BUREAU OF BUSINESS AND ECONOMIC RESEARCH
UNIVERSITY OF MONTANA

Timber Use, Processing Capacity and Capability of Mills to Utilize Timber By Diameter Size Class in the Black Hills National Forest Timber-Processing Area

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Introduction

Insect and disease outbreaks in the central Rocky Mountains and Black Hills region reached epidemic levels in the last two decades resulting in vast stands of dead trees across parts of Wyoming, Colorado and South Dakota. The resulting reduction in standing live sawtimber volume has necessitated an evaluation of mortality and current growth rates and their impact on future timber management in the region (Graham et al. 2021). Over the last decade both the States and the Forest Service have increased investments in forest health, hazardous fuels mitigation and safety protection on private and public lands (Wyoming State Forestry Division 2017, N.D.; Black Hills Regional Pine Beetle Working Group 2020). The combined reduction in the volume of sawtimber available for harvest and increased focus on treatments designed to restore ecological condition and function while reducing fire hazard have led to changes in the mix of timber available to manufacturers. The loss of milling infrastructure throughout the West, combined with changing disturbance regimes and stand characteristics, raise questions about the industry's ability to utilize timber of varying sizes and quality at a rate that is sustainable for the forest and adequate for the industry (Keegan et al. 2005; Keegan et al. 2006).

Goals and Objectives

This report was prepared by the Forest Industry Research Program at the University of Montana's Bureau of Business and Economic Research (BBER) as a forest planning support document for the Black Hills National Forests (hereinafter Black Hills NF) and seeks to:

1. examine the harvest of timber from the counties containing Black Hills NF timberland—the "study area";

2. identify the location of mills receiving timber harvested from the above counties—the "timber processing area", and

3. describe the kinds of mills, their capacity to process timber, their capability to use timber of various sizes, and their capacity utilization rates. The study focuses on facilities that exclusively use timber in round form (i.e., logs). Facilities that use only mill residuals (e.g., sawdust or chips) are not included.

Data Sources, Definitions and Methods

Data Sources

Information in this report is primarily generated through a statewide periodic census of manufacturers of primary forest products. The census is conducted through a cooperative agreement between the BBER and the USDA Forest Service, Interior West Forest Inventory and Analysis (FIA) program. This analysis is based primarily on 2018 mill survey data for Wyoming and South Dakota (Marcille et al. 2021; NRS 2022), supplemented by additional data collected in 2022. Mill survey data from Marcille et al. (2021), USFS Cut and Sold reports (USFS 2022), timber product output (TPO) data from the Northern Research Station (2018), and conversations with mill owners were used to characterize timber harvest and timber capacity and consumption by mills. These sources were supplemented by literature from peer-reviewed journals when appropriate.

Study Area

The study area for a national forest is defined as all counties that contain timberland within that national forest. Timberland is defined by FIA as producing or capable of producing at least 20 cubic feet per acre per year (USDA Forest Service). Reserved lands are excluded from calculation of the study area because they are statutorily exempt from timber harvesting activity. Non-forested lands are also excluded from this calculation because they also do not have the capability to produce timber. Once defined, the study area is analyzed to understand harvest and utilization trends for timber originating from all ownerships in order to understand national forest harvest trends in context and to characterize the broader market for timber in the area.

Timber-processing Area

A national forest's timber-processing area (TPA), or area of influence, establishes the geographic region and wood product manufacturers that *potentially* influence and are

influenced by timber harvested from that forest by analyzing the flow of timber from all ownerships within the study area. Counties containing mills that received and processed timber from the study area during 2018 were identified from mill surveys and included in the timber-processing area, unless the volume received was very small.

