# WOOD PULP AND THE EMERGENCE OF A NEW INDUSTRIAL LANDSCAPE IN MAINE, 1880 TO 1930

BY JOHN H. CLARK AND DERYCK W. HOLDSWORTH

*Between the 1880s and 1930s, investors developed over seventy pulp and paper mill sites to exploit the woods and inland waters of Maine. Authors John Clark and Deryck Holdsworth tracked the changing historical geographies of papermaking in Maine during this period through an analysis of data from* Lockwood's Directory, *the industry's leading monitor of investment. They also mapped mill sites, noting their changing capacity and shifts in product types as consumer needs evolved. Their work shows how the development of a railroad network helped facilitate a shift from smaller mills at coastal sites to larger mills at inland settings, which exploited water power from the state's major rivers. This spatial shift, they argue, was also accompanied by an increasing portion of the ownership being controlled by out-of-state capital. John Clark, Data Visualization and GIS Librarian at Lafayette College in Easton, Pennsylvania, is a contributing author to the* Historical Atlas of Maine *(2015). Deryck Holdsworth, Emeritus Professor of Geography at Pennsylvania State University, is the co-editor of the* Historical Atlas of Canada, Vol. III: Addressing the Twentieth Century *(1990).* *The authors would like to thank an anonymous reviewer as well as Professors Stephen Hornsby and Anne Knowles of the University of Maine for their careful reading and insightful critique of this paper.*

PAPER PRODUCTION in North America rose dramatically in the late nineteenth century as widespread literacy, dramatic changes in paper-based records and communication, and the rise of a print-based mass media drove demand. Rapidly falling paper prices were made possible by a combination of technological innovation and new industrial organizations. The shift from rags to wood as a feedstock for pulp production caused paper manufacturers to move production away from urban areas on the Eastern Seaboard and into forested regions stretching from the Great Lakes to the Canadian Maritimes, placing Maine almost literally in

the middle of this transformation. Journalists dubbed this rush of industrial investment the "pulp craze," and between the 1880s and the 1930s over seventy different mill sites were developed to exploit the woods and inland waters of Maine. At the eve of the Great Depression, after a period of adjustment that filtered out all but the most competitive firms, a stable industrial footprint of mill towns devoted to pulp and paper production had been established in the state.[1]

State-level trends in pulp and paper production indicate that Maine grew from the margins of national production capacity in the nineteenth century until, by 1930, it ranked second amongst states, surpassed only by New York. Because such trends in pulp and paper production masked the process that occurred as individual mills experienced changes in ownership and technology, this work examines a historical geography of the industry in Maine, at the level of the individual pulp and paper mill using data drawn from archival sources. Beginning with the location of mills in the nascent industry in 1880 and following developments, by decade, to 1930, it has been possible to identify which sites were successful and which sites fell by the wayside. Evolving statewide patterns of production not only reflected the location of new mills; they also reflected the "stickiness" of older mill sites built in earlier iterations of growth where owners had successfully adapted to changing conditions. Such a sorting process reflects the distribution of natural resources, the development of transportation infrastructure, and the capital and ancillary resources available to individual mill owners, as well as the business strategies adopted by mill owners in a constantly evolving competitive commercial environment.[2]

This study is intended to supplement the considerable work on the history of the pulp-and-paper industry that has been done at both state and national levels, and a brief discussion that situates our efforts within this literature is in order. David Smith's *History of Papermaking in the United States*, published in 1970, remains the standard work. Exploring the development of the industry from its origins as an artisanal craft through its industrialization and into the 1960s, Smith outlined the broad geographic trajectory, as the change of feedstock from rags to wood pulp drove production into the sub-boreal forests of the Northeast in the 1880s. Although a good deal of Smith's history of the early wood-pulp era was focused on examples in Maine, his geographical focus was not narrow enough to reveal the finer scale patterns of industrialization among the many towns involved in the state's nineteenth-century forest economy. [3]

Studies in economic history include a 1993 work by Nancy Ohanian, who examined the migration of the pulp-and-paper industry in the United States from the Northeast to the South from 1900 to 1940, and—more re-

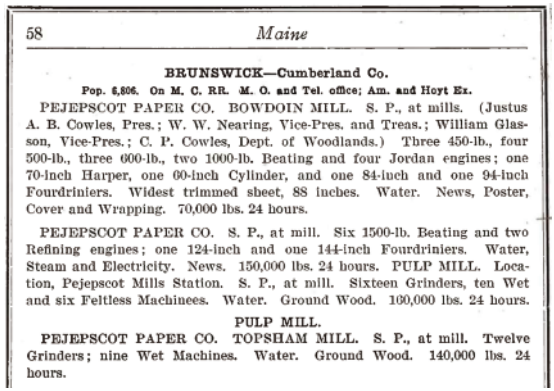
cently—a 2012 piece published by Hannes Toivanen, which examined the technological evolution of the industry in the United States from 1860 to 2000 as part of a larger global history of the paper industry. While both studies focused on coarser national and regional scales, their insights into technological innovation, firm survival, and location informed this study.[4]

In a 2009 study, Lloyd Irland charted the changing structure of pulp and paper manufacturing in Maine in the context of broader national and international trends. Tariff reform in the early twentieth century meant that all but a handful of very large mills in Maine succumbed to the pressure of Canadian newsprint imports, and manufacturers in the state moved into more specialized and technologically advanced paper products as the century advanced. The shift in investment from the Northeast to southern kraft paper production in the 1920s and 1930s also forced Maine mills to adjust and adapt new technologies and product lines. While Irland's work focused on the long-term fortunes of paper-mill towns in Maine, he emphasized changing conditions in the twentieth century rather than including the earliest investments in paper production during the "pulp craze" of the 1880s and early 1890s.[5]

Richard Judd's 1995 history of the industry from 1865 to 1930 in *Maine: The Pine Tree State from Prehistory to the Present* also chronicled the rapid growth and structural changes in pulp and paper production during this period. Additionally, he focused on the industry's role as a catalyst for the forest conservation movement in the state, the political struggles that followed in the early twentieth century, and the limited measures eventually taken by the state and the paper companies to mitigate the impact of intensive timber harvesting.[6]

Another window into the history of the paper industry in Maine was found in the visual narrative offered by the *Historical Atlas of Maine*, published in 2015. Plate 50, entitled "Pulp, Paper, and Power," traced the emergence of the industry from 1880 to 1910 in a collection of figures and maps ranging from local to national scales. Of particular interest were statewide maps offering a single snapshot of pulp and paper production in 1906 as well as employment data for 1883 and 1910, which illustrated the local distribution of industry resources during the period of greatest growth.[7]

Building on all of this scholarship, we present a fine-grained geography of the pulp-and-paper industry in Maine, which explores the spatio-temporal patterns of development at the level of individual pulp and paper mill sites. Using information from *Lockwood's Directory of Paper, Stationery and Allied Trades*, we used a geographic information system (GIS) to map the location of mills at roughly decadal time-steps from 1880 to 1930. This business directory provided a variety of attributes for individual pulp and



58 *Maine*

**BRUNSWICK—Cumberland Co.**

**Pop. 6,806. On M. C. RR. M. C. and Tel. office; Am. and Hoyt Ex.**

PEJEPSCOT PAPER CO. BOWDOIN MILL. S. P., at mills. (Justus A. B. Cowles, Pres.; W. W. Nearing, Vice-Pres. and Treas.; William Glasson, Vice-Pres.; C. P. Cowles, Dept. of Woodlands.) Three 450-lb., four 500-lb., three 600-lb., two 1000-lb. Beating and four Jordan engines; one 70-inch Harper, one 60-inch Cylinder, and one 84-inch and one 94-inch Fourdriniers. Widest trimmed sheet, 88 inches. Water. News, Poster, Cover and Wrapping. 70,000 lbs. 24 hours.

PEJEPSCOT PAPER CO. S. P., at mill. Six 1500-lb. Beating and two Refining engines; one 124-inch and one 144-inch Fourdriniers. Water, Steam and Electricity. News. 150,000 lbs. 24 hours. PULP MILL. Location, Pejepscot Mills Station. S. P., at mill. Sixteen Grinders, ten Wet and six Feltless Machinees. Water. Ground Wood. 100,000 lbs. 24 hours.

**PULP MILL.**

PEJEPSCOT PAPER CO. TOPSHAM MILL. S. P., at mill. Twelve Grinders; nine Wet Machines. Water. Ground Wood. 140,000 lbs. 24 hours.

