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NAVAL STORES

A History of an Early Industry Created from the South's Forests

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PHOTO CREDITS

Cover: A photo of a naval stores operation in northern Florida in the 1920s. One worker is emptying a bucket of gum resin collected from the cups attached below the worked faces on the trees. Another is loading a barrel of resinous material on a wagon to take to the distillery. A woodsrider is there to assure that procedures are followed and production quotas are being met (photo from Florida State Photographic Collection).

Unless otherwise noted, the photographs are from the collections of the U.S. Forest Service. A number of the photos were taken in 1936 by Dorothea Lange and are provided courtesy of the Library of Congress. Lange's images of Depression-era America made her one of the most acclaimed documentary photographers of the 20th century. She is remembered for revealing the plight of sharecroppers, displaced farmers, and migrant workers in the Depression years of the 1930s.

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ABSTRACT

Naval stores are a nearly forgotten legacy in the South, but throughout history nations have depended on them, sought them out, and fought wars over these coniferous products. These products—tar, pitch, turpentine, and rosin—long kept the wooden navies of the world afloat and found many other uses prior to petrochemical dominance. Even with the decline in sailing ships, there has been an international demand for these products. This is the story of a remarkable, but messy, industry that helped support much of the South's economy for nearly 400 years.

Keywords: Longleaf pine, naval stores, turpentining, forest products, southern pines.

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PREFACE

For as long as there have been wooden ships, there has been the need for pitch and tar to caulk seams and preserve ropes. The source of such materials largely has been coniferous trees. Early historians described how natives gathered the resins of trees and cooked them in pots until a thick pitch was left in the bottom, how they stretched fleecy sheepskins over the tops of the pots to catch the oily vapors, and then wrung out the wet fleece to recover the oils. The term for these products from trees that were needed for maintaining the sea worthiness of wooden ships became known as "naval stores."

Soon after colonists settled in America and learned of the resinous nature of southern pines, particularly that of longleaf pine (*Pinus palustris*), a demand for these products came from the English Navy. In fact, a bounty was established to ensure their production. As early as 1700, naval stores became major export products from North Carolina forests. The early products were tar and pitch, which were in demand for maintaining seaworthiness of wooden ships. The source of this material came from cooking lightwood from pines—lightwood was the pitch-rich remnants of decayed pines found on the forest floor. These were gathered and steamed in pine tar kilns dug in the forest floor. Over time, lightwood became scarce and the technology moved to collecting the resin, called gum, from live trees.

The principal products from gum naval stores were turpentine and rosin, and they met a growing international market. To collect the gum, cavities or "boxes" were cut into the base, the pines and the surface above the cavity scarified to stimulate the flow of gum to be collected into the cavity. Called "turpentining," this process was very labor intensive and required the use of slaves to meet demand for its products. Moreover, this procedure typically resulted in tree mortality and the longleaf forests of North Carolina were decimated.

As early as 1700, naval stores became major export products from North Carolina forests. The early products were tar and pitch, which were in demand for maintaining seaworthiness of wooden ships.

In the early 20th century, the technology improved and the "boxing" method was replaced by the "gum and gutter" method, which allowed the trees to be used for lumber after the turpentining use was completed. This technology did not, however, reduce the labor requirement for the production of turpentine. Even after the Civil War, when slavery was abolished, labor was frequently provided by coercion—convict leasing and debt peonage. Turpentining camps were placed in isolated areas near the trees to be tapped and outside of normal society. The abuse of workers continued to be prevalent.

Changes in the system occurred due to a number of interacting factors. Reformative laws replaced the "Jim Crow" laws of the early 20th century, economic changes occurred reducing available labor, and the wood naval stores operations of the West Gulf Region made turpentine available with a small labor requirement. Wood technology distilled turpentine was obtained from the pitch-rich stumps left from the aggressive harvesting of longleaf pine. In the late 20th century, naval stores operations ceased to exist and the desired products were made available from the byproducts of the Kraft pulp and paper industry. Naval stores are now forgotten forest products, but the industry was one of the economic mainstays of the Southern United States for several hundred years.

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INTRODUCTION

Some tree species produce large quantities of oleoresin. Oleoresin (often simply called "resin") is a semi-solid cocktail of complex organic compounds naturally produced by many species of trees [especially those in the pine genus (*Pinus*)], primarily as a defense mechanism (Rodrigues-Corrêa and others 2013). Production of these oleoresins in living pines increases in response to injury from insects, diseases, or physical damage (Hodges and others 1977). The sticky, water- and decay-resistant oleoresins have been used for thousands of years to keep wooden ships afloat and extend the life of their ropes and sails. Because of this, the products derived from these resins are termed "naval stores," although the refined chemicals are now used in many ways unconnected with wooden ships (Ward 1949).

Forests capable of providing an abundant supply of these products were a major economic resource to any nation. For example, in the New World, the English colonists of North Carolina soon found that their native longleaf pine (*Pinus palustris*) were exceptional producers of resins, and in the early 1700s an industry developed there to take advantage of this resource. Of the southern pines, longleaf and slash (*Pinus elliottii*) pines are the most prolific producers of resin and have become the pines most frequently tapped for naval stores.

The sticky, water- and decay-resistant oleoresins have been used for thousands of years to keep wooden ships afloat and extend the life of their ropes and sails.

A wooden sailing ship illustrating the need for tar and pitch for its maintenance. Tar was used to coat the ropes and rigging to extend their life and to make the rigging easier to climb. The pitch was used to caulk and treat the hull to make it watertight. (photo of the schooner Mary L. Cushing from www.shorpy.com)

Resin oozing from a wounded area on a pine—injury from naval stores chipping results in this response.

Historically, naval stores were produced via one of two major sources: the resinous material collected through "chipping" (wounding) pine trees—called "gum"; and wood, for which a distilling process was used to extract the resin. Biologically, wounding pines produces a response by resin ducts found in the cambium. These resin ducts extend radially throughout the woody tissues of the bole (the "xylem"); physically injuring or scarifying the xylem of the tree trunk exposes the resin ducts and oleoresin oozes out. With repeated injury, newly wounded resin ducts respond by producing resin and hence a continuous flow of gum resin during the long growing season. Resins can also gradually accumulate and saturate the xylem. Oleoresin-saturated wood is commonly known as "lightwood" or "lighterwood" (so-called because it was widely used to kindle or "light" fires in stoves and fireplaces) and was the ultimate source of wood naval stores.

The basic naval stores fall into one of four categories: tar, pitch, turpentine, and rosin.

- **Tar**—a dark, thick, sticky liquid produced in pine tar kilns, resulting from the melting of resin at a high temperature in smoldering lightwood. This gooey tar was used to coat sails, ropes, and rigging of ships to make them last longer against the effects of salt water, wind, and sun. It was also used on land as axle grease, to preserve fence posts, and to cover wounds on livestock and help them heal.
- **Pitch**—tar that has been boiled to get a higher grade substance used to paint the sides and bottoms and spread into cracks of wooden ships to make them watertight. At room temperature, pitch is nearly solid, but when heated it liquifies and can be spread like a paint.
- **Turpentine**—the major product derived from the distillation of gum. Since turpentine is the primary product from gum naval stores operations, the process is generally called turpentining. With the advent of wood naval stores, turpentine was again the primary product, but since the extraction from ground resinous stumps was done chemically a much wider array of chemicals could be produced. Turpentine has many uses, including a thinner in paint, medicinal purposes, and a cleanser for grease stains in clothing.
- **Rosin**—the solid residue resulting from distillation of gum naval stores resin. It is used in a number of products such as paper, printing inks, and soaps.

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ORIGINS OF THE INDUSTRY IN THE SOUTH

Soon after colonization of the New World began, pine tree resins provided a profitable, exportable naval stores resource. European immigrants, long-versed in naval stores production from their native conifers, became the forbearers of the American naval stores industry (Peterson 1939). As early as 1608, colonists in northeastern America found their pine forests capable of providing resins and began to export these products (Greer and others 2015). Early colonists used tar kilns and lightwood to produce tar and pitch, with England being the destination of most of their output.

England had exhausted most of its own naval stores (vital to the Royal Navy), and when deprived of supplies from Western Europe by ongoing hostilities, they paid premium prices to

Virgin longleaf pine forests became the resource that was the basis for the naval stores industry in the South. (photo from Louisiana Office of Forestry files)

producers to stimulate production and improve the quality of the products (Ward 1949). Tar was needed to apply frequently to ropes and rigging to preserve them and to facilitate climbing—it made the ropes stiff and tacky to the touch (Outland 2004). Along with food and other stores carried on sailing ships, there were always barrels of tar and pitch. The British government established economic bounties and premiums for the producers of naval stores so their navy would be provided with a continuous supply from their American colonies (Outland 2004). Eventually, producers of poor-quality tar began to refine their tar into pitch—a more valuable product. The Royal Navy was not happy with this shift toward pitch for two reasons: first, the colonists were not supposed to refine products, and second, the Navy needed more tar than pitch. In 1728, England enacted laws (which were promptly ignored) to prohibit the Colonies from shipping pitch, tar, and the crude gum, directly to any foreign country.

Although this industry first began in Virginia and Massachusetts, it soon moved southward to exploit the resin-rich and seemingly inexhaustible longleaf pine ecosystem that stretched along the Atlantic and Gulf Coastal Plains from southern Virginia southward to almost Lake Okeechobee in Florida and westward into Texas. The longleaf pine forests were the greatest turpentine forests in the country. They helped make the Southeast a worldwide economic player, and they made North Carolina the naval stores kingpin (Earley 2004).

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North Carolina had become the principal supplier of naval stores to England during the colonial period. This dominance continued well into the future. By 1840, North Carolina had virtually monopolized production of turpentine and rosin in the United States, with its ports shipping nearly 96 percent of the Nation's total; by 1850, North Carolina and South Carolina accounted for 95 percent of total American naval stores production.

