TIMBER HARVEST LEVELS AND PRESSURE ON SHORTLEAF PINE IN MISSOURI

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ABSTRACT.—Data from two sources are used to estimate the harvest pressure on Missouri's shortleaf pine (*Pinus echinata* Mill.) resource. By overlapping Timber Product Output (TPO) and Forest Inventory and Analysis (FIA) inventory data, we examine utilization pressure on shortleaf pine and the residual inventory. Conducted every three years in Missouri, the TPO survey consists of a complete census of all primary mills and is a snapshot in time of timber use. TPO data from 1969 to 2003 show that annual shortleaf pine harvest has varied between 4.0 and 8.9 million cubic feet. Most of the shortleaf pine harvested in the State was processed in Missouri. FIA field plots offer another method of estimating both shortleaf pine growth and removals on an annual basis using plot and tree measurements over time. In 1989, FIA data estimated annual removals of shortleaf pine growing stock at 6.8 million cubic feet (including both harvest and land use changes); in 2004, annual removals of shortleaf pine growing stock were 5.0 million cubic feet. In both 1989 and 1999-2003, most of the removals came from the medium- and small-size classes. FIA data also show overall sustainable utilization pressure, with annual net growth of shortleaf pine growing stock that has increased from 18.5 million cubic feet in 1989 to 25.1 million cubic feet in 2003. Questions of long-term ecological and economic sustainability and impacts are also addressed using these data sets.

INTRODUCTION

When early European settlers first reached Missouri, there were an estimated 6.6 million acres of shortleaf pine (Pinus echinata Mill.), concentrated particularly in the Ozarks. By 2003, shortleaf pines occupied only about 163,500 acres, a net loss of approximately 6.4 million acres (Moser et al. 2005). This decrease has substantially changed the appearance and ecology of the forests once dominated by the species (Stambaugh and Muzika 2001). Shortleaf pine was a primary source of timber in Missouri from the late 1800s until the early 1920s, when millions of board feet were harvested for large sawmills in the southern Missouri Ozarks. Railroad networks reached from the woods to the sawmills. Where railroads were lacking, oxen pulled wagons loaded with large pine logs to the mills. Missouri's timber production peaked in 1899. By 1910, nearly all the pine had been cut (Palmer 2000). Over the last century, the economic importance of shortleaf pine to Missouri has declined along with the area of the state dominated by pine forest.

Gwaze (2005) notes that the current population structure of shortleaf pine has been heavily influenced by past human activities. Shortleaf pine forests in Missouri have been reduced by the combined effects of 1) uncontrolled logging and high-grading between 1880 and 1920; 2) excessive surface fires in the first half of the 20th century that were used to encourage the growth of pasture but which also discouraged pine regeneration; 3) open-range grazing; and 4) effective fire suppression by state and federal agencies since 1950, preventing the periodic fires necessary for regeneration of shortleaf pine, a fire-dependent species. These disturbance patterns resulted in establishment of millions of acres of oak-dominated forest on areas that previously were dominated by shortleaf pine.

Shortleaf pine used to be a major component of Missouri's economy, and remains important to the state's biodiversity and natural heritage. The economic, ecological, and scientific importance of shortleaf pine has spurred the active promotion of both natural and artificial regeneration of the species to restore former pineries, increase forest diversity, and mitigate oak decline on sites better adapted to shortleaf pine. Over the last decades, natural resource management agencies have developed strategies and projects to restore shortleaf pine in areas of its previous range (Missouri Department of Conservation 2005). Indeed, shortleaf pine restoration on oak sites that are better suited to pine and have a high potential for future oak decline may be one way to deal with forest health issues. But such efforts may not be successful or sustainable, especially on private land, if the economic incentives of restoring shortleaf pine, and the harvest pressure it faces, are not well understood.