Figure 1. Segment from the 1914 issue of *Lockwood's Directory of Paper, Stationery and Allied Trades*, which shows mill data for Brunswick, Maine. Image courtesy of Raymond H. Fogler Library, Orono, ME

paper mills. These included the mill's location, ownership, firm officers, home office address, machinery, power sources, types of pulp and paper produced, and productive capacity in pounds per twenty-four hours. (See Figure 1.) Our discussion of changing mill locations, capacity, and outputs—illustrated on a suite of maps (Figures 2, 3, and 4)—drew from these *Lockwood's Directory* attributes. The five intervals covered in the time series are roughly decadal, beginning with data for the year 1880. Because of gaps in available *Lockwood's* volumes, the time-steps are 1892, 1900, 1909, 1921, and 1930. Increasingly common in digital humanities research, GIS is more than just a mapping tool; it is a powerful relational database which can link a rich array of information to the individual features being mapped.[8]

## Technology and Location

From the advent of papermaking in the western world during the Middle Ages until well into the late nineteenth century, paper was made from the animal and vegetable fibers found in rags. Originally, paper was produced one sheet at a time by pressing pulp in meshed frames, draining the water, and bonding the remaining fibers into sheets. Papermaking proceeded on artisanal scales until a mechanical breakthrough was made in the last decade of the eighteenth century. In 1799, the Fourdrinier brothers, stationers in London, England, copyrighted a papermaking machine invented in France, which came to bear their name. The Fourdrinier machine replaced the method of making individual sheets of paper with a rotating

loop of meshed belt upon which pulp was poured at a "wet end" and, after being squeezed between rollers and drained, emerged at a "dry end" as a continuous roll of paper. Although these machines became vastly more complex and productive over the years, this same basic mechanical architecture, and attendant nomenclature, remains at the heart of papermaking today.[9]

Fourdrinier machines had crossed the Atlantic by the late 1820s, and the industrialization of the paper industry in the United States began. Using rags as a feedstock constrained the location of paper mills and helped to define the initial geography of the papermaking business in the United States. Mills needed to be located far enough from urban areas to find the abundant clean water necessary for the pulping process while staying close enough to minimize the costs associated with transporting rags from city to mill and moving paper from mill to market. Consequently, papermaking was concentrated in the nearby hinterlands of the major cities on the Eastern Seaboard; for example, along the Schuylkill River, outside of Philadelphia, where the industry began in colonial times, and in western Massachusetts, where transportation costs to and from New York (via the Hudson and Connecticut Rivers) were minimized. This geography was fundamentally disrupted during the 1880s after new technology allowed cheap, high-quality paper to be made from a pulp rendered from wood.[10]

Creating paper from wood fiber first emerged in Germany in the 1850s with the perfection of wood-grinding machines that were capable of producing a low-quality pulp fit only for newsprint. However, it was not until the introduction of chemical wood-pulping technologies in the 1870s that paper production began to shift decidedly from rags to wood pulp. Chemical processes were able to reduce the wood to pulp while preserving the cellulose fibers in much longer lengths than the mechanical process employed by the wood grinders. This allowed paper manufacturers to substitute wood-pulp for rags in the manufacture of all their products, including more durable book and specialty papers.[11]

## Maine's Forest Economy in the 1870s

When businessmen began to construct pulp and paper mills in the interior of Maine they were not creating an industry in isolation. There was already a thriving forest economy based on the extraction, manufacture, and shipment of lumber. From the seventeenth to the early nineteenth century this economy was entirely dependent on water-based networks of

transportation linking up-river timberlands to sawmills and coastal shipping routes. The extent of tidewater determined how far inland the shipping point for sawn lumber would be located, and this was where the primary commercial centers were located. The next line of settlement occurred at the falls nearest to the littoral where the first sawmills were located. Where flat-water was found, early commercial interests built booms to store the logs from up-river destined for the mill and to store the rafts of sawn lumber awaiting shipment. The booms and mill towns were surrounded by a matrix of nearby villages at the center of small farming communities. Due to poor soil and a short growing season, these communities practiced a very limited commercial agriculture, often providing little more than a safety net for families while allowing the men and boys to engage in the broader commercial world of logging and millwork on a seasonal basis.[12]

Beginning with a fairly simple infrastructure in colonial days, lumbering in Maine reached its peak in the 1870s. By 1880, commercial interests in the state had created dams to regulate river flow; mutual-benefit corporations to coordinate river drives; and a legal framework and stable business networks, which mediated the harvest, transportation, and manufacture of sawn timber. This was the geographical legacy upon which the pulp and paper business would grow.[13]

Pulp and paper mills were established in these lumbering settlements, sometimes by local sawmill owners who invested in wood-pulp grinders as an adjunct to their lumber businesses. When chemical pulp technologies became available, some mill owners invested in pulp digesters. Instead of discarding the waste wood from their sawmills, they converted it to pulp while availing themselves of more pulp wood from the storage booms near their mills. When investors from Portland or Boston searched for locations to build pulp and paper mills it made sense to locate in towns such as these in order to take advantage of the pre-existing infrastructure and a workforce experienced in logging and acclimated to factory work.[14]

Rail transportation also played a critical role in the location of pulp and paper production. By 1880, at the outset of the pulp craze, Maine was connected to the West by four rail lines converging on Portland. To the East, Bangor was thinly connected to the Canadian Maritimes by the European and North American Railroad. Although the rail line along the eastern banks of the Penobscot opened up some water-power sites to industrial development, the majority of the watershed needed more railroad construction before its full industrial potential could be realized. The same was true for the Androscoggin watershed, which was partially connected by the St. Lawrence and Atlantic line linking Portland to Montreal.

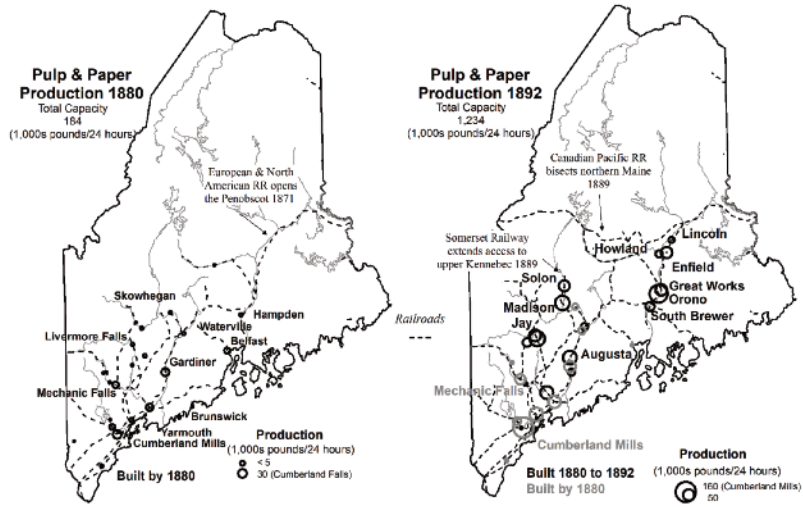



Figure 2. Pulp and Paper Production in Maine, 1880 and 1892. Maps by John H. Clark.

Through a junction a few miles east of Portland, this line ran north, bypassing the main branch of the Androscoggin River lying to the East. Before it turned northwest, it crossed the tributary Little Androscoggin River at the water-power site of Mechanic Falls but did not run along the Androscoggin proper until it was a short distance from the New Hampshire border. This left the most valuable water-power sites on the Maine side of this watershed unconnected to the outside world. Likewise, only a part of the upper Kennebec had been connected by branch lines extending from the interior trunk route running between Portland and Bangor, but in 1880 much of the up-river country still lay beyond the railroad network. Thus Maine's railroad network was sufficient to support the first stage of pulp and paper development, but further expansion would be necessary before the full potential of the forests and falling waters of Maine could be realized.[15] (See Figure 2.)

**The Pulp Craze, 1880s and 1890s**

In 1880, the location of Maine's nascent pulp-and-paper industry was still largely oriented toward river and ocean, a legacy of mid-nineteenth-century conditions. This was because most mill locations had been established when Maine's paper mills still used rags as the feedstock for their pulping operations. Building close to tidewater helped to minimize the

transportation costs of both rags and paper. As these locational considerations were superseded by the need for proximity to high volumes of wood and the growing need for larger water-power sites, investors in newer mills took advantage of the flexibility that railroad transportation afforded. The map sequences in Figures 2, 3, and 4 identify the emerging rail network associated with these new mill locations.