The shift to some gum resin production began in the early 1800s, as the demand for turpentine had increased dramatically before the Civil War. New uses for turpentine as a solvent in the rubber industry and as a main ingredient in a popular lamp fuel supplemented its existing uses as a thinner in paint, a cleanser for grease stains in clothing, and as a treatment for a multitude of respiratory illnesses. Following the Civil War, naval stores again became a major export. By this time, lightwood from forests had

This drawing illustrates the early gum collection method. The worker on the left is dipping resin from a box cut into the base of the tree. The worker in the center is scraping the worked face to remove resin that did not drain into the box. The worker on the right is bringing a wagon with barrels to collect the resin (Earley 2004).

become scarce and wood shipbuilding had declined. While there was still strong demand for tar and pitch, turpentine became a more important product, as spirit of turpentine and rosin were sought for industrial uses. Unlike tar and pitch, spirit of turpentine and rosin were manufactured from gum resin obtained from living trees. Earley (2004) described how bewitching the word "turpentine" became:

> *Getting turpentine became a mania in the 19th century, driving thousands into the forests of longleaf pine… cutting "boxes" into living trees, chipping trees, spooning the raw gum into buckets, and carting heavy barrels of it along woodland pathways to the turpentine stills.*

Workers cutting boxes to collect resin in the base of a pine (Vance 1896).

In the heyday of gum naval stores in North Carolina and Georgia, large owners, known as "factors" controlled huge tract of forests, some in the hundreds of thousands of acres, which they leased to "operators." The factors advanced capital, usually in the form of tools and other equipment and goods with which to operate. The operators satisfied their debt to the factors by returning portions of the produce: barrels of resin (Outland 2004).

While turpentining was a vital and colorful industry, it was also wasteful and destructive. Turpentining exploited the labor of tens of thousands of workers and devastated most of the longleaf pine forests. So destructive were early efforts to maximize production that the worked pines typically died or were left useless for other products. Tree mortality resulted from a combination of the "box" cut into the base of the pine to collect the flow of resin and the size and number of faces worked on the bole of the tree. As their pine resources diminished, Virginians and South Carolinians begin to grow and export agricultural crops—tobacco, indigo, rice—but the soil and climate of much of eastern North Carolina did not make it profitable to grow crops on a large scale (Bailey 2017, Outland 2004). Naval stores remained North Carolina's best commercial products, but by the 1850s, these operations had decimated most of their longleaf pine forests and they began seeking untapped longleaf pine forests farther south into Georgia and Florida. As this century came to a close, gum naval stores production started moving into Alabama, Mississippi, and Louisiana, where the virgin southern pine forests in the West Gulf Region remained largely untouched.

Rather than growing, however, the gum naval stores industry decreased in size as it moved westward. Naval stores also had to compete with another large-scale consumer of southern pines—the lumber industry. After the Civil War, southern lands in the public domain were again made available by the Government for homesteading and sale. With southern pine timberlands offered for sale at $1.25 per acre, many northern lumbermen and land speculators purchased large tracts of land. The aggressive lumbering of these tracts soon became a primary economic driver of the South, still recovering years after the end of the devastating Civil War. By the end of the first quarter of the 20th century, only isolated pockets of the old-growth forests remained. Landscapes once covered with majestic stands of longleaf pines had become vast "stumpscapes" void of any prospect of forest regeneration (Barnett and Carter 2017).

Landscapes once covered with majestic stands of longleaf pines had become vast "stumpscapes" void of any prospect of forest regeneration

Landscapes such as this were common on millions of acres of cutover longleaf pine forests. A massive naval stores effort began to extract these stumps and transport them to distilleries where they would be converted into valuable naval stores chemicals.

Indeed, Smith (1999) suggested Louisiana never became a major gum naval stores producer because lumbermen were so aggressive in their harvesting that soon only stumps remained. This was not universally true. Two of Louisiana's largest lumber companies did lease their forest land for naval stores before lumbering began. Probably the largest gum turpentine operation in Louisiana was that of the Gulf Lumber Company. It was located 1 mile south of the sawmill town of Fullerton on the Gulf and Sabine Railroad and consisted of 50 to 75 crops of 10,000 faces each. In 1908, the housing for this operation was described by Block (1996) as:

> *…about 129 neat, new cottages were erected and nicely arranged for the operatives. A good commissary and meat market were also built. A pretentious church and school house, size 38 by 80 feet, was built and furnished for the colored people, and a public school has been granted by the parish board of education. In front of the commissary is a beautiful little depot on the Gulf and Sabine Railroad, where all trains stop. A building has been erected for a cold drink and ice cream stand for the benefit of the many colored people who are on the place….*

At this time, longleaf pine lumber was too lucrative for most operations to delay harvesting to extract naval stores. Not that there wasn't money to be made in naval stores—between 1910 and 1925, American naval stores (mostly gum-based) production ranged between 18 and 36 million gallons of turpentine and from 620 to 1,182 million pounds of rosin, both valued at millions of dollars at that time (USDA Forest Service 1927). As late as 1949, the gum naval stores industry produced a $43 million income for over 8,000 gum producers, an average of $57,000 per producer (in 2018 dollars), proving it was still "an important segment of the economy of the South" (Ward 1949). At one point, Georgia State representatives even considered changing the State's name from the "Peach State" to the "Turpentine State" (American Turpentine-Farmers Association 2018).

While naval stores continued to be a significant contributor to the economy of the South into the late 20th century, the nature of the industry continued to change. Wood-based naval stores distilled from pine stumps proved the primary related industry in

While naval stores continued to be a significant contributor to the economy of the South into the late 20th century, the nature of the industry continued to change.

This is an early 1960s photograph of the Crosby Naval Stores facility at DeQuincy, LA. Note the large collections of stumps delivered by both truck and rail.

the Western Gulf Region of the South, and hastened the decline of gum naval stores programs in the Southeast. In Mississippi, Louisiana, and Texas, the utilization of the virgin longleaf stands had been so complete that only stumps remained—but a second harvest utilizing these highly resinous stumps emerged (Dyer and Sicilia 1990). The use of these stumps for wood naval stores brought some income to the owners of millions of acres of cutover forest land and resulted in another useful outcome—removal of these resinous stumps so the land could be used for other purposes (Barnett 2006). The species used in gum naval stores also changed with time. In 1960, Georgia and Florida produced 90 percent of the products from gum naval stores, primarily from slash pine. It would be new technology and the growth of the pulp and paper industry that would finally change the naval stores industry into what we have today.

...a second harvest utilizing these highly resinous stumps emerged.

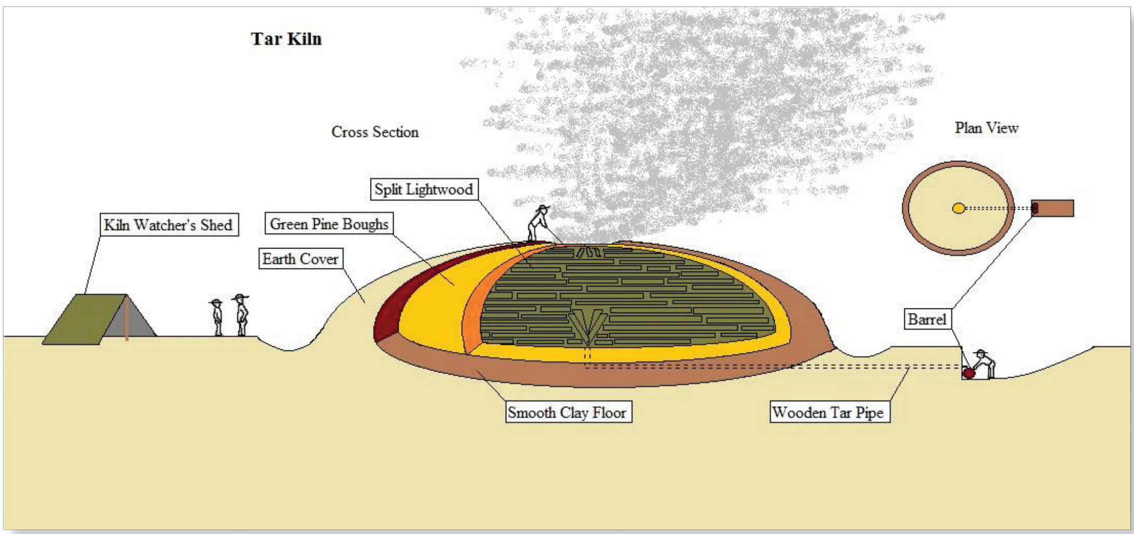
PRODUCTION TECHNIQUES

The methods to produce naval stores from southern pines evolved over time. The earliest naval stores need—to maintain the sea worthiness of wooden sailing vessels—was for tar and pitch; these products were most efficiently produced using tar kilns.

Tar Kilns

It took two men at least 3 weeks to prepare a site for a kiln, collect lightwood—the resinous boles, limbs, and stumps that remained after pines died and decayed—to be placed in the pit, cover the wood with straw and clay, and then monitor the oxygen-limited burning (Earley 2004). Kilns were typically either rectangular or oval and anywhere from 14 to 30 feet diameter. A depression was dug a few feet deep to clay subsoil, which was less porous than the sandy surface soil and minimized the amount of tar lost by seepage. A gutter was dug to guide the liquid tar to a collection pit where it would cool and be barreled.

