RELATIONSHIPS BETWEEN HARVEST OF AMERICAN GINSENG AND HARDWOOD TIMBER PRODUCTION

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ABSTRACT

The goal of this research was to quantify the relationship between American ginseng (*Panax quinquefolius*) and timber inventory and harvest. This was done through compilation and analysis of county-level data from public datasets: ginseng harvest data from U.S. Fish and Wildlife Service, US Forest Service (USFS) forest inventory and analysis (FIA) data, and roundwood production data from the USFS Timber Products Output (TPO) program. Data for the 18-state region from 2000 to 2007 were aggregated to the county level. Ginseng harvest was correlated with hardwood growing stock and hardwood forest area. No evidence of a relationship between timber harvest levels and ginseng harvest was observed. There is also no indication that ginseng harvest is higher in areas with more abundant public forestland. For the counties recording a ginseng harvest during the period, ginseng harvest was valued at $25 million, while timber harvest value was estimated to be $1 billion.

INTRODUCTION

Herbal medicines and other non-timber forest products have been a significant, yet underappreciated, part of the forest products industry in the United States for more than 300 years (Chamberlain and others 1998). Trade in American ginseng (*Panax quinquefolius*) between North America and China began in the early 1700s. By the mid-1700s, natural populations around Montreal had been depleted, and the plant was discovered in New England (Nash 1898). From the Revolutionary War until 1900, an estimated 20 million pounds of dried ginseng was exported to China from the US (Pritts 1995).

Since 1975, when American ginseng was put on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the United States has been tracking harvest and export of this important medicinal plant (Robbins 2000, U.S. Department of Interior 2009). Biannually, the U.S. Fish and Wildlife Service (FWS) must determine if export of wild-harvested ginseng will be detrimental to the species survival. For each of the years 2000-2010, the FWS determined that lawfully harvested ginseng could be exported from 19 states (Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Minnesota, Missouri, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin) without detriment to the survival of the species. Of the states approved to export American ginseng, most are found in the Appalachian region. The harvest data collected by FWS under CITES provides a county-level dataset of annual estimates that can inform analyses of the spatial distribution of ginseng harvest. Combined with data on forest conditions at the county level, there is an opportunity to examine relationships between ginseng harvest and forest inventory.

The Forest Inventory and Analysis (FIA) program of the U.S. Forest Service (USFS) collects, analyzes and reports on the status and trends of America's forests: how much exists and where it is located, who owns it, and how it is changing, as well as the health and well-being of forest trees and other vegetation. It has been in continuous operation since 1930, with a mission to "make and keep current a comprehensive inventory and analysis of the present and prospective conditions of and requirements for the renewable resources of the forest and rangelands of the US" (Frayer and Furnival, 1999). FIA regularly reports on the status of forests in specific states. FIA also reports, through the Timber Products Output (TPO) program, production of roundwood through mills. Unlike FIA data, which are based on a sampling design involving plots on which trees are measured, the TPO dataset is based on surveys of mills, in which mill managers respond with estimates of production by wood product and source county. Thus, through TPO data we have an additional estimate of timber production at the county level (Johnson and others 2008).

The goal of this study was to improve the understanding of the relationship between American ginseng and hardwood timber harvests. We examine the relationship between standing timber volume, the amount of timber harvested and wild American ginseng harvest. There have been a few studies done to estimate amount of available ginseng habitat (Van Manen and others 2005), but no efforts have been made to quantify the relationship between timber and ginseng harvests.

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METHODS

Data at the county level were compiled from two primary sources: ginseng harvest records from the FWS, and Forest Inventory and Analysis (FIA) data from the USFS. Data from each source were compiled from the states in the eastern US where recent (2000 – 2007) ginseng harvest data were available (Figure 1). Several states had missing ginseng harvest data for one or more years (Table 1), and Minnesota had no harvest data at the county level and was therefore omitted from this analysis. In all, data from 1,542 counties were compiled.

