United States Department of Agriculture

Forest Service

Forest Products Laboratory

Research Paper FPL–RP–602

United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970–2000

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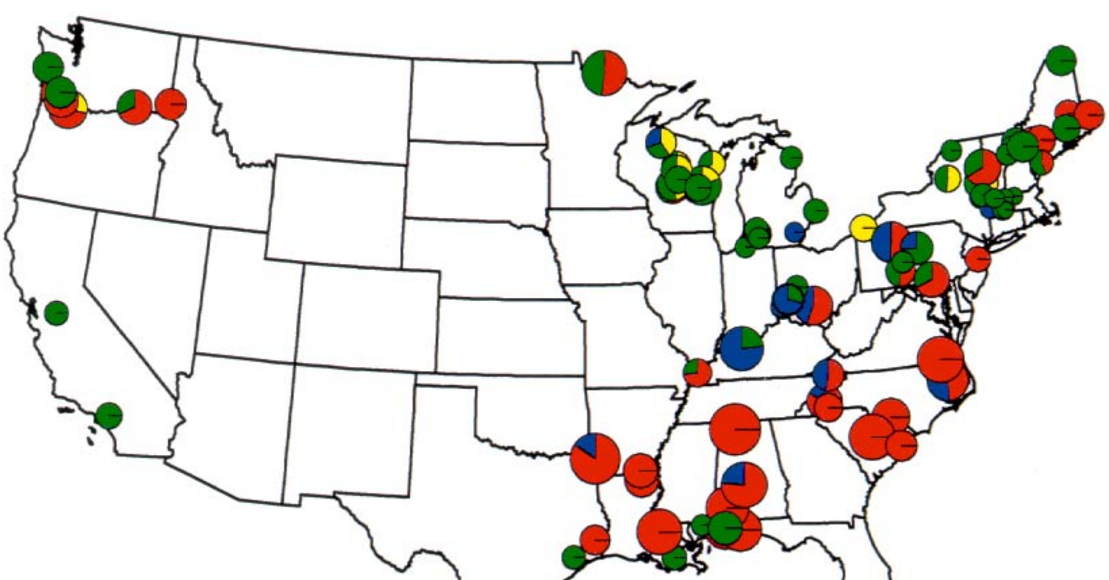

Abstract

This report presents a relational database with estimates of annual production capacity for all mill locations in the United States where paper, paperboard, or market pulp were produced from 1970 to 2000. Data for more than 500 separate mill locations are included in the database, with annual capacity data for each year from 1970 to 2000 (more than 17,000 individual data records). Numeric code, company name, city, state, region, and local postal ZIP code are included in the database. Capacity estimates are given for each of 12 principal categories of paper or paperboard commodities as well as different categories of market pulp. Capacity data at each mill location are further differentiated by process type within each category of paper or paperboard; for example, capacity based on recycled fiber is differentiated from capacity based on wood pulp. Estimates of mill capacity by process were derived from industry directories, corporate reports, trade journal articles, and other sources. This report provides documentation of the capacity database and a summary of capacity trends by commodity category, process, and region. The report includes tabulations and charts of annual capacity trends and also maps of capacity by commodity, process, and location for 1970 and 2000. By illustrating shifts in capacity, the report describes some of the more significant changes that have occurred in pulp and paper technology during the past several decades.

October 2001

Ince, Peter J.; Li, Xiaolei; Zhou, Mo; Buongiorno, Joseph; Reuter, Mary R. 2001. United States paper, paperboard, and market pulp capacity trends by process and location, 1970–2000. Res. Pap. FPL-RP-602. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 36 p.

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The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

Acknowledgments

The authors acknowledge contributions of former FPL employees and University of Wisconsin students who assisted in compilations of data for the capacity database. These include Jeff Lehmann, Kevin Check, and Mike Collet, who developed an earlier version of the database in 1996 with data from 1970 to 1995.

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United States Paper, Paperboard, and Market Pulp Capacity Trends by Process and Location, 1970–2000

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Introduction

This report provides a detailed data reference for capacity trends of the pulp and paper industry in the United States based on a compilation of individual mill and process data from 1970 to 2000. Capacity estimates by mill location and process type were derived from industry directories (Paperloop Publications 2000), from other industry sources (Miller–Freeman 1999), and from corporate reports, trade journal articles, and other sources (for example, equipment suppliers). To illustrate capacity changes in meaningful detail, the sector is divided into commodity categories within three broad commodity groups: paper, paperboard, and market pulp. The data presented in this report are compared with industry capacity data compiled and published by the American Forest & Paper Association (AF&PA 2000). The AF&PA data are regarded as the basic reference for actual industry capacity. However, unlike the data described in this report, the AF&PA capacity data are available at the aggregate national and regional levels only by product category and not by mill location or process type.

The paper commodity group includes eight conventional categories: newsprint, four categories of printing and writing paper, tissue and sanitary paper products, unbleached kraft paper, and other specialty packaging and industrial paper products. The paperboard commodity group includes four conventional commodity categories: linerboard and corrugating medium, solid bleached board, and other recycled paperboard. A more detailed description of each commodity category is provided in this report. The market pulp commodity group includes primarily hardwood and softwood kraft market pulp, deinked market pulp based on recycled fiber, and relatively small amounts of bleached chemithermomechanical market pulp (CTMP) and cotton linter pulp. These commodities are produced generally for use in papermaking. In addition, the market pulp commodity group includes dissolving pulp (or so-called special alpha pulp), which is also sold in the global pulp market but typically used in processes other than papermaking, such as in production of synthetic rayon and other cellulose polymers.

Although total capacity among these commodity groups has generally increased during the past 30 years, each commodity has distinctly different growth patterns. To illustrate this point, we discuss and present the data trends for each commodity separately. We provide a general description of each commodity and present data on total capacity in the United States plus detailed information on changes in capacity by process and region from 1970 to 2000. All information is based on data for individual mills. By aggregating mill data geographically, we can also derive capacities by States or regions as well as their changes with time.

The data were organized in a relational database[1] using Lotus Approach (Lotus Development Corporation, Cambridge, MA). The database permits quick retrieval of capacity data by organizational topic, such as capacity by year, product, process, or State or region. The mill capacity database, referred to in this report as the FPL–UW database, is maintained at the USDA Forest Service, Forest Products Laboratory (FPL) in Madison, Wisconsin, in collaboration with the University of Wisconsin–Madison.

[1]A copy of the database file (.dbf file) may be obtained by contacting the senior author.

Database Conventions and Structure

All capacity data contained in the FPL–UW database and discussed in this report are in thousands of short tons per year (1 short ton = 0.9072 metric ton). Generally, paper and paperboard production capacity refers to machine-dry weight (dry weight basis), whereas pulp capacity refers to air-dry weight (conventionally assumed to be 10% moisture content on a total weight basis). Data from the various sources were sometimes in other units of measure, such as metric tons. These were converted into thousands of short tons according to international conventions. Data were collected for each year from 1970 to 2000. The year 1970 thus serves conveniently as the base year for comparison of capacity changes with time in this report, although the database permits comparison of data among all years from 1970 to 2000.

Within the database, there is a data record for each mill location and each year, and the data record includes company name, city, state, ZIP code, and capacity estimates by process type for each product category. Altogether there are more than 17,000 data records in the database. An example of mill data records in the FPL–UW database is shown in Table 1, illustrating capacity records for one mill located in Albany, Oregon. The database indicates that an operational mill existed at this same location for more than 30 years. However, ownership of the mill changed in 1981, from Western Kraft Corporation to Willamette Industries, Inc. The data indicate also that the mill has been a producer of containerboard (kraft linerboard and corrugating medium) and unbleached kraft paper.

The capacities for each commodity category changed substantially with time at the Albany mill. For corrugating medium, the data indicate that the mill's capacity was integrated with the semichemical pulping process in the early 1970s (the term integrated in this report means that papermaking capacity is combined with pulping capacity at the same facility or mill location). Nationwide, production capacity for corrugating medium gradually shifted from semichemical pulp to recycled fiber. At the Albany mill, corrugating medium capacity based on recycled fiber appeared around 1977. However, in 1992, the mill ceased production of corrugating medium altogether. The mill also produced linerboard throughout 1970 to 2000 using primarily kraft pulp (with some use of recycled fiber). Beginning in the early 1980s, a major nationwide shift in kraft linerboard technology occurred with proliferation of newer types of press technology (wide-nip, shoe press, or high intensity pressing). Linerboard at the Albany mill was produced with old press technology until around 1987–1988, when this new press technology was introduced. The Albany mill has also produced unbleached kraft paper throughout 1970 to 2000, and in that case, kraft pulp has always been used.

From such detailed capacity data for all U.S. mill locations, we derived trends in capacity by process and region for each commodity group in the United States. Trends in capacity by process and region serve to document significant technological changes and shifts in capacity by commodity group. In addition, using the mill capacity database, we also computed capacity distributions by mill size to demonstrate changes in concentration and scale of production. Finally, we used the FPL–UW database to aggregate mill capacity data geographically and to map locations of mill capacity by commodity and process type, illustrating changes in capacities among States and regions during the past 30 years.

Geographic Presentation of Data

The geographic presentation of the data in this report illustrates shifts in capacity by process and location between 1970 and 2000. This was accomplished by mapping locations of U.S. mills in 1970 and in 2000, showing in each case the relative amount of capacity by proportional map symbols. The map symbols are also small pie charts that illustrate the distribution of capacity by process type at each mill location. Thus, the maps illustrate not only shifts in location of mill capacity by product category but also some of the significant shifts in technology that have occurred in recent decades, such as the shift toward more recycling capacity. Separate maps were produced for each of the following 13 principal commodity categories:

- newsprint
- uncoated free sheet
- coated free sheet
- uncoated groundwood
- coated groundwood
- tissue and sanitary
- specialty packaging and industrial paper
- kraft packaging paper
- linerboard
- corrugating medium
- solid bleached board
- recycled board
- market pulp

All mill capacities illustrated in the maps were derived from the FPL–UW mill capacity database. Similar maps can be produced for any year from 1970 to 2000.

Table 1—An example of annual mill capacity data records in the FPL–UW database for one mill location

					Capacity (thousand short tons)								
					Corrugating medium		Linerboard			Unbleached kraft paper		
Year	City	State	Company	ZIP	Semi chemi-cal	100% recycled	Old press technology	New press technology	100% recycled	Integrated with kraft pulp	100% recycled	Total
1970	Albany	OR	Western Kraft Corp	97321	66	0	169	0	0	23	0	258
1971	Albany	OR	Western Kraft Corp	97321	66	0	169	0	0	23	0	258
1972	Albany	OR	Western Kraft Corp	97321	66	0	231	0	0	32	0	329
1973	Albany	OR	Western Kraft Corp	97321	66	0	188	0	0	26	0	280
1974	Albany	OR	Western Kraft Corp	97321	66	0	188	0	0	26	0	280
1975	Albany	OR	Western Kraft Corp	97321	66	0	188	0	0	26	0	280
1976	Albany	OR	Western Kraft Corp	97321	66	0	188	0	0	26	0	280
1977	Albany	OR	Western Kraft Corp	97321	66	5	199	0	0	27	0	297
1978	Albany	OR	Western Kraft Corp	97321	66	17	235	0	0	32	0	350
1979	Albany	OR	Western Kraft Corp	97321	66	17	235	0	0	32	0	350
1980	Albany	OR	Western Kraft Corp	97321	66	17	235	0	0	32	0	350
1981	Albany	OR	Willamette Industries Inc	97321	66	21	246	0	0	34	0	367
1982	Albany	OR	Willamette Industries Inc	97321	70	21	246	0	0	34	0	371
1983	Albany	OR	Willamette Industries Inc	97321	66	33	236	0	0	32	0	367
1984	Albany	OR	Willamette Industries Inc	97321	66	33	236	0	0	32	0	367
1985	Albany	OR	Willamette Industries Inc	97321	66	33	236	0	0	32	0	367
1986	Albany	OR	Willamette Industries Inc	97321	66	33	236	0	0	32	0	366
1987	Albany	OR	Willamette Industries Inc	97321	66	33	148	87	0	32	0	366
1988	Albany	OR	Willamette Industries Inc	97321	66	33	0	277	0	38	0	414
1989	Albany	OR	Willamette Industries Inc	97321	66	33	0	277	0	38	0	414
1990	Albany	OR	Willamette Industries Inc	97321	64	27	0	277	0	38	0	406
1991	Albany	OR	Willamette Industries Inc	97321	64	27	0	277	0	38	0	406
1992	Albany	OR	Willamette Industries Inc	97321	64	27	0	377	0	50	0	518
1993	Albany	OR	Willamette Industries Inc	97321	0	0	0	385	0	50	0	435
1994	Albany	OR	Willamette Industries Inc	97321	0	0	0	378	0	50	0	428
1995	Albany	OR	Willamette Industries Inc	97321	0	0	0	421	0	50	0	471
1996	Albany	OR	Willamette Industries Inc	97321	0	0	0	471	0	50	0	521
1997	Albany	OR	Willamette Industries Inc	97321	0	0	0	501	0	50	0	551
1998	Albany	OR	Willamette Industries Inc	97321	0	0	0	504	0	50	0	554
1999	Albany	OR	Willamette Industries Inc	97321	0	0	0	518	0	50	0	568
2000	Albany	OR	Willamette Industries Inc	97321	0	0	0	554	0	50	0	604

Regions

In this report, reference is made to three large U.S. regions, the North, the South, and the West. Figure 1 shows the precise definition of each large region. Also, the maps in this report generally show the outline of State borders across the United States. Because there were no mills located in Hawaii and historically only two market pulp mills in Alaska, these two States are not shown in the maps of this report.

Geocoding

When data are geocoded, they are allocated to a location on the map according to geographic attributes, for example by longitude and latitude or by postal ZIP code. The capability to map geocoded data is a common built-in function of many computerized mapping systems and geographic information systems (GIS). In this study, the postal ZIP code was used to geocode each mill. After the data are geocoded, each mill can

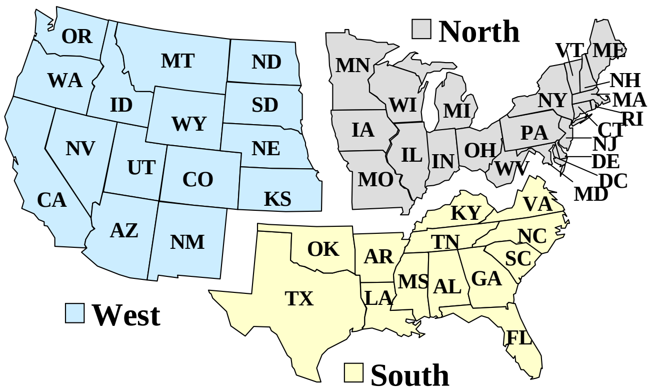

Figure 1—Mill capacity regions in the United States.

be positioned automatically at its location using appropriate desktop computer mapping software, in this case ATLAS GIS, version 3.0 (Environmental Systems Research Institute, Redlands, California).

Pie Charts

The capacity of each mill and its distribution by process was illustrated on the map by a proportionately scaled pie chart, using the ATLAS GIS Charts on Maps feature. On the maps, the proportional size of the pie chart represents the amount of total capacity at each mill location, and the distribution of capacity by process type is represented by slices of the pie, drawn to scale and color-coded. Thus, each map displays an array of spatial features and other information—locations of mills by commodity category and relative scale of capacity by geographic location, as well as the distributions of capacity by process type.

Spatial–Temporal Analysis

Because both capacity and process types change with time, they can be portrayed temporally as well as spatially. Spatial and temporal features can be combined into a single analysis model, as in the work of Kurttila (2001), Naesset (1997), and Loehle (2000). At FPL, the principal application of the FPL–UW database is in economic modeling, specifically as a source of reference data for an analytic approach to modeling and projecting capacity change by commodity, process, and region with time. In that application, the capacity data are first calibrated to the published AF&PA capacity data at the national level (and at the regional level for the years that AF&PA published regional capacity data). Essentially, the data in the FPL–UW database are used to determine the regional distributions of capacity by process type, within each commodity category, whereas the AF&PA capacity data are used to determine the aggregate capacity for each commodity category. Econometric techniques are used to establish relationships between capacity change and economic parameters with time.

In this report, shifts in capacity are shown in charts and on maps for the years 1970 and 2000, with separate maps for each commodity category. Comparison of the maps for 1970 and 2000 provides an explanation and a direct illustration of spatial–temporal shifts in capacity. However, the aggregates of annual capacity data in the FPL–UW database coupled with econometric methods provide the basis for a more detailed economic explanation for shifts in capacities by region and process type with time. (This will be the subject of subsequent research and is beyond the scope of this report.)

Map Discussion

By comparing two maps at different points in time, changes in the magnitude and locations of capacity are clearly apparent. Although the data are not given quantitatively, it is usually readily apparent on the maps where significant increases or decreases in capacity have occurred and also where capacity shifted from one process type to another. Nevertheless, interpretation of maps is sometimes an incomplete or inaccurate source of quantitative information and is sometimes even misleading due to the abundance of visual information, especially if some changes are relatively small and difficult to see. This shortcoming must be overcome by using quantitative data to analyze capacity distributions and changes in capacity with time.

Comparison With Industry Capacity Data

To test the accuracy of the mill-based capacity data, we compared our aggregated data at the national level with nationwide industry capacity data published by the leading industry trade association, the American Forest & Paper Association. The AF&PA capacity data are based primarily on surveys of member company mills. The AF&PA capacity survey is published annually with capacity reported by commodity category, although data are not publicly available at the mill level or by process type. Nevertheless, Figure 2 shows that the total U.S. paper and paperboard capacity from the FPL–UW database closely emulates the AF&PA data from 1970 to 2000.

Table 2 reports differences between aggregate data in the FPL–UW database and published AF&PA capacity data for paper, paperboard, market pulp, and in total. The largest difference in total capacity, 2.9%, occurred in 1988. For most years, the difference is less than 1%. Among paper, paperboard, and market pulp, differences were rarely more than 5% (Table 2). The largest differences occurred for market pulp. Some differences are expected to occur because of differences in estimation and reporting methods. For example, the FPL–UW database includes the rated capacity of each mill for every year in which the mill was in operation whether or not it was in operation for the entire year.

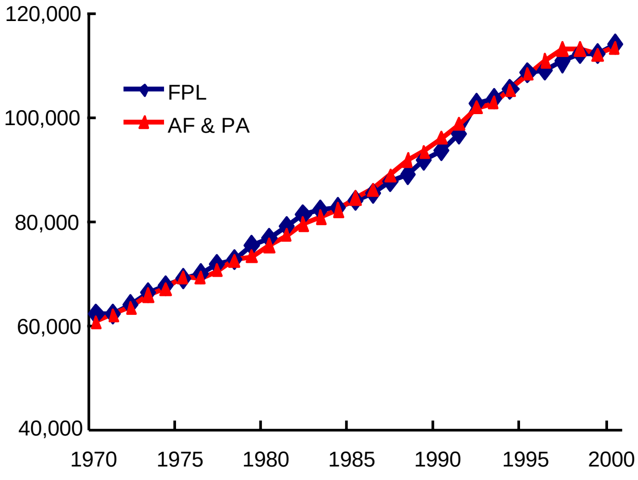

Figure 2—Total U.S. capacity of paper, paperboard, and market pulp (thousand short tons), according to FPL–UW database and AF&PA annual capacity report.

