



Research Article - harvesting & utilization

Timber Use, Processing Capacity, and Capability within the USDA Forest Service, Rocky Mountain Region Timber-Processing Area

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Abstract

Over the past two decades, more than half a million acres of forested land has experienced extensive insect- and disease-caused tree mortality within the USDA Forest Service Rocky Mountain Region 2 (R2) of the National Forest System. To plan for timber harvest treatments needed to restore forest health, managers need information on forest product facility capacity and capability to profitably process timber of various size classes. To answer this need, the authors summarized timber harvest volumes by state and county group, identified facilities in the R2 area, quantified timber-processing capacities and size class capabilities, and analyzed the geographic variability of timber flows from county of harvest to mill. Results showed that nearly 285.5 million board feet Scribner of timber flowed from the study area to 101 processors throughout the R2 timber-processing area. Approximately 70 percent of annual milling capacity can profitably process trees ≥ 10 in. dbh, whereas just 8 percent can process timber < 7 in. dbh. When planning forest-management activities, land managers should balance the need to remove small and/or dead trees with the local industry's ability to profitably use that material.

Keywords: small-diameter timber, timber harvest, timber-processing capacity, wood use

Insect and disease outbreaks in the central Rocky Mountains reached epidemic levels in the last two decades, resulting in large volumes of dead trees across parts of Wyoming, Colorado, and South Dakota. Annual mortality across all ownerships from insects and disease on timberland¹ in the National Forest System Rocky Mountain Region 2 (R2) is estimated to be 597.5 million cubic feet (MMCF), 88 percent of all mortality. By comparison, fire mortality accounts for 3.5 percent and logging for 0.5 percent (USDA 2019). State agencies and the US Forest Service have

increased investments in forest health, hazardous fuels mitigation, and safety protection on private and public lands (State of Colorado 2017, Wyoming State Forestry Division 2017). These treatments, designed to restore ecological condition and function, and reduce fire hazard, often require the removal of a mix of timber valuable enough to offset some of the costs associated with removing smaller trees with limited value and markets (Wagner et al. 2000). The loss of milling infrastructure throughout the West combined with changing management objectives on federal lands

Management and Policy Implications

This manuscript characterizes Rocky Mountain area forest products facilities capacity and capability to mill timber of varied sizes. This information will help land managers, forest planners, and production foresters plan viable timber harvest treatments that meet management objectives. Specifically, this work summarizes mill capacity and capability by timber size class and product, and will provide managers the knowledge needed to minimize the frequency of unsold timber sales.

has prompted questions about industry's ability to purchase and use timber of varying sizes and quality at harvest volumes adequate to meet forest-management goals while ensuring industry's economic sustainability (Keegan et al. 2005, 2006).

To plan for timber harvest treatments needed to restore the health of forest lands, R2 managers need in-depth information on forest product facility capacity and capability to process timber of various size classes. To answer this need, forest industry research staff at the University of Montana's Bureau of Business and Economic Research (BBER) summarized timber harvest volumes by state and county group, identified forest products facility locations, quantified timber-processing capacities and size class capabilities of facilities, and analyzed the geographic variability of timber flows from county of harvest to mill in a forest planning support document developed for R2 forest planners (Simmons et al. 2019a).² Individual forest-by-forest analyses have also been completed for the Medicine Bow-Routt National Forest (McIver et al. 2017a), Rio Grande National Forest (McIver et al. 2017b), Grand Mesa, Uncompahgre, Gunnison (GMUG) National Forest (McIver et al. 2017c), Black Hills National Forest (McIver et al. 2017d), and Pike San Isabel National Forest (Simmons et al. 2019b). The current research builds on these efforts. Current research objectives are to:

1. Characterize the harvest of timber from the counties containing R2 timberland—the “study area.”
2. Analyze the timber flow and identify the location of receiving timber harvested from the study area. This study focuses on facilities that exclusively use timber in round form (i.e., logs).
3. Characterize the types of facilities and quantify their capacity to process timber and their capability to use timber of various sizes at the Regional and state level.
4. Quantify facility consumption and use of timber at the Regional and state level.

Methods

Data for this analysis were based on 2014 data for Wyoming mills (McIver et al. 2017e) updated through communication with mill operators, and 2016 data for South Dakota, New Mexico, and Colorado mills

(Hayes et al. in press). Timber harvest and flow from all ownerships within the study area were analyzed using BBER's database developed from periodic censuses of the primary wood products industry in western states (Hayes et al. in press, McIver et al. 2017e), and USFS (2016) cut and sold reports and conversations with mill owners. To determine the Region 2 timber-processing area (R2-TPA), counties containing mills receiving timber from the R2 study area were identified. If historic (2010/2012) data indicated a substantial flow of R2 study area timber into a county, the county was included in the TPA, even if recent (2014/2016) flows were relatively small or nonexistent. Finally, all other counties receiving timber from the study area were included if the volume represented more than 10 percent of the total timber received in that county.

“Capacity” refers to the total volume of timber (a k a roundwood or logs) that existing timber processors can use annually. Also known as “timber-processing capacity,” it is a measure of input capacity and generally expressed in board feet Scribner or cubic feet log scale. Input capacity is a useful measure when attempting to express the capacity of multiple types of mills in a common unit of measure because finished products (output and output capacity) are measured in a variety of units: board feet lumber tally (lumber), lineal feet (house logs), and pieces (posts, small poles, and log furniture). Input capacity is a measure of the volume of logs that a mill can process in a given year, given firm market demand and sufficient raw material. The current research characterizes the input capacity of facilities that exclusively use timber in round form. This includes sawmills processing timber into lumber, facilities processing timber into house logs, posts, poles, log furniture, excelsior, fuel pellets, firewood, and landscaping chips, and mills processing timber into multiple products at the same facility (e.g., lumber and house logs).