Illustrative of the maritime orientation in 1880 was the S. D. Warren Company mill at the village of Cumberland Mills, then within the municipal boundaries of Portland. Originally built in 1854, this site met three critical locational criteria: it had sufficient water power; it was far enough away from the city to have plentiful clean water; and, despite this distance, it was only four miles from the wharves of Portland harbor. This same geographical logic drove the Hollingsworth and Whitney Company of Boston to purchase a pulp and paper mill with water privileges on Cobbosseecontee Stream in the town of Gardiner, then a busy little seaport on the lower reaches of the Kennebec River.[16]

At the outset of the study period in 1880, twenty-nine towns hosted pulp and paper mills; of these, only three—Cumberland Falls, Gardiner, and Brunswick—were significant centers of production featuring a capacity between twenty and thirty thousand pounds per day. Another three towns, Windham, Mechanic Falls, and Belfast, featured fairly large mill sites which averaged roughly half of that output. All of the other pulp and paper manufacturing centers fell short of ten thousand pounds per day, with most producing in the two-to-four-thousand-pound range. (See Figure 2.)

The largest papermaking place in 1880 was Cumberland Falls. While most Maine mills during this time period were locally controlled, these pulp and paper mills were owned and operated by the well-capitalized S.D. Warren firm of Boston. Samuel D. Warren, a rising paper wholesaler, entered paper production in the 1850s by purchasing and expanding what was then a small, locally-owned mill. He also invested in the Forest Paper Company, a pioneering chemical-pulp facility at nearby Yarmouth. By 1876, when he acquired full control of that facility, S.D. Warren Company was far ahead of the rest of Maine's industry in terms of both capital and technology. In Gardiner, another large Boston firm, Hollingsworth and Whitney, operated their Cobbessee Mill next to a mill operated by local entrepreneurs Richards and Company. Like Cumberland Mills, Gardiner was also served by rail and marine transportation routes. Its waterfront on the lower Kennebec River was busy in both the lumber and ice trades. All of these mills were located on water-power sites on Cobbossecontee Stream, first developed in 1806 by Robert Hallowell Gardiner, and only a mile or so above the town's anchorage.[17]

The third major papermaking town was Brunswick, located on navigable water just above Merrymeeting Bay where, a short distance from the ocean, the Androscoggin meets the Kennebec. Not only were the locational elements of water power on tidewater present, but the siting of the mill at Brunswick also represented a clear example of pulp and papermaking emerging from the lumber economy. Maine's oldest ground-wood pulp operations began there in 1868 in the basement of a sawmill owned by C. D. Brown and E. B. Denison. These two men managed to produce two thousand pounds of pulp per day, which they pressed and shipped in barrels. In 1870, the Androscoggin Pulp Company built the Pejepscot Mill, a much larger facility. By 1880, this mill was producing ten thousand pounds of wood pulp per day at Brunswick and was joined by the Bowdoin Paper Manufacturing Company, which was turning out an equal volume of newsprint.[18]

The second tier of pulp and paper manufacturers in 1880 included South Windham, Mechanic Falls, and Belfast. As with the three largest towns, these had good water-power sites and the necessary transportation links. After building the new mill at Brunswick (noted above), the Androscoggin Pulp Company expanded rapidly before failing in 1875 and reorganizing with the backing of a Lawrence, Massachusetts, entrepreneur named William A. Russell. Among the mills built by Russell's firm was the wood-pulp mill at South Wyndham, which was located a few miles up the Presumscot River from Cumberland Mills and was capable of producing twelve thousand pounds per day in 1880, making it one of the larger pulp mills in the state. Russell was also involved in a papermaking venture in Belfast, another second-tier town. There, in 1856, he leased two small mills with the capacity to make six thousand pounds of manila and newsprint. The last of these second-tier places was the only one of Maine's larger production sites in 1880 to be located inland and out of reach of maritime transportation routes. Mechanic Falls was located on the Little Androscoggin, an interior tributary of the Androscoggin itself; the St. Lawrence and Atlantic Railroad provided the necessary rail connection. Like the Pejepscot Mill at Brunswick, the pulp and paper mills at Mechanic Falls were built by a local entrepreneur whose business stumbled after a rapid expansion. Adna C. Dennison was a storekeeper in Norway, a small nearby town through which the St. Lawrence and Atlantic also passed. He prospered supplying the large work gangs who passed through the area building the road in the late 1840s and invested his money in a small paper mill in Norway. By 1851, he had expanded to Mechanic Falls and, by the late 1860s, was producing paper made with ground-wood pulp supplied from his Norway mill. Before his business failed in 1875, he

owned or operated additional mills in Poland and Brunswick and had investments in mills in Yarmouth, South Paris, and Gorham. The mortgage holder on Dennison's mills, W. H. Parsons Company of New York, salvaged the business by financing a state-of-the-art pulp mill at Canton, which provided a reliable supply of low-cost ground-wood pulp to the mills at Mechanic Falls, a task that the old Norway mill had been unable to fulfill.[19]

In 1880, many small mills, such as those at Norway, East Dover, North Wayne, Farmington, and Farmington Falls were operating with the limited machinery of the antebellum period and at what was basically a pre-industrial scale. In other words, they were operated by a master and a few hands. They had adopted industrial technology, such as beater engines and cylinder machines, and hence were able to produce about a ton of product every day compared to production measured in reams in the handcraft mills of the early nineteenth century. Nonetheless, they were completely outclassed by the grinders, engines, and much wider Fourdriniers and cylinders adopted by the larger mills of 1880, and they disappeared from the scene by 1892. (See Figure 2.)

What is notable about this early phase in the development of the industry in Maine is the reorganization of locally owned mills by outside capitalists with much deeper pockets than the original mill developers. As illustrated in the 1892 and 1900 maps, the local firms may have failed, but the production capacity of these facilities still manifested the exponential growth typical of this period. In the heady investment atmosphere of the 1880s, both local and metropolitan capital poured in to profit from the new business opportunities provided by wood-pulp technology and the surging demand for paper. However, over the long run, and not without some exceptions, mill survival depended on the larger financial resources available further up the urban hierarchy in emerging North American hubs of global finance, such as Boston and New York. In the case of other mills, sufficient capital was organized at intermediate levels such as in Portland or Bangor, Maine, and the distances between mill operations and mill management were less, both in terms of actual distance and in terms of individual mills remaining parts of smaller, less complex manufacturing firms.

**Corporate Consolidation, 1890s and 1900s**

The production capacity of Maine's pulp and paper mills continued to skyrocket between 1892 and 1900, growing nearly four-fold from 1.2 million pounds per day to 4.7 million pounds. The majority of this growth

came in existing mill towns as old facilities were upgraded and new machines were brought on line in new buildings at existing mill sites. Growth in the old mill towns more than tripled during this period, and in 1900 those towns amounted to roughly two-thirds of the state's capacity. However, not all pulp and paper mills were located where sawmills could be found. Industrial developers of the 1890s had the technology and resources to harness the great falls that were beyond the exploitation of lumbermen of an earlier generation, and, in the 1890s, two entirely new mill towns—Rumford Falls and Millinocket—were built in the wilderness at massive water-power sites, which were devoted exclusively to the production of pulp and paper. (See Figure 3.)

Ultimately, the location of pulp and paper mills was decided by the businessmen who directed their creation. Nature might have provided the forests and the streams, but capital dammed hydro-electric sites, financed railroads to haul out paper and supply workers in the towns that the mill owners built, and provided the impetus for lawyers to acquire millions of acres of timberlands to supply the pulp wood for the mills. The owners and managers of mills in Maine operated at different levels of the urban hierarchy. Many of the earliest mill owners lived in the small towns and villages where they built their mills, but this was not always the case. Intermediate cities, such as Portland and Bangor, also played an important role in the development of the industry. And, from the beginning of this period, capitalists from the metropolitan centers of Boston and New York

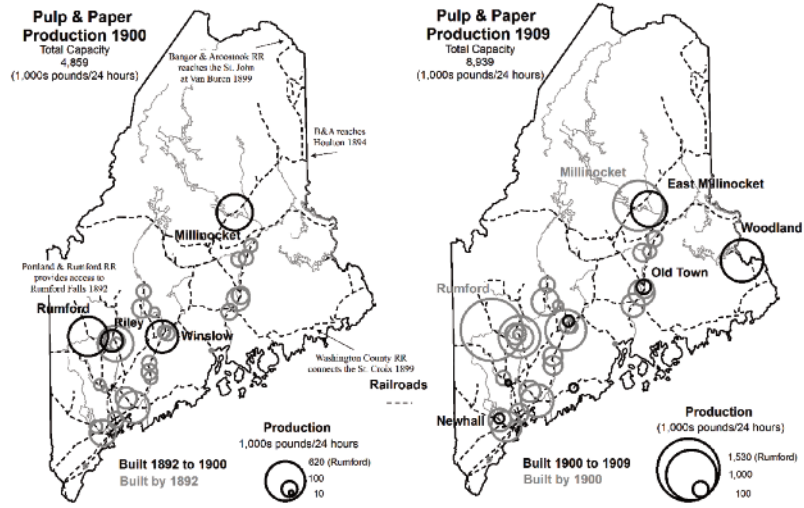



Figure 3. Pulp and Paper Production in Maine, 1900 and 1909. Maps by John H. Clark.

had a hand in investing in mills and directing their management, a hand that became firmer as the decades went by and production became concentrated in fewer firms.[20]

The geographical aspects of the management and control of pulp and paper production in Maine changed in two important respects from 1880 to 1930. First, as the industry developed, both ownership and management functions became more distant from the mills. The necessity for ever-increasing capital inputs to keep mills competitive drove these functions further up the urban hierarchy, and the successful mills which remained in production over time were increasingly controlled from metropolitan centers such as Boston, New York, and Toronto. Second, the nature of the management directives changed over time, resulting in a particular geography of mill location, which was contingent on the business strategies employed at each mill each step of the way.