Table 2—Differences in U.S. capacity between FPL–UW database and AF&PA capacity reports[a]

	Difference (fractional)			
Year	Paper	Paperboard	Market pulp	Total
1970	0.019	0.063	(0.120)	0.022
1971	0.007	0.031	(0.140)	0.000
1972	0.008	0.026	(0.058)	0.009
1973	0.008	0.018	(0.038)	0.007
1974	0.011	0.017	(0.031)	0.009
1975	0.008	(0.007)	(0.038)	(0.004)
1976	0.011	0.026	(0.047)	0.011
1977	0.011	0.027	0.005	0.018
1978	0.005	0.014	(0.049)	0.003
1979	0.021	0.044	0.003	0.029
1980	0.015	0.034	(0.015)	0.020
1981	0.007	0.048	(0.024)	0.021
1982	0.022	0.032	(0.007)	0.023
1983	0.03	0.020	(0.031)	0.018
1984	0.013	(0.000)	0.002	0.006
1985	(0.004)	(0.005)	(0.005)	(0.004)
1986	0.004	(0.020)	(0.003)	(0.007)
1987	0.002	(0.020)	(0.044)	(0.014)
1988	(0.017)	(0.022)	(0.098)	(0.029)
1989	(0.002)	0.004	(0.079)	(0.019)
1990	(0.000)	(0.017)	(0.146)	(0.025)
1991	0.002	(0.015)	(0.129)	0.021
1992	0.012	0.009	(0.006)	0.006
1993	0.019	0.007	(0.017)	0.009
1994	0.006	(0.017)	0.045	0.000
1995	0.018	(0.013)	0.013	0.003
1996	0.008	(0.054)	0.039	(0.017)
1997	0.002	(0.061)	0.047	(0.023)
1998	0.018	(0.047)	0.065	(0.042)
1999	0.003	(0.024)	0.025	0.001
2000	0.005	(0.005)	0.079	0.007

[a]Entries in parentheses are negative values.

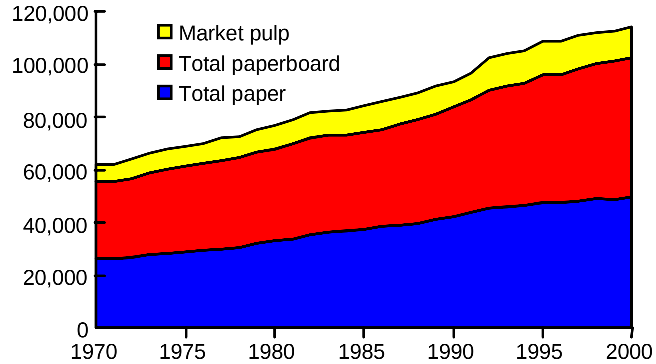

Figure 3—The capacity of paper, paperboard, and market pulp in the United States (thousand short tons) (FPL–UW database).

However, the AF&PA data refer to "practical maximum capacity," which may include changes in capacity for a portion of a year in which they are effective. Also, the AF&PA data generally retain for 12 months the capacities of mills that were shut down, whereas the FPL–UW database generally shows such capacities dropping to zero immediately in the year subsequent to closure (1 to 12 months after shut down).

Capacity Trends for Paper, Paperboard, and Market Pulp in the United States

Figure 3 shows that production capacity generally increased for paper, paperboard, and market pulp in the United States from 1970 to 2000, with an average compound annual increase of 2.1%. Nationwide capacity for the principal commodity groups all grew at nearly the same rate. Paper and market pulp capacity grew at 2.1% annually from 1970 to 2000, while paperboard grew at 2.0% per year.

In addition, as shown in Table 3, the rate of increase in capacity was generally decelerating with time (slower growth in the decade of the 1990s than in the 1970s). From 1970 through 1980, the annual growth rate of the total capacity for paper, paperboard, and market pulp was about 2.4%. It slowed to 1.9% from 1990 to 2000. This decelerating trend in growth occurred for all three principal commodity groups, but the slowdown in capacity growth was more pronounced for the paper commodities than for paperboard commodities.

Table 3 also illustrates another significant aspect of capacity change—expansion was not simply the result of capacity addition but rather it was the result of a greater rate of capacity addition than capacity reduction. Capacities expanded at some existing mills by the building of new machines or the improvement of existing machines. Also, some entirely new mills were built (so-called greenfield mills). At the same time, however, capacity declined at some existing mills, as some of their machines were taken out of production, while other mills were closed altogether.

Table 3—Capacity addition and reduction in the United States (1970–2000)[a]

Grades	1970–1980				1990–2000			
	Capacity (thousand short tons)			Average annual growth (%)	Capacity (thousand short tons)			Average annual growth (%)
	Addition	Reduction	Net gain or loss		Addition	Reduction	Net gain or loss	
Total paper, paperboard, and market pulp	26,742	11,763	14,979	2.4	43,249	25,370	17,879	1.9
Total paper	11,613	4,924	6,689	2.5	18,469	11,786	6,683	1.9
Newsprint	1,782	381	1,401	3.7	2,097	1,424	672	1.0
Printing and writing paper	6,011	2,180	3,831	3.2	11,914	6,527	5,387	2.0
Uncoated groundwood	638	510	128	1.1	1,066	1,028	38	0.2
Coated groundwood	948	431	517	2.6	1,758	1,299	459	1.1
Uncoated freesheet	3,253	975	2,277	3.4	6,328	2,834	3,484	3.0
Coated freesheet	1,172	264	908	4.0	2,762	1,366	1,396	3.0
Packaging and industrial converting[b]	2,203	1,482	721	1.3	2,155	2,719	–564	–1.0
Tissue	1,617	881	736	1.3	2,303	1,116	1,188	0.3
Total paperboard	11,233	5,491	5,741	1.9	17,912	8,389	9,523	2.3
Containerboard	8,679	3,238	5,414	3.2	13,120	4,364	8,756	3.0
Linerboard	5,831	1,736	4,068	3.1	8,784	2,609	6,175	3.0
Corrugating medium	2,848	1,502	1,346	2.8	4,336	1,755	2,581	3.4
Other paperboard[c]	2,554	2,253	301	0.3	4,792	4,025	767	1.0
Total market pulp	3,896	1,348	2,548	3.4	6,868	5,195	1,673	1.7

[a]Expansion includes both expansion of existing machines and building of new machines.
[b]Includes kraft and specialty paper.
[c]Includes recycled linerboard and solid bleached board.

The database also documents the increasing share of production capacity based exclusively on recycled fiber (100% recycled fiber). Figure 4 shows the percentage of capacity that is based exclusively on recycled fiber during the past 30 years. These numbers do not capture all of the recycling capacity of the industry because a large quantity of recycled fiber is also blended in with processes that are based primarily on wood pulp, but the industry is increasingly relying on recycled fiber. In 1970, industry capacity based exclusively on recycled fiber was no more than 5,310 thousand tons per year. By the year 2000, it had increased to 21,811 thousand tons per year, a four-fold increase compared with 1970. Most of the gain took place after the late 1980s. Capacity based exclusively on recycled fiber grew at more than 10% per year during the past 30 years, much more rapidly than capacity based on virgin wood pulp.

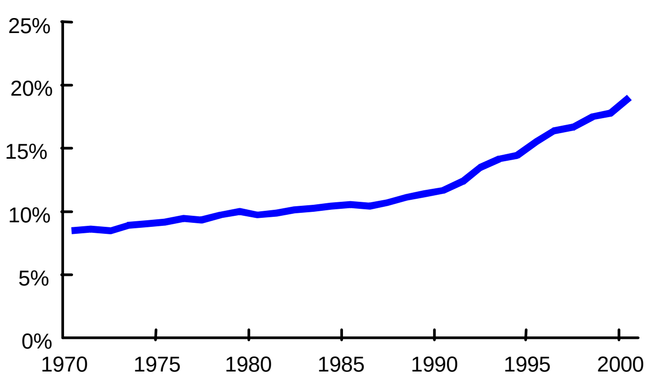

Figure 4—Share of production capacity based exclusively on recycled fiber in the United States.

Capacity Trends by Commodity, Process, and Region

The 13 principal commodity categories recognized in the FPL–UW database are generally differentiated by end use markets as well as by process type. Table 4 summarizes aggregate U.S. capacity of paper and paperboard by commodity category, from 1970 to 2000, according to the FPL–UW database. As explained previously, capacity totals from the FPL–UW database differ somewhat from published industry capacity data because of differences in estimation and reporting methods, but aggregate trends in the FPL–UW database generally follow the trends in actual industry capacity as reported by AF&PA. Furthermore, the database reveals trends in capacity by process and region, as well as by

Table 4—Aggregate U.S. annual capacities of paper, paperboard, and market pulp by commodity category according to FPL–UW mill capacity database

	Capacity (thousand short tons)																
		Paper									Paperboard						
				Printing and writing paper					Packaging and industrial paper								
Year	Total paper and paper-board	Total paper	News-print	Uncoated ground-wood	Coated ground-wood	Uncoated freesheet	Coated freesheet	Tissue and sanitary paper	Unbleached kraft paper	Specialty	Total paper-board	Liner-board	Other recycled paperboard	Solid bleached paperboard	Corrugating medium	Market pulp
1970	55,656	26,302	3,793	1,144	2,006	6,761	2,258	4,701	3,666	1,974	29,354	12,949	7,383	4,253	4,769	6,376
1971	55,653	26,309	3,783	1,145	2,011	6,770	2,258	4,701	3,666	1,976	29,343	12,944	7,383	4,247	4,769	6,415
1972	56,851	26,765	3,860	1,151	2,049	6,862	2,335	4,756	3,669	2,083	30,086	13,187	7,440	4,214	5,246	7,065
1973	58,716	27,601	3,933	1,205	2,071	7,093	2,399	4,925	3,840	2,136	31,114	13,601	7,623	4,311	5,580	7,514
1974	60,258	28,250	4,121	1,133	2,119	7,343	2,480	4,921	3,923	2,212	32,008	14,170	7,628	4,368	5,841	7,493
1975	61,590	28,849	4,178	1,262	2,240	7,230	2,684	4,926	3,967	2,361	32,742	14,830	7,671	4,247	5,994	7,455
1976	62,447	29,526	4,168	1,324	2,253	7,773	2,672	4,938	3,992	2,406	32,920	14,680	7,928	4,422	5,890	7,534
1977	63,629	30,191	4,265	1,263	2,325	7,959	2,746	5,090	4,077	2,464	33,438	15,075	7,941	4,570	5,851	8,147
1978	64,719	30,507	4,155	1,340	2,434	8,187	2,908	5,178	3,815	2,490	34,212	15,351	7,854	4,656	6,350	8,090
1979	66,727	31,825	4,774	1,342	2,388	8,540	3,017	5,468	3,820	2,477	34,902	16,159	7,837	4,531	6,374	8,695
1980	68,001	33,028	5,193	1,272	2,523	9,038	3,166	5,459	3,961	2,415	34,973	16,914	7,363	4,581	6,115	8,845
1981	70,061	33,929	5,629	1,336	2,562	9,460	3,009	5,316	4,072	2,545	36,132	17,609	7,436	4,638	6,449	9,100
1982	72,112	35,460	6,049	1,358	3,028	9,536	3,523	5,396	4,056	2,513	36,652	17,957	7,322	4,701	6,672	9,349
1983	72,948	36,492	6,343	1,354	2,999	9,568	3,619	5,425	4,139	3,046	36,456	17,853	7,260	4,721	6,623	9,315
1984	72,932	36,761	6,195	1,387	3,057	9,802	3,578	5,550	4,139	3,055	36,171	17,527	7,311	4,720	6,613	9,861
1985	73,985	37,439	6,118	1,430	3,296	10,315	3,656	5,585	3,924	3,115	36,546	17,784	7,227	4,771	6,765	10,219
1986	75,172	38,164	5,996	1,615	3,367	10,888	3,861	5,628	3,514	3,295	37,008	18,043	7,217	4,856	6,892	10,438
1987	77,460	39,147	5,864	1,613	3,829	11,626	3,734	5,688	3,529	3,262	38,313	18,952	7,429	4,902	7,030	10,270
1988	78,975	39,508	5,911	1,781	3,914	11,581	3,915	5,987	3,306	3,113	39,467	19,499	7,424	4,974	7,569	10,124
1989	81,227	41,068	6,298	1,811	3,995	12,026	3,970	6,239	3,376	3,353	40,159	20,049	7,578	5,041	7,491	10,419
1990	83,672	42,314	6,610	1,814	4,049	12,533	4,376	6,259	3,368	3,305	41,358	20,950	7,599	5,143	7,666	9,981
1991	86,340	43,878	7,142	1,848	3,907	13,172	4,584	6,521	3,432	3,272	42,462	21,795	7,688	5,336	7,644	10,417
1992	90,404	45,537	7,248	1,606	4,285	13,972	5,413	6,914	2,753	3,347	44,867	23,309	7,693	5,720	8,145	12,241
1993	91,748	46,027	7,150	1,610	4,347	14,411	5,384	7,085	2,685	3,355	45,721	23,618	7,923	5,761	8,420	12,164
1994	92,735	46,237	7,071	1,630	4,339	14,639	5,425	7,082	2,688	3,363	46,498	24,116	7,845	5,915	8,622	12,624
1995	95,935	47,518	7,595	1,709	4,382	15,436	5,052	7,168	2,818	3,358	48,417	25,177	7,845	6,095	9,299	12,769
1996	96,073	47,542	7,616	1,709	4,723	15,291	4,763	7,187	2,755	3,498	48,531	25,513	7,072	6,396	9,550	12,907
1997	98,125	48,110	7,359	1,898	4,818	15,391	5,079	7,280	2,683	3,602	50,015	26,676	7,002	6,631	9,706	12,576
1998	100,132	49,019	7,464	1,892	4,613	15,704	5,768	7,337	2,611	3,630	51,113	26,936	6,912	6,654	10,611	12,142
1999	101,192	48,817	7,279	1,874	4,541	15,968	5,856	7,259	2,658	3,381	52,376	27,708	7,223	6,724	10,721	11,103
2000	102,429	49,413	7,282	1,852	4,506	16,447	5,847	7,517	2,606	3,356	53,016	27,133	6,993	6,563	12,327	11,925

commodity category. The following sections describe capacity trends by process and region as revealed by the FPL–UW database.

Newsprint

Newsprint refers to the category of publication papers used mainly for printing daily newspapers, and also used to a smaller extent for advertising inserts, various other commercial printing applications, and some government publications. Newsprint is an uncoated paper product made from high-yield mechanical grades of wood pulp, such as thermomechanical pulp (TMP), chemithermomechanical pulp (CTMP), or groundwood pulp, often with a small fraction of bleached chemical pulp and also, increasingly, some recycled fiber, ranging up to 100% in some mills. Recycled fiber for newsprint is derived primarily from old newspapers (ONP) and to some extent from old magazines (OMG). Wood raw material for the refiner-based mechanical pulps (TMP and CTMP) is generally wood chips, although the older stone groundwood technology utilizes log bolts. Newsprint generally requires a high proportion of softwood fiber. This is because high-yield mechanical pulps tend to produce paper with less strength than, for example, chemical kraft pulp, but softwoods tend to have longer fibers than hardwood species. Longer fibers help provide sufficient sheet strength to avoid sheet breakage in high-speed printing presses.

In the early history of the United States, newsprint was often made with nonwood fiber from rags or straw, but use of wood fiber became increasingly prevalent in the late 19th and early 20th century along with development of the high-yield stone groundwood pulping technology. Also, from the 1920s onward, production of newsprint expanded rapidly in Canada primarily to serve U.S. markets, and eventually, Canada was producing well over half of U.S. newsprint requirements. In more recent decades, use of Southern Pine and recycled newsprint capacity was expanded, resulting in more of the newsprint production coming from the United States. Only a small fraction of U.S. newsprint capacity remains based on the old stone groundwood technology. Capacity expansion of recent decades was based primarily on more modern mechanical pulping technology (chiefly TMP, but also CTMP) as well as recycling and deinking technology. Newsprint in the United States is made mostly from mechanical pulp or recycled fiber, with some bleached chemical pulp added to improve sheet quality and performance in modern printing applications.

U.S. newsprint is usually produced in a basis weight of 30 lb (48.8 g/m^2), but it is available also in basis weights as low as 24 lb (39.5 g/m^2) and as high as 35 lb (56.9 g/m^2). Prior to 1974, the most common, or standard, basis weight for newsprint was 32 lb (52.1 g/m^2), but usage later shifted to 30 lb (48.8 g/m^2) to trim costs and conserve fiber (Miller–Freeman 1999). In 1995–1996, some leading U.S. newspapers also reportedly switched to a lighter weight 27-lb (43.9 g/m^2) newsprint.

Some products nearly identical to newsprint have higher brightness or a machine-calendered finish and are classified as uncoated groundwood paper (used for telephone directories and other commercial printing). Some paper machines (particularly those with soft-roll calenders or machine finishing capacity) can make a range of groundwood-based papers, including newsprint as well as calendered uncoated groundwood paper grades, and thus, capacity can fluctuate between these grades to a limited extent, depending on market conditions. Thus, there is some ambiguity and overlap in the reported capacities for newsprint and uncoated groundwood paper (discussed subsequently). Some of the groundwood paper grades and newsprint are so closely associated that it is often difficult to accurately determine actual capacity by mill location according to industry sources.

In the United States, the average amount of recycled fiber in newsprint used for newspapers increased from just 10% in 1989 to more than 28% in 1999 according to the Newspaper Association of America. In 1990, only one newsprint mill in Canada was reportedly producing newsprint made from recycled fiber, but more recently, 21 mills in Canada and 18 mills in the United States are reportedly using primarily recycled fiber (Miller–Freeman 1999).

On a per capita basis, U.S. newsprint consumption was increasing in the 1970s and early 1980s, but per capita consumption peaked during the late 1980s. During the past decade, growth in U.S. newsprint consumption was generally slower than growth in consumption of other paper commodities. Consequently, U.S. newsprint capacity increased from 7% of total U.S. paper and paperboard capacity in 1970 to nearly 9% in the early 1980s, but newsprint capacity receded back to 7% by 2000. As shown in Table 4, the FPL–UW database indicates that newsprint capacity increased from 3.793 million tons in 1970 to 7.282 million tons in 2000, peaking at around 7.6 million tons in the mid-1990s. By comparison, the AF&PA capacity survey indicates that actual U.S. newsprint capacity was 3.533 million tons in 1970 and 7.404 million tons in 2000, with a peak capacity of just more than 7.4 million tons in 1997. The AF&PA data indicate that actual U.S. newsprint capacity in recent years was about 2% less than the aggregate U.S. newsprint capacity shown in the FPL–UW database.

Figure 5 illustrates trends in U.S. newsprint capacity by region from 1970 to 2000. The South has dominated U.S. newsprint capacity with 56% of total capacity in 1970 and 57% in 2000, while newsprint capacity in the North receded from around 20% of U.S. capacity in 1970 to 11% in 2000. Capacity in the West rose from around 25% in the early 1970s to upwards of 35% in the early 1980s, but capacity in the West receded to around 32% in 2000.

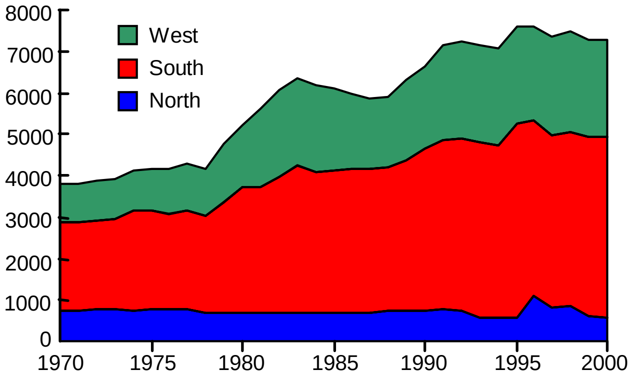

Figure 5—Regional capacity of newsprint in the United States (thousand short tons).

