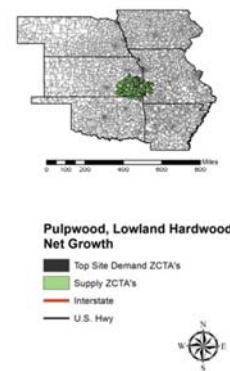
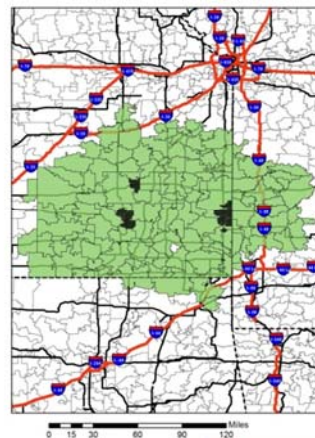
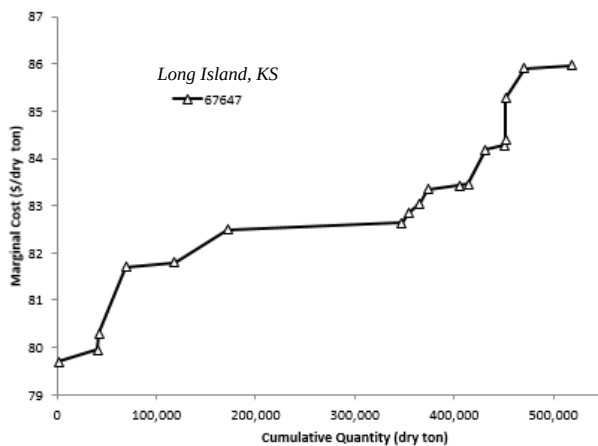


2016

# Kansas Woody Biomass Site Assessment Tool (KS BioSat)



[www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html)



**Sponsored by Kansas Forest Service**

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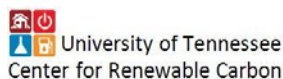
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February 29, 2016



## **Acknowledgements**

The authors wish to acknowledge Ms. Virginia Davis (Student Assistant - University of Tennessee, Center for Renewable Carbon) and Ms. Mariah Beane (Student Assistant - University of Tennessee, Center for Renewable Carbon). The authors also acknowledge The University of Tennessee Agricultural Experiment Station for their partial financial support of faculty salaries during this study. Acknowledgement is also extended to the staff from the U.S. Forest Service, Forest Inventory and Analysis group for providing data and guidance during this study. Kansas State University is acknowledged for providing administrative support during the project. Funding sources for this project were: Kansas Forest Service, USDA Forest Service and USDA McIntire-Stennis research project TENOOMS-107 as administered by The University of Tennessee Agricultural Experiment Station.



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## EXECUTIVE SUMMARY

The goal of this research project was to assess the geospatial economic availability of cellulosic feedstocks (woody and ag-residue) for demand sites in Kansas with supply zones coming from within the state and in some instances from the five-state surrounding region. The study will improve the overall understanding of the economic costs for cellulosic feedstocks for potential manufacturers wishing to locate in the state of Kansas. The study provides business decision-makers in the cellulosic feedstock-using industries with a geospatial economic tool that will allow them to assess the economic comparative advantages of cellulosic supply in the state, and at the sub-regional/interstate levels. A key outcome of the study was the development of the website <http://www.biosat.net/Kansas/index.html>, which will allow business decision makers to use the web-based tool for demand sites and supply regions for all possible locations in KS that are not possible to illustrate in this final report. Key cost inputs (*e.g.*, diesel costs, etc.) for the cost models of the KS BioSAT model are updated periodically for users of the website. The KS BioSAT project is an outcome of the “BioSAT” project by Perdue et al. (2011), <http://www.biosat.net/>. Users of the BioSAT model on <http://www.biosat.net/> will have an access link to the KS BioSAT model.

Assessing the economic capability and stability of the bioenergy supply chain infrastructure is essential for market organization of this emerging industry, and is the key question addressed by this study. Elbehri (2007) noted that lack of biomass production capacity, high relative costs of production, logistics, and transportation of feedstocks, are all potential constraints that need to be better understood. A plethora of literature exists on the economic availability of biomass (Young and Ostermeier 1989, Young *et al.* 1991a 1991b, Lunnan 1997, Walsh 1998, 2000, DiPardo 2000, Ugarte et al. 2000, 2006, 2007, Biomass Research and Development Board 2008, Western Governors Association 2008, Perez *et al.* 2009, Galik *et al.* 2009, U.S. Dept. of Energy 2011). A recent report by the U.S. Department of Agriculture and Department of Energy concluded that 1.3 billion tons of biomass are available annually for energy production (Perlack *et al.* 2005, U.S. Dept. of Energy 2011).

Geo-referenced producer supply curves were estimated in this study for woody and agricultural residue feedstocks. The resolution of the study was the 5-digit zip code tabulation areas (ZCTA) in Kansas and five of its surrounding states. The aggregate producer supply curves

are geo-referenced and estimate of resources costs (*e.g.*, stumpage), logging or harvesting costs, and transportation costs to the mill-gate.

Sourcing (or feedstock supply) areas are often non-concentric aggregations of ZCTAs which we believe accurately portray supply zones as a function of the corresponding available road network. Resource cost data (*e.g.*, mill residue prices, pulpwood prices, etc.) were obtained from Timber Mart South (TMS), Timber Mart North, and the Missouri price reporting service. The transportation cost model of the KS BioSAT model estimates trucking costs based on the shortest travel time (influences variable costs) between the potential demand ZCTA and its associated supply ZCTAs<sup>1</sup>. Microsoft© MapPoint® 2011<sup>2</sup> was used to estimate the shortest travel time routes and distances between ZCTAs. Road networks in MapPoint® are a combination of the Geographic Data Technology, Inc. (GDT) and Navteq data. The Subregional Timber Supply (SRTS) model was used to estimate logging residue supply and recovery rates (Abt *et al.* 2000, Abt 2008). The Fuel Reduction Cost Simulator (FRCS), as modified for the Billion Ton Study, was used to estimate the costs of harvesting “in-woods” logging residues (Dykstra 2008). The Auburn Harvest Analyzer (AHA) was used to estimate harvesting costs for ‘roundwood’ (Greene and Lanford 1987, Tufts *et al.* 1985, Tufts *et al.* 1988, Lanford and Stokes 1996, Holtzschler and Lanford 1997). The AHA model was adapted for the six-state study region given its ecoregions, forest stand types, and two available harvesting systems.<sup>3</sup>

Agricultural residues costs were estimated from the literature (Gallagher *et al.* 2003, U.S. Bureau of Labor Statistics, 2009).<sup>4</sup> Forest volume estimates were obtained from the Forest Inventory and Analysis Database (FIADB) (U.S. Department of Agriculture, Forest Service 2012). Mill residue estimates were obtained from the U.S. Forest Service Forest Inventory and Analysis Database Timber Product Output Reports (U.S. Department of Agriculture, Forest Service 2014).

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<sup>1</sup> Travel distance which influences fixed costs was allocated over the tractor-trailer’s estimated annual miles which was 100,000 miles for the tractor and dry van and flatbed trailers; 80,000 miles for the long-log and short-log trailers.

<sup>2</sup> <http://www.microsoft.com/mappoint/en-us/home.aspx> (software was discontinued on 12/31/2014)

<sup>3</sup> Ecoregions were: Gulf Coastal Plain, Appalachian Mountains, Eastern Broadleaf, Lake States, and Northeast (Bailey 1995). Tree stand types were: Upland Hardwoods, Lowland Hardwoods, Natural Softwood, Mixed Natural Pine and Hardwood, and Pine Plantation (Personal e-mail communication W.H. McNab 4/6/2011). Harvesting systems were: feller-buncher/grapple skidder, chainsaw/cable skidder, harvester/forwarder, chipper systems, swing feller-buncher/cable, and shovel/grapple. Note, not all eco-regions, tree stand types, and harvesting system combinations are used in the AHA adapted model.

<sup>4</sup> <http://cnre.vt.edu/harvestingsystems/Costing.htm#costingmodels>

Agricultural residue estimates were obtained using USDA National Agricultural Statistics Service survey data and residue derivatives were estimated using the equations and conversion factors of the literature (Proctor 1994, Nelson *et al.* 2004, USDA National Agricultural Statistics Service 2012).

Softwood and hardwood logging residue marginal cost curves were estimated for “chipping tops and limbs at the landing” (referred to as logging residue costs “at-landing”) and for “in-woods” harvesting of sub-merchantable material” (referred to as “in-woods” logging residue costs). Marginal cost curves for procuring mill residues were estimated for “clean softwood,” “clean hardwood,” “unclean softwood,” “unclean hardwood”. Marginal cost curves for ‘roundwood’ were estimated for “lowland hardwood,” “mixed natural softwood and hardwood,” “natural softwood,” “pine plantation,” and “upland hardwood” for both pulpwood and sawtimber.

Given that there were cost estimates for 44 possible combinations of feedstocks types available from the KS BioSAT model; cost data for only a select set of feedstocks are presented in this report. More detail is given in the results section of the report and cost data for all feedstock types are available at [www.biosat.net/Kansas/index.html/](http://www.biosat.net/Kansas/index.html/). Least cost sourcing areas for **clean hardwood mill residues** were identified in south-east Kansas. Average total cost (ATC) ranged from \$82.82 to \$84.69/dry ton. Least cost sourcing areas for **unclean hardwood mill residues** were also located in south-east Kansas. ATC ranged from \$46.45 to \$48.37/dry ton. Least cost sourcing areas for “**at-landing**” **hardwood logging residues** (*i.e.*, residues chipped at the logging landing) occurred in south-east Kansas. ATC ranged from \$21.37 to \$22.68/dry ton. Least cost sourcing areas for “**in-woods**” **hardwood logging residues** (*i.e.*, a second pass harvesting of non-merchantable logging residues) occurred in south-east Kansas. ATC ranged from \$192.75 to \$194.06/dry ton.

Least cost sourcing areas for upland **hardwood pulpwood** (using only the proportion of net growth of total inventory) were located in southeast Kansas. ATC ranged from \$83.95 to \$86.02/dry ton (\$100.74 to \$103.22/cord). Least cost sourcing areas for **upland hardwood pulpwood** (using only previous removals as the proportion of total inventory) were located in southeast Kansas. ATC ranged from \$91.14 to \$93.22/dry ton (\$109.37 to \$111.86/cord). Least cost sourcing areas for **upland hardwood pulpwood** (using the total standing inventory) were located in east and southeast Kansas. ATC ranged from \$79.05 to \$79.86/dry ton (\$94.86 to

\$95.83/cord). Least cost sourcing areas for **lowland hardwood pulpwood** (using only the proportion of net growth of total inventory) were located in north-central Kansas. ATC ranged from \$92.92 to \$93.48/dry ton (\$111.50 to \$112.18/cord). Least cost sourcing areas for **mixed natural softwood and hardwood pulpwood** (using the total standing inventory) were located in east Kansas. ATC ranged from \$82.02 to \$85.61/dry ton (\$98.42 to \$102.73/cord).

Least cost sourcing areas for **upland hardwood sawtimber** (total inventory of growing stock) were located in southeast Kansas when exclusion zones were applied. ATC ranged from \$144.55 to \$145.42/dry ton (\$451.72 to \$454.44/MBF). Least cost sourcing areas for **lowland hardwood sawtimber** (total inventory of growing stock) were located in north-east and central Kansas when exclusion zones were applied. ATC ranged from \$153.20 to \$154.60/dry ton (\$478.75 to \$483.13/MBF).



# 1. INTRODUCTION

As Elbehri (2007) noted procuring bio-based feedstocks presents several technical, economic, and research challenges, one of which is estimating the economic availability of cellulosic feedstocks. Elbehri (2007) also noted that lack of select cellulosic feedstock production capacities, high relative costs of production, logistics, and transportation of cellulosic feedstocks are all potential business constraints that need to be better understood.

The goal of this study was to assess the economic availability of cellulosic feedstocks for demand sites in Kansas with supply zones coming from Kansas and/or the five-state surrounding region. The results will improve the overall understanding of the economic costs for cellulosic feedstocks for potential manufacturers wishing to locate in the state of Kansas. The rationale for the research was to provide decision-makers in the cellulosic feedstock-using industries with a better geospatial economic tool that will allow them to assess the economic comparative advantages of cellulosic supply at the state level, sub-regions within the state, and interstate levels, see <http://www.biosat.net/Kansas/index.html>.

This study and its supporting statistics were not developed to support policy development at a national level. However, the study supports the research goals and priorities of the Kansas State Forest Service, U.S. Department of Agriculture, U.S. Forest Service, *i.e.*, the Forest Service R&D Strategic Plan for 2006-2010 noted the economic and environmentally sustainability of conventional energy supplies will necessitate the need for improved energy efficiency and conservation (U.S. Department of Agriculture Forest Service 2008a and 2008b). However, energy efficiency and conservation are only part of the solution to meet the demand for more energy. Bioenergy is an important long-term solution to providing a sustainable domestic energy supply. The U.S. Forest Service R&D Strategic Plan for 2006-2010 emphasized that availability of loans and grants play important role in the development of the bioenergy industry. Loan guarantees depend on the stability of the supply infrastructure that supports bioenergy plants. Study results may be useful in providing important economic research data to support loan guarantees which are critical for infrastructure development.

Cellulosic feedstocks are renewable resources procured from multiple sources which include land clearings, landscaping, industrial by-products, agricultural residues, and abundant forest resources (Caputo 2009). Developing any new industry, however, involves establishing

many relationships (Altman and Johnson 2008). Assessing the economic capability and stability of the bioenergy supply chain infrastructure is essential for market organization of this emerging industry, and is the key research question addressed by this study.

The economic availability of biomass has been a subject of many research works (Young and Ostermeier 1989, Young *et al.* 1991; Lunnan 1997; Walsh 1998, 2000; DiPardo 2000; Ugarte *et al.* 2000, 2006, 2007; Walsh 2008; Biomass Research and Development Board 2008; Western Governors Association 2008; Biomass Research and Development Board 2008, Perez *et al.* 2009, Galik *et al.* 2009, U.S. Dept. of Energy 2011, Perdue *et al.* 2012, Huang *et al.* 2012, and others). A report by the U.S. Department of Agriculture and Department of Energy concluded that 1.3 billion tons of biomass are available annually for energy production (U.S. Dept. of Energy 2011). Perlack *et al.* (2005) and U.S. Dept. of Energy (2011) indicated that the nation's forests represent a strategic asset in meeting the national goal of replacing 30% of the domestic petroleum consumption by 2030.

The problem addressed by this study was to “develop a web-based, economic decision tool with periodic data updates to assist business planners in Kansas for the development of facilities that require cellulosic feedstocks, *e.g.*, biorefineries, biopower, traditional biomass, etc.” Spatially explicit GIS data were overlaid to provide geo-referenced marginal cost curves (producer supply curves) of cellulosic feedstocks (Figure 1, next page). While prior studies have examined the availability of wood for biomass or the transportation costs associated with cellulosic biomass (Langholtz *et al.* 2006, Perlack *et al.* 2005, Jensen *et al.* 2002, Noon and Day 1997), this study was unique in that cost data for supplying cellulosic feedstocks to biorefineries are updated periodically and available in the public domain, [www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html) for the six-state region, at a 5-digit zip code tabulation area (ZCTA) resolution, see U.S. Census Bureau (2000b)<sup>5</sup>.

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<sup>5</sup> ZIP Code Tabulation Areas (ZCTAs<sup>TM</sup>) are a relatively new statistical entity developed by the U.S. Census Bureau (2000b) for tabulating summary statistics from Census 2000. This new entity was developed to overcome the difficulties in precisely defining the land area covered by each ZIP Code®. Defining the extent of an area is necessary in order to accurately tabulate census data for that area. ZCTAs are generalized area representations of U.S. Postal Service (USPS) ZIP Code service areas. Simply put, each one is built by aggregating the Census 2000 blocks, whose addresses use a given ZIP Code, into a ZCTA which gets that ZIP Code assigned as its ZCTA code. They represent the majority USPS five-digit ZIP Code found in a given area. For those areas where it is difficult to determine the prevailing five-digit ZIP Code, the higher-level three-digit ZIP Code is used for the ZCTA code, see <http://www.census.gov/geo/ZCTA/zcta.html>.

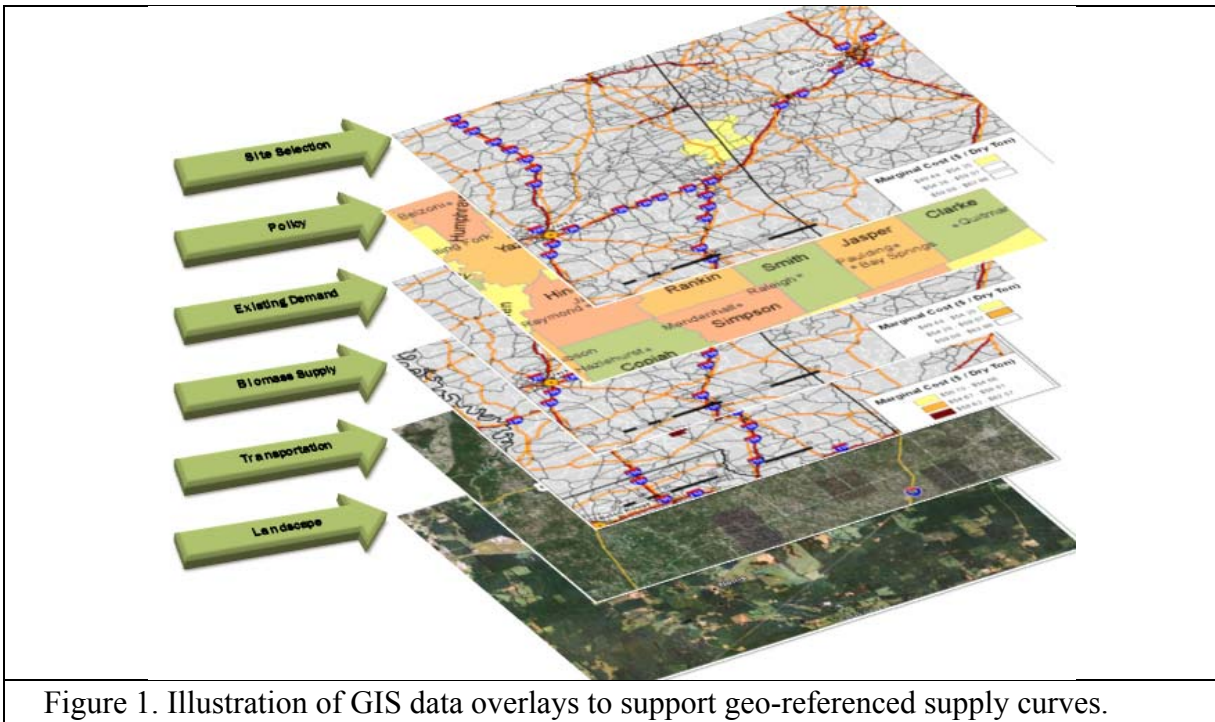


Figure 1. Illustration of GIS data overlays to support geo-referenced supply curves.

Given the problem definition of the study, there were five main project objectives:

1. a. Develop a GIS database of woody biomass for Kansas at the 5-digit ZCTA level. This database will include woody biomass quantification from the USFS FIA database and will be proportionally allocated based on current land cover maps. This dataset will also include urban areas, preserves and parks, EPA Level III Ecoregions and other key geographic information.
- b. Develop the road network for Kansas in the GIS database using the most current and accessible Microsoft MapPoint road network database.
- c. Develop economic data at the 5-digit ZCTA level for Kansas that will include transportation costs, harvesting costs and stumpage costs for woody biomass.
2. a. Conduct geospatial analyses of the “suitability zones” for woody biomass. This objective will identify the most suitable and unacceptable 5-digit ZCTAs for woody biomass, *e.g.*, urban areas (Kansas City) will be excluded with  $> 150$  people/mi<sup>2</sup>, parks and preserves will be excluded, identify existing competition for the resource, etc. (Figure 2).
- b. Conduct the economic site assessments for the acceptable woody biomass procurement zones at the 5-digit ZCTA level. This objective will prioritize suitable and low cost areas within Kansas based on the outcomes of objectives 1a, 1b, 1c, and 2a.

3. Develop a web-page in the public domain separately and as linked to [www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html) that will allow users to access and conduct analyses using the outcomes of objectives 1 and 2.
4. Conduct statistical analyses using logistic regression to assess the effect of uncertainty on the optimal site locations identified in objective 2.
5. Develop a final report in the public domain.

All study objectives were completed with the exception of Objective 4 which is in progress and will result in the submission of referred journal manuscript in 2016 from the results of this objective. The webpage (Figure 2) will be maintained throughout 2016 by The University of Tennessee. The **KS BioSAT** model (<http://www.biosat.net/Kansas/index.html>) is as a tool to help assess economic zones that support low cost production of cellulosic feedstocks for woody cellulosic users. This is essential for business developers and may be useful for the development of business plans. The final report summarizes the findings and methods of the study and presents examples of geo-referenced supply curves for cellulosic feedstocks for Kansas demand locations and when applicable, the five-state supply regions (Figures 3 to 5)<sup>6</sup>.

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<sup>6</sup> Kansas, Arkansas, Iowa, Oklahoma, Missouri, Nebraska.

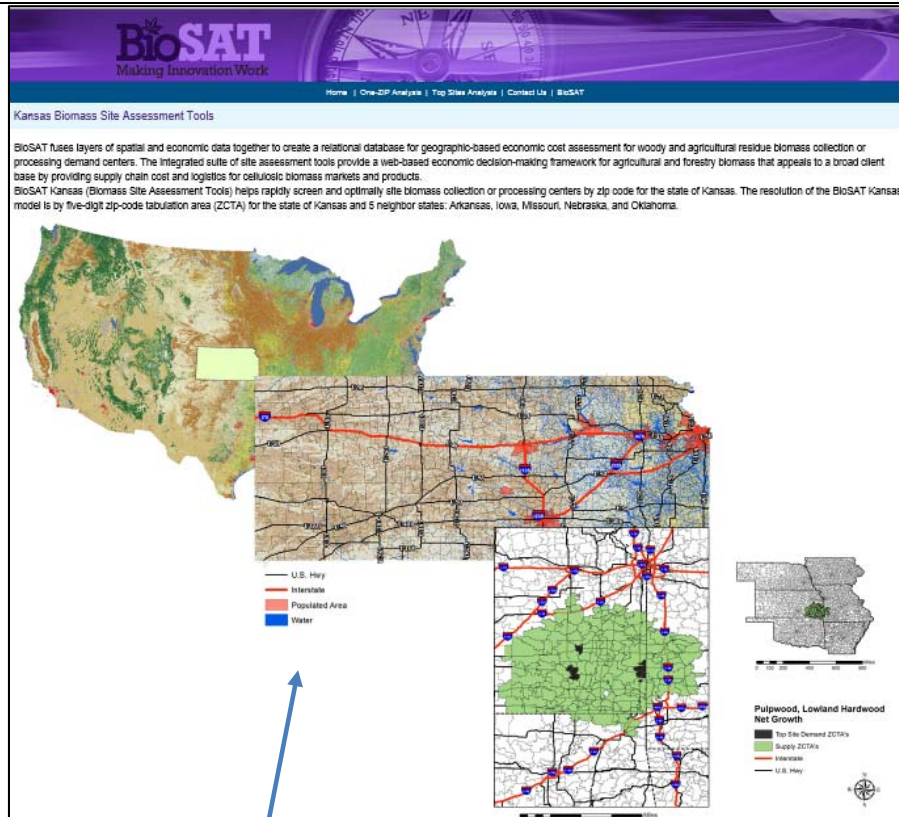


Figure 2. Homepage of KS BioSAT website, [www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html) (top figure) and orginla BioSAT website, <http://www.biosat.net/> (bottom figure).



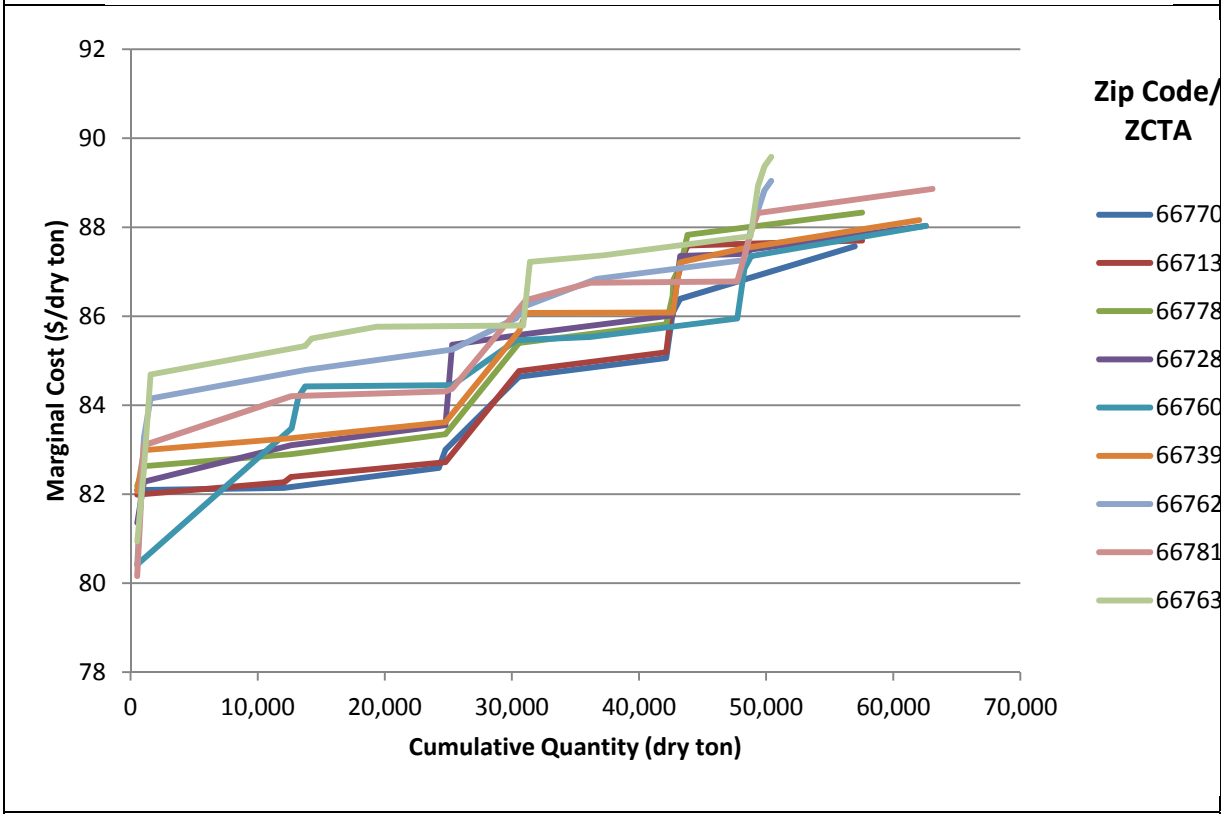
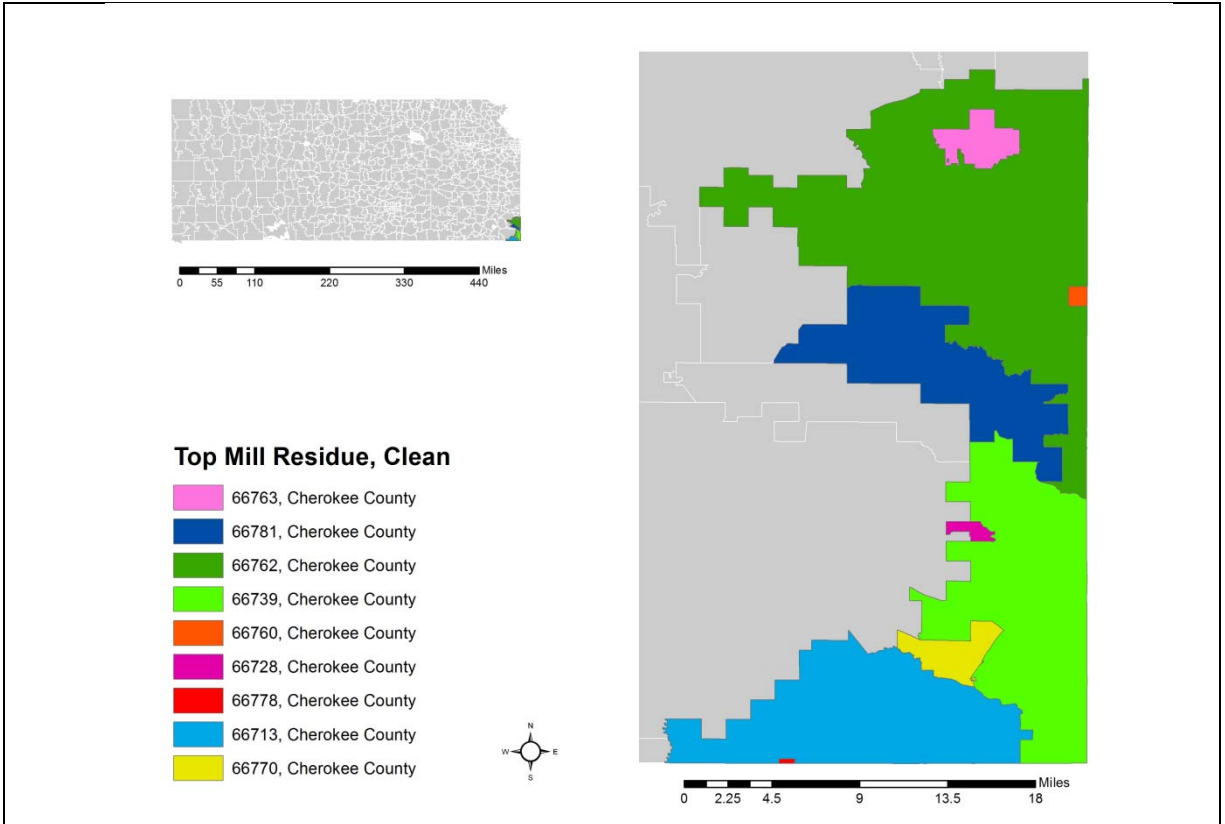


Figure 3. Low cost sourcing areas with corresponding marginal cost curves for clean mill hardwood residues in KS.

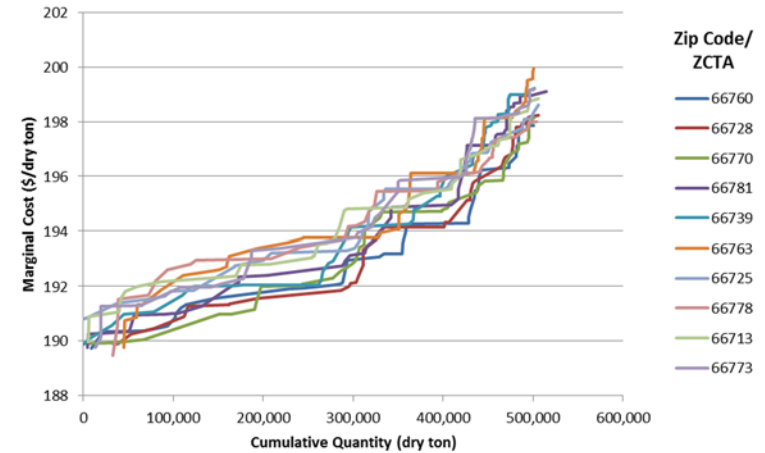
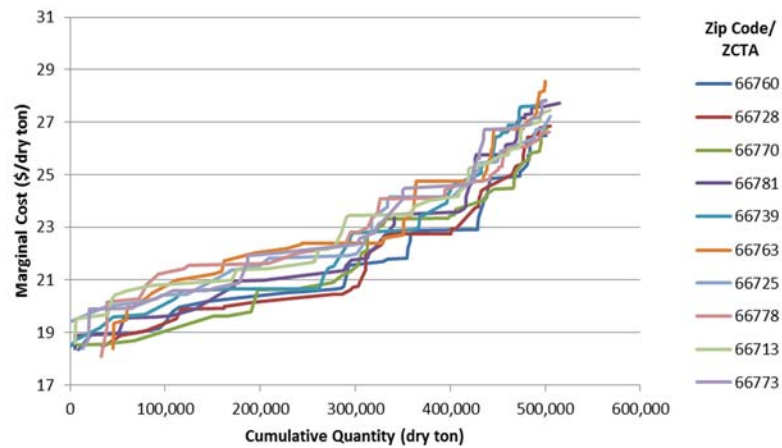
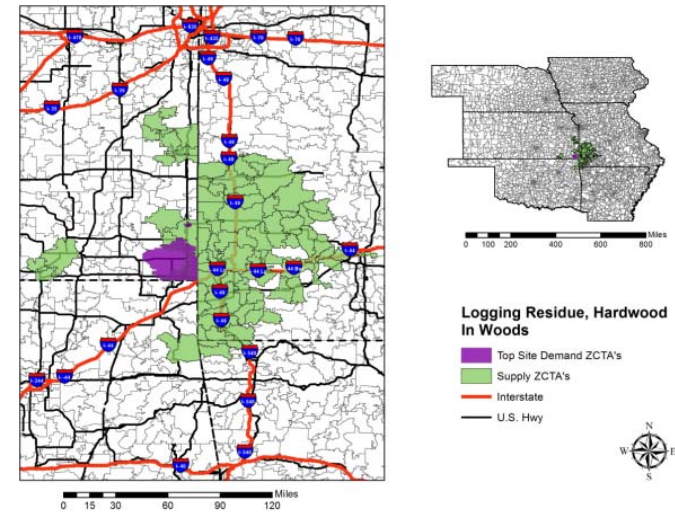
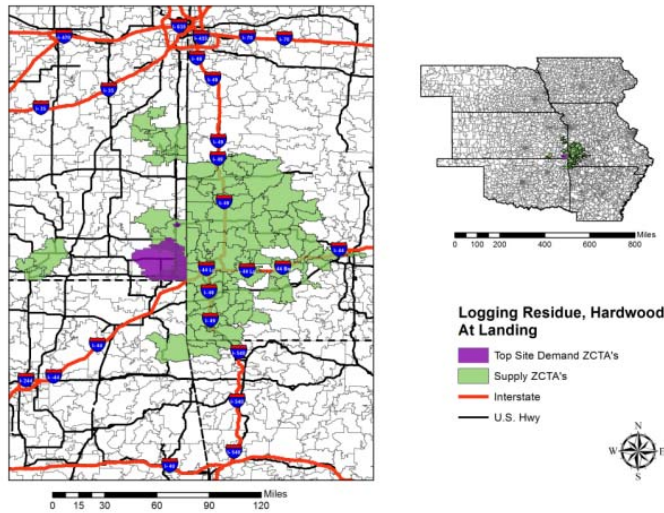


Figure 4. Logging hardwood residues “at-landing” (on the left) and “in-woods” (on the right) least cost sourcing areas with corresponding marginal cost curves in KS.

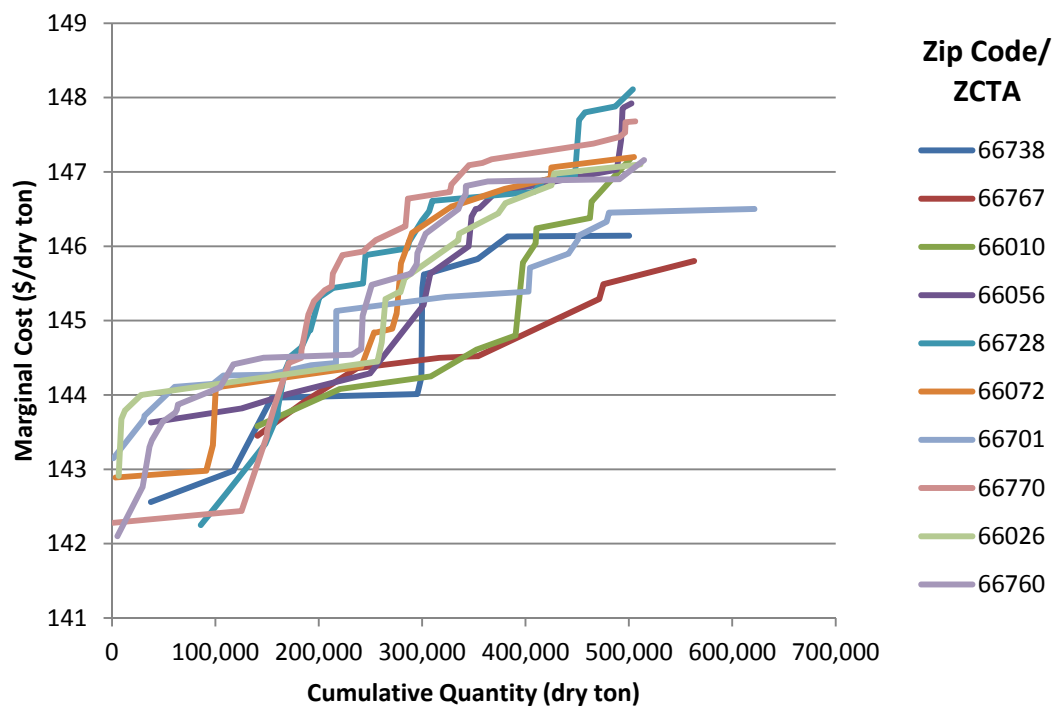
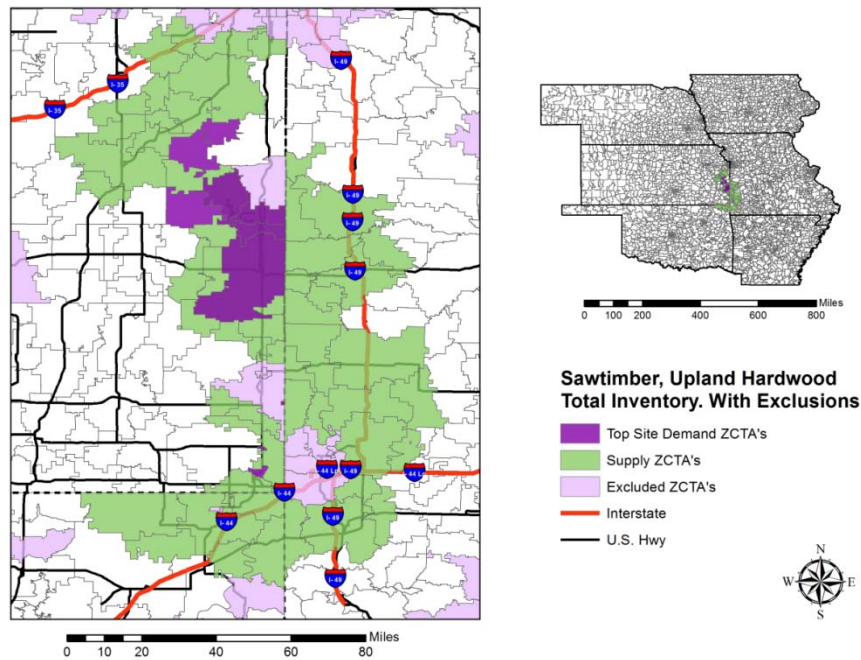


Figure 5. Least cost sourcing area with corresponding marginal cost curve for upland hardwood sawtimber total inventory in KS (excluding federal land, highly populated area and ecoregions).



## 2. METHODS

The supply chain supporting the Kansas BioSAT model used in the project has three main cost components: resource (*e.g.*, stumpage for standing trees), harvesting, and transportation. Detailed flow charts of the supply chain cellulosic feedstock model are given on the website [www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html) under the “Fact Sheets” tab.

### 2.1 Forest Resource Data

#### 2.1.1 Forest Residue

County level estimates of all-live total biomass, as well as growth, removals, and volume were obtained from the Forest Inventory and Analysis Database (FIADB) (U.S. Department of Agriculture Forest Service 2015). The latest complete cycle of data for each state was used. Forest data were obtained for net growth, removals, gross volume, and volume of pulpwood in cubic feet and sawtimber in board feet. The county level data was allocated to the ZCTA level for hardwood, softwood, and mixed wood. Forest data was converted to dry tons using metrics from the Biomass Energy Data Book (Oak Ridge National Laboratory). Forest data was attributed to ZCTA polygons in order to be visualized in map form.

County-level mill residue data was obtained from the USFS FIA Timber Product Output (TPO) data. All quantity data was converted to dry tons. The Subregional Timber Supply (SRTS) model was used to estimate and predict logging residues for the six-state region. SRTS uses U.S. Forest Service FIA data to project timber supply trends based on current conditions and the economic responses in timber markets (Abt *et al.* 2000, Abt 2008). Abt *et al.* (2000) noted that SRTS is a partial equilibrium market simulation model that can be used to analyze various forest resource and timber supply situations. Timber market and inventory modules are the two major SRTS model components. Market parameters are first used to solve for equilibrium price changes, where the market is defined by all of the included subregions. Price and supply shift information from the individual regions are used to calculate harvest change by subregion.

The internal inventory module in SRTS is based on the GRITS model (Cubbage *et al.* 1990). GRITS extrapolated forest inventories based on USDA Forest Service FIA estimates of timberland area, timber inventory, timber growth rates, and timber removals. GRITS classifies data into 10-year age class groups by broad species group (*softwoods and hardwoods*) and forest

management type (*planted pine, natural pine, oak-pine, upland hardwood, and lowland hardwood*). FIA data by species group, forest management type, and 10-year age class are summarized for each relevant region in the analysis. Land area trends by forest management type are exogenous to the model. Within a management type, the model can allocate harvest across age classes based on starting harvest proportions, current inventory proportions, or oldest age class first (Abt *et al.* 2000).

County level estimates were allocated to “zip code tabulation areas” (ZCTAs) based on area proportionality, *e.g., if a ZCTA accounts for ten percent of a county, ten percent of the county’s data are assigned to that ZCTA*. If a ZCTA boundary crosses multiple counties, proportions for each county were summed. ZCTAs are based on the 2000 census definition and were obtained from the U.S. Census Bureau (U.S. Census Bureau 2000). Area proportionality was performed using ArcGIS which produces a file containing ZCTAs, county Federal Information and Processing Standard (FIPS) codes, and the forest pixels were derived from National Land Cover Dataset (NLCD).

As ZCTAs do not account for all zip codes, files containing all possible zip codes as of January 31, 2010 were used from zip-codes.com (<http://www.zip-codes.com/>). This file contains the zip code, latitude, and longitude of the mail office associated with each zip code. These points were then assigned to the corresponding ZCTA. Users can query Kansas BioSAT using any zip code, although the results were based on ZCTAs, *i.e., there were 3,165 potential demand ZCTAs and 4,486 total ZCTAs in the 6-state study region, approximately 29% of total ZCTAs are under excluded areas that are Federal lands, highly populated areas (population density greater than 150 people per square mile) and not suitable ecoregions*. There were as many supply ZCTAs as there were demand ZCTAs since the study is strictly within the borders of the 6-state study region.

Confidence bounds of individual county level FIA data can be wide. Therefore, estimates of individual ZCTAs were not used in this study, but ZCTAs were aggregated together into larger groupings of “sourcing areas” where confidence bounds may be comparable to aggregate county groupings. Confidence bounds of the resource supply in any given sourcing area which is a grouping of ZCTAs do not offer any improvement over existing studies which aggregate county-level resource supply data. However, using the ZCTA as the demand point for biomass with the surrounding road network of the ZCTAs that make up a potential sourcing area may offer

improvement of cost estimates when compared to studies which rely on estimates based on the centroid of the county. Counties can be large and have geographic barriers that impact transportation time and distance (*e.g., bridges over large waterways, , lack of all-weather roads, large metropolitan areas, etc.*). ZCTAs offer improved precision of travel time and distance for road networks and thus improved the accuracy of transportation cost estimates. Land use change of ZCTAs was not considered in the current study, *i.e., a ZCTA that is predominately classified as pine plantation is assumed to remain as pine plantation*. All ZCTAs classified as water, unproductive lands, national parks, or national forests were considered to have zero biomass available.

### *2.1.2 Forest Residue Allocation Method*

Mill residues were allocated to the ZCTA level by taking the total capacity for a ZCTA and dividing it by the total capacity for the state, resulting in a percentage. This percentage is then multiplied by the mill residue value for the ZCTA, giving a mill residue value for each ZCTA with mill locations associated with it.

## **2.3 Feedstocks Available in Kansas BioSAT**

Forty-four feedstock types and combinations of feedstock types are available in the Kansas BioSAT model (see Table 1 and Table 2). Definitions and more details of each feedstock are given on the BioSAT website under the “Biomass Sources” tab at [www.biosat.net/Kansas/index.html](http://www.biosat.net/Kansas/index.html).

| Table 1. Listing of residue feedstocks in the Kansas BioSAT model. |                                      |
|--------------------------------------------------------------------|--------------------------------------|
| Residue Type                                                       |                                      |
| Mill                                                               |                                      |
|                                                                    | “Clean” and “Unclean” Hardwood       |
|                                                                    | “Clean” and “Unclean” Softwood       |
| Logging                                                            |                                      |
|                                                                    | “at-landing” and “in-woods” Hardwood |
|                                                                    | “at-landing” and “in-woods” Softwood |
| Agricultural                                                       |                                      |
|                                                                    | Barley Straw                         |
|                                                                    | Corn Stover                          |
|                                                                    | Oats Straw                           |
|                                                                    | Sorghum Straw                        |
|                                                                    | Wheat Straw                          |
|                                                                    | Winter Wheat Straw                   |

| Table 2. Listing of merchantable tree or ‘roundwood’ feedstocks in the Kansas BioSAT |                            |                                           |
|--------------------------------------------------------------------------------------|----------------------------|-------------------------------------------|
| Type of Merchantable                                                                 | Forest Type                | Forest Inventory Type                     |
| Pulpwood:                                                                            |                            |                                           |
|                                                                                      | Lowland Hardwood           | Net Growth, Removals, and Total Inventory |
|                                                                                      | Mixed Natural Softwood and |                                           |
|                                                                                      | Natural Softwood           |                                           |
|                                                                                      | Pine Plantation            |                                           |
|                                                                                      | Upland Hardwood            |                                           |
| Sawtimber:                                                                           |                            |                                           |
|                                                                                      | Lowland Hardwood           | Net Growth, Removals, and Total Inventory |
|                                                                                      | Mixed Natural Softwood and |                                           |
|                                                                                      | Natural Softwood           |                                           |
|                                                                                      | Pine Plantation            |                                           |
|                                                                                      | Upland Hardwood            |                                           |

There are two types of harvesting practices considered in the KS BioSat model, namely clearcut with 100% of trees removed and thinning when half of the available trees are removed, the user is also given an option to insert own percentage for the level of desired thinning. The harvesting equipment default is “chainsaw/cable skidder” for all types of merchantable trees. A “feller-buncher and skidder” is also available to the user of the system. The data are available in dry and green tons.

## 2.4 Resource Costs

Resource cost data (*e.g.*, *stumpage*, *mill residue prices*, *etc.*) for woody cellulosic were obtained from Timber Mart South (<http://www.tmart-south.com/tmart/>), Timber Mart North (Michigan, Minnesota, and Wisconsin),<sup>7</sup> and other state-reporting sources (*e.g.*, *Indiana*, *Kentucky*, *West Virginia*, *etc.*).<sup>8</sup> If a state did not have any resource cost or stumpage reporting system (*e.g.*, *Oklahoma*), prices from the closest Timber Mart South regions of neighboring states (*e.g.*, *Arkansas and Texas*) were averaged and this average was used for the entire state. The average of all Texas regions with prices from Timber Mart South was used for regions in Texas where prices were not reported. There are currently no estimates for logging residue stumpage or resource costs reported in the public domain. Logging residue stumpage was given a value of \$1/dry ton. Mill residue price data (*e.g.*, *hardwood sawdust*, *pine sawdust*, *pine shavings*, *etc.*) for a state were allocated equally to all ZCTAs. Agricultural residue resource costs were included in the harvesting equation [5] (Gallagher *et al.* 2003). See Agricultural Residue Harvesting Costs section (2.6.3) for details.

## 2.5 Transportation Costs

### 2.5.1 Transportation Network

Microsoft® MapPoint® 2011 (software was discontinued on 12/31/2014) was used in the BioSAT model to provide the shortest travel time routes between the demand and supply ZCTAs. Road networks in MapPoint® are a combination of the Geographic Data Technology, Inc. (GDT) and Navteq data. GDT data was used for rural areas and small to medium size cities. Navteq data was used for major metropolitan areas. The GDT data are based on “Tele Atlas Dynamap Streets” which are address level geocoding, <http://www.teleatlas.com/index.htm>. When an address level geocode is not available, the GDT data set uses cascading accuracy at the ZIP+4, ZIP+2, and ZIP Code centroid to return the highest level of geocode for the address. ZIP code boundary data are based on the Dynamap/5-Digit ZIP code Boundary data from Tele Atlas North America. It is designed to identify the boundaries of U.S. Postal Service ZIP Codes. Navteq maps provide a

---

<sup>7</sup> [http://www.prentissandcarlisle.com/content/4044/Timber\\_Mart\\_North/](http://www.prentissandcarlisle.com/content/4044/Timber_Mart_North/)

<sup>8</sup> Timber Mart South (TMS) does not report price data for Oklahoma, TMS price data for Arkansas and Texas are averaged and used for Oklahoma. TMS does not report for Kentucky. Kentucky’s price reporting system was used in the BioSAT model (Nevins 2009).

highly accurate representation of the detailed road network including up to 260 attributes like turn restrictions, physical barriers and gates, one-way streets, restricted access, and relative road heights (<http://www.navteq.com/about/whatis.html>).

### 2.5.2 Trucking Costs

The transportation cost model estimated fixed and variable trucking costs based on the shortest travel time from the MapPoint road network of a sourcing area and maximum annual mileage for tractor-trailers.<sup>9</sup> Single-driver day cabs were assumed with a maximum one-day round-trip time of 11 hours. Contract fleet carriers contracted by the ownership of a biorefinery were assumed given feedback from a critique by major trucking companies, *i.e., contract fleet carriers would be the least expensive trucking solution*. Trailer types in the trucking cost model depended on feedstock type and were: dry-van storage (*mill residues, logging residues and some agricultural residues*), flat-bed (*baled agricultural residues*), short-log (*northern state 'roundwood'*), and long-log (*southern states 'roundwood'*).

Trucking costs in the BioSAT model were estimated using equations [1], [2], [3], and [4] for estimating costs between all of the potential supply ZCTAs<sub>(j)</sub> and a given demand ZCTA<sub>(i)</sub> for a sourcing area  $Q_i$ . Trucking costs were sorted by least cost between each supply ZCTA<sub>(j)</sub> and demand ZCTA<sub>(i)</sub>. Trucking variable costs were a function of travel time between the supply ZCTAs and demand ZCTA, and trucking fixed costs were a function of travel distance between the supply ZCTAs and demand ZCTA. Least cost solutions for a set of supply ZCTAs to meet a specified demand quantity were generally dependent on shortest travel time between a supply ZCTA<sub>(j)</sub> and demand ZCTA<sub>(i)</sub>. The trucking cost model was an adaptation of the truck transportation model by Berwick and Farooq (2003). The following cost equations were:

$$\text{Total Truck Cost} = \sum_{r=1}^Z \left( (V_{t,s(i,j)} + V_{d,s(i,j)} + F_{d,s(i,j)}) \times B_{(i,j)} \right) \quad [1]$$

where,  $V_{t,s(i,j)}$  = variable cost for  $t$  for  $s$  of  $(i,j)$ ,  
 $V_{d,s(i,j)}$  = variable cost for  $d$  for  $s$  of  $(i,j)$ ,  
 $F_{d,s(i,j)}$  = fixed cost for  $d$  for  $s$  of  $(i,j)$ ,

---

<sup>9</sup> Travel distance which influences fixed costs was allocated over the tractor-trailer's estimated annual miles which was 100,000 miles for the tractor and dry van and flatbed trailers; 80,000 miles for the long-log and short-log trailers.

$B_{(i,j)} = Q_i/C_s$  = total hauls for each  $(i,j)$  for all routes  $r, r = 1 \dots z$ ,  
 $C_s$  = legal trailer capacity for  $s$ ,  
 $Q_i$  = annual capacity of demand ZCTA,  $i (i = 1 \dots m)$ ,  
 $d$  = round-trip travel distance  $(i,j)$ ,  
 $i$  = demand ZCTA,  $i = 1 \dots m$ ,  
 $j$  = supply ZCTA,  $j = 1 \dots n$ ,  
 $m$  = total number of biomass supply ZCTAs,  
 $n$  = total number of biomass supply ZCTAs,  
 $r$  = route  $(i,j)$ ,  $r = 1 \dots z$ ,  
 $s$  = U.S. state,  $q = 1 \dots 6$ ,  
 $t$  = round-trip travel time  $(i,j)$ .

$$V_{d,s(i,j)} = D_{d,s(i,j)} + M_{d(i,j)} + T_{d(i,j)} \quad [2]$$

where,  $D_{d,s(i,j)}$  = diesel fuel cost for  $d$  for  $s$  of  $(i,j)$ ,  
 $M_{d(i,j)}$  = maintenance and repair cost for  $d$  for  $(i,j)$ ,  
 $T_{d(i,j)}$  = tire cost for  $d$  for  $(i,j)$ .

$$V_{t,s(i,j)} = L_{t,s(i,j)} \quad [3]$$

where,  $L_{t(i,j)}$  = labor cost for  $t$  for  $s$  of  $(i,j)$ ,

$$F_{d,s(i,j)} = E_{d(i,j)} + S_{s(i,j)} + N_{s(i,j)} + O_{d(i,j)} + I_{s(i,j)} \quad [4]$$

where,  $E_{d(i,j)}$  = equipment cost for  $d$  for  $(i,j)$ ,  
 $S_{s(i,j)}$  = tax for  $s$  for  $(i,j)$ ,  
 $N_{s(i,j)}$  = license fee for  $s$  for  $(i,j)$ ,  
 $O_{d(i,j)}$  = management and overhead cost for  $d$  for  $(i,j)$ ,  
 $I_{s(i,j)}$  = insurance cost for  $s$  for  $(i,j)$ .