The list of mills receiving timber from the study area that are located within the TPA are identified and compiled in order to characterize the capacity and capability of manufacturers in the TPA to process timber in total, and by tree size class. A mill's procurement distance is determined by multiple factors including finished good market demand, competition, the value-added nature of a product and the total volume of timber consumed annually. For example, log homes are a high-value product that require high quality raw material of a certain size, enabling manufacturers to procure timber from longer distances, including Canada. Log furniture manufacturers produce medium to high value products but use a very small volume of timber and therefore are less likely to draw timber from long distances. This report should therefore be interpreted as a representation of the market conditions during 2018 with some updates representing conditions in 2022.

Timber-processing capacity

In this report, "capacity" refers to the total volume of timber (a.k.a., roundwood or logs) that timber processors could utilize annually. Also known as "timber-processing capacity", it is a measure of input capacity and is expressed in board feet Scribner or cubic feet. Input capacity is a useful measure when attempting to express the capacity of multiple types of mills in a common unit of measure. Since finished products (mill outputs and output capacity) are measured in a variety of units: board feet lumber tally for lumber, lineal feet for house logs, and pieces for posts, small poles, and log furniture, input capacity provides for direct comparisons between mill types. Input or timber-processing capacity is a measure of the volume of logs that a facility can process in a given year given firm market demand, sufficient raw material, and usual downtime for maintenance. Estimates in this report include the capacity of facilities that use timber in round form; this includes sawmills and facilities processing timber into plywood or

veneer, house logs, log homes, posts, poles, log furniture, firewood, clean/pulp chips, and biomass energy.

Timber-processing capability

In contrast to timber-processing capacity, “capability” refers to the volume of trees of a certain size class (measured as tree diameter at breast height – dbh) that timber processors can efficiently process annually. Most facilities are designed to operate using trees of a given size class. For example, log home manufacturers typically use trees ≥ 10 inches dbh, and post manufacturers primarily use trees < 8 inches 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 ability to process timber of various sizes (Wagner et a. 1998, 2000; Keegan et al. 2005, 2006; Stewart et al. 2004).

Sawmills often process trees that are larger than the smallest tree sizes they are capable of processing. In other words, most mills capable of processing trees 7 to 9.9-inches dbh are also capable of, and prefer, processing trees greater than 10-inches dbh, thus these mills tend to process substantially more of the larger trees. However, some mills that process larger trees are not capable of processing smaller-diameter trees. For this reason, this report presents capability to process trees greater than 10-inches dbh as the proportion of total capacity *not* capable of efficiently using trees less than 10-inches dbh. Whereas, capability to process trees less than 7-inches dbh and 7 to 9.9-inches dbh are presented as maximum volumes of trees of these size classes that can be processed efficiently.

Assigning capacity and capability at the mill level

For each mill in the TPA that received timber from the study area, an estimate of the mill’s capability to process timber of a given size was made based on literature (Wagner et al. 1998, 2000; Keegan et al. 2005, 2006; Stewart et al. 2004), conversations with mill owners and the most recent BBER mill census data, which aim to take into consideration the financial feasibility and physical characteristics of the mill. For this report, three tree size classes were used: less than 7-inches dbh, 7 to 9.9-inches dbh, and 10 inches dbh or greater. BBER

researchers first assigned capability to efficiently process timber in the less than 7-inch and 7 to 9.9-inch dbh classes. Capability to process trees 10 inches dbh or greater was then calculated as the remaining proportion of total capacity *not* capable of efficiently using trees less than 10 inches dbh. Total timber-processing capacity and capability by dbh class are presented in both hundred cubic feet (CCF) and thousand board feet Scribner (MBF) to facilitate discussion among national forest managers, timber purchasers, and wood products facility operators.