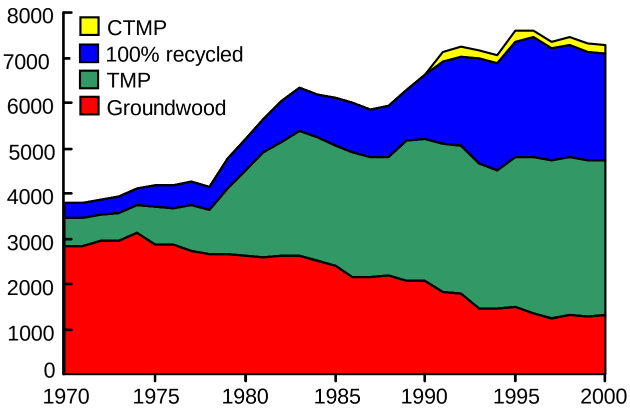

Figure 6—Newsprint capacity by process in the United States (thousand short tons).

Figure 6 illustrates trends from 1970 to 2000 in U.S. newsprint capacity by process, identifying four principal process types. The four process types include older stone groundwood pulp (usually blended with about 20% to 30% bleached chemical pulp), TMP (often blended with around 10% bleached chemical pulp), CTMP, and 100% recycled fiber. As noted previously, some recycled fiber is increasingly being blended with wood pulp at many newsprint mills that have used primarily wood pulp. Thus, even though 100% recycled newsprint accounts for one-third of U.S. newsprint capacity in the year 2000 according to the FPL–UW database, recycled fiber was about half of total fiber content overall in U.S. newsprint production (AF&PA 2000).

According to the FPL–UW database, the most significant apparent shifts in newsprint production technology included a shift in growth away from groundwood technology toward TMP capacity from the late 1970s to late 1980s and a subsequent shift toward capacity based on recycled fiber. The most rapid overall growth in newsprint capacity occurred for recycled newsprint, which grew from 0.331 million tons in 1970 to 2.384 million tons in 2000, an average annual compound growth of 6.8% per year. Newsprint capacity based on TMP grew a little more slowly at a compound growth rate of 5.8% per year, from 0.628 million tons in 1970 to 3.420 million tons in 2000. In addition, capacity based on CTMP appeared in the 1990s, but growth in CTMP capacity appears to have been limited by expansion of recycled newsprint capacity. Capacity based on the older groundwood pulping technology has generally declined since the mid-1970s. A number of mills using the groundwood process have incorporated more efficient pressurized groundwood technology. Thus, the stone groundwood process has not altogether disappeared, although newsprint capacity has shifted toward mechanical pulping processes based on mechanical refiners (the TMP and CTMP processes). Newsprint capacity based on the stone groundwood process decreased from 2.833 million tons in 1970 to 1.293 million tons in 2000. In addition, many U.S. newsprint mills that reportedly use the TMP process also employ some chemical pretreatment of wood chips in addition to steam pretreatment before refining, and thus, they may be using technology that effectively approaches CTMP.

Figure 7 gives the locations of U.S. newsprint capacity in 1970 and 2000, showing major shifts that have occurred in the regional distribution of newsprint capacity in recent decades. While U.S. newsprint capacity in recent decades was located primarily in the U.S. South, there was a significant shift in the South from the groundwood pulping process to the TMP process. By the year 2000, there was a more varied mix of processes in the South, with some capacity based on recycled fiber, groundwood pulp, and also CTMP. Newsprint capacity expansion in the West was based mainly on TMP and recycled fiber, whereas expansion in the North was based on recycling.

Coated and Uncoated Groundwood Papers

Coated and uncoated groundwood papers are two commodity categories within the broad group known as printing and writing paper (which includes also coated and uncoated free sheet paper). According to traditional industry standards, groundwood paper grades have mechanical pulp fiber content higher than 10% but lower than 65% (whereas newsprint has more than 65% mechanical pulp content according to the U.S. Harmonized Tariff Schedule). The term free sheet refers to paper grades that are produced primarily with low yield bleached chemical pulps, with generally less than 10% mechanical pulp content, thus largely free of lignin or wood particles commonly associated with mechanical pulp (hence the terms wood free or free sheet).

The term groundwood paper is now somewhat outdated because it simply refers in this context to paper produced with a substantial fraction of high yield mechanical pulp (but not necessarily groundwood per se). Capacity was based on stone groundwood in earlier times, but most U.S. groundwood paper capacity is now based on pulping

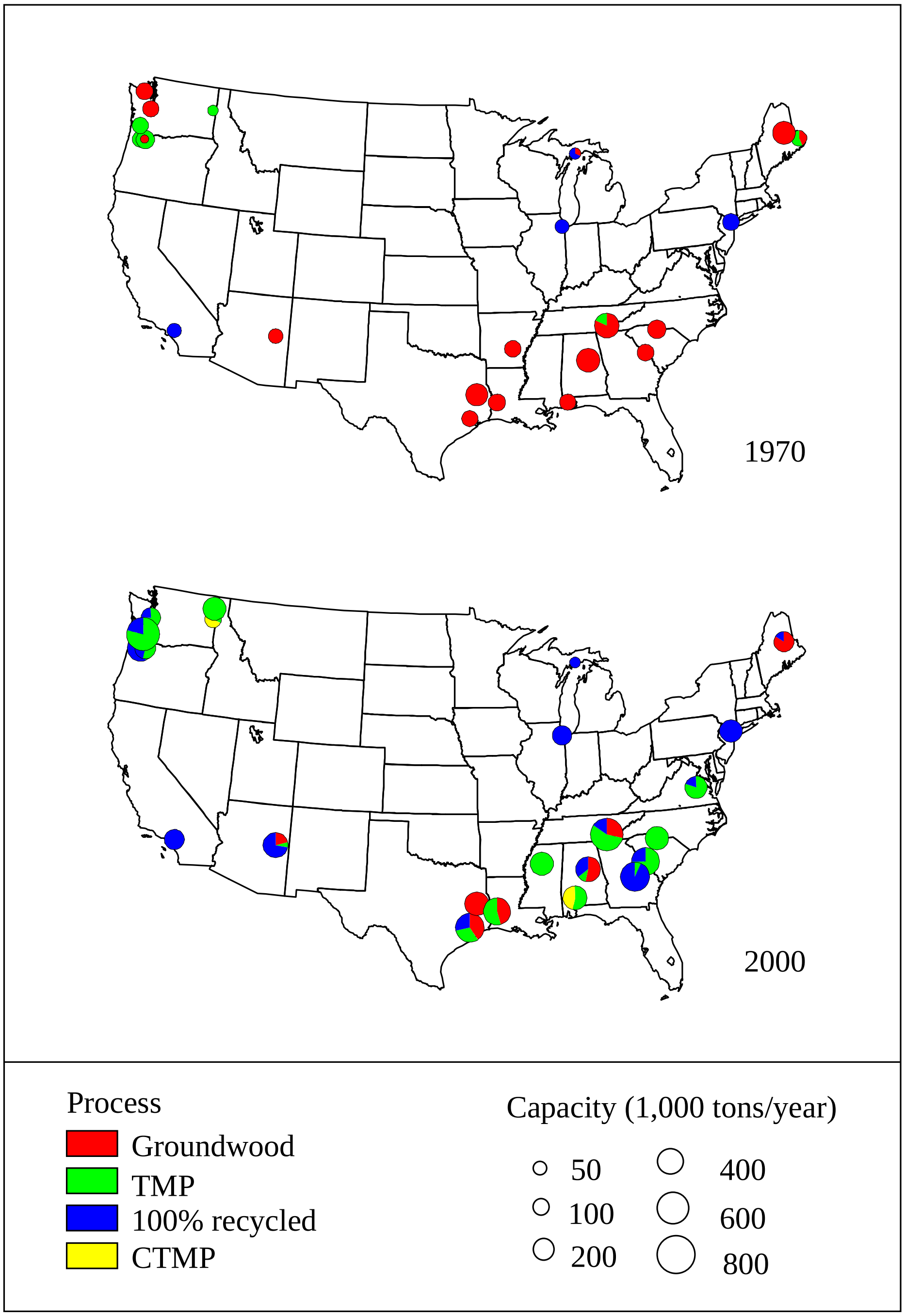

Figure 7—Location of newsprint capacity by process in the United States in 1970 and 2000.

technology using mechanical refiners (TMP or CTMP) rather than the stone groundwood process. Uncoated groundwood paper is also known as uncoated mechanical, for example.

While some uncoated groundwood paper grades are similar to newsprint, uncoated groundwood paper generally requires additional processing steps (such as machine calendering), lower mechanical pulp and higher chemical pulp content, and usually additional sheet fillers or pigments. Although newsprint typically contains very little inorganic fillers, uncoated groundwood paper may contain upwards of 10% inorganic filler and pigments by weight. Coated groundwood paper typically contains up to one-third inorganic coatings and fillers (primarily kaolin clay coatings to impart a smooth and glossy print surface for magazines). Surface sizing is also applied to some grades of uncoated groundwood paper to improve strength and impart water resistance. With higher bleached chemical pulp content, the uncoated groundwood paper grades have higher brightness levels than newsprint, ranging in brightness index from 62 to 72 according to the Elrepho test standard[2] compared with newsprint's typical range of 56 to 62 Elrepho (Miller–Freeman 1999). Coated groundwood paper grades have generally higher brightness, ranging typically from 68 to 84 Elrepho for lightweight coated paper for example, while free sheet paper grades generally have even higher brightness levels.

To some extent, technological advances and mill conversions are blurring traditional distinctions among products such as newsprint and groundwood paper grades. There is active competition for market share at the margins of these commodity categories. As discussed previously, some newsprint producers have equipped their machines to switch from standard newsprint to uncoated groundwood paper or higher quality products such as “smooth news” or “super news.” Although the magazine market in the United States has been served primarily by lightweight coated groundwood paper, producers of uncoated groundwood paper have been expanding in that market with supercalendered or glossy machine-finished grades.

Uncoated groundwood paper is used primarily in commercial printing and publication applications. The more traditional segments of the uncoated groundwood sector are directory paper (used commonly in telephone books, for example) and paperback book paper used in publication of inexpensive paperback books. Also widely used in commercial printing are so-called supercalendered publication papers, used primarily in publication of advertising inserts for newspapers, catalogs, some magazines, and in other rotogravure and offset commercial printing applications that do not require the sheet properties of coated paper or high brightness of free sheet paper.

Coated groundwood papers are represented by the No. 4 and No. 5 grades of coated paper (No. 1–3 are primarily coated free sheet). The No. 4 grade is made with mechanical pulp or a combination of mechanical and wood free chemical pulp. The No. 5 grade is usually a coated mechanical pulp product (with the pulp fraction consisting of usually at least 80% mechanical pulp). In either case, upwards of one-third of the product weight typically consists of clay coatings and fillers. Coated groundwood paper is generally coated on two sides and is used mostly for magazines, catalogs, advertising brochures and inserts, and other types of commercial printing. The term lightweight coated (LWC) is often used interchangeably with coated groundwood (CGW), though the range of basis weights for CGW grades is greater than that for LWC grades.

Uncoated groundwood paper capacity increased in the United States from 1.15 million tons in 1970 to 1.85 million tons in 2000 according to the FPL–UW database, an average compound annual growth rate of about 1.6% (Table 4). By comparison, data published in the AF&PA capacity surveys indicate that actual uncoated groundwood capacity was 1.23 million tons in 1970 and 2.04 million tons in 2000. After a fairly steady increase from 1970 to 1990, trends in U.S. uncoated groundwood paper capacity appear to have become more erratic in the 1990s according to the FPL–UW database. Capacity appears to have reached 1.85 million tons in 1991 but then appears to have dropped sharply in the early 1990s (to 1.61 million tons in 1993). It then appears to have recovered to about 1.90 million tons by 1997 and then receded to 1.85 million tons by the year 2000. Actual uncoated groundwood paper capacity (reported by AF&PA) did not decline but rather continued to increase in the early 1990s, from 1.97 million tons in 1991 to 2.31 million tons in 1997 (more than 20% higher than data in the FPL–UW database by 1997). Although capacity receded to 2.04 million tons in the year 2000 according to the AF&PA capacity survey, the actual industry capacity data are still 10% higher than indicated by the FPL–UW database.

As discussed previously, discrepancies between actual industry capacity data and the FPL–UW database are probably due in part to differences in data sources, and they may also be due to blurring of distinctions between uncoated groundwood and other similar paper grades, such as newsprint or coated groundwood. In general, there is much less of a discrepancy between the FPL–UW database and the AF&PA capacity survey for the aggregate total of newsprint, uncoated groundwood, and coated groundwood paper capacity (only 1% difference for most years in the late 1990s). This observation tends to support a view that capacity data reported in published sources for individual mills may not reveal many of the recent shifts in mill capacities among newsprint, uncoated groundwood, and coated groundwood grades. However, the FPL–UW database is probably fairly accurate in tracking shifts in production capacities by process and region for the totality of newsprint and groundwood paper grades.

Figure 8 illustrates trends in U.S. uncoated groundwood paper capacity by region from 1970 to 2000 according to the FPL–UW database. The North has dominated uncoated groundwood capacity with 82% of total U.S. capacity in 1970 and 65% in 2000, but uncoated groundwood capacity in the South expanded rapidly from none in the early 1970s to around 20% of total U.S. capacity in 2000. Capacity in the West has ranged between less than 10% and more than 20% of total U.S. uncoated groundwood capacity.

Figure 9 shows the evolution of uncoated groundwood paper capacity by process, according to the FPL–UW database.

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[2]The Zeiss Elrepho brightness test produces a measure of light reflectance relative to a standard reference. The Zeiss Elrepho photometer and brightness test is used internationally and is basically the same as the brightness test standard established by the International Organization for Standardization (ISO).

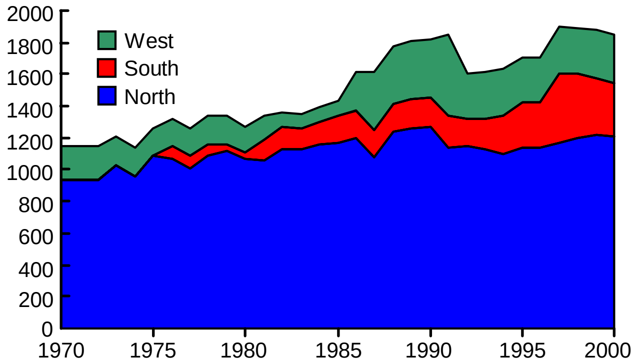

Figure 8—Regional capacity of uncoated groundwood paper in the United States (thousand short tons).

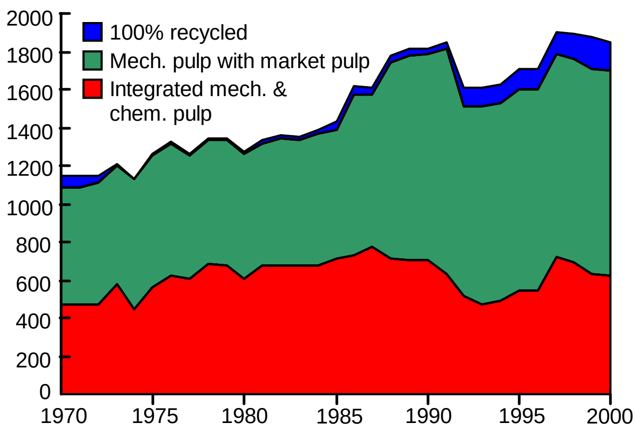

Figure 9—Uncoated groundwood paper capacity by process in the United States (thousand short tons).

Three general process types were identified: [1] uncoated groundwood capacity integrated with both mechanical pulping and chemical pulping capacity, [2] uncoated groundwood capacity integrated with mechanical pulping capacity but no chemical pulping capacity, necessitating purchase of market pulp, and [3] uncoated groundwood capacity based on recycled fiber. Some recycled fiber is blended with wood pulp at some uncoated groundwood mills, but generally, less recycled fiber is used at these mills than at newsprint mills. Capacity at mills integrated with mechanical and chemical pulping increased by about half as much as capacity at mills that use mechanical pulping and purchase market pulp (with average compound growth rates of 0.9% for the former and 1.9% for the latter). Capacity based on recycled fiber appears to have receded in the 1970s but then increased rapidly since the mid-1980s, with an average compound growth rate of 3.5% from 1970 to 2000.

Figure 10 illustrates geographical shifts in U.S. uncoated groundwood paper capacity at mill locations between 1970 and 2000. United States uncoated groundwood capacity was located entirely at mill locations in the North and West in 1970, and at that time, some of the mills in the North were integrated with chemical pulping capacity although many of the mills purchased market pulp. By 2000, however, a significant share of uncoated groundwood capacity was located at several mill locations in the South, although most of the capacity was still located in the North. Mills in the South were all integrated with chemical pulping capacity, whereas none of the mills in the North still had integrated chemical pulping capacity in 2000. Instead, mills in the North had shifted to purchasing market pulp.

Coated groundwood paper capacity in the United States increased from 2.01 million tons in 1970 to 4.51 million tons in 2000, an average compound annual growth rate of about 2.7% according to the FPL–UW database (Table 4). The FPL–UW database indicates that coated groundwood capacity peaked at 4.82 million tons in 1997. By comparison, the AF&PA capacity surveys indicate that actual coated groundwood capacity was 4.66 million tons in 2000, just 3% higher than indicated by the FPL–UW database. Also, actual coated groundwood capacity did not peak in 1997 as suggested by the FPL–UW database, but rather it stood at only 4.51 million tons in 1997 according to the AF&PA capacity surveys and it increased only gradually through the late 1990s. As suggested earlier, discrepancies for coated groundwood paper capacity probably reflect blurring of distinctions among capacities reported for newsprint, uncoated groundwood, and coated groundwood paper grades and the tendency of some mills to shift production from one category to another.

Figure 11 illustrates trends in U.S. coated groundwood paper capacity by region from 1970 to 2000 according to the FPL–UW database. The North has dominated coated groundwood capacity, with around 75% to 80% of total U.S. capacity throughout 1970 to 2000. Capacity in the South declined in the 1970s from around 19% of total U.S. capacity in 1970 to around 12% in the late 1970s, but then capacity increased in the South, reaching about 25% of total U.S. capacity in the year 2000. A relatively small amount of coated groundwood capacity existed in the West in the 1970s and 1980s, but capacity in the West declined to zero around 1990.