DATA AND METHODS

Forest Inventory and Analysis Methods

The national Forest Inventory and Analysis (FIA) program provides estimates of forest area, volume, change, and forest

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health throughout the United States (McRoberts 1999). The FIA sampling design consists of a random, equal probability sample with a base intensity of one plot per approximately 6,000 acres. Beginning with the 1999 inventory, Missouri was one of the first states in the nation to be inventoried with the new annualized FIA system (Moser et al. 2005). The FIA annual inventory system measures approximately one-fifth of all field plots each year. After 5 years, an entire inventory cycle will be completed. After the first 5 years, FIA will report and analyze results as a moving 5-year average. We used data from the 1999-2003 and the 2000-2004 inventories of Missouri to analyze the shortleaf pine resource. For estimates of both growth and removals these inventories demonstrate wide variation because of the long time gap between the last periodic inventory (1989) and the first full 5-year annualized inventory as well as changes in definitions and methods over that time period. In addition, the 2000-2004 inventory, although using consistent definitions and methods relies on the remeasurement of only one year's worth of data (the plots taken in 1999 and again in 2004) for growth and removals estimates.

Timber Product Output Data

Periodic Timber Product Output (TPO) survey is an on-going cooperative effort between the Missouri Department of Conservation (MDC) and the USDA Forest Service's Northern Research Station (NRS) (Treiman and Piva 2005). Consulting foresters from Missouri and MDC personnel visit all primary wood-using mills within the State every 3 years. They use questionnaires designed and supplied by MDC to determine the size and composition of the resources that are utilized by the State's primary wood-using industry, its use of roundwood, and its generation and disposition of wood residues. Survey questions and reports refer to wood-use during the previous calendar year. Follow-up visits are made as needed in an effort to achieve a 100-percent response. Completed questionnaires are sent to MDC for data entry and then electronically forwarded to NRS for editing and processing. As part of data editing and processing, roundwood volumes are converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging are estimated using factors developed from logging utilization studies previously conducted by NRS. Finalized data on Missouri's industrial roundwood receipts are loaded into a national timber removals database along with data from TPO studies from other States to provide a complete assessment of Missouri's timber product output.

Missouri Timber Price Data

MDC surveys Missouri foresters, loggers, and members of the forest industry on a quarterly basis to determine current price trends in the state. Survey response is voluntary and confidential; MDC has no statutory or regulatory power to compel sale reporting. For this reason, most reported sales tend to be reported by professional foresters and the results must be interpreted with that caveat in mind. We surmise that forester-assisted sales, which tend to be inventoried, marked, and bid out, represent the upper range of prices paid for stumpage. MDC publishes the survey results quarterly as Missouri Timber Price Trends and makes the publication available to landowners and the forest industry in paper and on the web: http://mdc.mo.gov/forest/products/prices/index.htm (Treiman and Tuttle 2006). Foresters turning in reports are free to lump species together in sale reports, and often do. Consequently, detailed price data for shortleaf pine is not available for all reporting periods.

RESULTS

Forest Inventory and Analysis Data

The 1972 Forest Inventory and Analysis plots in Missouri showed total annual removals of 167.7 million cubic feet (Spencer et al. 1976). Shortleaf pine accounted for 6.9 million feet per year (4 percent of the total). About 30 percent of the removals were from the Eastern Ozarks Forest Survey Unit (Table 1 and Figure 1).

The results from the 1989 forest inventory in Missouri show 6.8 million cubic feet of annual removals of shortleaf pine, representing about 6 percent of the 116.6 million cubic feet of total annual removals of all species in the State. The inventory found that over half (53 percent) of the removals came from the Eastern Ozarks unit with the rest coming from the Southwest Ozark unit. About two-thirds of the removals were from National Forest land with most of the remainder coming from private lands. Between 1972 and 1989, there was an average net annual growth of 19.6 million cubic feet of shortleaf pine. Sixty-two percent of

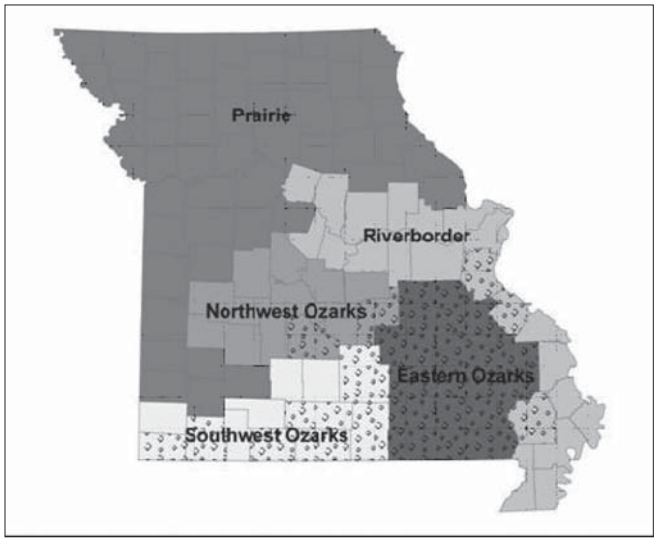

Figure 1.—A map of the FIA analysis units for Missouri. Counties with tree symbols had shortleaf pine or shortleaf pine/oak forest types in the 2000-2004 FIA inventory.

