Employment- and Wage-Consumption Ratios for Montana's Forest Products Manufacturers

Charles E. Keegan III *and* **Daniel P. Wichman**, *Bureau of Business and Economic Research, The University of Montana, Missoula, MT 59812;* **Gerald E. Evans**, *School of Business Administration, The University of Montana, Missoula, MT 59812; and* **Roger D. Fight**, *USDA Forest Service, Pacific Northwest Research Station, Portland, OR 97208.*

Abstract. *This article presents information on employment and payroll generated per unit volume of timber or wood fiber processed by the various manufacturing sectors of Montana's forest products industry for 1987–1989. Average employment ranged from a high of 117 workers per million cubic feet (mmcf) of wood fiber processed at house log plants, to a low of 12 workers per mmcf at stud mills. Employment-consumption ratios for cedar products plants and producers of utility poles and posts and small poles were 48, 47, and 34 workers per mmcf respectively. At sawmills, employment-consumption ratios ranged from 23 workers per mmcf for board mills to 12 workers per mmcf for stud mills. Plywood plants are slightly more labor intensive than board mills, employing 26 workers per mmcf of wood fiber processed. The processing of mill residue from sawmills and plywood plants by such users as the pulp and paper industry adds substantially to the employment per unit volume of timber processed. Because different components of the industry often use timber of different sizes, species, and quality, changes in the kind of timber available can have considerable influence on the structure of the industry and related employment. West. J. Appl. For. 8(2): 54-57.*

Many factors influence employment and payroll levels in the forest products industry. These can include such general and local factors as business cycles, timber availability, and technological changes. The way in which timber is processed can also have a substantial impact on employment. Consequently, resource managers, planners, and others concerned with estimating employment associated with timber production need to consider structural changes within the industry (Keegan and Jackson 1984, Keegan and Polzin 1987).

Employment and wages per volume of timber processed (referred to as *employment- and wage-consumption ratios*) have been developed only for the entire forest products industry in a given area (Schuster 1978, Wall 1979). Unfortunately, these ratios are not available for individual sectors of the forest products industry. Impacts and potential impacts of structural changes are, therefore, difficult to identify.

This paper presents employment- and wage-consumption ratios for the individual manufacturing sectors of Montana's forest products industry. These data assist in identifying and evaluating the potential changes in industry employment that are driven by changes in industry structure.

Volumes are presented both in board feet Scribner Decimal C log scale (Eastside Convention) and cubic feet of solid wood fiber.

Methodology and Data Sources

Montana's forest products industry produces an array of products typical of the Rocky Mountain region. These include numerous softwood lumber and plywood grades, products made from sawmill and plywood residue (linerboard, particleboard, and medium density fiberboard), log homes, utility poles, cedar products, and small roundwood products such as fence posts.

Data on Montana's industry came primarily from two sources: (1) The Current Forest Industries Information System (CURFOR), a cooperative project with the Montana Wood Products Association, is a series of quarterly and annual surveys of the state's largest plants. CURFOR captures about 90% of Montana's timber processing activity. (2) The Forest Industries Data Collection System (FIDACS) is conducted in cooperation with the USDA Forest Service, Intermountain Research Station,

NOTE: Funding was provided by The USDA Forest Service, Pacific Northwest Research Station under Coop Agreement #PNW 90-675.

Interior West Resource Inventory, Monitoring and Evaluation Program. FIDACS is a periodic census of forest products industry manufacturers in the various states of the Rocky Mountain region.

In combination, the surveys and census include a number of key variables relating to facility operations, including average monthly employment, payrolls, hours worked, and timber processed. These variables make it possible to calculate workers and wages per unit volume of timber processed, based on a 12 month year and a 40 hour week equivalent.

The most recent census of Montana's industry was done in 1988. CURFOR data from 1987–1989 and the 1988 census were used to develop the employment- and wage-consumption ratios for this paper. Because there are few utility pole and cedar products manufacturers in Montana, we surveyed similar mills in Idaho in 1990 and 1991 to increase sample size. The employment data presented are from 21 sawmills, 4 plywood plants, 3 residue-related processing facilities—a pulp and paper mill, a particleboard plant, and a medium density fiberboard plant—20 log home facilities, 6 post and pole facilities, 5 utility pole plants, and 6 cedar products plants.

Overview of the Forest Products Industry

For the period 1987–1989, 11,000 to 12,000 full- and part-time workers in Montana were involved in harvesting and processing approximately 1,250 million board feet (mmbf) Scribner of timber annually (U.S. Department of Commerce 1991, Bur. Bus. Econ. Res. 1991)—or an average of approximately 9 workers annually per mmbf. This paper deals with the approximately 7,000 full- and part-time workers employed in processing timber at mill sites.