Total trucking costs were a function of: variables costs which were a function of haul time; fixed costs which were a function of maximum annual tractor-trailer miles; and the quantity hauled between the demand ZCTA and each supply ZCTA of the sourcing area. Only ZCTAs with at least one full truck load of biomass were considered for the analysis. The variable cost inputs for the trucking model (*e.g., diesel fuel, labor wages, etc.*) are updated in the BioSAT model as necessitated by changes in prices (Energy Information Administration 2009). Minimum transportation travel times and distances between ZCTAs in a sourcing area were estimated from Microsoft® MapPoint® 2011.

## 2.6 Harvesting Costs

### 2.6.1 Logging Residue Harvesting Costs

The Fuel Reduction Cost Simulator (FRCS) as modified for the Billion Ton Study (Perlack *et al.* 2005, U.S. Dept. of Energy 2011) by Dykrsta (2008) was used to estimate the costs of harvesting logging residues (Fight *et al.* 2006; Stokes 1992). The original FRCS model was designed to simulate fuel-reduction treatments in the Interior West, where wildfire is a significant problem (Dykstra 2008). The FRCS was substantially revised by Dykstra (2008) including the development of new procedures to simulate harvests in the North, South, and coastal West as well as the Interior West. Logging residue costs were estimated for “*chipping tops and limbs at the landing*” and “*in woods harvesting of sub-merchantable material.*” In the modified FRCS model the following harvesting operations are assumed for biomass collection (Dykstra 2008):

- Manual felling and whole-tree extraction, either with conventional skidders or with cable systems; the simulator uses cable systems if the average ground slope is 40% or more;
- Mechanized felling and whole-tree skidding where mechanized felling is not used with cable yarding.

For ground-based logging (*defined as “in-woods” logging residue in this report*), the FRCS model calculated the production rates and costs for both of the possible alternatives (*manual felling and mechanized felling*). The model then selected the lower-cost alternative for use in deriving the supply curve for the Billion Ton Study which is the same approach that is used in the BioSAT model. The variable cost inputs for the FRCS model (*e.g., diesel fuel, labor wages, etc.*) are updated periodically in the BioSAT model. Forest resource input data was obtained from the logging residue estimates of the SRTS model and assumed a 30% recovery rate (Abt *et al.* 2000).

### 2.6.2 Merchantable Tree or ‘Roundwood’ Harvesting Costs

Merchantable wood harvesting costs were estimated from the Auburn Harvest Analyzer or AHA model (Tufts *et al.* 1985) which was enhanced by Mr. Shawn Baker and Dr. Dale Greene (Center for Forest Business, Warnell School of Forestry and Natural Resources, University of Georgia 2009). The primary drivers for the models were quadratic mean diameter, tons per acre removed, trees per acre removed, tract size, and average height of dominant trees (*in hardwood*



*stands only, if available*) obtained from the FIA merchantable trees estimates. The harvesting cost models generated ‘roundwood’ production costs on a per ton basis for five harvesting systems for five forest stand types for the six ecoregions of the study region. The costs were calculated for sawtimber and pulpwood merchantable ‘roundwood’. The AHA models assumed each harvesting system was only utilized for specific forest types.

The forest stand types assumed were upland hardwood, lowland hardwood, natural softwood, mixed natural and hardwood, and pine plantation. The harvesting systems assumed were feller-buncher/grapple skidder and chainsaw/cable skidder.<sup>10</sup> The calculated cost data for each forest-type and harvesting-system pair were allocated equally to all ZCTAs contained within the ecoregions where the harvesting system is feasible.

## 2.7 Excluded Zones Criteria

Three variables (Table 3) were used in a spatial context as geographical landscape and socio factors with the KS BioSAT model in determining ‘exclusion’ zones. This ‘exclusion’ criteria was developed to improve the geospatial analyses for identifying ZCTAs that are not restricted by geographic features, federal land restrictions, and high population densities that are not sustainable for production of cellulosic feedstocks.

|                                                                               |
|-------------------------------------------------------------------------------|
| Table 3. Geographical landscape and socio-economic factors used in the study. |
|-------------------------------------------------------------------------------|

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<sup>10</sup>Feller-Buncher - A heavy vehicle with a boom attachment that gathers and fells trees then places the cut trees on a stack suitable for transport and/or further processing; Chainsaw – A motorized saw with a cutting element consisting of a continuous chain that is pulled around a bar at high speed; Cable Skidder – A heavy vehicle with a main winch cable and choker attachment that is manually secured to a load of felled trees then drags the cut trees out of the forest. The process is more labor intensive than with a grapple skidder, but the cable allows it reach trees that the vehicle base cannot drive to; Grapple Skidder - A heavy vehicle with a boom or bottom-opening jaws attachment that assembles a load of felled trees then carries or drags the cut trees out of the forest. The process is less labor intensive than with a cable skidder, but the vehicle base must be able to drive closer to the trees.

| Variable                  | Original Data Resolution | Unit                     | Data Sources                                                       |
|---------------------------|--------------------------|--------------------------|--------------------------------------------------------------------|
| Population Density        | 5-digit ZCTA             | People/mile <sup>2</sup> | U.S. Census Bureau (2010) population density in each 5-digit ZCTA. |
| Ecoregions Level III      | Ecoregions               | -                        | U.S. EPA (2011)                                                    |
| Lands in Public Preserves | 5-digit ZCTA             | -                        | U.S. Forest Service (2009)                                         |

### 2.7.1 Competition for the Resource

Figure 6 illustrates existing mills in the 6-states region that use either woody or crop feedstocks.

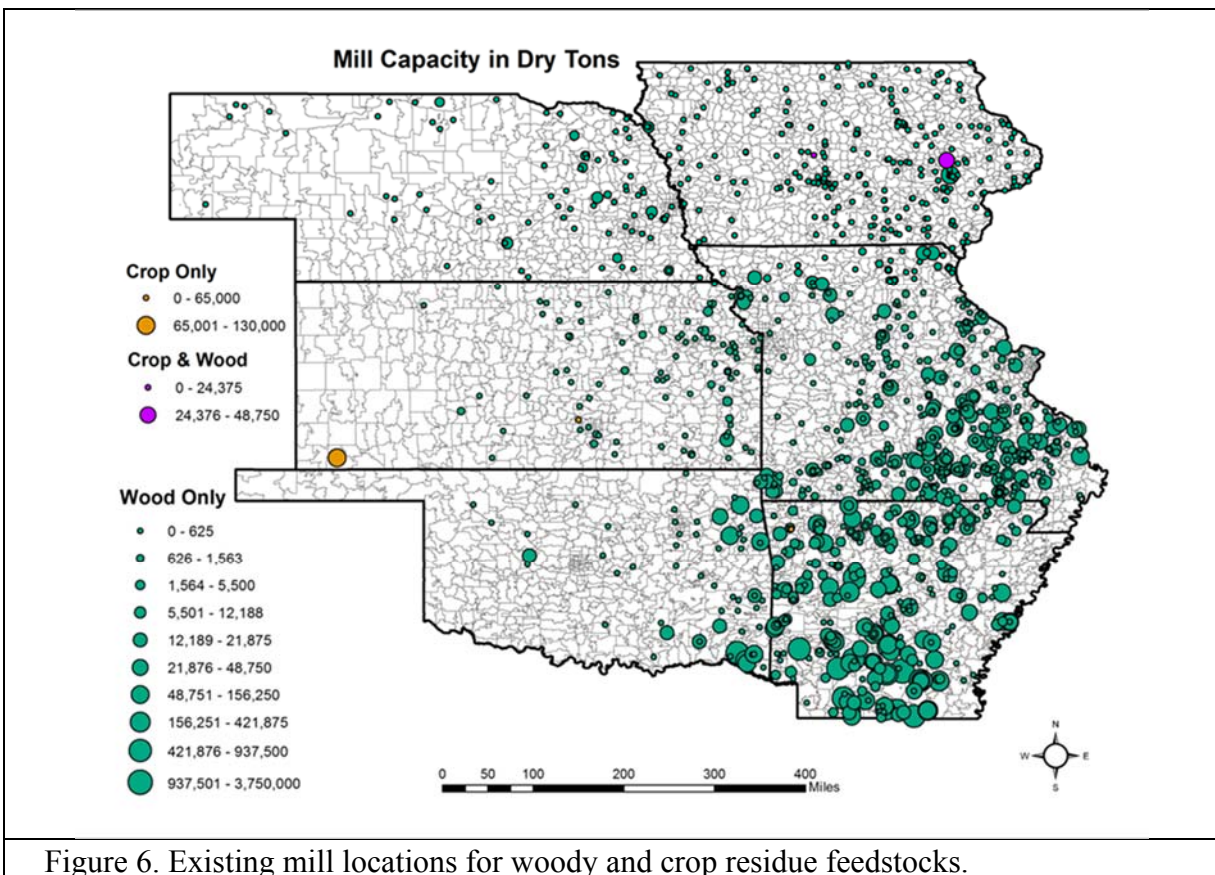
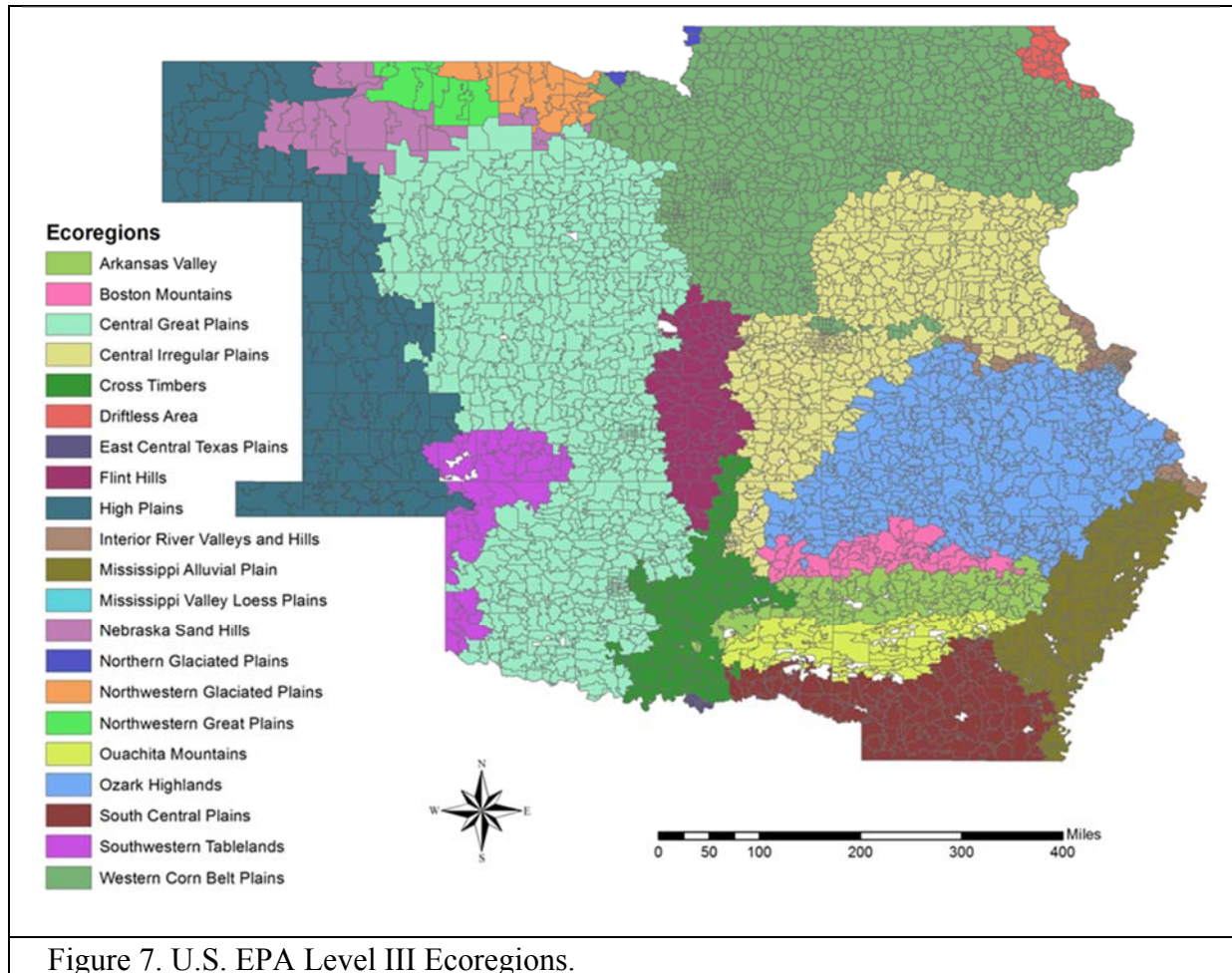


Figure 6. Existing mill locations for woody and crop residue feedstocks.

### 2.7.2 EPA Level III Ecoregions

Figure 7 illustrates US Environmental Protection Agency Level III Ecoregions that cover 6-states region of the interest. There are twenty one ecoregion observed in the area, see Appendix A for more detailed information.



### 2.7.3 Excluded Zones

Figure 8 illustrates excluded zones due to population density (greater than 150 people per square mile), federal land (Figure 10) and EPA ecoregions (Figure 9).

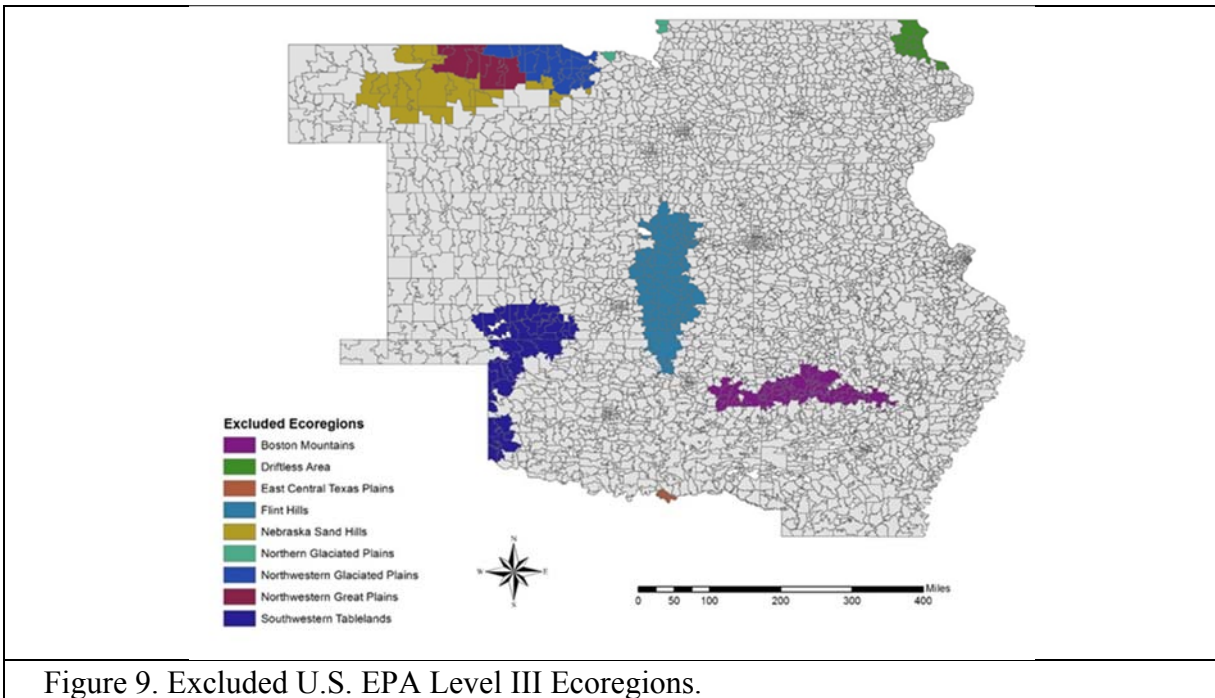
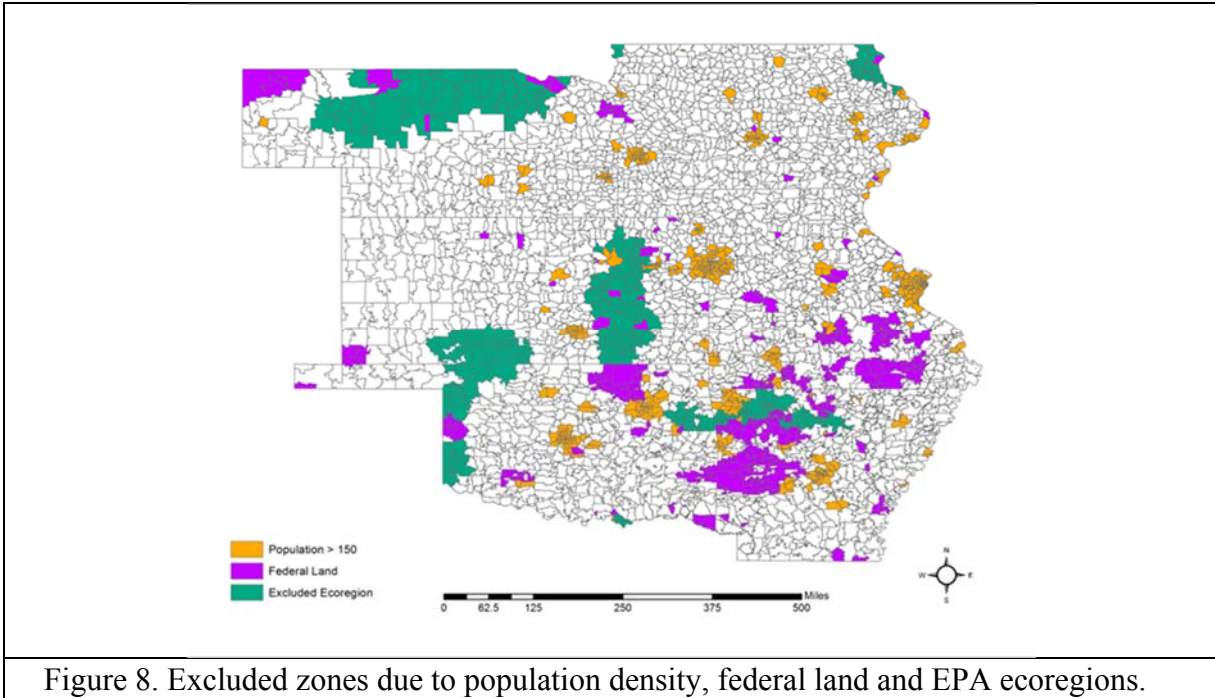




Figure 10 illustrates federal land excluded by type of federal ownership. The federal land types include but not limited to: Air Force Department of Defense (DOD), Bureau of Reclamation (BOR), National Grassland Forest Service (FS), National River National Park Service (NPS), National Wildlife Refuge Fish and Wildlife Service (FWS), and Indian Reservations.

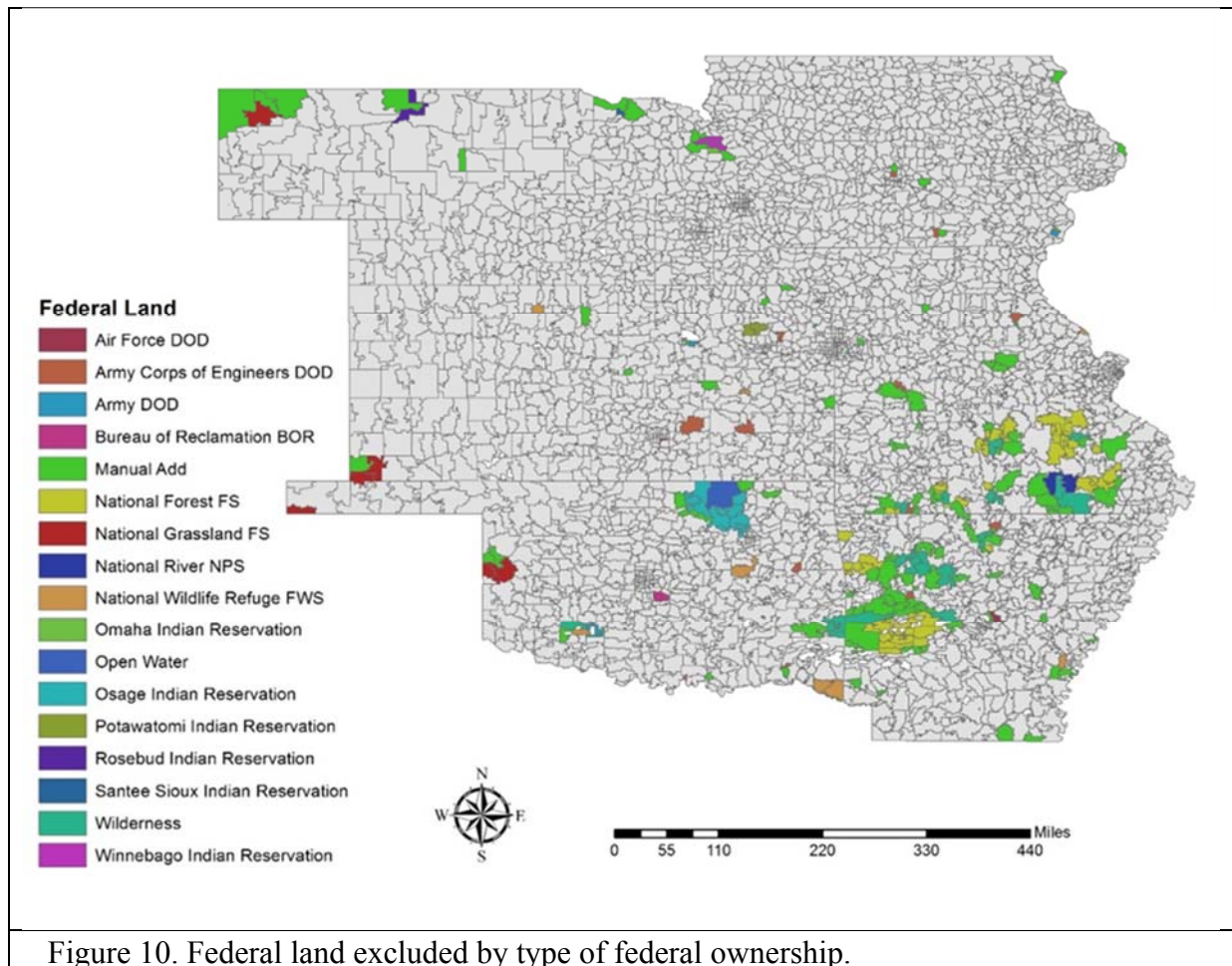


Figure 10. Federal land excluded by type of federal ownership.

### 3. RESULTS

Eleven out of forty four possible cellulosic feedstocks types available in Kansas BioSAT are illustrated in this section. A complete list of feedstock types was given in Table 1 and Table 2 of the Methods section. The summary statistics, detailed information on supply ZCTAs, top ten and least costs sourcing areas maps illustrations are presented for the following feedstocks: mill residues (hardwood “clean” and “unclean”), logging residues (hardwood “at-landing” and “in-woods”), and merchantable trees (pulpwood “upland hardwood”, “lowland hardwood”, and “mixed natural softwood and hardwood”, and sawtimber “upland hardwood” and “lowland hardwood”). Comparative Analysis for six US Forest Service FIA Regions of Interest were performed for “upland hardwood” and “lowland hardwood” pulpwood total inventory and described in section 3.4.

#### 3.1 Mill Residues

The mill residues category included in the KS BioSAT model were hardwood mill residues<sup>11</sup> (“clean” and “unclean”) and softwood mill residues (“clean” and “unclean). The maximum quantity available in a sourcing area and the associated total cost (TC), average total cost (ATC), and median marginal cost<sup>12</sup> (MC) in dollar per dry ton for hardwood (“clean” and “unclean) mill residues were estimated for this report assuming an annual consumption of fifty thousand dry tons and a maximum 80 mile one-way truck haul distance (with dry van trailer storage).

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<sup>11</sup> Wood wastes that are generated in wood-using mills when wood or wood products are converted to other products. Examples are slabs, edgings, trimmings, sawdust, shavings, veneer cores and clippings, and pulp screenings. Includes bark residues and wood residues (both coarse and fine materials) but excludes logging residues.

<sup>12</sup> Marginal cost is the change in the total cost when the quantity produced is incremented by one unit, in other words marginal cost at each level of production includes any additional costs required to produce the next unit.

### 3.1.1 Hardwood Mill Residues

#### 3.1.1.1 Hardwood “Clean”

The top ten ZCTA locations for clean hardwood mill residues were all located in south-east Kansas (Figure 11). Fifty thousand dry tons of clean hardwood mill residues are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$82.82 to \$84.69/dry ton. The median MC ranged from \$82.98 to \$84.90/dry ton ( Table 4, Figure 12).

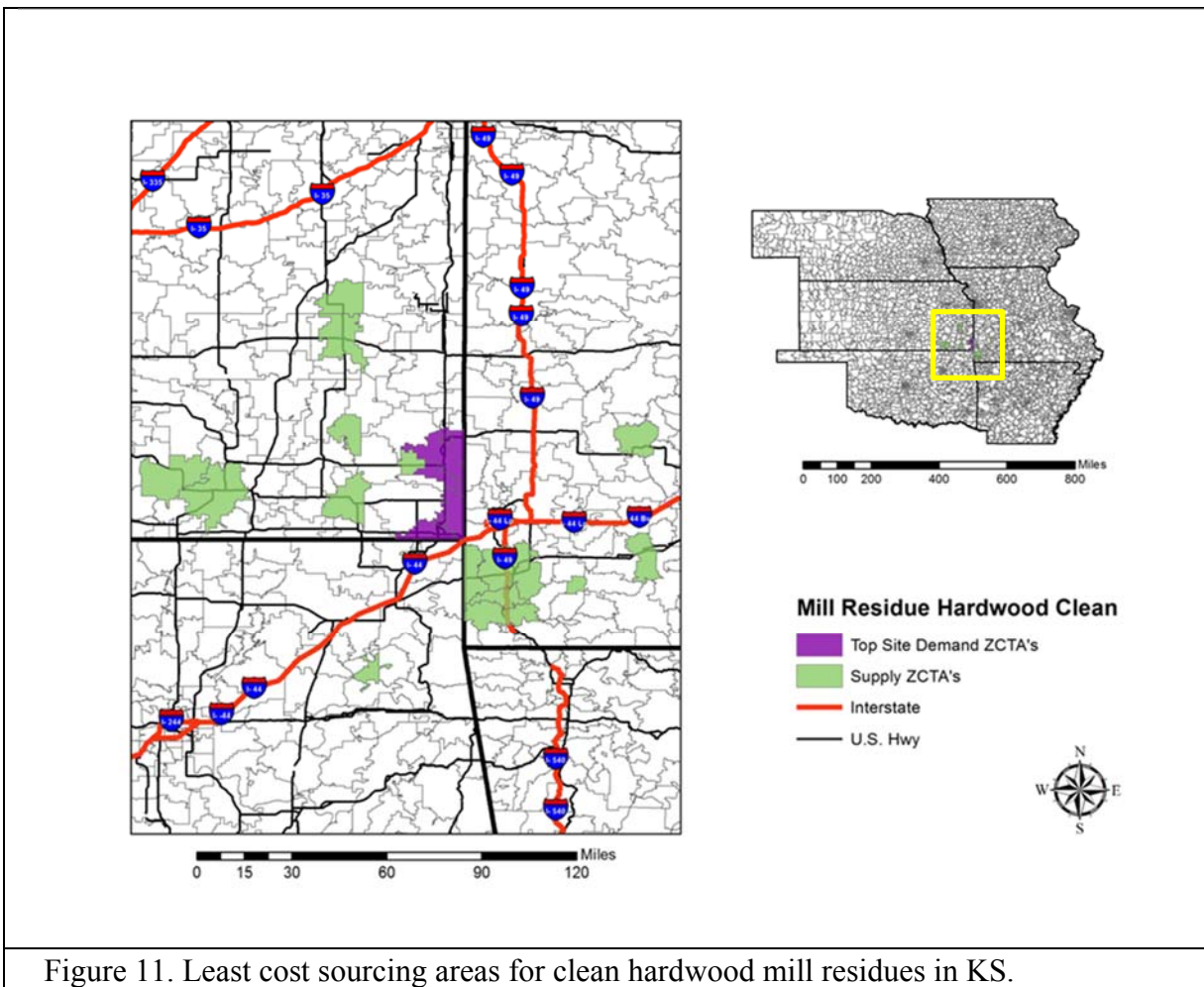
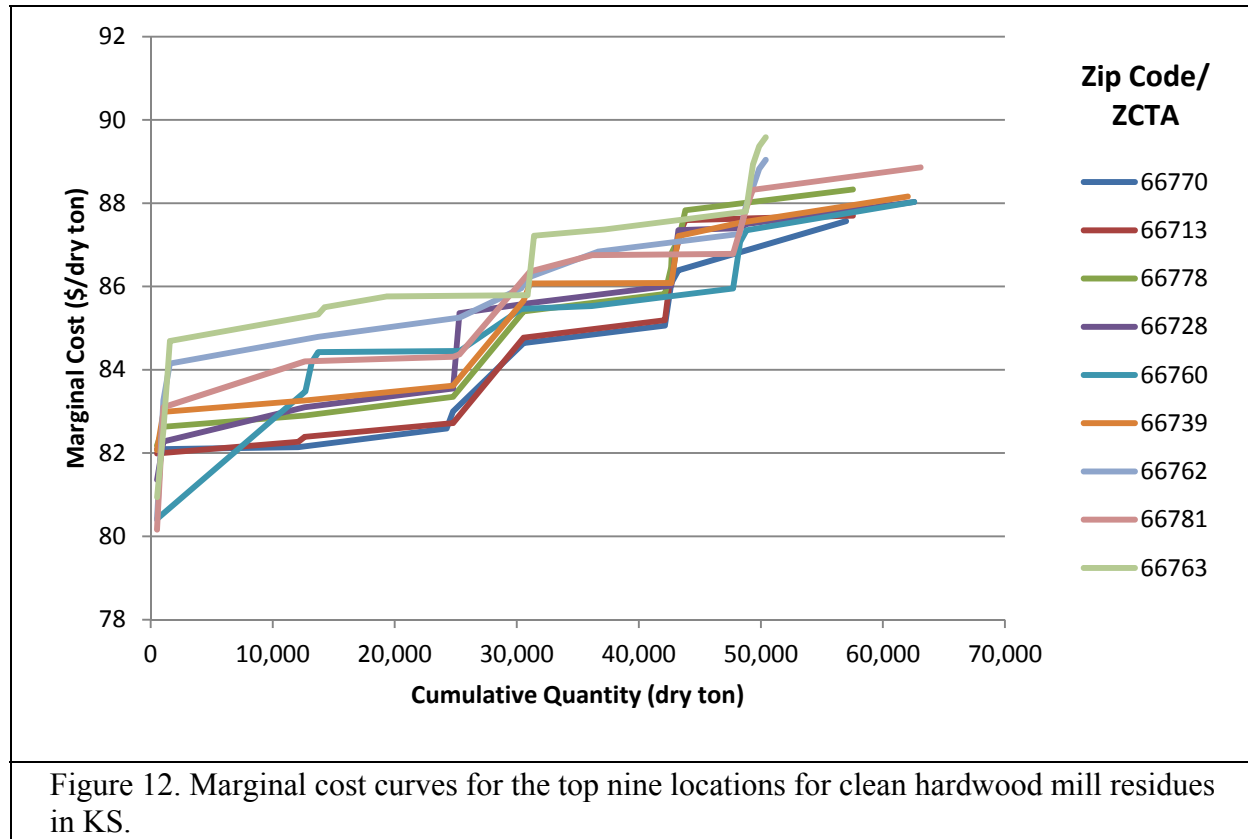


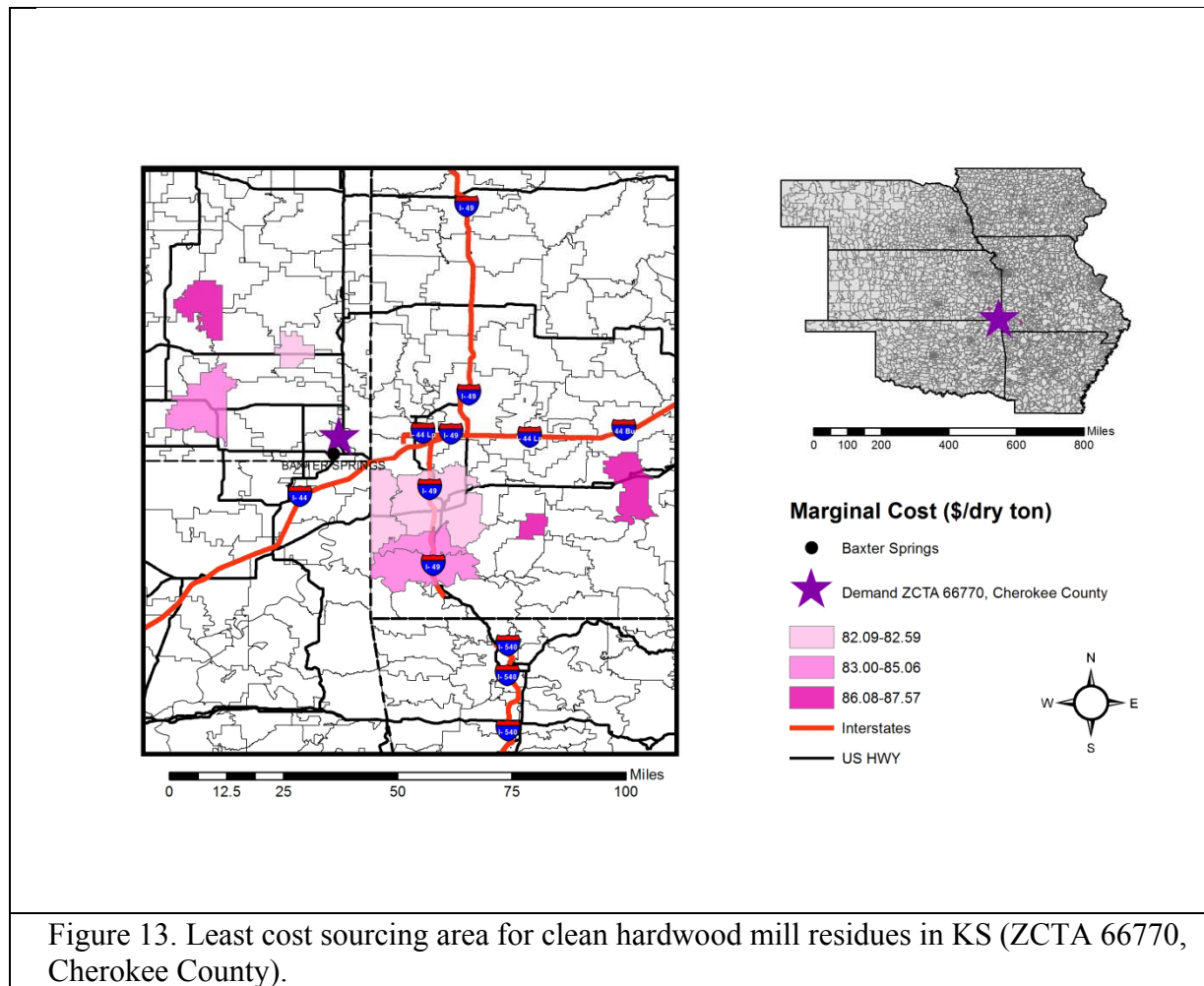
Table 4. Top nine locations in KS for clean hardwood mill residues based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66770                 | Cherokee | 56,975                   | 4,718,669       | 5,264       | 9                     | 82.82                     | 82.98                             |
| 66713                 | Cherokee | 57,550                   | 4,775,487       | 4,776       | 11                    | 82.98                     | 83.53                             |
| 66778                 | Cherokee | 57,550                   | 4,810,269       | 4,607       | 11                    | 83.58                     | 84.16                             |
| 66728                 | Cherokee | 62,563                   | 5,242,866       | 5,263       | 11                    | 83.80                     | 83.94                             |
| 66760                 | Cherokee | 62,563                   | 5,246,515       | 5,259       | 11                    | 83.86                     | 83.80                             |
| 66739                 | Cherokee | 62,038                   | 5,205,126       | 5,179       | 10                    | 83.90                     | 84.21                             |
| 66762                 | Cherokee | 50,400                   | 4,246,722       | 5,132       | 13                    | 84.26                     | 84.55                             |
| 66781                 | Cherokee | 63,088                   | 5,331,119       | 5,048       | 12                    | 84.50                     | 84.90                             |
| 66763                 | Crawford | 50,400                   | 4,268,203       | 4,033       | 13                    | 84.69                     | 84.13                             |





Demand ZCTA 66770 (Cherokee county, KS) has the least average total costs per dry ton of clean hardwood residues (Figure 13). Fifty thousand dry tons of clean hardwood residues are available within 80 mile radius from ZCTA 66770. The median MC per dry ton in the least cost sourcing area (ZCTA 66770, Cherokee county, KS) ranged from \$82.09 to \$87.57/dry ton (Table 5, Figure 14).



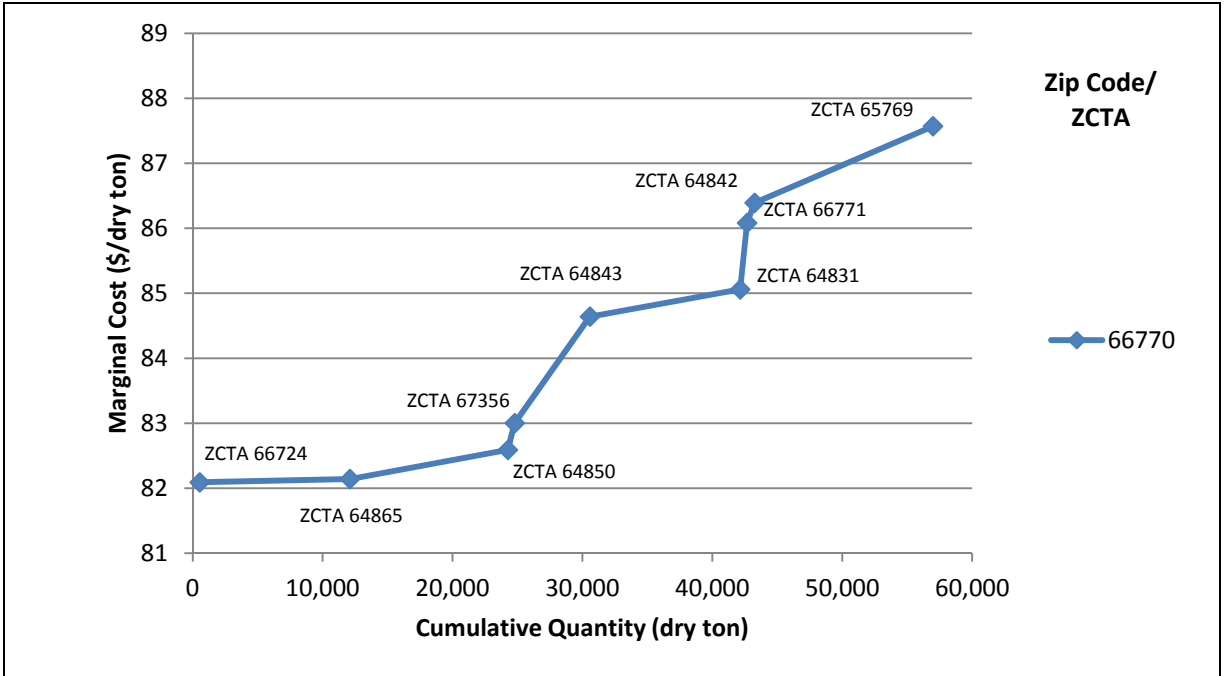


Figure 14. Marginal cost curve for clean hardwood mill residues in KS (ZCTA 66770, Cherokee County).

| Table 5. Supply ZCTAs for clean hardwood mill residues in KS (demand ZCTA 66770, Cherokee County). |                          |                       |                    |                            |                            |                 |                               |                            |
|----------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                        | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66724                                                                                              | 525                      | 42                    | 57.2               | 73.13                      | 7.30                       | 42,225          | 525                           | 80.43                      |
| 64865                                                                                              | 11,575                   | 926                   | 57.3               | 73.13                      | 7.35                       | 931,590         | 12,100                        | 80.48                      |
| 64850                                                                                              | 12,150                   | 972                   | 65.1               | 73.13                      | 7.80                       | 983,259         | 24,250                        | 80.93                      |
| 67356                                                                                              | 525                      | 42                    | 72.0               | 73.13                      | 8.21                       | 42,705          | 24,775                        | 81.34                      |
| 64843                                                                                              | 5,788                    | 463                   | 94.9               | 73.13                      | 9.85                       | 480,249         | 30,563                        | 82.98                      |
| 64831                                                                                              | 11,575                   | 926                   | 96.7               | 73.13                      | 10.27                      | 965,382         | 42,138                        | 83.40                      |
| 66771                                                                                              | 525                      | 42                    | 118.1              | 73.13                      | 11.29                      | 44,322          | 42,663                        | 84.42                      |
| 64842                                                                                              | 575                      | 46                    | 117.9              | 73.13                      | 11.60                      | 48,718          | 43,238                        | 84.73                      |
| 65769                                                                                              | 13,738                   | 1,099                 | 137.6              | 73.13                      | 12.78                      | 1,180,220       | 56,975                        | 85.91                      |
| 74366                                                                                              | 50                       | 4                     | 144.4              | 73.13                      | 13.29                      | 4,321           | 57,025                        | 86.42                      |
| 65661                                                                                              | 5,063                    | 405                   | 144.3              | 73.13                      | 13.33                      | 437,703         | 62,088                        | 86.46                      |
| 67301                                                                                              | 525                      | 42                    | 146.4              | 73.13                      | 13.43                      | 45,445          | 62,613                        | 86.56                      |
| 65610                                                                                              | 2,113                    | 169                   | 154.3              | 73.13                      | 13.53                      | 183,077         | 64,725                        | 86.66                      |
| 65605                                                                                              | 1,050                    | 84                    | 159.7              | 73.13                      | 14.11                      | 91,599          | 65,775                        | 87.24                      |

### 3.1.1.2 Hardwood “Unclean”

The top ten ZCTA locations for unclean hardwood mill residues were all located in south-east Kansas (Figure 15). Fifty thousand dry tons of unclean hardwood mill residues are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$46.32 to \$48.32/dry ton. The median MC ranged from \$46.45 to \$48.37/dry ton (Table 6, Figure 16).

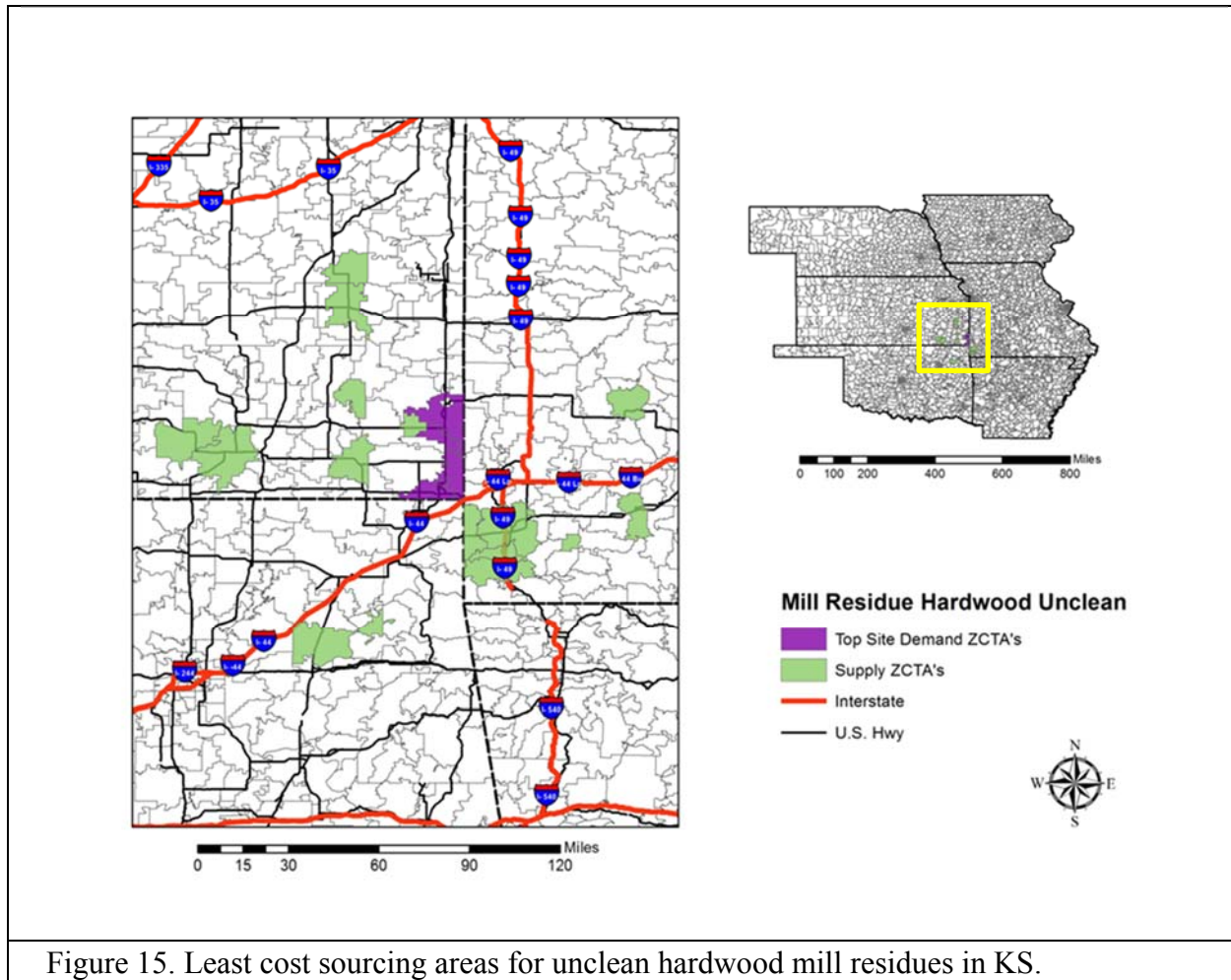
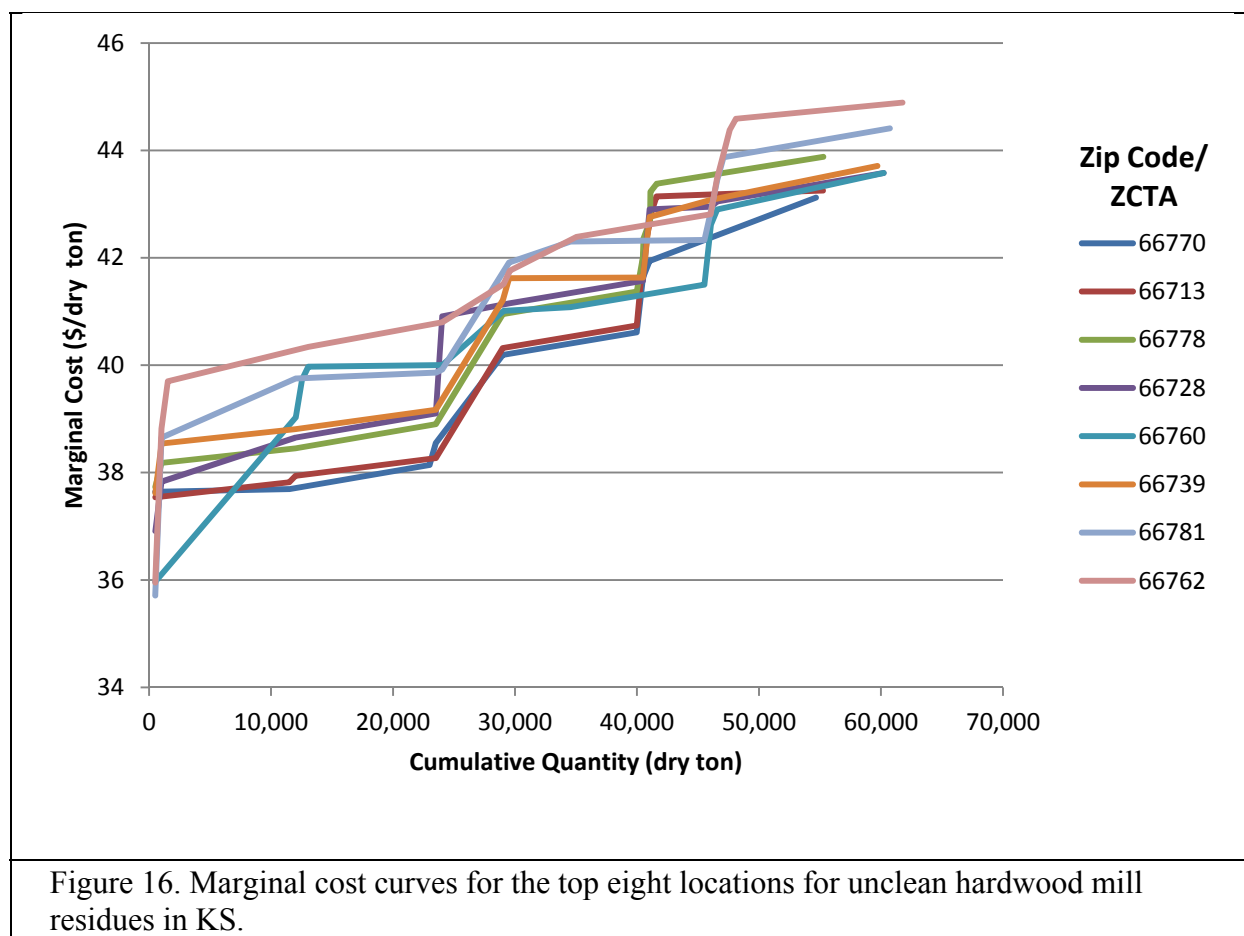


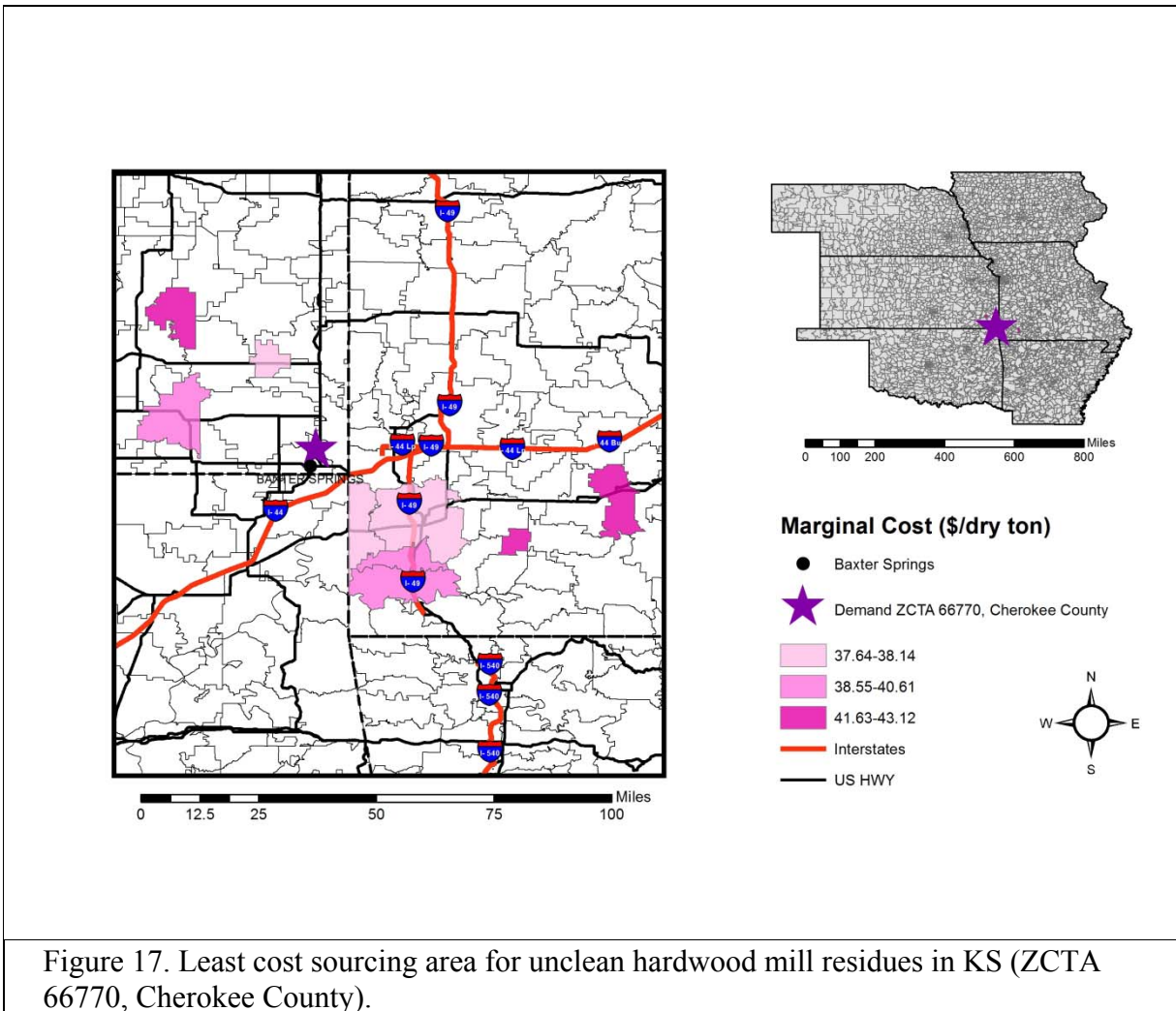
Table 6. Top eight locations in KS for unclean hardwood mill residues based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66770                 | Cherokee | 54,675                   | 2,532,803       | 5,077       | 9                     | 46.32                     | 46.45                             |
| 66713                 | Cherokee | 55,250                   | 2,568,311       | 4,592       | 11                    | 46.49                     | 47.00                             |
| 66778                 | Cherokee | 55,275                   | 2,602,905       | 4,424       | 12                    | 47.09                     | 47.96                             |
| 66728                 | Cherokee | 60,225                   | 2,848,942       | 5,074       | 11                    | 47.30                     | 47.41                             |
| 66760                 | Cherokee | 60,225                   | 2,851,946       | 5,069       | 11                    | 47.35                     | 47.27                             |
| 66739                 | Cherokee | 59,713                   | 2,830,765       | 4,992       | 10                    | 47.41                     | 47.68                             |
| 66781                 | Cherokee | 60,738                   | 2,915,506       | 4,860       | 12                    | 48.00                     | 48.37                             |
| 66762                 | Cherokee | 61,763                   | 2,994,550       | 4,942       | 14                    | 48.48                     | 48.34                             |