GINSENG HARVEST DATA

Ginseng harvest data provided by the FWS were entered manually into database tables. In some cases, dry weights were recorded in pounds and ounces and converted to decimal pounds. Also, for some states, green weights were recorded on data sheets provided by the FWS and were converted to dry weights using a factor of three pounds green weight per pound dry weight, a conversion ratio that is commonly used in the industry. Where the county of origin was not provided on data sheets (some records merely indicated "various" counties), the unassigned harvest numbers were allocated proportionally to counties where harvest was recorded. After entering all harvest data into the database and conducting error-checking for omitted or mis-entered data, average annual harvest across the time period was computed for each county.

FOREST INVENTORY DATA

FIA data are collected in all US states on an annual basis using a multiphase sampling scheme. Due to the transition from periodic to annual inventory, some states had incomplete inventories for the study period (Table 1). In such cases, however, state estimates are still available, but have larger variability than if complete data were available. The sampling intensity used in the FIA program results in estimates are not statistically reliable at the county level. The FIA program, therefore, recommends that totals for groups of counties called FIA units be used. We conducted this analysis at both the county and FIA unit level (Figure 1).

From the FIA data for each state, we compiled estimates of growing stock and removals (by softwood and hardwood), and forest area (by broad forest type and ownership) for each county and FIA unit. We anticipated that ginseng harvest may vary with forest type (hardwood versus softwood forests), and harvesters' access may vary with land ownership (public versus private), so we summarized inventory and removals by forest type and ownership class for analysis. We included as public lands all federal, state, and municipal forests except for military bases, in situations where we assumed ginseng harvesting would be restricted.

After compilation of FIA data and computation of relevant estimates, the FIA and ginseng harvest databases were merged by county identifier. This enabled creation of maps showing relevant variables as well as graphical and statistical analysis of relationships between ginseng harvest and forest inventory estimates. Both Pearson's and Spearman's correlation coefficients were calculated. These analyses were performed using ArcGIS software and JMP software (SAS Institute 2007).

PRODUCTION AND PRICE DATA

Data on sawtimber and pulpwood production from the states in the region were collected from the FIA Timber Product Output (TPO) dataset (Johnson and others 2008). Annual county figures from 2001 and 2006 were averaged to estimate annual wood product production for the period. Average stumpage price data for wood products were collected from Timber-Mart South (http://www.tmart-south.com) for the time period and applicable states in this study. Wood production and wood price data were used to compare economic value of ginseng and wood production for the individual states, averaged over the period 2000 – 2007.

Price data for ginseng is not as accessible or as readily available as for timber. Persons and Davis (2005) provide estimates of prices paid to ginseng harvesters for 1982 through 2005. Persons complemented this data with estimates for 2007 and 2008 through personal communications.

RESULTS AND DISCUSSION

GINSENG HARVEST

During the period of study, almost 500,000 pounds of American ginseng were harvested from the 18 states reported (Table 2). Kentucky accounted for more than 25 percent of the total, followed by Tennessee (13 percent), North Carolina (12 percent), West Virginia (9.5 percent), and Indiana (8.7 percent). These five states accounted for almost 70 percent of the total American ginseng harvest for the period 2000-2007. Maryland reported the lowest harvest of less than 600 pounds. The overall average annual ginseng harvest across the region during the period of study was 60,100 pounds. Annual harvest ranged from a high of 76,644 pounds in 2003 to a low of 42,085 in 2005.

Figure 2 illustrates the spatial distribution of American ginseng harvest. Counties reporting at least 600 pounds of annual harvest are located in eastern Kentucky, southern

West Virginia and western North Carolina. Fourteen states had counties with annual harvests greater than 90 pounds. The greatest majority of counties, though, reported less than 90 pounds of annual harvest. Clearly American ginseng harvest is concentrated in five states.