The lightwood was cut into 3-foot lengths and stacked like spokes of a wheel. The "burning" of the lightwood was the most important and precise part of the tar production process (Earley 2004). It required workers who understood how to control the



This is a diagram of a tar kiln illustrating the features essential for converting lightwood into tar and charcoal (Greer and others 2015).

temperature within the kiln—their efforts were critical in the production of high-quality tar. Once the lightwood was set on fire, the temperature was regulated by adjusting an opening at the top of the kiln. By limiting the access to oxygen, the lightwood "sweated" and did not actually burn—if it actually burned the tar would be consumed. This process might last as long as 2 weeks and required constant monitoring day and night to maintain a temperature that produced tar. After the tar was sweated out of the wood, charcoal remained that could be sold for blacksmith use.

One 30-foot diameter kiln could hold 180 cords of lightwood and produce as much as 5,700 gallons of tar—equivalent to 180 32-gallon barrels (Earley 2004). Barrels of the tar were transported to major ports such as Wilmington, NC, Charleston, SC, or Savannah, GA for export. Usually, however, the producer kept some tar for local use. This was frequently boiled to make pitch—it typically took two barrels of tar to make one barrel of pitch.

Gum Naval Stores or Turpentining

The use of tar kilns could not be scaled up easily, but significant quantities of tar and pitch could be produced in tar kilns by a small number of workers. The development of gum resin naval stores technology in the early 1800s required a large labor force, as many trees had to be worked to obtain commercial quantities of gum resin (Vance 1896). This system also could use laborers throughout the year. Cavities (called a "box") could be cut into the base of pines during the winter in anticipation of the chipping operations beginning in the spring. A "crop"—the basic number needed for a profitable operation—often consisted of 10,000 "faces" or areas on the bole of one tree scarified for resin production (these were frequently called "cat faces" because they resembled a cat's whiskers). Larger trees might have more than one face per tree.

Small producers may have worked less than one crop. The producers with sufficient capital could assume the role of a "factor;" factors owned or could lease tens or hundreds of thousands of acres of forest land for turpentining. Then, they could sublease portions to "operators" who managed the forests for turpentine production (Outland 2004). The largest operators owned or leased huge acreages of pine land for turpentining operations, and they might work 10 or more crops each year (Ward 1949).

...significant quantities of tar and pitch could be produced in tar kilns by a small number of workers. The development of gum resin naval stores technology in the early 1800s required a large labor force, as many trees had to be worked to obtain commercial quantities of gum resin.

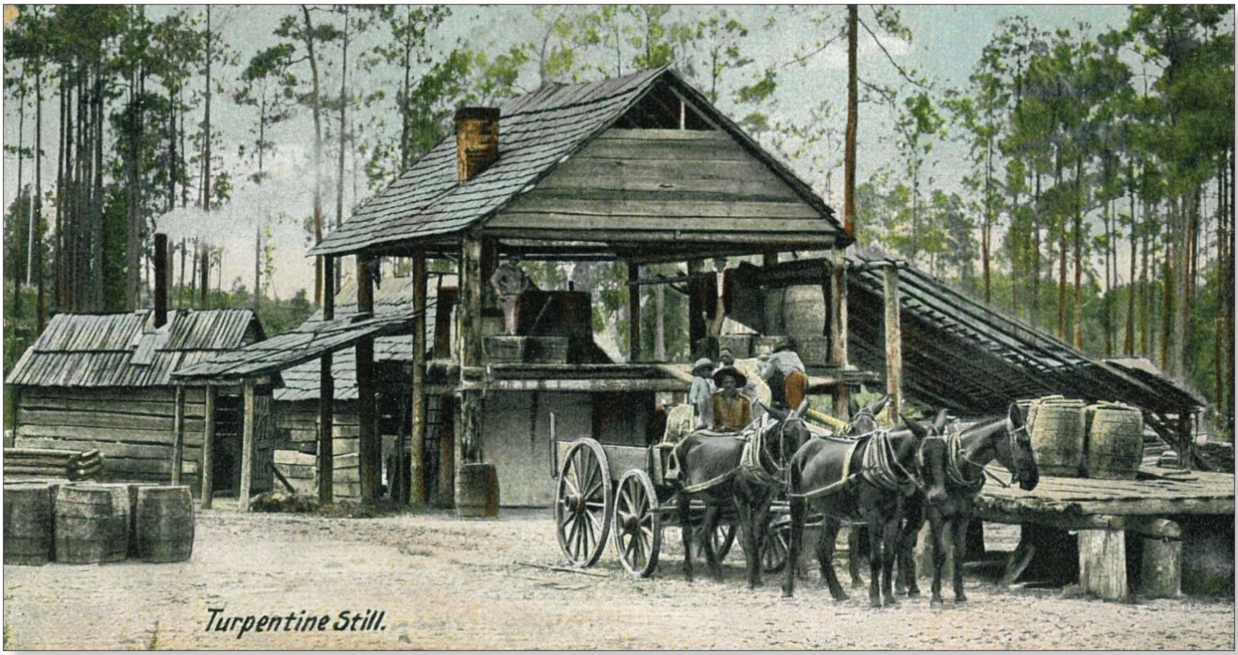
TOP: An example of the box method of resin collection—a cavity is cut into the base of the tree, weakening it (Greer and others 2015).

BOTTOM: The improved cup and gutter technique—a much less intrusive method. (photo from Florida State Photographic Collection)

The box collection method—The earliest widespread procedure for pine gum extraction was referred to as the box method. In the traditional box method, a worker would chop cavities in the trunk of the tree a few inches above the ground using a special tool called a "boxing axe." Boxes averaged 3 to 4 inches deep and ranged from 8 to 15 inches wide (Earley 2004, Outland 1996). A box could hold 1 to 2 quarts of resin. On trees > 2 feet in diameter, as many as three boxes could be cut, as long as 4 inches of bark remained intact between the boxes. Prior to the Civil War, enslaved beginners had to cut 50 boxes per day, while experienced boxers were required to cut from 75 to 100 boxes per day (Bailey 2017).

Once the box was cut, the tree face had to be prepared for the flow of gum. This was done by "cornering the box" or removing the bark above the box with a felling axe, then carving grooves into the wood in a chevron pattern—a process called "chipping"—using a specialized tool called a "hack" (Vance 1896). The gum then flowed down these channels and into the box. New chippings above the face were made on a weekly basis throughout the summer to stimulate additional resin flow. The accumulated gum resin was dipped from the boxes and added to buckets every 3 or 4 weeks. These were emptied into barrels brought onsite in wagons. Usually toward the end of the season, the surface of the worked face was scraped to remove the accumulation of crystalized resin, a lower quality but still valuable product. Flat scrapers were used to loosen the gum which was collected in a container pushed against the base of the tree (Outland 1996). The 40-gallon barrels of collected resin were shipped to distilleries where it was converted into turpentine and rosin.

Processing the gum resin—Originally, distilleries were located in major cities because the still machinery was too heavy and expensive to be located on a turpentine plantation. With technological improvements, smaller stills could be located at larger turpentine operations. Two-story distilleries were common because the furnace needed to be on the lower level, underneath a vat that held about 10 barrels of raw gum. Once the fire was lit and the gum began to boil, the turpentine separated into a pure vapor and water mixture which rose into the vat worm, or condensing tube, and the liquid rosin remained. The rosin was



A typical still located on a Georgia turpentine plantation. The raw gum resin mixture arrived in barrels; following distillation, pure turpentine and rosin remained and were barreled for transportation to markets. (photo courtesy of Tyler E. Bagwell)

conveyed though a screening and filtering process to remove wood chips and other impurities before it was barreled (Bailey 2017). The turpentine and water vapors moved into a separation system that split the volatile fractions from the water.

Negative effects of cut box method—Unfortunately, the box method killed or severely damaged trees. After 10 years of gum harvesting, a large percentage of turpentined trees succumbed to reduced vitality, weakened trunk structure, insect infestation, and disease (Outland 2004). Mortality due to boxing could be direct or indirect. Trees boxed became less vigorous and more susceptible to insect attack. Pine bark beetles—usually Ips (*Ips grandicollis)* and/or black turpentine beetle (*Dendroctonus terebrans)*—were attracted to the wounded areas of trees worked for turpentine. Frequently such attacks resulted in tree mortality. Periodic pine bark beetle outbreaks often resulted in heavy mortality. During an outbreak in 1848, one timber owner reported 130,000 trees lost. Another owner lost an astonishing 750,000 pines (Outland 2004).

Boxed pines were also felled more readily during storms and hurricanes. For example, unboxed trees sustained little damage from the hurricanes of 1893, but much of the boxed timber was

Trees boxed became less vigorous and more susceptible to insect attack.

devastated. Forester W.W. Ashe reported on a 100-tree sample, 85 were broken off at the box, 4 were broken above the box but along the face, 10 were blown up by the roots, and only 1 tree was broken above the face (Earley 2004). Trees with multiple boxes were even more vulnerable.

Fire could be highly destructive to turpentine operations, often putting producers out of business. While longleaf and slash pines are very tolerant of surface burning, boxing significantly increased their susceptibility to damage by fire. Boxes were natural flash points; once ignited, they were difficult to extinguish. They often burned deeply into the tree, promoting decay, insect attacks, or outright death. Even if the fire did not kill the tree, it slowed the pine's recovery for future turpentining use. To reduce the risk of this problem, the flammable forest floor was usually raked from around trees being turpentined. However, raking frequently proved unsuccessful in preventing fire damage to the pine. Wood and bark chips accumulated around trees being worked. When ignited, they in turn ignited the gum in the box causing fire to climb up the face. When the trunk of the tree was enveloped in flames, the gum on the face and in the cup was consumed, or scorched to the appearance of black glass, which prevented any productive working of the face for at least a year (Hawley 1964).