Approximately 4,000 additional workers are employed in the logging sector, and approximately 1,000 are employed in private sector timber management activities. In particular, logging employment per unit volume of timber harvested differs among the various manufacturing sectors. However, precise estimates of logging employment associated with the various sectors is impossible because few data are available on the logging sector.

The specific categories used for Montana's industry are described in more detail below.

Sawmill Sector

In descending order based on the volume of timber used, the major species used to produce lumber in Montana are: lodgepole pine *(Pinus contorta)*; Douglas-fir *(Pseudotsuga menziesii)*; ponderosa pine *(Pinus ponderosa)*; western larch *(Larix occidentalis)*; Engelmann spruce *(Picea engelmannii)*; true firs (*Abies* spp.); western redcedar *(Thuja plicata)*; western white pine *(Pinus monticola)*; and western hemlock *(Tsuga heterophylla)*. These species are processed into a range of grades from relatively low value studs to very high value select lumber produced from ponderosa pine and western white pine (Bur. Bus. Econ. Res., 1991).

We have divided Montana's sawmill sector into three categories—stud mills, board mills, and random length dimension mills. The major output of stud mills is lumber 2 by 4 in. or 2 by 6 in. and up to 10 ft long. We defined board mills as those producing 50% or more of their output in board, shop, and better lumber. Random length dimension mills were defined as sawmills which produce random lengths and widths of lumber with more than 50% of their output in dimension grades of lumber.

Plywood Sector

Montana's plywood mills primarily process Douglas-fir and western larch into industrial grade and structural grade plywood. Common uses of industrial grade plywood include manufacturing recreation vehicles, boats, van liners, and carpet strips. Structural grade plywood is suitable for construction uses such as structural sheathing and flooring.

Residue-Related Products Sector

Montana's residue-related products sector consists of three major facilities: a pulp and paper mill producing linerboard; a particleboard plant; and a medium density fiberboard plant.

The linerboard facility primarily uses coarse mill residue (chips) from sawmills and plywood plants and sawdust from sawmills to produce unbleached kraft linerboard used in the manufacture of corrugated containers. The particleboard plant primarily uses planer shavings from sawmills to produce industrial grade particleboard of both 45 lb and 55 lb/ft^3 density. Montana's medium density fiberboard plant uses chips, planer shavings, and sawdust to produce fiberboard in three densities—48, 55, and 60 lb/ft^3.

House Logs \ Log Home Sector

Virtually all Montana's house log manufacturers produce not just individual logs but predesigned log home shells, and in some cases, complete log homes. House logs may be hand-hewn, sawn (surfaced on two or more sides), or machine-planed or lathe-sized. About 4% of Montana's log home industry produces sawn logs; the remainder is fairly equally divided between hand-hewn and planed\lathe-sized logs (Keegan et al. 1990b).

Post and Small Pole Sector

This sector produces posts, small poles, and rails of various sizes—generally not greater than 6 in. average diameter—primarily for use in fence and corral construction. These products are often preservative treated. Producers in this sector also manufacture tree props used to support grape vines and orchard trees.

Utility Pole Sector

The utility pole sector produces wood poles to support electrical wires. Poles are normally purchased in lengths from 25 to 100 ft. The small end diameter of these poles is generally 5 to 8 in.

Cedar Products Sector

This sector specializes in two types of cedar products, shakes and shingles (used for roofing and siding on houses and other structures), and split-rail fencing.

We limited this analysis to facilities reporting at least five full-time equivalent workers annually. Each residue-related plant, plywood plant, and sawmill included in this analysis processed more than 5 mmcf of wood fiber annually. Among the remaining sectors, only 1 plant processed in excess of 1 mmcf, and none processed more than 2 mmcf of wood fiber annually.

When timber or mill residue in this article is expressed in cubic feet, it is solid wood equivalent (S.W.E.). S.W.E. is an equivalent amount of wood fiber to that found in a given volume of solid, green wood of the same species (Snellgrove et al. 1984).

Results

Average annual wages and employment and wages per unit volume of wood fiber processed vary among the sectors of the industry.

Average annual wages per worker are substantially higher at the larger plants. The highest wages are found in Montana's residue-related facilities—the linerboard, particleboard, and medium density fiberboard plants—where workers average $38,900/yr in 1989 dollars (Table 1).

Smaller producers have the highest employment per unit volume of wood fiber processed—or employment consumption ratios (Table 2). Log home plants are the most labor intensive at 116.7 workers per mmcf of wood fiber processed.

Among the large producers, plywood plants have the highest employment consumption ratios, employing 26.3 workers per mmcf of wood fiber processed. Major residue processors comprise the least labor intensive sector; their employment-consumption ratio is 9.3 workers per mmcf of wood fiber processed.