The successful production of pulp and paper was driven by economic factors beyond the control of individual mill owners. Overall, production in the United States grew exponentially throughout the 1880s and 1890s resulting in oversupply and falling prices. This challenging economic environment forced pulp and paper firms in Maine to adapt in order to survive, both by consolidating operations in large papermaking corporations and by specializing in particular types of paper production.[21]

Regardless of how a firm consolidated production, in strategic terms they tried to gain control of prices and reduce operating costs by combining their operations with competitors. In an age of monopoly capitalism, firms that consolidated horizontally aimed to control prices by merging with competitors producing the same types of paper in order to control sufficient market share to become price leaders and halt the slide in prices. Alongside such strategic considerations lay tactical decisions about individual mill operations. Economic historian Naomi Lamoreaux, in her 1985 study of corporate behavior during the wave of mergers that took place in the United States between 1895 and 1904, identified two contrasting business strategies, which industrial firms of the period employed in their production facilities: mass production and product differentiation.[22]

A Maine paper mill that followed the tactics of mass production might have begun in the 1870s, producing a small amount of newsprint, writing, and wrapping paper. In the 1880s, the managers could have decided to concentrate on newsprint production, invested in the widest and fastest possible Fourdrinier machines, and run them twenty-four hours a day, thus driving down unit costs and prevailing over competitors who were still trying to make newsprint amid an array of other paper types. This

tactic was particularly appropriate for newsprint, which could not be distinguished from a competitor's product and required producers to compete on price alone. This required constant improvements in papermaking processes in order to squeeze out razor-thin profit margins amidst constantly declining prices.

Alternatively, the same mill owners could have taken a different tack and decided to concentrate on high-quality writing paper. This would also have required investments in new pulp-making and finishing technology, the beaters and calendars that lay on either end of the Fourdrinier machines in the papermaking process. They might also have wanted to invest in branding and marketing their writing paper in order to ensure a premium price for their product as well as higher profit margins on a lower volume of production. Of course, some firms had the resources to pursue both tactics at once and built mills producing specialty paper products at great economies of scale. Both strategies also relied on plentiful capital, which, in an era of falling prices, could not be generated sufficiently within smaller firms. This led to a reliance on outside capital coming to Maine from further up the urban hierarchy.

A good example of pursuing economies of scale can be found in the development of mills and the consolidation of firms led by William A. Russell. Operating originally from his family's paper mill in Lawrence, Massachusetts, Russell was one of the most successful pulp and paper developers of the era. The fact that he began investing in Maine from the beginning of the pulp craze ensured the development and survival of mills in several Maine towns, most notably on the upper Androscoggin at Livermore Falls, Jay, and Rumford. As previously noted, it was Russell, along with a syndicate of Portland investors who bought the assets of the failed Androscoggin Paper Company. Any geographical history of pulp and paper development in Maine must unpack his participation at the local level, which includes a close examination of the work of his Maine partners.[23]

Russell's protégé, Portland businessman Hugh Chisholm, not only joined him in the acquisition of the Androscoggin Paper mills; he also led the acquisition and development of important mills throughout the Androscoggin watershed. Chisholm's efforts began in Livermore Falls and followed on the earlier efforts of local entrepreneur Alvin Record, who had initially built a small mill—which can be found in the 1880 *Lockwood's Directory*—with the capacity to produce four thousand pounds of leather board per day. Record found success in this enterprise and poured resources into a much larger complex of pulp and paper production at the falls just up the river, at the bridge crossing at the town of Jay. Chisholm,

working separately from Record in the late 1880s and early 1890s, built a large pulp operation at Livermore Falls known as the Umbagog Mills as well as a much larger pulp and paper complex at Otis Falls, which lay between Alvin Record's mills at Jay Bridge and Livermore Falls itself. In 1896, he bought out Record's mills in Jay, incorporating them as the Falmouth Paper Company. Finally, in partnership with other local entrepreneurs and capitalists from as far away as Detroit, he led the effort to develop what was then the largest paper mill in the world: a massive hydro-electric power system and mill complex in the wilderness at Rumford Falls. When this mill site went into production in 1893, the investors had also completed a rail line connecting it to the outside world as well as to the company town, complete with ancillary businesses and residential blocks. To complete these integrated businesses, Chisholm also developed an immense groundwood pulp mill across the river from Jay in Riley.[24]

With his partner Russell and others, Chisholm was a director in a number of firms controlling production sites on the upper Androscoggin. Although using a complex set of interlocking directorships for ownership purposes, these firms managed their operations from a single suite of offices on the third floor of a modest office building on Congress Street in Portland. However, despite the economies of scale this alliance of firms enjoyed, profits were hard to come by as paper prices continued to fall throughout the 1890s. In fact, these massive industrial developments on the Androscoggin simply added to a growing national supply juggernaut, acting as a damper on prices and putting further pressure on their bottom line.[25]

In the end, Russell and Chisholm elected to pursue a monopoly on newsprint production to raise their profit margins through market manipulation, rather than relying solely on investments in research and capital equipment that could lead to greater production efficiencies or new product development. After failed attempts to create a cartel arrangement with competitors in the mid-1890s, they finally managed to negotiate a series of complex financial transactions, which resulted in the creation of the International Paper Company (IP) in 1898. The IP merger consolidated twenty pulp and paper mills producing ninety percent of newsprint production in the eastern United States. Russell, its first president, immediately set to work stabilizing the price of newsprint. After less than a year at the helm, Russell died suddenly and was succeeded by his vice-president Hugh Chisholm, who had recently moved his office from Congress Street in Portland to 30 Broad Street at the heart of the New York City financial district.[26]

The IP consolidation included a number of important mills in Maine. Along with all of the mills managed by Chisholm on the Androscoggin, IP took control of a state-of-the-art pulp and paper complex at Orono,

developed by local magnate J. Frederick Webster. Another mill on the Penobscot at West Enfield, developed by Bostonian Samuel L. Montague as the Piscataquis Falls Pulp and Paper Company, also joined the "Paper Trust" (as IP was known to its detractors). The fact that Webster only contributed a single mill site to IP and that the bulk of Montague's contribution to the IP monopoly lay in mills in Massachusetts can be traced to the distribution of pulp and paper production in Maine. By 1930, corporate managers in New York had decided to close all IP mills on the Penobscot while investing heavily in their mills in western Maine. However, in the years immediately following the IP merger in 1898, with the inclusion of a mill site at Solon, IP was active on all three of Maine's major watersheds then developed for pulp and paper manufacturing: the Androscoggin, the Kennebec, and the Penobscot.[27]

The story of IP in Maine reveals how the consolidation of a multinational corporation could contribute directly to contingencies in historical geographic outcomes at a local level. Had a hypothetical corporation merged all of the mills on the Penobscot with only a couple of mills on the Androscoggin, the lives of those living in the respective mill towns might have been quite different as corporate officers from far away made investments in the Penobscot mills and let their initial Androscoggin investments wither on the vine. However, such was not the case.