Black Hills National Forest Study Area

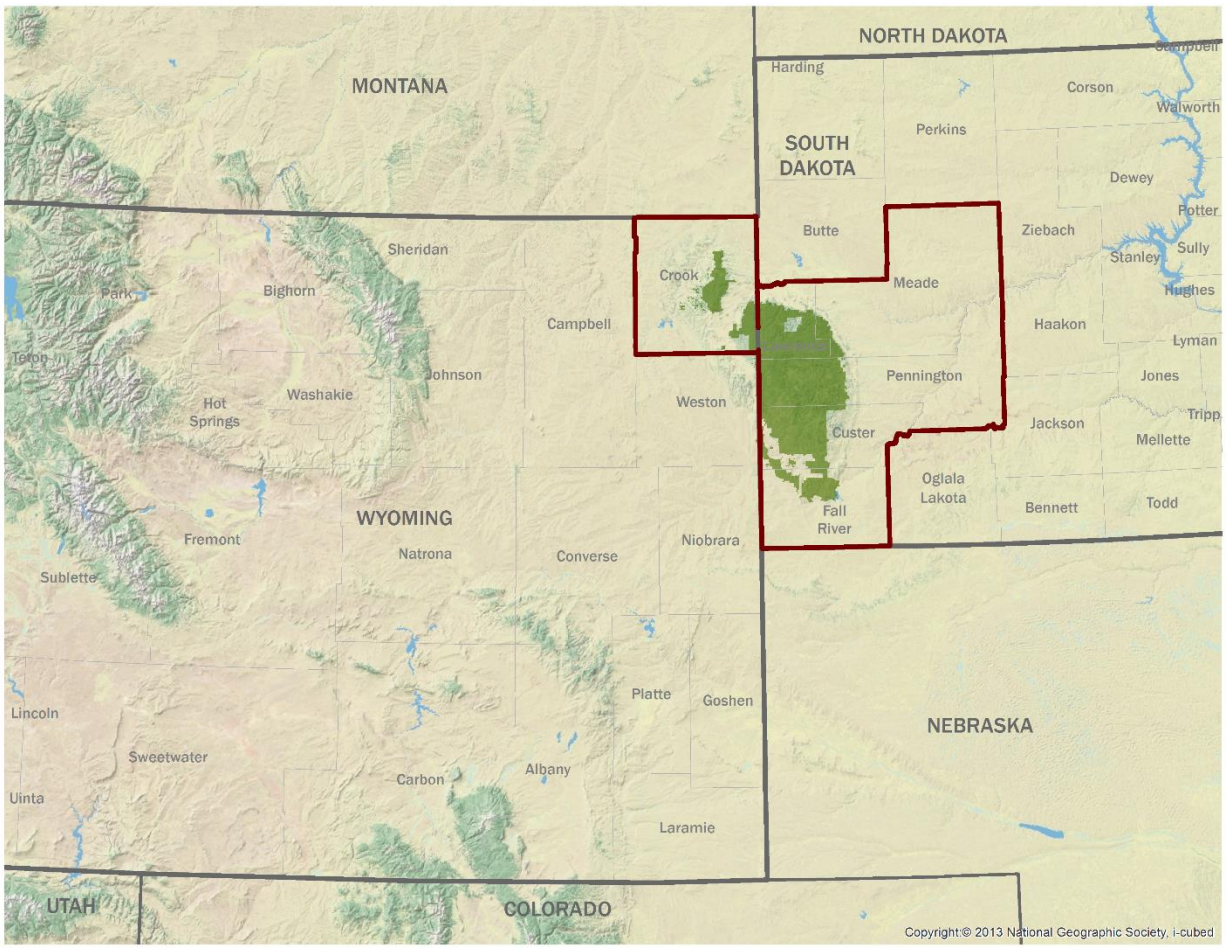

Figure 1—Black Hills National Forest and study area.

The Black Hills National Forest is spread over six counties and two states: Crook County in Wyoming and Custer, Fall River, Lawrence, Meade and Pennington Counties in South Dakota (figure 1). Within this area lies 1.86 million acres of non-reserved timberland, of which 59 percent is owned and managed by the US Forest Service (table 1). The estimated total volume of timber harvested and utilized from all ownerships in the study area during 2018 was 25.2 million cubic feet (MMCF) (131.6 million board feet, Scribner), of which timber from the Black Hills National Forest accounted for an estimated 71 percent (BBER 2022, Marcille et al. 2021, NRS 2022).