Regionally, the losses of pines became so severe that one newspaper editor concluded, "This is the work of destruction, it strips acre after acre of the noble trees, and if it goes on, the time is not far distant when the long-leaved pine will become nearly extinct in our region." Another observer stated, "from Rocky Mount to Wilmington the country presents the appearance of a dreary desolate pine barren wasteland" (Outland 2004). When their value for naval stores ended, trees would eventually die or topple because of the weak point at the box. Later, when guidelines for conservative turpentining practices were developed, they usually were ignored. Boxes were cut deeper and wider than optimum. With a responsibility for cutting 50 to 75 boxes per day, workers rarely followed recommended practices.

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Even after a less impactful cup and gutter system of turpentining was introduced in the early 20th century, the destruction continued. By 1909, the turpentine industry was responsible for the loss of an estimated 37 billion board feet of southern pine timber (Outland 2004). In Georgia alone, more than 10 billion board feet of standing timber were destroyed. In 1920, the Secretary of Agriculture reported to the Senate that "so pronounced is depletion of the timber upon which our naval stores industry depends for its supplies that it is commonly regarded as a dying industry in the United States." Later, the Southern Forest Survey (Harper 1937) described the impact of turpentining on over 9.5 million acres of longleaf forest in northeastern Florida:

> *Although current turpentining practices are relatively conservative… the industry exacts an excessive toll from the forest. …chipping small trees, placing too many cups on some trees, deep chipping, carelessness with fire, and other bad practices, …causes an excessive reduction in rate of growth and an increase in mortality of turpentine pines. Since it seems inevitable that the naval stores industry will continue to be an important user of forests in this region, the outlook for other forest industries will be limited thereby in scope, character, and volume of production. . . these results do not permit …an unqualified recommendation to turpentining before cutting. The returns from naval stores may not compensate for the loss in high-grade lumber in very large trees. …old growth trees, owing to their slower growth rate… are more likely to die as a result of turpentining than are young, vigorous trees.*

By the early 20th century, practices for chipping trees improved in allowing the pines to be used for lumber following turpentining. This was not enough to stop the decline of the gum turpentine operations, and the pine stumps left behind by the lumbering became the basis for the new wood naval stores operations that further hastened gum's decline.

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…pine stumps left behind by the lumbering became the basis for the new wood naval stores operations…

Wood Naval Stores

The millions of acres of "stumpscapes" provided a basis for an important, albeit short-lived, wood naval stores industry. From modest beginnings, wood-based naval stores extraction ramped up considerably. In 1951 alone, a total of 2,500,000 tons of pine stumps were processed (Black and Minch 1953).

From modest beginnings, wood-based naval stores extraction ramped up considerably. In 1951 alone, a total of 2,500,000 tons of pine stumps were processed.

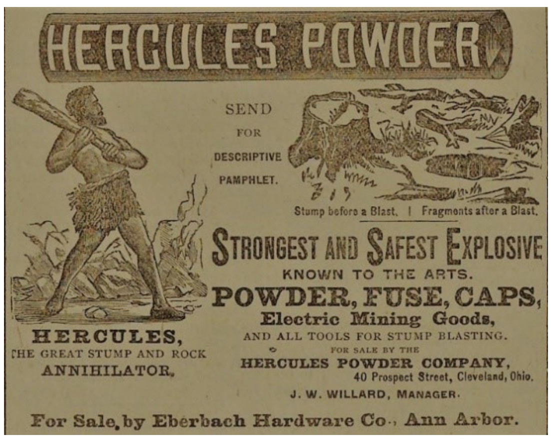
Wood naval stores extraction—While Hawley (1921) first laid out the potential for extracting, transporting, chipping, and distilling oleoresin-rich stumps of old-growth longleaf and slash pines as a commercial means of producing turpentine and rosin, some in industry had already recognized the potential of these decay-resistant stumps.

Unlike gum naval stores operations, which demanded a lot of hand labor, wood naval store extraction required a more organized and industrialized effort. First, the stumps needed to be acquired. Representatives from large wood naval stores distilleries worked across the region buying stumps from landowners. Usually these men were well-received because sale of the stumps—which hindered most uses of the cutover land—would provide some economic return. Stumps that had been in or on the ground for 10 to 15 years were preferred, as they were easier to reduce to a proper size for chemical extraction (Black and Minch 1953).

Second, the stumps needed to be removed from the ground, shipped to a plant, and prepared for processing. Small, well-trained crews used dynamite and specially equipped bulldozers to extract the stumps, which were then shipped by rail or truck to distillation plants. A sufficient supply of stumps to last for 6 months or a year were stockpiled for use when field activities

LEFT: Drilling holes with a hand auger to place dynamite to break up longleaf pine stumps. (photo courtesy of Ann Arbor District Library)

RIGHT: An advertisement by Hercules Powder Company for use of their dynamite to blast stumps. (Image from Ann Arbor Argus (April 21, 1893), courtesy of Ann Arbor District Library)



Stumps are being off loaded from railway cars to trucks which will carry them to the Newport Industries' plant at Pensacola, FL, for processing. (photo from Florida State Photographic Collection)

were halted due to unfavorable weather. Before the stump entered the plant, they moved along a conveyer where they were washed to remove dirt, sand, and loose or rotted wood. Clean stumps were fed into grinding equipment consisting of hogs and shredders, which delivered wood chips about 1 inch in length and ¼ inch in diameter.

Wood distillation methods and plants—The now shredded stumps were then sent through the extraction process. The chips were typically heated with steam to a point that the desired compounds were driven from the wood for further processing and distillation into the various naval stores. Spent chips were then used for fuel to produce steam for the operation of the plant. Wood distillation plants proved to be a more dynamic part of the naval stores industry as their operations changed over time.

After the end of World War I, a number of companies decided to diversify their operations to include the extraction of chemicals from pine stumps scattered across millions of cutover acres (Dyer and Sicilia 1990). These included the Wilmington, DE-based Hercules Powder Company, who joined forces with Yaryan Rosin and Turpentine Company. Yaryan had developed steam distillation technology for processing pine stumps and had plants in Brunswick, GA and Gulfport, MS.

Hercules created the "Turp" and "Tine" characters to promote turpentine sales. (photo courtesy of the Records of Hercules, Inc., Science History Institute Archives)

After buying rights to pull stumps and building a new steam distilling plant, Hercules quickly became the world's largest producer of naval stores. The Great Depression soon reduced the market, and Hercules was stuck with fields full of stumps, underutilized processing facilities, and a large amount of inferior turpentine (turpentine derived from stumps was dark in color and hence unsuitable for some uses in finishing and painting furniture). Hercules salvaged its naval stores division by developing a paler turpentine and convincing its customers that wood (as opposed to gum) naval stores was of better quality

(Dyer and Sicilia 1990). They did this by an aggressive publicity campaign touting the values of steam-distilled wood turpentine. Hercules lost money in its naval stores business until the mid-1930s when it created more and better naval stores products. With a broader range of better-quality naval stores products, by the mid-1930s Hercules started supplying new customers—makers of paper, varnish, and soap—with better grades of rosin and became profitable.

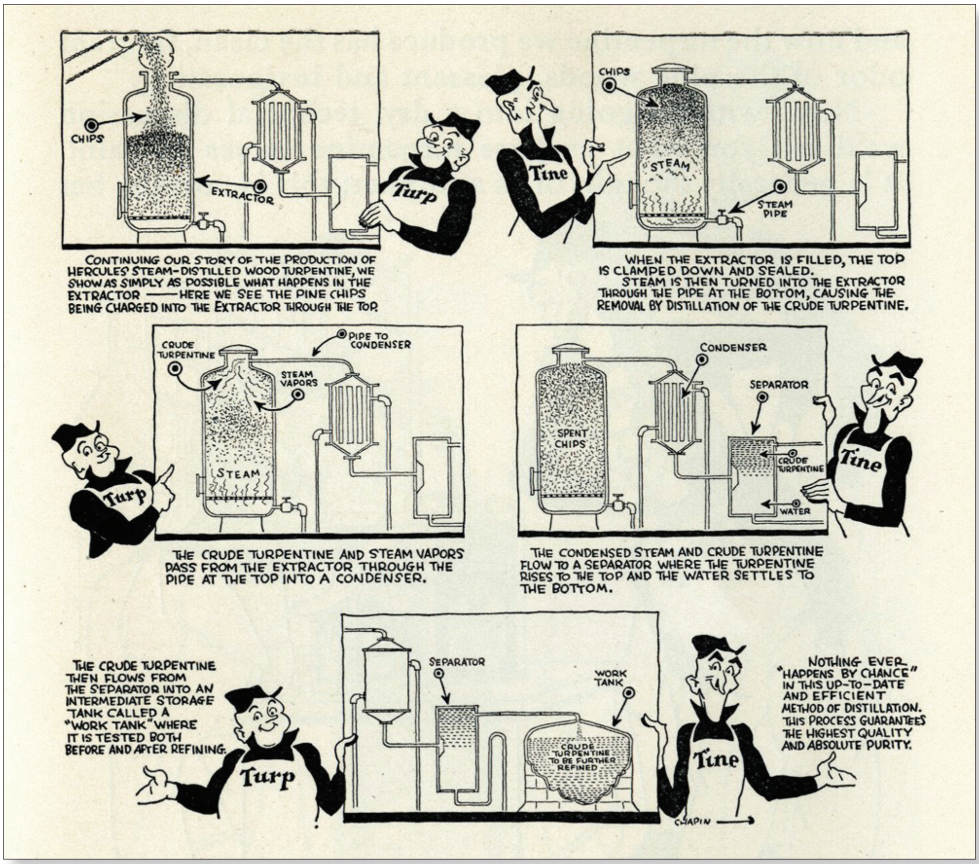
Hercules lost money in its naval stores business until the mid-1930s when it created more and better naval stores products.

Yaryan and Hercules were not, however, the only companies inventing ways to steam distill pine stumps. Newport Rosin and Turpentine Company was developed by the wealthy Schlesinger family of Milwaukee, WI. Originally, Newport consumed their products internally in the production of paper (Dyer and Sicilia 1990). Newport Industries operated plants in Pensacola, FL and DeQuincy, LA (the DeQuincy plant was purchased from Acme Products in 1928).