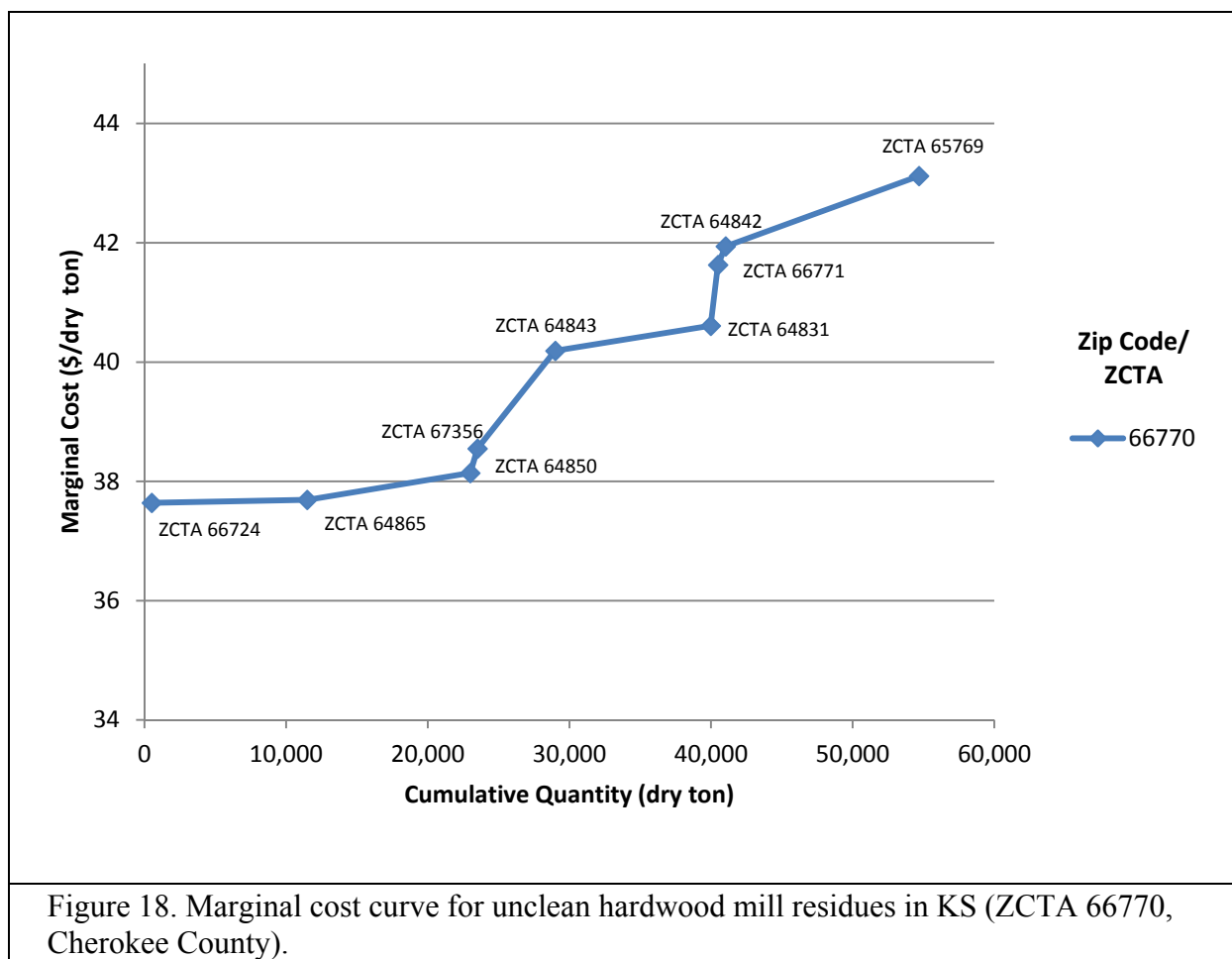


Demand ZCTA 66770 (Cherokee County, KS) has the least average total costs per dry ton of unclean hardwood residues (Figure 17). Fifty thousand dry tons of unclean hardwood residues

are available within 80 mile radius from ZCTA 66770. The median MC per dry ton in the least cost sourcing area (ZCTA 66770, Cherokee County, KS) ranged from \$37.64 to \$43.12/dry ton (Table 7, Figure 18).



| Table 7. Supply ZCTAs for unclean hardwood mill residues in KS (demand ZCTA 66770, Cherokee County). |                          |                       |                    |                            |                            |                 |                               |                            |
|------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                          | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66724                                                                                                | 513                      | 41                    | 57.2               | 36.60                      | 7.30                       | 22,498          | 513                           | 43.90                      |
| 64865                                                                                                | 10,975                   | 878                   | 57.3               | 36.60                      | 7.35                       | 482,384         | 11,488                        | 43.95                      |
| 64850                                                                                                | 11,513                   | 921                   | 65.1               | 36.60                      | 7.80                       | 511,117         | 23,000                        | 44.40                      |
| 67356                                                                                                | 513                      | 41                    | 72.0               | 36.60                      | 8.21                       | 22,966          | 23,513                        | 44.81                      |
| 64843                                                                                                | 5,488                    | 439                   | 94.9               | 36.60                      | 9.85                       | 254,896         | 29,000                        | 46.45                      |
| 64831                                                                                                | 10,975                   | 878                   | 96.7               | 36.60                      | 10.27                      | 514,423         | 39,975                        | 46.87                      |
| 66771                                                                                                | 513                      | 41                    | 118.1              | 36.60                      | 11.29                      | 24,545          | 40,488                        | 47.89                      |
| 64842                                                                                                | 538                      | 43                    | 117.9              | 36.60                      | 11.60                      | 25,906          | 41,025                        | 48.20                      |
| 65769                                                                                                | 13,650                   | 1,092                 | 137.6              | 36.60                      | 12.78                      | 674,068         | 54,675                        | 49.38                      |
| 74366                                                                                                | 63                       | 5                     | 144.4              | 36.60                      | 13.29                      | 3,118           | 54,738                        | 49.89                      |
| 65661                                                                                                | 5,038                    | 403                   | 144.3              | 36.60                      | 13.33                      | 251,521         | 59,775                        | 49.93                      |
| 67301                                                                                                | 513                      | 41                    | 146.4              | 36.60                      | 13.43                      | 25,642          | 60,288                        | 50.03                      |
| 65610                                                                                                | 2,100                    | 168                   | 154.3              | 36.60                      | 13.53                      | 105,281         | 62,388                        | 50.13                      |
| 65605                                                                                                | 1,050                    | 84                    | 159.7              | 36.60                      | 14.11                      | 53,243          | 63,438                        | 50.71                      |



### 3.2 Logging Residues

The logging residues<sup>13</sup> categories included in the KS BioSAT model were hardwood logging residues (“at-landing” and “in-woods”) and softwood logging residues (“at-landing” and “in-woods”). For illustration purposes, the maximum quantity available in a sourcing area and the associated total cost (TC), average total cost per dry ton (ATC), and median marginal cost (MC) in \$/dry ton were estimated for hardwood logging residues (“at-landing” and “in-woods”) assuming an annual consumption of half of a million dry tons and a maximum 80 mile one-way truck haul distance (with dry van trailer storage).

<sup>13</sup> The above ground woody portions of harvested trees that are not suitable for use as lumber or pulp. For merchantable trees, this includes the limbs and unmerchantable tops of the trees. This also includes whole trees that are harvested, but are too small or damaged to be used for conventional forest products.



### 3.2.1 Hardwood Logging Residues

#### 3.2.1.1 Hardwood “at-landing”

The top ten ZCTA locations for “at-landing” hardwood logging residues were all located in south-east Kansas (Figure 19). Half a million dry tons of “at-landing” hardwood logging residues are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$21.37 to \$22.68/dry ton. The median MC ranged from \$23.76 to \$25.47/dry ton (Table 8, Figure 20).

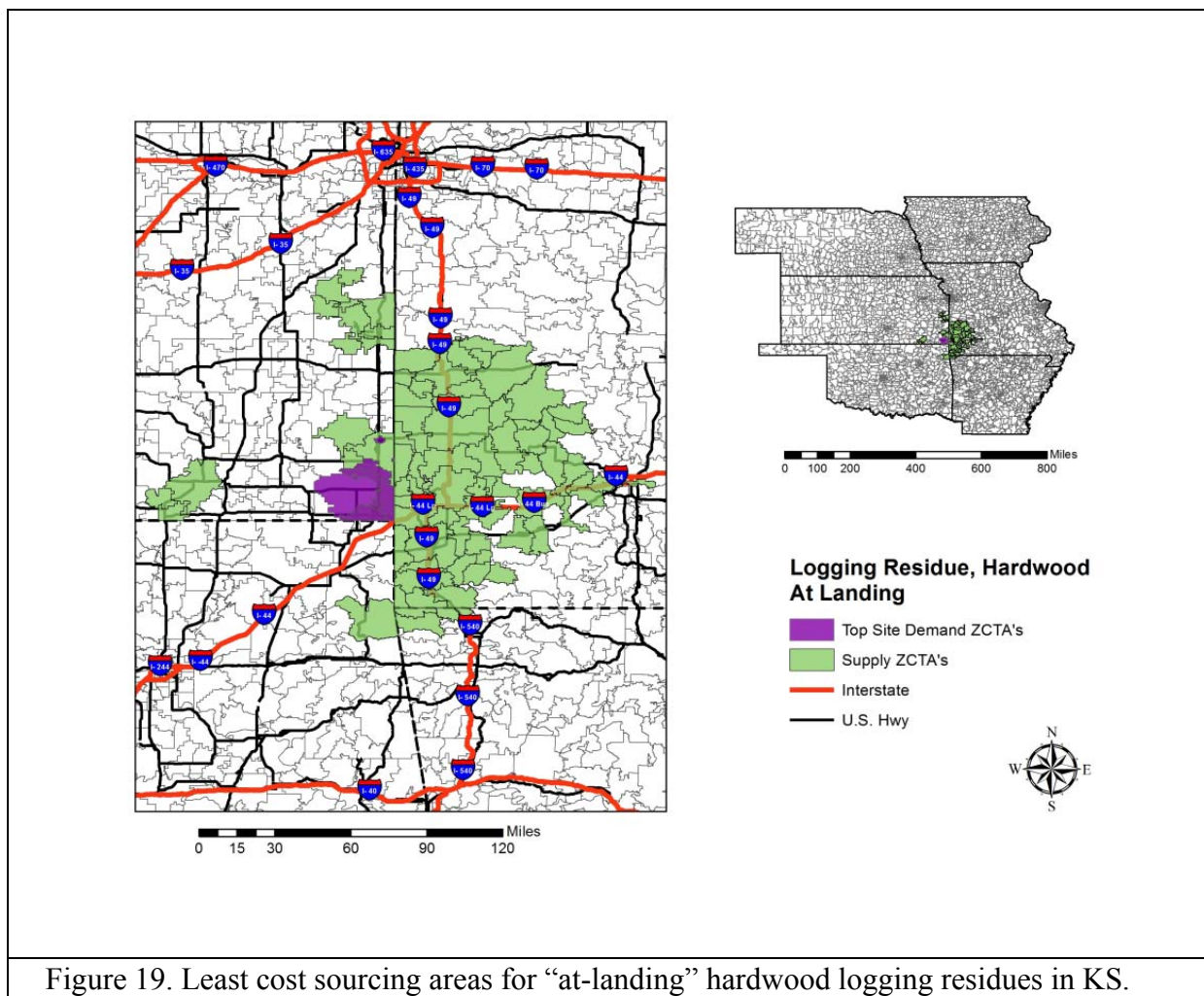
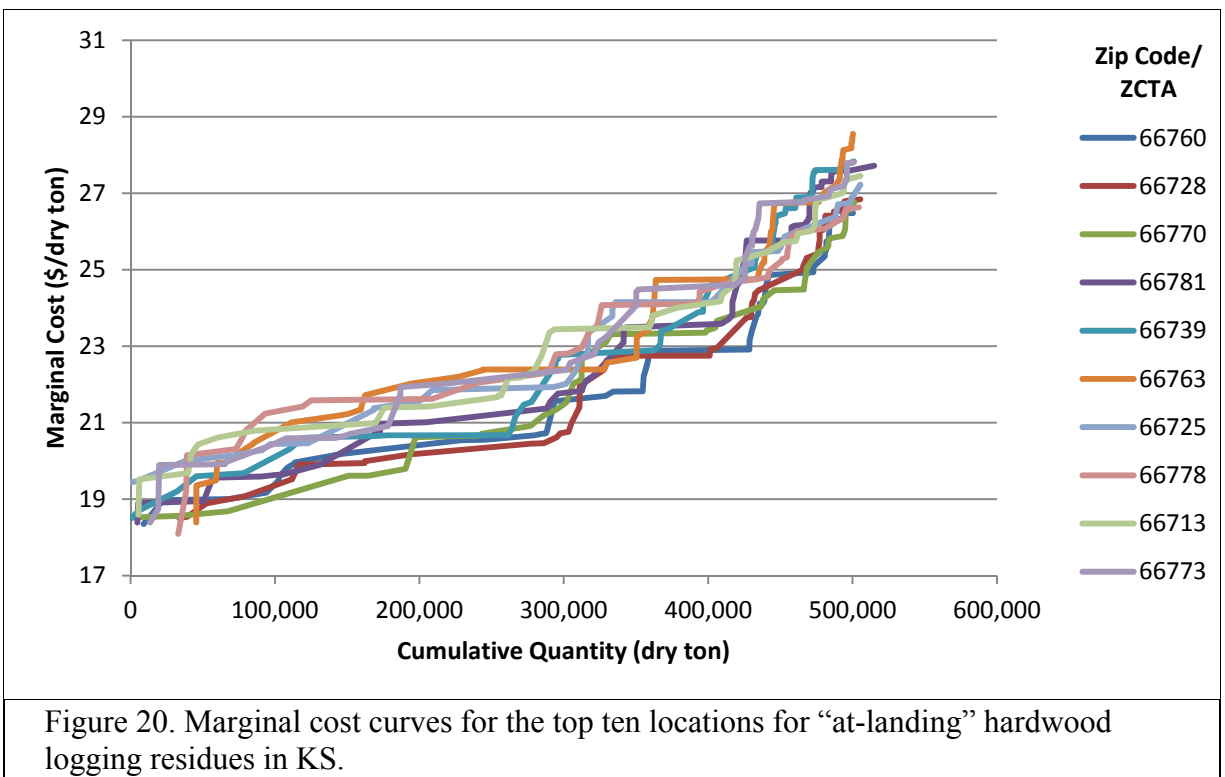


Table 8. Top ten locations in KS for “at-landing” hardwood logging residues based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66760                 | Cherokee | 500,338                  | 10,693,500      | 43,817      | 59                    | 21.37                     | 23.76                             |
| 66728                 | Cherokee | 505,350                  | 10,827,137      | 44,605      | 56                    | 21.43                     | 24.05                             |
| 66770                 | Cherokee | 501,325                  | 10,778,520      | 43,912      | 56                    | 21.50                     | 23.85                             |
| 66781                 | Cherokee | 514,963                  | 11,429,345      | 41,395      | 65                    | 22.19                     | 24.90                             |
| 66739                 | Cherokee | 500,963                  | 11,119,280      | 41,662      | 72                    | 22.20                     | 25.47                             |
| 66763                 | Crawford | 500,263                  | 11,292,564      | 41,386      | 73                    | 22.57                     | 24.67                             |
| 66725                 | Labette  | 505,400                  | 11,430,796      | 43,493      | 46                    | 22.62                     | 24.15                             |
| 66778                 | Cherokee | 504,400                  | 11,408,902      | 44,375      | 48                    | 22.62                     | 24.22                             |
| 66713                 | Cherokee | 505,563                  | 11,453,473      | 42,007      | 59                    | 22.65                     | 24.59                             |
| 66773                 | Cherokee | 500,988                  | 11,360,901      | 42,257      | 56                    | 22.68                     | 24.95                             |



**Marginal Cost (\$/dry ton)**

- Baxter Springs
- ★ Demand ZCTA 66760, Cherokee County
- 18.35-21.70
- 21.81-24.48
- 24.58-26.48
- Interstates
- US HWY

Table 9. Supply ZCTAs for “at-landing” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64832       | 9,075                    | 726                   | 10.8               | 1.00                       | 13.19                        | 4.16                       | 166,509         | 9,075                         | 18.35                      |
| 66781       | 13,438                   | 1075                  | 20.9               | 1.00                       | 13.19                        | 4.78                       | 254,940         | 22,513                        | 18.97                      |
| 66762       | 45,500                   | 3640                  | 20.3               | 1.00                       | 13.19                        | 4.81                       | 864,365         | 68,013                        | 19.00                      |
| 64834       | 26,000                   | 2080                  | 23.3               | 1.00                       | 13.19                        | 4.98                       | 498,336         | 94,013                        | 19.17                      |
| 64855       | 8,575                    | 686                   | 26.8               | 1.00                       | 13.19                        | 5.30                       | 167,117         | 102,588                       | 19.49                      |
| 64769       | 175                      | 14                    | 24.4               | 1.00                       | 13.19                        | 5.40                       | 3,428           | 102,763                       | 19.59                      |
| 66724       | 5,813                    | 465                   | 29.8               | 1.00                       | 13.19                        | 5.63                       | 115,225         | 108,575                       | 19.82                      |
| 66773       | 4,750                    | 380                   | 32.0               | 1.00                       | 13.19                        | 5.74                       | 94,674          | 113,325                       | 19.93                      |
| 66728       | 563                      | 45                    | 36.1               | 1.00                       | 13.19                        | 5.77                       | 11,229          | 113,888                       | 19.96                      |
| 64870       | 31,713                   | 2537                  | 36.5               | 1.00                       | 13.19                        | 5.99                       | 639,841         | 145,600                       | 20.18                      |
| 64801       | 83,550                   | 6684                  | 39.8               | 1.00                       | 13.19                        | 6.35                       | 1,716,208       | 229,150                       | 20.54                      |
| 64755       | 16,725                   | 1338                  | 41.8               | 1.00                       | 13.19                        | 6.36                       | 343,715         | 245,875                       | 20.55                      |
| 66739       | 33,763                   | 2701                  | 43.1               | 1.00                       | 13.19                        | 6.48                       | 697,910         | 279,638                       | 20.67                      |
| 66770       | 5,500                    | 440                   | 48.0               | 1.00                       | 13.19                        | 6.52                       | 113,925         | 285,138                       | 20.71                      |
| 64835       | 2,313                    | 185                   | 44.4               | 1.00                       | 13.19                        | 6.53                       | 47,926          | 287,450                       | 20.72                      |
| 64762       | 700                      | 56                    | 40.5               | 1.00                       | 13.19                        | 6.57                       | 14,534          | 288,150                       | 20.76                      |
| 64836       | 5,438                    | 435                   | 57.8               | 1.00                       | 13.19                        | 7.37                       | 117,255         | 293,588                       | 21.56                      |
| 66713       | 33,038                   | 2643                  | 63.2               | 1.00                       | 13.19                        | 7.50                       | 716,566         | 326,625                       | 21.69                      |
| 64804       | 2,200                    | 176                   | 58.0               | 1.00                       | 13.19                        | 7.51                       | 47,738          | 328,825                       | 21.70                      |
| 66743       | 5,325                    | 426                   | 59.7               | 1.00                       | 13.19                        | 7.62                       | 116,126         | 334,150                       | 21.81                      |
| 64748       | 20,575                   | 1646                  | 62.6               | 1.00                       | 13.19                        | 7.63                       | 448,988         | 354,725                       | 21.82                      |
| 64728       | 638                      | 51                    | 70.5               | 1.00                       | 13.19                        | 8.02                       | 14,156          | 355,363                       | 22.21                      |
| 64759       | 2,438                    | 195                   | 71.3               | 1.00                       | 13.19                        | 8.34                       | 54,911          | 357,800                       | 22.53                      |
| 64840       | 638                      | 51                    | 73.1               | 1.00                       | 13.19                        | 8.45                       | 14,431          | 358,438                       | 22.64                      |
| 64833       | 38                       | 3                     | 75.3               | 1.00                       | 13.19                        | 8.54                       | 853             | 358,475                       | 22.73                      |
| 64850       | 4,375                    | 350                   | 77.1               | 1.00                       | 13.19                        | 8.69                       | 100,117         | 362,850                       | 22.88                      |

Table 9. Supply ZCTAs for “at-landing” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64859       | 65,725                   | 5258                  | 77.8               | 1.00                       | 13.19                        | 8.72                       | 1,505,638       | 428,575                       | 22.91                      |
| 64771       | 88                       | 7                     | 81.9               | 1.00                       | 13.19                        | 8.96                       | 2,026           | 428,663                       | 23.15                      |
| 65682       | 1,500                    | 120                   | 82.5               | 1.00                       | 13.19                        | 9.19                       | 35,072          | 430,163                       | 23.38                      |
| 64862       | 3,063                    | 245                   | 89.2               | 1.00                       | 13.19                        | 9.57                       | 72,778          | 433,225                       | 23.76                      |
| 64865       | 1,413                    | 113                   | 88.1               | 1.00                       | 13.19                        | 9.66                       | 33,691          | 434,638                       | 23.85                      |
| 64873       | 813                      | 65                    | 94.0               | 1.00                       | 13.19                        | 9.88                       | 19,557          | 435,450                       | 24.07                      |
| 64784       | 2,213                    | 177                   | 94.2               | 1.00                       | 13.19                        | 9.92                       | 53,340          | 437,663                       | 24.11                      |
| 64848       | 250                      | 20                    | 93.6               | 1.00                       | 13.19                        | 9.92                       | 6,028           | 437,913                       | 24.11                      |
| 64844       | 1,113                    | 89                    | 96.5               | 1.00                       | 13.19                        | 10.01                      | 26,920          | 439,025                       | 24.20                      |
| 64741       | 38                       | 3                     | 99.1               | 1.00                       | 13.19                        | 10.07                      | 910             | 439,063                       | 24.26                      |
| 64767       | 413                      | 33                    | 99.8               | 1.00                       | 13.19                        | 10.16                      | 10,043          | 439,475                       | 24.35                      |
| 64772       | 388                      | 31                    | 99.5               | 1.00                       | 13.19                        | 10.29                      | 9,485           | 439,863                       | 24.48                      |
| 65752       | 225                      | 18                    | 99.0               | 1.00                       | 13.19                        | 10.39                      | 5,531           | 440,088                       | 24.58                      |
| 65661       | 2,063                    | 165                   | 103.2              | 1.00                       | 13.19                        | 10.67                      | 51,281          | 442,150                       | 24.86                      |
| 64843       | 30,700                   | 2456                  | 106.8              | 1.00                       | 13.19                        | 10.74                      | 765,307         | 472,850                       | 24.93                      |
| 66767       | 38                       | 3                     | 112.8              | 1.00                       | 13.19                        | 10.76                      | 936             | 472,888                       | 24.95                      |
| 66738       | 50                       | 4                     | 111.3              | 1.00                       | 13.19                        | 10.89                      | 1,254           | 472,938                       | 25.08                      |
| 64831       | 7,838                    | 627                   | 108.6              | 1.00                       | 13.19                        | 11.16                      | 198,684         | 480,775                       | 25.35                      |
| 64790       | 100                      | 8                     | 116.5              | 1.00                       | 13.19                        | 11.24                      | 2,543           | 480,875                       | 25.43                      |
| 64847       | 250                      | 20                    | 118.4              | 1.00                       | 13.19                        | 11.31                      | 6,374           | 481,125                       | 25.50                      |
| 64866       | 700                      | 56                    | 111.9              | 1.00                       | 13.19                        | 11.32                      | 17,857          | 481,825                       | 25.51                      |
| 65603       | 25                       | 2                     | 114.1              | 1.00                       | 13.19                        | 11.35                      | 638             | 481,850                       | 25.54                      |
| 64778       | 138                      | 11                    | 119.6              | 1.00                       | 13.19                        | 11.55                      | 3,539           | 481,988                       | 25.74                      |
| 64756       | 1,500                    | 120                   | 118.9              | 1.00                       | 13.19                        | 11.57                      | 38,641          | 483,488                       | 25.76                      |
| 65712       | 563                      | 45                    | 127.0              | 1.00                       | 13.19                        | 11.90                      | 14,673          | 484,050                       | 26.09                      |
| 66754       | 100                      | 8                     | 122.9              | 1.00                       | 13.19                        | 11.97                      | 2,616           | 484,150                       | 26.16                      |

Table 9. Supply ZCTAs for “at-landing” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 65708       | 388                      | 31                    | 121.6              | 1.00                       | 13.19                        | 12.05                      | 10,168          | 484,538                       | 26.24                      |
| 66075       | 100                      | 8                     | 133.7              | 1.00                       | 13.19                        | 12.10                      | 2,629           | 484,638                       | 26.29                      |
| 65646       | 3,288                    | 263                   | 124.4              | 1.00                       | 13.19                        | 12.11                      | 86,466          | 487,925                       | 26.30                      |
| 64854       | 5,563                    | 445                   | 129.2              | 1.00                       | 13.19                        | 12.15                      | 146,491         | 493,488                       | 26.34                      |
| 67363       | 175                      | 14                    | 126.5              | 1.00                       | 13.19                        | 12.16                      | 4,611           | 493,663                       | 26.35                      |
| 64842       | 88                       | 7                     | 125.4              | 1.00                       | 13.19                        | 12.28                      | 2,316           | 493,750                       | 26.47                      |
| 64867       | 6,588                    | 527                   | 133.5              | 1.00                       | 13.19                        | 12.29                      | 174,433         | 500,338                       | 26.48                      |
| 64861       | 338                      | 27                    | 132.3              | 1.00                       | 13.19                        | 12.52                      | 9,014           | 500,675                       | 26.71                      |
| 64750       | 38                       | 3                     | 137.2              | 1.00                       | 13.19                        | 12.57                      | 1,004           | 500,713                       | 26.76                      |
| 64856       | 8,963                    | 717                   | 136.4              | 1.00                       | 13.19                        | 12.57                      | 239,869         | 509,675                       | 26.76                      |
| 64863       | 1,200                    | 96                    | 137.3              | 1.00                       | 13.19                        | 12.75                      | 32,330          | 510,875                       | 26.94                      |
| 64783       | 200                      | 16                    | 137.2              | 1.00                       | 13.19                        | 12.87                      | 5,411           | 511,075                       | 27.05                      |
| 72768       | 238                      | 19                    | 138.9              | 1.00                       | 13.19                        | 12.89                      | 6,432           | 511,313                       | 27.08                      |
| 66056       | 175                      | 14                    | 142.8              | 1.00                       | 13.19                        | 13.01                      | 4,760           | 511,488                       | 27.20                      |
| 72714       | 238                      | 19                    | 147.5              | 1.00                       | 13.19                        | 13.21                      | 6,508           | 511,725                       | 27.40                      |
| 72715       | 350                      | 28                    | 145.8              | 1.00                       | 13.19                        | 13.24                      | 9,601           | 512,400                       | 27.43                      |
| 65769       | 675                      | 54                    | 140.7              | 1.00                       | 13.19                        | 13.24                      | 18,515          | 512,750                       | 27.43                      |
| 65738       | 175                      | 14                    | 148.0              | 1.00                       | 13.19                        | 13.27                      | 4,806           | 512,925                       | 27.46                      |
| 64744       | 1,063                    | 85                    | 143.9              | 1.00                       | 13.19                        | 13.30                      | 29,206          | 513,988                       | 27.49                      |
| 65612       | 163                      | 13                    | 148.1              | 1.00                       | 13.19                        | 13.38                      | 4,480           | 514,150                       | 27.57                      |
| 65635       | 188                      | 15                    | 139.4              | 1.00                       | 13.19                        | 13.54                      | 5,200           | 514,338                       | 27.73                      |
| 65705       | 8,300                    | 664                   | 152.3              | 1.00                       | 13.19                        | 13.59                      | 230,578         | 522,638                       | 27.78                      |
| 65802       | 1,413                    | 113                   | 155.0              | 1.00                       | 13.19                        | 13.61                      | 39,266          | 524,050                       | 27.80                      |
| 65604       | 463                      | 37                    | 153.3              | 1.00                       | 13.19                        | 13.70                      | 12,897          | 524,513                       | 27.89                      |
| 65647       | 2,488                    | 199                   | 148.1              | 1.00                       | 13.19                        | 13.74                      | 69,471          | 527,000                       | 27.93                      |
| 65734       | 288                      | 23                    | 145.3              | 1.00                       | 13.19                        | 13.83                      | 8,055           | 527,288                       | 28.02                      |

Table 9. Supply ZCTAs for “at-landing” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 72736       | 650                      | 52                    | 152.8              | 1.00                       | 13.19                        | 13.92                      | 18,270          | 527,938                       | 28.11                      |
| 65785       | 2,188                    | 175                   | 148.8              | 1.00                       | 13.19                        | 13.94                      | 61,526          | 530,125                       | 28.13                      |
| 65610       | 363                      | 29                    | 157.4              | 1.00                       | 13.19                        | 13.99                      | 10,216          | 530,488                       | 28.18                      |
| 67301       | 17,063                   | 1365                  | 150.8              | 1.00                       | 13.19                        | 14.06                      | 482,098         | 530,525                       | 28.25                      |
| 65601       | 38                       | 3                     | 150.9              | 1.00                       | 13.19                        | 14.06                      | 1,059           | 547,588                       | 28.25                      |
| 65649       | 113                      | 9                     | 157.3              | 1.00                       | 13.19                        | 14.63                      | 3,242           | 547,700                       | 28.82                      |

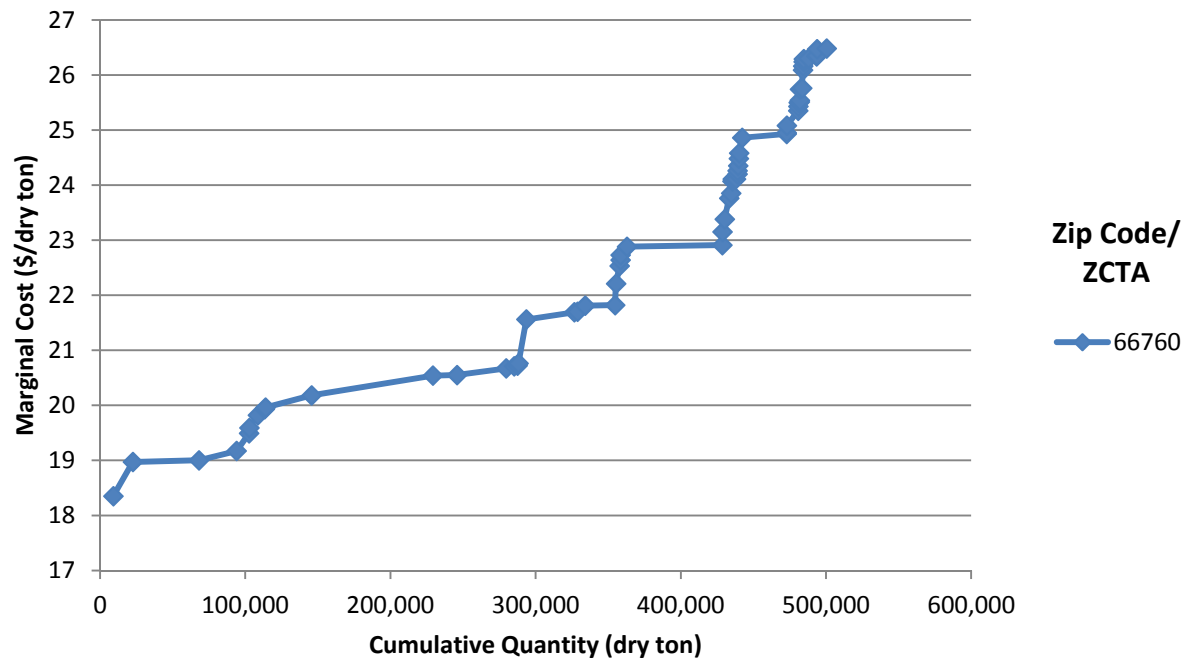


Figure 22. Marginal cost curve for “at-landing” hardwood logging residues in KS (ZCTA 66760, Cherokee County).



### 3.2.1.2 Hardwood “in-woods”

The top ten ZCTA locations for “in-woods” hardwood logging residues were all located in south-east Kansas (Figure 23). Half a million dry tons of “in-woods” hardwood logging residues are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$192.75 to \$194.06/dry ton. The median MC ranged from \$195.14 to \$196.85/dry ton (Table 10, Figure 24).

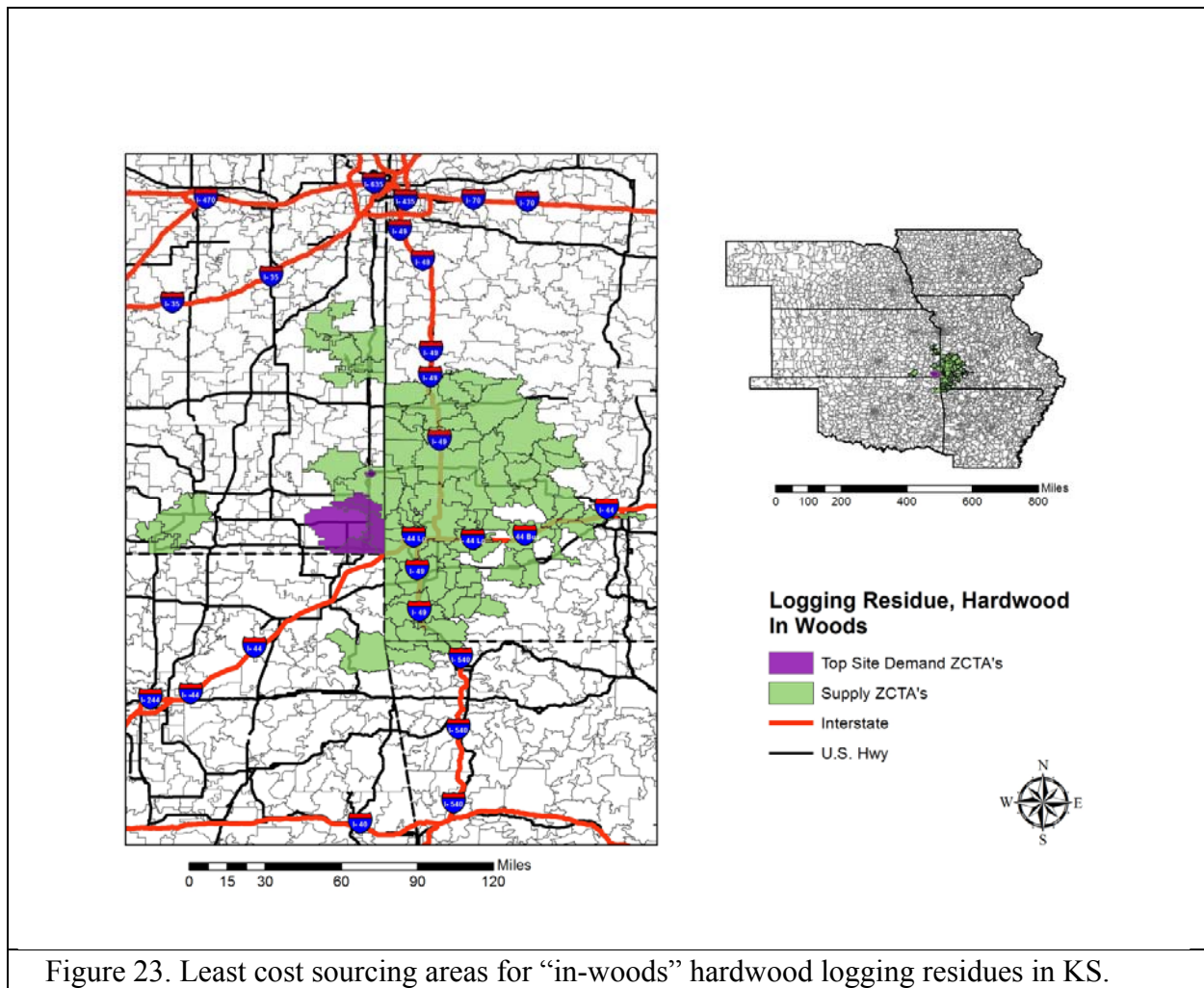




Table 10. Top ten locations in KS for “in-woods” hardwood logging residues based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66760                 | Cherokee | 500,338                  | 96,441,345      | 43,817      | 59                    | 192.75                    | 195.14                            |
| 66728                 | Cherokee | 505,350                  | 97,434,023      | 44,605      | 56                    | 192.81                    | 195.43                            |
| 66770                 | Cherokee | 501,325                  | 96,695,602      | 43,912      | 56                    | 192.88                    | 195.23                            |
| 66781                 | Cherokee | 514,963                  | 99,683,622      | 41,395      | 65                    | 193.57                    | 196.28                            |
| 66739                 | Cherokee | 500,963                  | 96,974,237      | 41,662      | 72                    | 193.58                    | 196.85                            |
| 66763                 | Crawford | 500,263                  | 97,027,555      | 41,386      | 73                    | 193.95                    | 196.05                            |
| 66725                 | Labette  | 505,400                  | 98,046,252      | 43,493      | 46                    | 194.00                    | 195.53                            |
| 66778                 | Cherokee | 504,400                  | 97,852,978      | 44,375      | 48                    | 194.00                    | 195.60                            |
| 66713                 | Cherokee | 505,563                  | 98,096,778      | 42,007      | 59                    | 194.03                    | 195.97                            |
| 66773                 | Cherokee | 500,988                  | 97,220,143      | 42,257      | 56                    | 194.06                    | 196.33                            |

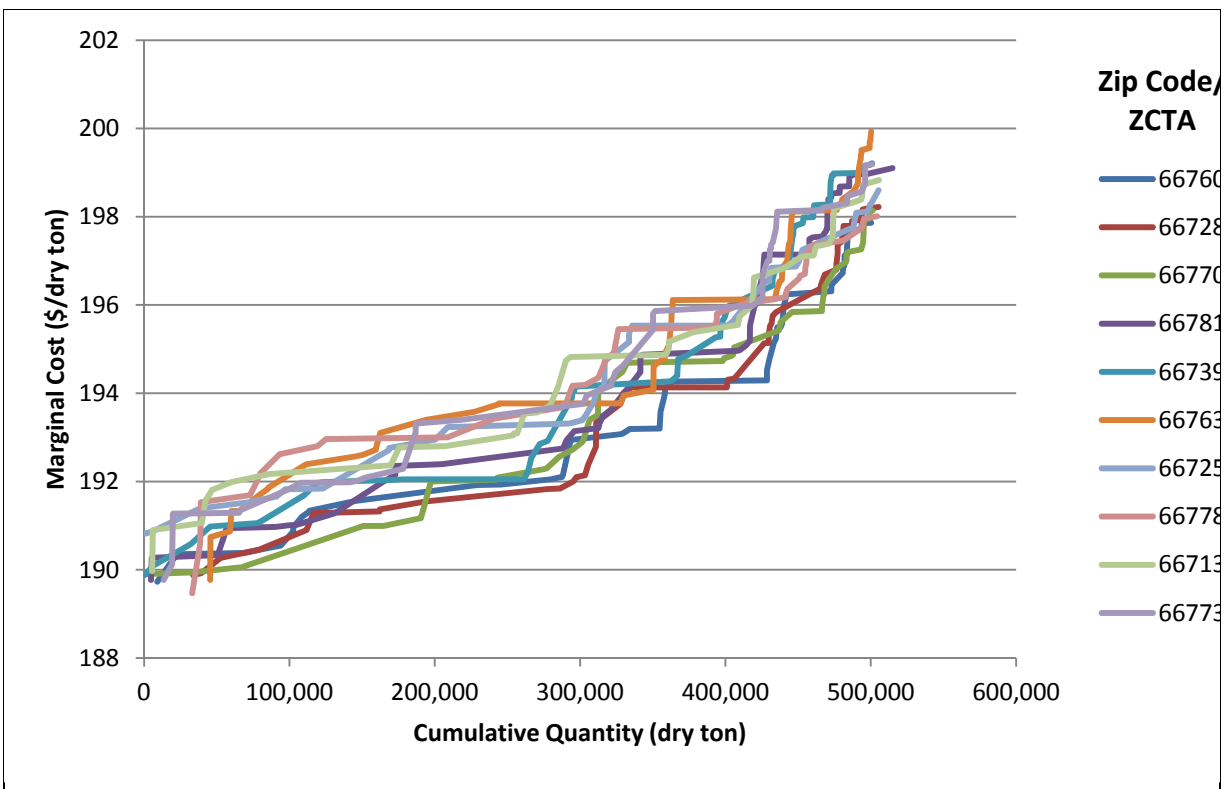
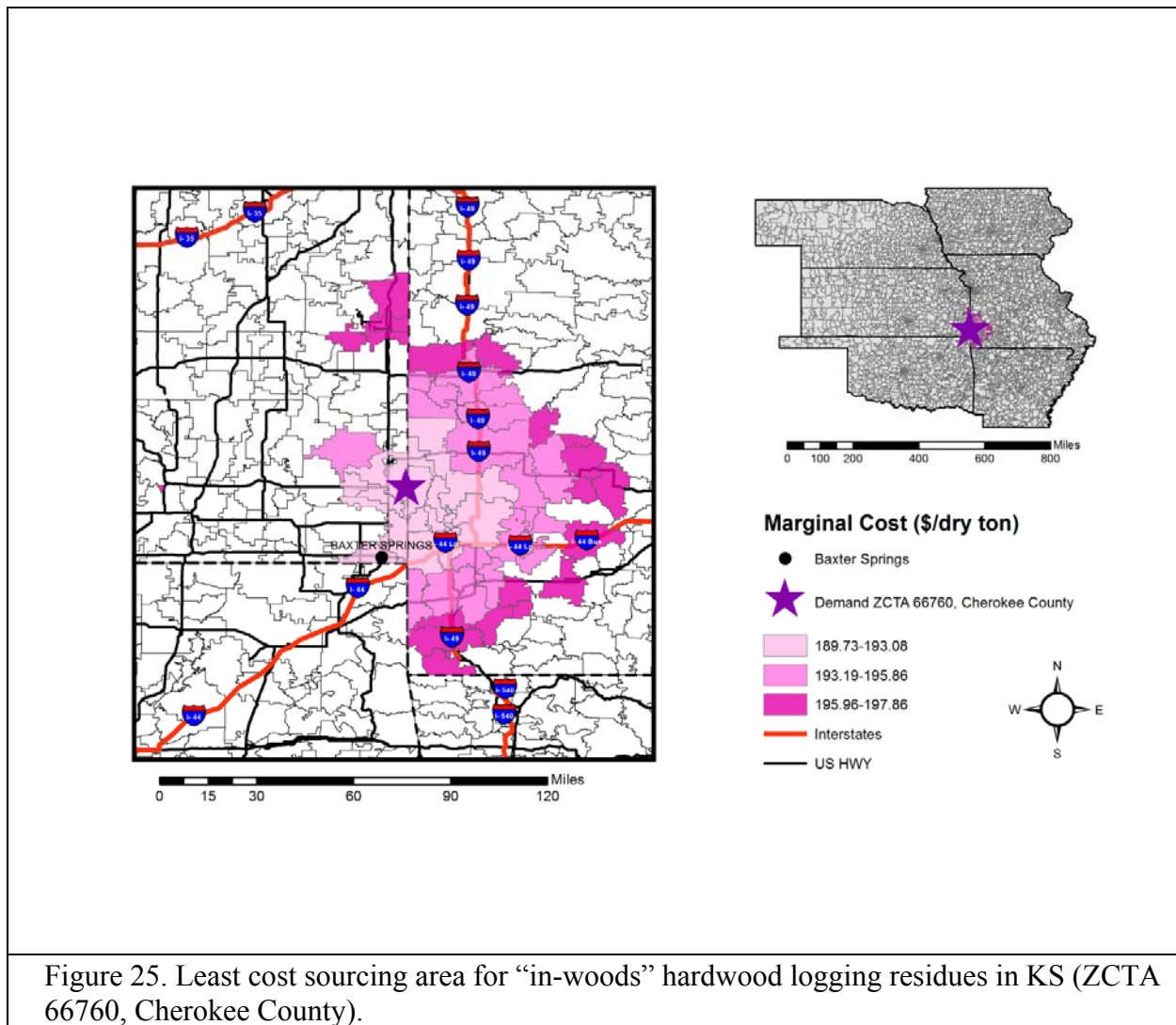


Figure 24. Marginal cost curves for the top ten locations for “in-woods” hardwood logging residues in KS.

