker legs to the forest research stool will inevitably endanger the national forests, other public forests, private forests and their landowners, the entire sector of the American economy based on forests and wood products, and the ultimately the quality of life of American citizens who enjoy today's forests so much.

NAFSR advocacy should make sure that no one can get away with shaving pieces off any of the three legs of that research stool!

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Appendix A: Influence of Sir Dietrich Brandeis and Sir Wilhem (William) Schlich.

These two German foresters had significant influence on the development of American forest management, research and education programs. Here's a synopsis of their backgrounds and experience.

In 1864, the British government created the position of Inspector General of Forests in India. The goal of the new position was to lead the transition from unrestricted exploitation of forests in India to a management regime that could provide sustainable yields of timber that met both the needs of the British empire as well as local needs. To achieve the goal, the Inspector General was expected to establish systematic, scientific forest management of forests in India. This involved a number of daunting steps, roughly:

- Conduct field surveys to determine current forest conditions—where they were, what they were, how they were being used;
- Analyze the inventory data and determine what changes were needed and where they were needed to reduce wanton exploitation and move towards sustainable management;
- Through research, develop the scientific foundations for moving towards sustainable forest management;
- Create the forest laws and regulations necessary to implement the changes needed, respecting both local as well as national demands for wood and forest products and get "buy-in" from the powers that be;
- Organize an agency to implement the scientific management strategies and actions needed to achieve the objectives of the laws and regulations;
- Train and hire foresters and rangers to staff the new agency;
- Implement science-based management actions on-the-ground—what was needed, where it was needed; then
- Periodically cycle back and conduct fresh field inventories to determine if and where progress toward more sustainable management was being achieved; and
- Based on fresh inventory data, analyses, and research results, make adjustments in laws, regulations, objectives, strategies, and management actions, where needed.

Like I said above, a daunting task of building a framework for practicing and administering more sustainable management of the diverse tropical forests of the British Empire in southeast Asia.[60] Recognize that this whole effort would reduce the East India Company's influence while expanding direct Crown control.

[60] In the 1870s, British India was a vast area of 1.5 million square miles, including modern-day India, Pakistan, and Bangladesh. For purposes of forestry, the British Forestry Department in Burma operated as an extension of the Indian Forest Service. Burma was governed as a province of India until 1937. Teak extraction from India and Burma was a key exploitive activity considered essential to Royal Navy shipbuilding during the 1800s and early 1900s.

Sir Dietrich Brandeis

Brandeis was a German-British forester and university professor who worked for the British Imperial Forestry Service in colonial Burma and India. In 1864, he was appointed the first Inspector General of Forests in India, a position he held until 1883.

Brandeis wrote forest laws, 1865 and 1878, that created an Imperial Forest Department to organize, administer, and implement scientific management. The 1865 Act gave the government control over forests, categorizing them into reserved, protected, and village forests. The 1878 Act provided revisions that fine-tuned the 1865 Act. He established the regional structure of the Forest Department, including outlining the duties of officers and rangers and the training they needed to be appointed to those positions. Important responsibilities included introducing fire protection measures, restricting shifting cultivation, and improving management of commercial species such as teak.

In 1878, Brandeis founded the Imperial Forest School at Dehradun, India, to train forest officers in scientific forest management practices. Lt. Colonel Frederic Bailey, Royal Engineers, was the first director of the school, but faculty was composed primarily of German forestry experts. In addition to coursework, it also had research facilities spanning the gamut of forest management activities to forest products utilization and testing.

The position of Inspector General of Forests in India was dominated by German expertise for its first 50 years. Brandeis, the first, was followed by Wilhelm Schlich (1883-1885) and Berthold Ribbentrop (1885-1900). The latter two were recruited by Brandeis to bring scientific forestry expertise to India.

From 1888 to 1896, Brandeis led the Royal Indian Engineering College at Coopers Hill, UK, the British Commonwealth's engineering school. Coopers Hill trained civil engineers specifically for the Indian Public Works Department. From 1872 to 1906, it provided specialized training in civil engineering to support infrastructure projects such as railways and irrigation systems, telegraphy, and, after 1885, forestry. In those days, forestry was classified as a branch of the broader field of engineering because of its need for land surveying, mapping, and inventory expertise. [61]

Globally, Brandeis is often called either the "father of tropical forestry" for his research on tropical forest species in Burma and India or the "father of scientific forestry" in India.

[61] Coincidentally, in the 1960s, the first two years of coursework in the forest science curriculum at Penn State was exactly the same as the coursework for civil engineering—with the exception of six credits. The two three-credit sophomore year courses in civil engineering for introduction to engineering drawing were replaced in the forestry curriculum by a three-credit course in zoology and a three-credit course in fundamentals of biology/botany.