Table 1 – Acres of timberland[1] by county and ownership in the Black Hills NF Study Area.

County	National Forest	Other Federal	State and Local	Private	Total
Crook County, WY	150,881	6,255	59,784	319,109	536,029
Custer County, SD	243,072	-	51,589	78,870	373,531
Fall River County, SD	22,955	4,834	7,844	73,230	108,863
Lawrence County, SD	265,355	17,348	4,435	62,468	349,606
Meade County, SD	58,639	1,583	-	24,225	84,447
Pennington County, SD	347,605	6,331	-	51,861	405,797
Total	1,088,507	36,351	123,652	609,763	1,858,273

[1] Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: 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.).

Source: USDA Forest Service, Forest Inventory and Analysis Program, Tue Jan 29 20:47:43 GMT 2019. Forest Inventory EVALIDator web-application Version 1.8.0.00. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. [Available only on internet: http://fsxopsx1056.fdc.fs.usda.gov:9001/Evalidator/evalidator.jsp].

Black Hills NF Timber-Processing Area

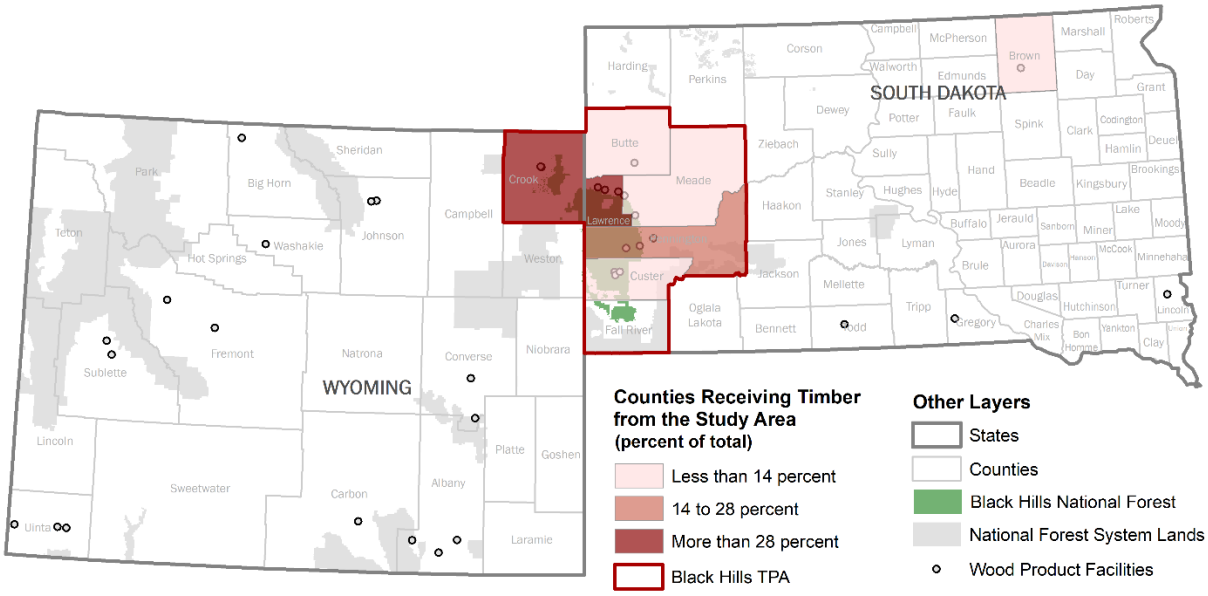

Figure 2. Counties receiving timber from the study area and resulting Black Hills NF Timber-Processing Area.

Based on analysis of timber flow trends in the Black Hills region, virtually all of the timber harvested in the study area was processed in six counties: Crook County in Wyoming and Butte, Custer, Lawrence, Meade and Pennington Counties in South Dakota (figure 2). A total of 14 primary wood products facilities are located within the TPA, of which 13 were active as of 2018. Among the facilities currently operating were: 9 sawmills, 1 house log/log home and 3 post and small pole facilities; one facility had both sawmill and post and pole capacity (table 2; figure 3).