Demand ZCTA 66760 (Cherokee County, KS) has the least average total costs per dry ton of “in-woods” hardwood logging residues (Figure 25). Half a million dry tons of “in-woods” hardwood logging residues are available within 80 mile radius from ZCTA 66760. The median MC per dry ton in the least cost sourcing area (ZCTA 66760, Cherokee County, KS) ranged from \$189.73 to \$197.86/dry ton (Table 11, Figure 26).



| Table 11. Supply ZCTAs for “in-woods” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|-------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                 | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 64832                                                                                                       | 9,075                    | 726                   | 10.8               | 1.00                       | 184.57                       | 4.16                       | 1,721,783       | 9,075                         | 189.73                     |
| 66781                                                                                                       | 13,438                   | 1,075                 | 20.9               | 1.00                       | 184.57                       | 4.78                       | 2,557,859       | 22,513                        | 190.35                     |
| 66762                                                                                                       | 45,500                   | 3,640                 | 20.3               | 1.00                       | 184.57                       | 4.81                       | 8,662,155       | 68,013                        | 190.38                     |
| 64834                                                                                                       | 26,000                   | 2,080                 | 23.3               | 1.00                       | 184.57                       | 4.98                       | 4,954,216       | 94,013                        | 190.55                     |
| 64855                                                                                                       | 8,575                    | 686                   | 26.8               | 1.00                       | 184.57                       | 5.30                       | 1,636,701       | 102,588                       | 190.87                     |
| 64769                                                                                                       | 175                      | 14                    | 24.4               | 1.00                       | 184.57                       | 5.40                       | 33,420          | 102,763                       | 190.97                     |
| 66724                                                                                                       | 5,813                    | 465                   | 29.8               | 1.00                       | 184.57                       | 5.63                       | 1,111,371       | 108,575                       | 191.20                     |
| 66773                                                                                                       | 4,750                    | 380                   | 32.0               | 1.00                       | 184.57                       | 5.74                       | 908,729         | 113,325                       | 191.31                     |
| 66728                                                                                                       | 563                      | 45                    | 36.1               | 1.00                       | 184.57                       | 5.77                       | 107,630         | 113,888                       | 191.34                     |
| 64870                                                                                                       | 31,713                   | 2,537                 | 36.5               | 1.00                       | 184.57                       | 5.99                       | 6,074,729       | 145,600                       | 191.56                     |
| 64801                                                                                                       | 83,550                   | 6,684                 | 39.8               | 1.00                       | 184.57                       | 6.35                       | 16,035,008      | 229,150                       | 191.92                     |
| 64755                                                                                                       | 16,725                   | 1,338                 | 41.8               | 1.00                       | 184.57                       | 6.36                       | 3,210,045       | 245,875                       | 191.93                     |
| 66739                                                                                                       | 33,763                   | 2,701                 | 43.1               | 1.00                       | 184.57                       | 6.48                       | 6,484,128       | 279,638                       | 192.05                     |
| 66770                                                                                                       | 5,500                    | 440                   | 48.0               | 1.00                       | 184.57                       | 6.52                       | 1,056,515       | 285,138                       | 192.09                     |
| 64835                                                                                                       | 2,313                    | 185                   | 44.4               | 1.00                       | 184.57                       | 6.53                       | 444,243         | 287,450                       | 192.10                     |
| 64762                                                                                                       | 700                      | 56                    | 40.5               | 1.00                       | 184.57                       | 6.57                       | 134,500         | 288,150                       | 192.14                     |
| 64836                                                                                                       | 5,438                    | 435                   | 57.8               | 1.00                       | 184.57                       | 7.37                       | 1,049,133       | 293,588                       | 192.94                     |
| 66713                                                                                                       | 33,038                   | 2,643                 | 63.2               | 1.00                       | 184.57                       | 7.50                       | 6,378,533       | 326,625                       | 193.07                     |
| 64804                                                                                                       | 2,200                    | 176                   | 58.0               | 1.00                       | 184.57                       | 7.51                       | 424,774         | 328,825                       | 193.08                     |
| 66743                                                                                                       | 5,325                    | 426                   | 59.7               | 1.00                       | 184.57                       | 7.62                       | 1,028,724       | 334,150                       | 193.19                     |
| 64748                                                                                                       | 20,575                   | 1,646                 | 62.6               | 1.00                       | 184.57                       | 7.63                       | 3,975,132       | 354,725                       | 193.20                     |
| 64728                                                                                                       | 638                      | 51                    | 70.5               | 1.00                       | 184.57                       | 8.02                       | 123,411         | 355,363                       | 193.59                     |
| 64759                                                                                                       | 2,438                    | 195                   | 71.3               | 1.00                       | 184.57                       | 8.34                       | 472,650         | 357,800                       | 193.91                     |
| 64840                                                                                                       | 638                      | 51                    | 73.1               | 1.00                       | 184.57                       | 8.45                       | 123,686         | 358,438                       | 194.02                     |
| 64833                                                                                                       | 38                       | 3                     | 75.3               | 1.00                       | 184.57                       | 8.54                       | 7,279           | 358,475                       | 194.11                     |
| 64850                                                                                                       | 4,375                    | 350                   | 77.1               | 1.00                       | 184.57                       | 8.69                       | 849,904         | 362,850                       | 194.26                     |

| Table 11. Supply ZCTAs for “in-woods” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|-------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                 | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 64859                                                                                                       | 65,725                   | 5,258                 | 77.8               | 1.00                       | 184.57                       | 8.72                       | 12,769,589      | 428,575                       | 194.29                     |
| 64771                                                                                                       | 88                       | 7                     | 81.9               | 1.00                       | 184.57                       | 8.96                       | 17,021          | 428,663                       | 194.53                     |
| 65682                                                                                                       | 1,500                    | 120                   | 82.5               | 1.00                       | 184.57                       | 9.19                       | 292,142         | 430,163                       | 194.76                     |
| 64862                                                                                                       | 3,063                    | 245                   | 89.2               | 1.00                       | 184.57                       | 9.57                       | 597,629         | 433,225                       | 195.14                     |
| 64865                                                                                                       | 1,413                    | 113                   | 88.1               | 1.00                       | 184.57                       | 9.66                       | 275,766         | 434,638                       | 195.23                     |
| 64873                                                                                                       | 813                      | 65                    | 94.0               | 1.00                       | 184.57                       | 9.88                       | 158,804         | 435,450                       | 195.45                     |
| 64784                                                                                                       | 2,213                    | 177                   | 94.2               | 1.00                       | 184.57                       | 9.92                       | 432,518         | 437,663                       | 195.49                     |
| 64848                                                                                                       | 250                      | 20                    | 93.6               | 1.00                       | 184.57                       | 9.92                       | 48,873          | 437,913                       | 195.49                     |
| 64844                                                                                                       | 1,113                    | 89                    | 96.5               | 1.00                       | 184.57                       | 10.01                      | 217,580         | 439,025                       | 195.58                     |
| 64741                                                                                                       | 38                       | 3                     | 99.1               | 1.00                       | 184.57                       | 10.07                      | 7,337           | 439,063                       | 195.64                     |
| 64767                                                                                                       | 413                      | 33                    | 99.8               | 1.00                       | 184.57                       | 10.16                      | 80,737          | 439,475                       | 195.73                     |
| 64772                                                                                                       | 388                      | 31                    | 99.5               | 1.00                       | 184.57                       | 10.29                      | 75,895          | 439,863                       | 195.86                     |
| 65752                                                                                                       | 225                      | 18                    | 99.0               | 1.00                       | 184.57                       | 10.39                      | 44,092          | 440,088                       | 195.96                     |
| 65661                                                                                                       | 2,063                    | 165                   | 103.2              | 1.00                       | 184.57                       | 10.67                      | 404,752         | 442,150                       | 196.24                     |
| 64843                                                                                                       | 30,700                   | 2,456                 | 106.8              | 1.00                       | 184.57                       | 10.74                      | 6,026,673       | 472,850                       | 196.31                     |
| 66767                                                                                                       | 38                       | 3                     | 112.8              | 1.00                       | 184.57                       | 10.76                      | 7,362           | 472,888                       | 196.33                     |
| 66738                                                                                                       | 50                       | 4                     | 111.3              | 1.00                       | 184.57                       | 10.89                      | 9,823           | 472,938                       | 196.46                     |
| 64831                                                                                                       | 7,838                    | 627                   | 108.6              | 1.00                       | 184.57                       | 11.16                      | 1,541,875       | 480,775                       | 196.73                     |
| 64790                                                                                                       | 100                      | 8                     | 116.5              | 1.00                       | 184.57                       | 11.24                      | 19,681          | 480,875                       | 196.81                     |
| 64847                                                                                                       | 250                      | 20                    | 118.4              | 1.00                       | 184.57                       | 11.31                      | 49,219          | 481,125                       | 196.88                     |
| 64866                                                                                                       | 700                      | 56                    | 111.9              | 1.00                       | 184.57                       | 11.32                      | 137,823         | 481,825                       | 196.89                     |
| 65603                                                                                                       | 25                       | 2                     | 114.1              | 1.00                       | 184.57                       | 11.35                      | 4,923           | 481,850                       | 196.92                     |
| 64778                                                                                                       | 138                      | 11                    | 119.6              | 1.00                       | 184.57                       | 11.55                      | 27,104          | 481,988                       | 197.12                     |
| 64756                                                                                                       | 1,500                    | 120                   | 118.9              | 1.00                       | 184.57                       | 11.57                      | 295,711         | 483,488                       | 197.14                     |
| 65712                                                                                                       | 563                      | 45                    | 127.0              | 1.00                       | 184.57                       | 11.90                      | 111,075         | 484,050                       | 197.47                     |
| 66754                                                                                                       | 100                      | 8                     | 122.9              | 1.00                       | 184.57                       | 11.97                      | 19,754          | 484,150                       | 197.54                     |

| Table 11. Supply ZCTAs for “in-woods” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|-------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                 | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 65708                                                                                                       | 388                      | 31                    | 121.6              | 1.00                       | 184.57                       | 12.05                      | 76,577          | 484,538                       | 197.62                     |
| 66075                                                                                                       | 100                      | 8                     | 133.7              | 1.00                       | 184.57                       | 12.10                      | 19,767          | 484,638                       | 197.67                     |
| 65646                                                                                                       | 3,288                    | 263                   | 124.4              | 1.00                       | 184.57                       | 12.11                      | 649,878         | 487,925                       | 197.68                     |
| 64854                                                                                                       | 5,563                    | 445                   | 129.2              | 1.00                       | 184.57                       | 12.15                      | 1,099,792       | 493,488                       | 197.72                     |
| 67363                                                                                                       | 175                      | 14                    | 126.5              | 1.00                       | 184.57                       | 12.16                      | 34,602          | 493,663                       | 197.73                     |
| 64842                                                                                                       | 88                       | 7                     | 125.4              | 1.00                       | 184.57                       | 12.28                      | 17,312          | 493,750                       | 197.85                     |
| 64867                                                                                                       | 6,588                    | 527                   | 133.5              | 1.00                       | 184.57                       | 12.29                      | 1,303,399       | 500,338                       | 197.86                     |
| 64861                                                                                                       | 338                      | 27                    | 132.3              | 1.00                       | 184.57                       | 12.52                      | 66,855          | 500,675                       | 198.09                     |
| 64750                                                                                                       | 38                       | 3                     | 137.2              | 1.00                       | 184.57                       | 12.57                      | 7,430           | 500,713                       | 198.14                     |
| 64856                                                                                                       | 8,963                    | 717                   | 136.4              | 1.00                       | 184.57                       | 12.57                      | 1,775,862       | 509,675                       | 198.14                     |
| 64863                                                                                                       | 1,200                    | 96                    | 137.3              | 1.00                       | 184.57                       | 12.75                      | 237,986         | 510,875                       | 198.32                     |
| 64783                                                                                                       | 200                      | 16                    | 137.2              | 1.00                       | 184.57                       | 12.87                      | 39,687          | 511,075                       | 198.43                     |
| 72768                                                                                                       | 238                      | 19                    | 138.9              | 1.00                       | 184.57                       | 12.89                      | 47,135          | 511,313                       | 198.46                     |
| 66056                                                                                                       | 175                      | 14                    | 142.8              | 1.00                       | 184.57                       | 13.01                      | 34,751          | 511,488                       | 198.58                     |
| 72714                                                                                                       | 238                      | 19                    | 147.5              | 1.00                       | 184.57                       | 13.21                      | 47,211          | 511,725                       | 198.78                     |
| 72715                                                                                                       | 350                      | 28                    | 145.8              | 1.00                       | 184.57                       | 13.24                      | 69,584          | 512,400                       | 198.81                     |
| 65769                                                                                                       | 675                      | 54                    | 140.7              | 1.00                       | 184.57                       | 13.24                      | 134,197         | 512,750                       | 198.81                     |
| 65738                                                                                                       | 175                      | 14                    | 148.0              | 1.00                       | 184.57                       | 13.27                      | 34,798          | 512,925                       | 198.84                     |
| 64744                                                                                                       | 1,063                    | 85                    | 143.9              | 1.00                       | 184.57                       | 13.30                      | 211,297         | 513,988                       | 198.87                     |
| 65612                                                                                                       | 163                      | 13                    | 148.1              | 1.00                       | 184.57                       | 13.38                      | 32,329          | 514,150                       | 198.95                     |
| 65635                                                                                                       | 188                      | 15                    | 139.4              | 1.00                       | 184.57                       | 13.54                      | 37,334          | 514,338                       | 199.11                     |
| 65705                                                                                                       | 8,300                    | 664                   | 152.3              | 1.00                       | 184.57                       | 13.59                      | 1,653,032       | 522,638                       | 199.16                     |
| 65802                                                                                                       | 1,413                    | 113                   | 155.0              | 1.00                       | 184.57                       | 13.61                      | 281,341         | 524,050                       | 199.18                     |
| 65604                                                                                                       | 463                      | 37                    | 153.3              | 1.00                       | 184.57                       | 13.70                      | 92,161          | 524,513                       | 199.27                     |
| 65647                                                                                                       | 2,488                    | 199                   | 148.1              | 1.00                       | 184.57                       | 13.74                      | 495,779         | 527,000                       | 199.31                     |
| 65734                                                                                                       | 288                      | 23                    | 145.3              | 1.00                       | 184.57                       | 13.83                      | 57,326          | 527,288                       | 199.40                     |

Table 11. Supply ZCTAs for “in-woods” hardwood logging residues in KS (demand ZCTA 66760, Cherokee County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 72736       | 650                      | 52                    | 152.8              | 1.00                       | 184.57                       | 13.92                      | 129,667         | 527,938                       | 199.49                     |
| 65785       | 2,188                    | 175                   | 148.8              | 1.00                       | 184.57                       | 13.94                      | 436,419         | 530,125                       | 199.51                     |
| 65610       | 363                      | 29                    | 157.4              | 1.00                       | 184.57                       | 13.99                      | 72,341          | 530,488                       | 199.56                     |
| 67301       | 17,063                   | 1,365                 | 150.8              | 1.00                       | 184.57                       | 14.06                      | 3,406,269       | 530,525                       | 199.63                     |
| 65601       | 38                       | 3                     | 150.9              | 1.00                       | 184.57                       | 14.06                      | 7,486           | 547,588                       | 199.63                     |
| 65649       | 113                      | 9                     | 157.3              | 1.00                       | 184.57                       | 14.63                      | 22,522          | 547,700                       | 200.20                     |

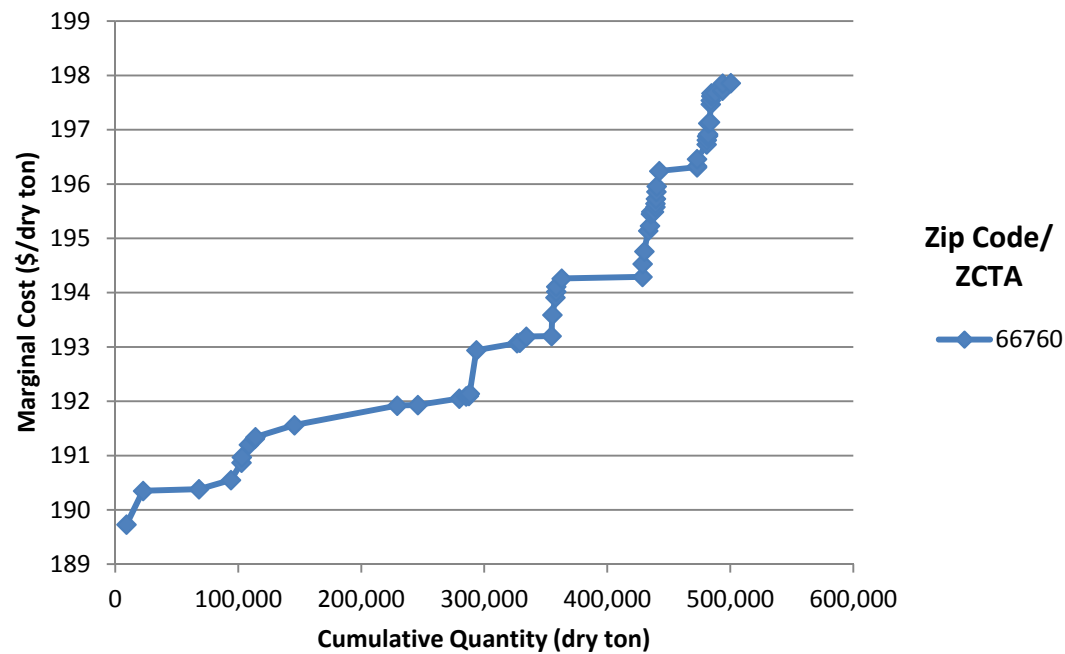


Figure 26. Marginal cost curve for “in-woods” hardwood logging residues in KS (ZCTA 66760, Cherokee County).

### 3.3 Merchantable Trees or ‘Roundwood’

The merchantable trees<sup>14</sup> (‘roundwood’) categories for pulpwood and sawtimber included in the KS BioSAT model were: mixed natural softwood and hardwood, natural softwood, pine plantation, and upland and lowland hardwood. For illustration purposes, the maximum quantity available in a sourcing area and the associated total cost (TC), average total cost per dry ton (ATC), and median marginal cost (MC) in \$/dry ton were estimated for upland and lowland hardwood, and mixed natural hardwood and softwood pulpwood as well as for upland and lowland hardwood sawtimber. The sourcing areas were constructed using a maximum 80 mile one-way truck haul distance with long-log trailers for all but upland hardwood pulpwood removals categories. Since there is not enough quantities present 120-mile one-way truck haul distance was used for upland hardwood pulpwood removals. Kansas State does not have any sourcing areas with sufficient quantity of fifty thousand dry tons for the pine plantation pulpwood removals and therefore they are not presented in the discussion below. More details for all possible categories and combinations of harvesting and haul distance scenarios are available on the website.

#### 3.3.1 Pulpwood

##### 3.3.1.1 Upland Hardwood

###### 3.3.1.1.1 Net Growth

The top ten ZCTA locations for upland hardwood pulpwood net growth<sup>15</sup> were all located in south-east Kansas (Figure 27). Hundred fifty thousand dry tons of upland hardwood pulpwood net growth are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$83.95 to \$86.02/dry ton. The median MC ranged from \$83.88 to \$86.03/dry ton (Table 12, Figure 28).

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<sup>14</sup> Trees of high enough quality to be sold as pulpwood or sawtimber.

<sup>15</sup> Gross growth (average annual change in volume of merchantable size trees on timberland in dry tons) minus mortality, where mortality is the average annual death of merchantable size trees on timberland in dry tons.

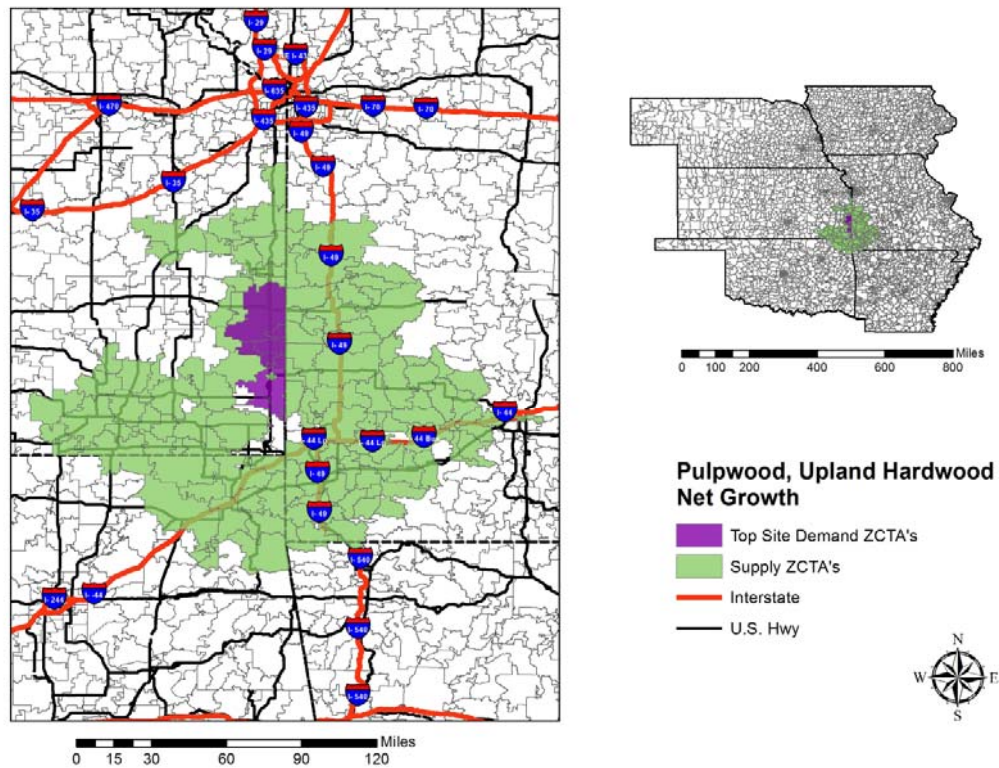


Figure 27. Least cost sourcing areas for upland hardwood pulpwood net growth in KS.

Table 12. Top ten locations in KS for upland hardwood pulpwood net growth based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66701                 | Bourbon  | 152,550                  | 12,806,092      | 15,061      | 59                    | 83.95                     | 83.88                             |
| 66711                 | Bourbon  | 153,450                  | 12,972,072      | 15,293      | 72                    | 84.54                     | 84.38                             |
| 66741                 | Bourbon  | 156,850                  | 13,272,344      | 15,055      | 69                    | 84.62                     | 84.28                             |
| 66735                 | Crawford | 153,513                  | 13,014,569      | 16,524      | 91                    | 84.78                     | 85.13                             |
| 66712                 | Crawford | 153,913                  | 13,072,014      | 15,363      | 84                    | 84.93                     | 85.08                             |
| 66756                 | Crawford | 156,275                  | 13,314,575      | 16,004      | 84                    | 85.20                     | 85.23                             |
| 66762                 | Cherokee | 156,450                  | 13,360,738      | 14,445      | 100                   | 85.40                     | 85.22                             |
| 66728                 | Cherokee | 150,075                  | 12,888,867      | 12,060      | 118                   | 85.88                     | 86.03                             |
| 66734                 | Crawford | 163,800                  | 14,083,992      | 14,563      | 79                    | 85.98                     | 85.95                             |
| 66781                 | Cherokee | 158,500                  | 13,634,186      | 12,791      | 108                   | 86.02                     | 85.67                             |



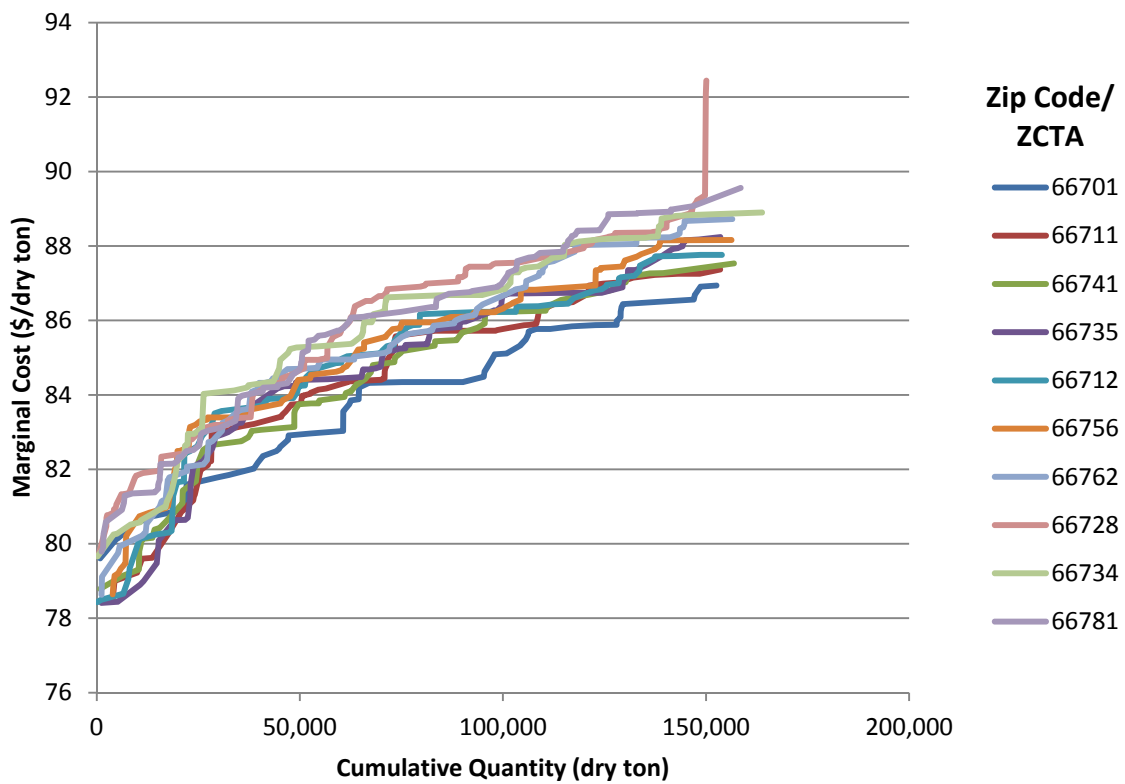


Figure 28. Marginal cost curves for the top ten locations for upland hardwood pulpwood net growth in KS.

Demand ZCTA 66701 (Bourbon County, KS) has the least average total costs per dry ton of upland hardwood pulpwood net growth (Figure 29). Hundred fifty thousand dry tons of upland hardwood pulpwood net growth are available within 80 mile radius from ZCTA 66701. The median MC per dry ton in the least cost sourcing area (ZCTA 66701, Bourbon County, KS) ranged from \$79.61 to \$86.94/dry ton (Table 13, Figure 30).

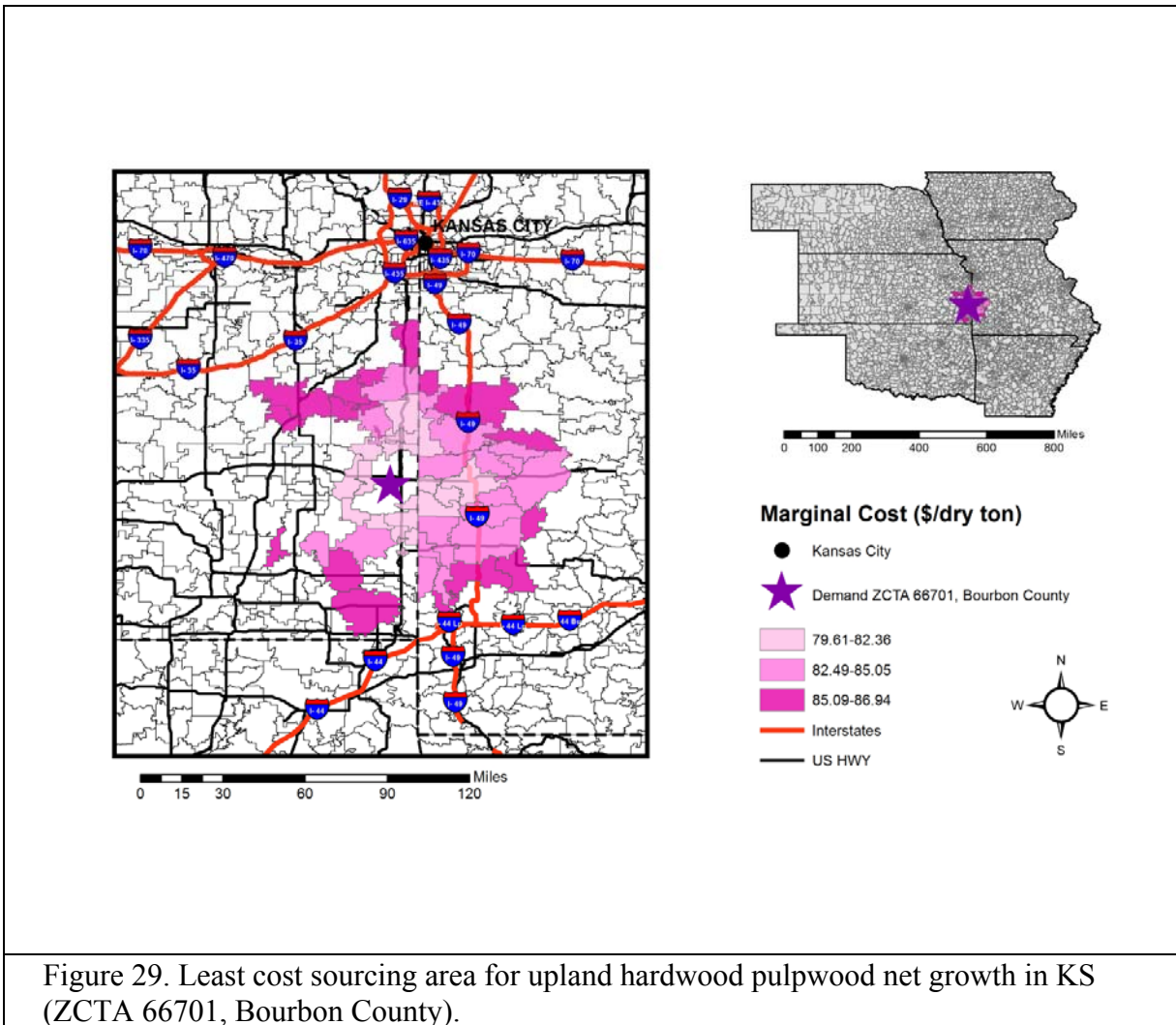


Figure 29. Least cost sourcing area for upland hardwood pulpwood net growth in KS (ZCTA 66701, Bourbon County).

| Table 13. Supply ZCTAs for upland hardwood pulpwood net growth in KS (demand ZCTA 66701, Bourbon County). |                                    |                             |                          |                                     |                                    |                                  |                    |                                     |                               |
|-----------------------------------------------------------------------------------------------------------|------------------------------------|-----------------------------|--------------------------|-------------------------------------|------------------------------------|----------------------------------|--------------------|-------------------------------------|-------------------------------|
| Suppl<br>y<br>ZCTA                                                                                        | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost<br>(\$/dry<br>ton) | Harvesting<br>Cost<br>(\$/dry ton) | Trucking<br>Cost<br>(\$/dry ton) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal Cost<br>(\$/dry ton) |
| 66711                                                                                                     | 863                                | 69                          | 26.7                     | 28.78                               | 45.58                              | 5.25                             | 68,664             | 863                                 | 79.61                         |
| 66712                                                                                                     | 3,938                              | 315                         | 34.5                     | 28.78                               | 45.58                              | 5.76                             | 315,483            | 4,800                               | 80.12                         |
| 66769                                                                                                     | 475                                | 38                          | 27.5                     | 28.78                               | 45.58                              | 5.78                             | 38,069             | 5,275                               | 80.15                         |
| 66741                                                                                                     | 313                                | 25                          | 31.8                     | 28.78                               | 45.58                              | 5.82                             | 25,057             | 5,588                               | 80.18                         |
| 66734                                                                                                     | 3,988                              | 319                         | 36.6                     | 28.78                               | 45.58                              | 6.21                             | 321,290            | 9,575                               | 80.57                         |
| 66767                                                                                                     | 1,400                              | 112                         | 41.3                     | 28.78                               | 45.58                              | 6.24                             | 112,848            | 10,975                              | 80.61                         |
| 64741                                                                                                     | 100                                | 8                           | 36.8                     | 28.78                               | 45.58                              | 6.25                             | 8,061              | 11,075                              | 80.61                         |
| 66735                                                                                                     | 138                                | 11                          | 42.8                     | 28.78                               | 45.58                              | 6.27                             | 11,087             | 11,213                              | 80.63                         |
| 64728                                                                                                     | 575                                | 46                          | 38.6                     | 28.78                               | 45.58                              | 6.35                             | 46,411             | 11,788                              | 80.72                         |
| 66738                                                                                                     | 1,663                              | 133                         | 39.9                     | 28.78                               | 45.58                              | 6.37                             | 134,222            | 13,450                              | 80.73                         |
| 66756                                                                                                     | 5,563                              | 445                         | 42.1                     | 28.78                               | 45.58                              | 6.49                             | 449,768            | 19,013                              | 80.86                         |
| 64771                                                                                                     | 1,688                              | 135                         | 39.5                     | 28.78                               | 45.58                              | 6.53                             | 136,501            | 20,700                              | 80.89                         |
| 66763                                                                                                     | 1,200                              | 96                          | 51.0                     | 28.78                               | 45.58                              | 6.87                             | 97,483             | 21,900                              | 81.24                         |
| 66746                                                                                                     | 225                                | 18                          | 46.1                     | 28.78                               | 45.58                              | 7.23                             | 18,358             | 22,125                              | 81.59                         |
| 64772                                                                                                     | 7,463                              | 597                         | 51.2                     | 28.78                               | 45.58                              | 7.42                             | 610,297            | 29,588                              | 81.78                         |
| 66754                                                                                                     | 2,975                              | 238                         | 51.4                     | 28.78                               | 45.58                              | 7.49                             | 243,505            | 32,563                              | 81.85                         |
| 66075                                                                                                     | 6,150                              | 492                         | 62.3                     | 28.78                               | 45.58                              | 7.66                             | 504,441            | 38,713                              | 82.02                         |
| 66779                                                                                                     | 888                                | 71                          | 57.2                     | 28.78                               | 45.58                              | 7.81                             | 72,928             | 39,600                              | 82.17                         |
| 64752                                                                                                     | 1,388                              | 111                         | 60.8                     | 28.78                               | 45.58                              | 8.00                             | 114,279            | 40,988                              | 82.36                         |
| 66743                                                                                                     | 3,213                              | 257                         | 65.6                     | 28.78                               | 45.58                              | 8.13                             | 265,015            | 44,200                              | 82.49                         |
| 64762                                                                                                     | 663                                | 53                          | 58.0                     | 28.78                               | 45.58                              | 8.19                             | 54,690             | 44,863                              | 82.55                         |
| 64778                                                                                                     | 313                                | 25                          | 61.5                     | 28.78                               | 45.58                              | 8.24                             | 25,812             | 45,175                              | 82.60                         |
| 64790                                                                                                     | 1,913                              | 153                         | 68.3                     | 28.78                               | 45.58                              | 8.43                             | 158,344            | 47,088                              | 82.79                         |
| 64769                                                                                                     | 163                                | 13                          | 69.8                     | 28.78                               | 45.58                              | 8.55                             | 13,473             | 47,250                              | 82.91                         |
| 66056                                                                                                     | 5,263                              | 421                         | 71.4                     | 28.78                               | 45.58                              | 8.60                             | 436,599            | 52,513                              | 82.96                         |

Table 13. Supply ZCTAs for upland hardwood pulpwood net growth in KS (demand ZCTA 66701, Bourbon County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64767       | 8,163                    | 653                   | 69.1               | 28.78                      | 45.58                        | 8.66                       | 677,705         | 60,675                        | 83.03                      |
| 64745       | 38                       | 3                     | 77.3               | 28.78                      | 45.58                        | 9.20                       | 3,134           | 60,713                        | 83.56                      |
| 64784       | 1,463                    | 117                   | 75.8               | 28.78                      | 45.58                        | 9.39                       | 122,483         | 62,175                        | 83.75                      |
| 64832       | 388                      | 31                    | 86.0               | 28.78                      | 45.58                        | 9.49                       | 32,492          | 62,563                        | 83.85                      |
| 64722       | 1,938                    | 155                   | 84.5               | 28.78                      | 45.58                        | 9.52                       | 162,516         | 64,500                        | 83.88                      |
| 64750       | 113                      | 9                     | 88.9               | 28.78                      | 45.58                        | 9.84                       | 9,473           | 64,613                        | 84.20                      |
| 64759       | 2,325                    | 186                   | 85.7               | 28.78                      | 45.58                        | 9.96                       | 196,045         | 66,938                        | 84.32                      |
| 66040       | 14,838                   | 1,187                 | 91.6               | 28.78                      | 45.58                        | 9.98                       | 1,251,441       | 81,775                        | 84.34                      |
| 64779       | 8,263                    | 661                   | 89.5               | 28.78                      | 45.58                        | 9.98                       | 696,896         | 90,038                        | 84.34                      |
| 64783       | 5,275                    | 422                   | 89.0               | 28.78                      | 45.58                        | 10.13                      | 445,710         | 95,313                        | 84.49                      |
| 66771       | 125                      | 10                    | 96.5               | 28.78                      | 45.58                        | 10.25                      | 10,577          | 95,438                        | 84.62                      |
| 64744       | 1,838                    | 147                   | 95.6               | 28.78                      | 45.58                        | 10.59                      | 156,099         | 97,275                        | 84.95                      |
| 64855       | 488                      | 39                    | 102.0              | 28.78                      | 45.58                        | 10.69                      | 41,461          | 97,763                        | 85.05                      |
| 66753       | 225                      | 18                    | 99.1               | 28.78                      | 45.58                        | 10.73                      | 19,146          | 97,988                        | 85.09                      |
| 64723       | 2,913                    | 233                   | 101.1              | 28.78                      | 45.58                        | 10.75                      | 247,894         | 100,900                       | 85.11                      |
| 66014       | 3,288                    | 263                   | 95.6               | 28.78                      | 45.58                        | 10.95                      | 280,479         | 104,188                       | 85.32                      |
| 64756       | 1,438                    | 115                   | 100.5              | 28.78                      | 45.58                        | 11.13                      | 122,892         | 105,625                       | 85.49                      |
| 66725       | 550                      | 44                    | 112.8              | 28.78                      | 45.58                        | 11.25                      | 47,088          | 106,175                       | 85.61                      |
| 64849       | 25                       | 2                     | 105.8              | 28.78                      | 45.58                        | 11.26                      | 2,141           | 106,200                       | 85.62                      |
| 64830       | 138                      | 11                    | 111.8              | 28.78                      | 45.58                        | 11.33                      | 11,783          | 106,338                       | 85.70                      |
| 66026       | 3,513                    | 281                   | 109.1              | 28.78                      | 45.58                        | 11.41                      | 301,284         | 108,188                       | 85.77                      |
| 64870       | 1,850                    | 148                   | 111.7              | 28.78                      | 45.58                        | 11.41                      | 158,674         | 111,700                       | 85.77                      |
| 64780       | 5,288                    | 423                   | 110.3              | 28.78                      | 45.58                        | 11.48                      | 453,893         | 116,988                       | 85.84                      |
| 66072       | 5,763                    | 461                   | 106.6              | 28.78                      | 45.58                        | 11.51                      | 494,839         | 122,750                       | 85.87                      |
| 66053       | 5,250                    | 420                   | 117.5              | 28.78                      | 45.58                        | 11.51                      | 450,851         | 128,000                       | 85.88                      |

Table 13. Supply ZCTAs for upland hardwood pulpwood net growth in KS (demand ZCTA 66701, Bourbon County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64857       | 25                       | 2                     | 115.6              | 28.78                      | 45.58                        | 11.63                      | 2,150           | 128,025                       | 85.99                      |
| 64755       | 938                      | 75                    | 116.8              | 28.78                      | 45.58                        | 11.72                      | 80,705          | 128,963                       | 86.09                      |
| 66740       | 63                       | 5                     | 118.4              | 28.78                      | 45.58                        | 11.89                      | 5,391           | 129,025                       | 86.25                      |
| 64835       | 125                      | 10                    | 119.6              | 28.78                      | 45.58                        | 11.98                      | 10,793          | 129,150                       | 86.35                      |
| 64748       | 413                      | 33                    | 122.5              | 28.78                      | 45.58                        | 12.08                      | 35,656          | 129,563                       | 86.44                      |
| 64781       | 17,425                   | 1,394                 | 120.7              | 28.78                      | 45.58                        | 12.19                      | 1,508,231       | 146,988                       | 86.56                      |
| 64841       | 13                       | 1                     | 125.0              | 28.78                      | 45.58                        | 12.27                      | 1,083           | 147,000                       | 86.63                      |
| 66091       | 263                      | 21                    | 125.3              | 28.78                      | 45.58                        | 12.32                      | 22,755          | 147,263                       | 86.69                      |
| 66032       | 1,375                    | 110                   | 125.7              | 28.78                      | 45.58                        | 12.55                      | 119,502         | 148,638                       | 86.91                      |
| 64730       | 3,925                    | 314                   | 124.9              | 28.78                      | 45.58                        | 12.58                      | 341,233         | 152,563                       | 86.94                      |
| 66013       | 250                      | 20                    | 135.9              | 28.78                      | 45.58                        | 12.64                      | 21,751          | 152,813                       | 87.00                      |
| 64720       | 225                      | 18                    | 128.3              | 28.78                      | 45.58                        | 12.75                      | 19,601          | 153,038                       | 87.12                      |
| 66064       | 713                      | 57                    | 127.3              | 28.78                      | 45.58                        | 12.76                      | 62,077          | 153,750                       | 87.13                      |
| 74360       | 25                       | 2                     | 132.9              | 28.78                      | 45.58                        | 12.80                      | 2,179           | 153,775                       | 87.16                      |
| 64836       | 1,450                    | 116                   | 133.0              | 28.78                      | 45.58                        | 12.87                      | 126,490         | 155,225                       | 87.23                      |
| 64742       | 150                      | 12                    | 132.0              | 28.78                      | 45.58                        | 12.89                      | 13,088          | 155,375                       | 87.25                      |
| 66776       | 388                      | 31                    | 132.0              | 28.78                      | 45.58                        | 13.01                      | 33,857          | 155,763                       | 87.37                      |
| 64738       | 838                      | 67                    | 130.5              | 28.78                      | 45.58                        | 13.07                      | 73,225          | 156,600                       | 87.43                      |
| 74363       | 1,263                    | 101                   | 129.9              | 28.78                      | 45.58                        | 13.15                      | 110,483         | 157,863                       | 87.51                      |
| 64804       | 1,713                    | 137                   | 142.0              | 28.78                      | 45.58                        | 13.18                      | 149,917         | 159,575                       | 87.54                      |
| 64746       | 75                       | 6                     | 138.0              | 28.78                      | 45.58                        | 13.28                      | 6,573           | 159,650                       | 87.64                      |
| 67357       | 388                      | 31                    | 135.4              | 28.78                      | 45.58                        | 13.34                      | 33,983          | 160,038                       | 87.70                      |
| 65603       | 150                      | 12                    | 131.6              | 28.78                      | 45.58                        | 13.34                      | 13,155          | 160,188                       | 87.70                      |
| 64734       | 125                      | 10                    | 140.0              | 28.78                      | 45.58                        | 13.36                      | 10,965          | 160,313                       | 87.72                      |
| 64725       | 75                       | 6                     | 139.6              | 28.78                      | 45.58                        | 13.37                      | 6,580           | 160,388                       | 87.73                      |

Table 13. Supply ZCTAs for upland hardwood pulpwood net growth in KS (demand ZCTA 66701, Bourbon County).

| Suppl<br>y<br>ZCTA | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost<br>(\$/dry<br>ton) | Harvesting<br>Cost<br>(\$/dry ton) | Trucking<br>Cost<br>(\$/dry ton) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal Cost<br>(\$/dry ton) |
|--------------------|------------------------------------|-----------------------------|--------------------------|-------------------------------------|------------------------------------|----------------------------------|--------------------|-------------------------------------|-------------------------------|
| 66071              | 1,738                              | 139                         | 147.6                    | 28.78                               | 45.58                              | 13.51                            | 152,680            | 162,125                             | 87.87                         |
| 66042              | 300                                | 24                          | 134.9                    | 28.78                               | 45.58                              | 13.54                            | 26,369             | 162,425                             | 87.90                         |
| 67356              | 400                                | 32                          | 145.8                    | 28.78                               | 45.58                              | 13.60                            | 35,185             | 162,825                             | 87.96                         |
| 67336              | 350                                | 28                          | 147.5                    | 28.78                               | 45.58                              | 13.64                            | 30,802             | 163,175                             | 88.01                         |
| 66080              | 213                                | 17                          | 142.4                    | 28.78                               | 45.58                              | 13.70                            | 18,712             | 163,388                             | 88.06                         |
| 65682              | 1,438                              | 115                         | 142.4                    | 28.78                               | 45.58                              | 13.71                            | 126,601            | 164,825                             | 88.07                         |
| 74354              | 1,663                              | 133                         | 143.4                    | 28.78                               | 45.58                              | 13.72                            | 146,432            | 166,488                             | 88.08                         |
| 66033              | 375                                | 30                          | 143.7                    | 28.78                               | 45.58                              | 13.76                            | 33,046             | 168,300                             | 88.12                         |
| 65785              | 1,813                              | 145                         | 140.5                    | 28.78                               | 45.58                              | 13.76                            | 159,719            | 168,675                             | 88.12                         |
| 66083              | 950                                | 76                          | 152.9                    | 28.78                               | 45.58                              | 13.84                            | 83,789             | 169,625                             | 88.20                         |
| 66710              | 38                                 | 3                           | 146.8                    | 28.78                               | 45.58                              | 13.99                            | 3,313              | 169,663                             | 88.35                         |
| 64840              | 500                                | 40                          | 148.3                    | 28.78                               | 45.58                              | 14.00                            | 44,181             | 170,163                             | 88.36                         |
| 66093              | 25                                 | 2                           | 140.3                    | 28.78                               | 45.58                              | 14.01                            | 2,209              | 170,188                             | 88.37                         |
| 65674              | 938                                | 75                          | 149.6                    | 28.78                               | 45.58                              | 14.13                            | 82,965             | 171,125                             | 88.50                         |
| 65774              | 1,800                              | 144                         | 146.3                    | 28.78                               | 45.58                              | 14.17                            | 159,363            | 172,925                             | 88.54                         |
| 67341              | 50                                 | 4                           | 149.1                    | 28.78                               | 45.58                              | 14.21                            | 4,429              | 172,975                             | 88.57                         |
| 66714              | 13                                 | 1                           | 158.1                    | 28.78                               | 45.58                              | 14.25                            | 1,108              | 172,988                             | 88.61                         |
| 64850              | 3,488                              | 279                         | 152.3                    | 28.78                               | 45.58                              | 14.26                            | 309,074            | 176,475                             | 88.62                         |
| 64859              | 3,850                              | 308                         | 153.0                    | 28.78                               | 45.58                              | 14.29                            | 341,303            | 180,325                             | 88.65                         |
| 66078              | 475                                | 38                          | 153.1                    | 28.78                               | 45.58                              | 14.62                            | 42,265             | 180,800                             | 88.98                         |
| 65661              | 5,088                              | 407                         | 153.4                    | 28.78                               | 45.58                              | 14.64                            | 452,821            | 185,888                             | 89.01                         |
| 64078              | 100                                | 8                           | 159.7                    | 28.78                               | 45.58                              | 14.66                            | 8,902              | 185,988                             | 89.02                         |
| 66079              | 463                                | 37                          | 156.0                    | 28.78                               | 45.58                              | 14.67                            | 41,175             | 186,450                             | 89.03                         |
| 65752              | 38                                 | 3                           | 158.9                    | 28.78                               | 45.58                              | 14.97                            | 3,350              | 186,488                             | 89.33                         |
| 65635              | 275                                | 22                          | 152.7                    | 28.78                               | 45.58                              | 15.02                            | 24,581             | 186,763                             | 89.39                         |

| Table 13. Supply ZCTAs for upland hardwood pulpwood net growth in KS (demand ZCTA 66701, Bourbon County). |                                   |                             |                          |                                     |                                    |                                  |                    |                                     |                               |
|-----------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------|--------------------------|-------------------------------------|------------------------------------|----------------------------------|--------------------|-------------------------------------|-------------------------------|
| Supply<br>ZCTA                                                                                            | Total<br>Quantity<br>(dry<br>ton) | Number<br>of Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost<br>(\$/dry<br>ton) | Harvesting<br>Cost<br>(\$/dry ton) | Trucking<br>Cost<br>(\$/dry ton) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal Cost<br>(\$/dry ton) |
| 65649                                                                                                     | 500                               | 40                          | 158.5                    | 28.78                               | 45.58                              | 15.20                            | 44,783             | 187,263                             | 89.57                         |

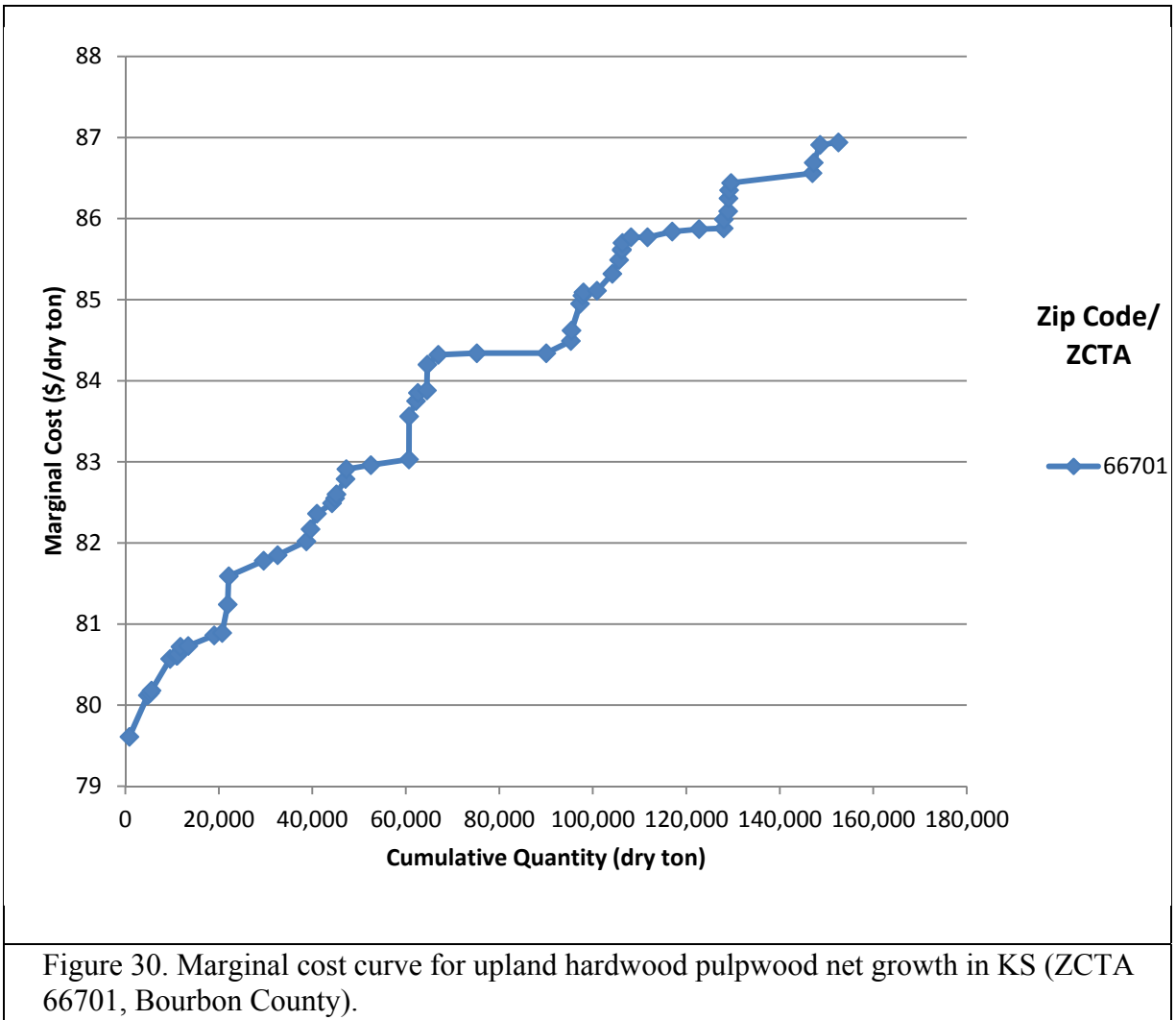
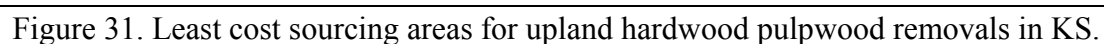


Figure 30. Marginal cost curve for upland hardwood pulpwood net growth in KS (ZCTA 66701, Bourbon County).



The top ten ZCTA locations for upland hardwood pulpwood removals<sup>16</sup> were all located in south-east Kansas (Figure 31). Hundred thousand dry tons of upland hardwood pulpwood removals are available within 120 miles radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$91.14 to \$93.22/dry ton. The median MC ranged from \$90.95 to \$92.95/dry ton (Table 14, Figure 32).



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Table 14. Top nine locations in KS for upland hardwood pulpwood removals based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66770                 | Cherokee | 100,213                  | 9,133,086       | 12,123      | 44                    | 91.14                     | 91.08                             |
| 66713                 | Cherokee | 102,138                  | 9,313,442       | 11,557      | 43                    | 91.19                     | 90.95                             |
| 66728                 | Cherokee | 104,100                  | 9,521,017       | 11,922      | 46                    | 91.46                     | 91.18                             |
| 66739                 | Cherokee | 104,100                  | 9,535,532       | 11,930      | 46                    | 91.60                     | 91.31                             |
| 66760                 | Cherokee | 101,775                  | 9,333,420       | 8,768       | 51                    | 91.71                     | 91.17                             |
| 66778                 | Cherokee | 114,763                  | 10,546,248      | 11,177      | 44                    | 91.90                     | 91.55                             |
| 66781                 | Cherokee | 100,175                  | 9,249,845       | 8,049       | 57                    | 92.34                     | 92.36                             |
| 66773                 | Cherokee | 103,350                  | 9,627,733       | 8,562       | 48                    | 93.16                     | 92.12                             |
| 67336                 | Labette  | 103,100                  | 9,611,243       | 8,248       | 50                    | 93.22                     | 92.95                             |

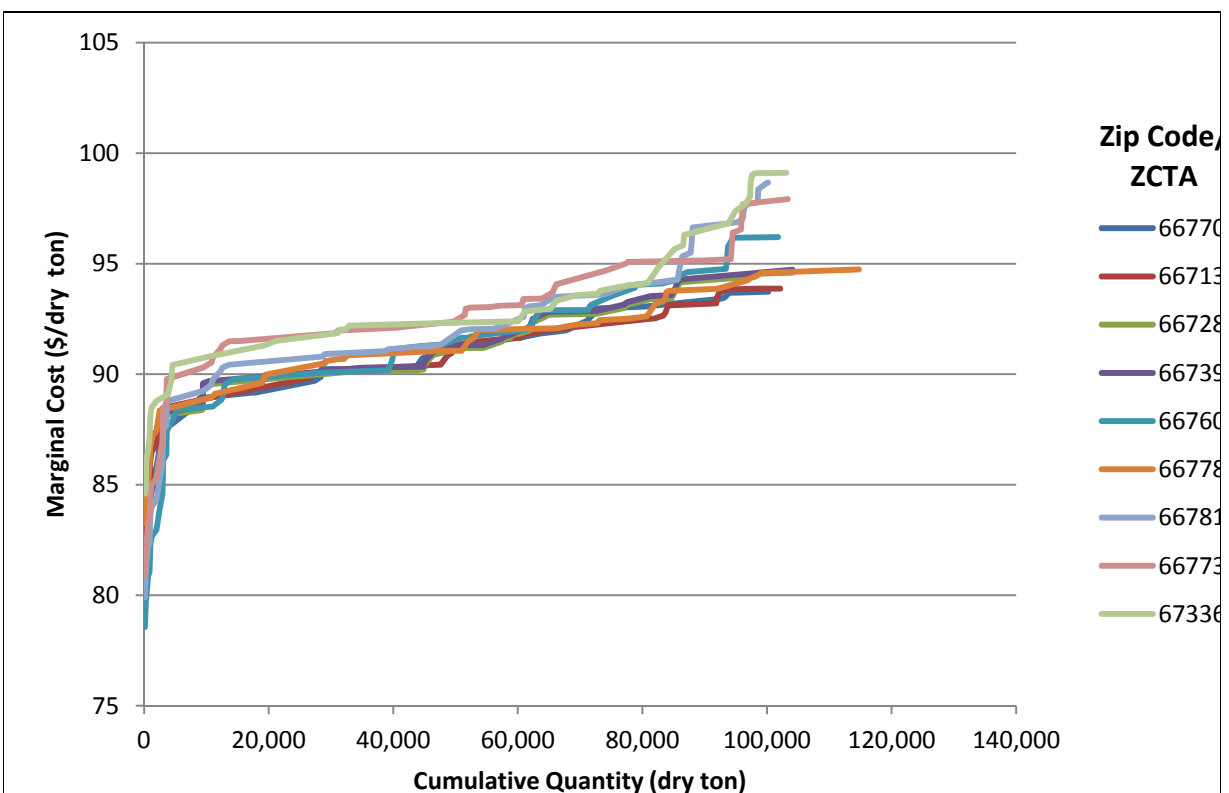


Figure 32. Marginal cost curves for the top nine locations for upland hardwood pulpwood removals in KS.

Demand ZCTA 66770 (Cherokee County, KS) has the least average total costs per dry ton of upland hardwood pulpwood removals (Figure 33). Hundred thousand dry tons of upland hardwood pulpwood removals are available within 120 miles radius from ZCTA 66770. The median MC per dry ton in the least cost sourcing area (ZCTA 66770, Cherokee County, KS) ranged from \$81.54 to \$93.73/dry ton (Table 15, Figure 34).