While IP eschewed any new investment in paper production on the Penobscot, a powerful new corporate competitor did move into the watershed. However, rather than locate production among the mill towns of the pre-existing forest economy, the Great Northern Paper Company (GNP) created new mill towns deep in the forest and well up-river from any population centers. And, unlike IP, whose origins lay in antecedent firms dating back many years, GNP emerged all at once, albeit after a brief prelude of local investment. This was initiated by Charles W. Mullen of Old Town, a local promoter of limited means, who envisioned the creation of a pulp and paper mill complex where anticipated rail access would connect to a massive hydro-power site, in the midst of plentiful timberlands, at the falls called Millinocket. Taking charge of a highly speculative real estate venture, he and his partners navigated through local, regional, and (finally) national networks of capital before cashing in their modest interest in the venture while leaving the more complex and capital-intensive final phase to others. Hence, the development of the mill complex and the management of the resulting pulp and paper firm never went through local or regional phases of management, but instead emerged complete under the direction and control of capitalists in Boston and New York.[28]

Mullen, a civil engineer trained at the Maine State College, began his

career working in the Penobscot Chemical Fibre Company mill in Old Town in the 1880s, and, by the time he began the Millinocket venture in 1891, he had been employed in designing and building two other chemical pulp and paper facilities. Upon returning from a surveying expedition through the Millinocket area on behalf of the Bangor & Aroostook Railroad, he put together a syndicate of mostly Bangor capitalists who set to buying options on lots and water rights around the future town completing their work five years later.[29]

Mullen's next step was to bring in a partner, Garret Schenk, who had the engineering and development experience to pique the interest of the nation's leading financiers. Active throughout the early wood-pulp era, by 1896, when he signed a contract with Mullen, he was widely recognized as one of the nation's most successful engineers and mill managers. This deal was done with some discretion, because Schenk already had obligations to the Rumford Falls Pulp and Paper Company, where he was both a director of the firm and the manager of their mill complex on the Androscoggin River. As a company director, Schenk was privy to the negotiations begun in the year that would eventually see his mill merged into IP. Well before the talks concluded, it must have become clear to Schenk that he had an uncertain future in the corporate hierarchy of any mega-firm that might emerge. By making a quiet side-deal with Mullen, he was clearly hedging his bets.[30]

Mullen and Schenk proceeded to form a partnership with the option to buy out the unnamed and unincorporated syndicate, which in turn held options to the land and water development rights needed to build a mill at Millinocket. The deal was further refined by the formation of the Northern Development Company (NDC), chartered by the state legislature in 1897 and authorized to develop and transmit hydro-electric power, establish manufacturing facilities, and build towns and roads with only minor restrictions. With this shell in place, the two partners then went in search for the financing they would need to bring their enterprise to fruition. However, before completing a final deal, time-sensitive land options forced them to bring in another partner, Colonel E. H. Haskell, an associate of Schenk and Chisholm in the Rumford Falls project. Finally, in 1899, they secured the necessary capital in New York from the deep pockets of Standard Oil partner Colonel Oliver H. Payne who, with a number of minority shareholders (including Garret Schenk), took control of the NDC. Shortly thereafter, the state legislature obliged the investors by authorizing both an increase in the capitalization of NDC and a change in the company name to Great Northern Paper. In May of that year, after the Bangor & Aroostook completed a spur line to the site, construction began on a mas-

sive mill and hydro-electric complex at Millinocket, which began producing newsprint in 1900. Six years later, following their initial success, the firm expanded production, building another state-of-the-art facility several miles downstream in East Millinocket.[31]

There were profound implications from the arrival of IP and GNP in Maine. Corporate control eventually replaced many of the ways of the nineteenth-century forest economy, including flowage regulation and cooperative river driving. However, as this is primarily a study of paper-production location and mill towns, we will simply note that the success of these two great firms was a key factor in determining where the industrial labor force would settle on all three of Maine's major rivers.[32]

**Adaptation and Survival, 1900s to 1920s**

By 1900, pulp and paper production in Maine had increased dramatically. (See Figure 4.) The growth of industrial-scale integrated pulp and paper mills showed no sign of slowing, nor did the steady erosion of the price of paper. Still to come was fierce competition in newsprint production from mills on the Canadian Shield, and the continued development of rival industries in the upper Great Lakes region and the Pacific Northwest. In addition to minimizing the marginal cost of production through economies of scale, mill owners also searched for advanced paper products, which would command premium prices. Firms that chose this product

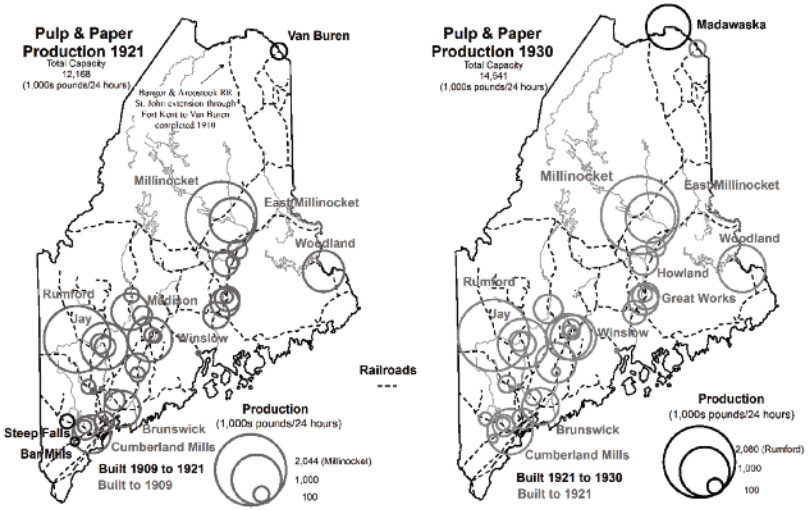



Figure 4. Pulp and Paper Production in Maine, 1921 and 1930. Maps by John H. Clark.

differentiation strategy invested in the production of more and more specialized paper products, which, in turn, faced less competition, were more resistant to price pressure, and yeilded higher profit margins. The types of paper that firms chose to produce at individual mills reflected which of the two different business strategies, mass production and product differentiation, the owner had chosen to pursue.[33]

In order to make sense of the scores of different paper products identified in *Lockwood's*, it was necessary to reclassify them into four broad categories: newsprint, book, paper board, and specialty papers, following a taxonomy found in a contemporary papermaking textbook. This classification of paper products was based on broadly different production techniques. "Newsprint" fell in a category of its own due to the use of ground-wood pulp, which produced a thin, brittle, and relatively impermanant paper. The author of the textbook used the term "book paper" to categorize all of the paper products designed to hold ink, including a long list of sub-categories which was not limited to publishing and included stationary and art papers. Book paper, while it could include a small proportion of ground-wood pulp, required stronger chemical pulps, which preserved the longer wood fibers and produced stronger paper. A third broad category—"paper board"—was used to designate all of the paper products formed by stacking layers of paper on top of each other during the production process using cylinder machines to form a thicker, stiffer product. This included a variety of products used for packaging, such as corrogated cardboard. The fourth category—"specialty papers"—was adapted from a 1917 report on the paper industry issued by the Federal Trade Commission in which separate sub-categories were defined according to the type of finishing process applied to paper products running through the Fourdrinier machine.[34]

Papermaking machines, in and of themselves, were not sufficient to keep up with the competition; the types of paper that mills produced mattered as well, and mills began to specialize. The types of paper that firms chose to produce at individual mills reflected which of the two different business strategies—mass production and product differentiation—the mill's owners had chosen to pursue. In 1880, several Maine mills produced newsprint as well as other paper products. The firms that continued to engage in newsprint production were forced to follow a mass-production strategy and build the most efficient mills possible, running for twenty-four hours a day. On the other hand, firms that chose a product differentiation strategy invested in the production of more and more specialized paper products, which faced less competition, were more resistant to price pressure, and yeilded higher profit margins. Tracking the changing output of mills in *Lockwood's* revealed a remarkable shift in types of paper pro-

duced in Maine from 1880 to 1930. (See Figure 5.) Initially, the output of mills was described in *Lockwood's* in very general terms, such as "news," "book," or "leather board." However, by 1930, *Lockwood's* was reporting the production of scores of different paper products, including "postal card," "lithograph label," and "die-wiping" papers.[35]

Maine mills altered the types of paper they produced considerably from 1880 to 1930. Figure 5 charts this changing mix of paper products, revealing two major trends. The first was an explosion of newsprint production beginning in the 1890s, which reached a plateau after 1909. The second was the rapid rise of specialty papers between 1900 and 1930. In 1880, most

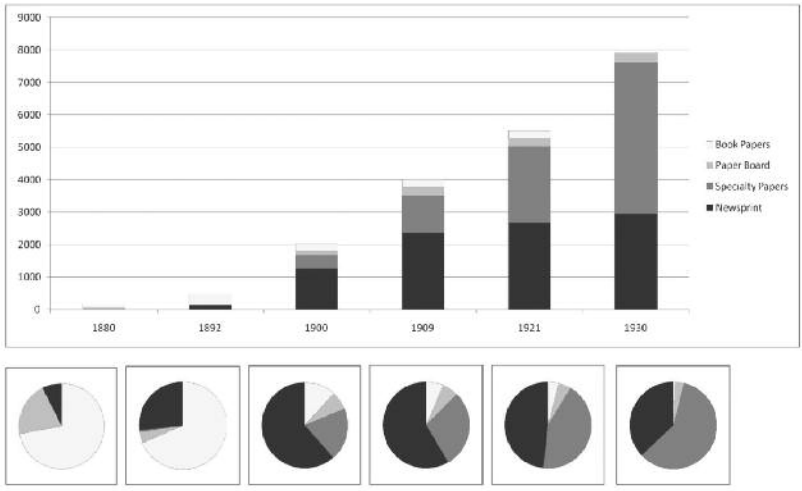



Figure 5. Paper Product Differentiation in Maine, 1880 to 1930. Chart by John H. Clark.