In contrast, “capability” refers to the volume of trees of a certain size class (measured as diameter at breast height [dbh]) that existing timber processors can *efficiently and economically* process annually. Most facilities are designed to operate using trees of a given size class (e.g., log home manufacturers, producing house

logs, typically use trees ≥ 10 in. dbh, and post manufacturers primarily use trees < 8 in. dbh). Capability at these facilities is readily classified in a single size class. This is true for some sawmills, but sawmills can vary greatly in equipment, configuration, product output, and their ability to process timber of various sizes (Wagner et al. 1998, 2000, Stewart et al. 2004, Keegan et al. 2005, 2006).

For each facility in the R2-TPA, an estimation of the facility's capability to process timber of a given size was made based on literature (Wagner et al. 1998, 2000, Stewart et al. 2004, Keegan et al. 2005, 2006), conversations with mill owners, and the most recent BBER mill census data, taking into consideration the financial feasibility and physical characteristics of the mill. For this research, three tree size classes were used: < 7 in. dbh, 7–9.9 in. dbh, and ≥ 10 in. dbh. BBER researchers first assigned capability to efficiently process timber < 10 in. dbh. Capability to process trees ≥ 10 in. dbh was then calculated as the proportion of total capacity *not* capable of efficiently using trees < 10 in. dbh. Total timber-processing capacity and capability by dbh class are presented in both thousand board feet (MBF) Scribner and thousand cubic feet (MCF) to facilitate discussion among forest managers, timber purchasers, and facility operators.

Results and Discussion

Timber Harvest

The R2 study area comprises of 66 counties with National Forest lands located in Colorado, Wyoming, and South Dakota (Figure 1). Although there are two National Forests in Nebraska, they were not included in this analysis. National Forests account for nearly 71 percent (11.6 million acres) of the timberland in the R2 study area, of which 36 percent (approximately 4.2 million acres) are considered suitable for timber production³ (Sidon 2019). Among the R2 states, Colorado has the largest proportion of timberland (63 percent) and accounts for the largest proportion of National Forest timberland throughout R2.

Timber harvested from the R2 study area for commercial products and delivered to primary wood products facilities totaled nearly 285,500 MBF, or approximately 67,500 MCF in 2016. National Forests accounted for the largest proportion (66 percent) of harvest in the study area. South Dakota had the largest proportion of harvest from National Forest (72 percent) and Wyoming the smallest (57 percent). Private timberlands were the second largest provider of timber in each state. Timber harvested in the study

area comprised ponderosa pine (*Pinus ponderosa*) (43 percent), lodgepole pine (*Pinus contorta*) (30 percent), and spruce (*Picea* spp.) (12 percent). Douglas-fir (*Pseudotsuga menziesii*) accounted for 5 percent, aspen (*Populus tremuloides*) 3 percent, and undifferentiated softwoods 7 percent.

Timber-Processing Facility Overview

The R2-TPA includes 73 counties in six western states. A total of 101 primary timber-processing facilities were active in the R2-TPA during 2016 (Figure 2), with Colorado having the majority of the facilities and the most diverse range of wood products. Sawmills, post, pole, and log furniture facilities were the most abundant types of facilities in each state and overall. An understanding of the structure of the industry can add insight into which facilities have the capability to use timber of various sizes as well as other characteristics (e.g., log quality) that may be important to potential timber sale bidders and timber processors. Generally speaking, capability to use larger-diameter timber is concentrated in sawmills and log home or other houselog producers, whereas capability to use smaller-diameter timber resides with post, pole, log furniture, and firewood producers. Sawmills can process a limited percentage of their inputs from smaller trees or trees that have been killed by insect or disease as long as the material is sound. Log home and other houselog-producing facilities need larger trees and prefer standing recently dead trees, particularly lodgepole pine or spruce. Post, pole, firewood, and other facilities can use smaller and lower-quality timber for their products.

Timber Flow

Nearly 285,500 MBF Scribner of timber flowed from the R2 study area to processors throughout the R2-TPA in 2016 (Table 1), of which approximately 30 percent were dead at the time of harvest. Forestland in Colorado provided the largest share (42 percent) of the timber harvested in the study area, and facilities in Colorado and South Dakota together processed about 69 percent of the timber harvested in the study area. Colorado had the highest (84 percent) in-state retention of timber, followed by South Dakota, with 78 percent. About 24,890 MBF (43 percent) of the timber harvested in Wyoming was processed out of state, with over 12,100 MBF going to out-of-region facilities (i.e., facilities within the R2-TPA, but not in Colorado, South Dakota, or Wyoming). Out-of-region facilities received 5.6 percent of the total timber volume harvested in the R2 study area, the majority of which was harvested in