Sir Wilhelm (Willliam) Schlich

Schlich, also a German-British forester, succeeded Brandeis in Burma, then in India, and finally at Coopers Hill, UK. During his 19 years in Burma and India, he was a forester in Burma, then appointed Conservator of Forests in 1871. The Conservator position was essentially the head of the India Forest Service, essentially responsible for managing state forests for sustainable timber supplies (especially teak). In 1874, he helped establish the professional and scientific journal *Indian Forester*. After Brandeis retired in 1883 to Bonn, Germany, Schlich replaced him as Inspector General of Forests in India. But two years later in 1885 Schlich was called to England to become the first Professor of Forestry at the Royal Indian Engineering College at Coopers Hill, UK.

Starting a forestry program requires textbooks. Schlich prepared a five-volume *Manual of Forestry* that was the first English language forestry curriculum. Schlich wrote the first three volumes on forest policy, silviculture, and forest management. Volume IV on forest protection was written by Dr. Richard Hess, professor of forestry at the University of Giessen (Hesse Germany). Volume V on forest utilization was written by Dr. Karl Gayer, professor of forestry at the University of Munich. These latter two volumes in German were translated to English by W.R. Fisher, who was heavily involved in the education of foresters bridging European, Indian, and British forestry practices. When the college at Coopers Hill was closed in 1905, Schlich moved to Oxford University to start the forestry program there. His five volumes[62] had significant influence on the curricula at early U.S. forestry schools, as did three volumes[63] from another German forester--Carl Schenck, head of the Biltmore Forest School at Asheville, NC.

Influence of Brandeis, Schlich, and Schenck on Gifford Pinchot

The interests of Brandeis and Schlich in American forestry affairs led him to devote special care and mentoring of American foresters, especially Gifford Pinchot and Bernhard Fernow.

When Gifford Pinchot went to Europe after earning a baccalaureate degree at Yale in 1889, he not only studied at the French National School of Forestry at Nancy, he also spent time in Germany and Austria, specifically training with and being mentored by Sir Dietrich Brandeis and Sir William Schlich.[64] Their contacts and mentoring of Pinchot continued until their deaths—Brandeis in 1907 and Schlich in 1925.

Brandeis maintained a large number and detailed correspondences with leaders of forestry as it emerged in America. He provided advice to Fernow on developing U.S. forest policies while Fernow was head of the USDA Bureau of Forestry, and later as head of the forestry school in New York and ultimately University of Toronto. Brandeis respected Fernow's importance in

[62] Each of the volumes went through several editions between 1905 and 1927.
[63] Schenck's 1905 book on forest mensuration focused on inventory methods and statistics. His 1911 book focused on forest policy outside the British Empire, and his 1912 book was titled, the art of the second growth, or American silviculture.
[64] See Chapter 3 Pinchot (1947).

developing American forestry, considering him along with Gifford Pinchot and Charles Sprague Sargent as the three most significant persons in the emergence of forestry, forest science and policy in America.

Pinchot's first job as forester after he returned from Europe was with William Vanderbilt on his estate in North Carolina. In this position, Pinchot wrote to Brandeis asking him to recommend a person to work under Pinchot. As Pinchot wrote, "*He (Brandeis) chose a highly trained and energetic young German named Alvin Schenck, whom I had come to know on the Coopers Hill excursion*." (pages 64-65). Although Pinchot describes his reasons for falling out with Schenck, he did credit Schenck for selecting and training two students in the first two years of the Biltmore Forest School—Overton Price and Frederick "Fritz" Olmsted—who played vital roles in the early years of the Forest Service.

Schlich was also mentored Henry Graves—both early in his career as a forester and close friend of Pinchot's, then as head of the new forestry school at Yale, as second Chief of the Forest Service, and later when Graves returned to Yale a university dean.

Following Schlich's death in 1925, Oxford University raised a fund to establish an award in his name. After awards were given in several countries, the Society of American Foresters permanently adopted the award to recognize outstanding contributions to the field of forestry. SAF presented the first Sir William Schlich Memorial Award to President Franklin Roosevelt in 1935 for his leadership in creating the Civilian Conservation Corps. The second Schlich Memorial Award was presented to Gifford Pinchot in 1940. I received the Schlich Memorial Award in 2020.

Main Point: Several salient points of the evolution of forest research, organization of forestry agencies, and education of forestry professionals in the U.S. had their roots in work by Brandeis and Schlich in India and in the United Kingdom at Coopers Hill and later Oxford, and their mentoring of Fernow, Pinchot, Graves, and others not mentioned here. The "saplings" that ultimately emerged in the U.S. as a federal agency and land grant college forestry schools, clearly had learned lessons from the experiences of foresters educated in Germany who had adapted what they learned to new situations, new forests and different societies in the British Empire. Adaptive management, decentralized to best achieve clearly stated goals and objectives of sustainable forest management, supported by science from place-based research.