Table 1.—Average net annual growth and average annual removals of shortleaf pine on timberland by survey year and Forest Survey Unit, Missouri (in thousand cubic feet).

	Total			Forest Inventory Unit							
				Eastern Ozarks		Southwestern Ozarks		Northwestern Ozarks		Riverborder	
Survey Year	Growth	Removals	Pct. of Growth	Growth	Removals	Growth	Removals	Growth	Removals	Growth	Removals
1959[1]	15,642	5,000	32%	na	na	na	na	na	na	na	na
1972[1]	10,718	6,854	64%	8,241	2,060	2,256	4,704	141	3	79	88
1989	19,618	6,788	35%	12,138	3,613	5,761	3,175	1,432	--	287	--
1999-2003[2]	18,480	8,560	46%	11,028	4,513	5,500	4,047	1,798	--	155	--
2000-2004[2]	25,094	5,059	20%	17,842	3,864	6,925	1,195	--	--	327	--

na = Not available
[1]Converted from cords at 79 cubic feet per cord.
[2]From Forest Inventory Mapmaker version 2.1 at: http://www.ncrs2.fs.fed.us/4801/FIADB/index.htm

the growth occurred in the Eastern Ozarks unit with most of the rest coming from the Southwest Ozark unit. Some net growth also occurred in the Northwest Ozarks and Riverborder units (Spencer et al. 1992).

Results from the 1999-2003 annual inventory show an increase of annual removals of shortleaf pine to 8.6 million cubic feet, but shortleaf pine still makes up around 7 percent of the total 118.6 million cubic feet of annual removals in the state. Almost 40 percent of the removals were in the Eastern Ozarks unit. Average net annual growth was 18.5 million cubic feet for shortleaf pine. About 60 percent of the growth occurred in the Eastern Ozarks unit (Moser et al. 2007). Table 1 also shows results labeled "2004", based on the continuing annual FIA plots. For removals, the figures vary widely from the "2003" figures (based on 5 years of plots, 1999-2003) and those labeled "2004" because they represent only a 20 percent sample—those plots measured in 1999 and remeasured in 2004.

In addition, FIA plot data can be analyzed to show growth and removals by public and private ownerships, and acreage in each ownership category (see Table 2). Note that although 83 percent of timberland in Missouri was privately owned (1999-2003) and 85 percent of all growth of growing stock volume occurred on that private land, only 45 percent of shortleaf pine growth occurred on private land. Similarly, although 69 percent of all removals came from private land only 55 percent of shortleaf pine removals were from private land. These findings accord with overall volume on private land: 8 percent of all growing stock volume was on private land while only 42 percent of shortleaf pine growing

Table 2.—Removals, growth, and growth removed by ownership type (percent of cubic foot volume).

		Inventory Year and Species			
		1999-2003		2000-2004	
		All Species	Shortleaf Pine	All Species	Shortleaf Pine
Removals	Private Land	69%	55%	83%	90%
	Public Land	31%	45%	17%	10%
Growth	Private Land	85%	45%	82%	48%
	Public Land	15%	55%	18%	52%
Removals/Growth	Private Land	15%	56%	31%	38%
	Public Land	39%	38%	28%	4%
	Overall	19%	46%	30%	20%

stock volume was on private land. Given these volume percentages growth and removals figures for shortleaf pine by ownership are not surprising. In addition, FIA plots show that in both 1989 and 1999-2003 most of the removals came from the medium- and small-size classes.