Across the 1,002 counties that reported some ginseng harvest between 2000 and 2007, the average annual harvest ranged from 0.008 to 1,113.3 pounds. The top 10 percent of producing counties reported at least 166 pounds per year and together accounted for approximately 34,718 pounds per year, or 60 percent of the overall harvest. The top 10 producing counties accounted for nearly 8,615 pounds or 15 percent of the overall average ginseng harvest. Five of these counties are in Kentucky, and four are in North Carolina.

RELATIONSHIPS WITH FOREST INVENTORY

Using correlation analysis we examined the relationship of a suite of variables with ginseng harvest. We did this for two subsets of the data. First, all counties with any reported ginseng harvest were used as a subset of the total dataset (which included 1,542 counties/cities, nearly a third of which had no reported harvest). Because many counties had only minimal harvest, we examined a second subset of only counties with an average annual harvest of at least 50 pounds. The first subset (all producing counties) consisted of 1,002 counties, and the second (producers of at least 50 pounds per year) consisted of 256 counties.

Table 3 summarizes the Pearson correlation coefficients at the county level for the suite of FIA variables examined. The number of counties included in the calculations may be less than the number of counties in a dataset because of missing observations (e.g., counties with no public land, no removals data, etc.).

Analysis of all counties with some harvest (first data subset) provides many statistically significant but low correlations. This dataset contains many counties that had very low harvest but might have large forest areas, growing stock volumes, etc. For example, many of these counties may be along the edges of the expected ginseng range, or may contain only small areas of forest that are conducive to ginseng growth and reproduction. Or, these counties may have a limited numbers of harvesters. Regardless, the strongest relationships were with hardwood growing-stock volume, total forest growing-stock volume, and hardwood forest area.

The analysis of counties producing at least 50 pounds annually (second data subset) presents a slightly different picture (Table 3). These counties, while numbering only a quarter of the total number of counties with any harvest, account for 84 percent of total ginseng harvest. Among these counties, we might expect to find more meaningful relationships with forest inventory variables. Again, the strongest and most significant correlations are with growing stock volume and forest area. This is not surprising as it indicates more ginseng harvest in counties with more hardwood forest, and with more or larger hardwood trees.

Growing stock volume per acre is simply the total growing stock divided by number of forest acres, and represents relative timber density. This variable shows the one of the highest correlations among the variables in the second dataset. Figure 3 depicts the relationship between ginseng harvest and hardwood growing stock volume. This relationship had the strongest correlation for the 256 counties producing at least 50 pounds/year However, there is tremendous variability, with some heavily forested counties (growing stock in excess of 800 million cubic feet) producing less than 200 pounds of ginseng annually, while some counties with much less forest volume (300 to 800 million cubic feet) are producing amounts of ginseng in excess of 600 pounds per year.

We also found, in the counties producing at least 50 pounds, positive (but non-significant) correlations with timber removals. This could be because counties with more timber removals also have more growing stock, which is positively correlated to ginseng harvest. Dividing timber removals by growing stock, therefore, gives us a variable that measures intensity of removals relative to standing inventory. For these, the correlations were negative, very low and not statistically significant, meaning the observed relationship could be based on chance alone.

As noted, FIA data are sparse within individual counties such that county-level estimates are not considered reliable as they have high variability. For some analyses, relevant patterns are clearer when data are aggregated to the FIA unit level. To test this effect, we examined correlation coefficients for total ginseng harvest within FIA unit aggregates (Table 4). At the FIA unit level, we see stronger and more significant correlations, due to the removal of county-to-county variability. Hardwood growing-stock volume and hardwood forest area are again significantly correlated with ginseng harvest. Correlations related to public land ownership are weaker or insignificant. The correlation of timber harvest (removals) to ginseng harvest is significant and positive, but lower than the correlations with growing-stock volume. Part of this effect could be due to the very strong and positive way in which removals are themselves correlated with growing-stock volume (0.72 correlation coefficient between hardwood growing stock and hardwood removals).