Table 2—Active timber processing facilities in the Black Hills National Forest Timber Processing Area, 2018.

Type	2018
Sawmills	9
Log home	1
Post and Pole	3
Total	**13**

Sources: Marcille and others 2021; BBER, 2022; USFS NRS 2018

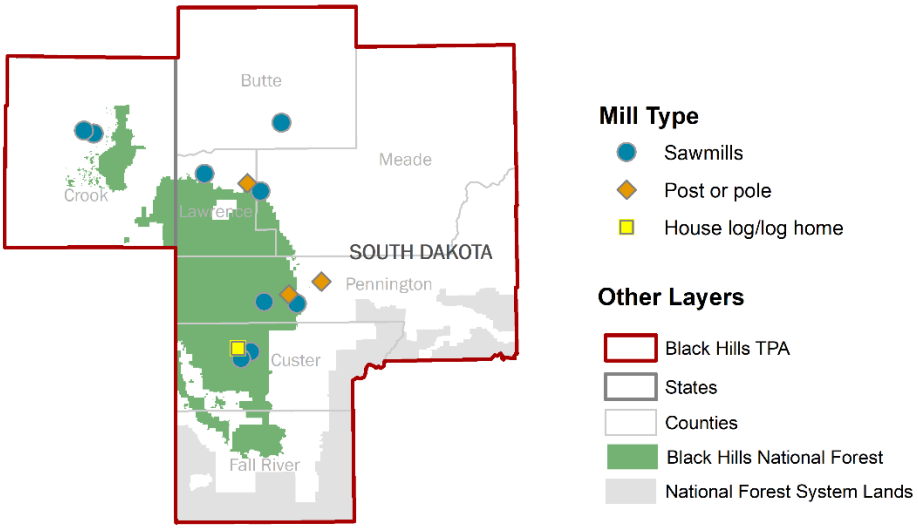

Figure 3. Location and type of timber-processing facilities in the Black Hills NF Timber-Processing Area, 2018.

Timber Flow Trends – Into Study Area

Facilities in the study area received 26.3 MMCF of timber for processing in 2018 (119.9 MMBF). Ninety-six percent (25.2 MMCF) of the timber received by mills came from the study area counties. The remaining volume came from state and private lands in Nebraska and Montana with smaller volumes from the Bighorn and Custer national forests, making the area a net importer of timber. Of the timber received and processed by mills, 66 percent came from the Black Hills National Forests and less than one percent came from other national forest timberlands in Wyoming and Montana. Private (industrial and non-industrial) timberlands provided 21 percent and state timberlands supplied 12 percent. The Bureau of Land Management provided less than 1 percent.

Timber Flow Trends- Out of Study Area

Of the 25.2 MMCF of timber harvested in the 6-county study area, 96 percent was processed in three counties: Crook County in Wyoming and Lawrence and Pennington Counties in South Dakota and less than 1 percent was processed outside the study area. On average, 43

percent of timber harvested in the study area was processed within the county of harvest (table 3).

Table 3 - Timber flow from the Black Hills National Forest six-county study area to county of processing facility, 2018

County of harvest	Processed within the county of harvest	Processed within TPA	Processed outside TPA
	----------percentage of harvest by county----------		
Custer County, SD	1%	99%	0%
Fall River County, SD	0%	100%	0%
Lawrence County, SD	54%	46%	0%
Meade County, SD	38%	62%	0%
Pennington County, SD	72%	28%	0%
Crook County, WY	48%	51%	0%