Figure 12 shows the evolution of U.S. coated groundwood paper capacity by process, according to the FPL–UW database. Two general types of processes were identified: [1] coated groundwood capacity with integrated on-site mechanical pulping and chemical pulping capacity, and [2] coated groundwood capacity with integrated mechanical pulping capacity but no chemical pulping capacity, necessitating purchase of market pulp. Some recycled fiber also may be blended with wood pulp at some coated groundwood mills, but there does not appear to be any coated groundwood capacity based exclusively on recycled fiber in the United States. Capacity at mills with integrated mechanical pulping and chemical pulping capacity declined in the 1970s but then increased significantly starting in the early 1980s. Capacity based on mechanical pulping and purchased market pulp appears to have peaked in the late 1980s. Figure 13 illustrates

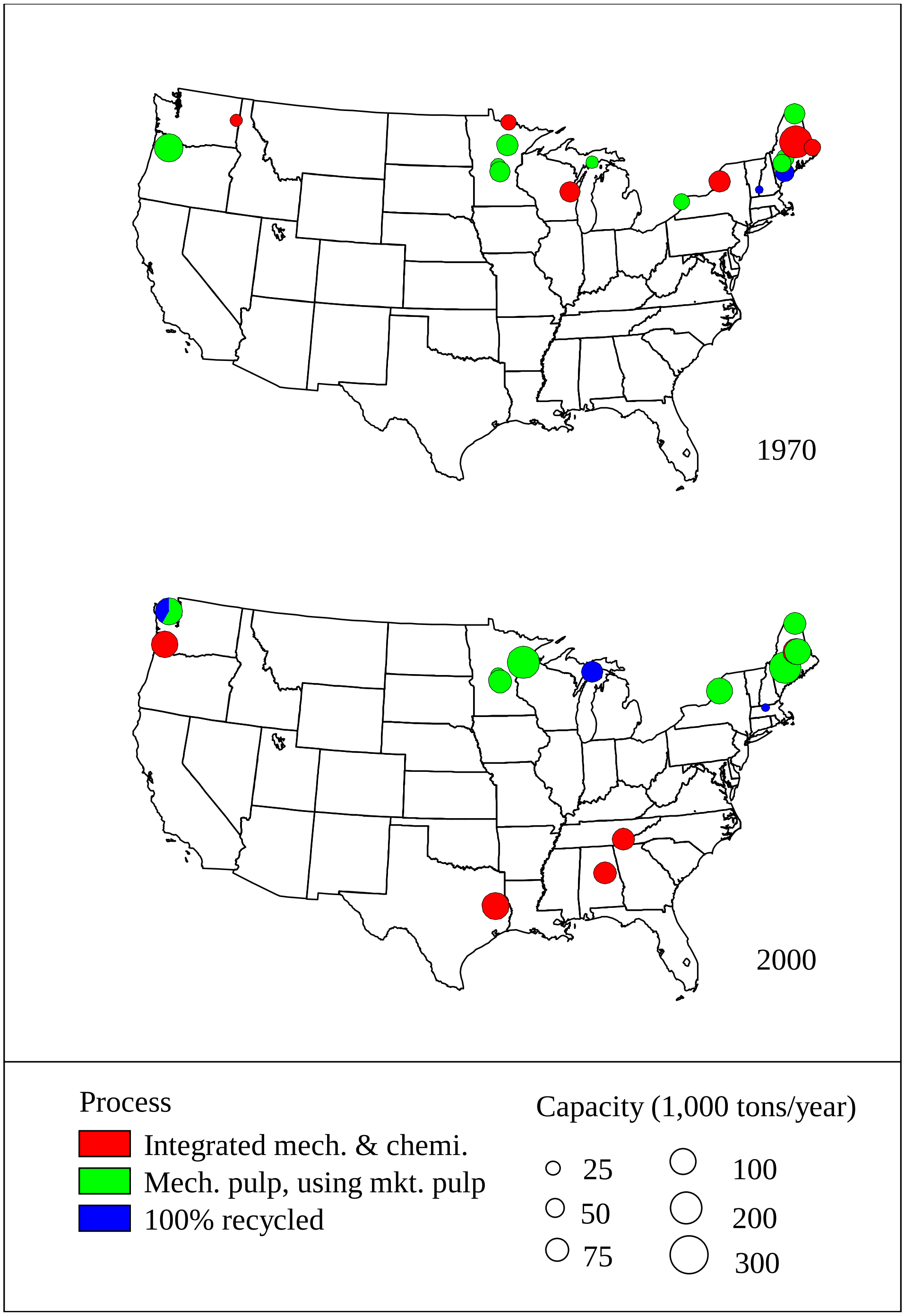

Figure 10—Location of uncoated groundwood capacity by process in the United States in 1970 and 2000.

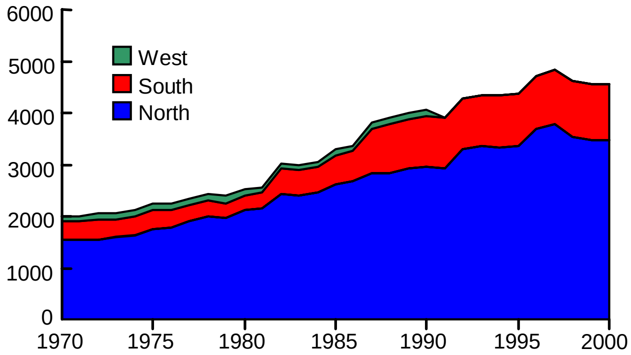

Figure 11—Regional capacity of coated groundwood paper in the United States (thousand short tons).

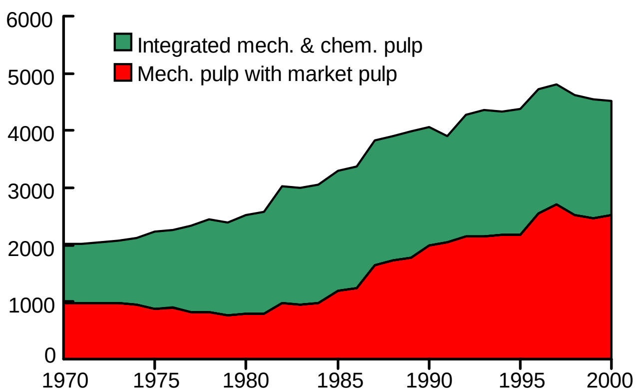

Figure 12—Coated groundwood paper capacity by process in the United States (thousand short tons).

geographical shifts in U.S. coated groundwood paper capacity between 1970 and 2000. United States coated groundwood capacity increased at mill locations in the North (primarily in the central Lake States and northern New England) and in the South (south central region). In the 1970s and 1980s, capacity existed also at one mill location in the West, but there has been no coated groundwood capacity in the West since 1990.

Coated and Uncoated Free Sheet Papers

Coated and uncoated free sheet papers are the remaining two commodity categories within the larger group known as printing and writing paper (which also includes coated and uncoated groundwood paper). According to traditional industry standards, free sheet paper grades are produced primarily with low-yield bleached chemical pulps, predominantly bleached kraft (sulfate) pulp but also sulfite pulp, with generally less than 10% mechanical pulp content. Whereas newsprint and the groundwood paper grades depend heavily on softwood fiber to impart adequate sheet strength with high yield mechanical pulps, free sheet paper grades are often made primarily with hardwood pulp or a mix of hardwood and softwood pulps, predominately bleached kraft. Some free sheet mills use pulp from recycled fiber (deinked pulp), but use of recycled fiber is relatively low in free sheet paper because of the cost of contaminant removal and high product quality standards.

Uncoated free sheet paper has maintained a dominant share of capacity within the printing and writing paper group, accounting for more than half of all printing and writing paper capacity throughout 1970 to 2000 (Table 4). In the United States, office reprographic paper for copiers and printers is the dominant use for uncoated free sheet paper, accounting for about one-third of production (Miller–Freeman 1999). Other large end-uses include offset printing paper for commercial printing and books, business forms, and other converted paper products such as envelopes, stationary, and writing tablet paper. The use of bleached chemical pulp provides uncoated free sheet paper with high brightness and uniformity, while high proportions of hardwood fiber help provide sheet smoothness and good printing characteristics.

Uncoated free sheet capacity increased in the United States from 6.8 million tons in 1970 to 16.4 million tons in 2000, an average compound annual growth rate of about 3.0% according to the FPL–UW database (Table 4). The database indicates that uncoated free sheet capacity continued to increase steadily throughout the period from 1970 to 2000, although capacity growth was slowly decelerating with time (Table 3). In the FPL–UW database, uncoated free sheet encompasses so-called thin papers and some bleached bristols (heavy card stock paper) as well as the other common uncoated free sheet paper grades. In general, total capacity trends for uncoated free sheet in the FPL–UW database agree closely with the trends reported by the AF&PA capacity surveys for total capacity of uncoated free sheet, thin papers, and bleached bristols. The AF&PA capacity survey indicated that actual capacity was 16.8 million tons in 2000 for all uncoated free sheet paper, thin papers, and bleached bristols. Although the total industry capacity appears to be about 2% higher than estimates in the FPL–UW database, the apparent discrepancy is probably because some of the capacity for bleached bristols was included in solid bleached paperboard (some mills produce bristols and bleached paperboard).

Figure 14 illustrates trends in U.S. uncoated free sheet paper capacity by region from 1970 to 2000 according to the FPL–UW database. The North dominated uncoated free sheet capacity in 1970, with around 64% of total U.S. capacity, but capacity increased in the South, growing from around 25% of total U.S. capacity in 1970 to around 50% in 2000. Capacity in the North peaked in the early 1990s and then declined to around 38% of total U.S. capacity in 2000. The West has accounted for a comparatively smaller fraction of U.S. uncoated free sheet capacity, around 11% in 1970, peaking at 15% around 1990 but dropping back to 12% by 2000.

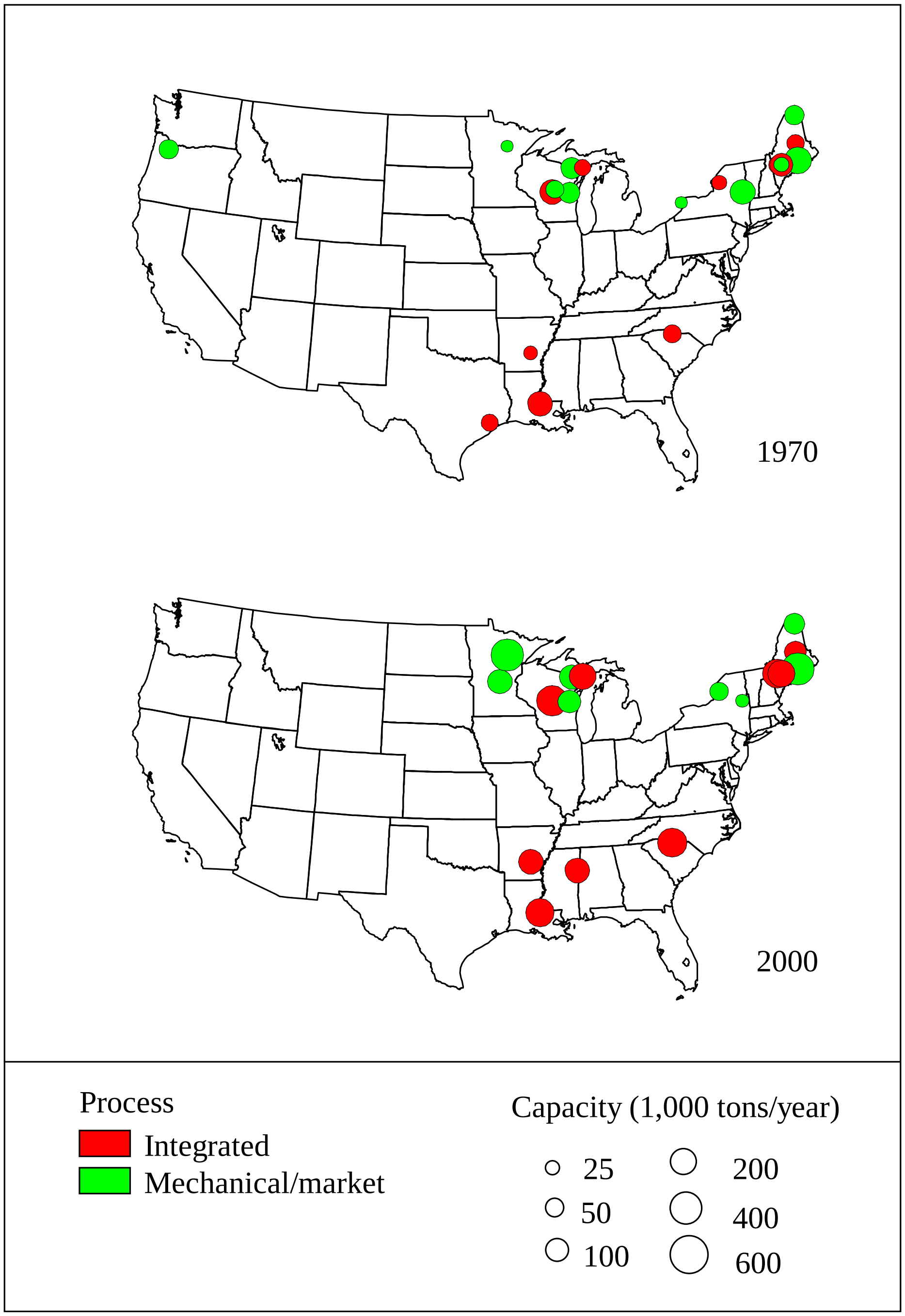

Figure 13—Location of coated groundwood capacity by process in the United States in 1970 and 2000.

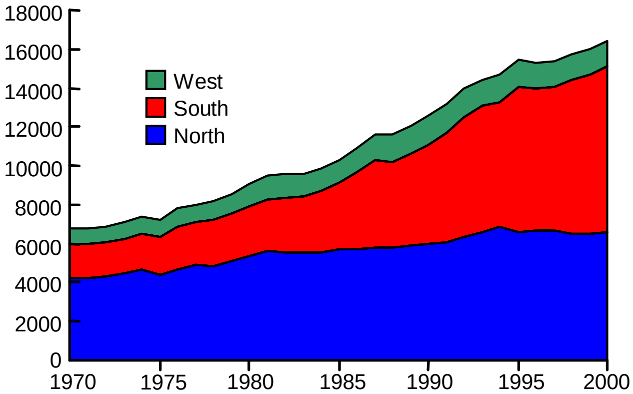

Figure 14—Regional capacity of uncoated free sheet paper in the United States (thousand short tons).

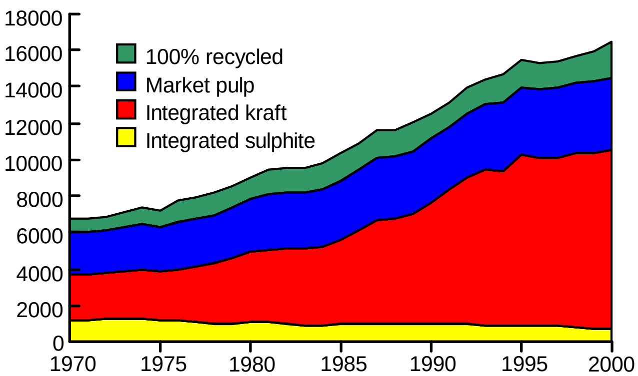

Figure 15—Uncoated free sheet paper capacity by process in the United States (thousand short tons).

Figure 15 shows the evolution of U.S. uncoated free sheet capacity by process, according to the FPL–UW database. Four general types of processes were identified: [1] 100% recycled fiber, [2] capacity based on market pulp, [3] capacity integrated with bleached kraft (sulfate) pulping, and [4] capacity integrated with bleached sulfite pulping. Capacity at mills with integrated kraft pulping increased more significantly than any other type of process, more than tripling. This capacity increased from around 37% of total U.S. uncoated free sheet capacity in 1970 to 60% by the late 1990s. Capacity based on sulfite technology receded from 17% of total U.S. capacity in 1970 to less than 5% in 2000. Capacity based on recycled fiber and market pulp approximately doubled from 1970 to 2000, but their total share of U.S. capacity receded from around 45% in 1970 to around 35% by the late 1990s (25% based on market pulp and 10% based on recycled fiber).

Figure 16 illustrates geographical shifts in U.S. uncoated free sheet paper capacity at mill locations between 1970 and 2000. The largest numbers of U.S. uncoated free sheet mills have existed in the North, where many small- to medium-sized mills remain in operation. Also, a majority of mills in the North are based on purchased market pulp. Figure 16 shows that most of the growth of recent decades in U.S. uncoated free sheet capacity was in the South. Generally, larger mills characterize capacity in the South with papermaking capacity typically integrated with kraft pulping capacity. Most of the U.S. capacity expansion in uncoated free sheet between 1970 and 2000 was based on kraft pulp in the South. In 1970, there were still quite a few mills with integrated sulfite pulping capacity (particularly in the North Central region and the West), but the number of such mills has declined as kraft pulping capacity has expanded in recent decades. Capacity based on recycled fiber also increased notably between 1970 and 2000, particularly at mill locations in the eastern United States, but capacity based entirely on recycled fiber remains a relatively small element of total uncoated free sheet capacity.

United States coated free sheet paper capacity more than doubled from 1970 to 2000, outpacing the average rate of growth in U.S. paper and paperboard capacity (Table 4). Coated free sheet paper is generally the highest value end of the printing and writing paper spectrum. Coated free sheet paper is used almost entirely in commercial printing applications such as annual reports, product sales brochures, or advertising pamphlets that generally demand high image quality and color printing.

Figure 17 illustrates trends in U.S. coated free sheet paper capacity by region from 1970 to 2000 according to the FPL–UW database. United States coated free sheet capacity and growth have been concentrated primarily in the North, where hardwood pulpwood supply predominates, with relatively modest capacity growth in the South and West.

Figure 18 shows the evolution of U.S. coated free sheet paper capacity by process, according to the FPL–UW database. Three general types of processes were identified: [1] 100% recycled fiber, [2] capacity based on market pulp, and [3] capacity integrated with bleached kraft (sulfate) pulping. Most of the growth from 1970 to 2000 was at mills with integrated kraft pulping capacity. Figure 19 illustrates geographical shifts in U.S. coated free sheet capacity at mill locations between 1970 and 2000. Although the number of coated free sheet mills did not change significantly, the capacity at many mill locations increased substantially.

Tissue and Sanitary Paper

Tissue and sanitary paper includes bathroom tissue, paper toweling, facial tissue, napkins, and also absorbent sanitary products such as diapers and adult hygiene products. Unlike many other categories of paper and paperboard that are produced primarily as global commodities in large bulk rolls or reams, most tissue and sanitary paper products in the United States are converted at the mills into packaged consumer goods (boxed and packaged for final retail sale).

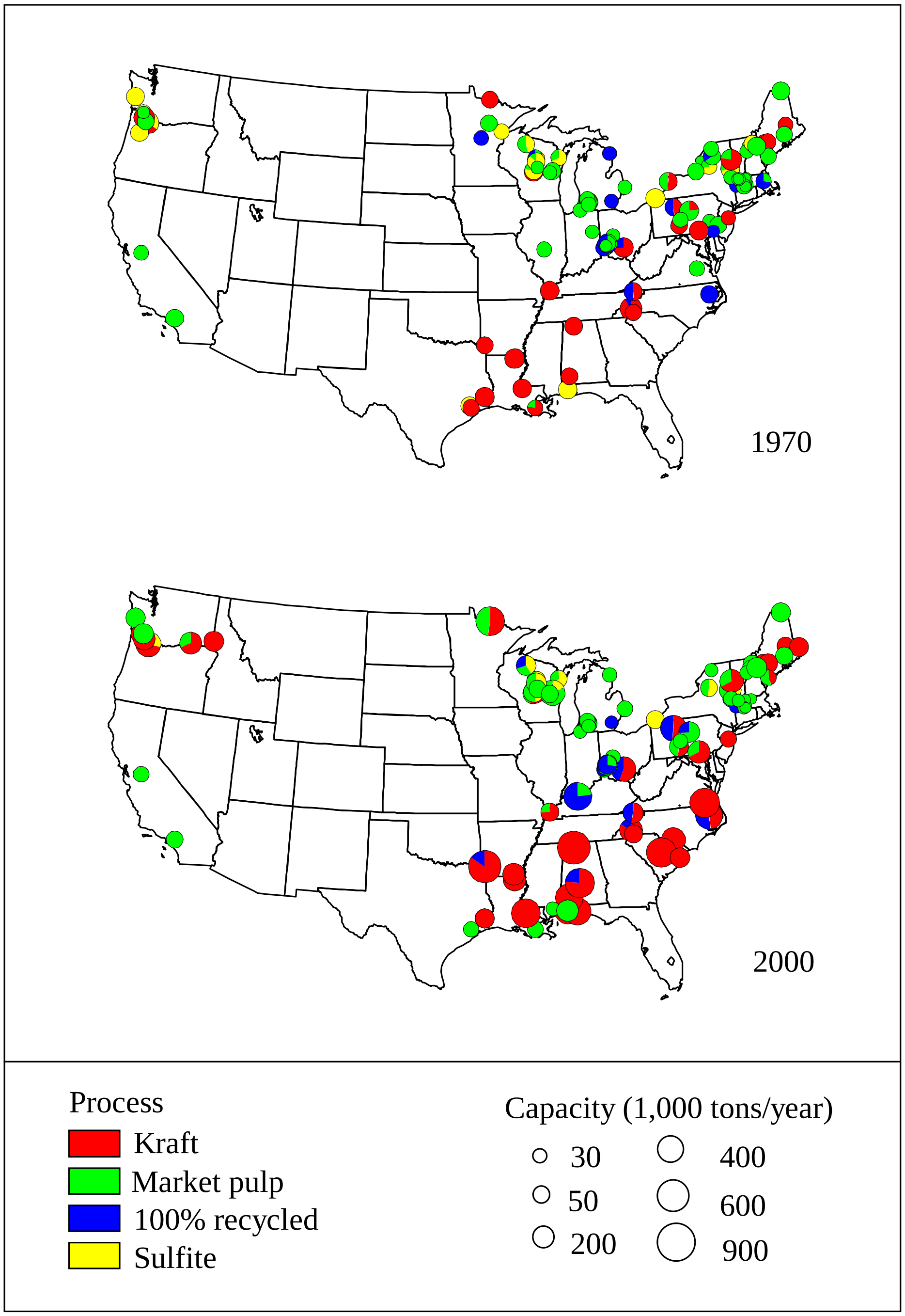

Figure 16—Location of uncoated free sheet capacity by process in the United States in 1970 and 2000.