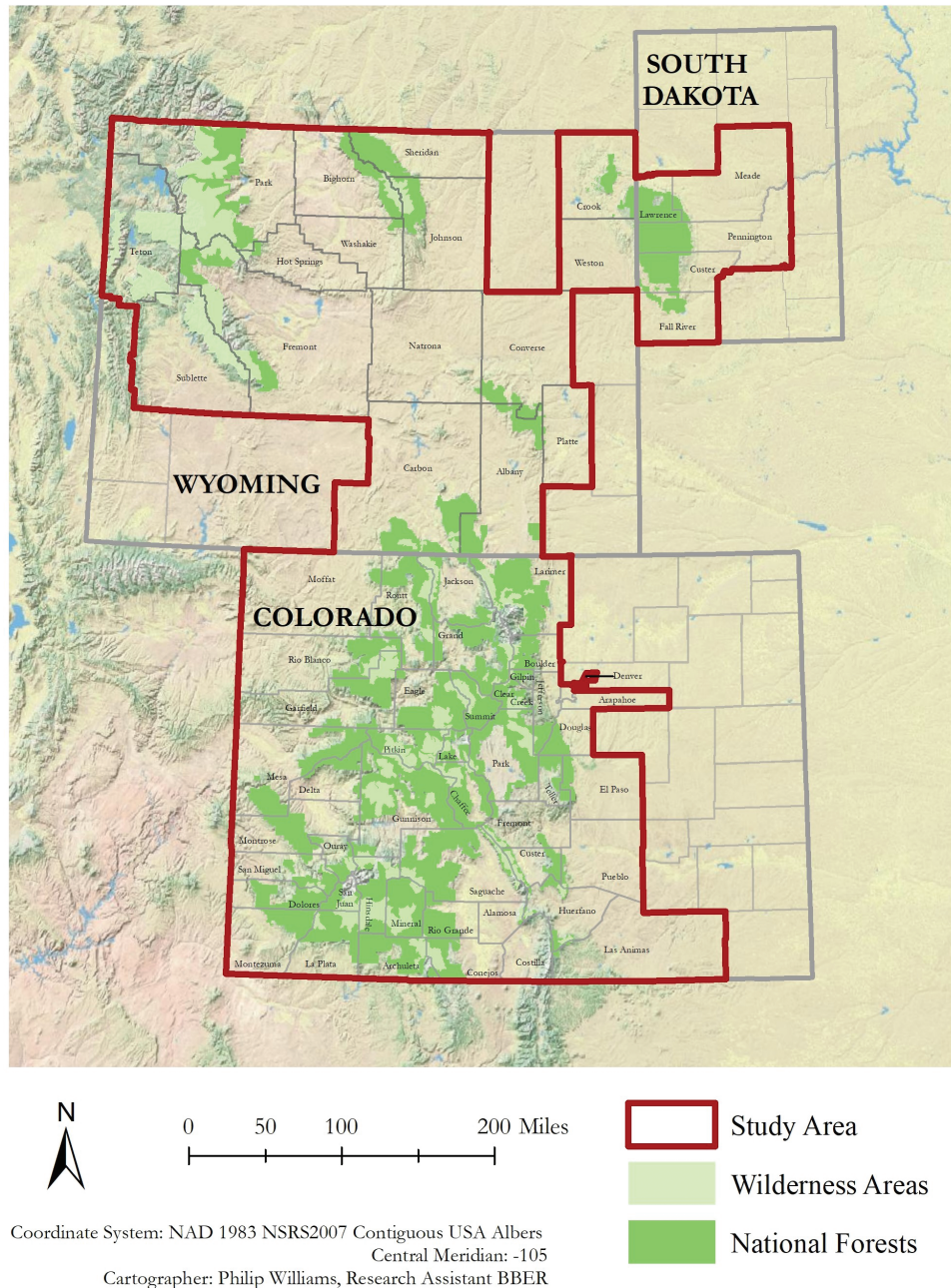


Figure 1. Region 2 (R2) study area—counties that contain R2 timberlands.

Wyoming. Approximately 3 percent of all the timber processed in the R2 study area came from out of region with approximately two-thirds (6,271 MBF) coming from various ownerships in Intermountain Region 4, suggesting limited interdependence between R2 and the other Forest Service regions.

Capacity, Capability, Consumption, and Use

The annual capacity to process timber within the R2-TPA in 2016 was 134,642 MCF, or approximately

579,185 MBF Scribner (Table 2, Figure 3). Colorado had the largest share (35 percent—on a cubic foot basis) of the overall capacity, with South Dakota and Wyoming each having around 20 percent. Approximately 27 percent of R2-TPA timber-processing capacity resided in a few larger sawmills in Idaho, Montana, and New Mexico—outside Region 2. The quantity of timber from the R2 study area flowing to these more distant facilities can be highly variable from year to year and is strongly influenced by national lumber markets, availability of timber from lands near those mills, and