Unable to find buyers for the stumps on their cutover lands in southern Mississippi, the Crosby Lumber and Manufacturing Company decided in 1937 to build a plant. As the quality of Crosby Naval Stores' products became recognized, the capacity of their wood naval stores plant at Picayune, MS expanded to 600 tons of stumps per day—the third largest in the country. Indeed, because this Crosby facility was so successful, the family-owned company decided to build another plant in DeRidder, LA. Located near three railroads and within 50 miles of a deep-water port, the DeRidder location was in the middle of thousands of acres of "virgin" land "…considered as poor and without much value… the resources lay in the lands, predominantly in longleaf pine stumps" (Crosby Land and Resources 2018). By 1947, the growing and successful Crosby Naval Stores changed its name to Crosby Chemicals.

Black and Minch (1953) also reported that in the early 1950s there were 14 steam-distilled wood naval stores plants operating in five Gulf Coast States. Six of these plants were in Mississippi and four in Louisiana, but they had about equal overall production. The capacity of these plants ranged from 200 to 1,000 tons of stumps processed per day. For example, the two Crosby plants were capable of processing 1,600 tons of stumps daily. However, Crosby sold both plants in 1977 and returned to managing its forest lands in response to the next great change in the naval stores industry—competition with sulfate wood naval stores operations.

In the early 1950s, there were 14 steam-distilled wood naval stores plants operating in five Gulf Coast States.



The Hercules Powder Company used the caricatures of Turp and Tine to explain the process of converting stump wood into valuable chemicals. (photo courtesy of Forest History Society)

Sulfate Wood Naval Stores

During the 20th century, production of naval stores progressed from a very labor-intensive woods effort to one where the chemicals are extracted from commercial pulpwood milling operations. Sulfate naval stores are byproducts recovered during the conversion of pine wood chips to pulp by the sulfate (Kraft) pulping process. This method of naval stores production is the primary way turpentine is produced today. At pulpwood plants, pine trunks are chipped and placed in sulfuric acid to separate the cellulose (the organic material that gives plants structure) from the rest of the wood material. In addition, this process produces turpentine spirits and tall oil, a form of rosin used in the paper-making and as a drying agent in paint. When the turpentine spirits are condensed from the cooking vapors, they form sulfate turpentine. Crude tall oil, obtained from the alkaline liquors, is fractionated into various products including tall oil rosin and tall oil fatty acids (Black and Minch 1953).

SOCIAL IMPLICATIONS OF THE NAVAL STORES INDUSTRY

Until recently, the history of the American naval stores industry was poorly documented, perhaps attributable to the rural, messy nature of this nontraditional form of agriculture (Bailey 2017). However, there are many social implications of how naval stores were acquired that are consistent with the past of the United States. Major turpentining operations whose workers were continually mistreated benefited from States with political, economic, and civic leaders who overlooked those abusive practices. The largest naval stores operations required many workers, and here in the South, the turpentine industry with its attendant methods of labor control lasted the longest and engaged in the most dismal labor exploitation (Lauriault 2018). As with many other industries, exploitation and privilege depended on race.

Because of its need for large numbers of workers, turpentining had its roots in slavery.

Exploitation, Privilege, and Race

Because of its need for large numbers of workers, turpentining had its roots in slavery. Slaves, requiring little funding to support their work, dominated the workforce prior to the Civil War. This was true in the 1850s, as turpentining with the box gum collection method depleted North Carolina's longleaf pine forests. This drove the major turpentining companies into the untapped forests of Georgia, Florida, and Alabama—and the requisite enslaved workforce along with them. The Civil War freed the slaves, but for the vast majority, their economic or social environment did not improve. Within a decade and half, a new system of "Jim Crow" laws rigidly reinforced the customary segregation of the races (Shofner 1981).

Additionally, two often overlapping institutions—convict leasing and debt peonage—also arose in the wake of emancipation (but neither were exclusive to African Americans). Vagrancy laws were extended to include "persons who neglect their calling or employment… and all able-bodied males over 18 without means of support and who remain idle" (Shofner 1981). Once arrested, individuals could be leased to work in turpentine camps. Peonage—holding of a person to forced labor for payment of a debt, although a violation of United States statues—was the outgrowth of the disruptions of labor caused by emancipation. Most workers were paid a pittance for their labors; as a result, they often became insufferably indebted to the owners (Greer and others 2015). Peonage included both White tenants and workers as well as Black ones, but the majority of those involved were African Americans. They had been slaves of Whites and the latter still regarded them as their natural labor supply to be used as they saw fit. The leasing of State convicts to private firms was touted as a means to keep prison costs down, but its practice—and that of peonage—provided hundreds of low-cost workers for turpentine camps and retarded the wages of free laborers (Outland 2004).

Prizer (2009) interviewed individuals in south Georgia, both Black and White, who had worked in the turpentining industry; he found that most African American workers retained memories of hardship and struggle, as well as the feeling that turpentine was "just a lot of hard work for no money." Also, there were memories of outright abuse and racial violence. It is also important to point out that while some operations were abusive to workers, there were others where the workers were treated with a degree of respect. For some, the cash they earned was critical. Many poor White families supplemented their meager wages by harvesting small quantities of gum on land they acquired through squatting (Prizer 2009). Destitute parents and children worked together to collect gum from pine trees, which they sold to larger turpentine operations for food and other goods. "Turpentine production often provided a family of small means the only staple they could produce from the sandy pineland" (Outland 2004). In addition to remembering their struggles, Prizer (2009) also reported proud recollections of perseverance, resilience, and adversities overcome. It is "a bitter history, but one they are proud of"—a history of disadvantaged workers creating, against all odds, a degree of dignity and self-respect.

Turpentine production often provided a family of small means the only staple they could produce from the sandy pineland.

LEFT: Worker chipping a new cut on the face of the pine. RIGHT: Worker is emptying the gutter into the container for carrying to a barrel. (photos by Dorothea Lange, courtesy of the Library of Congress)

Work in the Turpentine Camps

PRACTICALLY ALL NAVAL STORES WORK WAS DIFFICULT AND grueling. Even under the most favorable circumstances, turpentining was dirty, physically exhausting, and frequently dangerous. Working with the sticky gum and carrying the heavy buckets made the job a difficult one, and each worker was expected to care for several thousand trees. The worker's burden was sometimes increased by having to struggle through heavy undergrowth, mud, or standing water. Added to the physical burden was oppressive supervision by camp bosses or woodsriders. Camp bosses or woodsriders tended to be hard men, driven by their employer to meet certain work standards. Some even resorted to whipping the workers to keep them moving at an exhausting pace (Shofner 1981). When leased convicts or indebted workers were used in the camps, there would be armed guards checking all entering or leaving the camp.

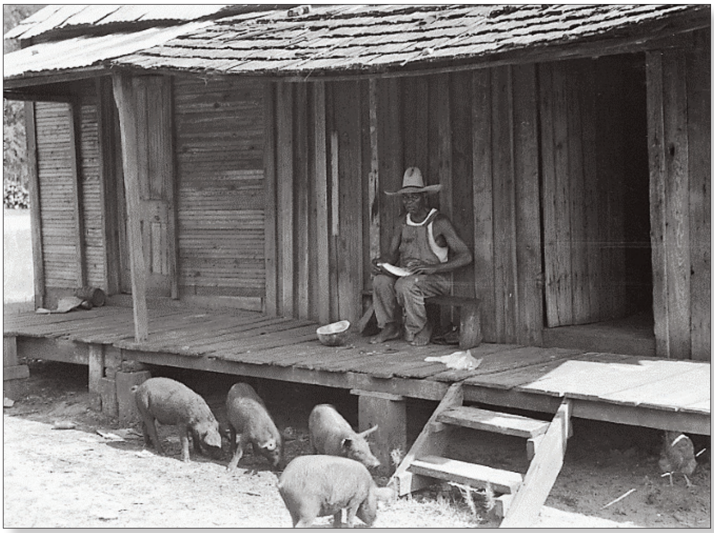
Practically all naval stores work was difficult and grueling. Even under the most favorable circumstances, turpentining was dirty, physically exhausting, and frequently dangerous.

The work days lasted from "can't to can't, that is from can't see in the morning to can't see at night" (Lauriault 2018). Wagons picked them up before sunrise so they would be at their working area by daylight. The workers were divided into squads, although a person would serve in different squads with the change of season. The chipping squad would streak or chip the trees with a hacking tool, weekly from the middle of March to the middle of November. The dipping squad visited the trees

A woodsrider overseeing a turpentine operation in Georgia. (photo by Dorothea Lange, courtesy of the Library of Congress)

being worked about every 8 days depending upon the age of the tree and the length time it had been tapped, and emptied the cups into a dip bucket which was carried from tree to tree. When the bucket was full, the dipper would carry the 50-pound bucket to a mule-drawn wagon somewhere in his drift—area of forest for which the worker was responsible—and empty his bucket into a barrel. When the barrels were full, they were moved back to the still for processing. After chipping ended in the fall, the pulling squad scraped the crystallized gum resin from the worked faces. (Lauriault 2018).

A woodsrider was responsible for overseeing the operation of a camp consisting of about six crops, with 10,000 faces per crop. Some trees would have more than one face. He patrolled the woods on horseback each day to see that the cups and gutters were attached correctly, the trees properly streaked or chipped, brush cut away from the trees to reduce fire hazards, and to insure quotas were being met.