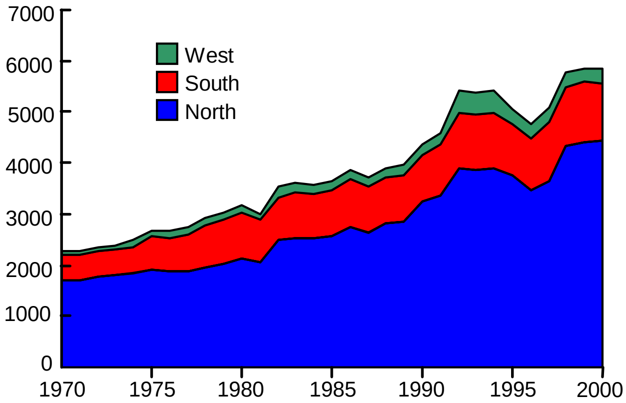

Figure 17—Regional capacity of coated free sheet paper in the United States (thousand short tons).

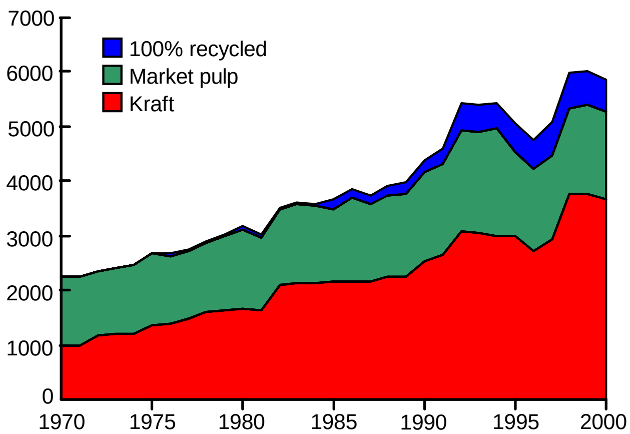

Figure 18—Coated free sheet paper capacity by process in the United States (thousand short tons).

The consumer orientation of product output and product differentiation coupled with limited foreign competition in U.S. markets have historically contributed to relatively high profit margins and stable growth rates for U.S tissue paper producers.

Figure 20 illustrates trends in U.S. tissue and sanitary paper capacity by region from 1970 to 2000 according to the FPL–UW database. Most of the U.S. tissue and sanitary paper capacity has been concentrated in the North, but most of the growth in capacity of recent decades has occurred in the South. Consequently, the share of total U.S. capacity located in the North receded from 66% in 1970 to 47% in 2000, while the share of capacity in the South increased from 17% to 37%. The share of total U.S. capacity located in the West remained relatively constant, between 14% and 17%.

Figure 21 shows the evolution of U.S. tissue and sanitary paper capacity by process according to the FPL–UW database. Three general categories of production capacity or process types were identified: [1] capacity integrated with chemical pulping, primarily kraft pulping, [2] 100% recycled fiber, and [3] purchased market pulp. Although capacity based on market pulp increased in the 1970s, capacity growth since the mid-1980s has been based primarily on recycled fiber. Very little capacity growth from 1970 to 2000 was at mills with integrated chemical pulping, although capacity also did not decline substantially at such mills during that period.

Figure 22 illustrates geographical shifts in U.S. tissue and sanitary paper capacity at mill locations between 1970 and 2000. The largest number of U.S. tissue mills and the largest share of total U.S. capacity were in the North. However, the distribution of process types and the range in sizes of mills in the North exhibited only modest change between 1970 and 2000. Most of the capacity in the North was based on recycled fiber. Most of the capacity in the West was based on integrated chemical pulping (mainly in the Northwest) and to a smaller extent on recycled fiber. In 1970, most of the capacity in the South was based on integrated chemical pulping, but most of the expansion in capacity in the South was based on recycled fiber. By the year 2000, mills in the South were generally larger than mills in the North.

Specialty Packaging and Industrial Paper

Specialty packaging and industrial papers include a diverse range of paper products used in a variety of industrial and packaging end-uses. Products include pressure-sensitive release paper or release liners, food wrapping paper such as greaseproof wrapping and glassine paper (wax paper), flexible packaging paper, label paper, abrasive paper (for sandpaper), masking tape and other self-adhesive paper, gasket and filter paper, saturating kraft paper used in decorative laminates, and many other products. The mills in this sector usually specialize in producing products tailored to meet unique customer requirements and specifications. Because of the wide spectrum of product applications and manufacturing requirements and because there are many smaller mills with varied production processes, there was no attempt to categorize capacity by process type for the specialty packaging and industrial paper mills in the FPL–UW database. For the most part, production capacity is based on integrated pulping and papermaking facilities (mostly kraft pulp but typically sulfite pulp in the case of glassine and wax papers). Capacity is also based on purchased market pulp at many smaller mill locations, and in some cases, mills use recycled fiber. In addition, bleached kraft packaging paper capacity is included within specialty packaging and industrial paper capacity in the FPL–UW database. In general, specialty packaging and industrial paper mills are noted for their diverse variety of fiber sources, papermaking technology, and coating and finishing operations (Miller–Freeman 1999).

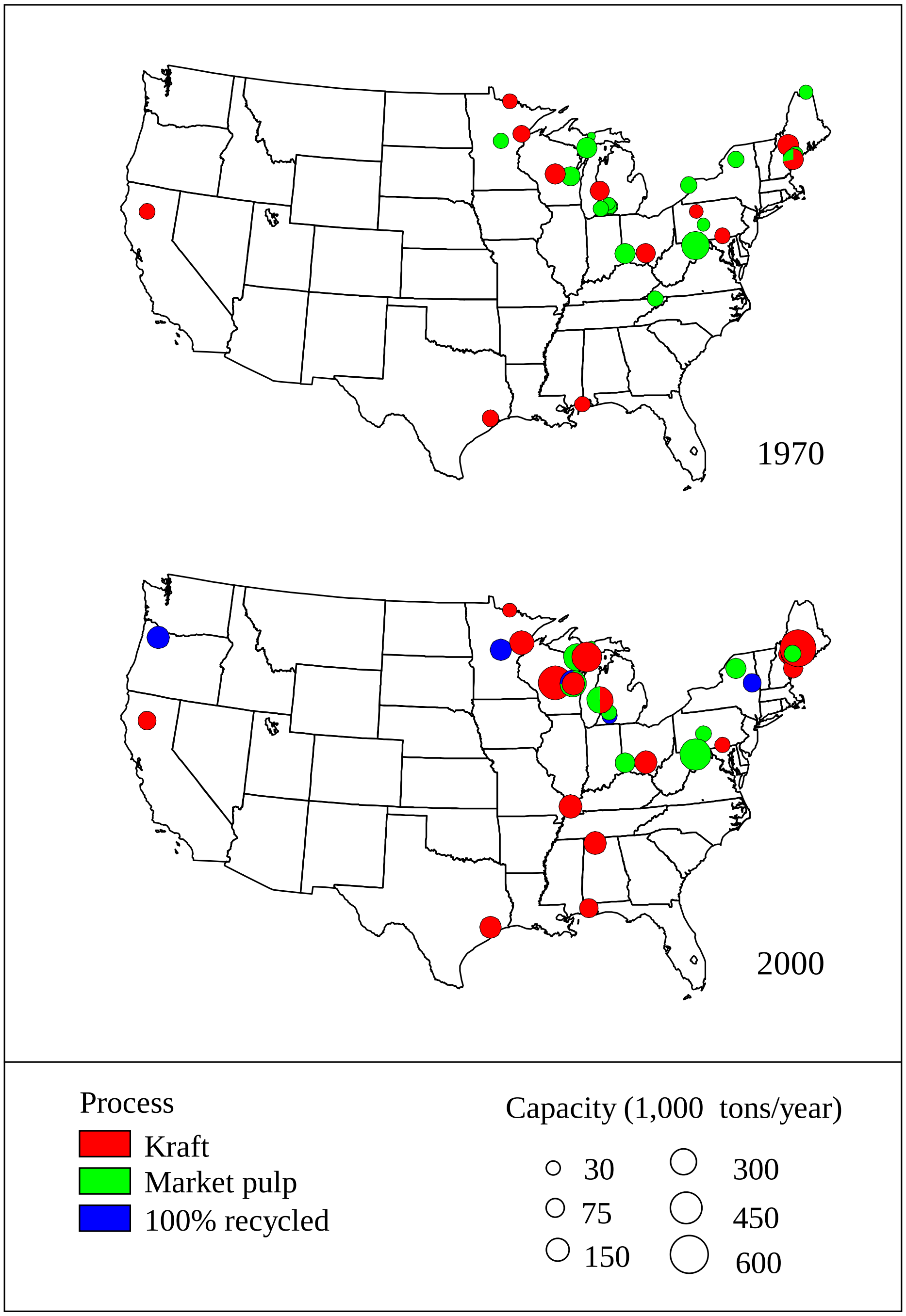

Figure 19—Location of coated free sheet capacity by process in the United States in 1970 and 2000.

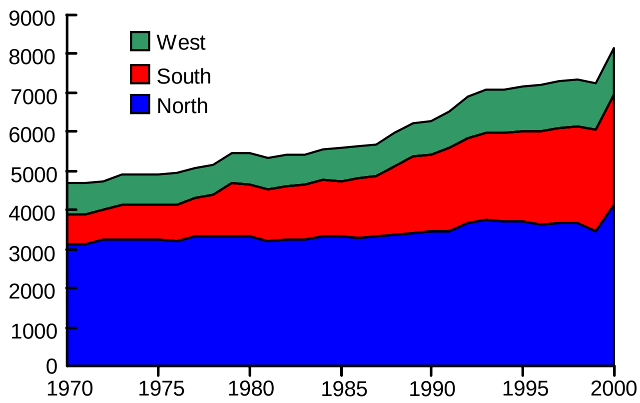

Figure 20—Regional capacity of tissue and sanitary paper in the United States (thousand short tons).

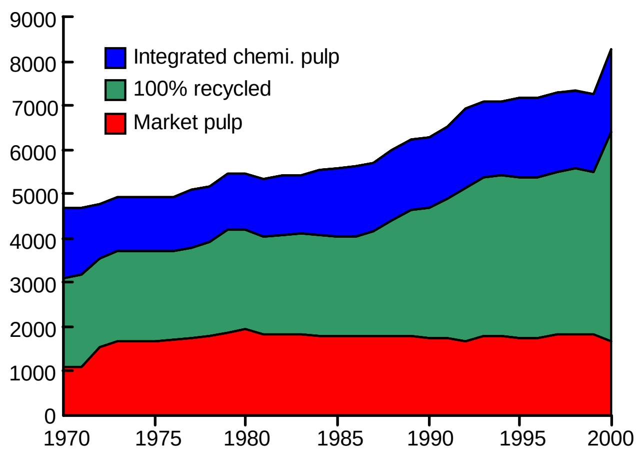

Figure 21—Tissue and sanitary paper capacity by process in the United States (thousand short tons).

Figure 23 illustrates trends in U.S. specialty packaging and industrial paper capacity by region from 1970 to 2000 according to the FPL–UW database. Until the late 1990s, the largest share of U.S. capacity was concentrated in the North, but most of the growth in capacity of recent decades occurred in the South. The North's share of total U.S. capacity declined from 67% in 1970 to 42% in 2000, while the South's share of capacity increased from 17% to 45%, surpassing the North. Capacity in the West remained in the range of 12% and 17% of total U.S. capacity.

Figure 24 illustrates geographical shifts in specialty packaging and industrial paper capacity at U.S. mill locations between 1970 and 2000. The largest number of mills and largest share of total U.S. capacity existed in the North up until the late 1990s. The distribution of mill locations and the range in sizes of mills in the North exhibited only modest change between 1970 and 2000, with the closure of some smaller mills mostly in the Northeast. Capacity expansion in the South was concentrated at a much smaller number of mills that were relatively larger than mills in the North on average.

Kraft Packaging Paper

In the FPL–UW database, kraft packaging paper capacity includes only unbleached kraft paper grades (bleached kraft packaging paper capacity was included within specialty packaging and industrial paper). As such, kraft packaging paper includes primarily grocery bag and sack paper, shipping sack paper (such as multiwall shipping sacks used for shipping animal feed, flour, cement, and other bulk materials), and a relatively small volume of unbleached kraft wrapping paper. The markets for unbleached kraft paper, particularly in grocery bags and sack paper, have suffered from significant substitution by plastic bags, and production capacity has been generally declining for the past 20 years. However, the rate of decline was much slower in the 1990s than in the 1980s.

Figure 25 illustrates trends in U.S. (unbleached) kraft packaging paper capacity by region from 1970 to 2000 according to the FPL–UW database. By far the largest share of U.S. capacity was concentrated in the South with unbleached kraft pulp made primarily from southern pines, although capacity was declining since the early 1980s. In some cases, shifting production from kraft packaging paper to kraft linerboard caused capacity reductions in the South. A sizable share of capacity was also located in the West where other softwood timber species are common. The relatively long and flexible fibers from softwood species help provide sheet strength that is important in products such as grocery bag and sack paper. Relatively little capacity was located in the North, where hardwood species predominate in pulpwood supply.

Figure 26 shows the evolution of U.S. kraft packaging paper capacity by process according to the FPL–UW database. Two general types of processes were identified: [1] capacity integrated with unbleached kraft pulping, and [2] 100% recycled fiber. Even as overall U.S. kraft packaging paper capacity has been declining, the share of capacity based on recycled fiber has been increasing since the mid-1980s.

Figure 27 illustrates geographical shifts in kraft packaging paper capacity at U.S. mill locations between 1970 and 2000. The largest number of mills and largest share of total U.S. capacity were in the South followed by the West. Mills in the North were generally much smaller on average than mills in the South and West, and mills in the North were based primarily on recycled fiber, whereas mill capacity in the South and West was primarily based on integrated kraft pulping.

Linerboard (and Other Unbleached Kraft Paperboard)

Linerboard production capacity in the United States (including other unbleached kraft paperboard and recycled linerboard) was in excess of 27 million tons in the year 2000, which is greater than any other single commodity category of paper or paperboard. Linerboard is paperboard that is used primarily as the flat facing material in corrugated

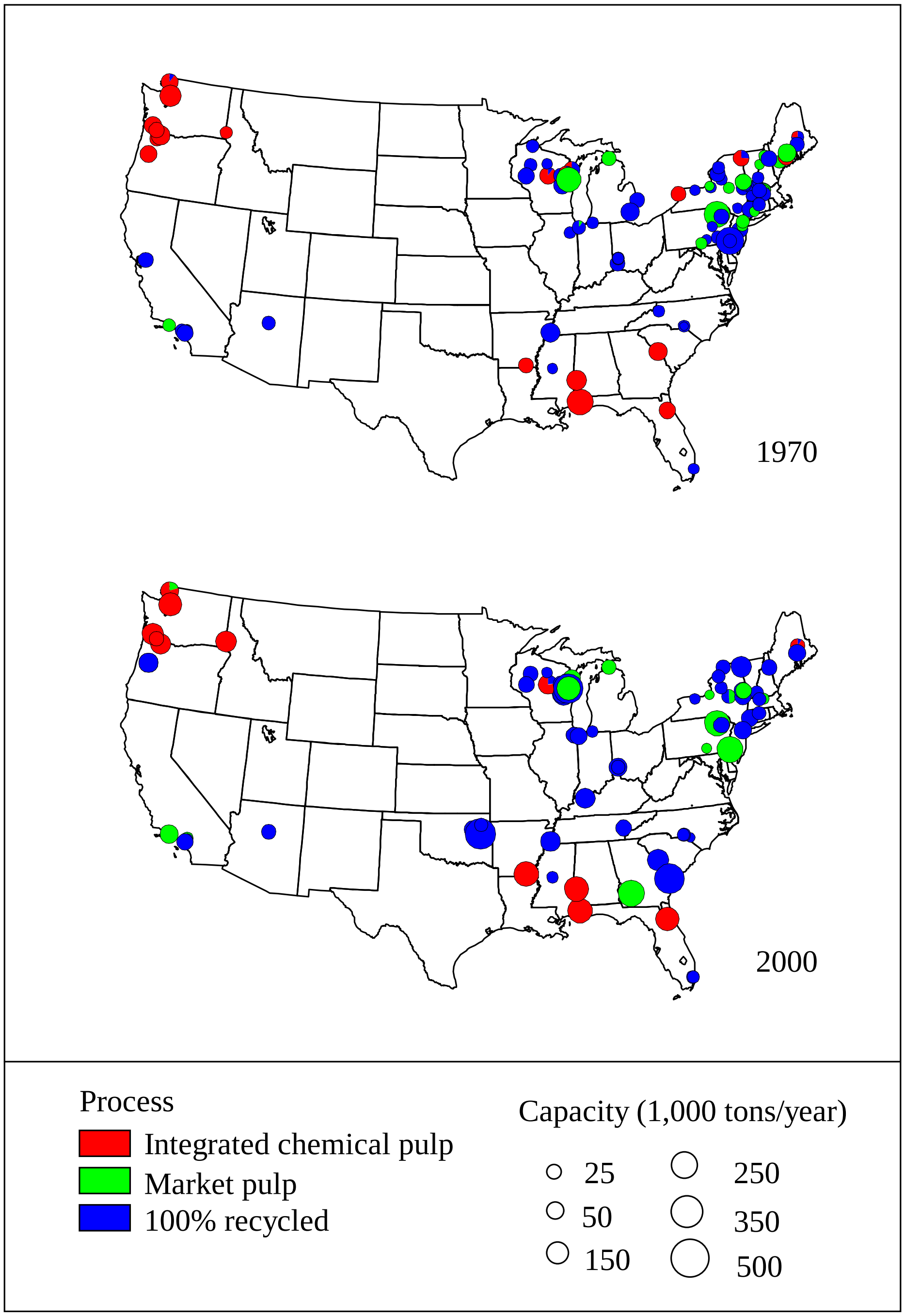

Figure 22—Location of tissue and sanitary paper capacity by process in the United States in 1970 and 2000.