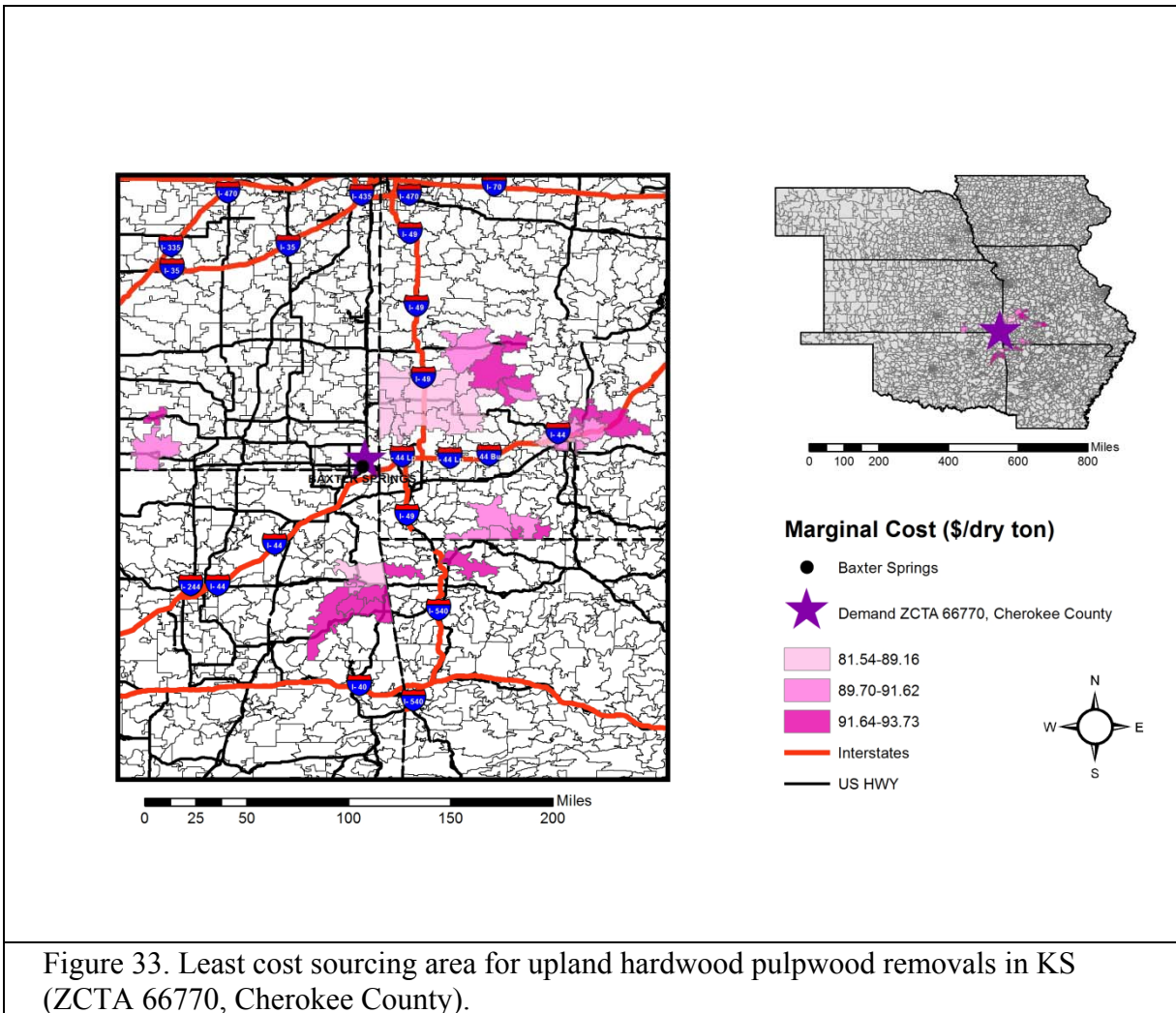


Figure 33. Least cost sourcing area for upland hardwood pulpwood removals in KS (ZCTA 66770, Cherokee County).

| Table 15. Supply ZCTAs for upland hardwood pulpwood removals in KS (demand ZCTA 66770, Cherokee County). |                                    |                                |                          |                       |                         |                       |                    |                                     |                                  |
|----------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------|--------------------------|-----------------------|-------------------------|-----------------------|--------------------|-------------------------------------|----------------------------------|
| Suppl<br>y<br>ZCTA                                                                                       | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of<br>Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost (\$) | Harvesting<br>Cost (\$) | Trucking Cost<br>(\$) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal<br>Cost<br>(\$/dry ton) |
| 64855                                                                                                    | 163                                | 13                             | 52.8                     | 35                    | 56                      | 9                     | 13,251             | 163                                 | 81.54                            |
| 64832                                                                                                    | 125                                | 10                             | 56.6                     | 35                    | 56                      | 9                     | 10,215             | 288                                 | 81.72                            |
| 64769                                                                                                    | 50                                 | 4                              | 70.1                     | 35                    | 55                      | 11                    | 4,155              | 338                                 | 83.10                            |
| 64755                                                                                                    | 313                                | 25                             | 82.0                     | 34                    | 55                      | 11                    | 26,117             | 650                                 | 83.58                            |
| 64762                                                                                                    | 225                                | 18                             | 87.5                     | 34                    | 54                      | 12                    | 18,932             | 875                                 | 84.14                            |
| 64748                                                                                                    | 138                                | 11                             | 103.7                    | 34                    | 54                      | 13                    | 11,691             | 1,013                               | 85.02                            |
| 64728                                                                                                    | 188                                | 15                             | 111.6                    | 34                    | 53                      | 13                    | 16,019             | 1,200                               | 85.44                            |
| 64759                                                                                                    | 788                                | 63                             | 112.4                    | 34                    | 53                      | 13                    | 67,536             | 1,988                               | 85.76                            |
| 65682                                                                                                    | 488                                | 39                             | 123.6                    | 33                    | 53                      | 14                    | 42,244             | 2,475                               | 86.65                            |
| 64784                                                                                                    | 500                                | 40                             | 135.3                    | 33                    | 52                      | 15                    | 43,712             | 2,975                               | 87.42                            |
| 65802                                                                                                    | 5,813                              | 465                            | 162.2                    | 32                    | 51                      | 16                    | 515,520            | 8,788                               | 88.69                            |
| 65603                                                                                                    | 113                                | 9                              | 155.2                    | 32                    | 51                      | 16                    | 10,004             | 8,900                               | 88.92                            |
| 64756                                                                                                    | 488                                | 39                             | 160.0                    | 32                    | 51                      | 17                    | 43,468             | 17,300                              | 89.16                            |
| 74338                                                                                                    | 8,400                              | 672                            | 155.8                    | 32                    | 51                      | 17                    | 748,942            | 17,788                              | 89.16                            |
| 65625                                                                                                    | 9,550                              | 764                            | 163.8                    | 32                    | 51                      | 17                    | 856,629            | 27,338                              | 89.70                            |
| 65807                                                                                                    | 1,063                              | 85                             | 177.9                    | 32                    | 51                      | 17                    | 95,507             | 28,400                              | 89.89                            |
| 64750                                                                                                    | 75                                 | 6                              | 178.3                    | 32                    | 51                      | 18                    | 6,767              | 28,475                              | 90.23                            |
| 65803                                                                                                    | 15,025                             | 1202                           | 181.4                    | 32                    | 51                      | 18                    | 1,356,034          | 43,500                              | 90.25                            |
| 65641                                                                                                    | 1,075                              | 86                             | 177.2                    | 32                    | 50                      | 18                    | 97,503             | 44,575                              | 90.70                            |
| 65745                                                                                                    | 675                                | 54                             | 186.0                    | 32                    | 50                      | 18                    | 61,295             | 45,250                              | 90.81                            |
| 74347                                                                                                    | 1,813                              | 145                            | 177.5                    | 32                    | 50                      | 18                    | 164,862            | 47,063                              | 90.96                            |
| 64744                                                                                                    | 1,363                              | 109                            | 185.0                    | 32                    | 50                      | 18                    | 123,962            | 48,425                              | 90.98                            |
| 65747                                                                                                    | 963                                | 77                             | 190.5                    | 32                    | 50                      | 18                    | 87,761             | 49,388                              | 91.18                            |
| 74359                                                                                                    | 513                                | 41                             | 185.7                    | 32                    | 50                      | 19                    | 46,808             | 49,900                              | 91.33                            |
| 65809                                                                                                    | 3,263                              | 261                            | 200.1                    | 31                    | 50                      | 19                    | 298,319            | 53,163                              | 91.44                            |

Table 15. Supply ZCTAs for upland hardwood pulpwood removals in KS (demand ZCTA 66770, Cherokee County).

| Suppl<br>y<br>ZCTA | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of<br>Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost (\$) | Harvesting<br>Cost (\$) | Trucking Cost<br>(\$) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal<br>Cost<br>(\$/dry ton) |
|--------------------|------------------------------------|--------------------------------|--------------------------|-----------------------|-------------------------|-----------------------|--------------------|-------------------------------------|----------------------------------|
| 65757              | 3,513                              | 281                            | 202.6                    | 31                    | 50                      | 19                    | 321,443            | 56,675                              | 91.51                            |
| 67361              | 1,863                              | 149                            | 184.6                    | 31                    | 50                      | 19                    | 170,584            | 58,538                              | 91.59                            |
| 65601              | 225                                | 18                             | 197.7                    | 31                    | 50                      | 19                    | 20,614             | 58,763                              | 91.62                            |
| 65785              | 1,338                              | 107                            | 189.9                    | 31                    | 50                      | 19                    | 122,564            | 60,100                              | 91.64                            |
| 65648              | 2,975                              | 238                            | 204.4                    | 31                    | 50                      | 19                    | 273,144            | 63,075                              | 91.81                            |
| 65635              | 200                                | 16                             | 194.3                    | 31                    | 50                      | 19                    | 18,365             | 63,275                              | 91.83                            |
| 74965              | 4,413                              | 353                            | 190.6                    | 31                    | 50                      | 19                    | 405,870            | 67,688                              | 91.98                            |
| 74964              | 3,375                              | 270                            | 196.7                    | 31                    | 49                      | 20                    | 311,875            | 71,063                              | 92.41                            |
| 64781              | 625                                | 50                             | 210.0                    | 31                    | 49                      | 20                    | 57,866             | 71,688                              | 92.59                            |
| 65658              | 338                                | 27                             | 202.5                    | 31                    | 49                      | 20                    | 31,278             | 72,025                              | 92.68                            |
| 67345              | 225                                | 18                             | 215.9                    | 31                    | 49                      | 20                    | 20,905             | 72,250                              | 92.91                            |
| 65649              | 363                                | 29                             | 212.1                    | 31                    | 49                      | 20                    | 33,703             | 72,613                              | 92.97                            |
| 65706              | 7,763                              | 621                            | 224.9                    | 31                    | 49                      | 20                    | 722,408            | 80,375                              | 93.06                            |
| 74464              | 12,125                             | 970                            | 225.0                    | 31                    | 49                      | 20                    | 1,132,630          | 92,500                              | 93.41                            |
| 64738              | 625                                | 50                             | 219.8                    | 31                    | 49                      | 20                    | 58,414             | 93,125                              | 93.46                            |
| 72734              | 288                                | 23                             | 159.8                    | 31                    | 53                      | 16                    | 26,890             | 93,413                              | 93.53                            |
| 72756              | 1,325                              | 106                            | 165.6                    | 31                    | 53                      | 16                    | 124,138            | 94,738                              | 93.69                            |
| 65681              | 500                                | 40                             | 219.9                    | 31                    | 49                      | 21                    | 46,846             | 95,238                              | 93.69                            |
| 65644              | 3,563                              | 285                            | 229.9                    | 31                    | 49                      | 21                    | 333,917            | 100,213                             | 93.73                            |
| 74457              | 4,975                              | 398                            | 213.1                    | 31                    | 49                      | 21                    | 466,297            | 103,775                             | 93.73                            |
| 72745              | 150                                | 12                             | 172.7                    | 31                    | 53                      | 17                    | 14,124             | 103,925                             | 94.16                            |
| 74960              | 15,688                             | 1255                           | 220.9                    | 31                    | 48                      | 21                    | 1,477,950          | 119,613                             | 94.21                            |
| 65640              | 275                                | 22                             | 230.3                    | 31                    | 48                      | 21                    | 25,914             | 119,888                             | 94.23                            |
| 65674              | 688                                | 55                             | 239.0                    | 30                    | 48                      | 21                    | 64,986             | 120,575                             | 94.53                            |
| 67353              | 113                                | 9                              | 231.7                    | 30                    | 48                      | 21                    | 10,645             | 120,688                             | 94.62                            |

| Table 15. Supply ZCTAs for upland hardwood pulpwood removals in KS (demand ZCTA 66770, Cherokee County). |                                    |                                |                          |                       |                         |                       |                    |                                     |                                  |
|----------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------|--------------------------|-----------------------|-------------------------|-----------------------|--------------------|-------------------------------------|----------------------------------|
| Suppl<br>y<br>ZCTA                                                                                       | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of<br>Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost (\$) | Harvesting<br>Cost (\$) | Trucking Cost<br>(\$) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal<br>Cost<br>(\$/dry ton) |
| 72761                                                                                                    | 7,225                              | 578                            | 171.9                    | 30                    | 53                      | 17                    | 684,250            | 127,913                             | 94.71                            |
| 72762                                                                                                    | 163                                | 13                             | 186.3                    | 30                    | 53                      | 17                    | 15,410             | 128,075                             | 94.83                            |
| 65611                                                                                                    | 425                                | 34                             | 236.9                    | 30                    | 48                      | 22                    | 40,345             | 128,500                             | 94.93                            |
| 72732                                                                                                    | 825                                | 66                             | 186.8                    | 30                    | 52                      | 17                    | 78,568             | 129,325                             | 95.23                            |
| 72769                                                                                                    | 1,675                              | 134                            | 184.8                    | 30                    | 52                      | 18                    | 160,134            | 131,000                             | 95.60                            |
| 72764                                                                                                    | 250                                | 20                             | 189.7                    | 30                    | 52                      | 18                    | 23,924             | 131,250                             | 95.70                            |
| 74931                                                                                                    | 5,675                              | 454                            | 238.6                    | 30                    | 48                      | 22                    | 543,221            | 136,925                             | 95.72                            |
| 72704                                                                                                    | 488                                | 39                             | 198.1                    | 30                    | 52                      | 18                    | 46,755             | 137,413                             | 95.91                            |
| 72730                                                                                                    | 63                                 | 5                              | 209.1                    | 30                    | 52                      | 19                    | 6,035              | 137,475                             | 96.55                            |
| 72701                                                                                                    | 938                                | 75                             | 210.8                    | 30                    | 51                      | 19                    | 90,793             | 138,413                             | 96.85                            |
| 72703                                                                                                    | 213                                | 17                             | 206.6                    | 30                    | 51                      | 19                    | 20,583             | 138,625                             | 96.86                            |
| 72631                                                                                                    | 438                                | 35                             | 200.5                    | 30                    | 51                      | 19                    | 42,408             | 139,063                             | 96.93                            |
| 72744                                                                                                    | 5,063                              | 405                            | 200.8                    | 30                    | 51                      | 19                    | 490,946            | 144,125                             | 96.98                            |
| 72738                                                                                                    | 438                                | 35                             | 214.0                    | 30                    | 51                      | 19                    | 42,431             | 144,563                             | 96.99                            |
| 72774                                                                                                    | 1,238                              | 99                             | 223.0                    | 30                    | 51                      | 19                    | 120,576            | 145,800                             | 97.44                            |
| 72753                                                                                                    | 563                                | 45                             | 224.6                    | 29                    | 51                      | 20                    | 54,995             | 146,363                             | 97.77                            |
| 72727                                                                                                    | 1,525                              | 122                            | 225.5                    | 29                    | 51                      | 20                    | 149,126            | 147,888                             | 97.79                            |
| 72729                                                                                                    | 1,263                              | 101                            | 224.6                    | 29                    | 51                      | 20                    | 124,388            | 149,150                             | 98.52                            |
| 72632                                                                                                    | 1,075                              | 86                             | 231.2                    | 29                    | 50                      | 20                    | 106,137            | 150,225                             | 98.73                            |
| 72660                                                                                                    | 88                                 | 7                              | 237.4                    | 29                    | 50                      | 21                    | 8,695              | 150,313                             | 99.37                            |
| 72616                                                                                                    | 1,225                              | 98                             | 236.5                    | 29                    | 50                      | 21                    | 121,953            | 151,538                             | 99.55                            |

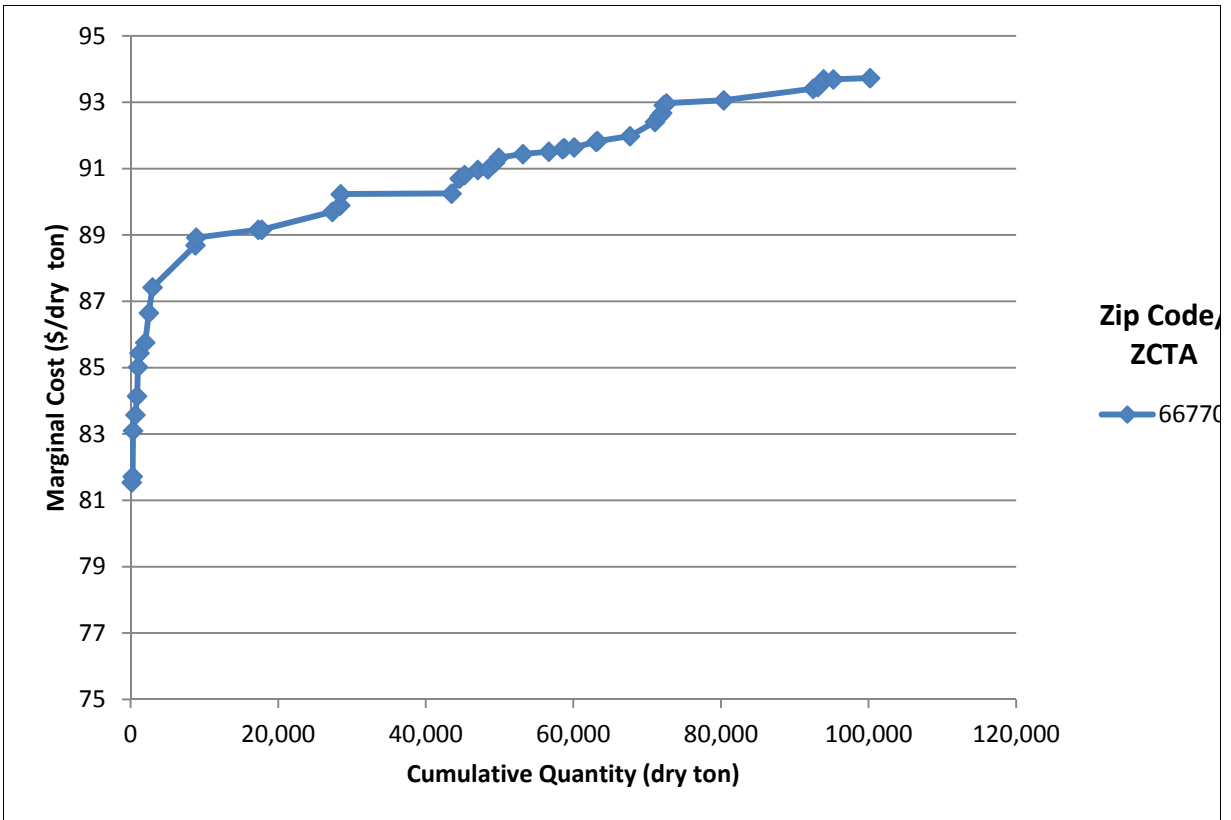
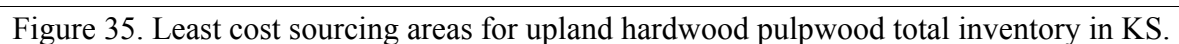


Figure 34. Marginal cost curve for upland hardwood pulpwood removals in KS (ZCTA 66770, Cherokee County).

The top ten ZCTA locations for upland hardwood pulpwood total inventory<sup>17</sup> were all located in east and south-east Kansas (Figure 35). Half a million dry tons of upland hardwood pulpwood removals are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$79.05 to \$79.86/dry ton. The median MC ranged from \$78.85 to \$80.04/dry ton (Table 16, Figure 36).



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Table 16. Top ten locations in KS for upland hardwood pulpwood total inventory based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County     | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|------------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 67334                 | Chautauqua | 534,875                  | 42,279,316      | 164,698     | 1                     | 79.05                     | 79.05                             |
| 66045                 | Douglas    | 620,150                  | 49,024,391      | 202,550     | 4                     | 79.05                     | 78.90                             |
| 66735                 | Crawford   | 508,500                  | 40,199,796      | 768,160     | 8                     | 79.06                     | 79.06                             |
| 66728                 | Cherokee   | 502,950                  | 39,783,012      | 674,156     | 6                     | 79.10                     | 79.22                             |
| 66763                 | Crawford   | 506,713                  | 40,117,273      | 779,704     | 9                     | 79.17                     | 79.57                             |
| 66770                 | Cherokee   | 589,175                  | 46,727,254      | 615,171     | 4                     | 79.31                     | 78.85                             |
| 66767                 | Linn       | 915,725                  | 72,707,474      | 520,912     | 2                     | 79.40                     | 79.44                             |
| 66781                 | Cherokee   | 503,038                  | 40,016,101      | 681,159     | 8                     | 79.55                     | 79.52                             |
| 66760                 | Cherokee   | 613,563                  | 48,920,817.86   | 742,261     | 14                    | 79.73                     | 79.98                             |
| 66056                 | Linn       | 606,738                  | 48,456,599.28   | 487,040     | 3                     | 79.86                     | 80.04                             |

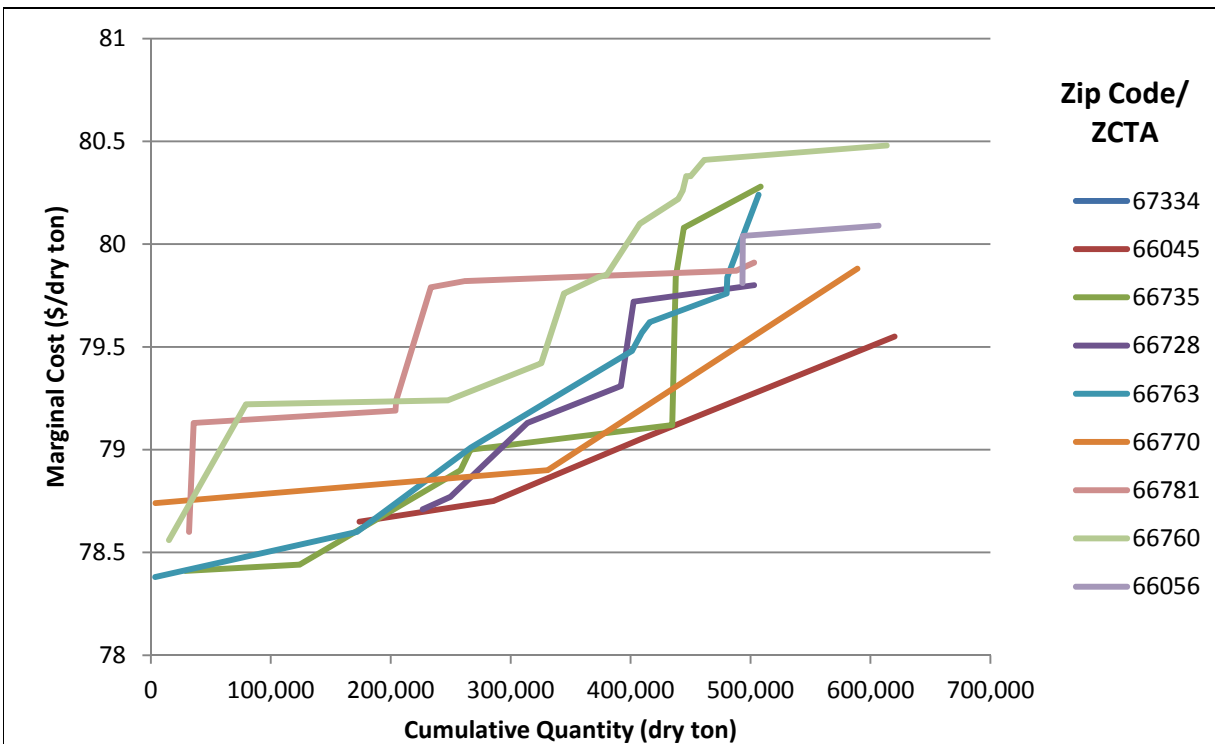
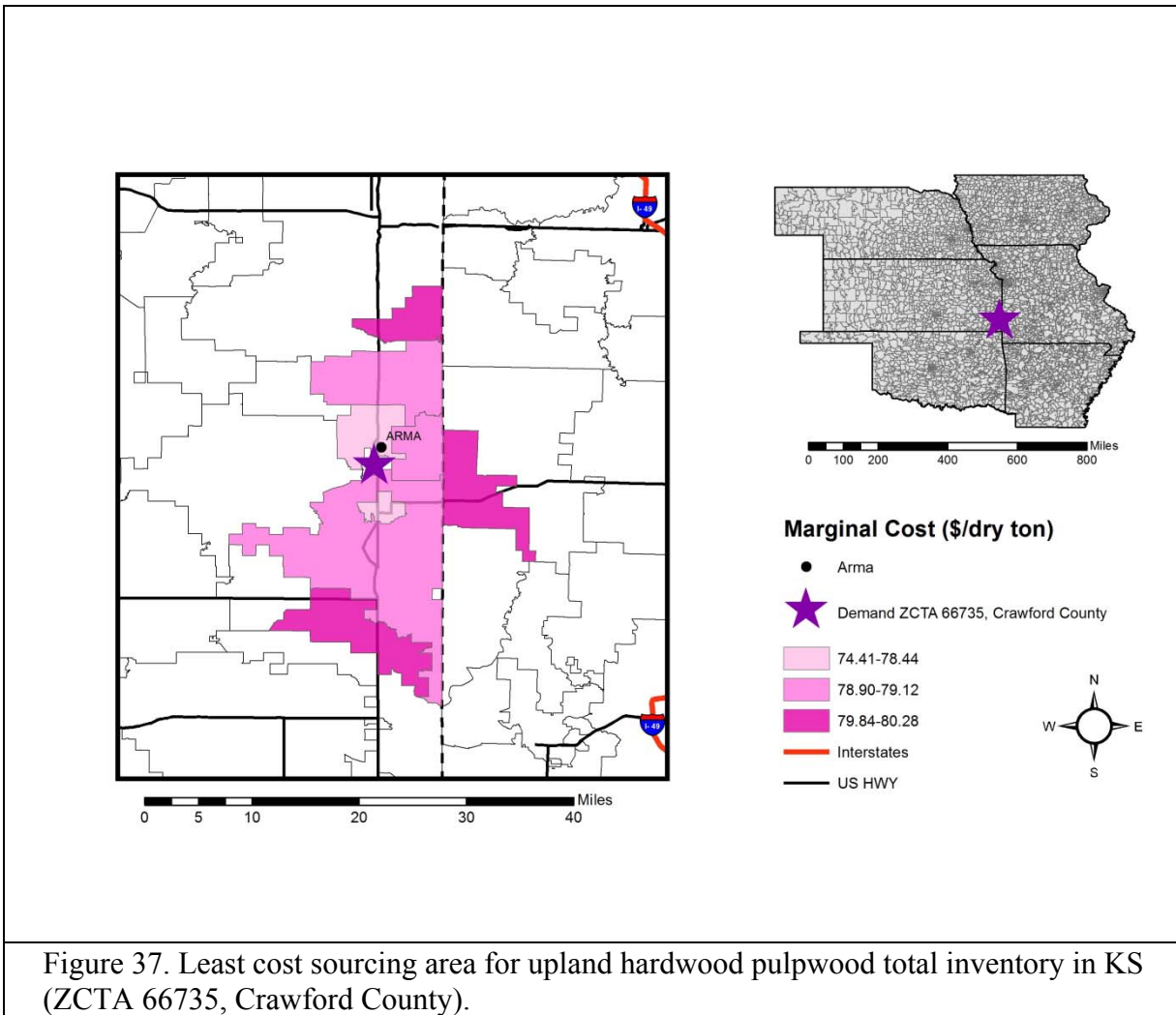


Figure 36. Marginal cost curves for the top ten locations for upland hardwood pulpwood total inventory in KS.

Demand ZCTA 66735 (Crawford County, KS) has the least average total costs per dry ton of upland hardwood pulpwood total inventory (Figure 37). Half a million dry tons of upland hardwood pulpwood total inventory are available within 80 mile radius from ZCTA 66735. The MC per dry ton in the least cost sourcing area (ZCTA 66735, Crawford County, KS) ranged from \$74.41 to \$80.28/dry ton (Table 17, Figure 38).



ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66735, Crawford County).

| Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 2,316                 | 10.5               | 28.78                      | 45.58                        | 4.04                       | 2,269,832       | 28,950                        | 78.41                      |
| 7,601                 | 11.0               | 28.78                      | 45.58                        | 4.07                       | 7,452,406       | 123,963                       | 78.44                      |
| 10,745                | 14.6               | 28.78                      | 45.58                        | 4.54                       | 10,597,728      | 258,275                       | 78.90                      |
| 658                   | 19.1               | 28.78                      | 45.58                        | 4.64                       | 649,766         | 266,500                       | 79.00                      |
| 13,462                | 19.6               | 28.78                      | 45.58                        | 4.76                       | 13,313,959      | 434,775                       | 79.12                      |
| 239                   | 28.3               | 28.78                      | 45.58                        | 5.48                       | 238,532         | 437,763                       | 79.84                      |
| 529                   | 29.3               | 28.78                      | 45.58                        | 5.72                       | 529,513         | 444,375                       | 80.08                      |
| 5,130                 | 37.2               | 28.78                      | 45.58                        | 5.92                       | 5,148,059       | 508,500                       | 80.28                      |
| 40                    | 36.8               | 28.78                      | 45.58                        | 5.99                       | 40,177          | 509,000                       | 80.35                      |
| 7,708                 | 38.3               | 28.78                      | 45.58                        | 6.27                       | 7,768,594       | 605,350                       | 80.63                      |
| 1,913                 | 42.9               | 28.78                      | 45.58                        | 6.27                       | 1,928,217       | 629,263                       | 80.64                      |
| 2,083                 | 37.6               | 28.78                      | 45.58                        | 6.34                       | 2,101,221       | 655,300                       | 80.70                      |
| 2,220                 | 40.8               | 28.78                      | 45.58                        | 6.54                       | 2,245,158       | 683,050                       | 80.91                      |
| 1,208                 | 45.5               | 28.78                      | 45.58                        | 6.66                       | 1,223,379       | 698,150                       | 81.02                      |
| 19                    | 47.7               | 28.78                      | 45.58                        | 6.81                       | 19,278          | 698,388                       | 81.17                      |
| 178                   | 46.8               | 28.78                      | 45.58                        | 6.86                       | 180,727         | 700,613                       | 81.23                      |
| 2,551                 | 48.3               | 28.78                      | 45.58                        | 6.92                       | 2,591,835       | 732,500                       | 81.28                      |
| 307                   | 52.4               | 28.78                      | 45.58                        | 6.96                       | 312,091         | 736,338                       | 81.33                      |
| 200                   | 54.1               | 28.78                      | 45.58                        | 7.24                       | 204,002         | 738,838                       | 81.60                      |
| 6,246                 | 58.0               | 28.78                      | 45.58                        | 7.52                       | 6,392,943       | 816,913                       | 81.88                      |
| 1,807                 | 59.3               | 28.78                      | 45.58                        | 7.66                       | 1,852,624       | 839,500                       | 82.02                      |
| 18,139                | 59.5               | 28.78                      | 45.58                        | 7.70                       | 18,606,210      | 1,066,238                     | 82.06                      |
| 348                   | 56.7               | 28.78                      | 45.58                        | 7.72                       | 357,043         | 1,070,588                     | 82.08                      |
| 1,844                 | 64.3               | 28.78                      | 45.58                        | 7.76                       | 1,892,877       | 1,093,638                     | 82.12                      |
| 5,788                 | 69.2               | 28.78                      | 45.58                        | 7.82                       | 5,858,825       | 1,166,125                     | 82.18                      |

Table 17. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66735, Crawford County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64855       | 18,913                   | 1,513                 | 61.5               | 28.78                      | 45.58                        | 7.85                       | 1,554,924       | 1,185,038                     | 82.22                      |
| 64759       | 90,213                   | 7,217                 | 64.8               | 28.78                      | 45.58                        | 8.20                       | 7,448,265       | 1,275,250                     | 82.56                      |
| 66725       | 10,525                   | 842                   | 72.3               | 28.78                      | 45.58                        | 8.42                       | 871,295         | 1,285,775                     | 82.78                      |
| 64849       | 2,888                    | 231                   | 65.4               | 28.78                      | 45.58                        | 8.43                       | 239,065         | 1,288,663                     | 82.79                      |
| 64830       | 11,463                   | 917                   | 71.3               | 28.78                      | 45.58                        | 8.50                       | 949,846         | 1,300,125                     | 82.87                      |
| 64870       | 152,075                  | 12,166                | 71.2               | 28.78                      | 45.58                        | 8.58                       | 12,612,952      | 1,452,200                     | 82.94                      |
| 66767       | 113,038                  | 9,043                 | 78.2               | 28.78                      | 45.58                        | 8.64                       | 9,382,113       | 1,565,238                     | 83.00                      |
| 64741       | 1,038                    | 83                    | 73.7               | 28.78                      | 45.58                        | 8.65                       | 86,121          | 1,566,275                     | 83.01                      |
| 66738       | 133,350                  | 10,668                | 76.7               | 28.78                      | 45.58                        | 8.77                       | 11,085,299      | 1,699,625                     | 83.13                      |
| 66713       | 100,438                  | 8,035                 | 79.6               | 28.78                      | 45.58                        | 8.79                       | 8,351,489       | 1,800,063                     | 83.15                      |
| 64857       | 2,913                    | 233                   | 75.1               | 28.78                      | 45.58                        | 8.80                       | 242,205         | 1,802,975                     | 83.16                      |
| 66740       | 1,263                    | 101                   | 75.9               | 28.78                      | 45.58                        | 8.88                       | 105,088         | 1,804,238                     | 83.24                      |
| 66769       | 4,600                    | 368                   | 76.4               | 28.78                      | 45.58                        | 8.88                       | 382,926         | 1,808,838                     | 83.24                      |
| 64755       | 36,500                   | 2,920                 | 76.3               | 28.78                      | 45.58                        | 8.89                       | 3,038,798       | 1,845,338                     | 83.25                      |
| 64801       | 258,163                  | 20,653                | 74.5               | 28.78                      | 45.58                        | 8.95                       | 21,508,990      | 2,103,500                     | 83.32                      |
| 66733       | 313                      | 25                    | 78.1               | 28.78                      | 45.58                        | 9.02                       | 26,057          | 2,103,813                     | 83.38                      |
| 66779       | 8,463                    | 677                   | 71.6               | 28.78                      | 45.58                        | 9.09                       | 706,182         | 2,112,275                     | 83.45                      |
| 66775       | 75                       | 6                     | 75.0               | 28.78                      | 45.58                        | 9.11                       | 6,260           | 2,112,350                     | 83.47                      |
| 64835       | 11,113                   | 889                   | 79.1               | 28.78                      | 45.58                        | 9.15                       | 928,073         | 2,123,463                     | 83.52                      |
| 64748       | 16,238                   | 1,299                 | 82.0               | 28.78                      | 45.58                        | 9.25                       | 1,357,590       | 2,139,700                     | 83.61                      |
| 64841       | 1,213                    | 97                    | 84.5               | 28.78                      | 45.58                        | 9.44                       | 101,607         | 2,140,913                     | 83.80                      |
| 64772       | 320,413                  | 25,633                | 88.1               | 28.78                      | 45.58                        | 9.81                       | 26,971,165      | 2,461,325                     | 84.18                      |
| 64784       | 56,925                   | 4,554                 | 87.7               | 28.78                      | 45.58                        | 9.86                       | 4,794,611       | 2,518,250                     | 84.23                      |
| 66754       | 239,363                  | 19,149                | 88.3               | 28.78                      | 45.58                        | 9.88                       | 20,165,087      | 2,757,613                     | 84.24                      |
| 74360       | 1,263                    | 101                   | 92.5               | 28.78                      | 45.58                        | 9.97                       | 106,472         | 2,758,875                     | 84.33                      |

Table 17. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66735, Crawford County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66776       | 7,338                    | 587                   | 89.6               | 28.78                      | 45.58                        | 10.00                      | 618,979         | 2,766,213                     | 84.36                      |
| 64836       | 54,063                   | 4,325                 | 92.5               | 28.78                      | 45.58                        | 10.04                      | 4,563,068       | 2,820,275                     | 84.40                      |
| 66772       | 50                       | 4                     | 86.0               | 28.78                      | 45.58                        | 10.06                      | 4,221           | 3,313,625                     | 84.42                      |
| 66075       | 493,350                  | 39,468                | 99.1               | 28.78                      | 45.58                        | 10.06                      | 41,647,370      | 3,313,675                     | 84.42                      |
| 64767       | 349,963                  | 27,997                | 93.3               | 28.78                      | 45.58                        | 10.12                      | 29,566,562      | 3,313,888                     | 84.48                      |
| 74339       | 213                      | 17                    | 95.0               | 28.78                      | 45.58                        | 10.12                      | 17,953          | 3,663,850                     | 84.48                      |
| 66716       | 350                      | 28                    | 94.1               | 28.78                      | 45.58                        | 10.24                      | 29,610          | 3,664,200                     | 84.60                      |
| 67357       | 7,463                    | 597                   | 92.9               | 28.78                      | 45.58                        | 10.32                      | 631,955         | 3,711,200                     | 84.68                      |
| 74363       | 47,000                   | 3,760                 | 89.5               | 28.78                      | 45.58                        | 10.32                      | 3,979,975       | 3,718,663                     | 84.68                      |
| 64804       | 63,663                   | 5,093                 | 101.5              | 28.78                      | 45.58                        | 10.35                      | 5,392,974       | 3,782,325                     | 84.71                      |
| 64752       | 111,588                  | 8,927                 | 97.6               | 28.78                      | 45.58                        | 10.40                      | 9,457,881       | 3,893,913                     | 84.76                      |
| 66755       | 188                      | 15                    | 105.0              | 28.78                      | 45.58                        | 10.54                      | 15,919          | 3,894,100                     | 84.90                      |
| 64778       | 3,025                    | 242                   | 98.4               | 28.78                      | 45.58                        | 10.63                      | 257,108         | 3,897,125                     | 84.99                      |
| 67356       | 7,688                    | 615                   | 105.3              | 28.78                      | 45.58                        | 10.77                      | 654,453         | 3,904,813                     | 85.13                      |
| 67336       | 6,838                    | 547                   | 107.0              | 28.78                      | 45.58                        | 10.81                      | 582,388         | 3,911,650                     | 85.18                      |
| 64790       | 82,313                   | 6,585                 | 105.2              | 28.78                      | 45.58                        | 10.83                      | 7,012,096       | 3,993,963                     | 85.19                      |
| 66732       | 50                       | 4                     | 95.1               | 28.78                      | 45.58                        | 10.88                      | 4,262           | 3,994,013                     | 85.24                      |
| 65682       | 55,650                   | 4,452                 | 101.9              | 28.78                      | 45.58                        | 10.88                      | 4,743,570       | 4,049,663                     | 85.24                      |
| 74354       | 61,113                   | 4,889                 | 102.9              | 28.78                      | 45.58                        | 10.89                      | 5,209,756       | 4,110,775                     | 85.25                      |
| 66056       | 422,375                  | 33,790                | 108.2              | 28.78                      | 45.58                        | 11.00                      | 36,053,445      | 4,533,150                     | 85.36                      |
| 64858       | 138                      | 11                    | 109.7              | 28.78                      | 45.58                        | 11.03                      | 11,741          | 4,533,288                     | 85.39                      |
| 66720       | 325                      | 26                    | 105.9              | 28.78                      | 45.58                        | 11.06                      | 27,763          | 4,533,613                     | 85.42                      |
| 64840       | 18,913                   | 1,513                 | 107.8              | 28.78                      | 45.58                        | 11.17                      | 1,617,614       | 4,552,525                     | 85.53                      |
| 67341       | 1,100                    | 88                    | 106.7              | 28.78                      | 45.58                        | 11.19                      | 94,111          | 4,553,625                     | 85.56                      |
| 64833       | 200                      | 16                    | 110.0              | 28.78                      | 45.58                        | 11.27                      | 17,127          | 4,553,825                     | 85.64                      |

| Table 17. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66735, Crawford County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|-----------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                     | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 65603                                                                                                           | 13,700                   | 1,096                 | 107.6              | 28.78                      | 45.58                        | 11.36                      | 1,174,443       | 4,567,525                     | 85.73                      |
| 64850                                                                                                           | 129,250                  | 10,340                | 111.8              | 28.78                      | 45.58                        | 11.43                      | 11,088,685      | 4,696,775                     | 85.79                      |
| 64859                                                                                                           | 315,300                  | 25,224                | 112.5              | 28.78                      | 45.58                        | 11.46                      | 27,058,870      | 5,012,075                     | 85.82                      |
| 66751                                                                                                           | 63                       | 5                     | 118.7              | 28.78                      | 45.58                        | 11.53                      | 5,368           | 5,012,138                     | 85.89                      |
| 64756                                                                                                           | 55,725                   | 4,458                 | 112.4              | 28.78                      | 45.58                        | 11.61                      | 4,790,564       | 5,067,863                     | 85.97                      |
| 65661                                                                                                           | 348,563                  | 27,885                | 112.9              | 28.78                      | 45.58                        | 11.81                      | 30,037,635      | 5,416,425                     | 86.18                      |
| 64722                                                                                                           | 155,463                  | 12,437                | 121.4              | 28.78                      | 45.58                        | 11.91                      | 13,412,320      | 5,571,888                     | 86.27                      |
| 64865                                                                                                           | 41,938                   | 3,355                 | 121.0              | 28.78                      | 45.58                        | 11.92                      | 3,618,466       | 5,613,825                     | 86.28                      |
| 67330                                                                                                           | 1,538                    | 123                   | 122.4              | 28.78                      | 45.58                        | 11.97                      | 132,733         | 5,615,363                     | 86.33                      |
| 67335                                                                                                           | 10,163                   | 813                   | 121.1              | 28.78                      | 45.58                        | 11.98                      | 877,478         | 5,625,525                     | 86.34                      |
| 67332                                                                                                           | 1,338                    | 107                   | 125.1              | 28.78                      | 45.58                        | 12.03                      | 115,543         | 5,626,863                     | 86.39                      |
| 66010                                                                                                           | 350                      | 28                    | 124.3              | 28.78                      | 45.58                        | 12.17                      | 30,285          | 5,627,213                     | 86.53                      |
| 64750                                                                                                           | 10,188                   | 815                   | 125.8              | 28.78                      | 45.58                        | 12.23                      | 882,187         | 5,637,400                     | 86.60                      |
| 66039                                                                                                           | 225                      | 18                    | 127.8              | 28.78                      | 45.58                        | 12.34                      | 19,508          | 5,679,350                     | 86.70                      |
| 74343                                                                                                           | 41,950                   | 3,356                 | 119.6              | 28.78                      | 45.58                        | 12.34                      | 3,637,074       | 5,679,575                     | 86.70                      |
| 64779                                                                                                           | 354,588                  | 28,367                | 126.4              | 28.78                      | 45.58                        | 12.38                      | 30,756,580      | 6,034,163                     | 86.74                      |
| 64783                                                                                                           | 226,513                  | 18,121                | 125.9              | 28.78                      | 45.58                        | 12.53                      | 19,681,518      | 6,260,675                     | 86.89                      |
| 67354                                                                                                           | 2,513                    | 201                   | 133.9              | 28.78                      | 45.58                        | 12.71                      | 218,764         | 6,263,188                     | 87.07                      |
| 67342                                                                                                           | 3,338                    | 267                   | 136.1              | 28.78                      | 45.58                        | 12.72                      | 290,653         | 6,266,525                     | 87.09                      |
| 66749                                                                                                           | 175                      | 14                    | 133.6              | 28.78                      | 45.58                        | 12.74                      | 15,243          | 6,266,700                     | 87.11                      |
| 66748                                                                                                           | 263                      | 21                    | 131.9              | 28.78                      | 45.58                        | 12.78                      | 22,874          | 6,266,963                     | 87.14                      |
| 64844                                                                                                           | 33,213                   | 2,657                 | 131.2              | 28.78                      | 45.58                        | 12.81                      | 2,895,335       | 6,300,175                     | 87.18                      |
| 67363                                                                                                           | 50                       | 4                     | 135.0              | 28.78                      | 45.58                        | 12.99                      | 4,368           | 6,461,150                     | 87.35                      |
| 64744                                                                                                           | 160,975                  | 12,878                | 132.5              | 28.78                      | 45.58                        | 12.98                      | 14,060,586      | 6,461,200                     | 87.35                      |
| 66717                                                                                                           | 87,575                   | 7,006                 | 138.0              | 28.78                      | 45.58                        | 13.23                      | 7,670,595       | 6,548,775                     | 87.59                      |

Table 17. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66735, Crawford County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66014       | 263,525                  | 21,082                | 132.5              | 28.78                      | 45.58                        | 13.35                      | 23,114,118      | 6,812,300                     | 87.71                      |
| 66761       | 25                       | 2                     | 146.7              | 28.78                      | 45.58                        | 13.47                      | 2,196           | 6,812,325                     | 87.83                      |
| 74370       | 106,900                  | 8,552                 | 139.9              | 28.78                      | 45.58                        | 13.55                      | 9,398,218       | 6,919,225                     | 87.92                      |
| 64843       | 46,763                   | 3,741                 | 141.5              | 28.78                      | 45.58                        | 13.58                      | 4,112,487       | 6,965,988                     | 87.94                      |
| 67351       | 2,588                    | 207                   | 143.8              | 28.78                      | 45.58                        | 13.63                      | 227,669         | 7,006,788                     | 87.99                      |
| 74333       | 40,800                   | 3,264                 | 144.3              | 28.78                      | 45.58                        | 13.63                      | 3,589,878       | 7,009,375                     | 87.99                      |
| 66015       | 88                       | 7                     | 149.8              | 28.78                      | 45.58                        | 13.70                      | 7,706           | 7,009,463                     | 88.06                      |
| 65635       | 24,213                   | 1,937                 | 133.7              | 28.78                      | 45.58                        | 13.74                      | 2,133,179       | 7,033,675                     | 88.10                      |
| 64780       | 227,138                  | 18,171                | 147.2              | 28.78                      | 45.58                        | 13.88                      | 20,041,968      | 7,260,813                     | 88.24                      |
| 74369       | 114,150                  | 9,132                 | 142.6              | 28.78                      | 45.58                        | 13.93                      | 10,078,387      | 7,374,963                     | 88.29                      |
| 64831       | 191,388                  | 15,311                | 143.3              | 28.78                      | 45.58                        | 14.01                      | 16,913,410      | 7,566,350                     | 88.37                      |
| 65785       | 158,388                  | 12,671                | 142.3              | 28.78                      | 45.58                        | 14.08                      | 14,007,869      | 7,724,738                     | 88.44                      |
| 64866       | 19,488                   | 1,559                 | 146.6              | 28.78                      | 45.58                        | 14.18                      | 1,725,485       | 7,744,225                     | 88.54                      |
| 64847       | 6,250                    | 500                   | 153.1              | 28.78                      | 45.58                        | 14.19                      | 553,460         | 7,750,475                     | 88.55                      |
| 64781       | 1,088,375                | 87,070                | 157.6              | 28.78                      | 45.58                        | 14.59                      | 96,811,147      | 8,838,850                     | 88.95                      |
| 65601       | 26,625                   | 2,130                 | 148.6              | 28.78                      | 45.58                        | 14.66                      | 2,370,140       | 8,865,475                     | 89.02                      |
| 64863       | 29,475                   | 2,358                 | 159.7              | 28.78                      | 45.58                        | 14.75                      | 2,626,463       | 8,894,950                     | 89.11                      |
| 67301       | 4,050                    | 324                   | 158.0              | 28.78                      | 45.58                        | 14.82                      | 361,180         | 8,899,000                     | 89.18                      |
| 65770       | 659,050                  | 52,724                | 154.1              | 28.78                      | 45.58                        | 15.00                      | 58,892,731      | 9,558,050                     | 89.36                      |
| 65649       | 43,950                   | 3,516                 | 157.7              | 28.78                      | 45.58                        | 15.26                      | 3,938,779       | 9,602,000                     | 89.62                      |

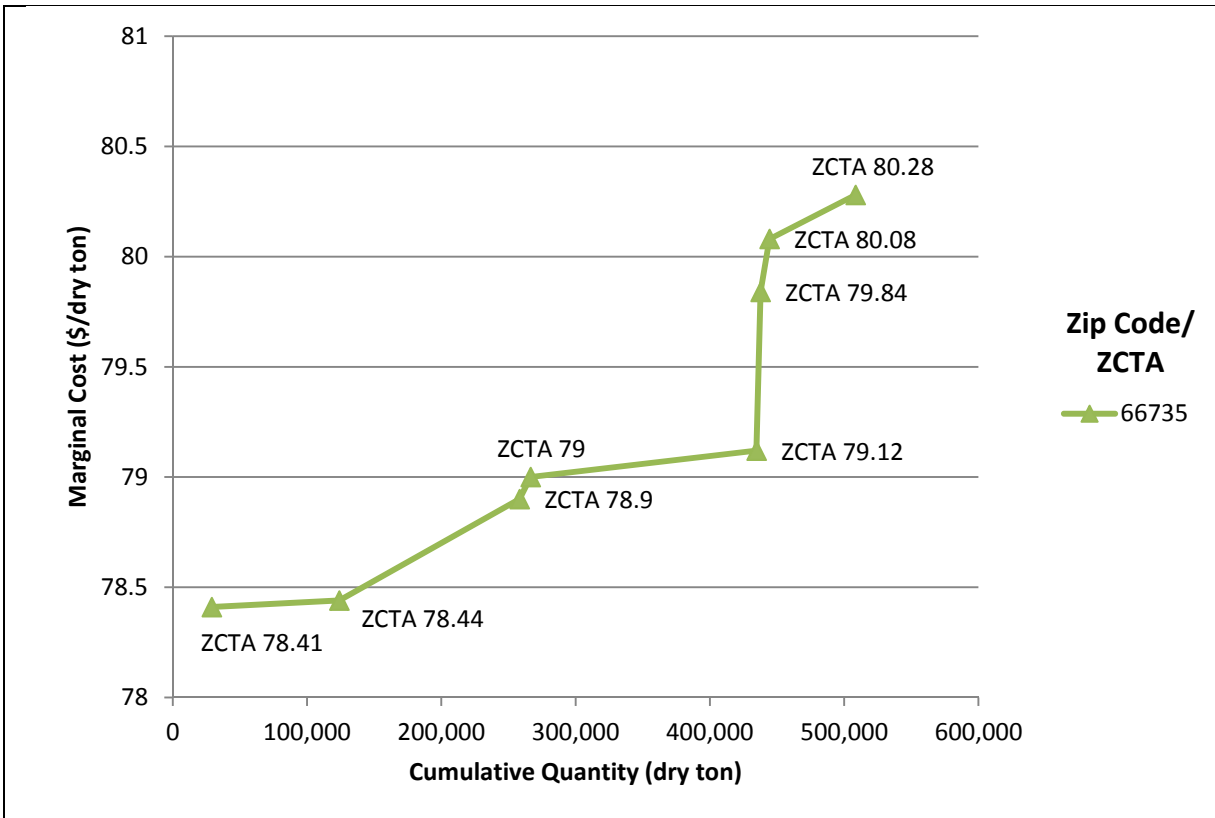


Figure 38. Marginal cost curve for upland hardwood pulpwood total inventory in KS (ZCTA 66735, Crawford County).



### 3.3.1.2 Lowland Hardwood

#### 3.3.1.2.1 Net Growth

The top ten ZCTA locations for lowland hardwood pulpwood net growth were all located in north-central Kansas (Figure 39). Hundred fifty thousand dry tons of lowland hardwood pulpwood net growth are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$92.92 to \$93.48/dry ton. The median MC ranged from \$92.93 to \$93.85/dry ton (Table 18, Figure 40).