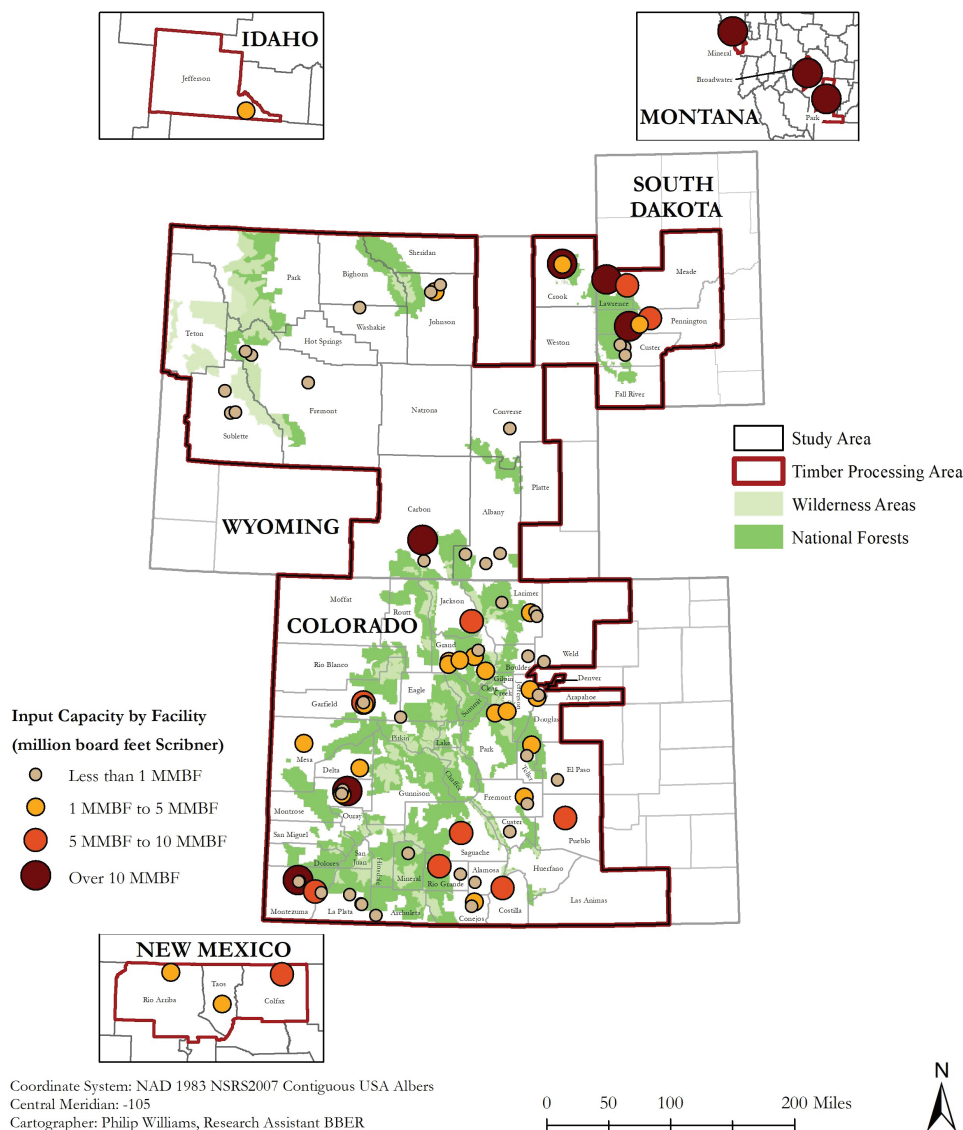


Figure 2. Timber-processing facilities in the Region 2 Timber-Processing Area (R2-TPA), 2016.

transportation costs (e.g., diesel fuel prices). The majority (20,558 MCF) of capability to process trees <10 in. dbh was concentrated in Colorado, whereas larger tree (≥ 10 in. dbh) capability was more evenly distributed among the states. Seventy-five percent of the out-of-region capacity was concentrated in the ≥ 10 in. dbh size class, which reflects the greater economic value of larger-diameter logs and financial feasibility for them to be transported longer distances to mills.

Sawlogs (i.e., logs sawn into lumber) accounted for 80 percent of total (cubic) capacity to process timber by product type (Table 2). Almost 82 percent of sawlog capability was in the ≥ 10 in. dbh class. Post, pole, and log furniture products together with firewood and energy products represented the vast majority (88 percent

on a cubic basis) of the capability to process trees <7 in. dbh. There was no capability to process houselogs <7 in. dbh, although there was more than 2,527 MCF of larger (dbh ≥ 10 in.) houselog capability. Several facilities in the R2-TPA produced firewood from mill residuals or took in smaller logs to produce firewood as an ancillary product, contributing substantially to total capacity in firewood products.

Almost 66 percent (on a cubic foot basis) of the total timber consumed by mills in the R2-TPA was from trees ≥ 10 in. dbh, and the largest share of timber consumed in each state was in that size class (Table 3). Wyoming had the greatest proportional (93 percent) consumption of trees ≥ 10 in. dbh, although the consumption volume (14,491 MCF) was relatively small.

Table 1. Region 2 study area timber flow by state*, 2016.

Destination	Origin			Total
	Colorado	South Dakota	Wyoming	
	Thousand board feet Scribner			
Colorado	100,529	NA	896	101,425
South Dakota	NA	84,745	11,873	96,618
Wyoming	15,160	23,715	32,503	71,377
Out of region	3,928	NA	12,121	16,049
Total†	119,616	108,460	57,393	285,469

*Does not include timber received from outside the R2 study area.

†Values may not sum because of rounding.

Table 2. Region 2 Timber-Processing Area (R2-TPA) annual timber-processing capacity and size class capability by state and product, 2016.