We found a negative but insignificant correlation with percent hardwood growing stock on public lands. The negative correlation (if significant) would suggest that

counties with a higher proportion of their hardwood forests under public ownership harvest less American ginseng than counties with less hardwood forest on public land. In fact, the FIA unit with peak ginseng harvest per hardwood forest area had only 8.5 percent of hardwood forest in public ownership, ranking 61st out of 76 FIA units. If public lands were a consistent, primary source of ginseng harvest, we would expect these correlations to be larger, positive, and significant.

At the aggregate level of FIA units, we looked at the harvest level of ginseng relative to hardwood forest area to get an indicator of production per unit area. It is impossible to extrapolate from this how much area might support ginseng harvest, because hardwood forest area alone does not account for all the factors relevant to ginseng growth, reproduction, survival, and harvest. But it is evident that ginseng harvest per hardwood acre varies widely, with the highest reported level being 2,615 pounds of ginseng produced per million acres of hardwood forest, in Eastern Kentucky (Figure 4). This eight-county area produced 27,375 pounds of ginseng in the six years for which we had data. An annual harvest of 4,562 pounds was derived from a hardwood forest area of 1.74 million acres. The top ten FIA units each produced over 1,000 pounds of ginseng per million acres of hardwood forest.

PRODUCTION AND ECONOMIC VALUE

While ginseng prices ranged from $200/pound to an abnormal peak of $1,150/pound (Persons and Davis 2005), we used a nominal average price of $423.42/pound to obtain estimates of annual harvest value. Ginseng prices reflect the amount paid to harvesters for dried wild-harvested root.

For timber stumpage, we used averages of prices from southern states reported during the period: $212 per thousand cubic feet for hardwood pulpwood and $736.16 per thousand cubic feet for hardwood sawtimber. These prices may not reflect the entire study region, but are indicative of the active southern timber markets. Prices were for stumpage, the price paid to a landowner for standing timber before harvesting and transportation to a mill.

Timber product output data indicate that during the period 2000 – 2007, hardwood timber production in the 1,002 ginseng-producing counties averaged approximately 2.1 billion cubic feet per year, consisting of 0.982 billion cubic feet of pulpwood and 1.153 billion cubic feet of sawtimber.

While the average prices used may not reflect the variability over time and geographic region, they indicate the relative magnitude of the economic value of the timber and ginseng crops. Annual hardwood timber revenue in the ginseng-producing counties was slightly more than $1.0 billion, compared to approximately $25 million for ginseng (Table 5). These numbers actually understate the difference in value, as the timber prices used are for stumpage (standing timber in the forest), and the ginseng prices are for dried ginseng delivered to a dealer.

CONCLUSIONS

Ginseng harvest in an area (county or FIA unit) is related to the amount of hardwood forests in the area, as well as other factors. There was a correlation between ginseng harvest and total hardwood forest area as well as hardwood growing stock. Also, there was a positive but statistically insignificant correlation between ginseng harvest and harvest of timber. Our findings suggest a slight negative relationship between ginseng harvest and amount of public lands. We also conclude that while the value of ginseng harvest may be significant to rural counties it is minor compared to hardwood timber values.

Further analysis of the relationship between ginseng harvest and forest conditions (including timber harvest) is possible. It is also reasonable to consider combining the spatial database of ginseng harvest (Figure 2) with other spatially-defined data that might help explain ginseng abundance. For example, temperature, precipitation, elevation, soil conditions, and other environmental parameters may be associated with ginseng distribution and abundance, and could be modeled with harvest data. Such analyses might provide further insights about factors explaining varying levels of ginseng harvest, and enhance the sustainable utilization of this valuable resource.