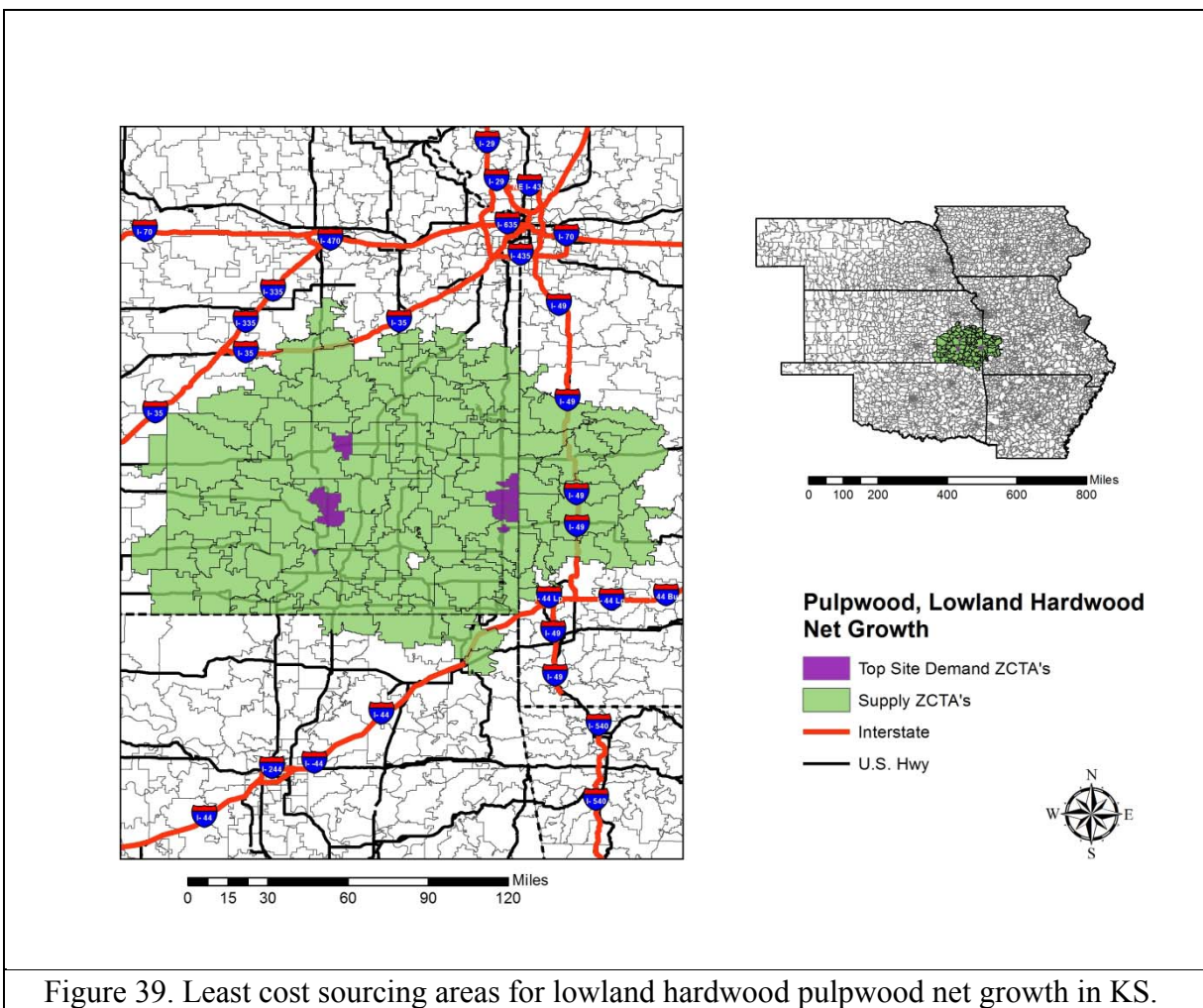


Table 18. Top ten locations in KS for lowland hardwood pulpwood net growth based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County     | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|------------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66741                 | Bourbon    | 150,900                  | 14,021,900      | 21,548      | 71                    | 92.92                     | 93.42                             |
| 66756                 | Crawford   | 150,425                  | 13,995,073      | 21,724      | 67                    | 93.04                     | 92.93                             |
| 66712                 | Crawford   | 155,075                  | 14,430,006      | 21,288      | 74                    | 93.05                     | 93.27                             |
| 66711                 | Bourbon    | 150,300                  | 13,986,262      | 19,302      | 72                    | 93.06                     | 93.09                             |
| 66735                 | Crawford   | 167,363                  | 15,585,544      | 18,192      | 83                    | 93.12                     | 93.59                             |
| 66763                 | Crawford   | 163,388                  | 15,224,936      | 18,156      | 80                    | 93.18                     | 93.55                             |
| 67363                 | Montgomery | 151,300                  | 14,103,939      | 14,129      | 73                    | 93.22                     | 93.82                             |
| 66710                 | Wilson     | 151,888                  | 14,192,331      | 17,351      | 66                    | 93.44                     | 93.85                             |
| 66714                 | Wilson     | 152,500                  | 14,253,010      | 17,184      | 68                    | 93.46                     | 93.67                             |
| 66761                 | Allen      | 151,800                  | 14,189,700      | 16,669      | 68                    | 93.48                     | 93.75                             |

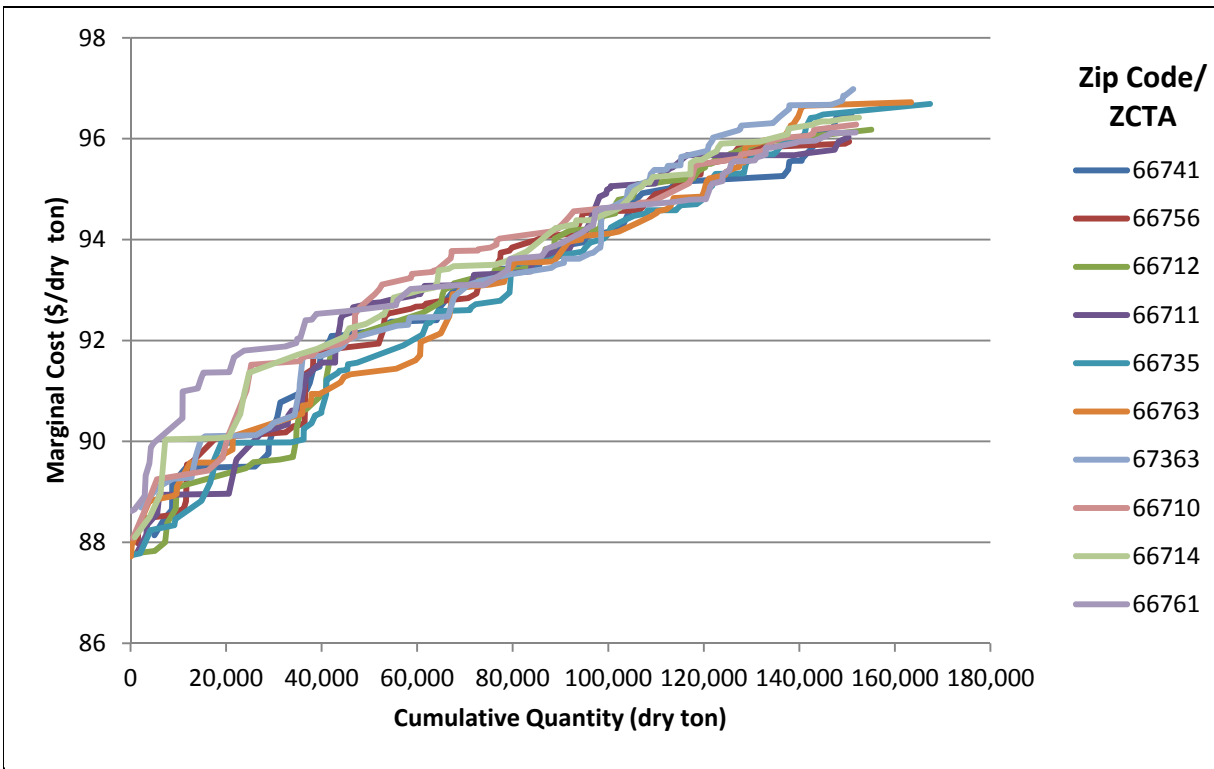
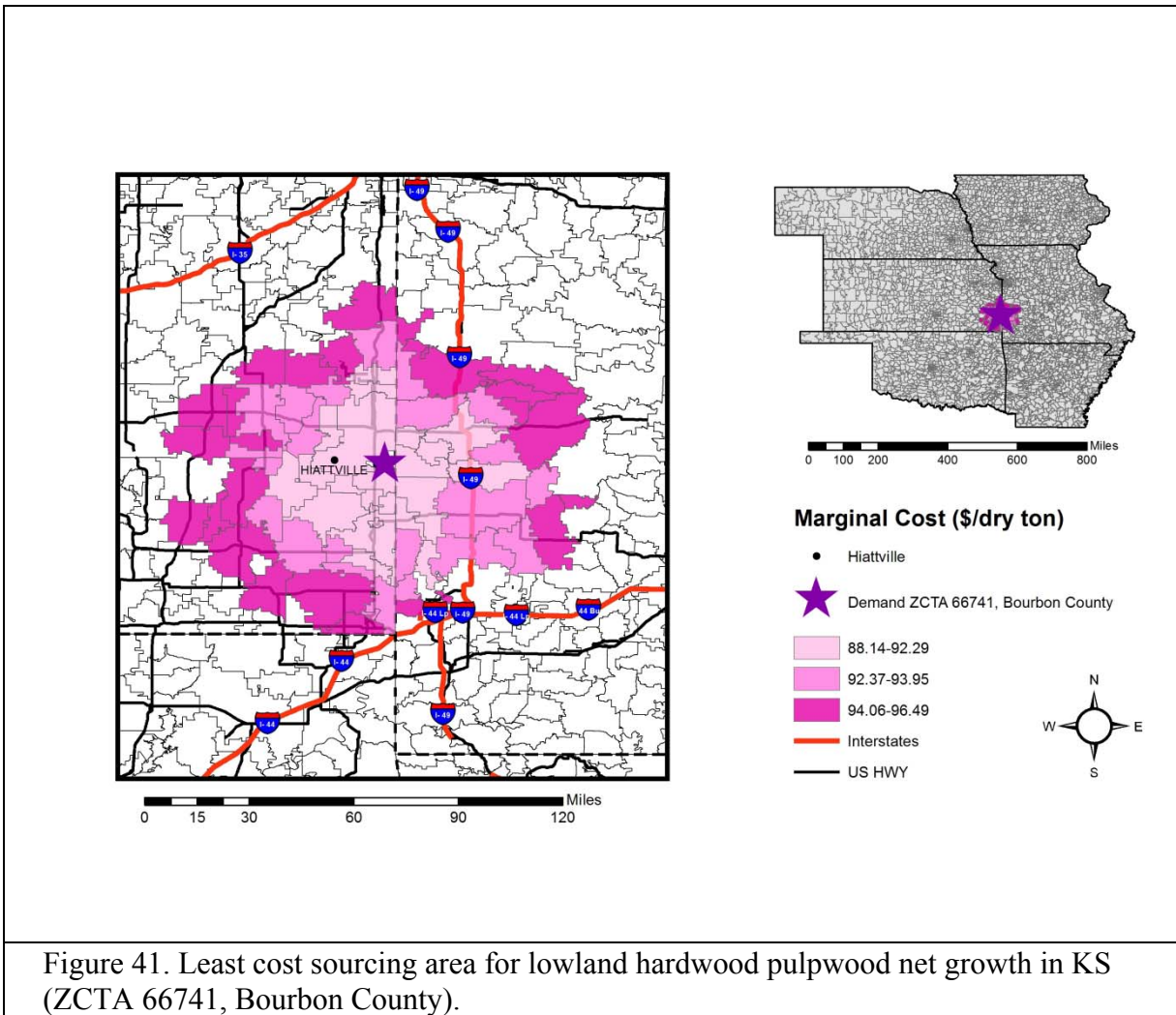


Figure 40. Marginal cost curves for the top ten locations for lowland hardwood pulpwood net growth in KS.

Demand ZCTA 66741 (Bourbon County, KS) has the least average total costs per dry ton of lowland hardwood pulpwood net growth (Figure 41). Hundred fifty thousand dry tons of lowland hardwood pulpwood net growth are available within 80 mile radius from ZCTA 66741. The median MC per dry ton in the least cost sourcing area (ZCTA 66741, Bourbon County, KS) ranged from \$88.14 to \$96.49/dry ton (Table 19, Figure 42).



| Table 19. Supply ZCTAs for lowland hardwood pulpwood net growth in KS (demand ZCTA 66741, Bourbon County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66711                                                                                                      | 4,988                    | 399                   | 12.2               | 28.78                      | 54.92                        | 4.43                       | 439,574         | 4,988                         | 88.14                      |
| 66756                                                                                                      | 2,175                    | 174                   | 14.9               | 28.78                      | 54.92                        | 4.78                       | 192,448         | 7,163                         | 88.48                      |
| 66712                                                                                                      | 1,538                    | 123                   | 20.0               | 28.78                      | 54.92                        | 4.94                       | 136,295         | 8,700                         | 88.65                      |
| 66735                                                                                                      | 50                       | 4                     | 28.2               | 28.78                      | 54.92                        | 5.45                       | 4,458           | 8,750                         | 89.16                      |
| 64762                                                                                                      | 2,763                    | 221                   | 26.1               | 28.78                      | 54.92                        | 5.77                       | 247,156         | 11,513                        | 89.47                      |
| 66701                                                                                                      | 14,513                   | 1,161                 | 31.9               | 28.78                      | 54.92                        | 5.80                       | 1,298,860       | 26,025                        | 89.50                      |
| 64728                                                                                                      | 2,400                    | 192                   | 32.9               | 28.78                      | 54.92                        | 6.02                       | 215,326         | 28,425                        | 89.72                      |
| 66763                                                                                                      | 463                      | 37                    | 36.5               | 28.78                      | 54.92                        | 6.06                       | 41,514          | 28,888                        | 89.76                      |
| 64771                                                                                                      | 88                       | 7                     | 30.6               | 28.78                      | 54.92                        | 6.25                       | 7,871           | 28,975                        | 89.95                      |
| 66734                                                                                                      | 1,550                    | 124                   | 39.7               | 28.78                      | 54.92                        | 6.73                       | 140,170         | 30,525                        | 90.43                      |
| 66762                                                                                                      | 200                      | 16                    | 45.5               | 28.78                      | 54.92                        | 6.77                       | 18,095          | 30,725                        | 90.48                      |
| 64741                                                                                                      | 625                      | 50                    | 37.8               | 28.78                      | 54.92                        | 7.07                       | 56,732          | 31,350                        | 90.77                      |
| 66743                                                                                                      | 5,475                    | 438                   | 51.1               | 28.78                      | 54.92                        | 7.32                       | 498,332         | 36,825                        | 91.02                      |
| 64769                                                                                                      | 700                      | 56                    | 50.4               | 28.78                      | 54.92                        | 7.46                       | 63,813          | 37,525                        | 91.16                      |
| 66780                                                                                                      | 725                      | 58                    | 51.2               | 28.78                      | 54.92                        | 7.73                       | 66,286          | 38,250                        | 91.43                      |
| 66746                                                                                                      | 1,350                    | 108                   | 50.3               | 28.78                      | 54.92                        | 7.78                       | 123,505         | 39,600                        | 91.48                      |
| 66781                                                                                                      | 75                       | 6                     | 63.2               | 28.78                      | 54.92                        | 7.93                       | 6,873           | 39,675                        | 91.64                      |
| 66767                                                                                                      | 900                      | 72                    | 67.2               | 28.78                      | 54.92                        | 8.16                       | 82,677          | 40,575                        | 91.86                      |
| 66738                                                                                                      | 1,063                    | 85                    | 65.8               | 28.78                      | 54.92                        | 8.29                       | 97,742          | 41,638                        | 91.99                      |
| 64772                                                                                                      | 425                      | 34                    | 61.9               | 28.78                      | 54.92                        | 8.39                       | 39,140          | 42,063                        | 92.09                      |
| 66769                                                                                                      | 2,788                    | 223                   | 65.4               | 28.78                      | 54.92                        | 8.40                       | 256,751         | 44,850                        | 92.11                      |
| 64784                                                                                                      | 6,050                    | 484                   | 63.4               | 28.78                      | 54.92                        | 8.50                       | 557,836         | 50,900                        | 92.20                      |
| 64855                                                                                                      | 2,000                    | 160                   | 69.8               | 28.78                      | 54.92                        | 8.58                       | 184,571         | 52,900                        | 92.29                      |
| 64832                                                                                                      | 1,600                    | 128                   | 71.4               | 28.78                      | 54.92                        | 8.67                       | 147,798         | 54,500                        | 92.37                      |
| 64759                                                                                                      | 9,588                    | 767                   | 68.6               | 28.78                      | 54.92                        | 8.70                       | 885,892         | 64,088                        | 92.40                      |
| 64767                                                                                                      | 463                      | 37                    | 69.1               | 28.78                      | 54.92                        | 8.77                       | 42,771          | 64,550                        | 92.48                      |

| Table 19. Supply ZCTAs for lowland hardwood pulpwood net growth in KS (demand ZCTA 66741, Bourbon County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66724                                                                                                      | 25                       | 2                     | 72.1               | 28.78                      | 54.92                        | 8.82                       | 2,313           | 64,575                        | 92.52                      |
| 66773                                                                                                      | 38                       | 3                     | 74.3               | 28.78                      | 54.92                        | 8.93                       | 3,474           | 64,613                        | 92.64                      |
| 64755                                                                                                      | 3,875                    | 310                   | 80.2               | 28.78                      | 54.92                        | 9.39                       | 360,731         | 68,488                        | 93.09                      |
| 66754                                                                                                      | 1,900                    | 152                   | 77.3               | 28.78                      | 54.92                        | 9.41                       | 176,905         | 68,588                        | 93.11                      |
| 64790                                                                                                      | 100                      | 8                     | 79.0               | 28.78                      | 54.92                        | 9.40                       | 9,311           | 70,488                        | 93.11                      |
| 66771                                                                                                      | 963                      | 77                    | 82.0               | 28.78                      | 54.92                        | 9.44                       | 89,648          | 71,450                        | 93.14                      |
| 66075                                                                                                      | 3,925                    | 314                   | 88.2               | 28.78                      | 54.92                        | 9.58                       | 366,126         | 75,375                        | 93.28                      |
| 64834                                                                                                      | 88                       | 7                     | 85.5               | 28.78                      | 54.92                        | 9.61                       | 8,165           | 75,463                        | 93.31                      |
| 64748                                                                                                      | 1,725                    | 138                   | 85.5               | 28.78                      | 54.92                        | 9.68                       | 161,093         | 77,188                        | 93.39                      |
| 66739                                                                                                      | 275                      | 22                    | 85.4               | 28.78                      | 54.92                        | 9.71                       | 25,689          | 77,463                        | 93.42                      |
| 66779                                                                                                      | 5,138                    | 411                   | 83.1               | 28.78                      | 54.92                        | 9.73                       | 479,996         | 82,600                        | 93.43                      |
| 64778                                                                                                      | 1,838                    | 147                   | 82.1               | 28.78                      | 54.92                        | 9.73                       | 171,680         | 84,438                        | 93.43                      |
| 66716                                                                                                      | 1,075                    | 86                    | 83.1               | 28.78                      | 54.92                        | 9.76                       | 100,471         | 85,513                        | 93.46                      |
| 66770                                                                                                      | 25                       | 2                     | 90.3               | 28.78                      | 54.92                        | 9.77                       | 2,337           | 85,538                        | 93.48                      |
| 66775                                                                                                      | 225                      | 18                    | 77.2               | 28.78                      | 54.92                        | 9.88                       | 21,056          | 85,763                        | 93.58                      |
| 66753                                                                                                      | 1,675                    | 134                   | 84.6               | 28.78                      | 54.92                        | 9.92                       | 156,812         | 87,438                        | 93.62                      |
| 64752                                                                                                      | 888                      | 71                    | 86.7               | 28.78                      | 54.92                        | 9.92                       | 83,088          | 88,325                        | 93.62                      |
| 66755                                                                                                      | 600                      | 48                    | 94.1               | 28.78                      | 54.92                        | 10.06                      | 56,258          | 88,925                        | 93.76                      |
| 66772                                                                                                      | 175                      | 14                    | 80.0               | 28.78                      | 54.92                        | 10.14                      | 16,423          | 89,100                        | 93.85                      |
| 64756                                                                                                      | 5,925                    | 474                   | 88.2               | 28.78                      | 54.92                        | 10.24                      | 556,626         | 95,025                        | 93.95                      |
| 64801                                                                                                      | 313                      | 25                    | 94.0               | 28.78                      | 54.92                        | 10.36                      | 29,394          | 95,338                        | 94.06                      |
| 66725                                                                                                      | 4,050                    | 324                   | 98.3               | 28.78                      | 54.92                        | 10.44                      | 381,262         | 99,388                        | 94.14                      |
| 66056                                                                                                      | 3,363                    | 269                   | 97.3               | 28.78                      | 54.92                        | 10.52                      | 316,821         | 102,750                       | 94.22                      |
| 66713                                                                                                      | 125                      | 10                    | 105.5              | 28.78                      | 54.92                        | 10.80                      | 11,813          | 102,875                       | 94.51                      |
| 64750                                                                                                      | 1,413                    | 113                   | 99.6               | 28.78                      | 54.92                        | 10.81                      | 133,500         | 104,288                       | 94.51                      |
| 64779                                                                                                      | 463                      | 37                    | 100.2              | 28.78                      | 54.92                        | 10.95                      | 43,779          | 104,750                       | 94.66                      |

| Table 19. Supply ZCTAs for lowland hardwood pulpwood net growth in KS (demand ZCTA 66741, Bourbon County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66751                                                                                                      | 200                      | 16                    | 107.8              | 28.78                      | 54.92                        | 11.05                      | 18,952          | 104,950                       | 94.76                      |
| 66740                                                                                                      | 488                      | 39                    | 103.8              | 28.78                      | 54.92                        | 11.07                      | 46,204          | 105,438                       | 94.78                      |
| 64783                                                                                                      | 300                      | 24                    | 99.6               | 28.78                      | 54.92                        | 11.10                      | 28,442          | 105,738                       | 94.81                      |
| 64745                                                                                                      | 450                      | 36                    | 103.2              | 28.78                      | 54.92                        | 11.12                      | 42,670          | 106,188                       | 94.82                      |
| 66733                                                                                                      | 950                      | 76                    | 106.0              | 28.78                      | 54.92                        | 11.22                      | 90,175          | 107,138                       | 94.92                      |
| 65682                                                                                                      | 5,913                    | 473                   | 105.4              | 28.78                      | 54.92                        | 11.32                      | 561,797         | 113,050                       | 95.02                      |
| 64722                                                                                                      | 1,238                    | 99                    | 110.5              | 28.78                      | 54.92                        | 11.43                      | 117,732         | 114,288                       | 95.14                      |
| 64744                                                                                                      | 22,350                   | 1,788                 | 106.3              | 28.78                      | 54.92                        | 11.56                      | 2,129,169       | 136,638                       | 95.26                      |
| 66010                                                                                                      | 1,075                    | 86                    | 113.3              | 28.78                      | 54.92                        | 11.69                      | 102,545         | 137,713                       | 95.39                      |
| 66732                                                                                                      | 175                      | 14                    | 114.1              | 28.78                      | 54.92                        | 11.83                      | 16,719          | 137,888                       | 95.54                      |
| 66039                                                                                                      | 688                      | 55                    | 116.9              | 28.78                      | 54.92                        | 11.86                      | 65,700          | 139,788                       | 95.56                      |
| 65603                                                                                                      | 1,900                    | 152                   | 111.5              | 28.78                      | 54.92                        | 11.86                      | 181,570         | 140,475                       | 95.56                      |
| 66040                                                                                                      | 113                      | 9                     | 117.5              | 28.78                      | 54.92                        | 11.90                      | 10,755          | 140,588                       | 95.60                      |
| 66776                                                                                                      | 2,825                    | 226                   | 117.5              | 28.78                      | 54.92                        | 12.20                      | 270,913         | 143,413                       | 95.90                      |
| 66749                                                                                                      | 550                      | 44                    | 122.7              | 28.78                      | 54.92                        | 12.27                      | 52,783          | 143,963                       | 95.97                      |
| 64780                                                                                                      | 300                      | 24                    | 121.0              | 28.78                      | 54.92                        | 12.45                      | 28,847          | 144,263                       | 96.16                      |
| 67357                                                                                                      | 2,875                    | 230                   | 120.9              | 28.78                      | 54.92                        | 12.52                      | 276,644         | 147,138                       | 96.22                      |
| 66748                                                                                                      | 800                      | 64                    | 131.6              | 28.78                      | 54.92                        | 12.78                      | 77,183          | 147,938                       | 96.48                      |
| 67356                                                                                                      | 2,963                    | 237                   | 131.3              | 28.78                      | 54.92                        | 12.78                      | 285,844         | 150,900                       | 96.49                      |
| 67336                                                                                                      | 2,638                    | 211                   | 133.0              | 28.78                      | 54.92                        | 12.83                      | 254,600         | 153,538                       | 96.53                      |
| 66014                                                                                                      | 2,100                    | 168                   | 121.5              | 28.78                      | 54.92                        | 12.87                      | 202,806         | 155,638                       | 96.57                      |
| 74354                                                                                                      | 38                       | 3                     | 128.8              | 28.78                      | 54.92                        | 12.90                      | 3,623           | 155,675                       | 96.60                      |
| 66761                                                                                                      | 88                       | 7                     | 135.7              | 28.78                      | 54.92                        | 12.99                      | 8,461           | 155,763                       | 96.70                      |
| 64781                                                                                                      | 450                      | 36                    | 131.4              | 28.78                      | 54.92                        | 13.17                      | 43,591          | 156,213                       | 96.87                      |
| 66710                                                                                                      | 913                      | 73                    | 132.2              | 28.78                      | 54.92                        | 13.18                      | 88,402          | 157,125                       | 96.88                      |
| 66015                                                                                                      | 300                      | 24                    | 138.9              | 28.78                      | 54.92                        | 13.22                      | 29,078          | 157,425                       | 96.93                      |

| Table 19. Supply ZCTAs for lowland hardwood pulpwood net growth in KS (demand ZCTA 66741, Bourbon County). |                          |                       |                    |                            |                              |                            |                 |                               |                            |
|------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| Supply ZCTA                                                                                                | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
| 66720                                                                                                      | 1,000                    | 80                    | 133.8              | 28.78                      | 54.92                        | 13.26                      | 96,964          | 158,425                       | 96.96                      |
| 65785                                                                                                      | 21,988                   | 1,759                 | 128.5              | 28.78                      | 54.92                        | 13.32                      | 2,133,275       | 180,413                       | 97.02                      |
| 66026                                                                                                      | 25                       | 2                     | 135.0              | 28.78                      | 54.92                        | 13.33                      | 2,426           | 180,438                       | 97.03                      |
| 67341                                                                                                      | 413                      | 33                    | 134.6              | 28.78                      | 54.92                        | 13.39                      | 40,052          | 180,850                       | 97.10                      |
| 66072                                                                                                      | 38                       | 3                     | 132.6              | 28.78                      | 54.92                        | 13.43                      | 3,642           | 180,888                       | 97.13                      |
| 66053                                                                                                      | 38                       | 3                     | 143.4              | 28.78                      | 54.92                        | 13.43                      | 3,643           | 180,925                       | 97.13                      |
| 64730                                                                                                      | 39,613                   | 3,169                 | 134.2              | 28.78                      | 54.92                        | 13.50                      | 3,850,606       | 220,538                       | 97.21                      |
| 64724                                                                                                      | 288                      | 23                    | 142.0              | 28.78                      | 54.92                        | 13.94                      | 28,073          | 220,825                       | 97.65                      |
| 67330                                                                                                      | 588                      | 47                    | 148.3              | 28.78                      | 54.92                        | 13.98                      | 57,390          | 221,413                       | 97.69                      |
| 66714                                                                                                      | 488                      | 39                    | 145.1              | 28.78                      | 54.92                        | 14.01                      | 47,637          | 221,900                       | 97.72                      |
| 67332                                                                                                      | 513                      | 41                    | 151.0              | 28.78                      | 54.92                        | 14.04                      | 50,093          | 222,413                       | 97.74                      |
| 64738                                                                                                      | 10,213                   | 817                   | 141.1              | 28.78                      | 54.92                        | 14.04                      | 998,224         | 232,625                       | 97.75                      |
| 65635                                                                                                      | 3,363                    | 269                   | 140.3              | 28.78                      | 54.92                        | 14.14                      | 328,989         | 235,988                       | 97.84                      |
| 67335                                                                                                      | 3,925                    | 314                   | 149.0              | 28.78                      | 54.92                        | 14.18                      | 384,197         | 238,775                       | 97.88                      |
| 64776                                                                                                      | 2,788                    | 223                   | 142.2              | 28.78                      | 54.92                        | 14.18                      | 272,842         | 242,700                       | 97.88                      |
| 66091                                                                                                      | 700                      | 56                    | 151.2              | 28.78                      | 54.92                        | 14.24                      | 68,561          | 243,400                       | 97.94                      |
| 74343                                                                                                      | 25                       | 2                     | 145.6              | 28.78                      | 54.92                        | 14.35                      | 2,451           | 243,425                       | 98.06                      |
| 66032                                                                                                      | 1,225                    | 98                    | 151.6              | 28.78                      | 54.92                        | 14.47                      | 120,256         | 244,650                       | 98.17                      |
| 66757                                                                                                      | 2,213                    | 177                   | 150.6              | 28.78                      | 54.92                        | 14.49                      | 217,256         | 246,863                       | 98.19                      |
| 65649                                                                                                      | 6,100                    | 488                   | 143.9              | 28.78                      | 54.92                        | 14.50                      | 599,027         | 252,963                       | 98.20                      |
| 66758                                                                                                      | 238                      | 19                    | 151.6              | 28.78                      | 54.92                        | 14.65                      | 23,360          | 253,200                       | 98.36                      |
| 66064                                                                                                      | 638                      | 51                    | 153.2              | 28.78                      | 54.92                        | 14.68                      | 62,719          | 253,838                       | 98.38                      |
| 67354                                                                                                      | 963                      | 77                    | 159.9              | 28.78                      | 54.92                        | 14.72                      | 94,735          | 254,800                       | 98.43                      |
| 65601                                                                                                      | 3,688                    | 295                   | 155.3              | 28.78                      | 54.92                        | 15.05                      | 364,169         | 258,488                       | 98.76                      |
| 65774                                                                                                      | 38                       | 3                     | 157.0              | 28.78                      | 54.92                        | 15.15                      | 3,707           | 258,525                       | 98.85                      |
| 64770                                                                                                      | 163                      | 13                    | 157.4              | 28.78                      | 54.92                        | 15.27                      | 16,084          | 258,688                       | 98.98                      |

Table 19. Supply ZCTAs for lowland hardwood pulpwood net growth in KS (demand ZCTA 66741, Bourbon County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66736       | 10,650                   | 852                   | 159.4              | 28.78                      | 54.92                        | 15.34                      | 1,054,769       | 269,338                       | 99.04                      |

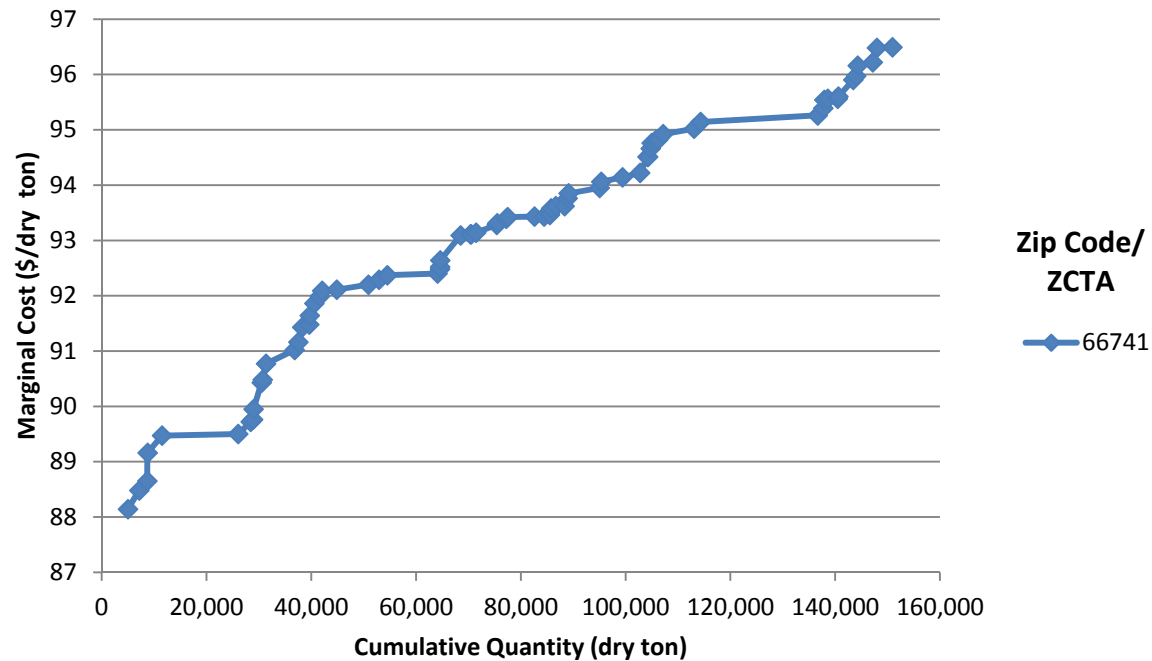


Figure 42. Marginal cost curve for lowland hardwood pulpwood net growth in KS (ZCTA 66741, Bourbon County).



### 3.3.1.3 Mixed Natural Softwood and Hardwood

#### 3.3.1.3.1 Total Inventory

The top ten ZCTA locations for mixed natural softwood and hardwood pulpwood total inventory were all located in east Kansas (Figure 43). Hundred fifty thousand dry tons of mixed natural softwood and hardwood pulpwood total inventory are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$82.02 to \$85.61/dry ton. The median MC ranged from \$82.81 to \$85.47/dry ton (Table 20, Figure 44).

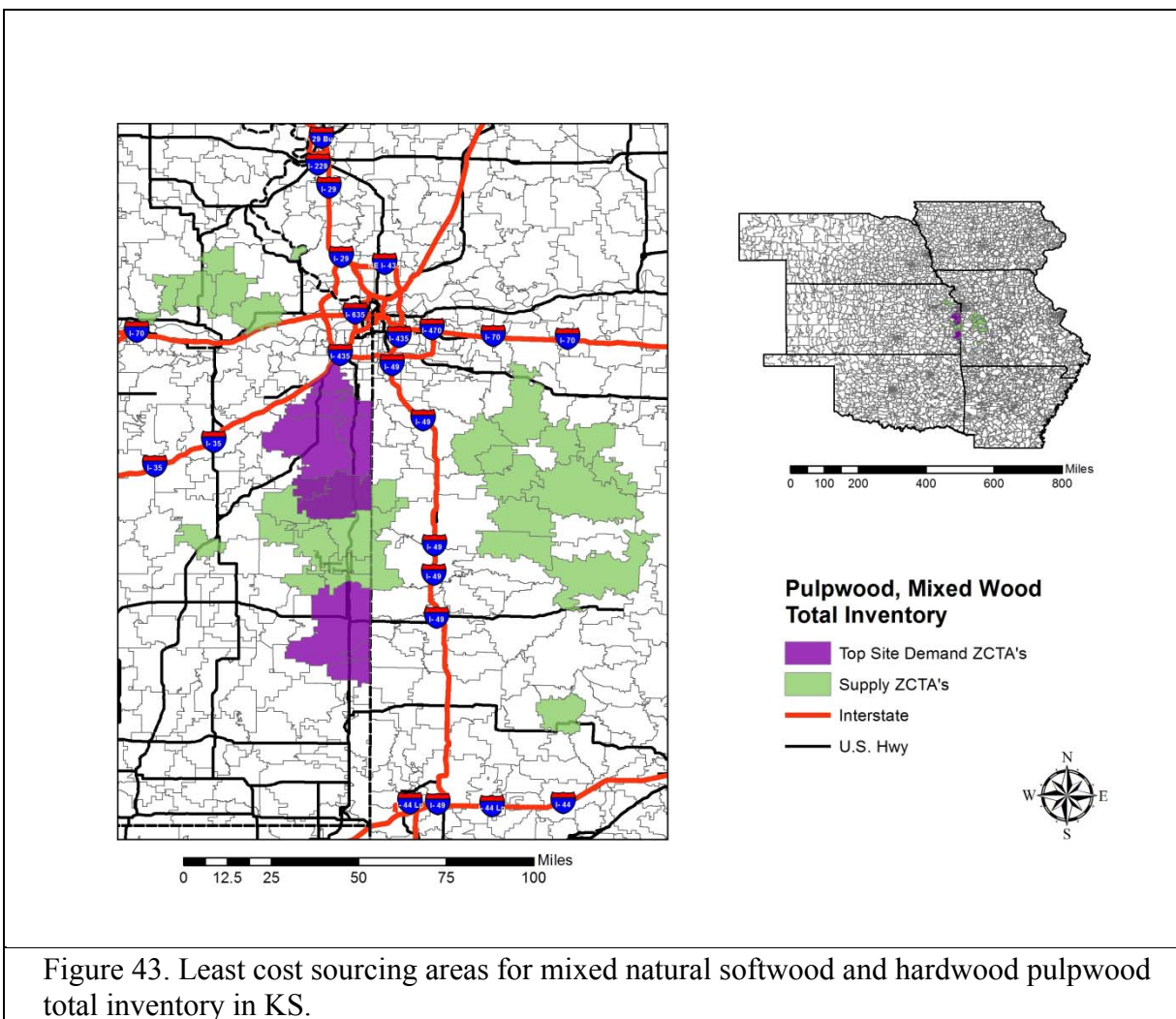


Table 20. Top ten locations in KS for mixed natural softwood and hardwood pulpwood total inventory based on average total cost per dry ton.

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66040                 | Miami    | 150,825                  | 12,370,770      | 13,064      | 19                    | 82.02                     | 82.81                             |
| 66026                 | Miami    | 153,975                  | 12,646,426      | 12,319      | 22                    | 82.13                     | 83.42                             |
| 66701                 | Bourbon  | 154,000                  | 12,805,258      | 12,401      | 17                    | 83.15                     | 84.11                             |
| 66053                 | Miami    | 151,325                  | 12,662,813      | 13,408      | 25                    | 83.68                     | 83.78                             |
| 66071                 | Franklin | 151,238                  | 12,677,064      | 12,309      | 23                    | 83.82                     | 84.11                             |
| 66711                 | Bourbon  | 152,888                  | 12,879,941      | 12,232      | 16                    | 84.24                     | 85.10                             |
| 66013                 | Johnson  | 150,063                  | 12,678,165      | 13,533      | 23                    | 84.49                     | 83.78                             |
| 66741                 | Bourbon  | 152,888                  | 12,942,609      | 12,321      | 16                    | 84.65                     | 85.47                             |
| 66083                 | Johnson  | 152,488                  | 12,937,276      | 12,313      | 25                    | 84.84                     | 84.42                             |
| 66062                 | Johnson  | 152,513                  | 13,056,765      | 12,313      | 25                    | 85.61                     | 84.80                             |

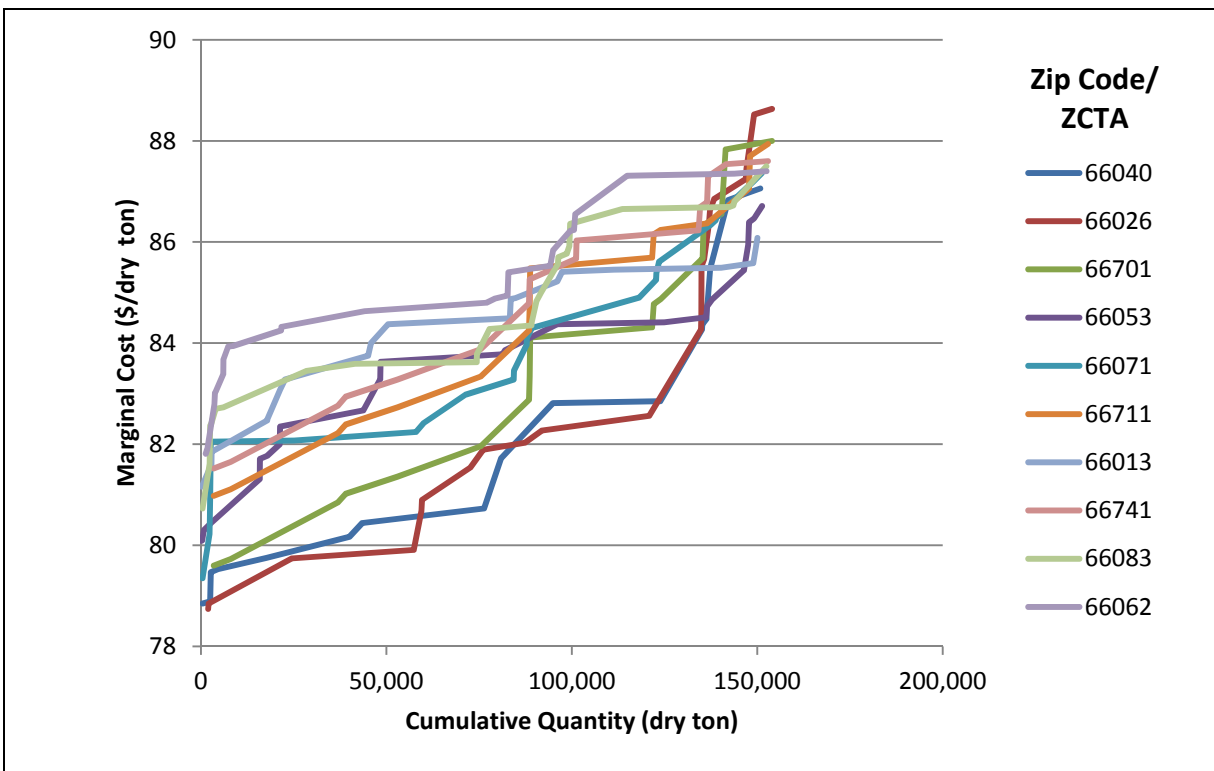


Figure 44. Marginal cost curves for the top ten locations for mixed natural softwood and hardwood pulpwood total inventory in KS.

Demand ZCTA 66040 (Miami County, KS) has the least average total costs per dry ton of mixed natural softwood and hardwood pulpwood total inventory (Figure 45). Hundred fifty thousand dry tons of mixed natural softwood and hardwood pulpwood total inventory are available within 80 mile radius from ZCTA 66040. The median MC per dry ton in the least cost sourcing area (ZCTA 66040, Miami County, KS) ranged from \$78.85 to \$87.06/dry ton (Table 21, Figure 46).

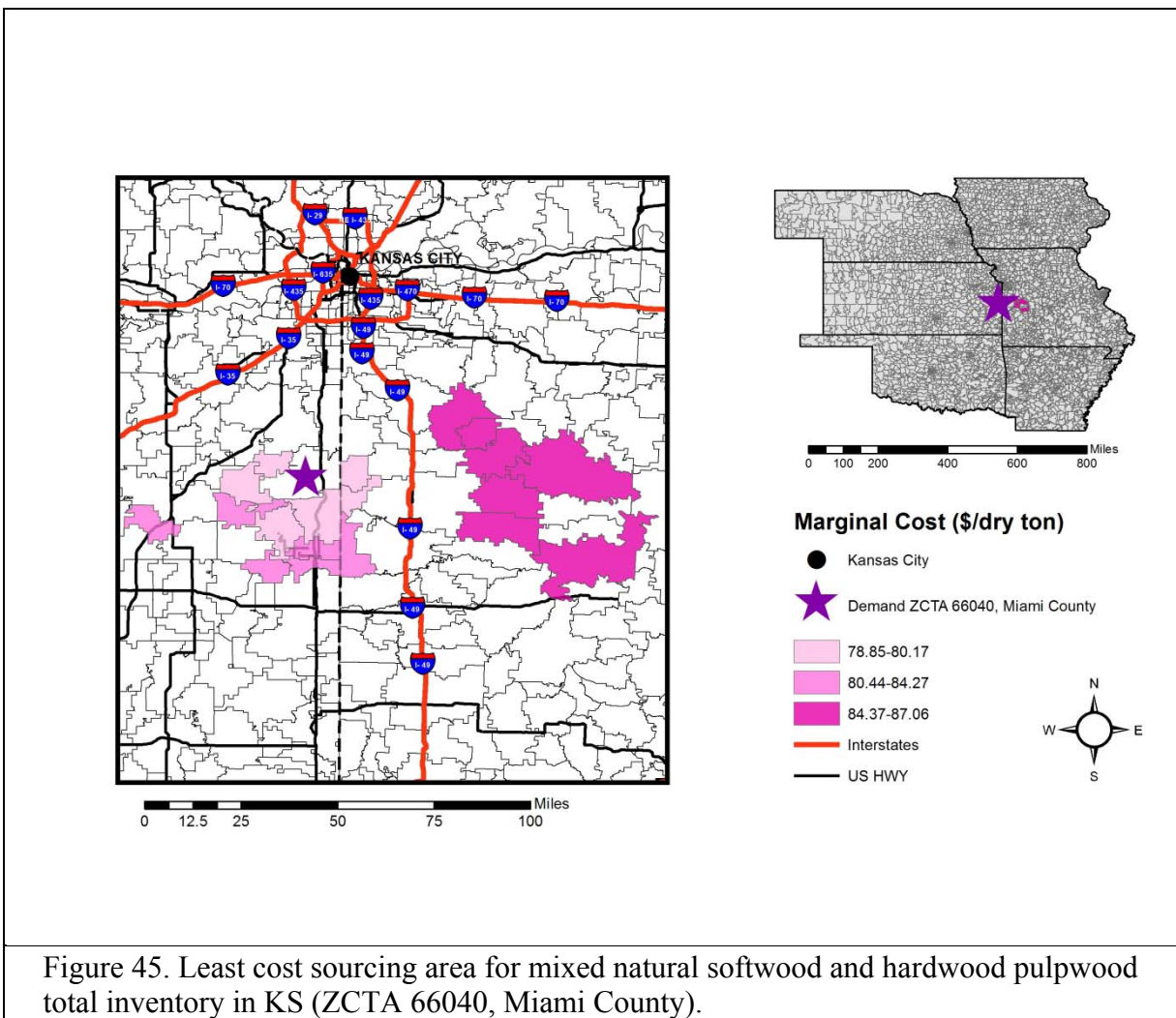


Table 21. Supply ZCTAs for mixed natural softwood and hardwood pulpwood total inventory in KS (demand ZCTA 66040, Miami County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles ) | Resource Cost (\$) | Harvesting Cost (\$) | Trucking Cost (\$) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|---------------------|--------------------|----------------------|--------------------|-----------------|-------------------------------|----------------------------|
| 66026       | 425                      | 34                    | 24.6                | 22.65              | 50.71                | 5.49               | 33512.3         | 425                           | 78.85                      |
| 66075       | 2,088                    | 167                   | 29.4                | 22.65              | 50.71                | 5.53               | 164675          | 2512.5                        | 78.89                      |
| 64723       | 163                      | 13                    | 30.6                | 22.65              | 50.71                | 6.11               | 12914.2         | 2675                          | 79.47                      |
| 66072       | 1,913                    | 153                   | 30.0                | 22.65              | 50.71                | 6.17               | 152105          | 4587.5                        | 79.53                      |
| 64722       | 13,038                   | 1,043                 | 36.9                | 22.65              | 50.71                | 6.39               | 1039682         | 17625                         | 79.75                      |
| 66053       | 13                       | 1                     | 45.6                | 22.65              | 50.71                | 6.75               | 1001.37         | 17637.5                       | 80.11                      |
| 66056       | 22,425                   | 1,794                 | 38.4                | 22.65              | 50.71                | 6.81               | 1797852         | 40062.5                       | 80.17                      |
| 66767       | 3,425                    | 274                   | 51.6                | 22.65              | 50.71                | 7.08               | 275492          | 43487.5                       | 80.44                      |
| 66014       | 32,875                   | 2,630                 | 41.5                | 22.65              | 50.71                | 7.37               | 2654029         | 76362.5                       | 80.73                      |
| 66738       | 4,575                    | 366                   | 68.1                | 22.65              | 50.71                | 8.36               | 373871          | 80937.5                       | 81.72                      |
| 64752       | 13,988                   | 1,119                 | 78.5                | 22.65              | 50.71                | 9.45               | 1158282         | 94925                         | 82.81                      |
| 66754       | 28,938                   | 2,315                 | 77.8                | 22.65              | 50.71                | 9.49               | 2397367         | 123863                        | 82.85                      |

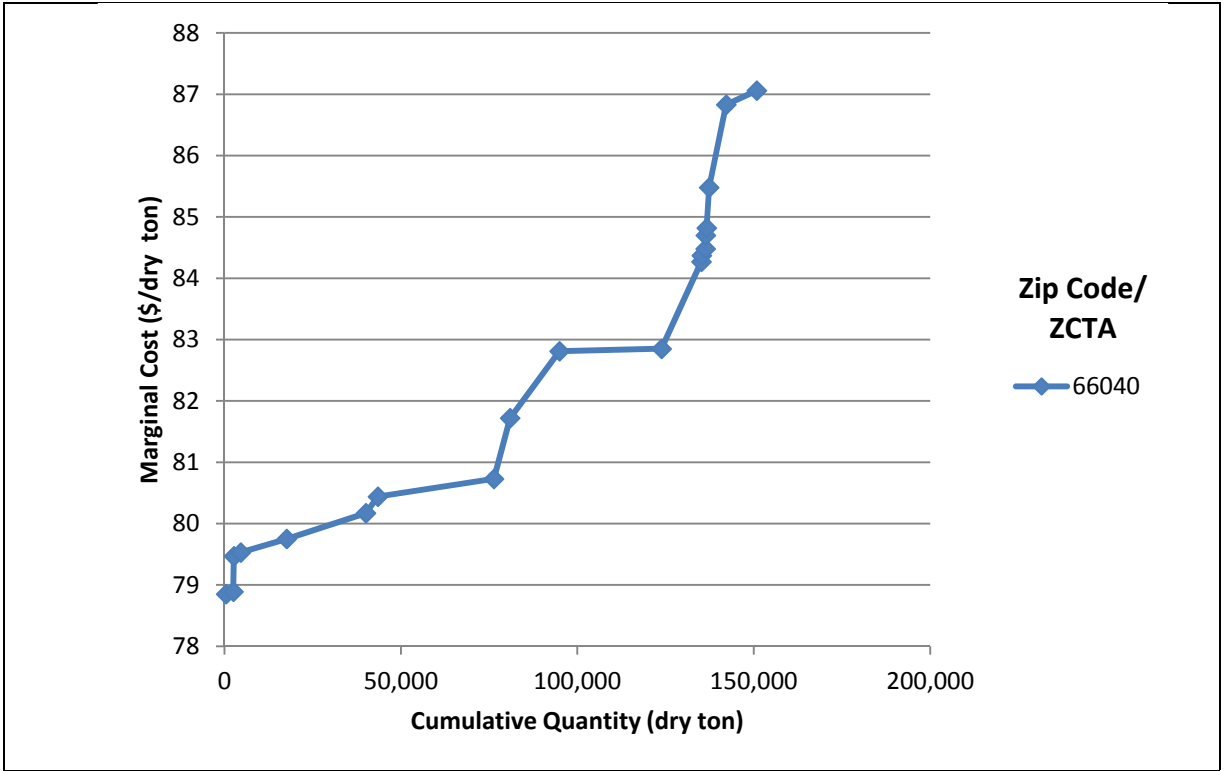


Figure 46. Marginal cost curve for mixed natural softwood and hardwood pulpwood total inventory in KS (ZCTA 66040, Miami County).

### 3.3.2 Sawtimber

#### 3.3.2.1 Upland Hardwood

##### 3.3.2.1.1 Total Inventory (with exclusions)

The top ten ZCTA locations for upland hardwood sawtimber total inventory were all located in east and south-east Kansas (Figure 47). Half a million dry tons of upland hardwood sawtimber total inventory are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$144.55 to \$145.42/dry ton. The median MC ranged from \$144.42 to \$146.51/dry ton (Table 22, Figure 48).