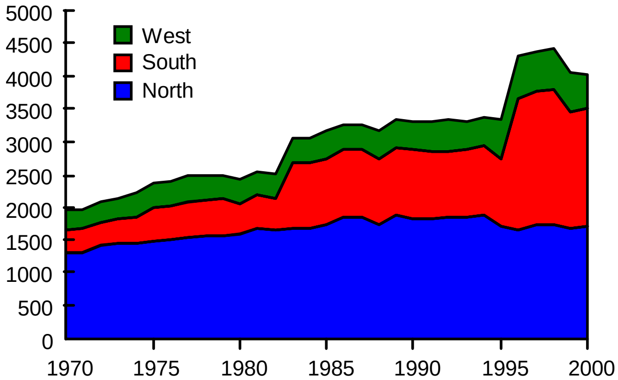

Figure 23—Regional specialty packaging and industrial paper capacity in the United States (thousand short tons).

containerboard. As such, linerboard is combined with corrugating medium (the fluted or corrugated inner layer of containerboard) to produce corrugated boxes and other corrugated shipping containers. Both linerboard and corrugating medium are produced at typically large paperboard mills that ship these commodities in large bulk rolls to corrugating and converting plants (numerous smaller plants across the country that combine linerboard and corrugating medium and convert them into corrugated containerboard and corrugated containers). In the FPL–UW database, linerboard capacity also includes all other unbleached kraft paperboard capacity. Other unbleached kraft paperboard is produced mainly for folding boxboard and other applications, less than 10% of total output.

The United States is by far the largest producer of linerboard in the world, and in recent decades, production capacity has undergone significant growth and evolution in technology. Both linerboard and corrugating medium have been produced commercially in the United States for corrugated shipping containers since at least the early part of the 20th century. The gradual substitution of efficient corrugated shipping containers for the more traditional wooden boxes or wooden crates in the early 20th century was itself a remarkable achievement in conservation of wood resources, as corrugated boxes typically use much less wood raw material than wooden crates per unit volume. During the latter half of the 20th century, corrugated boxes and shipping containers eventually became the dominant medium for shipment of most goods in the U.S. economy. Along the way, innovations in box technology facilitated the expansion of markets for corrugated shipping containers, such as the development of moisture-resistant boxes for shipping fruits and vegetables.

Key to the expansion of corrugated containerboard markets was a system of uniform freight classification and shipping standards for corrugated boxes adopted by the rail and trucking industries early in the 20th century. The shipping standards helped establish uniform tests for certification of box performance, such as the mullen burst test and basis weight standards, used traditionally to rate the strength performance of corrugated boxes. Box classification standards and tests assured the rail, trucking, and warehousing industries of adequate protection for packaged goods, facilitating bonding or insurance of goods in transit. However, by the 1970s, it had become apparent that shipping and warehousing systems were changing, as corrugated boxes were increasingly being shipped in stacks or unitized pallet loads, with boxes often stacked on one another in warehouses and in transit. The risks of damage to goods in transit had changed. The performance of boxes in terms of compression strength (resisting the effect of crushing by compressive forces) was eventually recognized as more important in many cases than the standard burst test (designed to ensure that the box contents would not spill if the box was dropped). Beginning in the 1970s, the freight classification committees of the rail and trucking industries began to consider revision of box standards, eventually resulting in approval of new rules (in 1991) allowing box producers to replace the mullen burst test with compression strength standards and also eliminating minimal basis weight requirements. Technological developments in paperboard production and box design had already shown by then that it was possible to produce lighter weight linerboard that offered superior compression strength in corrugated boxes (so-called high performance linerboard).

To a large extent, enhancement of the production efficiency and performance of linerboard was facilitated in recent decades by development of improved paper machine technology, most notably the advent of extended nip or high-intensity pressing technology in the early 1980s, and also by the development of multi-ply linerboard. In the linerboard industry prior to the 1980s, kraft linerboard was produced almost exclusively from unbleached softwood kraft pulp to ensure good strength performance. With conventional papermaking technology prior to the 1980s, the long and flexible softwood fibers assured good tensile strength in linerboard, enhancing the burst test performance of corrugated boxes. At that time, linerboard was sometimes made from recycled fiber, but recycled linerboard was known as testliner, because of the need for more frequent testing and the recognition that recycled fibers generally provided inferior strength performance relative to virgin kraft. The advent of extended nip pressing technology in the early 1980s, coupled with ongoing revision in freight rules, changed the production possibilities by demonstrating that it was possible to produce linerboard with higher compression strength while incorporating significantly higher proportions of hardwood pulp, recycled fiber, or higher yield softwood pulp. The lower cost of hardwood pulpwood and recycled fiber also provided economic incentive for adoption of the new press technology in linerboard. At the same time, multi-ply sheet forming technology was facilitating production of linerboard with multiple layers. This led to possibilities such as softwood kraft pulp in a core or base layer for strength and hardwood pulp or even bleached

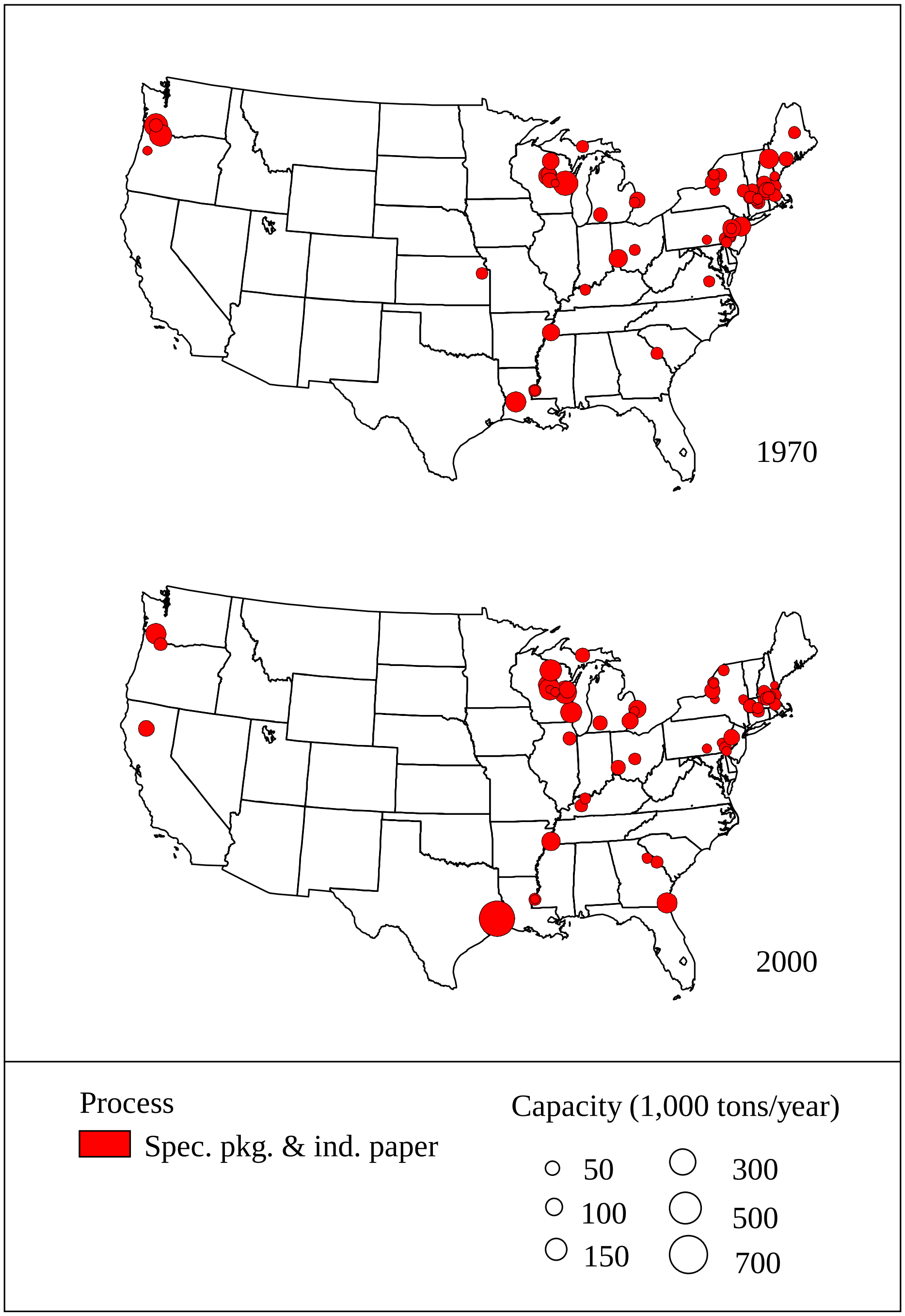

Figure 24—Location of specialty packaging and industrial paper capacity in the United States (thousand short tons).

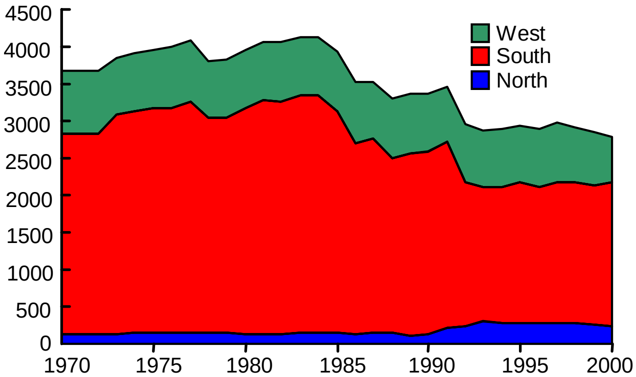

Figure 25—Regional capacity of (unbleached) kraft packaging paper in the United States (thousand short tons).

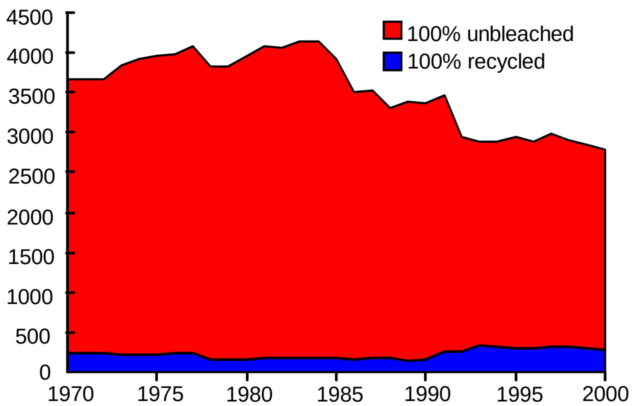

Figure 26—Kraft packaging paper capacity by process in the United States (thousand short tons).

pulp in a surface layer for better print quality. With multi-ply sheet forming and other technological advances, linerboard mills using recycled fiber (generally from old corrugated containers) or higher proportions of hardwood fiber now commonly produce linerboard with performance characteristics comparable with those of linerboard produced with virgin softwood fiber.

Figure 28 illustrates trends in U.S. linerboard capacity by region from 1970 to 2000 according to the FPL–UW database (including kraft linerboard, recycled linerboard, and all other unbleached kraft paperboard). The largest share of U.S. capacity and most capacity growth in recent decades has been concentrated in the South, because of the need for softwood fiber and the abundance of Southern Pine pulpwood. A sizable share of capacity has also been located in the West. Historically, only a small fraction of capacity was located in the North, based almost exclusively on recycled fiber.

Figure 29 shows the evolution of U.S. linerboard capacity by process according to the FPL–UW database. Three general categories of production capacity were identified: [1] capacity based on 100% recycled fiber, [2] integrated kraft pulping using pre-1980s press technology, and [3] integrated kraft pulping using new press technology such as extended nip pressing. The new press technology made rapid and significant inroads in linerboard capacity from the early 1980s to the mid-1990s. Since the early 1990s, most of the expansion in linerboard capacity was based exclusively on recycled fiber, and capacity with integrated kraft pulping appears to have peaked in the late 1990s along with overall U.S. linerboard capacity.

Figure 30 illustrates geographical shifts in linerboard capacity at U.S. mill locations between 1970 and 2000. The preponderance of large kraft paperboard mills in the U.S. South is readily apparent. The South has been home to the largest number of mills and largest share of total U.S. capacity for decades. A number of relatively large kraft paperboard mills have also existed in the West (in the Pacific Northwest). A notable increase in linerboard capacity occurred in the North, but linerboard mills in the North are based on recycled fiber, generally without any capacity from integrated kraft pulping. Also, although mill capacity has increased in general, linerboard mills in the North remain typically smaller in capacity on average than mills in the South and West. Figure 30 also illustrates that new press technology has been introduced incrementally at most large kraft paperboard mills that typically have more than one paper machine. In general, almost every linerboard mill in the South has been upgraded with new press technology, but not every machine at each mill has been updated.

Corrugating Medium

Corrugating medium is used almost entirely in the manufacture of corrugated boxes and corrugated containers. It is combined with linerboard to produce corrugated containerboard. Both linerboard and corrugating medium are produced in a range of basis weights, but a typical containerboard combination includes a middle layer of corrugating medium with a basis weight of 26 lb per thousand square feet (42.8 g/m^3) sandwiched between two layers of linerboard each with a basis weight of 42 lb (69.1 g/m^3). Because the corrugating medium in the containerboard is not flat but rather it is fluted (or corrugated), a material take-up factor results in the corrugating medium weighing roughly half of what the linerboard used in the typical containerboard weighs. Thus, corrugating medium capacity in the United States was about 11 million tons in the year 2000, or roughly half the capacity of linerboard produced for containerboard (deducting 5 million tons or so of linerboard and unbleached kraft board capacity that served export and folding boxboard markets).

Unlike the linerboard industry, which has been concentrated mainly in the South and also the Northwest (based on softwood fiber), U.S. corrugating medium mill capacity has been distributed more evenly across all regions, with a large share of capacity in the North. Corrugating medium is distinguished from linerboard by product characteristics that have

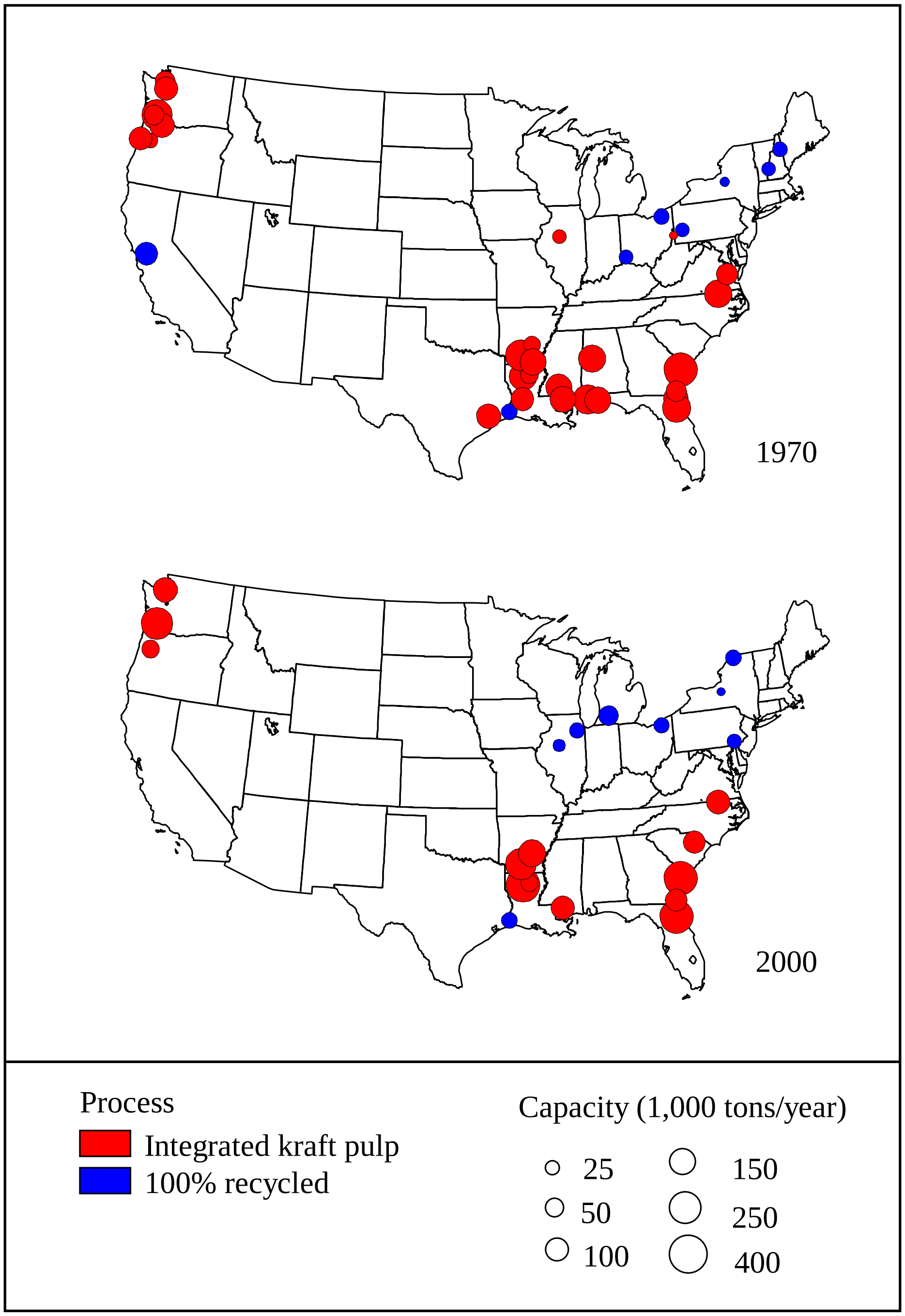

Figure 27—Location of unbleached kraft paper capacity by process in the United States in 1970 and 2000.

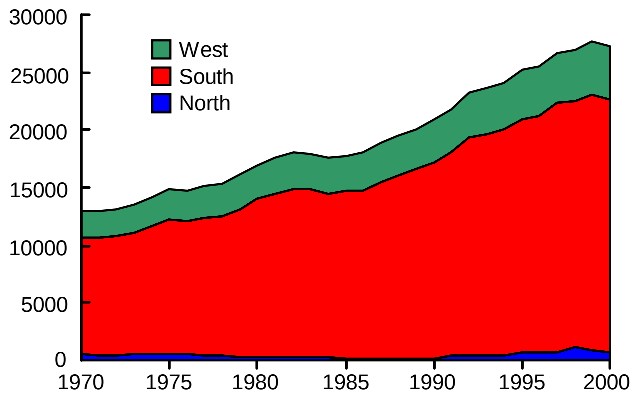

Figure 28—Regional capacity of linerboard (and unbleached kraft board) in the United States (thousand short tons).

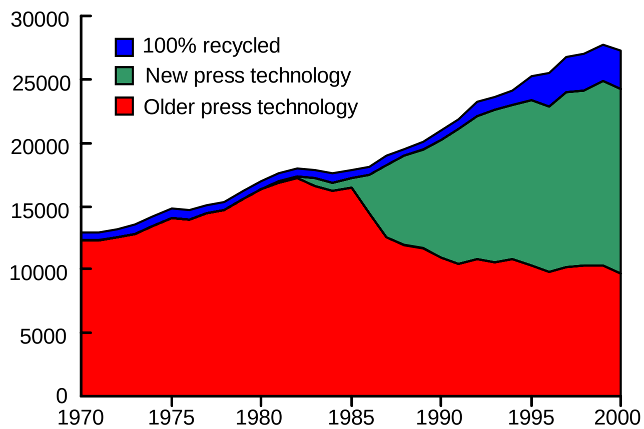

Figure 29—Linerboard (plus other unbleached kraft paperboard) capacity by process in the United States (thousand short tons).

determined production process and fiber raw material inputs, as well as differences in regional distributions of production capacity. Whereas linerboard has been required to meet standards related primarily to tensile strength and box compression strength (mullen burst test and edgewise compression tests), corrugating medium is rated primarily according to the concora crush test (measuring its ability to keep the linerboard facings separated). Differences between linerboard and corrugating medium in sheet performance requirements permit corrugating medium to be made with semichemical pulp, using a large proportion of hardwood fiber, and also with recycled fiber. Thus, whereas U.S. linerboard capacity was based traditionally on unbleached kraft pulp using primarily softwood fiber, U.S. corrugating medium capacity has been based on variants of the semichemical pulping process using primarily hardwood fiber. Also, since the 1970s, most of the growth in U.S. corrugating medium capacity has been based on recycled fiber.