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Table 1—Ginseng harvest and FIA data availability. Gray cells represent years in which county-level ginseng harvest data are missing. The FIA data years indicate the time period for the FIA data used for each State

State	2000	2001	2002	2003	2004	2005	2006	2007	Counties	FIA Data Years
Alabama									67	2001 - 2005
Arkansas									75	2000 - 2005
Georgia									159	1998 - 2004
Illinois									102	2002 - 2006
Indiana									92	2002 - 2006
Iowa									99	2002 - 2006
Kentucky									120	2000 - 2004
Maryland									24	2004 - 2006
Missouri									115	2002 - 2006
New York									62	2002 - 2006
North Carolina									100	2003 - 2006
Ohio									88	2001 - 2006
Pennsylvania									67	2002 - 2006
Tennessee									95	2000 - 2004
Vermont									14	2003 - 2006
Virginia									136	2002 - 2007
West Virginia									55	2004 - 2006
Wisconsin									72	2002 - 2006
Count	**15**	**15**	**16**	**15**	**17**	**18**	**15**	**17**	**1542**	

Table 2—Ginseng harvest by State and year (pounds dry weight). Where county-level data were unavailable, Statewide summary data were used and are shown in italics

State	2000	2001	2002	2003	2004	2005	2006	2007	Total
Alabama	256	*874*	457	1,011	649	221	761	340	4,569
Arkansas	519	927	2,075	2,633	1,717	496	863	990	10,220
Georgia	311	707	266	416	243	161	*167*	259	2,530
Illinois	2,781	2,884	1,748	2,844	2,682	1,234	2,000	2,082	18,255
Indiana	6,273	6,818	3,192	6,915	4,823	4,926	5,106	3,862	41,915
Iowa	940	783	798	554	286	230	609	1,014	5,215
Kentucky	*16,216*	*22,765*	12,149	22,572	16,672	9,393	13,713	11,332	124,813
Maryland	48	56	72	*109*	*160*	31	*62*	53	590
Missouri	1,477	1,703	1,907	2,452	1,358	2,093	1,722	1,097	13,809
New York	1,398	621	485	633	359	309	133	439	4,376
North Carolina	8,417	6,788	8,790	*6,548*	4,265	5,733	6,447	12,317	59,305
Ohio	3,492	3,254	3,135	4,559	3,978	3,311	2,265	3,126	27,120
Pennsylvania	*1,749*	1,370	*1,730*	920	1,025	930	1,355	*1,947*	11,025
Tennessee	*8,164*	*8,737*	*5,815*	*10,826*	8,204	5,034	*8,153*	8,730	63,663
Vermont	205	119	183	117	112	36	60	114	946
Virginia	5,723	3,821	3,810	4,675	3,435	1,569	2,798	3,050	28,881
West Virginia	8,602	5,409	5,206	7,170	5,882	4,785	4,561	4,150	45,765
Wisconsin	3,024	2,495	2,580	1,690	1,946	1,593	2,146	2,396	17,869
Totals	69,596	70,131	54,399	76,644	57,795	42,085	52,919	57,299	480,868

Table 3—Pearson correlation coefficients relating FIA-derived variables to average annual ginseng harvest at the county level. An asterisk indicates the correlations are statistically significant (at the 95 percent confidence level)

		Counties with some production			Counties producing at least 50 pounds annually		
	Variable	Correlation Coefficient		Number of Counties	Correlation Coefficient		Number of Counties
	Forest area	0.1629	*	1002	0.1584	*	256
	Hardwood forest area	0.2177	*	1002	0.1844	*	256
	Forest growing-stock volume	0.2340	*	1000	0.1978	*	256
	Hardwood growing-stock volume	0.2884	*	1000	0.2189	*	256
	Average growing stock per acre	0.2069	*	1000	0.2143	*	256
	Hardwood growing stock on public lands	0.0822	*	678	-0.0297		196
	Percent hardwood growing stock on public lands	-0.0418		678	-0.0886		196
	Removals from all species	0.1175	*	783	0.1159		189
	Removals of hardwood species	0.1746	*	782	0.1378		189
	Removals as a percent of growing stock	-0.0163		781	-0.0314		189
	Hardwood removals as percent of growing stock	0.0076		780	-0.0173		189