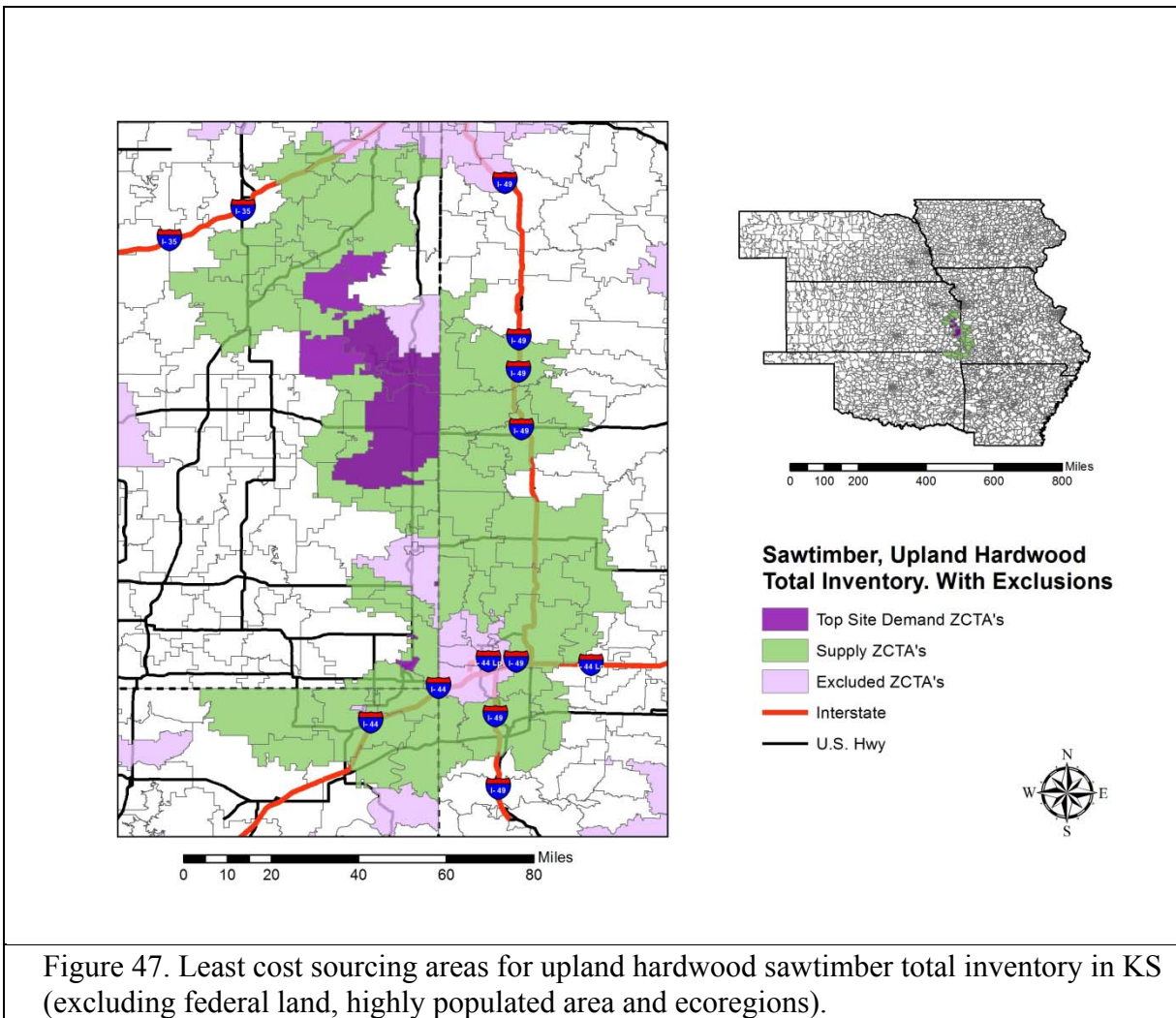


Table 22. Top ten locations in KS for upland hardwood sawtimber total inventory based on average total cost per dry ton (with exclusions).

| Demand Zip Code /ZCTA | County   | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|----------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66738                 | Linn     | 500,175                  | 72,302,160      | 140,285     | 12                    | 144.55                    | 145.41                            |
| 66767                 | Linn     | 563,138                  | 81,402,169      | 129,586     | 8                     | 144.55                    | 144.51                            |
| 66010                 | Allen    | 500,975                  | 72,451,548      | 105,739     | 11                    | 144.62                    | 145.78                            |
| 66056                 | Linn     | 502,463                  | 72,973,121      | 114,917     | 18                    | 145.23                    | 146.51                            |
| 66728                 | Cherokee | 503,763                  | 73,169,947      | 134,573     | 29                    | 145.25                    | 145.88                            |
| 66072                 | Miami    | 504,850                  | 73,341,340      | 108,690     | 17                    | 145.27                    | 145.10                            |
| 66701                 | Bourbon  | 621,500                  | 90,301,218      | 161,512     | 22                    | 145.30                    | 144.42                            |
| 66770                 | Cherokee | 506,063                  | 73,575,024      | 126,576     | 30                    | 145.39                    | 145.91                            |
| 66026                 | Miami    | 511,163                  | 74,323,508      | 101,791     | 19                    | 145.40                    | 145.38                            |
| 66760                 | Cherokee | 514,650                  | 74,839,908      | 172,853     | 27                    | 145.42                    | 145.07                            |

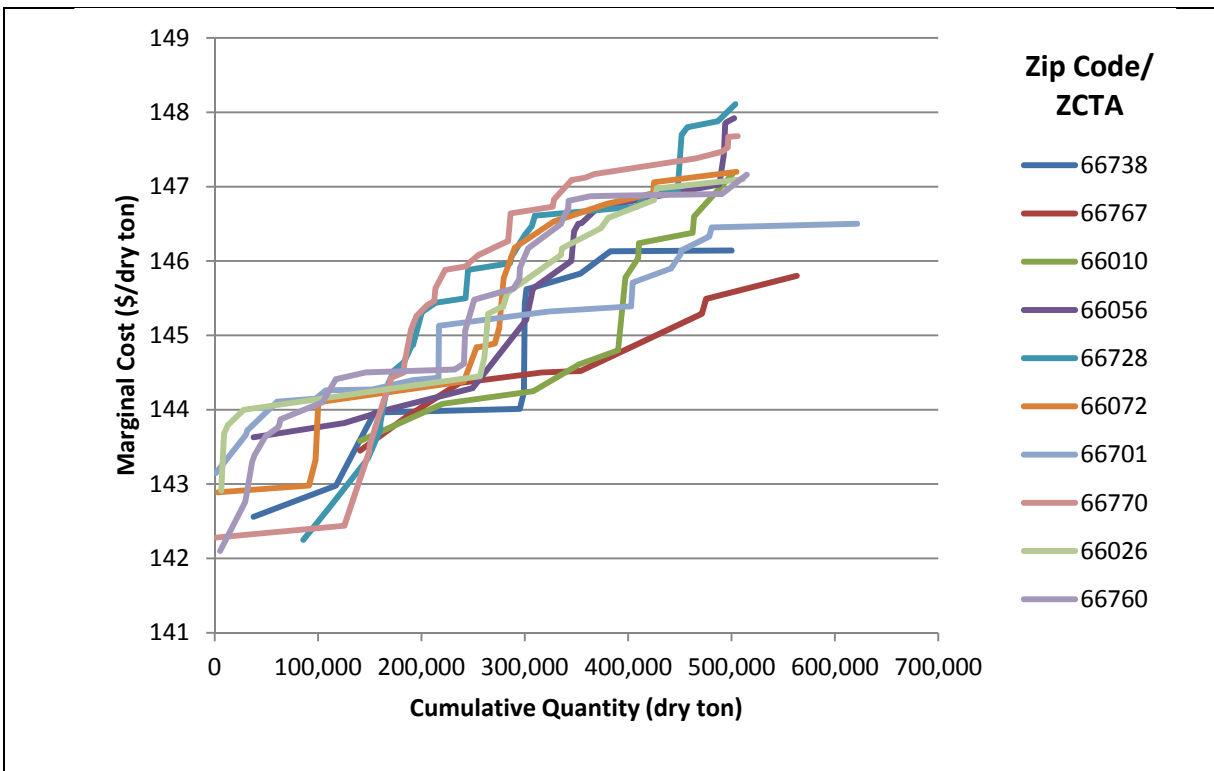


Figure 48. Marginal cost curves for the top ten locations for upland hardwood sawtimber total inventory in KS (with exclusions).



Demand ZCTA 66738 (Linn County, KS) has the least average total costs per dry ton of upland hardwood sawtimber total inventory (Figure 49). Half a million dry tons of upland hardwood sawtimber total inventory are available within 80 mile radius from ZCTA 66738. The MC per dry ton in the least cost sourcing area (ZCTA 66738, Linn County, KS) ranged from \$142.56 to \$146.14/dry ton (Table 23, Figure 50).

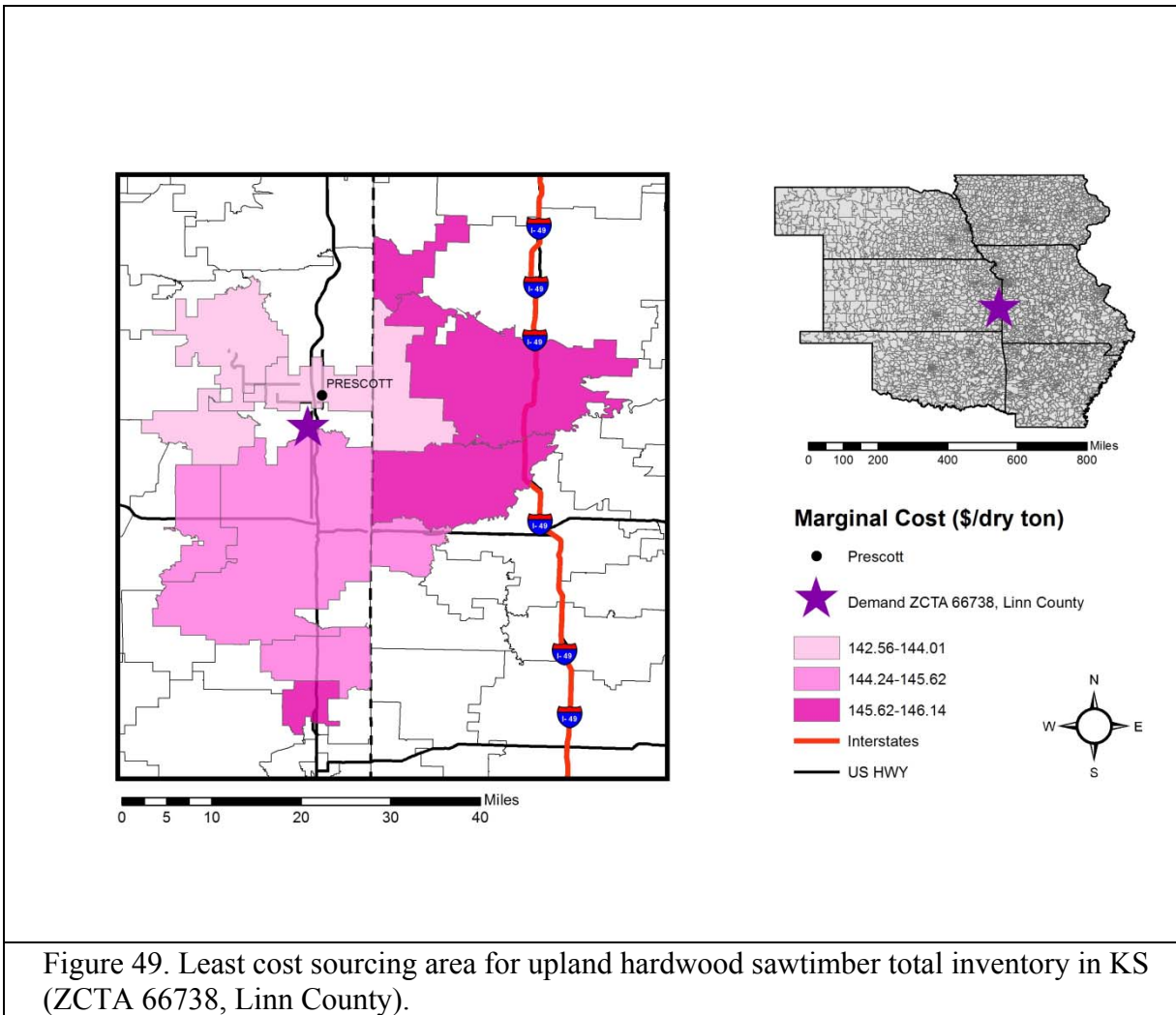




Table 23. Supply ZCTAs for upland hardwood sawtimber total inventory in KS (demand ZCTA 66738, Linn County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66767       | 37,650                   | 3,012                 | 18.2               | 92.32                      | 45.58                        | 4.66                       | 5,367,414       | 37,650                        | 142.56                     |
| 66754       | 79,750                   | 6,380                 | 19.0               | 92.32                      | 45.58                        | 5.08                       | 11,402,695      | 117,400                       | 142.98                     |
| 64752       | 37,175                   | 2,974                 | 26.3               | 92.32                      | 45.58                        | 6.06                       | 5,351,885       | 154,575                       | 143.96                     |
| 66056       | 140,713                  | 11,257                | 33.0               | 92.32                      | 45.58                        | 6.10                       | 20,263,392      | 295,288                       | 144.01                     |
| 66701       | 4,000                    | 320                   | 39.6               | 92.32                      | 45.58                        | 6.34                       | 576,964         | 299,288                       | 144.24                     |
| 66769       | 763                      | 61                    | 54.6               | 92.32                      | 45.58                        | 7.48                       | 110,852         | 300,050                       | 145.38                     |
| 64741       | 175                      | 14                    | 55.9               | 92.32                      | 45.58                        | 7.54                       | 25,452          | 300,225                       | 145.44                     |
| 66711       | 1,375                    | 110                   | 60.4               | 92.32                      | 45.58                        | 7.71                       | 200,223         | 300,725                       | 145.62                     |
| 64778       | 500                      | 40                    | 48.1               | 92.32                      | 45.58                        | 7.71                       | 72,808          | 302,100                       | 145.62                     |
| 64722       | 51,788                   | 4,143                 | 61.4               | 92.32                      | 45.58                        | 7.93                       | 7,552,401       | 353,888                       | 145.83                     |
| 66712       | 28,800                   | 2,304                 | 68.2               | 92.32                      | 45.58                        | 8.23                       | 4,208,513       | 382,688                       | 146.13                     |
| 64779       | 117,488                  | 9,399                 | 62.0               | 92.32                      | 45.58                        | 8.24                       | 17,169,561      | 500,175                       | 146.14                     |
| 66741       | 500                      | 40                    | 65.6               | 92.32                      | 45.58                        | 8.29                       | 73,094          | 500,675                       | 146.19                     |
| 66014       | 87,800                   | 7,024                 | 57.3               | 92.32                      | 45.58                        | 8.46                       | 12,850,238      | 588,475                       | 146.36                     |
| 66734       | 29,200                   | 2,336                 | 70.3               | 92.32                      | 45.58                        | 8.68                       | 4,280,149       | 617,675                       | 146.58                     |
| 64772       | 106,163                  | 8,493                 | 70.3               | 92.32                      | 45.58                        | 8.71                       | 15,564,446      | 723,838                       | 146.61                     |
| 66735       | 1,088                    | 87                    | 76.5               | 92.32                      | 45.58                        | 8.73                       | 159,468         | 724,925                       | 146.64                     |
| 66779       | 1,413                    | 113                   | 72.3               | 92.32                      | 45.58                        | 8.80                       | 207,215         | 726,338                       | 146.70                     |
| 66756       | 40,713                   | 3,257                 | 75.8               | 92.32                      | 45.58                        | 8.96                       | 5,979,172       | 767,050                       | 146.86                     |
| 64771       | 24,013                   | 1,921                 | 77.1               | 92.32                      | 45.58                        | 9.01                       | 3,527,730       | 791,063                       | 146.91                     |
| 64728       | 7,963                    | 637                   | 83.2               | 92.32                      | 45.58                        | 9.28                       | 1,171,924       | 799,025                       | 147.18                     |
| 66746       | 363                      | 29                    | 79.8               | 92.32                      | 45.58                        | 9.69                       | 53,504          | 799,388                       | 147.60                     |
| 64790       | 27,263                   | 2,181                 | 87.4               | 92.32                      | 45.58                        | 9.72                       | 4,024,544       | 826,650                       | 147.62                     |
| 64767       | 115,963                  | 9,277                 | 88.2               | 92.32                      | 45.58                        | 9.95                       | 17,145,576      | 942,613                       | 147.85                     |
| 64780       | 75,263                   | 6,021                 | 85.5               | 92.32                      | 45.58                        | 10.00                      | 11,131,363      | 1,017,875                     | 147.90                     |

| Table 23. Supply ZCTAs for upland hardwood sawtimber total inventory in KS (demand ZCTA 66738, Linn County). |                                    |                             |                          |                                  |                                    |                                  |                    |                                     |                                  |
|--------------------------------------------------------------------------------------------------------------|------------------------------------|-----------------------------|--------------------------|----------------------------------|------------------------------------|----------------------------------|--------------------|-------------------------------------|----------------------------------|
| Suppl<br>y<br>ZCTA                                                                                           | Total<br>Quantit<br>y (dry<br>ton) | Number<br>of Truck<br>Loads | Round<br>Trip<br>(miles) | Resource<br>Cost<br>(\$/dry ton) | Harvesting<br>Cost<br>(\$/dry ton) | Trucking<br>Cost<br>(\$/dry ton) | Total Cost<br>(\$) | Cumulative<br>Quantity<br>(dry ton) | Marginal<br>Cost<br>(\$/dry ton) |
| 66064                                                                                                        | 6,488                              | 519                         | 88.9                     | 92.32                            | 45.58                              | 10.26                            | 961,231            | 1,024,363                           | 148.17                           |
| 64769                                                                                                        | 2,325                              | 186                         | 103.5                    | 92.32                            | 45.58                              | 11.01                            | 346,226            | 1,026,688                           | 148.91                           |
| 66042                                                                                                        | 2,700                              | 216                         | 96.6                     | 92.32                            | 45.58                              | 11.04                            | 402,135            | 1,029,388                           | 148.94                           |
| 66091                                                                                                        | 7,125                              | 570                         | 91.9                     | 92.32                            | 45.58                              | 11.05                            | 1,061,254          | 1,036,513                           | 148.95                           |
| 66013                                                                                                        | 950                                | 76                          | 112.8                    | 92.32                            | 45.58                              | 11.06                            | 141,512            | 1,037,463                           | 148.96                           |
| 64750                                                                                                        | 3,388                              | 271                         | 108.0                    | 92.32                            | 45.58                              | 11.13                            | 504,833            | 1,040,850                           | 149.03                           |
| 66033                                                                                                        | 3,400                              | 272                         | 99.4                     | 92.32                            | 45.58                              | 11.14                            | 506,738            | 1,044,250                           | 149.04                           |
| 66781                                                                                                        | 24,288                             | 1,943                       | 111.4                    | 92.32                            | 45.58                              | 11.22                            | 3,621,718          | 1,068,538                           | 149.12                           |
| 64762                                                                                                        | 9,175                              | 734                         | 108.9                    | 92.32                            | 45.58                              | 11.27                            | 1,368,697          | 1,077,713                           | 149.18                           |
| 66760                                                                                                        | 188                                | 15                          | 111.0                    | 92.32                            | 45.58                              | 11.29                            | 27,973             | 1,077,900                           | 149.19                           |
| 66032                                                                                                        | 12,375                             | 990                         | 98.3                     | 92.32                            | 45.58                              | 11.30                            | 1,846,406          | 1,090,275                           | 149.20                           |
| 64783                                                                                                        | 75,050                             | 6,004                       | 108.0                    | 92.32                            | 45.58                              | 11.42                            | 11,206,660         | 1,165,325                           | 149.32                           |
| 64784                                                                                                        | 20,063                             | 1,605                       | 110.3                    | 92.32                            | 45.58                              | 11.51                            | 2,997,601          | 1,185,388                           | 149.41                           |
| 64744                                                                                                        | 53,588                             | 4,287                       | 114.7                    | 92.32                            | 45.58                              | 11.88                            | 8,026,317          | 1,238,975                           | 149.78                           |
| 66071                                                                                                        | 15,650                             | 1,252                       | 124.4                    | 92.32                            | 45.58                              | 11.93                            | 2,344,823          | 1,254,625                           | 149.83                           |
| 64832                                                                                                        | 5,325                              | 426                         | 119.7                    | 92.32                            | 45.58                              | 11.95                            | 797,980            | 1,259,950                           | 149.86                           |
| 64759                                                                                                        | 31,800                             | 2,544                       | 120.3                    | 92.32                            | 45.58                              | 12.08                            | 4,769,496          | 1,291,750                           | 149.98                           |
| 66724                                                                                                        | 10,513                             | 841                         | 120.3                    | 92.32                            | 45.58                              | 12.10                            | 1,576,906          | 1,302,263                           | 150.00                           |
| 66773                                                                                                        | 12,075                             | 966                         | 122.5                    | 92.32                            | 45.58                              | 12.22                            | 1,812,670          | 1,314,338                           | 150.12                           |
| 66083                                                                                                        | 3,588                              | 287                         | 129.8                    | 92.32                            | 45.58                              | 12.25                            | 538,679            | 1,317,925                           | 150.15                           |
| 66728                                                                                                        | 1,450                              | 116                         | 126.7                    | 92.32                            | 45.58                              | 12.26                            | 217,737            | 1,319,375                           | 150.16                           |
| 66080                                                                                                        | 1,950                              | 156                         | 115.0                    | 92.32                            | 45.58                              | 12.45                            | 293,186            | 1,321,325                           | 150.35                           |
| 66078                                                                                                        | 4,288                              | 343                         | 119.0                    | 92.32                            | 45.58                              | 12.93                            | 646,693            | 1,325,613                           | 150.83                           |
| 66739                                                                                                        | 85,888                             | 6,871                       | 133.7                    | 92.32                            | 45.58                              | 13.00                            | 12,960,213         | 1,411,500                           | 150.90                           |
| 66079                                                                                                        | 4,213                              | 337                         | 132.8                    | 92.32                            | 45.58                              | 13.08                            | 636,016            | 1,415,713                           | 150.98                           |

Table 23. Supply ZCTAs for upland hardwood sawtimber total inventory in KS (demand ZCTA 66738, Linn County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64855       | 6,663                    | 533                   | 140.4              | 92.32                      | 45.58                        | 13.24                      | 1,006,986       | 1,422,375                     | 151.14                     |
| 64756       | 19,638                   | 1,571                 | 135.1              | 92.32                      | 45.58                        | 13.25                      | 2,968,292       | 1,442,013                     | 151.15                     |
| 64781       | 145,638                  | 11,651                | 139.8              | 92.32                      | 45.58                        | 13.48                      | 22,047,105      | 1,587,650                     | 151.38                     |
| 64755       | 12,863                   | 1,029                 | 146.1              | 92.32                      | 45.58                        | 13.71                      | 1,950,129       | 1,600,513                     | 151.61                     |
| 66021       | 2,688                    | 215                   | 152.0              | 92.32                      | 45.58                        | 13.95                      | 408,092         | 1,603,200                     | 151.85                     |
| 64748       | 5,713                    | 457                   | 151.8              | 92.32                      | 45.58                        | 14.06                      | 868,112         | 1,608,913                     | 151.97                     |
| 66713       | 38,038                   | 3,043                 | 153.8              | 92.32                      | 45.58                        | 14.09                      | 5,781,247       | 1,646,950                     | 151.99                     |
| 64738       | 24,513                   | 1,961                 | 149.5              | 92.32                      | 45.58                        | 14.36                      | 3,732,278       | 1,671,463                     | 152.26                     |
| 66067       | 12,013                   | 961                   | 159.6              | 92.32                      | 45.58                        | 14.76                      | 1,833,852       | 1,675,088                     | 152.66                     |
| 66092       | 3,625                    | 290                   | 158.6              | 92.32                      | 45.58                        | 14.76                      | 553,396         | 1,687,100                     | 152.66                     |
| 66857       | 13,738                   | 1,099                 | 156.4              | 92.32                      | 45.58                        | 14.91                      | 2,099,293       | 1,700,838                     | 152.81                     |
| 65785       | 52,725                   | 4,218                 | 159.6              | 92.32                      | 45.58                        | 15.05                      | 8,064,234       | 1,753,563                     | 152.95                     |

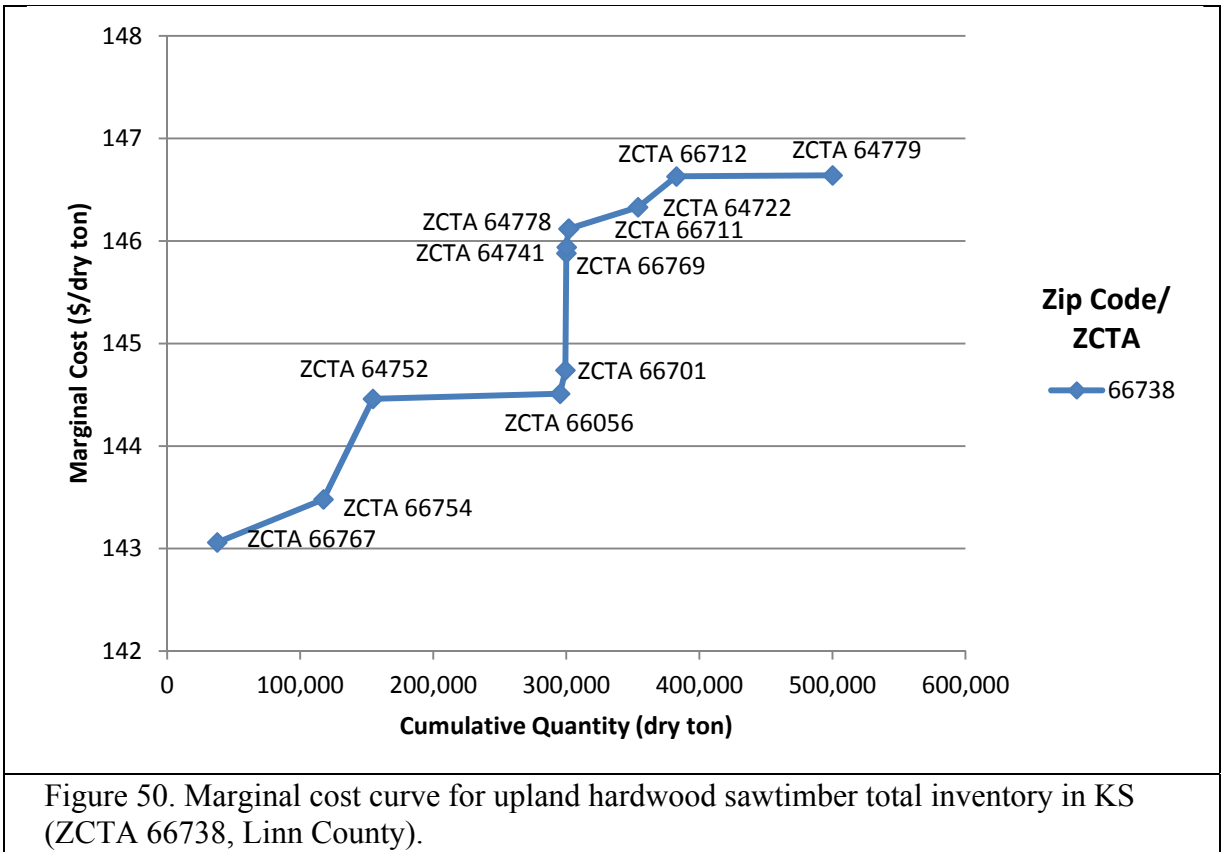


Figure 50. Marginal cost curve for upland hardwood sawtimber total inventory in KS (ZCTA 66738, Linn County).

### 3.3.2.2 Lowland Hardwood

#### 3.3.2.2.1 Total Inventory (with exclusions)

The top ten ZCTA locations for lowland hardwood sawtimber total inventory were located in the north-east and central Kansas (Figure 51). Half a million dry tons of lowland hardwood sawtimber total inventory are available within 80 mile radius in KS. ATC per dry ton in the least cost sourcing areas ranged from \$153.20 to \$154.60/dry ton. The median MC ranged from \$154.10 to \$159.12/dry ton (Table 24, Figure 52).

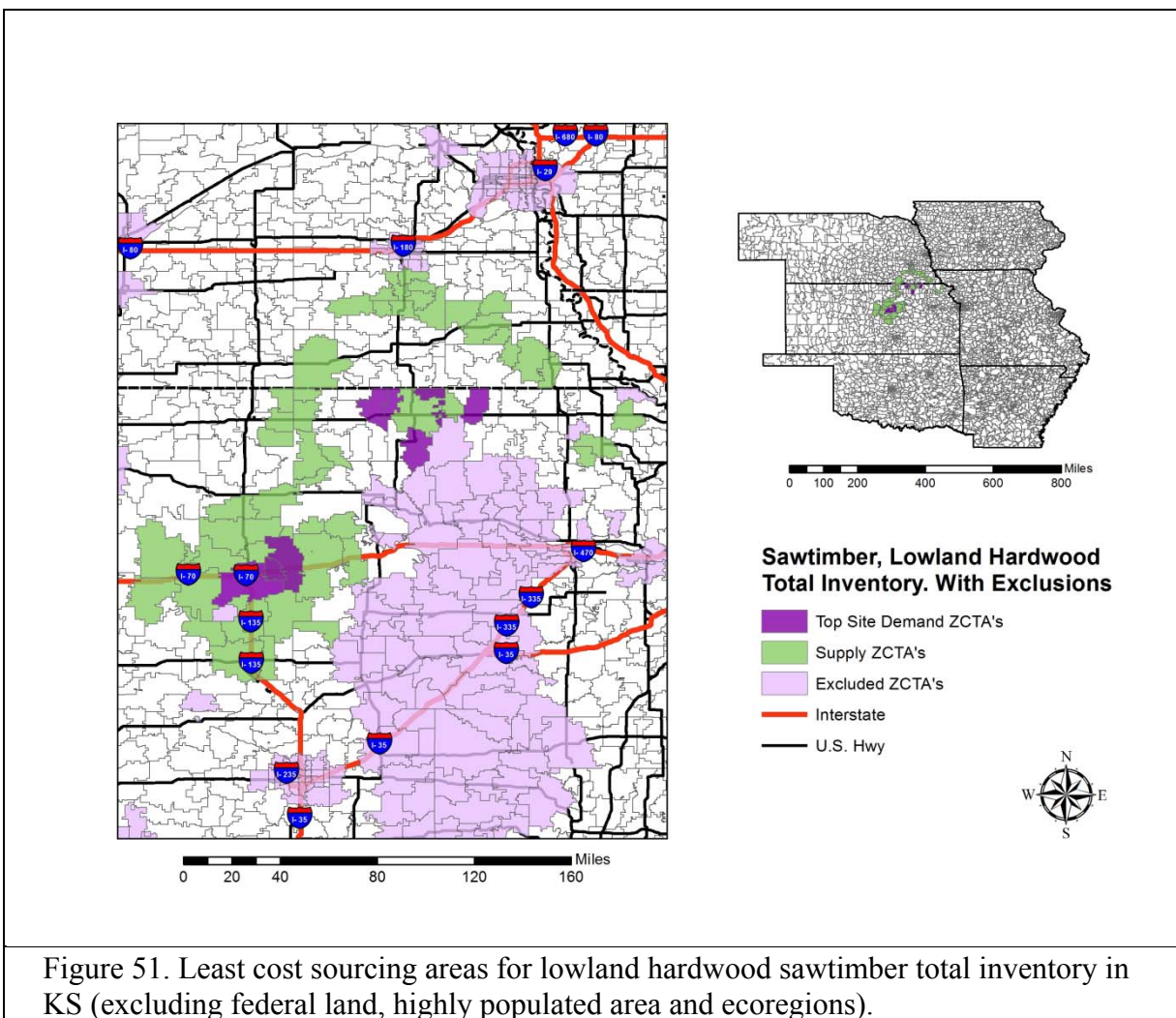


Table 24. Top ten locations in KS for lowland hardwood sawtimber total inventory based on average total cost per dry ton (with exclusions).

| Demand Zip Code /ZCTA | County     | Total Quantity (dry ton) | Total Cost (\$) | Truck Loads | Number of Supply ZCTA | Average Cost (\$/dry ton) | Median Marginal Cost (\$/dry ton) |
|-----------------------|------------|--------------------------|-----------------|-------------|-----------------------|---------------------------|-----------------------------------|
| 66438                 | Marshall   | 500,850                  | 76,727,977      | 53,268      | 8                     | 153.20                    | 157.36                            |
| 67482                 | Dickinson  | 502,763                  | 77,082,966      | 68,719      | 17                    | 153.32                    | 155.66                            |
| 66518                 | Marshall   | 513,513                  | 79,047,875      | 62,867      | 26                    | 153.94                    | 159.12                            |
| 66412                 | Washington | 504,525                  | 77,668,594      | 54,586      | 6                     | 153.94                    | 154.36                            |
| 66411                 | Riley      | 501,100                  | 77,230,431      | 53,202      | 5                     | 154.12                    | 154.84                            |
| 67470                 | Ottawa     | 540,625                  | 83,443,941      | 73,368      | 15                    | 154.35                    | 154.99                            |
| 67480                 | Ottawa     | 526,413                  | 81,269,834      | 73,475      | 17                    | 154.38                    | 155.18                            |
| 66945                 | Washington | 504,525                  | 77,949,235      | 60,339      | 6                     | 154.50                    | 154.94                            |
| 66403                 | Nemaha     | 500,275                  | 77,312,168      | 66,668      | 14                    | 154.54                    | 158.43                            |
| 67401                 | Ottawa     | 502,563                  | 77,694,713      | 72,793      | 17                    | 154.60                    | 154.10                            |

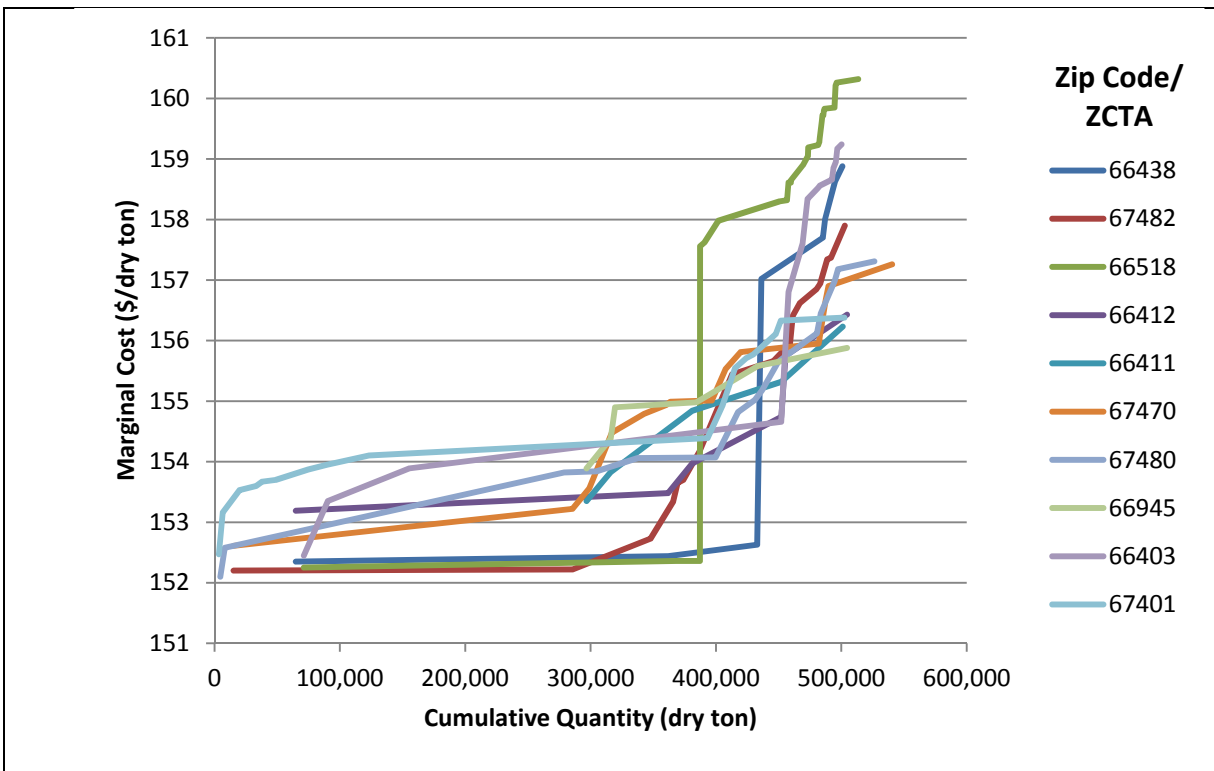


Figure 52. Marginal cost curves for the top ten locations for lowland hardwood sawtimber total inventory in KS (with exclusions).

Demand ZCTA 66438 (Marshall County, KS) has the least average total costs per dry ton of lowland hardwood sawtimber total inventory (Figure 53). Half a million dry tons of lowland hardwood sawtimber total inventory are available within 80 mile radius from ZCTA 66438. The MC per dry ton in the least cost sourcing area (ZCTA 66438, Marshall County, KS) ranged from \$152.35 to \$158.88/dry ton (Table 25, Figure 54).

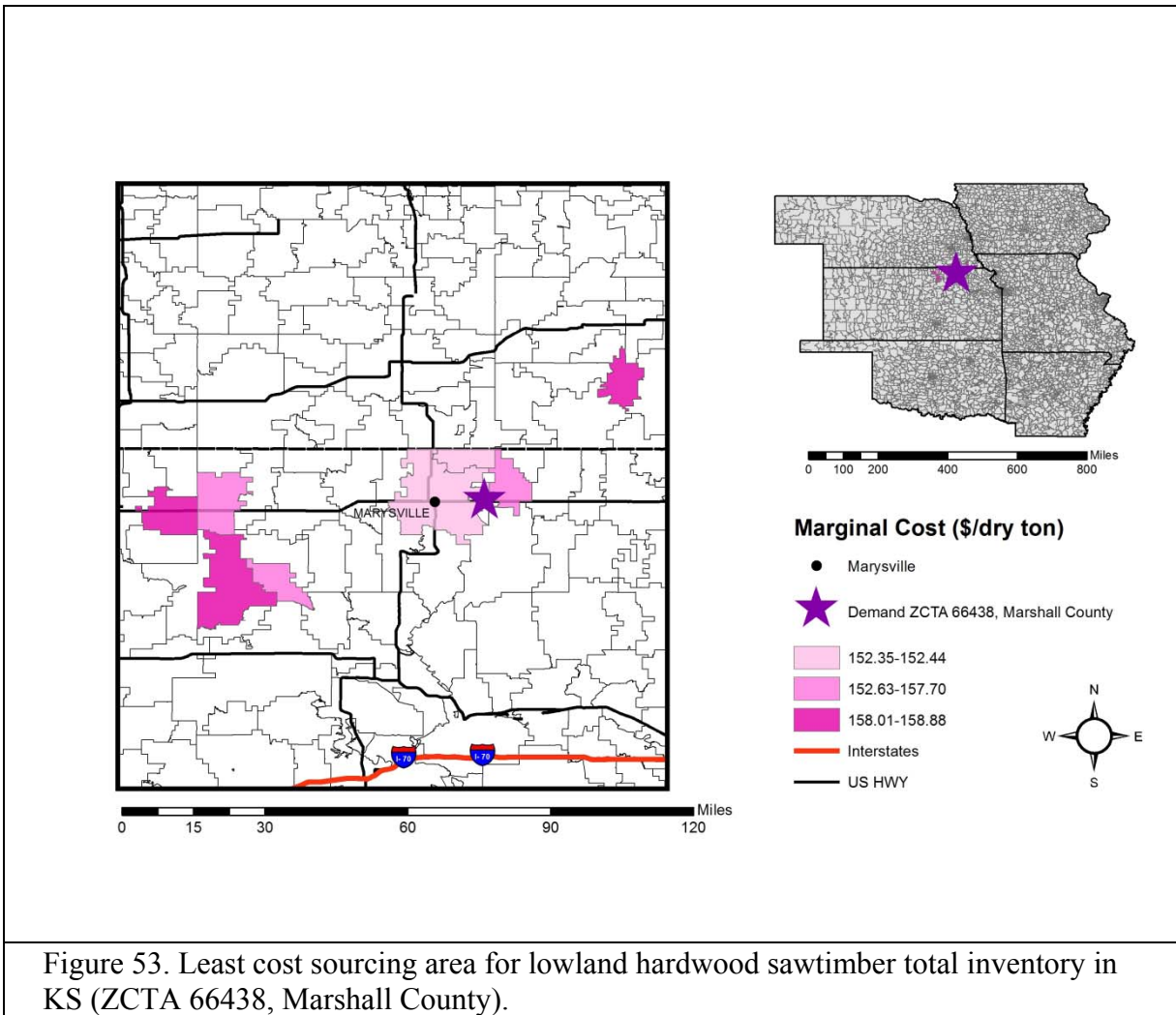


Table 25. Supply ZCTAs for lowland hardwood sawtimber total inventory in KS (demand ZCTA 66438, Marshall County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66518       | 64,925                   | 5,194                 | 20.1               | 92.32                      | 54.92                        | 5.11                       | 9,891,621       | 64,925                        | 152.35                     |
| 66508       | 296,813                  | 23,745                | 21.6               | 92.32                      | 54.92                        | 5.20                       | 45,247,297      | 361,738                       | 152.44                     |
| 66406       | 71,200                   | 5,696                 | 24.7               | 92.32                      | 54.92                        | 5.38                       | 10,867,057      | 432,938                       | 152.63                     |
| 66944       | 3,425                    | 274                   | 90.1               | 92.32                      | 54.92                        | 9.77                       | 537,776         | 436,363                       | 157.02                     |
| 66962       | 48,925                   | 3,914                 | 92.2               | 92.32                      | 54.92                        | 10.45                      | 7,715,276       | 485,288                       | 157.70                     |
| 66940       | 1,875                    | 150                   | 105.6              | 92.32                      | 54.92                        | 10.76                      | 296,263         | 487,163                       | 158.01                     |
| 66937       | 7,863                    | 629                   | 105.5              | 92.32                      | 54.92                        | 11.39                      | 1,247,238       | 495,025                       | 158.63                     |
| 68447       | 5,825                    | 466                   | 99.2               | 92.32                      | 54.92                        | 11.63                      | 925,447         | 500,850                       | 158.88                     |
| 66930       | 1,675                    | 134                   | 115.1              | 92.32                      | 54.92                        | 11.77                      | 266,350         | 502,525                       | 159.01                     |
| 66955       | 788                      | 63                    | 109.5              | 92.32                      | 54.92                        | 11.87                      | 125,304         | 503,313                       | 159.12                     |
| 68331       | 125                      | 10                    | 116.3              | 92.32                      | 54.92                        | 11.93                      | 19,897          | 503,438                       | 159.17                     |
| 68450       | 11,113                   | 889                   | 102.1              | 92.32                      | 54.92                        | 12.04                      | 1,770,055       | 514,550                       | 159.29                     |
| 68337       | 8,400                    | 672                   | 123.3              | 92.32                      | 54.92                        | 12.18                      | 1,339,141       | 522,950                       | 159.42                     |
| 66532       | 1,538                    | 123                   | 125.0              | 92.32                      | 54.92                        | 12.22                      | 245,173         | 524,488                       | 159.46                     |
| 68376       | 9,613                    | 769                   | 122.4              | 92.32                      | 54.92                        | 12.32                      | 1,533,831       | 534,100                       | 159.57                     |
| 66960       | 925                      | 74                    | 121.4              | 92.32                      | 54.92                        | 12.38                      | 147,647         | 535,025                       | 159.62                     |
| 68443       | 1,188                    | 95                    | 98.0               | 92.32                      | 54.92                        | 12.45                      | 189,638         | 536,213                       | 159.70                     |
| 66439       | 1,963                    | 157                   | 128.2              | 92.32                      | 54.92                        | 12.61                      | 313,711         | 538,175                       | 159.85                     |
| 68348       | 3,900                    | 312                   | 108.4              | 92.32                      | 54.92                        | 12.78                      | 624,097         | 542,075                       | 160.02                     |
| 66552       | 1,138                    | 91                    | 131.1              | 92.32                      | 54.92                        | 12.83                      | 182,082         | 543,213                       | 160.07                     |
| 66935       | 2,888                    | 231                   | 135.9              | 92.32                      | 54.92                        | 12.93                      | 462,492         | 546,100                       | 160.17                     |
| 66959       | 1,100                    | 88                    | 132.5              | 92.32                      | 54.92                        | 13.02                      | 176,289         | 546,250                       | 160.26                     |
| 68328       | 150                      | 12                    | 127.2              | 92.32                      | 54.92                        | 13.01                      | 24,039          | 547,350                       | 160.26                     |
| 68457       | 3,463                    | 277                   | 135.6              | 92.32                      | 54.92                        | 13.09                      | 555,169         | 550,813                       | 160.34                     |
| 66436       | 5,200                    | 416                   | 143.6              | 92.32                      | 54.92                        | 13.31                      | 834,882         | 556,013                       | 160.55                     |



Table 25. Supply ZCTAs for lowland hardwood sawtimber total inventory in KS (demand ZCTA 66438, Marshall County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 68358       | 325                      | 26                    | 138.8              | 92.32                      | 54.92                        | 13.56                      | 52,261          | 556,338                       | 160.80                     |
| 66966       | 1,638                    | 131                   | 142.0              | 92.32                      | 54.92                        | 13.58                      | 263,344         | 557,975                       | 160.82                     |
| 66035       | 2,150                    | 172                   | 143.5              | 92.32                      | 54.92                        | 13.59                      | 345,794         | 560,125                       | 160.83                     |
| 68301       | 938                      | 75                    | 135.4              | 92.32                      | 54.92                        | 13.65                      | 150,838         | 561,063                       | 160.89                     |
| 66424       | 1,338                    | 107                   | 139.6              | 92.32                      | 54.92                        | 13.69                      | 215,252         | 562,400                       | 160.94                     |
| 68368       | 275                      | 22                    | 140.5              | 92.32                      | 54.92                        | 13.71                      | 44,262          | 562,675                       | 160.95                     |
| 66087       | 6,575                    | 526                   | 152.1              | 92.32                      | 54.92                        | 13.86                      | 1,059,230       | 569,250                       | 161.10                     |
| 68375       | 1,125                    | 90                    | 135.7              | 92.32                      | 54.92                        | 13.92                      | 181,311         | 570,375                       | 161.16                     |
| 68442       | 2,050                    | 164                   | 143.7              | 92.32                      | 54.92                        | 13.95                      | 330,453         | 572,425                       | 161.20                     |
| 66938       | 1,525                    | 122                   | 138.8              | 92.32                      | 54.92                        | 14.07                      | 246,004         | 573,950                       | 161.31                     |
| 68404       | 413                      | 33                    | 146.0              | 92.32                      | 54.92                        | 14.09                      | 66,548          | 574,363                       | 161.33                     |
| 66939       | 1,763                    | 141                   | 152.0              | 92.32                      | 54.92                        | 14.16                      | 284,466         | 574,825                       | 161.40                     |
| 68372       | 463                      | 37                    | 147.5              | 92.32                      | 54.92                        | 14.16                      | 74,647          | 576,588                       | 161.40                     |
| 68430       | 563                      | 45                    | 149.2              | 92.32                      | 54.92                        | 14.20                      | 90,812          | 577,150                       | 161.44                     |
| 68352       | 7,900                    | 632                   | 140.1              | 92.32                      | 54.92                        | 14.21                      | 1,275,492       | 585,050                       | 161.45                     |
| 66058       | 688                      | 55                    | 150.6              | 92.32                      | 54.92                        | 14.30                      | 111,058         | 585,738                       | 161.54                     |
| 68329       | 17,275                   | 1,382                 | 128.6              | 92.32                      | 54.92                        | 14.38                      | 2,792,027       | 603,013                       | 161.62                     |
| 67468       | 2,913                    | 233                   | 139.1              | 92.32                      | 54.92                        | 14.52                      | 471,141         | 605,925                       | 161.77                     |
| 68324       | 9,900                    | 792                   | 127.4              | 92.32                      | 54.92                        | 14.56                      | 1,601,873       | 615,825                       | 161.81                     |
| 68431       | 13,950                   | 1,116                 | 150.2              | 92.32                      | 54.92                        | 14.57                      | 2,257,237       | 629,775                       | 161.81                     |
| 68465       | 725                      | 58                    | 146.7              | 92.32                      | 54.92                        | 14.63                      | 117,355         | 630,500                       | 161.87                     |
| 68355       | 11,413                   | 913                   | 153.4              | 92.32                      | 54.92                        | 14.67                      | 1,847,779       | 641,913                       | 161.91                     |
| 68437       | 2,750                    | 220                   | 153.4              | 92.32                      | 54.92                        | 14.73                      | 445,414         | 644,663                       | 161.97                     |
| 68305       | 7,250                    | 580                   | 157.2              | 92.32                      | 54.92                        | 14.90                      | 1,175,565       | 651,913                       | 162.15                     |
| 68523       | 100                      | 8                     | 159.7              | 92.32                      | 54.92                        | 14.97                      | 16,221          | 652,013                       | 162.21                     |

Table 25. Supply ZCTAs for lowland hardwood sawtimber total inventory in KS (demand ZCTA 66438, Marshall County).

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67487       | 12,913                   | 1,033                 | 157.9              | 92.32                      | 54.92                        | 15.08                      | 2,095,951       | 664,925                       | 162.32                     |
| 68333       | 925                      | 74                    | 159.6              | 92.32                      | 54.92                        | 15.92                      | 150,930         | 665,850                       | 163.17                     |

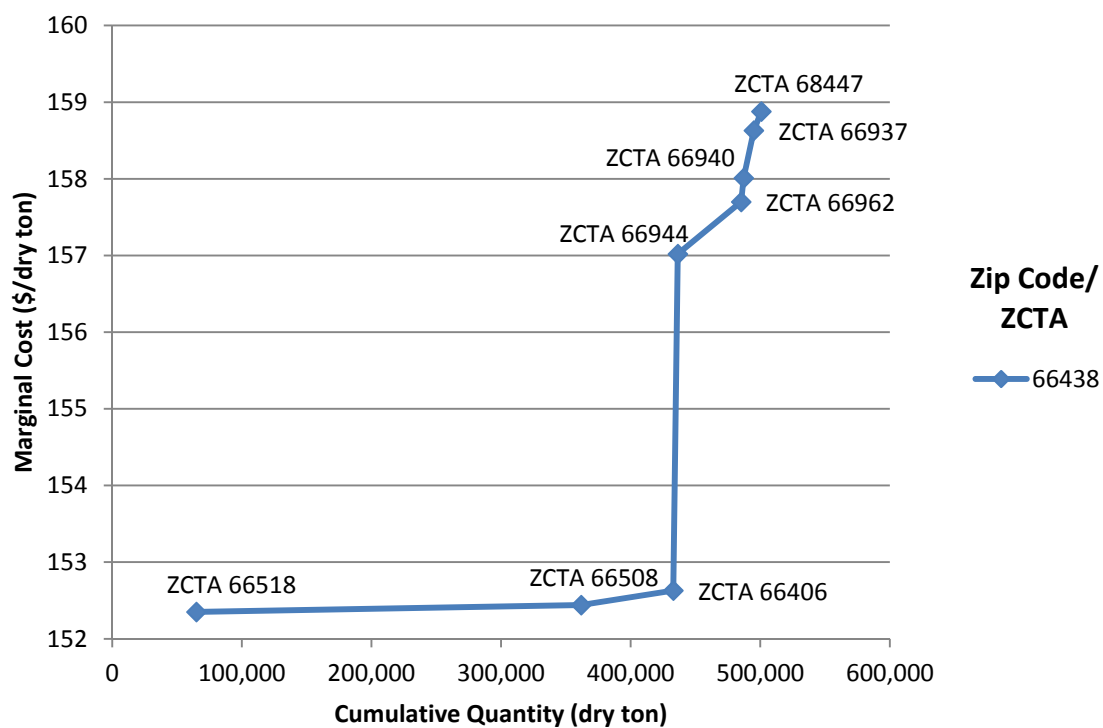


Figure 54. Marginal cost curve for lowland hardwood sawtimber total inventory in KS (ZCTA 66438, Marshall County).

### 3.4 Comparative Analysis for Pulpwood for six US Forest Service FIA Regions of Interest.

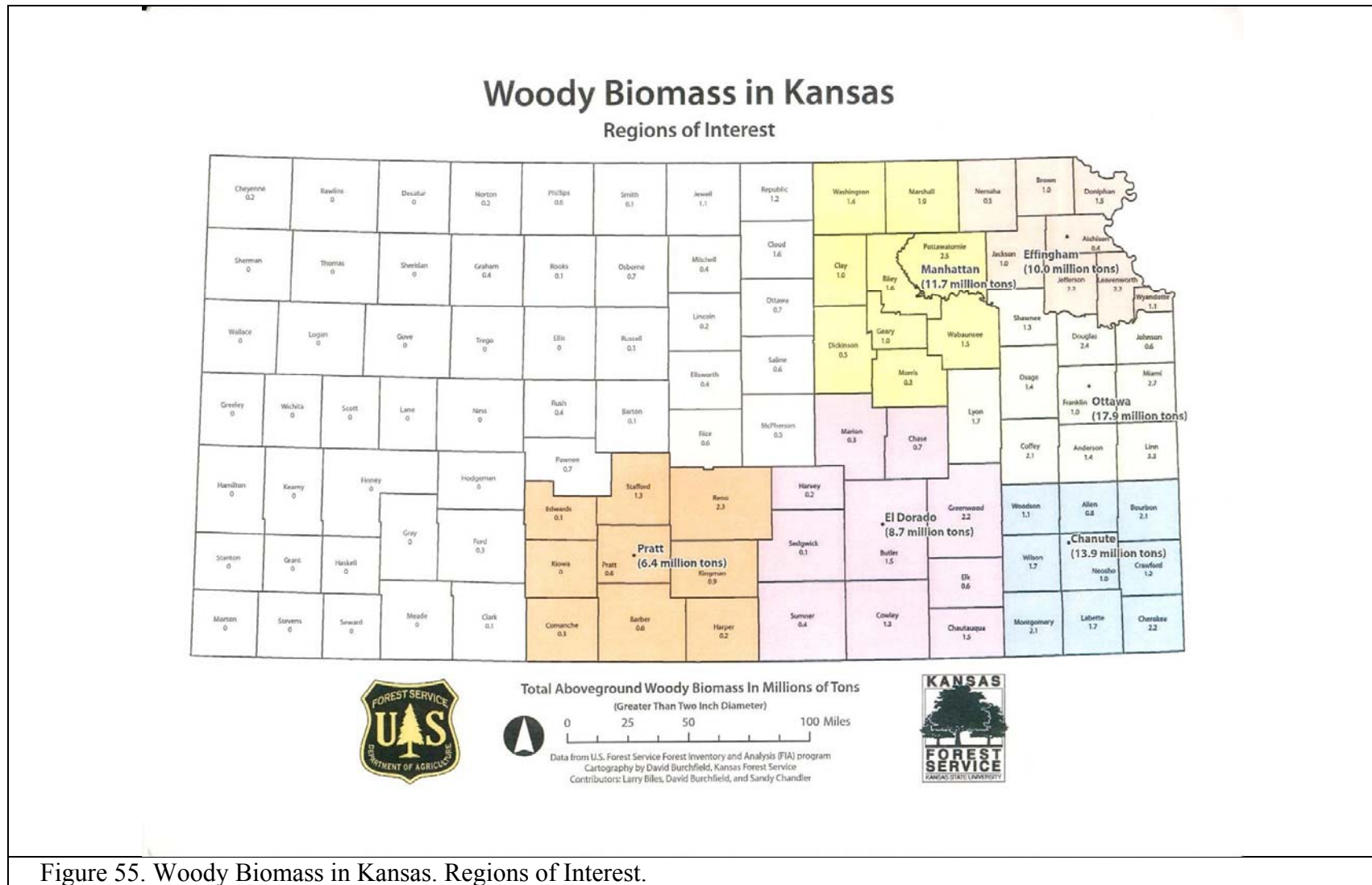


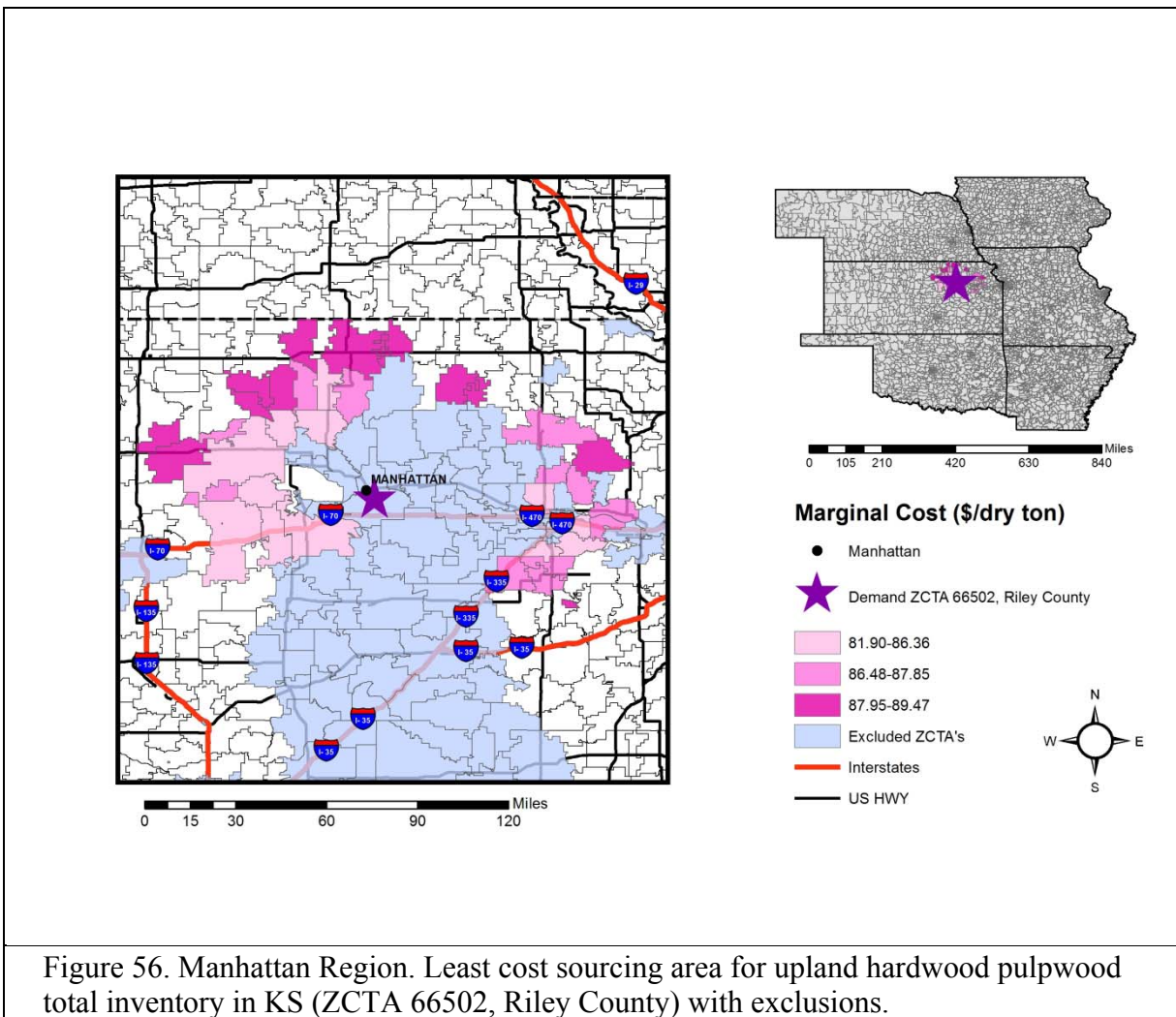
Figure 55. Woody Biomass in Kansas. Regions of Interest.