The data presented in Table 2 represent nearly the entire population of mills in Montana. In fact, the data for 1988 are based on the entire population, excluding only the very smallest producers. For 1987 and 1989, the sample represents about 90% of the state's processed timber. Given this virtual census of mills, an inferential procedure is unnecessary—one does not need to estimate parameters that are known. Consequently, the differences presented in Table 2 are actual differences in the population. The inferential procedures were performed, and, as expected, all differences were statistically reliable.

Worker payroll is often a better measure than employment numbers when analyzing effects on local economies (Polzin 1990). Data for the late 1980s show that the most labor intensive facilities generally have lower wages. Therefore, the spread in wages generated per mmcf of timber processed is less than the spread in numbers of workers per mmcf.

Table 1. Wages by industry sector in 1989 dollars.[1]

Industry sector	Ave. annualwage per worker ($)
Sawmills	
Board mills	22,900
Random length mills	23,300
Stud mills	23,700
Plywood plants	25,400
Residue-related sector	38,900
Other processors	
House log plants	17,000
Post/pole plants	16,000
Utility pole plants	17,500
Cedar product mills	19,200

[1] Wages are annual average wages for full-time equivalent production, administrative, and clerical workers. Approximately 80% are production workers and 20% are administrative and clerical. These are workers employed 40 hr/wk, 52 wk/yr including vacation and holidays

House log plants—the most labor intensive—also generate the highest wage-consumption ratios; on average they pay $1,984,400 in workers' wages per mmcf of wood fiber processed (Table 3).

Among the larger timber processors, plywood plants have the highest wage-consumption ratio, generating $669,200 per mmcf of wood fiber processed. Among sawmills, total wages paid per mmcf range from a low of $273,100 at stud mills to $531,400 at board mills. The residue-related sector's wage-consumption ratio is slightly higher than at stud mills, generating $362,400 per mmcf of wood fiber processed.

Discussion

These ratios provide some insight into the relationship between how timber is processed, the structure of the forest products industry, and employment. A key component of this relationship is the processing of sawmill and plywood residue.

Since Montana's residue-related sector depends on sawmills and plywood plants for virtually all its raw materials, one could argue that employment and wages in the residue-related sector should be associated with these mills. Montana sawmills ship

Table 2. Mill employment-consumption ratios.

Industry sector	Employees per mmbf, Scribner[1]	Range	Employees per mmcf[2]	Range
Sawmills				
Board mills	4.3	4.0–5.7	23.2	21.5–30.9
Random length mills	3.7	3.1–4.1	18.5	15.4–20.7
Stud mills	2.7	2.2–3.5	11.5	9.6–15.1
Plywood plants	5.0	4.4–6.2	26.3	23.3–32.9
Residue-related sector	NA*		9.3	9.0–11.0
Other processors				
House log plants	23.0	12.0–84.0	116.7	60.0–420.0
Post/pole plants	NA*		34.1	15.1–61.7
Utility pole plants	9.6	7.0–12.4	48.0	35.0–62.0
Cedar product mills	9.5	7.1–17.5	47.3	35.6–87.5

NOTE: Employment is presented on a full-time equivalent basis—40 hr/wk, 52 wk/yr, including paid holidays and vacation. About 80% of these employees are production workers and 20% are associated administrative and clerical workers.
[1] Million board feet, Scribner log rule.
[2] Million cubic feet.
NA* Not applicable.

Table 3. Wage-consumption ratios.

Industry sector	Wages per mmbf, Scribner[1] ($)	Wages per mmcf[2] ($)
Sawmills		
Board mills	98,400	531,400
Random length mills	86,100	430,400
Stud mills	63,500	273,100
Residue-related sector	NA*	362,400
Plywood plants	126,300	669,200
Other processors		
House log plants	396,900	1,984,400
Post/pole plants	NA*	546,200
Utility pole plants	168,000	840,000
Cedar product mills	203,900	1,019,400

[1] Million board feet Scribner log rule.
[2] Million cubic feet.
NA* = Not applicable.

about 91% of their chips and planer shavings and about 32% of their sawdust to these processors. Plywood plants ship virtually all their chippable residue to these users (Bur. Bus. Econ. Res. 1991).

Because of this relationship, employment- and wage-consumption ratios were developed for the sawmill and plywood sectors assuming residue-related sector employment is directly linked to these timber processing mills. More specifically, for every 1.0 mmcf of logs processed by board mills, random length dimension mills, and stud mills, 0.44 mmcf of wood fiber residue was shipped to the residue-related processors. For every 1.0 mmcf of logs processed by plywood mills, 0.47 mmcf of residue was shipped to the residue-related processors (Keegan et al 1990a).