State	Total capacity and capability by size class MCF*				Total capacity and capability by size class MBF†			
	Total	<7" dbh	7–9.9" dbh	≥10" dbh	Total	<7" dbh	7–9.9" dbh	≥10" dbh
Colorado	46,531	9,273	11,285	25,973	176,780	19,320	39,985	117,475
South Dakota	26,197	500	7,956	17,741	109,654	1,000	26,497	82,157
Wyoming	25,371	638	1,611	23,122	115,065	1,742	6,607	106,717
Out of region‡	36,543	259	9,199	27,084	177,685	399	43,149	134,137
Total§	134,642	10,669	30,052	93,921	579,185	22,461	116,238	440,485
Timber product								
Sawlogs	108,133	702	18,946	88,485	516,541	3,320	91,189	422,032
Post, pole, and furniture logs	12,195	4,716	6,753	726	17,937	5,844	11,331	762
Firewood/energy logs	6,805	4,692	1,388	724	16,969	11,730	3,455	1,785
Houselogs	3,560	—	1,033	2,527	16,306	—	4,743	11,563
Other product logs¶	3,949	560	1,932	1,458	11,432	1,567	5,521	4,344
Total§	134,642	10,669	30,052	93,921	579,185	22,461	116,238	440,485

Note: *MCF = 1,000 cubic feet.

†MBF = 1,000 board feet Scribner.

‡Out-of-region states: Idaho, Montana, New Mexico.

§Values may not sum because of rounding.

¶Other products include pellets, shavings, excelsior, vigas, mulch, and playground chips.

Consumption of smaller trees varied considerably among the states. For trees of 7–9.9 in. dbh, consumption was around 30 percent overall and similar for Colorado and South Dakota, whereas in Wyoming, this size class represented just 6 percent of consumption. Out-of-region facilities had a slightly higher proportional consumption of trees in the 7–9.9 in. class (37 percent), and the smallest use (185 MCF) of trees <7 in. dbh. The economic feasibility of using smaller trees diminishes considerably as hauling distances increase, because the products (e.g., firewood, posts) that

are made from small material are generally of lower value, and hauling costs are higher per unit volume with small logs. Colorado had the highest volume (5,086 MCF) and proportion (17 percent) of timber consumption in the <7 in. dbh class likely because of timber availability, shorter hauling distances, and more diverse timber products than the other R2 states.

Sawlogs played a major role in the R2-TPA; they accounted for 80 percent of the timber consumed in the R2-TPA, and 78 percent of sawlog consumption was in the ≥10 in. dbh class (Table 3). Sawlogs also accounted

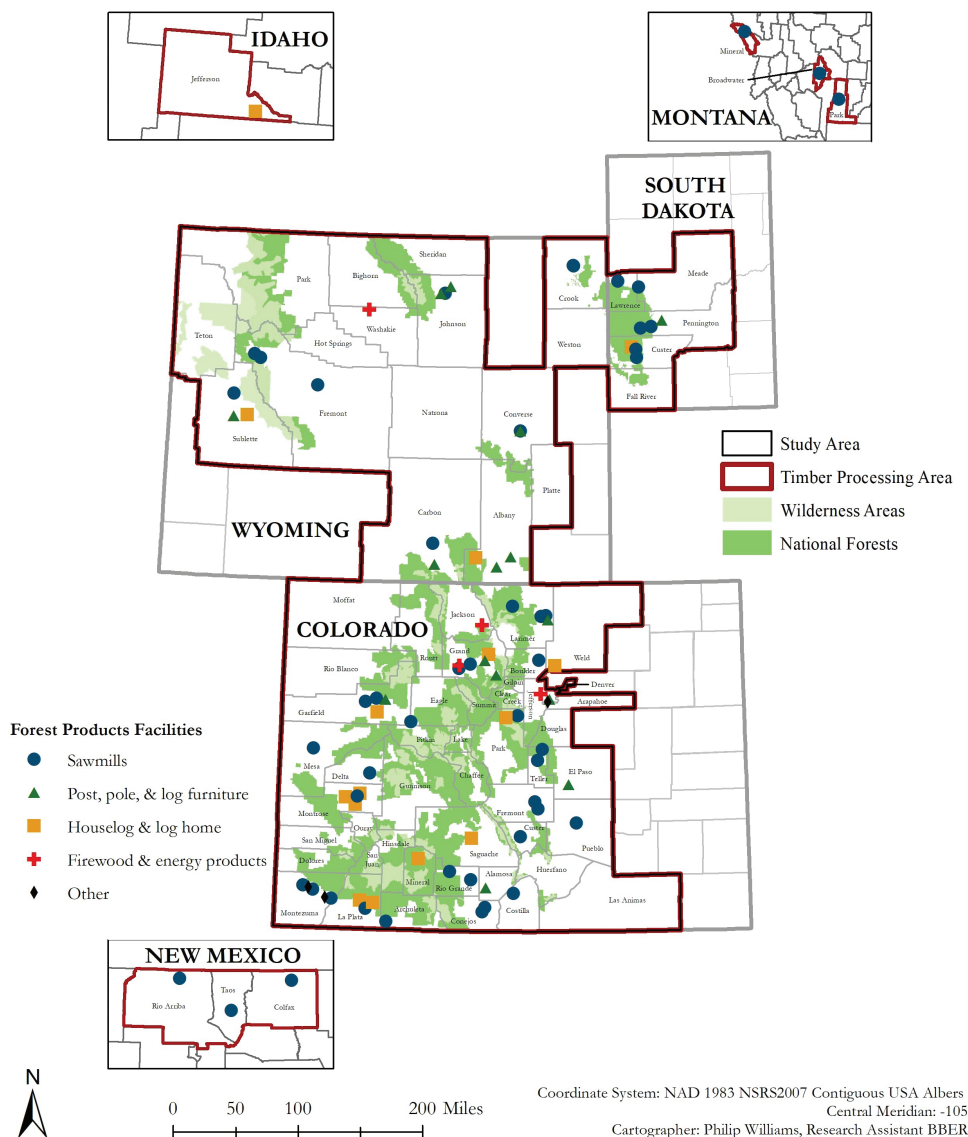


Figure 3. Region 2 Timber-Processing Area (R2-TPA) facility capacities, 2016.