Figure 31 illustrates trends in U.S. corrugating medium capacity by region from 1970 to 2000 according to the FPL–UW database (including semichemical corrugating medium and recycled corrugating medium). Among U.S. regions, the North has had the largest share of total U.S. capacity and capacity growth.

Figure 32 shows evolution of U.S. corrugating medium capacity by fiber input according to the FPL–UW database. Two general categories of production capacity were identified based on fiber furnish: [1] recycled fiber and [2] semichemical pulp. Most of the growth in U.S. corrugating medium capacity was based on recycled fiber, whereas capacity based on semichemical pulp has remained relatively constant in recent decades. In the FPL–UW database, the precise share of capacity based on recycled fiber was estimated for mills with semichemical pulping facilities. This approach differs from capacity data published by AF&PA (in which semichemical corrugating medium means corrugating medium containing not less than 75% virgin wood pulp and recycled corrugating medium means corrugating medium containing less than 75% virgin wood pulp).

Figure 33 illustrates geographical shifts in corrugating medium capacity at U.S. mill locations between 1970 and 2000. The even distribution of mill locations in the eastern United States is readily apparent. In 1970, most mills used a higher proportion of semichemical pulp than recycled fiber. By 2000, the situation was reversed, and very few mills were using exclusively virgin wood pulp. Capacity expansion has occurred at many mill locations across all regions, with the largest mills concentrated in the North Central and South Central regions.

Solid Bleached Board

Solid bleached paperboard is made primarily from bleached kraft pulp and used primarily for boxboard, milk carton, and food service applications (for example, paper cups, paper plates). To a much lesser extent, solid bleached board is used also for linerboard and other uses. Used heavily in food packaging and food service applications, solid bleached board produced in the United States generally contains little or no recycled fiber to avoid potential food contamination and to meet standards for food packaging materials. Virtually all U.S. mill capacity is integrated with bleached kraft pulp production.

In the FPL–UW database, solid bleached board mill capacity estimates also include some of the capacity for bleached bristols, lightweight bleached board that is produced for book covers, greeting cards, index cards, and other printing or writing applications. Production technology for solid bleached packaging board and bleached bristols is quite similar, and capacity estimates are not differentiated by product type in many cases, although bristols are traditionally classified by the industry as printing and writing paper

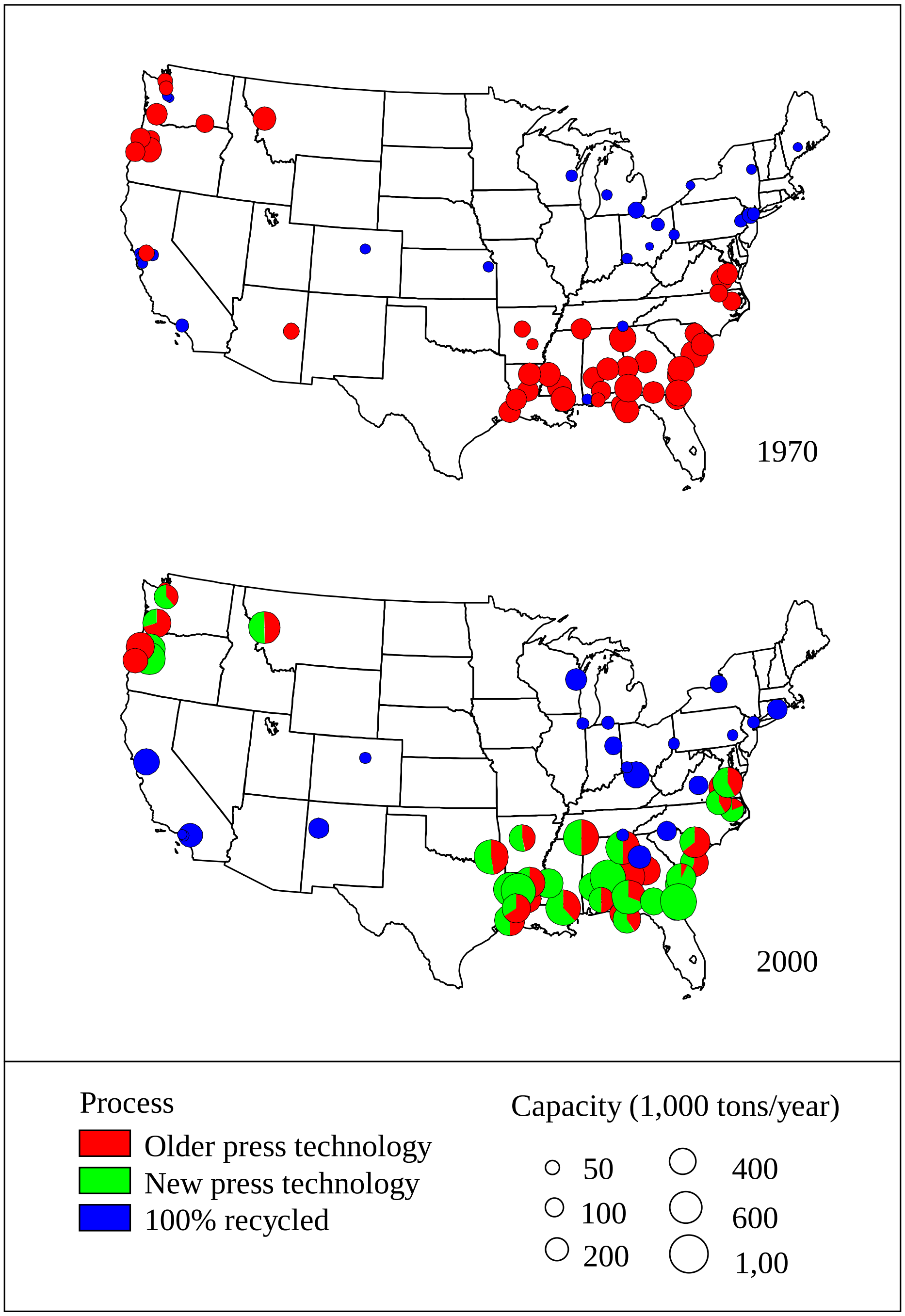

Figure 30—Location of linerboard capacity by process in the United States in 1970 and 2000.

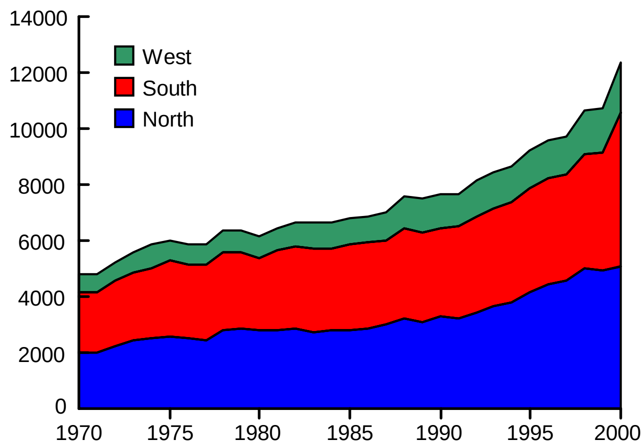

Figure 31—Regional capacity of corrugating medium in the United States (thousand short tons).

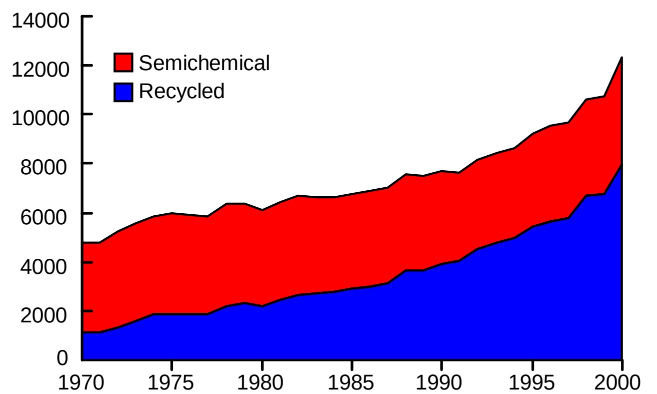

Figure 32—Corrugating medium capacity by fiber furnish in the United States (thousand short tons).

products rather than paperboard. Thus, the total U.S. capacity for solid bleached board according to the FPL–UW database is somewhat higher than the actual solid bleached paperboard capacity data published by AF&PA (by about one million tons in the year 2000, representing the capacity of bleached bristols).

Figure 34 illustrates trends in U.S. solid bleached board capacity by region from 1970 to 2000 according to the FPL–UW database (capacity estimates include solid bleached paperboard and some of the capacity for bleached bristols). Although solid bleached board is made typically from a mix of softwood and hardwood kraft pulp, capacity has always been located in the regions where softwoods are more abundant, the South and West. There is no capacity in the North. Most of the existing capacity and the bulk of the capacity growth in recent decades has been concentrated in the South.

Figure 35 illustrates geographical shifts in solid bleached board capacity at U.S. mill locations between 1970 and 2000. The distribution of mill locations changed very little during that period with most of the same mills still operating in the year 2000 as in 1970, although there was a trend of capacity expansion at many mill locations.

Other Recycled Paperboard

In the FPL–UW database, other recycled paperboard includes all paperboard that is made exclusively from recycled fiber except for recycled linerboard and recycled corrugating medium. Other recycled paperboard is produced primarily for boxboard (used mostly in consumer packaging), gypsum liner (facings for gypsum wallboard), other special packaging and board applications, and converting applications such as tube, can, and drum stock.

Figure 36 illustrates trends in other recycled paperboard capacity by region in the United States from 1970 to 2000, according to the FPL–UW database. The North has maintained the dominant share of total capacity among U.S. regions, but capacity has been gradually declining in the North. More capacity growth occurred in the South in recent decades than any other region. Overall U.S. capacity for other recycled paperboard (excluding linerboard and corrugating medium) has shown relatively little change with a gradual decline in recent decades according to the FPL–UW capacity database. By contrast, industry capacity data published by AF&PA indicate that other recycled paperboard capacity actually increased modestly (by somewhat more than a million tons) during the same period.

Figure 37 illustrates geographical shifts in other recycled paperboard capacity at U.S. mill locations between 1970 and 2000 according to the FPL–UW database. The distribution of mill locations for other recycled paperboard changed little during that period with many of the same mills still operating in the year 2000 as in 1970, although production capacity was expanded at many mill locations. Some mills were closed in the North between 1970 and 2000, while capacity generally expanded at other locations and other regions. However, there were still a relatively large number of mills and numerous relatively small mills operating in the North in the year 2000.

Market Pulp

Market pulp is pulp produced at one location and sold to industrial users at another location or exported. Market pulp has always represented a minor share of total U.S. pulp capacity, generally less than 15% (most U.S. pulping capacity is directly integrated at the same location with paper or paperboard production). Roughly half of U.S. market pulp production is exported. Compared with pulp used for paper production at integrated pulping and papermaking facilities, market pulp generally undergoes additional processing steps to facilitate warehouse storage and transportation, including pulp drying and baling. The principal categories of market pulp produced in the United States include bleached paper-grade chemical pulp (chiefly kraft pulp), deinked (or recycled)

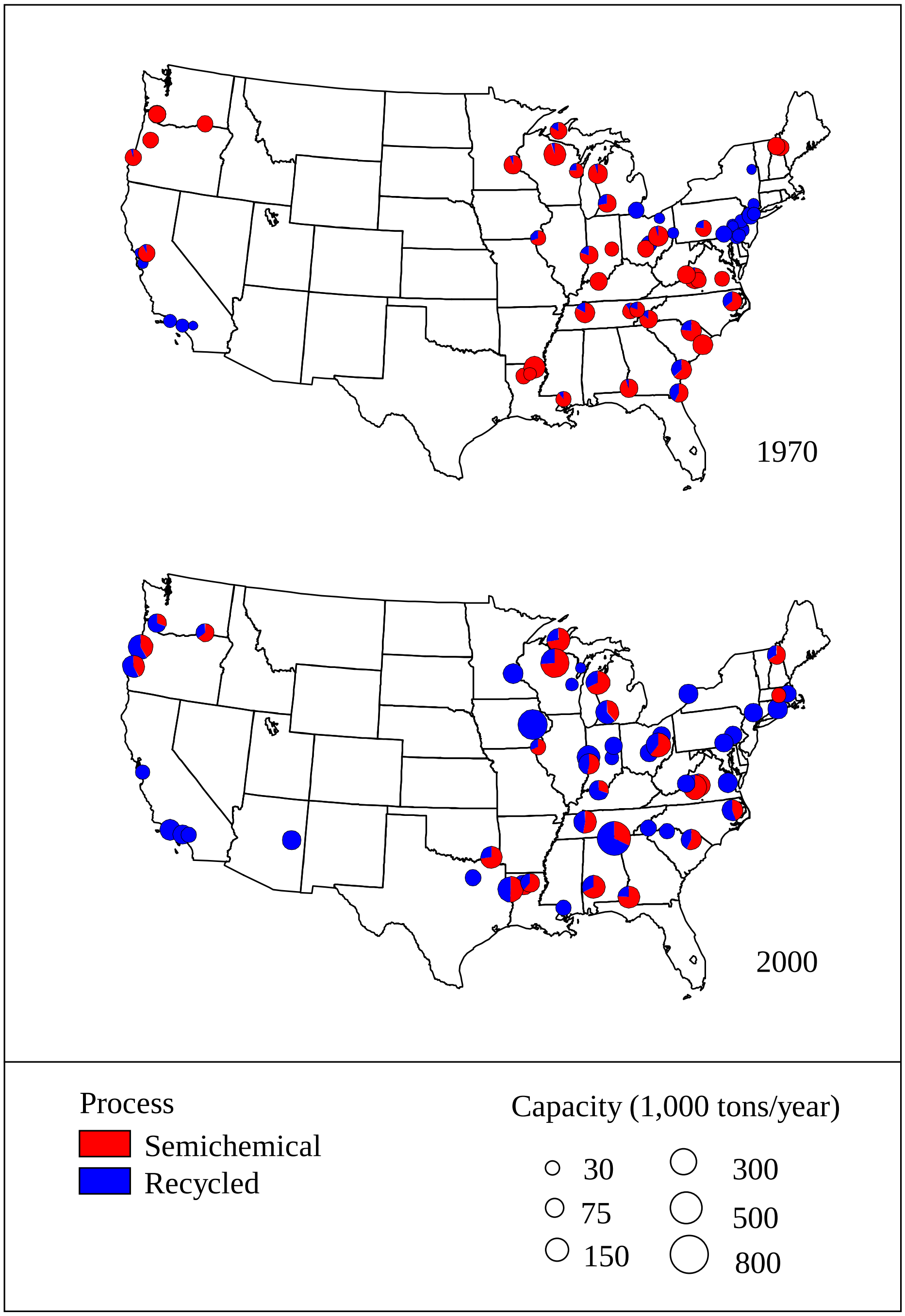

Figure 33—Location of corrugating medium capacity by fiber furnish in the United States in 1970 and 2000.

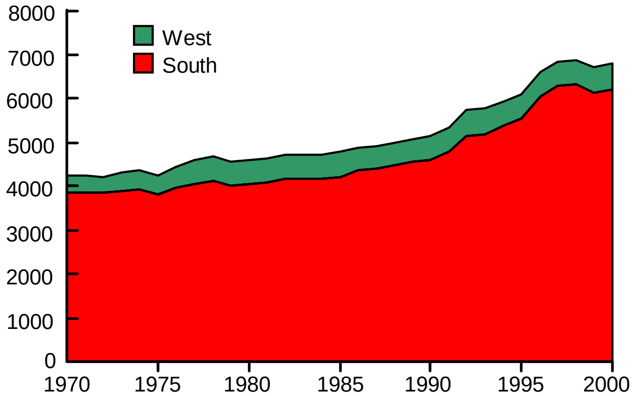

Figure 34—Regional capacity of solid bleached board in the United States (thousand short tons).

market pulp, dissolving pulp, and cotton linter pulp. A very small volume of mechanical pulp was produced as market pulp in the 1970s and 1980s, but capacity dropped to zero in the 1990s.

Paper-grade chemical pulp produced in the United States is primarily bleached or semibleached kraft pulp, sold to paper-makers for use in newsprint, printing and writing paper, tissue paper products, and also as 'fluff pulp' for use in applications such as wadding in diapers and other sanitary products. Mill capacity is differentiated into hardwood kraft and softwood kraft, based on fiber furnishes. A relatively small and declining share of paper-grade chemical pulp capacity is sulfite market pulp (sulfite capacity was less than 2% of chemical market pulp capacity in the year 2000, and it is included with kraft market pulp capacity in the FPL–UW database). Only a relatively small share of kraft market pulp is unbleached kraft pulp (less than 5%).

Deinked or recycled market pulp is pulp that is produced from recycled fiber and usually marketed as a lower cost substitute for bleached hardwood kraft market pulp. There was a surge in U.S. deinked market pulp capacity in the 1990s with a number of new mills built during that period. Expansion was stimulated in part by presidential executive orders that required U.S. government agencies to purchase office paper with specified recycled content standards. However, deinked market pulp capacity decreased somewhat in the late 1990s with limited growth in demand and weak prices.

Dissolving and special alpha pulps are highly processed low-yield pulps that consist of mostly alpha cellulose (wood cellulose). Dissolving pulp has been used traditionally to make rayon, acetate, and other cellulose derivatives and also to make some specialty paper products.

Figure 38 illustrates trends in total market pulp capacity by region in the United States from 1970 to 2000, according to the FPL–UW database. Most of the growth in U.S. market pulp capacity has occurred in the South, primarily based on expansion in kraft pulping capacity. Capacity in the North has fluctuated but increased modestly during the past decade. Capacity in the West receded significantly since the late 1980s, with declining harvest of timber on public lands in the West and declining supply of pulpwood chips from sawmills and plywood mills in the region.

Figure 39 shows trends in market pulp capacity by principal category according to the FPL–UW database, including hardwood and softwood kraft, recycled (deinked), mechanical (including bleached CTMP), dissolving, and cotton linter. Expansion in U.S. market pulp capacity in recent decades was concentrated in kraft pulp and deinked pulp.

Figure 40 illustrates geographical shifts in market pulp capacity at U.S. mill locations between 1970 and 2000 according to the FPL–UW capacity database. Softwood kraft pulping capacity expanded at a number of mill locations in the South and West, but the number of mills in the West declined (leading to an overall decline in capacity in the West). Hardwood kraft pulping capacity expanded in both the South and North. A proliferation of deinked market pulp mills appeared in the North along with several mills in the South, each generally smaller in capacity than the typically larger kraft pulp mills.

Shifts in Mill Size

In general, the average size of pulp, paper, and paperboard mills increased from 1970 to 2000. In part, this shift is attributable to a decline in the number of operational mills from 666 in 1970 to 530 in 2000 according to the FPL–UW database. During the same period, the total capacity of all paper, paperboard, and market pulp mills increased from 62.0 to 114.4 million tons. Thus, the average capacity per mill more than doubled, increasing from around 93 thousand tons per year to around 216 thousand tons per year.