Timber-Processing Capacity, Capability, and Utilization

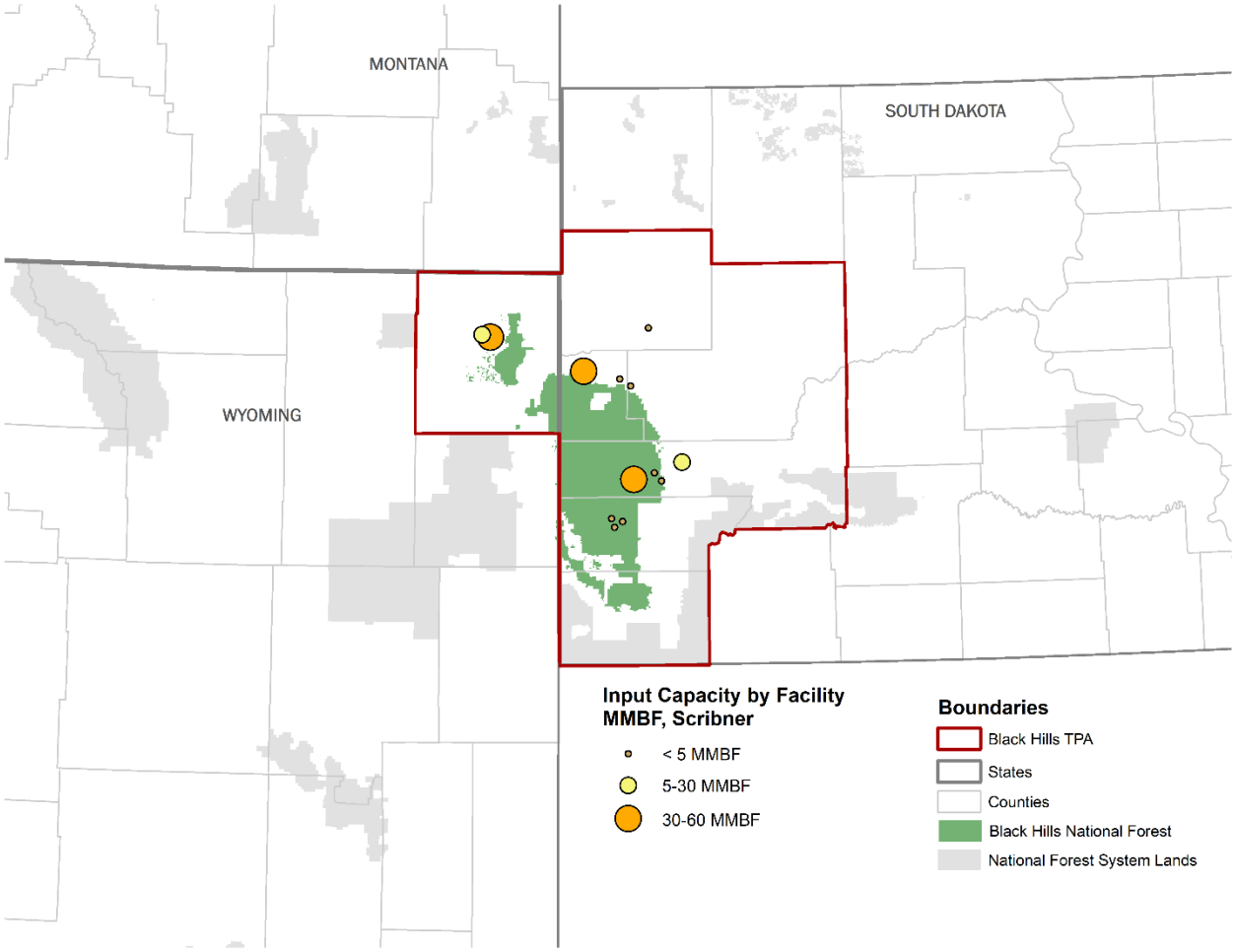

Figure 4. Capacity and location of active mills in the Black Hills NF Timber-Processing Area, 2018.

In late 2021, the authors contacted primary timber-processing facilities operating in the Black Hills TPA to gather information on each mill's assessment of their capacity to process trees by size class as well as the size characteristics of their roundwood inputs for 2021 (see Methods for more detail on the data collection process). Summary data are presented in both hundred cubic feet (CCF) and thousand board feet, Scribner (MBF) in concordance with the standard units used by the Forest Service and industry, respectively.