for 94 percent of the volume processed in the ≥ 10 inch dbh class. Post, pole, log furniture, and firewood accounted for slightly less than 16 percent of the total timber volume processed in the R2-TPA. The majority of the timber used for these products was in the < 10 in. dbh classes and combined accounted for nearly 43 percent of the volume consumed in these size classes. Nearly 87 percent of the timber used for houselog production came from trees ≥ 10 in. dbh. Most sawmill operators reported that the capability to process trees in the 7–9.9 inch dbh class was weighted to trees ≥ 9 in. dbh. They also stipulated that trees in this size class needed to be completely sound in the butt log to make them economically viable to process, reinforcing the notion that not only is tree size an important

consideration when evaluating timber sale feasibility, but also log quality should be considered (Fahey et al. 1986, Loeffler and Anderson 2018).

Total capacity use in the R2-TPA was 69 percent, and South Dakota had the highest (90 percent) proportional use (Table 4). About 37 percent of capacity was not used in both Colorado (17,066 MCF unused) and Wyoming (9,750 MCF unused), indicating substantially more timber could be used by timber processors, particularly sawmills, in those parts of the Region. Capacity use at out-of-region facilities was 68 percent and in line with the associated state-level use rates (Hayes and Morgan 2017, Hayes et al. in press, Simmons and Morgan 2017). Again, it is important to note that the capacity and consumption data for

Table 3. Region 2 Timber-Processing Area (R2-TPA) annual timber consumption by size class, state, and product, 2016.

	Consumption by size class MCF*				Consumption by size class MBF†			
	Total	<7" dbh	7–9.9" dbh	≥10" dbh	Total	<7" dbh	7–9.9" dbh	≥10" dbh
State								
Colorado	29,466	5,086	8,551	15,829	105,511	9,175	25,990	70,346
South Dakota	23,485	475	7,345	15,665	97,598	950	24,111	72,538
Wyoming	15,621	271	859	14,491	71,420	653	3,796	66,971
Out of region‡	24,775	185	9,137	15,453	120,204	285	43,675	76,244
Total§	93,348	6,017	25,892	61,439	394,733	11,063	97,571	286,099
Timber product								
Sawlogs	74,541	657	15,902	57,982	355,309	3,146	76,828	275,335
Post, pole, and furniture logs	10,935	4,266	6,055	615	15,879	5,103	10,141	635
Firewood/energy logs	3,765	838	2,446	481	9,332	2,095	6,086	1,151
Houselogs	1,415	—	187	1,228	6,484	—	852	5,632
Other product logs¶	2,692	256	1,302	1,134	7,729	718	3,665	3,347
Total§	93,348	6,017	25,892	61,439	394,733	11,063	97,571	286,099

Note: * MCF = 1,000 cubic feet.

†MBF = 1,000 board feet Scribner.

‡Out-of-region states: Idaho, Montana, New Mexico.

§Values may not sum because of rounding.

¶Other products include pellets, shavings, excelsior, vigas, mulch, and playground chips.

Table 4. Region 2 Timber-Processing Area (R2-TPA) timber-processing capacity, consumption, and use by state and product, 2016.

	Capacity MCF*	Consumption MCF*	Percentage used	Capacity MBF†	Consumption MBF†	Percentage used
State						
Colorado	46,531	29,466	63	176,780	105,511	60
South Dakota	26,197	23,485	90	109,654	97,598	89
Wyoming	25,371	15,621	62	115,065	71,420	62
Out of region‡	36,543	24,775	68	177,685	120,204	68
Total§	134,642	93,348	69	579,185	394,733	68
Timber product						
Sawlogs	108,133	74,541	69	516,541	355,309	69
Post, pole, and furniture logs	12,195	10,935	90	17,937	15,879	89
Firewood/energy logs	6,805	3,765	55	16,969	9,332	55
Houselogs	3,560	1,415	40	16,306	6,484	40
Other product logs¶	3,949	2,692	68	11,432	7,729	68
Total§	134,642	93,348	69	579,185	394,733	68

Note: * MCF = 1,000 cubic feet.

†MBF = 1,000 board feet Scribner.

‡Out-of-region states: Idaho, Montana, New Mexico.

§Values may not sum because of rounding.

¶Other products include pellets, shavings, excelsior, vigas, mulch, and playground chips.

out-of-region facilities included all the timber received by the facilities, and R2 timber was generally a small fraction of the total volume consumed among those

facilities. About 10,935 MCF (90 percent) of post, pole, and log furniture timber-processing capacity in the R2-TPA was used, whereas only 69 percent (74,541

MCF) of sawlog capacity was used (Table 4). Sawlog processing capacity is currently high enough for mills to process an additional 33,592 MCF (161,232 MBF) of timber annually, mostly for trees ≥ 10 in. dbh. Houselog capacity, consumption, and capacity use (40 percent) were the lowest among the timber products in the R2-TPA. Currently, markets for house logs are constrained by the log home industry's recovery from the housing crisis caused by the Great Recession (Simmons and Morgan 2017). Additionally, the need to use timber ≥ 10 in. dbh to produce houselogs creates an additional challenge to that portion of the industry.