Timber Product Output Data

In TPO surveys conducted between 1969 and 2003, total production of industrial roundwood in Missouri ranged from a low of 87.6 million cubic feet (1980) to 139.6 million cubic feet (1997). During this period, shortleaf pine remained in the top five species harvested, peaking at number three from 1987 to 1997. In 2000, shortleaf pine fell to the fourth most harvested species. Red and white oaks have always had much higher harvest levels. The total harvest of shortleaf pine varied from a low of 4.0 million cubic feet in 1969 to a high of 8.9 million cubic feet in 1991 (Table 3).

The Eastern Ozark Unit has historically contained most of the harvest volume of shortleaf pine in the State. The highest harvest in the region was 6.5 million cubic feet in 1994, about 80 percent of all shortleaf pine harvested that year. The low came in 2003, 3.4 million cubic feet or 75 percent of the total shortleaf pine harvest for that year. Since 1980, the Southwestern Ozark Unit has had the second highest shortleaf pine volume harvested, with an average of just over 20 percent of the State's harvest.

Historically, more than 95 percent of the shortleaf pine harvested in Missouri was processed in Missouri and the majority has been used for sawlogs. The percentage used for other purposes (mostly posts) has varied from a low of 9 percent in 1987 to a high of 34 percent in 1969. Since 1969, posts have remained as the second most processed product in the State using shortleaf pine. The production of poles from shortleaf pine reached its peak in the 1969 survey, and has since disappeared from TPO reports. This situation may change with the opening in 2006 of a pole mill near Licking, MO (John Tuttle, MDC Forest Products Supervisor, pers. commun. with the author).

In 1987, a logging utilization study was conducted which lets us estimate of the volume of industrial roundwood that is removed during harvest and the volume that is left on the ground as harvest residue. The volume of shortleaf pine harvest residues since 1987 has ranged from a high of 5.3 million cubic feet in 1997 to a low of 3.1 million cubic feet in 2000. About two-thirds of the volume of the trees that are cut is utilized for products. Ninety percent of the volume that is utilized comes from growing stock sources (Blyth and Massengale 1972, Blyth et al. 1983, Smith and Jones 1990, Hackett et al. 1993, Piva and Jones 1997, Piva and Treiman 2003, Treiman and Piva 2005).

The most recent TPO data from 2003 were also used to compile a directory of Missouri's primary wood processing mills which showed that 92 out of 444 processed some shortleaf pine (Jones et al. 2004).

Missouri Timber Price Data

Stumpage prices for shortleaf pine sawlogs have ranged between $90 and $155 per International ¼" MBF, according to sales reports collected for *Missouri Timber Price Trends*. Fence post prices have ranged between $0.20 and $0.65 per post over the same period (see Figure 2).

Combining the TPO results with these price data allows the calculation of the total value of all shortleaf pine sales, assuming that all landowners receive the forester-assisted

Table 3.—Total industrial roundwood production and shortleaf pine industrial roundwood production by year and Forest Survey Unit, Missouri (in thousand cubic feet).

		Shortleaf Pine Production						
				Forest Inventory Unit				
Survey Year	Total Roundwood	Total Shortleaf Pine	Pct. of Total Roundwood	Eastern Ozarks	Southwestern Ozarks	Northwestern Ozarks	Prairie	Riverborder
1969	123,546	4,023	3.2%	na	na	na	na	na
1980	87,558	5,450	6.2%	3,642	1,633	88	0	87
1987	99,932	7,114	7.1%	5,860	1,153	55	0	46
1991	121,392	8,865	7.3%	5,520	2,790	54	0	501
1994	132,593	8,127	6.1%	6,472	1,489	132	12	23
1997	139,643	8,723	6.2%	6,022	2,380	209	0	112
2000	128,974	5,239	4.1%	4,496	652	64	0	27
2003	128,106	4,560	3.6%	3,442	869	84	17	147