Capacity to process timber in the Black Hills National Forest TPA during 2022 was estimated to be 280,670 CCF (100.1 MMBF). Mills processed 242,920 CCF that year, indicating that they were operating at approximately 87 percent of capacity. Approximately two-thirds of the volume processed in the TPA was composed of trees with a diameter at breast height (dbh) greater than 10 inches. Another 19 percent came from trees 7 – 9.9 dbh, while the remaining 14 percent was made up of trees less than 7 inches dbh (Table 4).

Table 4. Annual volume of timber processed by tree size class (excluding pulpwood) for the Black Hills National Forest timber processing area, 2022

Hundred cubic feet (CCF)		*Thousand board feet, Scribner (MBF)*	
Tree dbh	**Volume used**	**Tree dbh**	**Volume used**
<7 in.	28,500	<7 in.	5,763
7 - 9.9 in.	44,980	7 - 9.9 in.	15,878
>10 in.	169,440	>10 in.	78,453
Total	**242,920**	**Total**	**100,094**

Most facilities are designed to operate using trees of a given size class (for example, post and rail manufacturers generally use trees less than 7 inches dbh while house log manufacturers typically only use trees greater than 10 inches dbh). Capacity at these facilities is readily classified as being capable of processing timber in just one size class. While this is also true for some sawmills, sawmills can vary greatly in equipment, products produced, and ability to process timber of various sizes.

In addition, sawmills often process trees that are larger than the smallest tree size they are capable of processing due to higher recovery rates, and thus greater profitability (see Conclusion for more discussion on this topic). However, some mills that process larger trees are not capable of processing smaller-diameter trees. For this reason, capability to process trees greater than 10 inches dbh is calculated as the proportion of total capacity *not capable* of processing trees less than 10 inches dbh. Conversely, capability to process trees less than 7 inches dbh is presented as a maximum volume that could be processed efficiently (for more on sawmill feasibility by size see Wagner et al. 2000 and Stewart et al. 2004). Thus, for those mills with a great deal of flexibility in the size of material utilized (e.g. whole log chipping or

grinding), all of their capacity was assigned to the smallest size class since this is where the greatest limitations in the industry exist.

The authors estimate that 71 percent of existing capacity in the Black Hills National Forest TPA is not capable of efficiently utilizing trees less than 10 inches dbh (Table 5). However, as much as 14 percent of total capacity is capable of utilizing trees between 7 and 10 inches dbh and another 14 percent is capable of processing trees less than 7 inches dbh.

Approximately 91 percent of the stated capability to process trees < 10 inches dbh was used in 2022. Mills processed 73,480 CCF of the estimated 80,930 CCF capable of processing trees <10 inches dbh. Seventy percent of capability was utilized in the <7-inch dbh class, indicating that some remaining capacity exists for mills to take in more trees in the smaller size classes while still remaining profitable.

Table 5. Annual capacity and capability of mills to process trees by size class for the Black Hills National Forest timber processing area, 2022

Hundred cubic feet (CCF)		*Thousand board feet, Scribner (MBF)*	
Tree dbh	**Capability**	**Tree dbh**	**Capability**
<7 in.	40,510	<7 in.	8,735
7 - 9.9 in.	40,420	7 - 9.9 in.	22,918
>10 in.	199,740	>10 in.	120,075
Total Capacity	**280,670**	**Total Capacity**	**151,728**

Discussion

This report provides an update to a similar analysis conducted in 2016 and offers an opportunity to compare changes in timber harvest and movement as well as industry characteristics over time. The Black Hills National Forest has experienced a significant exogenous shock in the form of tree mortality due to insects and disease. As a result, the Forest has been in the process of updating its sustainable harvest levels, known as the allowable cut volume. Changes in timber policies have direct impacts on businesses that use raw timber inputs to manufacture finished goods such as lumber, fencing and other wood products and this report is intended to help the Forest Service and other stakeholders understand the potential effects of changes in the Black Hills National Forest's allowable cut volume on regional timber processors.