Overall, for all states and products, approximately 41,294 MCF of unused timber-processing capacity is available in the R2-TPA. Of this, mills could efficiently process an estimated 8,812 MCF of timber < 10 in. dbh. Current available small-log capacity may therefore limit the number of acres that could be treated annually.

Conclusions

As R2 land managers continue to implement fuel reduction and ecosystem restoration treatments, an understanding of the current industry composition, capacity, and constraints associated with processing trees of various sizes is essential. Already, some facilities have reported using greater volumes of small-diameter timber than they felt they were capable of efficiently and economically processing. This is likely a reflection of the fact that the National Forests comprise the majority of timberland in the area and are offering substantial quantities of small trees in efforts to reduce wildfire hazard and mitigate the impacts of widespread tree mortality.

Throughout the R2-TPA, sawmills have the largest capacity to process timber and, with the exception of South Dakota, have approximately 30–40 percent of that capacity unused. Virtually all of the sawlog timber-processing capacity in the > 7 in. dbh class is used (94 percent), with 30,504 MCF available in the ≥ 10 in. dbh class. Most facilities, but sawmills in particular, prefer and often process trees that are larger than the smallest tree sizes they are capable of processing because of higher recovery rates (i.e., more output per unit of input) and greater profitability (Stewart et al. 2004). Increasing small-tree timber-processing capabilities for sawmills is capital-intensive and, without secure timber supplies from the National Forests, of greater financial risk than many operators would be

willing to take (Stewart et al. 2004, Durango Herald 2019).

The R2-TPA has 7,702 MCF of unused timber-processing capacity for products other than sawlogs. Capability to process trees < 10 in. dbh tends to be concentrated in post and pole and firewood facilities or in smaller sawmills that make ancillary products (e.g., firewood, posts, poles, or pellets). However, these ancillary products are generally not of high value or high volume, or the major components of the region's industry. Caution should be taken so as not to over-rely on these sectors to handle large volumes of smaller-diameter material. Some of the operators of these facilities voiced concerns that many projects being proposed and offered for sale were simply too large (i.e., acreage or volume) and therefore not feasible for them to bid on. They were not critical of the Forest Service personnel they work with but were frustrated with a process perceived to encourage planning larger projects.

In short, when planning forest-management activities that involve removing trees from the landscape, land managers should balance their need to remove small and/or dead trees with the local industry's ability to profitably use that material. Offering larger quantities of small and/or dead trees than the industry can profitably use could lead to unsold sales and fewer acres being treated. Regional and forest-level planners should engage with their local industry stakeholders to understand where there are under-used capacity and potential for industry expansion to meet National Forest management needs.

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Endnotes

1. Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber use by statute or administrative regulation. (Areas qualifying as timberland are capable of producing at least 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

2. This journal article is based on a report (white paper) funded by and provided to Region 2. A PowerPoint presentation summarizing the report was presented at the National Silviculture Workshop (NSW) in May 2019, and this article is a condensed-for-publication version of the original report submitted for inclusion as an NSW proceedings contribution to *Journal of Forestry*.
3. Lands suited for timber production—area that defines where timber harvest for the purpose of timber production may occur. Timber harvest for purposes other than timber production may also occur here.