Figure 41 shows that in 1970 there were 471 mills (out of a total of 666 mills) with capacity of less than 100 thousand tons per year. This was more than 71% of the total. By 2000, only 52% of mills had capacity less than 100 thousand tons per year (277 mills out of a total of 530). Also, in 1970, there were only 14 mills with capacity greater than 500 thousand tons per year. In 2000, this number had increased to 72 mills, more than five times the number in 1970. In general, many mills became significantly larger while many smaller mills were closed, so that in effect, larger mills were replacing smaller mills, and thus capacity expanded even though there was an absolute decline in the total number of mills.

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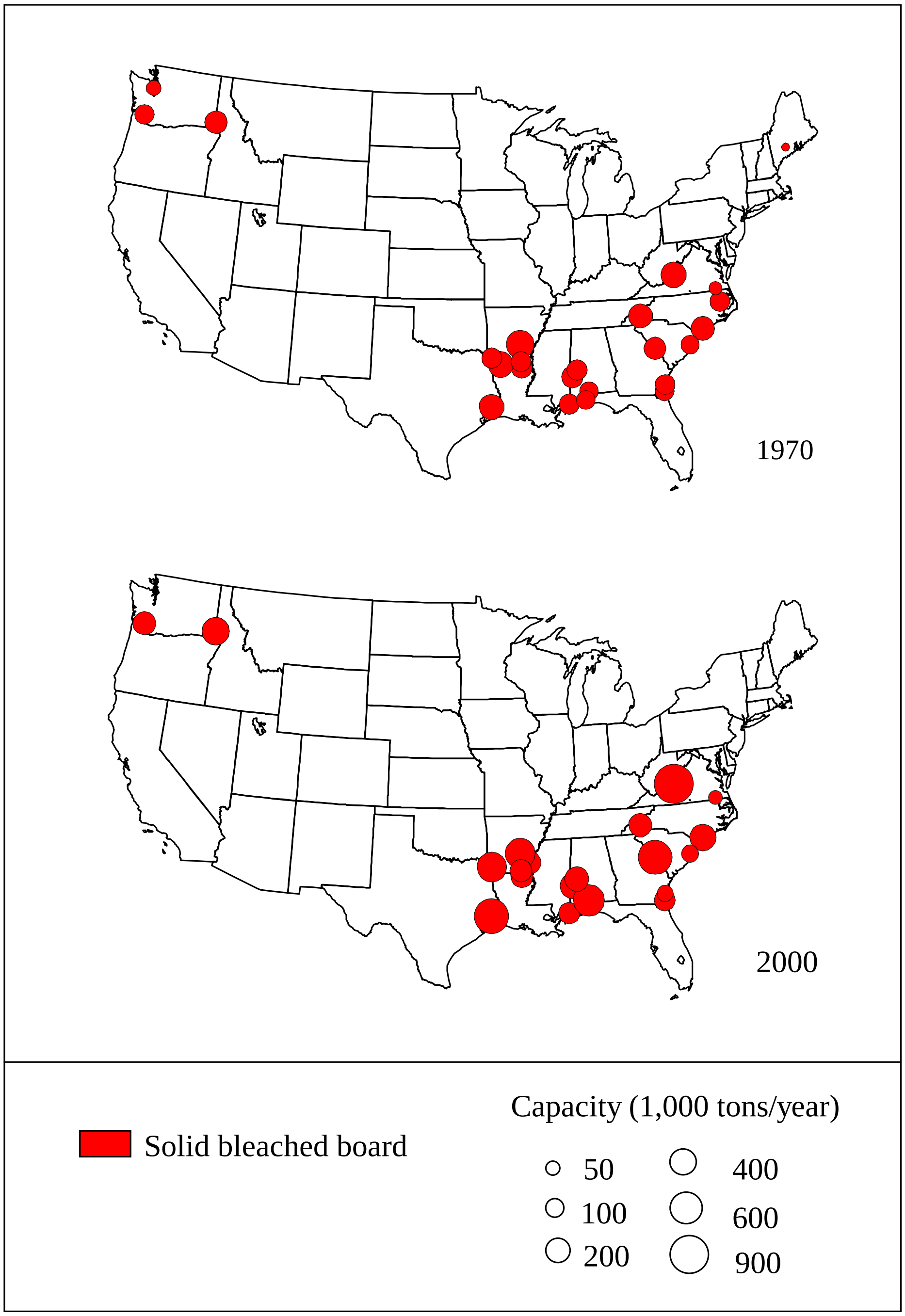

Figure 35—Location of solid bleached board capacity in the United States in 1970 and 2000.

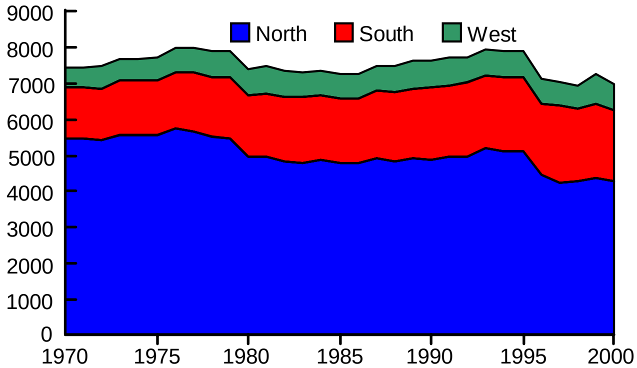

Figure 36—Regional capacity of other recycled paperboard in the United States (thousand short tons).

Shifts in Concentration by Firm and by State

As indicated in Table 5, there was a shift toward concentration of production capacity among larger firms between 1970 and 2000. In 1970, the top ten companies accounted for less than 35% of total paper, paperboard, and market pulp capacity. By 2000, the top ten companies accounted for nearly half the total capacity. The capacity of each of the top ten producers more than doubled from 1970 to 2000. The top two producers did not change rankings between 1970 and 2000, but the other eight rankings were either different companies or the same companies in a different order.

Table 6 shows the total capacity of paper, paperboard, and market pulp among the highest-producing States in 1970 and 2000. In general, the ranking of States in the West went down while the ranking of States in the East and South shifted upward.

Summary

On the whole, the production capacity of the U.S. pulp and paper industry expanded from 1970 to 2000, although the rate of growth gradually decelerated. Geographically, capacity growth shifted from the West to the East, and particularly to the South. Significant expansion occurred in production capacity based on recycled fiber, especially from the late 1980s to the late 1990s. The rate of overall capacity expansion has slowed since the late 1990s, with corporate consolidation and numerous mill closures, but average mill capacity more than doubled between 1970 and 2000.

From the standpoint of forestry and forest management, the fact that there is relatively little pulping and papermaking capacity in the Rocky Mountain and Great Plains regions is important. Pulpwood markets for small-diameter timber from National Forests in the interior West are limited.

The FPL–UW database provides a resource for analysis of shifts in production capacity by process and region. One application is in the area of modeling capacity change as a function of economic determinants, as part of larger efforts to model long-run evolution of capacity and production technology in the pulp and paper sector. Because the FPL–UW database allows more detailed analysis of shifts in capacity by process category and region, it supplements published national data on industry capacity by product (AF&PA 2000). Analyzing shifts in capacity by process and region is important in forest sector modeling where it is recognized that fiber input requirements vary by process type (for example, requirements for virgin materials differ from those of recycled wood fiber) and also regional pulpwood market trends are determined by regional pulp, paper, and paperboard capacity trends.

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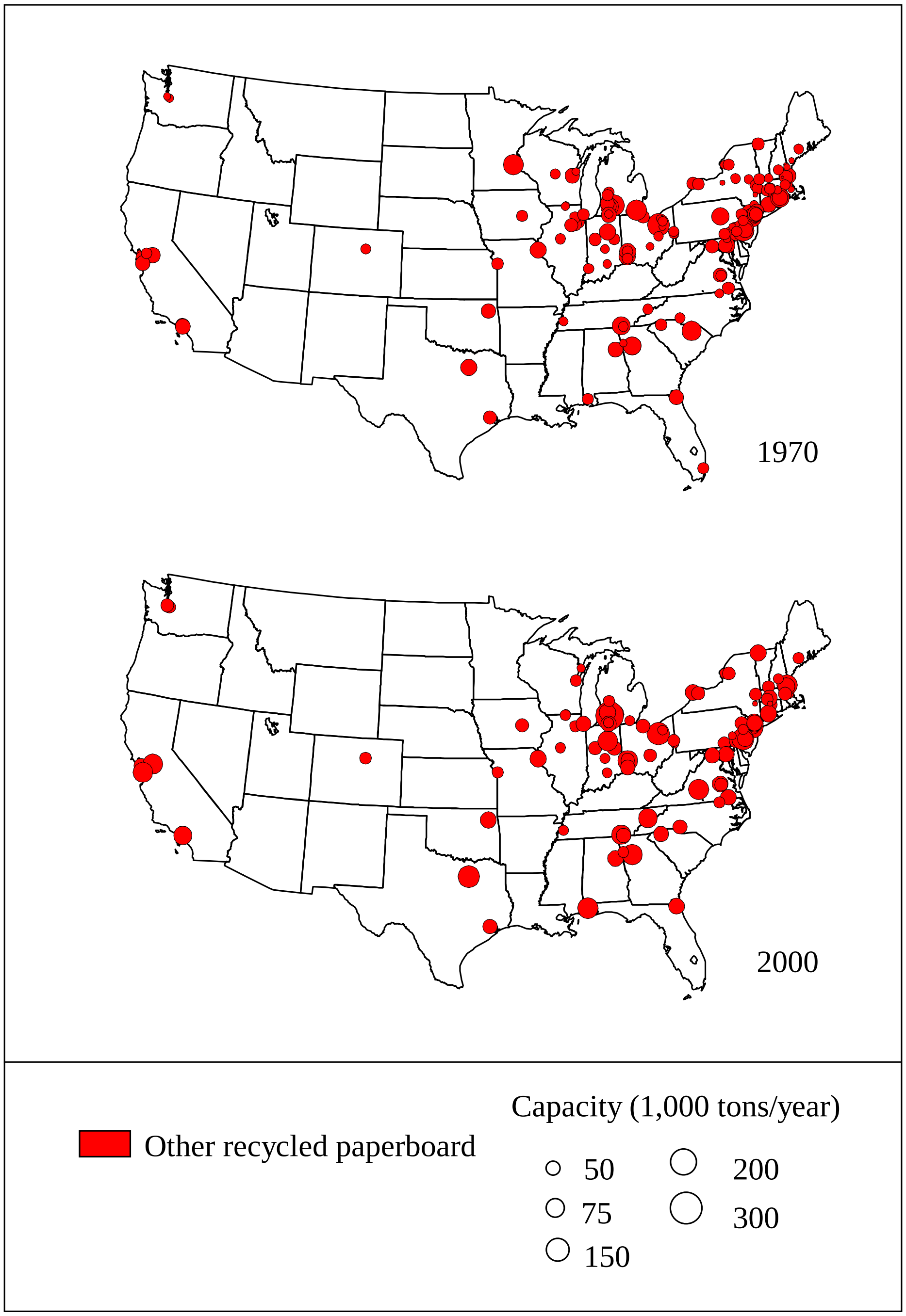

Figure 37—Location of other recycled board capacity by process in the United States in 1970 and 2000.

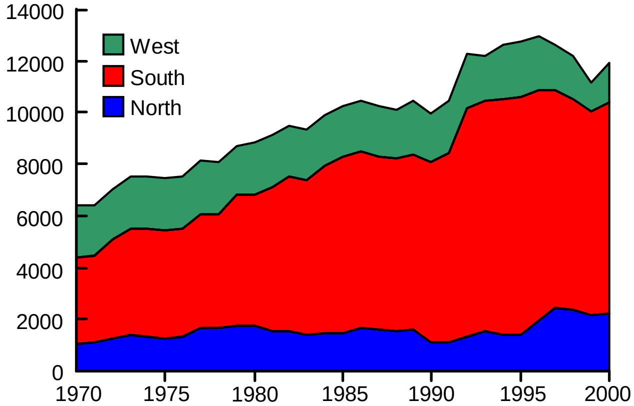

Figure 38—Regional market pulp capacity in the United States (thousand short tons).

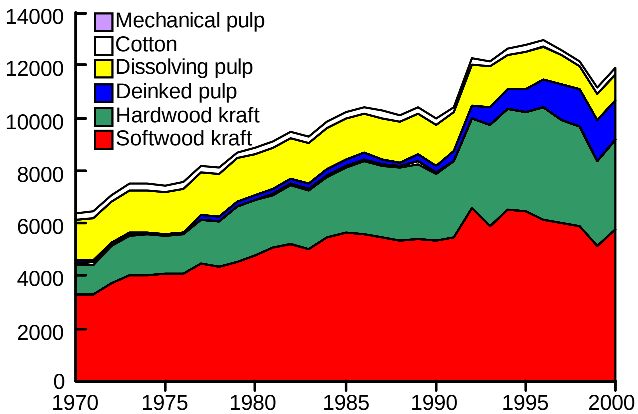

Figure 39—Market pulp capacity by category in the United States (thousand short tons) (capacity of mechanical pulp was insignificant).

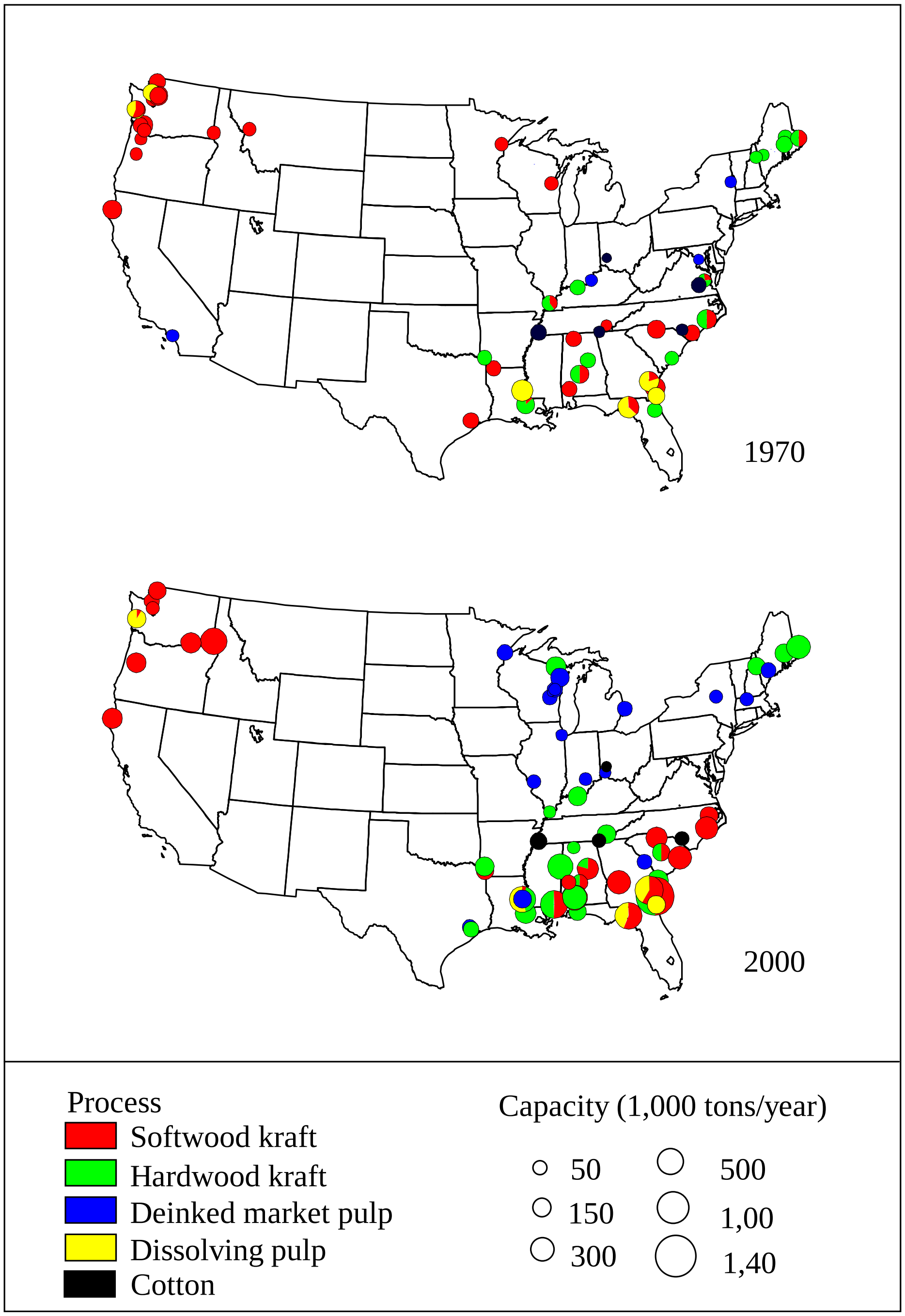

Figure 40—Location of market pulp capacity by category in the United States in 1970 and 2000.

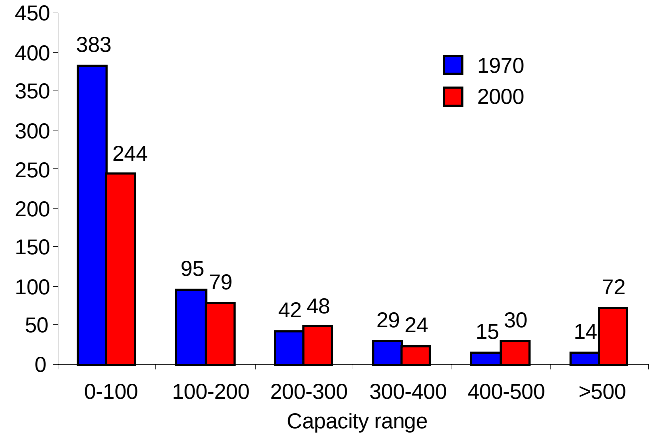

Figure 41—Number of U.S. paper, paperboard, and market pulp mills by capacity (thousand short tons) in 1970 and 2000.

Table 5—Top ten U.S. firms in total paper, paperboard, and market pulp capacity, 1970 and 2000

1970			2000		
	Annual capacity			Annual capacity	
	(thousand short tons)	(%)[a]		(thousand short tons)	(%)[a]
International Paper Co.	4,372	7.06	International Paper	11,920	10.42
Georgia–Pacific Corp.	2,741	4.43	Georgia–Pacific Corp.	7,571	6.62
Crown Paper Corp.	2,665	4.31	Smurfit–Stone Container Corp.	7,425	6.49
St Regis Paper Co.	2,193	3.54	Weyerhaeuser Co.	5,514	4.82
Weyerhaeuser Co.	2,072	3.35	Abitibi–Consolidated Inc.	4,730	4.14
Kimberly–Clark Corp.	1,716	2.77	Mead Corp.	3,685	3.22
Union Camp Corp.	1,440	2.33	Temp–Inland Inc.	3,525	3.08
Great Northern Paper Inc.	1,405	2.27	Westvaco Corp.	3,285	2.87
Scott Paper Co.	1,333	2.15	Willamette Industries Inc.	3,239	2.83
Container Corp. of America	1,278	2.07	Fort James Corp.	3,195	2.79

[a]Percentage of total United States capacity.

Table 6—Total capacity of paper, paperboard, and market pulp in highest-producing States

	1970		2000	
Rank	State	Capacity (thousand short tons)	State	Capacity (thousand short tons)
1	Georgia	4,727	Georgia	10,415
2	Washington	4,159	Alabama	9536
3	Alabama	3,842	Louisiana	7,437
4	Louisiana	3,602	Washington	7,265
5	Wisconsin	3,472	Wisconsin	7,129
6	Florida	3,139	Michigan	5,212
7	Maine	3,085	South Carolina	4,911
8	Oregon	2857	Maine	4,796
9	Michigan	2,609	Oregon	4,657
10	Pennsylvania	2,498	Virginia	4,638