mills (74.4 percent) were producing simple book paper, either for publishers or as wrapping paper. Several small mills devoted to leather board, a type of leather substitute used in the shoe industry, comprised a second category. Their proximity to the shoe factories of Maine and the Merrimac Valley ensured that this category would persist. Finally, there was only a single mill, Bowdoin Manufacturing of Brunswick, which was devoted exclusively to newsprint although it was one of the larger operations in the state at the time and accounted for 7.4 percent of total output. Great investments in newsprint plants were made on the Androscoggin during the 1890s, most notably by Hugh J. Chisholm and his associates at Otis Falls and Rumford Falls, and also by the W.H. Parsons associated mills at Lisbon Falls and Brunswick.[36]

Newsprint production in Maine did not continue growing through 1930. It reached its apex as a proportion of statewide paper production, as well as reaching a plateau in terms of volume, in 1909. Overall production of newsprint grew only marginally during the 1910s and 1920s. At a national level, newsprint production began to shift to Canada after a controversial congressional action that removed tariff barriers to its importation in 1913. The last great newsprint mill to be built in Maine, the St. Croix Paper Company mill at Woodland, was brought on line in 1906. After the Canadian tariffs were eliminated, six mills dropped out of newsprint production as their owners either closed them or switched their production to specialty papers. The IP newsprint mill at Rumford Falls, the largest mill in the world when it opened in 1893, ceased producing newsprint and, in 1921, *Lockwood's* reported that the products produced there included bag and wrapping, express, kraft, envelope manila, and decorated poster paper among other specialty papers. By 1930, only three mills, those of GNP at Millinocket and East Millinocket, as well at the St. Croix mill at Woodland, were producing newsprint.[37]

By the 1890s, the industry nationwide was suffering from a crisis of overcapacity and falling prices. From 1900 forward, according to *Lockwood's* data on paper products, mill owners in Maine were beginning to pursue a strategy of product differentiation. During the 1890s, specialty paper grew from less than 1 percent of the statewide total to nearly one-fifth (19.7 percent). Although none of the older mills extant in 1892 were producing this category, two large new mills built in the late 1890s were responsible for all of the specialty paper produced in 1900. Production in this category tripled in the next time-step, and in 1909 the proportion of specialty paper had grown to nearly thirty percent. During this period, not only were large new facilities constructed, such as the Oxford Paper Company mill at Rumford Falls, but existing mills began to retool for specialty paper production. By the end of the 1920s, nearly sixty percent of the production capacity in the state was specialty papers. This surge in the volume and proportion of specialty paper production from 1900 onward had come about as book-paper mills upgraded to specialty pulps and finishes and as newsprint production was abandoned in the face of competition from Canada.[38]

**Maine's Paper Mill Towns, 1930**

According to *Lockwood's*, seventy-two pulp and/or paper mills existed in Maine from 1880 to 1930, beginning with the twenty-nine listed in the

1880 volume. Where the forty facilities which emerged in 1930 were located depended on decisions made in earlier iterations. Over time, a sorting process, evident within common trends in industry integration and mill-level investment strategies, left the industrial landscape of the region with a unique geographical pattern of mill location.

The four maps in Figure 6 give a detailed view of which localities lost mills. In the first two time-steps of the 1880s and 1890s, mill closures reflected the impact of massive investment in new pulp and paper production; the new mills drove out older mills without the economies of scale or new technology to compete. During the first decade of the twentieth century, only a single mill site was closed, illustrating a peak in wood-pulp and paper investments in Maine. None of the new large-scale mills developed in the 1880s and 1890s were shuttered, nor were any of the lesser mills which survived the shakeout of the previous two decades. As illustrated in the fourth map in Figure 6, paper firms, by the end of the nineteenth century, were abandoning newsprint in western Maine and consolidating specialized production in the largest and most efficient mills.

The *Lockwood's* data (mapped in Figure 7) revealed a particular pattern that had developed in the distribution of pulp and paper production in Maine by 1930, a pattern that was the logical outcome of locational choices contingent upon pre-existing conditions. A sorting process had taken place though the intervening decades, which reflected a number of factors, including the ecological and transportation needs of pulp and paper production, capital available to mill owners, and the business strategies adopted for each mill.

Of course, it was the aggregation of production in these plants which made up statewide trends, but production at each plant was contingent upon changes wrought at earlier time-steps. Therefore, a detailed explanation of statewide trends depends on unpacking these changes in ownership and business strategy. For example, Alvin Record's decision to build a pulp and paper mill at the falls at Jay Bridge opened up an opportunity for up-river loggers, whose sales had previously gone to the sawmills still operating in the area. In this way, pulp production emerged in the midst of the geography of a lumber economy. Other pulp-wood entrepreneurs failed in similar sawmill locations, but Record succeeded and was able to sell his operation to the Chisholm associates in Portland. This firm added new buildings and the latest Fourdrinier machines to the site in the 1890s, and a thriving newsprint operation emerged. Similar integrated mills of that scale existed elsewhere—for example, in Brunswick and Orono—but their production remained steady or declined over the next three decades, while IP, to whom Chisholm had sold the Jay mills, was willing to invest

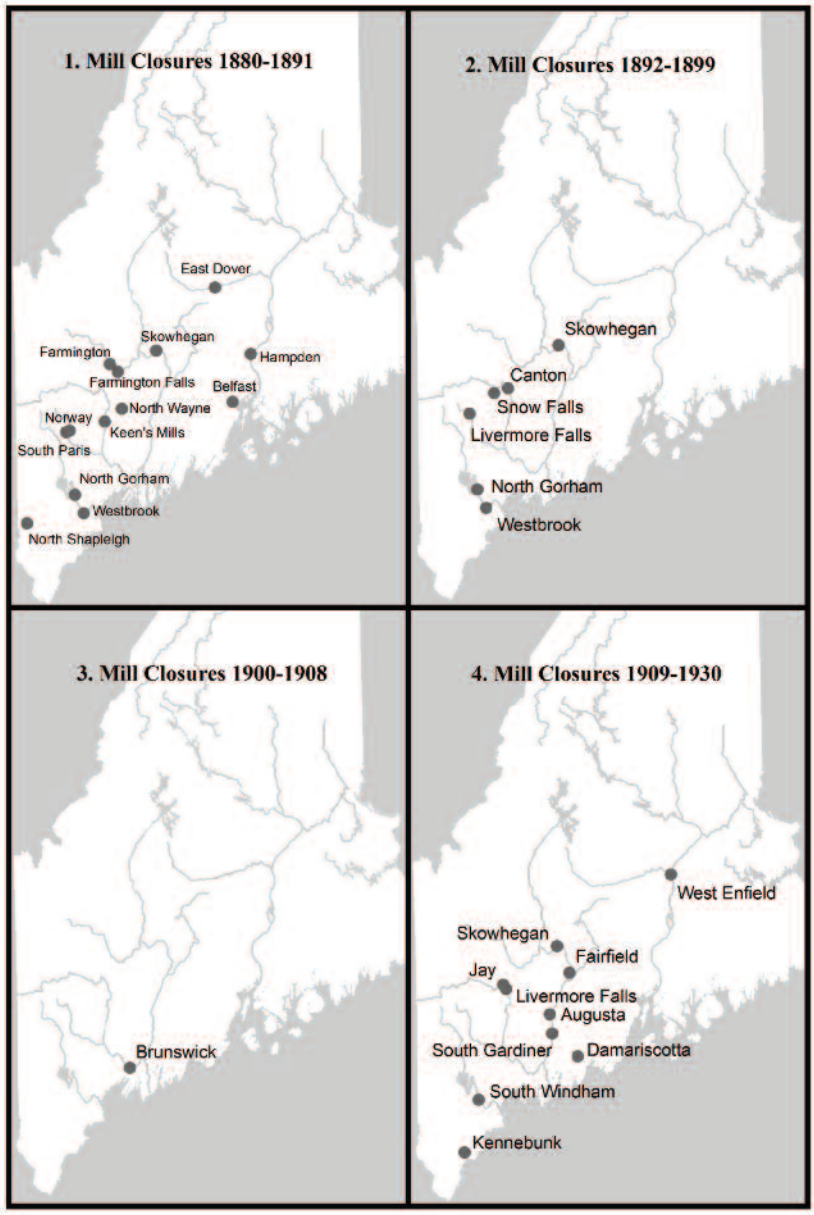



Figure 6. Pulp and Paper Mill Closures in Maine, 1880 to 1930. Maps by John H. Clark.