Between 2016 and 2022, overall capacity to process timber in the Black Hills NF TPA declined by 25 percent due to mills idling temporarily or permanently closing (McIver, Gale and Simmons 2018). On a volume basis, most of the loss in capacity impacted the industry's capability to process trees >10 inches dbh. Capability in the 7-9.9-inch dbh class decreased only slightly and capability in the smallest size class (< 7 inches dbh) actually increased during this period. Much of this increase was due to new estimates from mills regarding the profitability of processing timber in this size class.

The volume of timber harvested from the Black Hills National Forest has been in decline for over a decade. The forest reported a harvest of 230,902 CCF in 2010 compared to 116,806 CCF 2022 (US Forest Service, n.d.) (figure 5). Research by Graham et al. (2021) and others suggests that the allowable cut volume on the forest may need to be reduced further to between 72,400 and 90,500 CCF annually (Graham et al. 2021), raising questions about the relationship between future timber harvest volumes and regional timber-processing capacity.

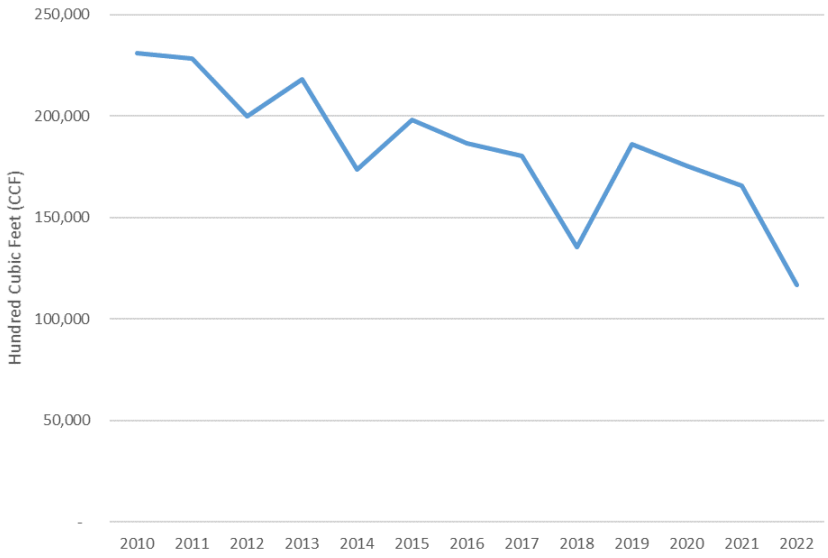

Figure 5. Timber harvested from the Black Hills National Forest 2010-2022.

As reported earlier, timber from the Black Hills National Forest makes up between 70 and 80 percent of the total timber consumed by mills in the Black Hills NF TPA. Assuming that timber harvest levels from all other ownerships remain relatively constant, the authors

estimate that future timber harvest levels in the study area under a new allowable cut policy could fall to somewhere around 164,700 CCF, indicating that existing mills would need to source additional timber volume from outside the study area to maintain current operating levels.

In addition to changes in the volume of timber offered by the Black Hills National Forest, the size and quality of timber offerings are likely also changing and may influence the point at which a mill is no longer profitable. As documented by Stewart et al. (2004) and others, the profitability of processing timber diminishes as the average diameter of the timber decreases. When markets are poor it becomes more difficult to profitably produce lumber from small and low-quality logs. This was evident across the western United States during the Great Recession which reduced mill demand for small diameter logs used to make studs. In the past, sawmill owners have also spoken to the impact that the condition of timber, namely live versus dead, has on their ability to recover economic value from the material. In the past, mills have reported that their capability to process dead timber that is less than 10 inches dbh is reduced when compared to green trees due to the associated lower grade recovery. Similar relationships among log size, live versus dead trees and value have been documented by Fahey et al. (1986).

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