Houses typical of those provided in turpentine camps in the early 20th century and through the Depression years. (photos by Dorothea Lange, courtesy of the Library of Congress)

Camp Life

Turpentine camps were located near the trees to be worked, isolated from other towns or communities, homes, and families. Such isolation often was intentional to maintain control of workers and their families. Since the life of a camp would last only a few years, minimal effort went into developing housing for workers. Typically, the families lived in shacks or lean-tos provided by the company without adequate heat in the winter or ventilation in the summer. The workers bought groceries from the company commissary and worshipped in churches erected by the company. They were taught to be submissive, a belief that they were lower-class citizens. It is interesting that in spite of this treatment, many were proud of their achievements—the human spirit will even find a way to deal with bondage (Prizer 2009).

Typically, the families lived in shacks or lean-tos provided by the company without adequate heat in the winter or ventilation in the summer.

Relatively few females worked in the naval stores industry, but some camps employed women and their children to dip gum which freed men for more strenuous work. Women were also used at times to weed areas around the trees being chipped, but their primary role was domestic: cooking, washing clothes, and childcare. Women were up about 4:00 a.m. to cook a substantial breakfast—commonly scrambled eggs, salt pork, baked biscuits, and grits—to sustain the men until their noon lunch (which had also been prepared early in the morning by the women). In camps where there was room, women also raised gardens to supplement the supply of fresh food.

TOP: Turpentine worker's wife looking out of a window of her house—note the wooden window.

BOTTOM: A worker's family in a turpentine camp. (photos by Dorothea Lange, courtesy of the Library of Congress)

Opportunities for sending the children to school were limited in many camps. Girls typically played games like jump rope, "hop scotch," and spinning and twirling while singing rhymes (Prizer 2009). Boys generally gathered separately from girls and played a variety of games—marbles, use of cans to make different clanking sounds, and inventing toys or games of their own. As boys reached the age where they could help their fathers, they began going to the woods to learn the skill of turpentining.

While a description of callousness and exploitation in turpentine camps is frequently portrayed—it was the subject of Federal investigation in several States—not every camp owner was abusive. In the years following World War II, camp life improved markedly. The direct cause of these improved conditions was the gradual modification of State labor laws. These changes made it increasingly difficult for turpentine interests to secure cooperation from States in ensuring a plentiful yet impotent labor pool (Lauriault 2018). The USDA's Bureau of Agricultural and Industrial Chemistry efforts to assure quality standards in the naval stores industry led to Federal investigations and indictments of operators for violation of the 13th Amendment and challenged the foundations of forced labor on which the industry had rested. Some of the Southern States had played an ambiguous role by working to preserve peonage (Outland 2004). To help correct these injustices, the Justice Department began efforts to dismantle the peonage system. However, despite intense national interest and the practice's apparent widespread use, only a relatively small number of producers were tried and convicted of peonage.

Once the last vestiges of forced labor were eliminated, the gum naval stores industry had to compete with less onerous employment opportunities in lumbering and the mechanized wood naval stores operations and centralized distilleries. Labor shortages helped bring about the decline in the gum naval stores industry.

THE AMERICAN TURPENTINE-FARMERS ASSOCIATION

Attempts to organize a turpentine producer association had failed until Judge Harley Langdale of Valdosta, GA, organized the American Turpentine-Farmers Association (ATFA) in 1936. Langdale was the world's largest gum naval store producer. By the late 1930s, alone or with partners, Langdale's operations covered nearly 3 million acres, working approximately 315 crops (3,150,000 faces) and maintaining 25 camps and stills scattered from North Carolina to Florida (Outland 2004).

Langdale understood that industry cooperation offered the only hope that the Great Depression would not destroy producers, large or small. The mission of ATFA was to unify gum naval stores producers into a cohesive force that could stabilize the market and industry. As a cooperative, it promoted education, research, advertising, legislation, insurance, and marketing for the industry (Greer and others 2015). The Association successfully encouraged the Federal Government to increase research into improved processing and new uses.

ATFA also helped to secure loans for gum producers from the newly formed Commodity Credit Corporation (CCC). In 1936, the U.S. Congress created the Naval Stores Conservation Program to financially support operators who reduced their production. Operators who had successfully applied for a CCC loan agreed to keep their summer production off the market and were required to remove from 15 to 30 percent of the faces from production. The U.S. Department of Agriculture, Forest Service was charged with the difficult task of ensuring that producers removed the required faces from production (Outland 2004).

One of the greatest changes ATFA achieved came in the marketing of turpentine in small containers. In the late 1930s, only 5 percent of gum turpentine was sold in small bottles or cans for household use. ATFA began a national campaign to promote the consumption of turpentine in association-approved containers. As a result, by 1959, 80 percent of gum turpentine was sold in bottles and cans (Outland 2004).

Gum turpentine marketed by the American Turpentine-Farmers Association for sale in small containers.

ATFA achieved a number of developments for its members, although these were largely to the detriment of the workers. It secured the exemption of gum producers from the provisions of the Federal Security Act, the Federal Wages and Hours Law, and the Workmen's Compensation Laws of Alabama, Georgia, and Texas (Greer and others 2015).

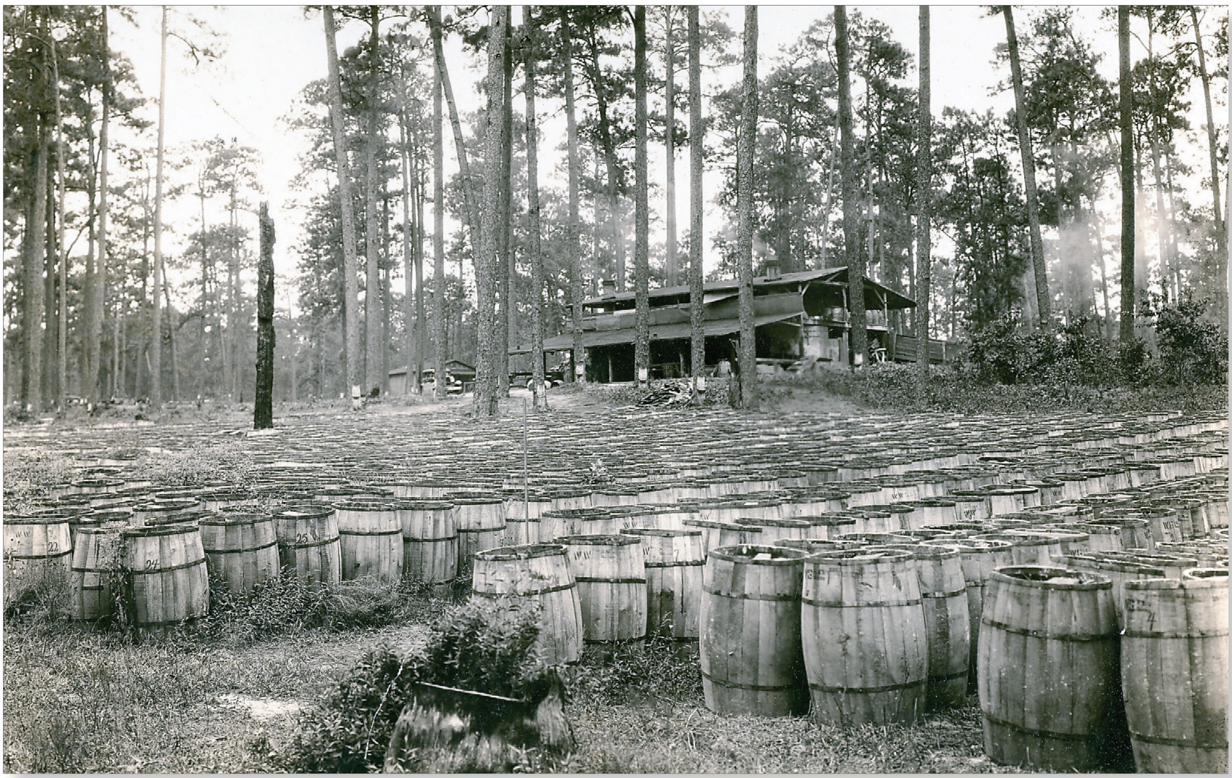
ATFA continued to exert influence, even with the decline in the industry into the late 1960s until Langdale died in 1972. The membership in ATFA dropped steadily in the 1970s and 1980s, and the final meeting of its board of directors was held in 1999 (American Turpentine-Farmers Association 2018).

Country stores such as this one in Georgia were common across the South in the early 20th century. They provided a real service to rural communities by not only providing needed household items, but also as a meeting place to communicate with neighbors. (photo by Dorothea Lange, courtesy of the Library of Congress)

THE ROLE OF NAVAL STORES RESEARCH

Operational techniques became well established long before there was research capability to support or improve the system. Gum resin operators were slow to seek or to accept changes in production methods. Naval stores extraction continued to be carried out in the Southeast with few improvements over the decades. Cultural attitudes and practices in the U.S. South hindered the adoption of more conservative methods (Ashe 1894, Outland 2004). After all, nearly all the timber worked was old-growth longleaf pine and the methods used had produced significant profits for over 300 years. Slowly, however, the industry finally recognized that the virgin pine forests of the South were coming to an end. If gum naval stores extraction was to continue, a method of production had to be found that was not as destructive as the cut box technique (Harrington 1969).

A typical naval stores still in a virgin longleaf pine stand. Barrels of turpentine and rosin are stored waiting for transport to a shipping center. Such stills were common throughout the forests of the Southeast during the late 19th and early 20th centuries. (photo from Florida State Photographic Collection)



In the late 19th century, professional foresters and leaders of the naval stores industry, highly alarmed by the loss of timber supplies due to prevailing turpentining methods, sent a commission to France and Spain where turpentining systems seemed to be sustainable (Ostrom and Squires 1946). As an example, the French followed a forest-use pattern that permitted them to continuously produce naval stores from the same stands. Operators cut only one face per tree, which they worked for 5 years. The trees then rested for 3 to 5 years before they were cupped again. Under this system, the French had created a highly successful naval stores industry in a once-barren sand region (Outland 2004). Compared to European methodology, boxing of turpentine trees in America was nothing short of butchery that transformed once healthy pine forests into near-worthless wastelands.