7. Location of Pulp and Paper Production in Maine, 1930. Map by John H. Clark.

in greater newsprint capacity and expanded production. By the 1920s, however, the corporate officers in New York chose to shut the paper machines on this stretch of the Androscoggin, and in 1930 only ground-wood production at Jay and Livermore Falls remained, while upriver at Rumford, IP and the Oxford Paper Company maintained highly competitive mills producing a variety of specialty paper products.[39]

Similar geographical patterns of increasingly distant locations of management and ownership emerged on other watersheds in Maine. Local papermakers were the pioneers, either operating small-scale, rag-based paper mills on tidewater or experimenting with ground-wood pulp works amongst the sawmills of down-river manufacturing towns linked to markets by the limited rail connections of the 1870s and early 1880s. Many of these mills disappeared, but others were acquired by new owners in Portland or Boston, often consolidated with other mills, and rapidly expanded their production in the 1880s and 1890s. During those decades, these legacy mills were joined by a new generation of larger papermaking operations either integrated into existing pulp facilities, such as the case of Jay, or built with their own pulp-making capacity on site. Many of these new facilities were owned and managed from the intermediate cities of Portland and Bangor, but others were constructed by much larger firms based in Boston or New York. Finally, beginning in 1898 with the arrival of IP, the largest mill complexes began to be consolidated into modern corporations and management shifted from local towns and intermediate in-state cities to distant metropolitan centers where operating decisions became embedded in national and global networks of equity and credit.

## Conclusion

Using the records for individual mills found in *Lockwood's Directory of Paper and Allied Trades*, it was possible to illuminate some of the geographical changes that contributed to the emergence of paper-mill towns in Maine. Prior to the "pulp craze" of the 1880s, Maine played a small role in the production of pulp and paper in the United States. However, as noted above, by 1930 the state had become one of the top national producers. The geography of Maine's industry had changed profoundly as well. In 1880, paper production was to be found, for the most part, along the coast and navigable waterways in the more heavily populated southern regions of the state. However, there was some evidence of trends to come. Scattered about the interior, some pioneering ground-wood pulp mills operated at relatively small scales. And a large integrated pulp and paper complex

owned by S. D. Warren Company of Boston was operating at Cumberland Falls and Yarmouth. For the most part, however, small mills owned by Maine firms were catering to local markets, producing basic book paper and newsprint on slow and narrow Fourdrinier machines while using rags as their feedstock.

In contrast, by 1930, the industry had changed drastically. Two large corporations, GNP and IP, managed by executives in Boston and New York, controlled nearly forty-five percent of the production capacity statewide, concentrated in a handful of massive integrated pulp and paper mills powered by giant hydro-electric developments. These facilities were no longer owned by local elites engaged in their communities, but were publicly traded corporations, owned by anonymous shareholders concerned only with "return on investment" and the dividends which that would yield.[40] Maine's pulp-and-paper industry was a part of the evolution of a broader forest economy which had begun with the extraction, transportation and manufacture of lumber. The location of early pulp and paper mills took advantage of this infrastructure and some sawmill towns became paper-mill towns. However, the great mills of the 1880s and 1890s required far more energy than the sawmills of an earlier age, and connecting hitherto unexploited water-power sites by railroad was also a part of the geographical changes in production from 1880 to 1930. Many smaller operators either failed or chose to sell out to their competitors. Only investors with deep pockets could compete as the scale of production and the sophistication of the technology grew over the years. There were local capitalists who had these resources and invested successfully in the industry, but the long-term trend was towards consolidation and control from intermediate cities such as Portland, to the great financial centers of Boston and New York.

Finally, the choice between a strategy of mass production or product differentiation not only influenced where a new plant would be located, but also determined if a plant would survive over the course of many decades. Minutes of board meetings would be needed to identify the timing and detail of particular choices, but it is reasonable to deduce such pathways from *Lockwood's* data on product types, using them as a proxy measure across the life courses of all mills across the state.

The statewide distribution of pulp and paper production at a particular moment in time is best understood by tracking the interaction of these factors at regular intervals at the mill level. Such an analysis can explain the rapid expansion and subsequent plateau of newsprint production in Maine, not just in terms of spruce-wood supply and the change in United States import tariffs, but also according to the Chisholm group investments in various ground-wood and newsprint facilities on the upper Androscog-

gin, and the subsequent consolidation of these mills into IP. Similar details emerge on the Kennebec and the Penobscot, where GNP created massive new production centers, and where IP failed to upgrade the smaller facilities it had acquired in 1898. By 1930, a discernable pattern emerged in the location of pulp and paper production, explained by the historical and geographic contingencies that determined mill location and survival over the previous five decades. In turn, the location of each of these large industrial complexes played an important role in the socio-economic landscape of Maine. Some mills, such as that of S.D. Warren in Westbrook or Eastern Manufacturing in Brewer, reinforced the economic vitality of established the urban centers of Portland and Bangor, respectively. And some other mills determined the economic fortunes of remote mill towns, such as Solon, Madison, Livermore Falls, and Lincoln, as the demographic patterns established by the nineteenth-century lumber industry were rearranged in the twentieth. Also notable were great mill towns located deep in the woods, such as Rumford and the two Millinockets, whose establishment and growth stemmed exclusively from the pulp-and paper-industry.

As the fortunes of these paper-mill towns wane, we can reflect on the work of generations past and the lives they lived scattered about the storied woods and rivers of Maine. However, the towns in which they lived were not scattered randomly; rather, their formation and prosperity followed choices built upon and constrained by previous choices, emerging into a deliberate and unique pattern as revealed in these maps. Maine lives with this geographical legacy today.

## NOTES

1. For more on Maine's "pulp craze," see David C. Smith, *History of Papermaking in the United States (1691–1969)* (New York: Lockwood Publishing, 1970), 166.
2. Lloyd C. Irland, "Papermaking in Maine: Economic Trends from 1894 to 2000," *Maine History* 45, no. 1 (December 2009): 62–63.
3. Smith, *History of Papermaking.*
4. See Nancy C. Ohanian, *The American Pulp and Paper Industry, 1900–1940: Mill Survival, Firm Structure, and Industry Relocation* (Westport, CT: Greenwood Press, 1993) and Hannes Toivanen, "Waves of Technological Innovation: The Evolution of the U.S. Pulp and Paper Industry, 1860–2000," in Lamberg, Juha-Antti, and Jari Ojala, eds., *The Evolution of Global Paper Industry 1800–2050* (Dordrecht: Springer, 2012).
5. Irland, "Papermaking in Maine," 53–74.
6. See Richard W. Judd, "The Pulp and Paper Industry, 1865–1930" in Richard W. Judd, Edwin A. Churchill, and Joel W. Eastman, eds., *Maine: The Pine Tree State from Prehistory to the Present* (Orono, ME: University of Maine Press, 1995), 426–431.