Literature Cited

- Durango Herald. 2018. *Web page*. Available online at <https://the-journal.com/articles/83535>; last accessed January 30, 2020.
- Durango Herald. 2019. *Web page*. Available online at <https://durangoherald.com/articles/156817-multiple-agencies-battle-fire-at-western-excelsior-in-mancos>; last accessed July 26, 2019.
- Fahey, T.D., T.A. Snellgrove, and M.E. Plank. 1986. *Changes in product recovery between live and dead lodgepole pine: A compendium*. USDA Forest Service Research Paper PNW-RP—353, Pacific Northwest Forest and Rangeland Experiment Station, Portland, OR. 32 p.
- Hayes, S.W., and T.A. Morgan. 2017. *The forest products industry in Montana, Part 2: Industry sectors, capacity and outputs*. Forest Industry Brief BBER-FIB-04, University of Montana, Bureau of Business and Economic Research, Missoula, MT. 6 p. Available online at http://www.bber.umt.edu/FIR/S_MT.asp; last accessed June 1, 2019.
- Hayes, S.W., C.A. Bingaman, T.A. Morgan, E.A. Simmons, K.C. Marcille, and J. Shaw. in press. *The Four Corners timber harvest and forest products industry, 2016*. 2018. USDA Forest Service Resour. Bull. RMRS-RB-XXX, Rocky Mountain Research Station, Fort Collins, CO. Available online at <http://www.bber.umt.edu/pubs/forest/fidacs/FC2016.pdf>; last accessed July 26, 2019.
- Keegan, C.E., T.A. Morgan, K.M. Gebert, J.P. Brandt, K.A. Blatner, and T.P. Spoelma, 2006. Timber-processing capacity and capabilities in the western United States. *J. For.* 104(5):262–268.
- Keegan, C.E., T.A. Morgan, F.G. Wagner, P.J. Cohn, K.A. Blatner, T.P. Spoelma, and S.R. Shook. 2005. Capacity for utilization of USDA Forest Service, region 1 small-diameter timber. *For. Prod. J.* 55(12):143–147.
- Loeffler, D., and N.M. Anderson. 2018. Impacts of the mountain pine beetle on sawmill operations, costs, and product values in Montana. *For. Prod. J.* 68(1):15–24.
- McIver, C.P., C.B. Gale, and S.W. Hayes. 2017a. *Timber use, processing capacity and capability of mills to utilize timber by diameter size class in the Medicine Bow-Routt National Forest timber-processing area*. University of Montana, Bureau of Business and Economic Research, Missoula, MT. Available online at http://www.bber.umt.edu/FIR/H_Capacity.asp; last accessed June 1, 2019.
- McIver, C.P., E.A. Simmons, and T.A. Morgan. 2017b. *Timber use, processing capacity and capability of mills to utilize timber by diameter size class in the Rio Grande National Forest timber-processing area*. University of Montana, Bureau of Business and Economic Research, Missoula, MT. Available online at http://www.bber.umt.edu/FIR/H_Capacity.asp; last accessed June 1, 2019.
- McIver, C.P., E.A. Simmons, and T.A. Morgan. 2017c. *Timber use, processing capacity and capability of mills to utilize timber by diameter size class in the Grand Mesa, Uncompahgre and Gunnison National Forests timber-processing area*. University of Montana, Bureau of Business and Economic Research, Missoula, MT. Available online at http://www.bber.umt.edu/FIR/H_Capacity.asp; last accessed June 1, 2019.
- McIver, C.P., C.B. Gale, and E.A. Simmons. 2017d. *Timber use, processing capacity and capability of mills to utilize timber by diameter size class in the Black Hills National Forest timber-processing area*. University of Montana, Bureau of Business and Economic Research, Missoula, MT. Available online at http://www.bber.umt.edu/FIR/H_Capacity.asp; last accessed June 1, 2019.
- McIver, C.P., C.B. Sorenson, and T.A. Morgan. 2017e. *Wyoming's forest products industry and timber harvest, part 1: Timber harvest, products and flow*. Forest Industry Brief BBER-FIB-01, University of Montana, Bureau of Business and Economic Research, Missoula, MT. 6 p. Available online at http://www.bber.umt.edu/FIR/S_WY.asp; last accessed June 1, 2019.
- Sidon, J. 2019. *Regional Economist, USDA Forest Service, Rocky Mountain Region*, pers. commun. July 29, 2019.
- Simmons, E.A., and T.A. Morgan. 2017. *The forest products industry in Idaho, part 2: Industry sectors, capacity and outputs*. Forest Industry Brief BBER-FIB-11, University of Montana, Bureau of Business and Economic Research, Missoula, MT. 8 p. Available online at http://www.bber.umt.edu/FIR/S_ID.asp; last accessed June 1, 2019.
- Simmons, E.A., T.A. Morgan, S.W. Hayes, C.P. McIver, and P.W. Williams. 2019a. *Timber use, processing capacity and capability within the USDA Forest Service Region 2 timber-processing area*. Research analyses report for Region 2, Bureau of Business and Economic Research, Missoula, MT. 16 p. Available online only at <http://www.bber.umt.edu/pubs/forest/capacity/TechReportRegion2-2019.pdf>; last accessed December 13, 2019.
- Simmons, E.A., T.A. Morgan, S.W. Hayes, and P.W. Williams. 2019b. *Timber use, processing capacity and capability within the Pike-San Isabel National Forest Timber-Processing Area*. Report submitted to USDA Forest Service Rocky Mountain Region, Lakewood, CO. 17 p.
- State of Colorado. 2017. *2016 report on the health of Colorado's forests: Fire and water*. Colorado Department of Natural Resources, Denver, CO. 36 p.

- Stewart, H.G., K.A. Blatner, F.G. Wagner, and C.E. Keegan. 2004. Risk and feasibility of processing small-diameter material in the U.S. West, Part I: Structural lumber. *For. Prod. J.* 54(12):97–103.
- USDA Forest Service Forest Inventory and Analysis Program. 2019. *Forest inventory EVALIDator web-application Version 1.8.0.00*. USDA For. Ser., Northern Research Station, St. Paul, MN. Available online at <https://apps.fs.usda.gov/Evalidator/evalidator.jsp>; last accessed March 5, 2020.
- US Forest Service (USFS). 2016. *Forest products cut and sold from the National Forests and Grasslands*. USDA. Available online at <https://www.fs.fed.us/forestmanagement/products/cut-sold/index.shtml>; last accessed December 7, 2018.
- Wagner, F.G., C.E. Fiedler, and C.E. Keegan. 2000. Processing value of small-diameter sawtimber at conventional stud sawmills and modern high-speed, small-log sawmills in the western United States- a comparison. *West. J. Appl. For.* 15(4):208–212.
- Wagner, F.G., C.E. Keegan, R.D. Fight, and S.A. Willits. 1998. Potential for small-diameter sawtimber utilization by the current sawmill industry in Western North America. *For. Prod. J.* 48(9):30–35.
- Wyoming State Forestry Division. 2017. *State and private forestry fact sheet: Wyoming 2017*. National Association of State Foresters. Available online at <https://www.stateforesters.org/wp-content/uploads/2018/07/Wyoming-2018.pdf>; last accessed December 13, 2019.