na = Not available

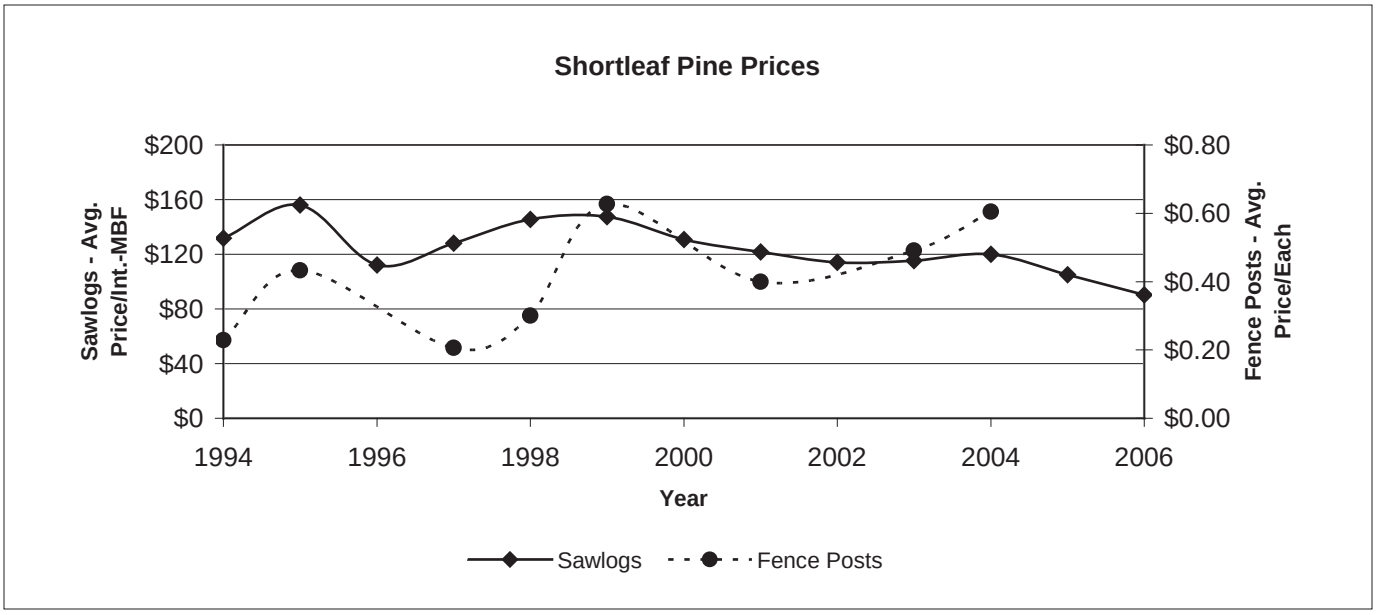

Figure 2.—Shortleaf pine prices for sawlogs (Int-MBF) and fence posts (each) in Missouri. Prices are based on reports received for the Missouri Timber Price Trends publication. These reports are voluntary and come from sales assisted by a professional forester. As such, the price trends shown tend towards the price for a well planned sale that is bid out to multiple loggers. (Prices were not available for posts from 2004-2006.)

prices represented by the *Missouri Timber Price Trends* data. The *Missouri Timber Price Trends* reports prices for sawlogs, posts, and pulpwood. Volumes for these species and products are also reported in the TPO surveys. The value of shortleaf pine products peaked in the 1990s at $7.5 million. After 1997, the value of the shortleaf pine harvest has continued to fall to the 2003 level of $3.5 million. These values are in Figure 3 as the line labeled "production". All annual totals have been converted into 2006 dollars.

Using FIA data, the potential value for the shortleaf pine resource in Missouri can be calculated. Assuming the maximum sustainable cut would be no more than total annual growth, and the highest value (price) is for the highest value product, which proves to be sawlogs, a theoretical upper bound to the sustainable total value of shortleaf pine can be calculated (Fig. 3).