Alarmed by the loss of timber supplies due to turpentining, professional foresters and industry leaders sought more sustainable techniques for naval stores production.

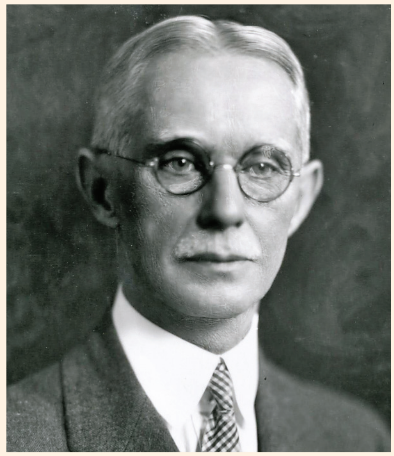
Scientific research to improve naval stores operations in the Southern United States was slow to develop. Late in the 19th century, private forest landowners (including the naval stores industry) began receiving assistance from the Federal Government. In 1876, Congress authorized a special agent for forestry in the U.S. Department of Agriculture (USDA). The Agency was upgraded to a Division of Forestry in 1881 and a Bureau of Forestry in 1891. In 1905, the forest reserves were transferred from the U.S. Department of the Interior to the new Forest Service agency within the U.S. Department of Agriculture. Early in its existence, the Forest Service lacked resources and specialists to meet regional research needs. They did, however, support some exceptional individuals who greatly helped improve naval stores practices.

Replacing "Boxing" with the Cup and Gutter Method

Charles H. Herty, a prominent scientist, humanitarian, and statesman, led the charge to replace the box method and adopt a less destructive cup and gutter system (Reed 2010). Herty, a native of Georgia and a chemist, was intimately familiar with the turpentine business. With modest support from Gifford Pinchot, then head of the Bureau of Forestry, Herty began an effort to determine if the cup and gutter system used in France would work in the southern pines of the United States. The new system involved cutting shallow chips into the tree and attaching metal gutters, which channeled the gum into clay cups. This eliminated the need to cut a deep cavity into the tree to collect the gum. Also, the gutter and cup could be moved up the tree's face, reducing the amount of inferior scrape.

In 1901 and 1902, Herty began testing to compare the French system with boxing on several operations in Georgia (Ward 1949). This new method greatly reduced tree mortality. Herty's demonstrations convinced the industry of the merits of the cup and gutter system, which was soon widely adopted throughout the turpentining industry. Furthermore, after being worked for gum production, pine trees could be felled and sawn into lumber. It became a common practice by lumber producers to conduct turpentining operations a few years in advance of the removal of trees for the sawmill.

To facilitate the conversion to the cup and gutter system, Herty formed a partnership to manufacture the needed clay cups. Herty's cups were essentially flower pots without a hole in the bottom and they were widely accepted. Gradually, other types of cups were developed—some metal cups were introduced in about 1914. They did, however, rust and stain. A clay cup was curved to fit around the tree and tapered to reduce breakage from water freezing in the cups. The Herty cups hanging from trees seemed to inspire their use as targets from hunters. Broken and discarded clay pots still can be found strewn throughout forests in the South.



TOP: Charles H. Herty made major contributions to forestry in the South by his efforts to improve the naval stores techniques and later his work to develop the pulp and paper industry (Reed 2010).

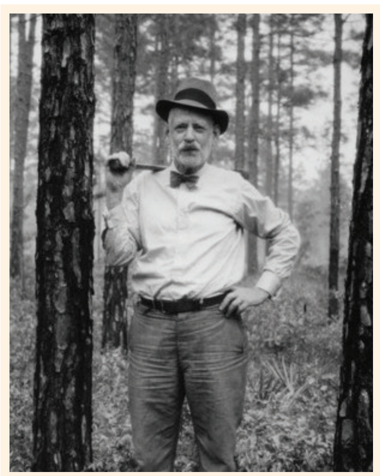
BOTTOM: Eloise Gerry in the Forest Products Laboratory viewing specimens with her microscope.

Early Forest Service Researchers

The early and highly successful collaboration between Herty and Pinchot began the effort to make naval stores a more efficient and responsible industry. Soon other specialists were added to the Forest Service to assist naval stores operators by further improving the technology. One of these was Eloise Gerry, who was hired by the Forest Service in 1910 to work at the newly created Forest Products Laboratory in Madison, WI. Gerry's knowledge of the anatomy of wood and its physiological properties helped her get this job—and no male with similar expertise was available! In 1921, she obtained a doctorate degree from the University of Wisconsin on oleoresin production and turpentining.

One of the earliest and most lasting contributions from her illustrious career with the Forest Service came from her studies of southern pines and the production of turpentine (McBeath 1978). Gerry communicated the understanding that resin was not tree sap. She studied resin production, the role of resin ducts, and how chipping stimulated production. Gerry (1922) studied the effect of turpentining on resin duct formation and flow rates—the rates were stimulated by producing new resin ducts that saturated the xylem with resin. The resin ducts themselves would increase up to 10-fold in size around the wound site (Snow 1949). These studies indicate the efficiency of resin production in longleaf and slash pines.

Gerry also determined that most stimulation occurs for only a few feet above the initial working—so, extending chipping face up the tree was not productive. She found, too, that deep chipping did nothing to improve gum production (Outland 2004). Gerry evaluated the chipping process and determined that the width and depth of the weekly chipped streak should be reduced—this would make the process less laborious and increase resin production. Her studies also showed that lighter methods of chipping could reduce the frequency of a dry face which occurred frequently (Gerry 1922). Her research resulted in major changes in turpentining procedures.



Austin Cary spent much of his career in the South while attached to the Washington office of the Forest Service.

When Gerry started studying the resin production of southern pines, she determined that she needed to go to the field to advance her research. Her supervisors objected, saying forests were "no place for a woman," but she prevailed. Beginning in 1916, she made many trips to work in turpentine operations, often with Austin Cary, a Forest Service specialist working in the South. Born in Maine in 1865 and later trained as a forester, Cary was one of the unsung heroes of American forestry (Lewis 2015).

When he came to the South in 1917 as a logging engineer for the Forest Service, Cary was struck by the backwardness of forest practices, and he hoped to promote sound forestry among the South's landowners. A Yankee through-and-through, Cary had an unorthodox, nonconformist approach to life and work. Considered blunt and tactless by his friends, many southerners were charmed by "his disrespect for propriety and authority" (Lewis 2015). He found professional success in the South by evaluating the effects of fire and other cultural practices in southern pines. He, too, evaluated the effects of turpentining from a forester's perspective and studied its effect on tree performance (Cary 1928, 1933). For example, Cary (1933) claimed 90 percent of trees tapped for naval stores suffered various reductions in growth. Cary was perhaps the most influential Federal forester in naval stores and helped bring improved scientific management to the turpentine industry (Barnett 2011, Outland 2004). Through his outreach efforts, turpentine operators learned the best size streaks, the most productive number of faces per tree, tree diameter for gum production, improved methods of cup and gutter installation, and the effects of turpentining on tree growth (Harrington 1969).

Forest Service Experiment Stations and Naval Stores Research

When created in 1921, the Southern Forest Experiment Station was headquartered in New Orleans, LA, and its territory covered the Gulf Coastal Plain from Georgia and Florida west into East Texas. One of the first scientists hired by the Southern Station was Lenthall Wyman. In 1922, Wyman was assigned to Starke, FL, to work on naval stores extraction techniques in the woods (Wakeley and Barnett 2011). A colleague of Wyman, Philip C. Wakeley commented that by "direct contact with key men in the naval stores industry, Wyman in a decade or less, he got his results into practice and revolutionized the industry" (Wakeley and Barnett 2011).

Progress was made and many practical techniques were worked out and recommended for industrial applications (Wyman 1932). One advance was in determining the minimum size of trees to be turpentined. When gum prices were high and large virgin trees scarce, the operators began to work very small trees—some as small as 5 inches in diameter at breast height (DBH). Research determined that the minimum size of trees for profitable tapping was 9 inches DBH. Another practice found to be uneconomical was that of placing more than one face on small trees (Harrington 1969).

The works of Gerry, Cary, and Wyman were combined with forest management and conservation practices and published as a Naval Stores Handbook (U.S. Forest Service 1934).

In 1932, Wyman's research at Starke ended and the program was transferred to a research center at Olustee, FL, which opened in 1936. The Southern (and later the Southeastern) Forest Experiment Station (station boundaries were realigned in 1946 and the Southeastern Forest Experiment Station assumed responsibility for the eastern portion of the Gulf Coastal Plain), continued naval stores research at Olustee for nearly five decades.

Efforts at the station's Olustee research center focused on improving the efficiency of turpentining operations.

Efforts at the station's Olustee research center focused on improving the efficiency of turpentining operations. Examples of studies of immediate use included the development of techniques for sulfuric acid stimulation treatments and the conversion gum collection from gutters to bags that could be attached with staples (Harrington 1969). Stimulation of resin production with sulfuric acid proved to be one of the most significant advances. Although studies of acid's application began in 1936 at the Olustee Experimental Forest, serious research began during World War II to meet increased demands for naval stores (Ostrom 1945). Research showed that a 50-percent water and sulfuric acid solution, when applied to a streak made only through the bark, collapsed the wood cells lining the resin ducts. This enlarged the duct opening and allowed for a longer period of gum flow. The acid held the resin ducts open for 2 weeks, after which new streaks and acid were necessary. This reduced labor costs because workers only had to visit trees half as often. Another benefit was the slowing of the face expansion up the tree trunk. With only the bark removed, pines could more easily survive turpentining and remain suitable for use as lumber. By the mid-1940s, the method was ready for the industrial adoption (Outland 2004). Although sulfuric acid had a greater effect on prolongation of gum flow than any chemical evaluated, it is corrosive and had to be handled with caution. Workers had to be trained to handle the process carefully.