Table 4—Pearson correlation coefficients relating FIA-derived variables to average annual ginseng harvest at the FIA Unit level. An asterisk indicates the correlations are statistically significant (at the 95 percent confidence level)

Variable	Correlation Coefficient		Number of FIA Units
Forest area	0.3400	*	76
Hardwood forest area	0.3835	*	76
Forest growing-stock volume	0.4565	*	76
Hardwood growing-stock volume	0.4853	*	76
Average growing stock per acre	0.2897	*	76
Hardwood growing stock on public lands	0.2948	*	76
Percent of hardwood growing stock on public lands	-0.0620		58
Removals from all species	0.3389	*	58
Removals of hardwood species	0.4275	*	58
Removals as a percent of growing stock	-0.1121		58
Hardwood removals as a percent of growing stock	-0.0620		58

Table 5—Annual revenue from ginseng and hardwood timber harvest by State for 1,002 counties with recorded ginseng harvest during 2000-2007

State	Average Annual Ginseng Harvest (pounds)	Ginseng Revenue* (thousand $)	Timber Revenue (thousand $)
Alabama	571.1	$242	$32,996
Arkansas	1,277.5	$541	$27,464
Georgia	316.3	$134	$8,121
Illinois	2,281.9	$966	$35,404
Indiana	5,239.4	$2,218	$59,256
Iowa	651.9	$276	$11,315
Kentucky	15,601.6	$6,606	$118,108
Maryland	73.8	$31	$6,154
Missouri	1,726.1	$731	$78,073
New York	547.0	$232	$60,409
North Carolina	7,413.1	$3,139	$53,092
Ohio	3,390.0	$1,435	$38,006
Pennsylvania	1,378.1	$584	$109,602
Tennessee	7,957.9	$3,370	$127,923
Vermont	118.3	$50	$17,961
Virginia	3,610.1	$1,529	$78,640
West Virginia	5,720.6	$2,422	$93,249
Wisconsin	2,233.6	$946	$101,554
Total	**60,108.3**	**$25,451**	**$1,057,327**

** Based on $423.42 per pound*

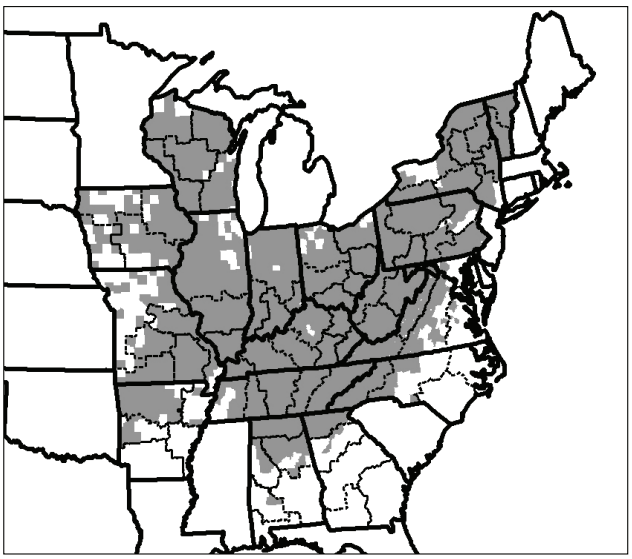

Figure 1—States for which county-level ginseng harvest data were available included Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Missouri, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin. Counties shown in gray had at least one record of ginseng harvest during 2000-2007. Dashed lines within States indicate boundaries of FIA aggregation units.