Employment- and wage-consumption ratios of sawmills and plywood plants increase by 17 to 36% and 24 to 56%, respectively, when residue-related processors' employment and wages are assigned to the sawmills and plywood plants that generate wood residue (Tables 4 and 5). The highest percentage increase is at stud mills, where employment per mmcf rises 36% and wages per mmcf rise 56%.

The findings clearly show that different mill types and industry structures can generate substantially different numbers of jobs and different payrolls per unit volume of timber processed. Changes in mill types in an industry can be directly related to the size, species, and quality of timber available for processing, therefore, employment and income may change substantially even with no change in the volume of timber harvested (Keegan and Polzin 1987). For example, a switch from harvesting old growth ponderosa pine processed by board mills to small diameter lodgepole pine suitable for stud logs: Even if timber volume remained constant, the switch would lead to a decline in mill employment from approximately 23 workers/mmcf to 12 workers/mmcf. Associated wages generated per mmcf would decline from approximately $531,000 to $273,000.

On the other hand, a large increase in the proportion of the harvest suitable for house logs or other labor intensive timber products such as utility poles or cedar product logs might produce a dramatic increase in timber related employment. Thus the structure of the forest products industry is an important factor to be considered when examining potential changes in employment in the forest products industry. Changes in employment driven by structural changes may be at least as important as those caused by volume changes or labor saving technology.

Table 4. Employment per mmcf for plywood plants and sawmills, assuming a direct linkage to residue-related sectors.

Industry sector	Employees per mmcf (W/O residue)[1]	Employees per mmcf (with residue)[2]
Plywood plants	26.3	30.7
Board mills	23.2	27.3
Random length mills	18.5	22.6
Stud mills	11.5	15.6

[1] Not including the employment generated by the residue processing facilities which get their material from plywood plants and sawmills.
[2] Including the employment generated by the residue processing facilities which get their material from plywood plants and sawmills.

Table 5. Wages per mmcf for plywood plants and sawmills, assuming a direct linkage to residue-related sectors.

Industry sector	Wages per mmcf ($) (W/O residue)[1]	Wages per mmcf ($) (with residue)[2]
Plywood plants	669,200	831,400
Board mills	531,400	683,400
Random length mills	430,400	582,200
Stud mills	273,100	425,000

[1] Not including the wages generated by the residue processing facilities which get their material from plywood plants and sawmills.
[2] Including the wages generated by the residue processing facilities which get their material from plywood plants and sawmills.

Literature Cited

BUREAU OF BUSINESS AND ECONOMIC RESEARCH. 1991. CURFOR: Current forest industries information system [data base]. Bur. Bus. Econ. Res., The Univ. of Montana, Missoula.

BUREAU OF BUSINESS AND ECONOMIC RESEARCH. 1991. FIDACS: Forest industries data collection system [data base]. Bur. Bus. Econ. Res., The Univ. of Montana, Missoula.

KEEGAN, C.E. III, and T.P.JACKSON. 1984. The future of Montana's forest products industry. Montana Bus. Quart. Vol. 22 No. 3. Bur. Bus. Econ. Res., The Univ. of Montana, Missoula. 4 p.

KEEGAN, C.E. III, L.D. SWANSON, D.P. WICHMAN, and D.D. VAN HOOSER. 1990a. Montana's forest products industry: A descriptive analysis 1969–1988. Bur. Bus. Econ. Res., The Univ. of Montana, Missoula. 52 p.

KEEGAN, C.E. III, D.P. WICHMAN, P. LARSON, and D.D. VAN HOOSER. 1990b. Montana's log home industry. Bur. Bus. Econ. Res., The Univ. of Montana, Missoula. 8 p.

KEEGAN, C.E. III, and P.E. POLZIN. 1987. Trends in the wood and paper products industry: Their impact on the Pacific Northwest economy. J. For. 85(11). 6 p.

POLZIN, P.E. 1990. The verification process and regional science. The Ann. Reg. Sci. 24:61–67.

SCHUSTER, E.G. 1978. Montana's timber harvest and timber-using industry: A study of relationships. Montana For. Cons. Exp. Stn., School of For., The Univ. of Montana, Missoula. 36 p.

SNELLGROVE, T.A., T.D. FAHEY, and B.S. BRYANT. 1984. User's guide for cubic measurement. USDA For. Serv. PNW, Portland, OR. 107 p.

U.S. DEPARTMENT OF COMMERCE. 1991. Regional economic information system. Bur. Econ. Anal.

WALL, B. 1979. Employment: wood consumption ratios for the forest products industry in subareas of Oregon and Washington. USDA For. Serv. Res. Note PNW-342. 7 p.