Application of the sulfuric acid solution to the new streak on the face. This had to be done carefully due to the corrosive nature of the chemical.

Late in the Southeastern Forest Experiment Station's research effort at Olustee was the refinement of a technique to induce oleoresin content and lightwood formation in southern pines by the application of the herbicide paraquat (Roberts 1973). The increase in oleoresin content in the affected area could be as much as an order of magnitude, providing total yield increases of 2 to 5 times over control trees. Paraquat-induced lightwood formation seemed to be the result of the repartitioning of the tree's fixed carbon resources into a directed synthesis of large quantities of oleoresin. Lightwood formation was the result of a complex set of physiological and biochemical events that were set into motion by the novel chemical properties of paraquat (Brown and Nix 1975). Stubbs and others (1984) reported on a large study evaluating the effects of paraquat injection or sprays on loblolly (*Pinus taeda*) and slash pines with the anticipation that the chemically induced lightwood could create an important and expanding source of oleoresins. The results were positive, but paraquat was found to be extremely toxic to humans, lost its registration, and was withdrawn from the marketplace before its potential in increasing oleoresin could be demonstrated in a commercial venture.

Longer term research included the development of strains of pine of superior gum-yielding capacity. This would be accomplished through selection and breeding of superior gum producing trees (Dorman 1945). Early selections of pines provided at least twice the gum previously produced per tree; they could be grown in plantations containing 200 or more workable trees per acre in place of 20 or 30 faces per acre in wild stands (Ostrom and Squires 1949). While this effort was actively pursued for decades, specialized naval stores plantations were never fully realized because of the decline of the industry. Other studies considered the impacts of turpentining on tree growth. Harper (1937) determined that the related retardation in growth was attributable to two things: (1) a diversion of the tree's photosynthetic products to gum rather than to wood, and (2) to the slowing of translocation and flow of solutes by the face. He concluded that following turpentining, as the face healed over, the growth could be expected to return gradually to normal for an un-turpentined tree. Wahlenberg (1946) reported that active chipping for oleoresin collection reduced diameter growth of old-growth trees by 25 percent; however, most resumed normal growth once tapping was terminated.

In 1949, forest management in some areas of the South was still dominated by naval stores, but less than before (Ward 1949). The destructive use of cutting boxes in trees had been largely abandoned; hence, tree mortality had been greatly reduced. This was the beginning of an evaluation of the effects of naval stores on other aspects of concern.

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Other Federal Naval Stores Research

Established in 1915, the USDA's Bureau of Chemistry and Soils conducted research leading to the improvement of rosin, turpentine, and other pine wood derivatives used in naval stores. Following a 1936 reorganization, the program became known as the Naval Stores Research Division of the Bureau of Agricultural and Industrial Chemistry, but still worked on the production, properties, and uses of naval stores (turpentine, rosin, pine gum, etc.). As mentioned earlier, the Bureau had also established better naval stores production standards and put inspectors in major ports to ensure that products were accurately labeled. Standards were developed for rosin and turpentine based on color (Outland 2004). The Bureau's classifications and inspections helped the industry to provide assurance to consumers that the products purchased were in fact the standard they expected.

Located in Olustee, FL, this was the laboratory of the Naval Stores Research Division of the Bureau of Agricultural and Industrial Chemistry whose role was to improve distilling methods and establish standards for turpentine and rosin production. (photo by Dorothea Lange, courtesy of the Library of Congress)

DECLINE AND LEGACY OF THE NAVAL STORES INDUSTRY

Although technological innovations of the early 20th century made the gum naval stores operations more efficient, the increased cost of labor resulted in a decline in profitability throughout the industry (Greer and others 2015). Federal laws related to civil rights and workers' health and safety, together with the availability of jobs with other rural industries such as lumbering and pulp and paper, made it nearly impossible for the turpentine industry to find and/or afford the workers necessary to maintain their operations. Wood naval stores companies also had the resources for elaborate marketing campaigns for their products, something gum turpentine producers could not match.

Markets for the chemicals derived from naval stores continued to be strong, and both wood and gum naval stores producers increased their efficiencies. But both were plagued by increasing labor costs and shrinking profit margins. Competition from byproducts of the sulfate pulp mills were constrained only by the mill owners. Pulp mills did not want to compete too aggressively with gum naval stores operators, who owned large acreages of timberland and supplied significant amounts of needed pulpwood.

The decline came quickly. In 1950, there were almost 9,000 turpentine producers in the United States; by 1960, only about 1,000 (Greer and others 2015). The last quarter of the 20th century saw the further erosion of the industry until the last barrel of gum was gathered from a pine forest near Soperton, GA, in 2001 (Georgia Forestry Magazine 2003). With that closure, an industry that had been an important component of the rural economy of the U.S. South for nearly 400 years disappeared.

One of the legacies of the naval stores industry was a history of devastated forests—and laws passed to limit the industry's impact on forests. Even early in American history, people have

By 2001, an industry disappeared that had been an important component of the rural southern economy for nearly 400 years.

Worker removing scrape from the face of a pine in probably the last commercial gum naval stores operation in the South. This occurred at Soperton, GA, in 2001 (Georgia Forestry Magazine 2003).

recognized negative impacts of some forest harvesting techniques, and they have attempted to legislate it. In 1715, at Cape Cod, MA, legislation, an act of conservation, was passed to protect the owners of pines, perhaps the first legislation of its kind in America. Wholesale removal of trees had given way to sand, the harbors were filling in, and dunes were moving inland. The law provided penalties to those who, "presumed to cut or carry off any tree, or timber, or bark, or to box any tree for drawing turpentine without license obtained from the owners of said pine trees" (Gamble 1921).

By the mid-1880s, there was widespread decimation of the longleaf pine forests and public opinion shifted.

When turpentining first moved aggressively into North Carolina, pines being boxed for naval stores was seen as a positive, economic practice. However, by the mid-1880s, there was widespread decimation of the longleaf pine forests and public opinion shifted. Newspaper editors and citizens loudly decried the practice and legislation was proposed, but the damage had already occurred. As turpentining moved into Georgia and Florida, concern grew about the effects of boxing on a tree's ability to survive. Turpentining was primarily responsible for eliminating the virgin longleaf and slash pine forests of the Atlantic Coastal States.

Charles Herty's efforts to improve upon naval stores extraction occurred in the early 20th century, about the same time that the practice of forestry was beginning in the United States, helping him gain support. The need for research to reduce the destructive aspects of turpentining was high on the list of priorities. The commitment to lessen the deleterious effects of the system represents a beginning of conservation and a movement toward sustainability. The boxing technique was replaced by the cup and gutter system, which did not kill the trees and left them useable for other purposes. Research continued to improve the system and reduce effects on the pines. However, research was unable to reduce manual labor requirements sufficiently to allow the naval stores industry to successfully compete with the byproducts from sulfate pulp mills.

The commitment to lessen the deleterious effects of turpentining represents a beginning of conservation and a movement toward sustainability.

This photo was taken at Gulfport, MS, ca. 1905. Barrels of rosin and turpentine are being moved to flat-bed rail cars for shipment to ports. (photo courtesy of Shorpy, Inc.)

Perhaps the most substantial legacy of the naval stores industry came from how it impacted longleaf pine. Fortunately, today's southern forest is once again dominated by pines on most upland areas. Nature, free enterprise, and public policy combined to bring about the restoration of the South's forest during the second half of the 20th century (Carter and others 2015). However, loblolly and slash pine now occupy most of the land once covered by pure stands of longleaf. The competitive advantage of longleaf was due to the species' amazing tolerance of fire. Once beyond the cotyledon stage, longleaf seedlings and young trees can withstand repeated scorching and loss of crowns due to fire. Much of the longleaf pine's wide distribution and original dominance was a result of Native American's propensity to repeatedly burn the forest to protect their crops and communities from wildfire and to improve visibility of both game and enemies.

European immigrants who displaced the Native Americans were less prone to use fire and introduced hogs to the southern pine lands. Allowed to forge freely without depredation, these animals developed a voracious appetite and preference for young longleaf pine seedlings. In the absence of fire and the presence of hogs, other pine species, especially loblolly pine, rapidly regenerated over vast areas formerly dominated by longleaf pine. Longleaf pine's decline was further exacerbated when intensive forest management became widespread in the mid- to late-20th century. Foresters found longleaf to be far more difficult to establish and less responsive to intense cultural treatments than other southern pines.

In the absence of fire and the presence of hogs, other pine species, especially loblolly pine, rapidly regenerated over vast areas formerly dominated by longleaf pine.

CONCLUSIONS

For more than 3 centuries, naval stores production was a major economic contributor to the United States, and critical to much of the South. For several decades following the American Civil War, naval stores and other forest industries were a significant—and often the only—source of employment and wealth accumulation in the region. The South's economy was in shambles; its previous agrarian-based economy was largely destroyed. It was the longleaf pine forests then that provided the resources to help rebuild the South's rural economy.

While decimation of the virgin, old-growth longleaf pine forests enabled the people to survive, it had a highly detrimental impact on longleaf pine forests and exploited a destitute labor force. Only after the mid-20th century did technology improve sufficiently to eliminate much of this degradation and exploitation. By then, byproducts recovered from pine pulping mills all but eliminated the market for raw gum collected from living trees. Today's widespread effort to restore longleaf pine to at least a portion of its original range and grandeur is a fitting tribute to the contribution of the original forest and to the well-being of the region and nation.

Today's widespread effort to restore longleaf pine is a fitting tribute to the contribution of the original forest and to the well-being of the region and Nation.

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