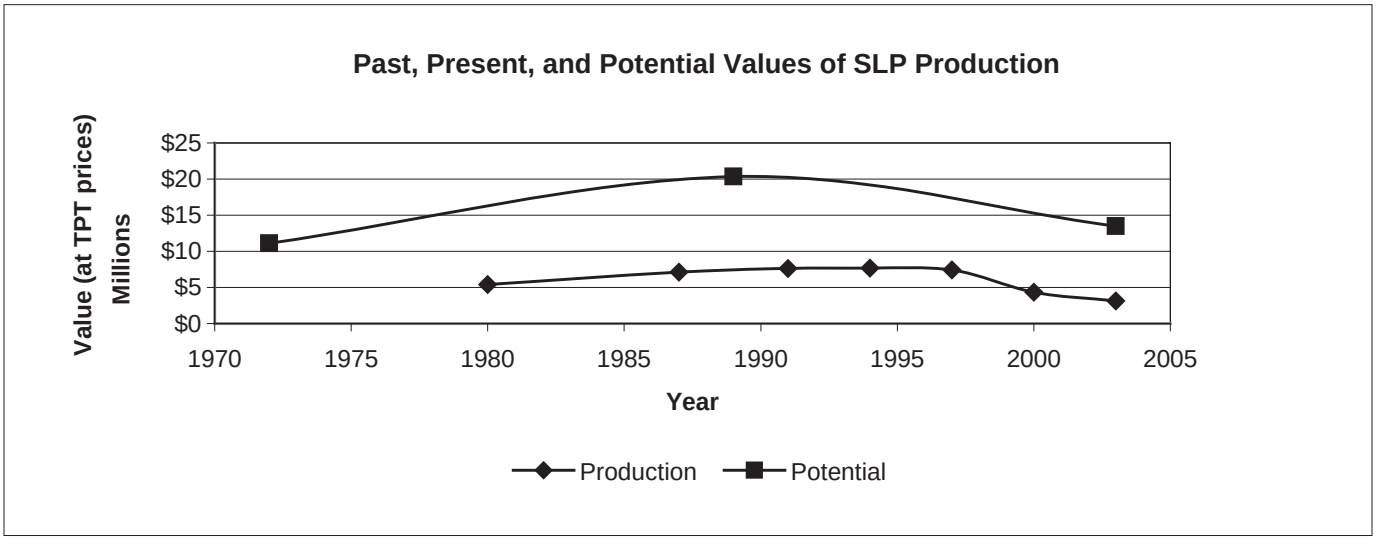

Figure 3.—Calculated present values of shortleaf pine industrial roundwood production[1] and potential production[2] in Missouri by year.

[1]Production is the value of product based on products and volumes harvested from TPO studies and *Missouri Timber Price Trends* reports in 2006 dollars.

[2]Potential is based on the maximum sustainable cut, which would be no more than total annual growth, and the highest value (price) for the highest value product.

DISCUSSION

From a low point in the early 20th century, shortleaf pine has been making a slow return to Missouri's forests. To date, more of this return (growth) has occurred on public land than on private land (Table 3). If shortleaf pine is to return to its historical prominence as a component of both the state's biodiversity and its economy, the role of private landowners will take on ever greater importance. Financial incentives are of paramount importance to many private forest landowners, so profitable markets for shortleaf pine will also be essential to the species' return.

Shortleaf pine is growing faster than it is being harvested in Missouri, a clear indicator of sustained yield. Shortleaf pine's rate of growth increased dramatically between 1972 and the 1999-2003 and the 2000-2004 FIA inventories. In 1972, 64 percent of shortleaf pine growth was removed, while for the 1989, the 1999-2003 and the 2000-2004 FIA inventories this percentage varied between 20 percent and 46 percent. For all species combined 30 percent of growth is being removed. Utilization of shortleaf pine is relatively high compared to all other species.

The 1999-2003 inventory estimates removals of shortleaf pine occur disproportionately on private land; 56 percent of private land shortleaf pine growth is being removed compared with 38 percent on public land. The 2000-2004 inventory estimates removals of shortleaf pine of only 4 percent of public land shortleaf pine growth compared with 38 percent on private land. (Note the high variation between the two, in part because of the earlier mentioned issues with switching inventory systems.) Many factors contribute to forest utilization, including markets, availability, and operability. The lower rate of utilization (as a percentage of growth) on public lands may indicate that public lands managers may have a valuable role to play in helping develop and improve markets for shortleaf pine. The higher rate of utilization of shortleaf pine on private lands may indicate that private forest landowners will be willing to take advantage of such markets for the product. Our rough calculation of the upper bound, "potential", also shows that the full economic benefits that might be reaped from this softwood are not yet being realized by landowners and as such, shortleaf pine may not be a fully thought-out part of many land management plans.

These results suggest a potentially fruitful area for further research: How does shortleaf pine potential (as defined in this paper) compare to that of other commercial species in the state? What is the relative economic position of shortleaf pine? Answers to these questions may help professional foresters working with private landowners to better understand why shortleaf pine is not in many management plans, and how to get it there. Some of this work may best be accomplished after another full 5-year annualized inventory is complete, allowing for more precise estimates of growth and removals.

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