7. See Stephen J. Hornsby, Lloyd C. Irland, and Richard W. Judd, "Pulp, Paper, and Power" [Plate 50] in Stephen J. Hornsby and Richard W. Judd, eds., *Historical Atlas of Maine* (Orono, ME: University of Maine Press, 2015).
8. *Lockwood's Directory of the Paper, Stationery and Allied Trades* [for the years 1880, 1892, 1900, 1909, 1921, 1930] (New York: Lockwood Trade Journal Company); The GIS was created using ArcInfo 9.3 (ESRI, © 2008). Representations of individual mills and their attributes were created in shapefile format before being stored in a relational database using the ESRI Personal Geodatabase model. Examples of Historical GIS scholarship can be found in Anne K. Knowles and Amy Hillier, eds., *Placing History: How Maps, Spatial Data, and GIS are Changing Historical Scholarship* (Redlands, CA: ESRI Press, 2008); For a more theoretical approach, see Alexander von Lunen and Charles Travis, *History and GIS: Epistemologies, Considerations and Reflections* (Dordrecht: Springer, 2013).
9. For a brief but comprehensive explanation of this technology, see Ohanian, *American Pulp and Paper Industry,* 183–192.
10. A. J. Valente, *Rag Paper Manufacture in the United States, 1801–1900: A History, with Directories of Mills and Owners* (Jefferson, NC: McFarland and Company, 2010), 89–102; Irland, "Papermaking in Maine," 62; Ohanian, *American Pulp and Paper*, 4–5; Judith A. McGaw, *Most Wonderful Machine: Mechanization and Social Change in Berkshire Paper Making, 1801–1885* (Princeton, NJ: Princeton University Press, 1992), 18–27.
11. Smith, *History of Papermaking*, 132, 136, 139.
12. An overview of this history can be found in Richard W. Judd, "Maine's Lumber Industry," in Judd et al., *Pine Tree State*, 265–275; Essential to understanding these geographies are Hans M. Carlson, Stephen J. Hornsby, and Richard W. Judd, "Lumbering" [Plate 31] and Stephen J. Hornsby, "Mill Towns" [Plate 47] in Hornsby et al., *Historical Atlas of Maine*; A fine explanation of this spatialized forest economy can be found in Graeme Wynn, *Timber Colony: A Historical Geography of Early Nineteenth Century New Brunswick* (Toronto: University of Toronto Press, 1981). (See especially the schematic figure 5.2, 119.) And see Graeme Wynn, "Commercial Structure of the Timber Trade" [Plate 11, Timber Production and Trade to 1850] in R. Louis Gentilcore, ed., *Historical Atlas of Canada, Volume II: The Land Transformed, 1800–1891* (Toronto: University of Toronto Press, 1993). Despite being situated in different political economies, the great rivers of Maine developed a natural and cultural landscape of lumbering similar to that in New Brunswick, enabling merchant concerns to exploit extensive forest resources well away from the coast as lumbermen worked their way up rivers and tributary streams.
13. See Judd, "Maine's Lumber Industry."
14. Smith, *History of Papermaking*, 166, 177–178.
15. John H. Clark and Stephen J. Hornsby, "Railroads" [Plate 43] in Hornsby et al., *Historical Atlas of Maine*; Source maps from Harold W. Leavitt, *Some Interesting Phases of the Development of Transportation in Maine* (Orono, ME: University of Maine Press, 1940). For an account of the evolution of this network, see Edward E. Chase, *Maine Railroads: A History of the Development of the Maine Railroad System* (Portland, ME: Southworth Press, 1926).
16. Smith, *History of Papermaking*, 158–160; S.D. Warren Company, *A History of the S.D. Warren Company, 1854–1954* (Westbrook, ME: [publisher not identified], 1954) 8–11, 19.

17. Smith, *History of Papermaking*, 158–160; S.D. Warren Company, *A History*, 8–21, 36–37; Maine Historic Engineering Record, "Dam No. 5, Cobbossecontee Stream, Gardiner, Maine, MHER No. 22," accessed 30 May 2010, http://www.kennebecriverartisans.com/kennebec.org/fks/historicrecords.html.
18. Smith, *History of Papermaking*, 155; *Lockwood's Directory*, 1880, 35.
19. Hugh J. Chisholm, "History of Papermaking in Maine, and the Future of the Industry" in *Twentieth Annual Report of the Bureau of Industrial and Labor Statistics for the State of Maine 1906* (Augusta, ME: Kennebec Journal Print, 1907), 162–163; *Lockwood's Directory*, 1880, 38; Smith, *History of Papermaking*, 156–158.
20. Each *Lockwood's* record lists the name of the company controlling the mill, the names of the company's officers, and in many cases, especially when the company's business was not conducted through a local post office, the company's address as well. This information provided the data to map the geography of management and control for each mill complex in the state.
21. Naomi R. Lamoreaux, *The Great Merger Movement in American Business, 1895–1904.* (Cambridge, MA: Cambridge University Press, 1985), 44–45.
22. Lamoreaux, *Great Merger Movement*, 16–26, 27–37.
23. Smith, *History of Papermaking*, 168–169.
24. Chisholm, in "History of Papermaking in Maine" gives an accurate, if somewhat self-serving, account of his work on the Androscoggin; Leather board is created from scraps of left-over leather from shoemaking or other manufacturing, pulped and fed through papermaking machinery to create a cheap leather substitute; Sherry Judd and Celina Nelke, "Jay and Livermore Falls, Pioneers in Paper Making," accessed 12 December 2014, http://www.mainememory.net/sitebuilder/site/2450/page/3934/display?use_mmn=1; "The Development of Rumford Falls," in *Sixteenth Annual Report of the Bureau of Industrial and Labor Statistics for the State of Maine 1902* (Augusta, ME: Kennebec Journal Print, 1903), 117–125.
25. By cross referencing *Lockwood's* with G. F. Bacon, *Portland, Its Representative Businessmen and Points of Interest* (Newark, NJ: Glenwood Publishing Company, 1891), it was discovered that the following firms all operated from 390 Congress Street: Androscoggin Paper Company, Otis Falls Pulp Company, Umbagog Pulp Company, Rumford Falls Paper Company, Sebago Wood Board Company, and United Indurated Fibre Company; Lamoreaux, *Great Merger Movement*, 44–45.
26. Smith, *History of Papermaking*, 166–170.
27. Smith, *History of Papermaking*, 166–170; *Moody's Analyses of Investments, Industrials* (New York: Moody's Investors Service, 1915), 1163.
28. Smith, *History of Papermaking*, 171–175.
29. J.E. McCleod, "The Northern Development Company" [chapter 7] in *The Great Northern Paper Company* [unpublished manuscript] (1974), 1–2 in "John E. McCleod Papers," box 59, folder 23, *Great Northern Paper Company Papers, Series V*, Special Collections, Raymond H. Fogler Library, University of Maine, Orono, ME; The Bangor men were James Rice, Millard E. Mudget, Joseph P. Bass, and Thomas Hegarty. Clarence S. Lunt, a Maine timberland owner based in Rochester, New York, rounded out the group. Completion of this phase of investment also required the later involvement of the Bangor-based brothers H. A. and F. H. Appleton, as well as the Prentiss estate; McCleod, "Northern Development Company," 2–3.
30. McCleod, "Northern Development Company," 8.

31. This story is outlined in more detail in McCleod, "Northern Development Company," 1–39. Supporting primary documentation of the various contracts and partnerships can be found in "Schenk–Mullen agreements, 1896–1899: Schenk, Mullen, Haskell, Paine papers, 1896–1913" in sub-series 1, box 13, folder 4, *Great Northern Paper Company Papers, Series I*, Special Collections, Raymond H. Fogler Library, University of Maine, Orono, ME.
32. Judd, "The Pulp and Paper Industry, 429.
33. Irland, "Papermaking in Maine," 54.
34. G. S. Withham, *Modern Pulp and Papermaking: A Practical Treatise* (New York: Chemical Catalog Company, 1920). Witham, identified as a plant manager for the Union Bag and Paper Company, was a mill operator of long experience; Witham outlines other categories, such as construction papers and tissue papers, but these were either not found in Maine or were produced in the state by methods that fall into the "specialty papers" category; United States Federal Trade Commission, *Report of the Federal Trade Commission on the News-print Paper Industry* (Washington, DC: Government Printing Office, 1917). A standard "machine finish" was applied by a calander stack to smooth the surface and allow for the general application of ink. It is by that criteria that we define simple "book paper." Paper products that required specialty pulps and finishes, such as "sized and supercalandered" paper, in which a specialty calander stack is heated and fitted with different surfaces with which to smooth the finished paper, are categorized as "specialty paper."
35. *Lockwood's Directory*, 1930, 118–125.
36. Chisholm, "History of Papermaking in Maine," 163–164.
37. *Lockwood's Directory*, 1909; Thomas Heinrich, "Product Diversification in the U.S. Pulp and Paper Industry: The Case of International Paper, 1898–1941," *The Business History Review* 75, no. 3: 475.
38. Lamoreaux, *Great Merger Movement*, 26; Smith, *History of Papermaking*, 195; As revealed by the *Lockwood's* data from 1892 to 1900.
39. "Pulp and Paper Manufacture" in H.E. Mitchell and B.V. Davis, compilers, *The Jay Register, 1905* (Brunswick, ME: H. E. Mitchell Co., 1905), 30–31.
40. While GNP was incorporated in Maine and listed corporate offices in New York in *Lockwood's*, it was actually run by Schenk and a small corporate team in a suite of offices at 201 Devonshire in the Boston Safe Deposit and Trust Company Building in Boston. This subterfuge was discovered by the tax authorities in Massachusetts only after the murder of GNP's then President, William A. Whitcomb by a disappointed job seeker in 1946. See J. E. McCleod, "Boston" [chapter 14] in *The Great Northern Paper Company* [unpublished manuscript] (1974), 1–2 in "John E. McCleod Papers," box 60, folder 7, *Great Northern Paper Company Papers, Series V*, Special Collections, Raymond H. Fogler Library, University of Maine, Orono, ME.