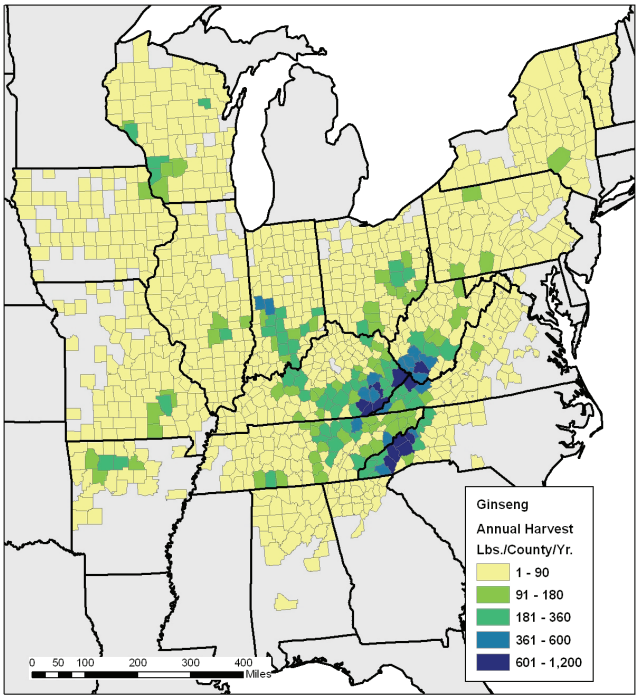

Figure 2—Map of average ginseng harvest.

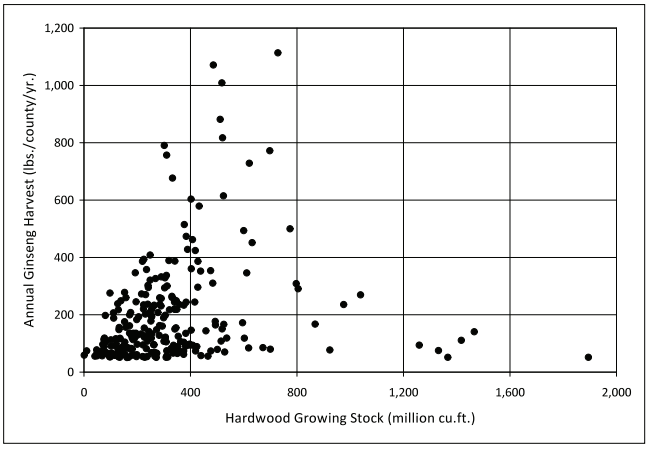

Figure 3—Scatterplot of hardwood growing stock volume and annual ginseng harvest for the 256 counties producing at least 50 pounds of ginseng per year.

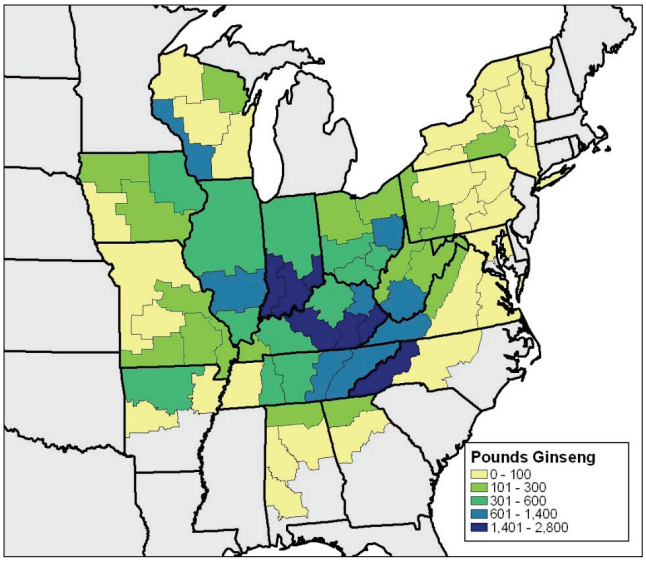

Figure 4—Ginseng harvest per million acres of hardwood forest, by FIA unit.