### 3.4.1 Manhattan

#### 3.4.1.1 Upland Hardwood

##### 3.4.1.1.1 Total Inventory (with exclusions)

ZCTA 66502 (Riley County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Manhattan region for upland hardwood pulpwood total inventory. There are 37 Supply ZCTAs within 80 mile radius from ZCTA 66502 (Table 26). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$81.90 to \$89.47 (Figure 56, Figure 57).



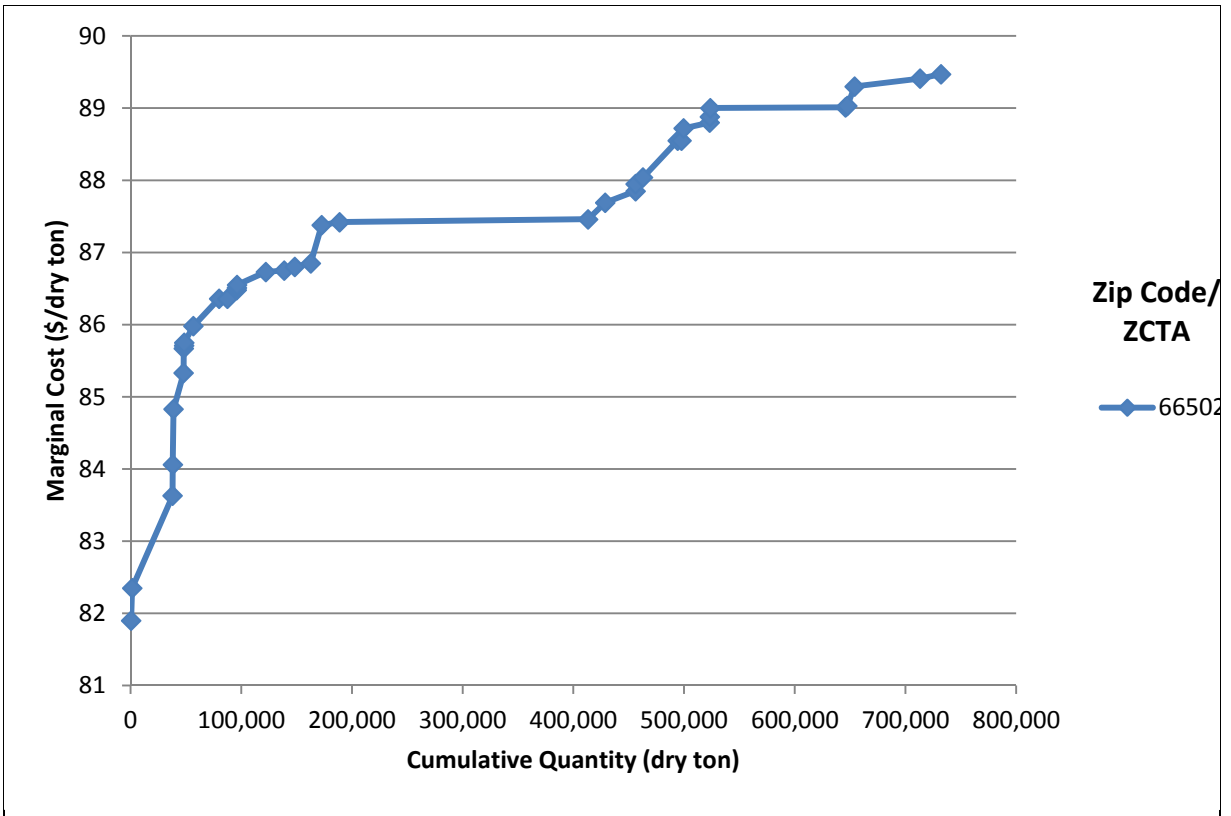


Figure 57. Manhattan Region. Marginal cost curve for upland hardwood pulpwood total inventory in KS (ZCTA 66502, Riley County) with exclusions.

Table 26. Manhattan Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66502, Riley County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66441       | 538                      | 43                    | 52.6               | 28.78                      | 45.58                        | 7.54                       | 44,021          | 538                           | 81.90                      |
| 67431       | 925                      | 74                    | 67.0               | 28.78                      | 45.58                        | 7.99                       | 76,172          | 1,463                         | 82.35                      |
| 67410       | 36,513                   | 2,921                 | 86.9               | 28.78                      | 45.58                        | 9.27                       | 3,053,705       | 37,975                        | 83.63                      |
| 66554       | 188                      | 15                    | 90.9               | 28.78                      | 45.58                        | 9.70                       | 15,762          | 38,163                        | 84.06                      |
| 67487       | 663                      | 53                    | 94.4               | 28.78                      | 45.58                        | 10.47                      | 56,203          | 38,825                        | 84.83                      |
| 66618       | 9,138                    | 731                   | 110.0              | 28.78                      | 45.58                        | 10.97                      | 779,691         | 47,963                        | 85.33                      |
| 66548       | 100                      | 8                     | 112.8              | 28.78                      | 45.58                        | 11.31                      | 8,567           | 48,063                        | 85.67                      |
| 67432       | 325                      | 26                    | 109.9              | 28.78                      | 45.58                        | 11.35                      | 27,856          | 48,388                        | 85.71                      |
| 67447       | 50                       | 4                     | 109.3              | 28.78                      | 45.58                        | 11.39                      | 4,287           | 48,438                        | 85.75                      |
| 66546       | 8,338                    | 667                   | 120.3              | 28.78                      | 45.58                        | 11.62                      | 716,899         | 56,775                        | 85.98                      |
| 66409       | 23,263                   | 1,861                 | 122.9              | 28.78                      | 45.58                        | 11.99                      | 2,008,833       | 80,038                        | 86.36                      |
| 66542       | 7,438                    | 595                   | 123.8              | 28.78                      | 45.58                        | 12.00                      | 642,313         | 87,475                        | 86.36                      |
| 67458       | 8,413                    | 673                   | 115.2              | 28.78                      | 45.58                        | 12.11                      | 727,480         | 95,888                        | 86.48                      |
| 66933       | 75                       | 6                     | 122.9              | 28.78                      | 45.58                        | 12.15                      | 6,488           | 95,963                        | 86.51                      |
| 66411       | 200                      | 16                    | 124.4              | 28.78                      | 45.58                        | 12.19                      | 17,311          | 96,163                        | 86.55                      |
| 66413       | 26,075                   | 2,086                 | 117.2              | 28.78                      | 45.58                        | 12.37                      | 2,261,478       | 122,238                       | 86.73                      |
| 66414       | 16,625                   | 1,330                 | 129.0              | 28.78                      | 45.58                        | 12.39                      | 1,442,297       | 138,863                       | 86.75                      |
| 66440       | 9,463                    | 757                   | 131.9              | 28.78                      | 45.58                        | 12.44                      | 821,389         | 148,325                       | 86.80                      |
| 66512       | 14,425                   | 1,154                 | 133.2              | 28.78                      | 45.58                        | 12.49                      | 1,252,827       | 162,750                       | 86.85                      |
| 66537       | 9,938                    | 795                   | 141.8              | 28.78                      | 45.58                        | 13.01                      | 868,297         | 172,688                       | 87.38                      |
| 67468       | 16,113                   | 1,289                 | 130.4              | 28.78                      | 45.58                        | 13.06                      | 1,408,618       | 188,800                       | 87.42                      |
| 66073       | 224,500                  | 17,960                | 139.1              | 28.78                      | 45.58                        | 13.10                      | 19,634,731      | 413,300                       | 87.46                      |
| 66050       | 15,538                   | 1,243                 | 139.3              | 28.78                      | 45.58                        | 13.33                      | 1,362,560       | 428,838                       | 87.69                      |
| 66436       | 27,375                   | 2,190                 | 149.6              | 28.78                      | 45.58                        | 13.49                      | 2,404,973       | 456,213                       | 87.85                      |

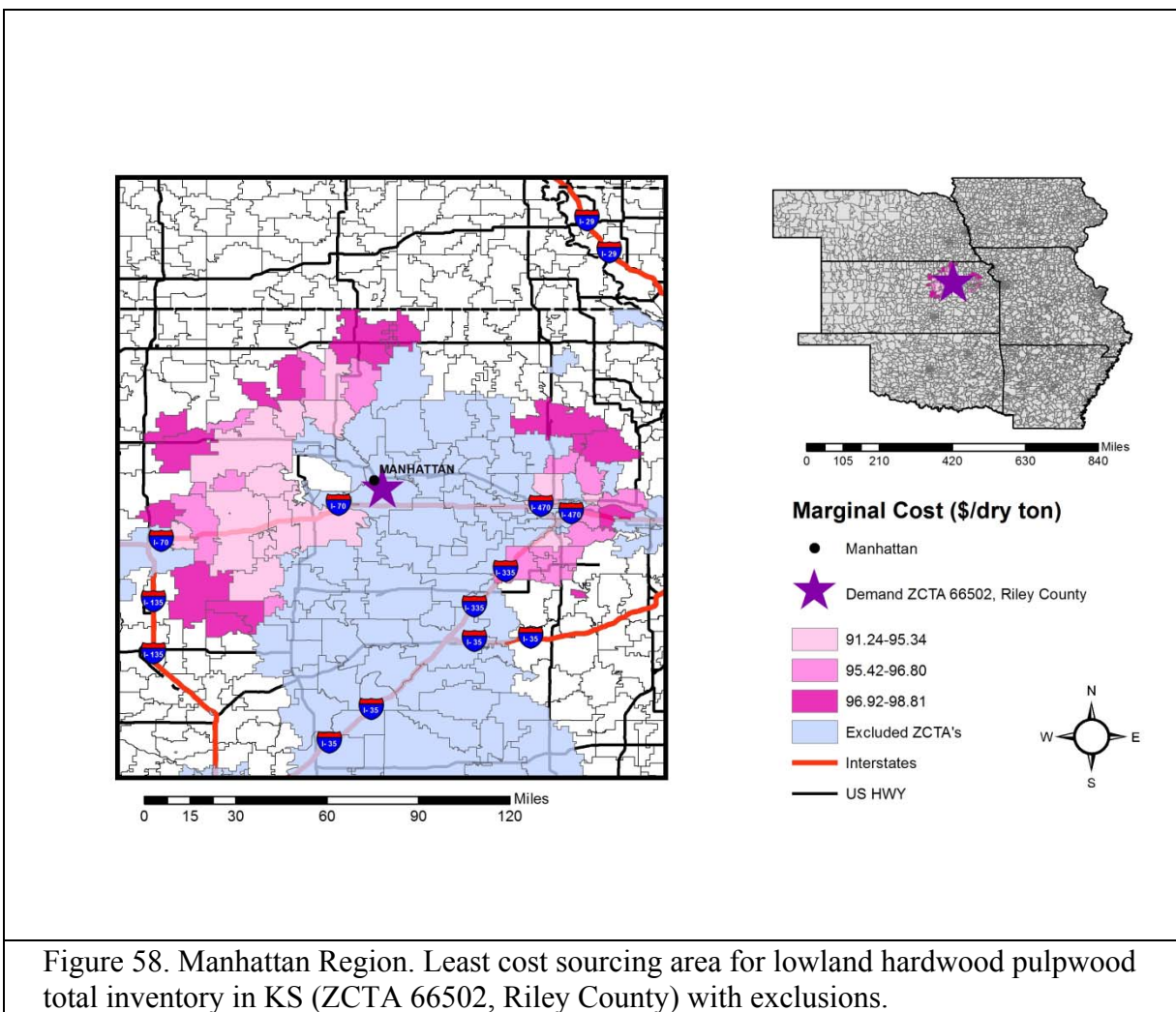
Table 26. Manhattan Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66502, Riley County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66943       | 75                       | 6                     | 139.6              | 28.78                      | 45.58                        | 13.58                      | 6,596           | 456,288                       | 87.95                      |
| 66962       | 6,600                    | 528                   | 137.1              | 28.78                      | 45.58                        | 13.68                      | 581,058         | 462,888                       | 88.04                      |
| 67466       | 31,400                   | 2,512                 | 146.0              | 28.78                      | 45.58                        | 14.19                      | 2,780,471       | 494,288                       | 88.55                      |
| 66417       | 3,450                    | 276                   | 147.2              | 28.78                      | 45.58                        | 14.19                      | 305,501         | 497,738                       | 88.55                      |
| 66508       | 1,875                    | 150                   | 151.7              | 28.78                      | 45.58                        | 14.36                      | 166,349         | 499,613                       | 88.72                      |
| 66088       | 23,538                   | 1,883                 | 157.0              | 28.78                      | 45.58                        | 14.43                      | 2,090,026       | 523,150                       | 88.80                      |
| 66438       | 113                      | 9                     | 158.8              | 28.78                      | 45.58                        | 14.52                      | 9,999           | 523,263                       | 88.88                      |
| 66406       | 450                      | 36                    | 158.8              | 28.78                      | 45.58                        | 14.63                      | 40,048          | 523,713                       | 89.00                      |
| 66945       | 122,200                  | 9,776                 | 150.1              | 28.78                      | 45.58                        | 14.64                      | 10,876,656      | 645,913                       | 89.01                      |
| 66543       | 1,575                    | 126                   | 158.8              | 28.78                      | 45.58                        | 14.66                      | 140,216         | 647,488                       | 89.03                      |
| 66415       | 6,613                    | 529                   | 159.0              | 28.78                      | 45.58                        | 14.94                      | 590,526         | 654,100                       | 89.30                      |
| 66953       | 59,075                   | 4,726                 | 154.9              | 28.78                      | 45.58                        | 15.05                      | 5,282,142       | 713,175                       | 89.41                      |
| 67417       | 19,038                   | 1,523                 | 157.9              | 28.78                      | 45.58                        | 15.11                      | 1,703,325       | 732,213                       | 89.47                      |

### 3.4.1.2 Lowland Hardwood

#### 3.4.1.2.1 Total Inventory (with exclusions)

ZCTA 66502 (Riley County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Manhattan region for lowland hardwood pulpwood total inventory. There are 44 Supply ZCTAs within 80 mile radius from ZCTA 66502 (Table 27). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$91.24 to \$98.81 (Figure 58, Figure 59).





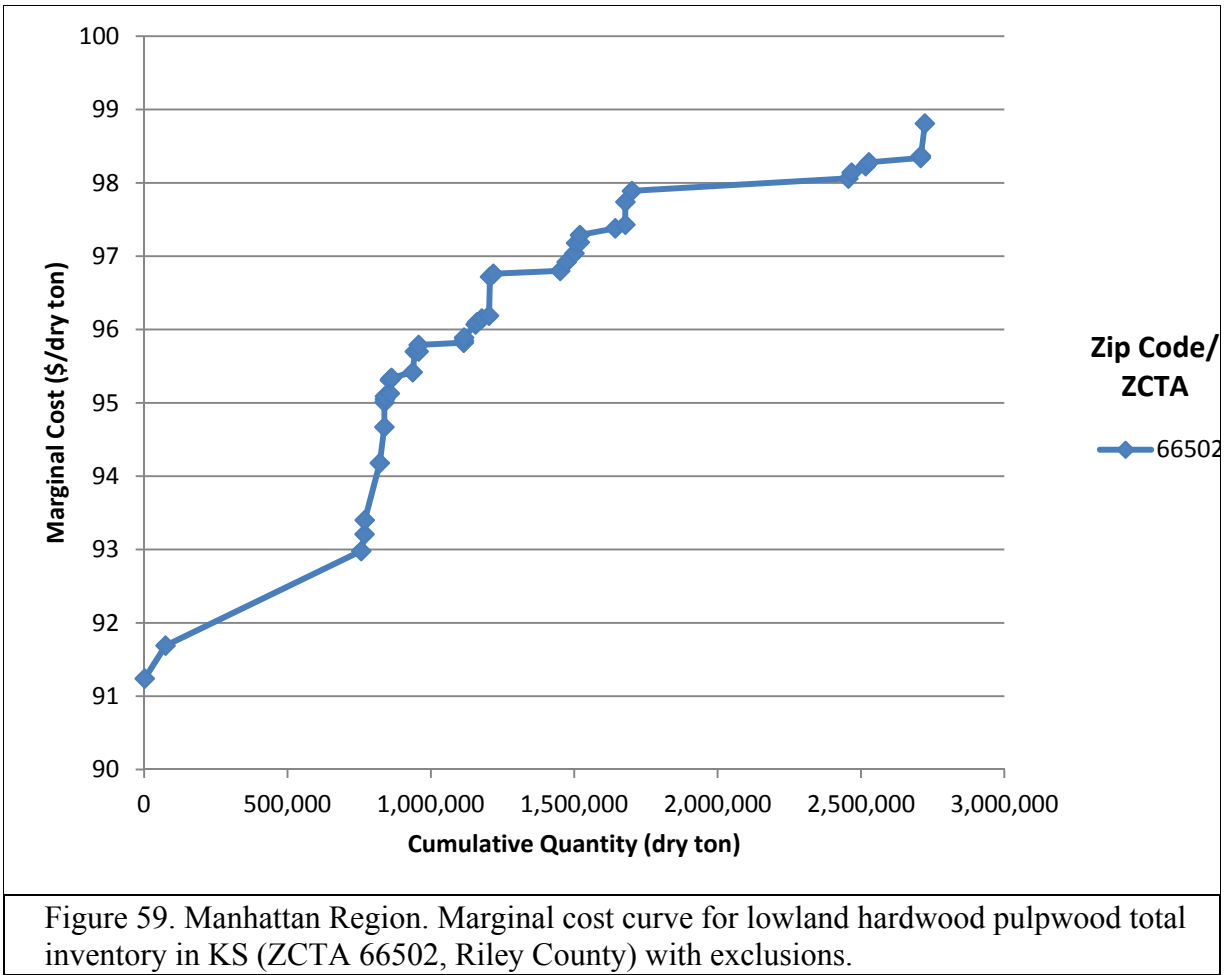


Table 27. Manhattan Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66502, Riley County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66441       | 1,888                    | 151                   | 52.6               | 28.78                      | 54.92                        | 7.54                       | 172,215         | 1,888                         | 91.24                      |
| 67431       | 72,925                   | 5,834                 | 67.0               | 28.78                      | 54.92                        | 7.99                       | 6,686,425       | 74,813                        | 91.69                      |
| 67410       | 682,450                  | 54,596                | 86.9               | 28.78                      | 54.92                        | 9.27                       | 63,451,006      | 757,263                       | 92.98                      |
| 67441       | 11,638                   | 931                   | 86.1               | 28.78                      | 54.92                        | 9.51                       | 1,084,770       | 768,900                       | 93.21                      |
| 66554       | 650                      | 52                    | 90.9               | 28.78                      | 54.92                        | 9.70                       | 60,712          | 769,550                       | 93.40                      |
| 67487       | 52,475                   | 4,198                 | 94.4               | 28.78                      | 54.92                        | 10.47                      | 4,941,843       | 822,025                       | 94.18                      |
| 66618       | 16,013                   | 1,281                 | 110.0              | 28.78                      | 54.92                        | 10.97                      | 1,515,896       | 838,038                       | 94.67                      |
| 66548       | 363                      | 29                    | 112.8              | 28.78                      | 54.92                        | 11.31                      | 34,443          | 838,400                       | 95.01                      |
| 67432       | 1,138                    | 91                    | 109.9              | 28.78                      | 54.92                        | 11.35                      | 108,120         | 839,538                       | 95.05                      |
| 67447       | 175                      | 14                    | 109.3              | 28.78                      | 54.92                        | 11.39                      | 16,641          | 839,713                       | 95.09                      |
| 67470       | 17,150                   | 1,372                 | 118.3              | 28.78                      | 54.92                        | 11.43                      | 1,631,453       | 856,863                       | 95.13                      |
| 66429       | 88                       | 7                     | 120.2              | 28.78                      | 54.92                        | 11.61                      | 8,340           | 856,950                       | 95.31                      |
| 66546       | 2,638                    | 211                   | 120.3              | 28.78                      | 54.92                        | 11.62                      | 251,422         | 859,588                       | 95.33                      |
| 67451       | 3,525                    | 282                   | 116.2              | 28.78                      | 54.92                        | 11.64                      | 336,089         | 863,113                       | 95.34                      |
| 67480       | 73,738                   | 5,899                 | 114.9              | 28.78                      | 54.92                        | 11.71                      | 7,035,791       | 936,850                       | 95.42                      |
| 66409       | 7,350                    | 588                   | 122.9              | 28.78                      | 54.92                        | 11.99                      | 703,364         | 944,200                       | 95.70                      |
| 66542       | 13,038                   | 1,043                 | 123.8              | 28.78                      | 54.92                        | 12.00                      | 1,247,718       | 957,238                       | 95.70                      |
| 67475       | 375                      | 30                    | 123.5              | 28.78                      | 54.92                        | 12.08                      | 35,920          | 957,613                       | 95.79                      |
| 67458       | 157,288                  | 12,583                | 115.2              | 28.78                      | 54.92                        | 12.11                      | 15,070,799      | 1,114,900                     | 95.82                      |
| 66933       | 275                      | 22                    | 122.9              | 28.78                      | 54.92                        | 12.15                      | 26,359          | 1,115,175                     | 95.85                      |
| 66411       | 738                      | 59                    | 124.4              | 28.78                      | 54.92                        | 12.19                      | 70,721          | 1,115,913                     | 95.89                      |
| 66413       | 40,213                   | 3,217                 | 117.2              | 28.78                      | 54.92                        | 12.37                      | 3,863,236       | 1,156,125                     | 96.07                      |
| 66414       | 5,250                    | 420                   | 129.0              | 28.78                      | 54.92                        | 12.39                      | 504,502         | 1,161,375                     | 96.10                      |
| 66440       | 16,588                   | 1,327                 | 131.9              | 28.78                      | 54.92                        | 12.44                      | 1,594,812       | 1,177,963                     | 96.15                      |

Table 27. Manhattan Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66502, Riley County) with exclusions.

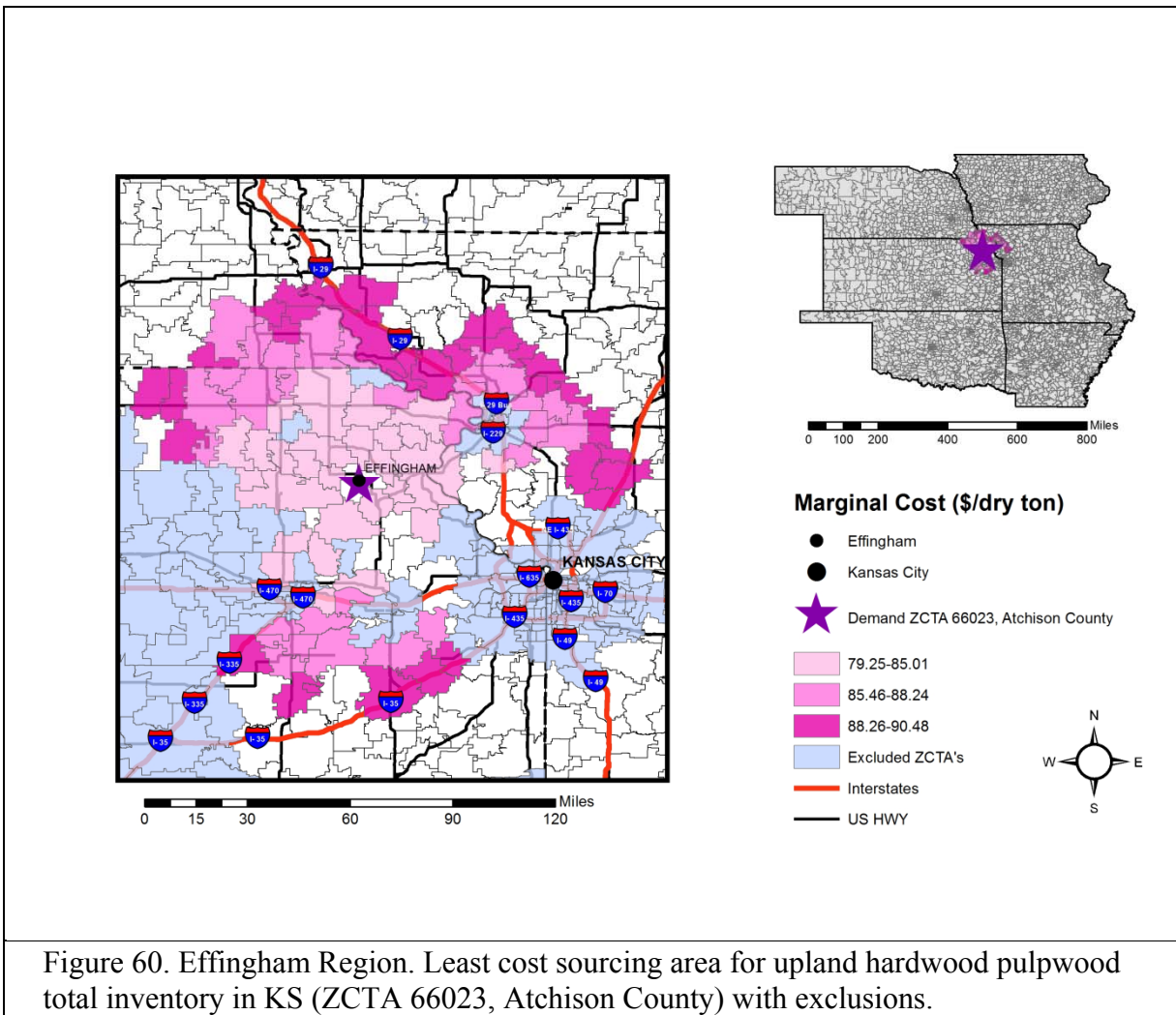
| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66512       | 25,288                   | 2,023                 | 133.2              | 28.78                      | 54.92                        | 12.49                      | 2,432,452       | 1,203,250                     | 96.19                      |
| 66537       | 3,138                    | 251                   | 141.8              | 28.78                      | 54.92                        | 13.01                      | 303,448         | 1,206,388                     | 96.72                      |
| 67468       | 11,763                   | 941                   | 130.4              | 28.78                      | 54.92                        | 13.06                      | 1,138,195       | 1,218,150                     | 96.76                      |
| 66073       | 233,013                  | 18,641                | 139.1              | 28.78                      | 54.92                        | 13.10                      | 22,555,756      | 1,451,163                     | 96.80                      |
| 67422       | 22,713                   | 1,817                 | 132.1              | 28.78                      | 54.92                        | 13.21                      | 2,201,207       | 1,473,875                     | 96.92                      |
| 66050       | 27,225                   | 2,178                 | 139.3              | 28.78                      | 54.92                        | 13.33                      | 2,641,798       | 1,501,100                     | 97.04                      |
| 67483       | 5,500                    | 440                   | 139.6              | 28.78                      | 54.92                        | 13.47                      | 534,478         | 1,506,600                     | 97.18                      |
| 66436       | 13,063                   | 1,045                 | 149.6              | 28.78                      | 54.92                        | 13.49                      | 1,269,593       | 1,519,663                     | 97.19                      |
| 66943       | 275                      | 22                    | 139.6              | 28.78                      | 54.92                        | 13.58                      | 26,754          | 1,519,938                     | 97.29                      |
| 66962       | 123,488                  | 9,879                 | 137.1              | 28.78                      | 54.92                        | 13.68                      | 12,025,197      | 1,643,425                     | 97.38                      |
| 67448       | 34,900                   | 2,792                 | 147.5              | 28.78                      | 54.92                        | 13.73                      | 3,400,237       | 1,678,325                     | 97.43                      |
| 66419       | 100                      | 8                     | 150.5              | 28.78                      | 54.92                        | 14.04                      | 9,774           | 1,678,425                     | 97.74                      |
| 67466       | 22,938                   | 1,835                 | 146.0              | 28.78                      | 54.92                        | 14.19                      | 2,245,371       | 1,701,363                     | 97.89                      |
| 66508       | 754,813                  | 60,385                | 151.7              | 28.78                      | 54.92                        | 14.36                      | 74,017,007      | 2,456,175                     | 98.06                      |
| 66088       | 11,225                   | 898                   | 157.0              | 28.78                      | 54.92                        | 14.43                      | 1,101,581       | 2,467,400                     | 98.14                      |
| 66438       | 48,938                   | 3,915                 | 158.8              | 28.78                      | 54.92                        | 14.52                      | 4,806,889       | 2,516,338                     | 98.23                      |
| 67438       | 11,350                   | 908                   | 153.5              | 28.78                      | 54.92                        | 14.58                      | 1,115,509       | 2,527,688                     | 98.28                      |
| 66406       | 181,063                  | 14,485                | 158.8              | 28.78                      | 54.92                        | 14.63                      | 17,805,047      | 2,708,750                     | 98.34                      |
| 66543       | 500                      | 40                    | 158.8              | 28.78                      | 54.92                        | 14.66                      | 49,183          | 2,709,250                     | 98.37                      |
| 67417       | 13,913                   | 1,113                 | 157.9              | 28.78                      | 54.92                        | 15.11                      | 1,374,734       | 2,723,163                     | 98.81                      |

### 3.4.2 Effingham

#### 3.4.2.1 Upland Hardwood

##### 3.4.2.1.1 Total Inventory (with exclusions)

ZCTA 66023 (Atchison County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Effingham region for upland hardwood pulpwood total inventory. There are 86 Supply ZCTAs within 80 mile radius from ZCTA 66023 (Table 28). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$79.25 to \$90.48 (Figure 60, Figure 61).



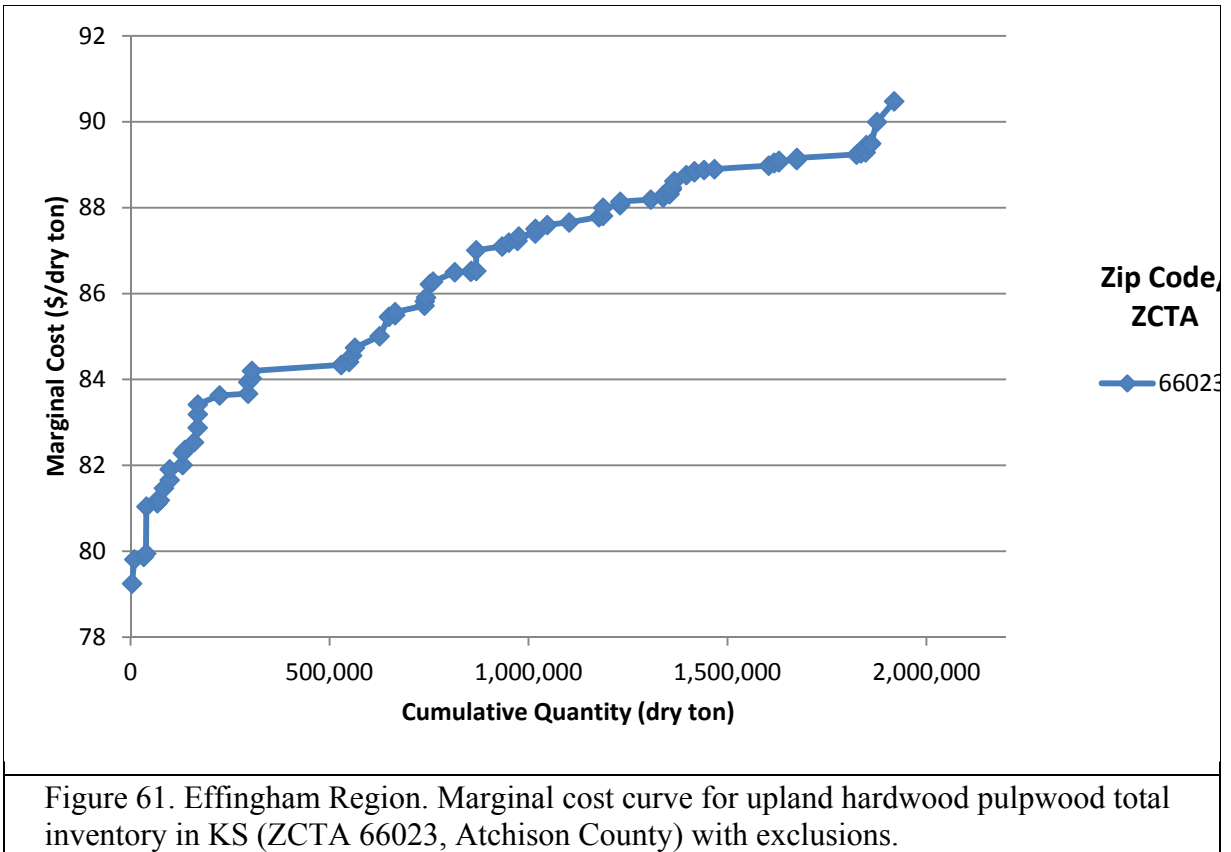


Figure 61. Effingham Region. Marginal cost curve for upland hardwood pulpwood total inventory in KS (ZCTA 66023, Atchison County) with exclusions.

Table 28. Effingham Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66058       | 3,663                    | 293                   | 18.1               | 28.78                      | 45.58                        | 4.89                       | 290,263         | 3,663                         | 79.25                      |
| 66016       | 5,775                    | 462                   | 23.8               | 28.78                      | 45.58                        | 5.45                       | 460,929         | 9,438                         | 79.81                      |
| 66088       | 23,538                   | 1,883                 | 19.8               | 28.78                      | 45.58                        | 5.51                       | 1,879,966       | 32,975                        | 79.87                      |
| 66060       | 5,963                    | 477                   | 26.1               | 28.78                      | 45.58                        | 5.58                       | 476,675         | 38,938                        | 79.95                      |
| 66002       | 925                      | 74                    | 40.0               | 28.78                      | 45.58                        | 6.68                       | 74,965          | 39,863                        | 81.04                      |
| 66436       | 27,375                   | 2,190                 | 38.3               | 28.78                      | 45.58                        | 6.76                       | 2,220,590       | 67,238                        | 81.12                      |
| 66041       | 88                       | 7                     | 38.9               | 28.78                      | 45.58                        | 6.82                       | 7,104           | 67,325                        | 81.19                      |
| 66552       | 5,988                    | 479                   | 38.0               | 28.78                      | 45.58                        | 6.83                       | 486,114         | 73,313                        | 81.19                      |
| 66439       | 10,350                   | 828                   | 42.6               | 28.78                      | 45.58                        | 7.11                       | 843,234         | 83,663                        | 81.47                      |
| 66512       | 14,425                   | 1,154                 | 48.7               | 28.78                      | 45.58                        | 7.30                       | 1,177,958       | 98,088                        | 81.66                      |
| 66424       | 88                       | 7                     | 42.8               | 28.78                      | 45.58                        | 7.55                       | 7,167           | 98,175                        | 81.91                      |
| 66516       | 32,675                   | 2,614                 | 53.0               | 28.78                      | 45.58                        | 7.65                       | 2,679,812       | 130,850                       | 82.01                      |
| 64484       | 250                      | 20                    | 55.5               | 28.78                      | 45.58                        | 7.93                       | 20,573          | 131,100                       | 82.29                      |
| 66416       | 5,475                    | 438                   | 52.0               | 28.78                      | 45.58                        | 8.00                       | 450,911         | 136,575                       | 82.36                      |
| 66020       | 22,713                   | 1,817                 | 58.3               | 28.78                      | 45.58                        | 8.18                       | 1,874,676       | 159,288                       | 82.54                      |
| 66440       | 9,463                    | 757                   | 62.1               | 28.78                      | 45.58                        | 8.52                       | 784,245         | 168,750                       | 82.88                      |
| 66017       | 63                       | 5                     | 60.8               | 28.78                      | 45.58                        | 8.83                       | 5,199           | 168,813                       | 83.19                      |
| 66008       | 88                       | 7                     | 68.5               | 28.78                      | 45.58                        | 9.06                       | 7,300           | 168,900                       | 83.42                      |
| 66550       | 54,650                   | 4,372                 | 70.2               | 28.78                      | 45.58                        | 9.27                       | 4,570,351       | 223,550                       | 83.63                      |
| 66434       | 71,550                   | 5,724                 | 70.3               | 28.78                      | 45.58                        | 9.30                       | 5,986,313       | 295,100                       | 83.67                      |
| 66087       | 450                      | 36                    | 77.0               | 28.78                      | 45.58                        | 9.58                       | 37,775          | 295,550                       | 83.94                      |
| 66618       | 9,138                    | 731                   | 80.1               | 28.78                      | 45.58                        | 9.66                       | 767,781         | 304,688                       | 84.03                      |
| 66532       | 100                      | 8                     | 78.3               | 28.78                      | 45.58                        | 9.84                       | 8,420           | 304,788                       | 84.20                      |
| 66073       | 224,500                  | 17,960                | 83.3               | 28.78                      | 45.58                        | 9.97                       | 18,933,420      | 529,288                       | 84.34                      |

Table 28. Effingham Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66425       | 19,525                   | 1,562                 | 87.3               | 28.78                      | 45.58                        | 10.05                      | 1,648,141       | 548,813                       | 84.41                      |
| 66428       | 7,638                    | 611                   | 80.6               | 28.78                      | 45.58                        | 10.19                      | 645,798         | 556,450                       | 84.56                      |
| 66542       | 7,438                    | 595                   | 87.7               | 28.78                      | 45.58                        | 10.37                      | 630,220         | 563,888                       | 84.74                      |
| 64448       | 61,975                   | 4,958                 | 93.1               | 28.78                      | 45.58                        | 10.65                      | 5,268,577       | 625,863                       | 85.01                      |
| 66409       | 23,263                   | 1,861                 | 96.9               | 28.78                      | 45.58                        | 11.09                      | 1,987,905       | 649,125                       | 85.46                      |
| 66050       | 15,538                   | 1,243                 | 92.7               | 28.78                      | 45.58                        | 11.14                      | 1,328,486       | 664,663                       | 85.50                      |
| 66035       | 138                      | 11                    | 96.8               | 28.78                      | 45.58                        | 11.21                      | 11,766          | 664,800                       | 85.57                      |
| 66534       | 73,913                   | 5,913                 | 103.1              | 28.78                      | 45.58                        | 11.36                      | 6,335,582       | 738,713                       | 85.72                      |
| 66090       | 275                      | 22                    | 101.7              | 28.78                      | 45.58                        | 11.46                      | 23,601          | 738,988                       | 85.82                      |
| 66417       | 3,450                    | 276                   | 94.5               | 28.78                      | 45.58                        | 11.55                      | 296,387         | 742,438                       | 85.91                      |
| 66515       | 9,463                    | 757                   | 110.0              | 28.78                      | 45.58                        | 11.85                      | 815,822         | 751,900                       | 86.22                      |
| 66546       | 8,338                    | 667                   | 109.4              | 28.78                      | 45.58                        | 11.92                      | 719,351         | 760,238                       | 86.28                      |
| 64401       | 54,625                   | 4,370                 | 112.1              | 28.78                      | 45.58                        | 12.14                      | 4,725,115       | 814,863                       | 86.50                      |
| 64443       | 40,263                   | 3,221                 | 113.2              | 28.78                      | 45.58                        | 12.15                      | 3,483,233       | 855,125                       | 86.51                      |
| 66538       | 12,438                   | 995                   | 117.6              | 28.78                      | 45.58                        | 12.17                      | 1,076,271       | 856,075                       | 86.53                      |
| 68431       | 950                      | 76                    | 103.4              | 28.78                      | 45.58                        | 12.16                      | 82,201          | 868,513                       | 86.53                      |
| 64421       | 163                      | 13                    | 115.7              | 28.78                      | 45.58                        | 12.65                      | 14,140          | 868,675                       | 87.01                      |
| 68355       | 65,213                   | 5,217                 | 112.8              | 28.78                      | 45.58                        | 12.74                      | 5,680,008       | 933,888                       | 87.10                      |
| 66414       | 16,625                   | 1,330                 | 120.2              | 28.78                      | 45.58                        | 12.82                      | 1,449,457       | 950,513                       | 87.19                      |
| 66025       | 22,025                   | 1,762                 | 120.4              | 28.78                      | 45.58                        | 12.86                      | 1,921,131       | 972,538                       | 87.23                      |
| 66408       | 2,925                    | 234                   | 122.4              | 28.78                      | 45.58                        | 12.97                      | 255,441         | 975,463                       | 87.33                      |
| 66006       | 41,588                   | 3,327                 | 124.5              | 28.78                      | 45.58                        | 13.04                      | 3,634,923       | 1,017,050                     | 87.40                      |
| 68337       | 438                      | 35                    | 130.8              | 28.78                      | 45.58                        | 13.15                      | 38,287          | 1,017,488                     | 87.51                      |
| 64436       | 29,763                   | 2,381                 | 124.7              | 28.78                      | 45.58                        | 13.24                      | 2,607,123       | 1,047,250                     | 87.60                      |

Table 28. Effingham Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 68376       | 54,913                   | 4,393                 | 130.0              | 28.78                      | 45.58                        | 13.30                      | 4,813,549       | 1,102,163                     | 87.66                      |
| 68433       | 74,838                   | 5,987                 | 132.2              | 28.78                      | 45.58                        | 13.42                      | 6,569,154       | 1,177,000                     | 87.78                      |
| 66537       | 9,938                    | 795                   | 133.0              | 28.78                      | 45.58                        | 13.44                      | 872,577         | 1,186,938                     | 87.81                      |
| 64485       | 625                      | 50                    | 129.9              | 28.78                      | 45.58                        | 13.64                      | 55,000          | 1,187,563                     | 88.00                      |
| 64430       | 42,688                   | 3,415                 | 133.3              | 28.78                      | 45.58                        | 13.70                      | 3,759,129       | 1,230,250                     | 88.06                      |
| 64483       | 138                      | 11                    | 135.3              | 28.78                      | 45.58                        | 13.78                      | 12,119          | 1,230,388                     | 88.14                      |
| 64490       | 76,925                   | 6,154                 | 136.2              | 28.78                      | 45.58                        | 13.83                      | 6,783,954       | 1,307,313                     | 88.19                      |
| 66524       | 30,925                   | 2,474                 | 135.8              | 28.78                      | 45.58                        | 13.88                      | 2,728,899       | 1,338,238                     | 88.24                      |
| 64427       | 125                      | 10                    | 138.6              | 28.78                      | 45.58                        | 13.89                      | 11,032          | 1,338,363                     | 88.26                      |
| 64437       | 125                      | 10                    | 127.7              | 28.78                      | 45.58                        | 13.89                      | 11,032          | 1,338,488                     | 88.26                      |
| 64459       | 113                      | 9                     | 133.3              | 28.78                      | 45.58                        | 13.93                      | 9,932           | 1,338,600                     | 88.29                      |
| 68437       | 15,725                   | 1,258                 | 127.7              | 28.78                      | 45.58                        | 13.96                      | 1,388,814       | 1,354,325                     | 88.32                      |
| 66404       | 5,300                    | 424                   | 142.7              | 28.78                      | 45.58                        | 14.07                      | 468,691         | 1,354,500                     | 88.43                      |
| 68457       | 175                      | 14                    | 143.2              | 28.78                      | 45.58                        | 14.07                      | 15,475          | 1,359,800                     | 88.43                      |
| 64449       | 138                      | 11                    | 138.7              | 28.78                      | 45.58                        | 14.11                      | 12,165          | 1,359,938                     | 88.47                      |
| 66415       | 6,613                    | 529                   | 145.4              | 28.78                      | 45.58                        | 14.26                      | 585,981         | 1,366,550                     | 88.62                      |
| 64477       | 30,063                   | 2,405                 | 138.5              | 28.78                      | 45.58                        | 14.40                      | 2,668,371       | 1,396,613                     | 88.76                      |
| 64474       | 20,225                   | 1,618                 | 143.7              | 28.78                      | 45.58                        | 14.47                      | 1,796,594       | 1,416,838                     | 88.83                      |
| 64465       | 388                      | 31                    | 145.4              | 28.78                      | 45.58                        | 14.49                      | 34,431          | 1,417,225                     | 88.85                      |
| 68414       | 23,888                   | 1,911                 | 134.4              | 28.78                      | 45.58                        | 14.52                      | 2,123,187       | 1,441,113                     | 88.88                      |
| 66413       | 26,075                   | 2,086                 | 140.1              | 28.78                      | 45.58                        | 14.54                      | 2,318,087       | 1,467,188                     | 88.90                      |
| 64422       | 136,600                  | 10,928                | 145.5              | 28.78                      | 45.58                        | 14.62                      | 12,155,307      | 1,603,788                     | 88.98                      |
| 66092       | 13,400                   | 1,072                 | 144.1              | 28.78                      | 45.58                        | 14.68                      | 1,193,180       | 1,617,188                     | 89.04                      |
| 64480       | 100                      | 8                     | 149.6              | 28.78                      | 45.58                        | 14.69                      | 8,905           | 1,617,288                     | 89.05                      |



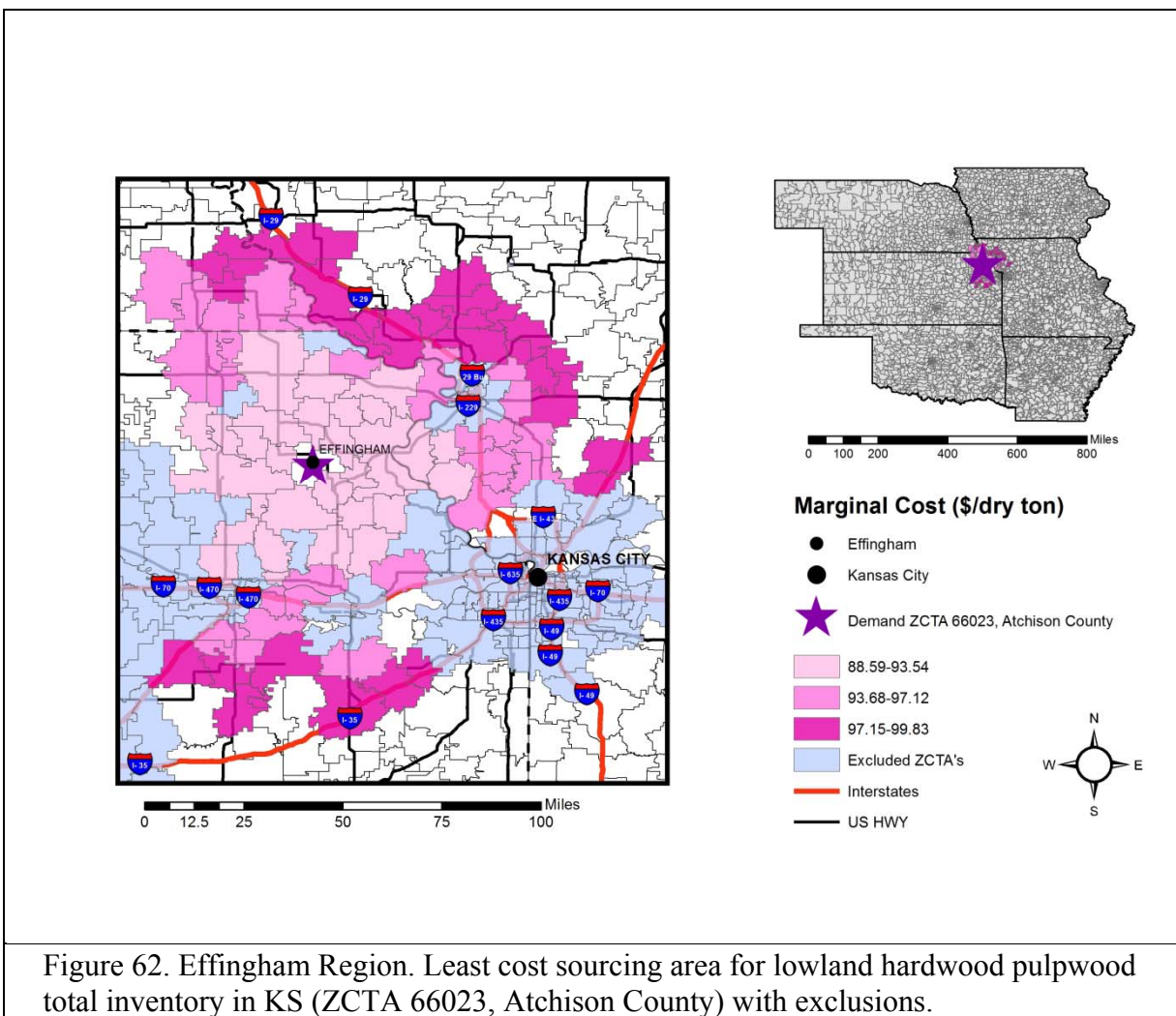
Table 28. Effingham Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66451       | 11,550                   | 924                   | 151.5              | 28.78                      | 45.58                        | 14.70                      | 1,028,614       | 1,628,838                     | 89.06                      |
| 64473       | 363                      | 29                    | 146.3              | 28.78                      | 45.58                        | 14.72                      | 32,294          | 1,629,200                     | 89.09                      |
| 68345       | 463                      | 37                    | 146.7              | 28.78                      | 45.58                        | 14.73                      | 41,203          | 1,629,663                     | 89.09                      |
| 66067       | 44,450                   | 3,556                 | 145.8              | 28.78                      | 45.58                        | 14.74                      | 3,960,741       | 1,674,113                     | 89.11                      |
| 64423       | 200                      | 16                    | 151.4              | 28.78                      | 45.58                        | 14.79                      | 17,831          | 1,674,313                     | 89.15                      |
| 64494       | 225                      | 18                    | 146.2              | 28.78                      | 45.58                        | 14.80                      | 20,062          | 1,674,538                     | 89.16                      |
| 64048       | 149,738                  | 11,979                | 148.9              | 28.78                      | 45.58                        | 14.87                      | 13,362,012      | 1,824,275                     | 89.24                      |
| 66403       | 11,213                   | 897                   | 153.7              | 28.78                      | 45.58                        | 14.91                      | 1,000,921       | 1,835,488                     | 89.27                      |
| 68442       | 11,763                   | 941                   | 151.3              | 28.78                      | 45.58                        | 14.93                      | 1,050,258       | 1,847,250                     | 89.29                      |
| 66543       | 1,575                    | 126                   | 150.0              | 28.78                      | 45.58                        | 15.09                      | 140,894         | 1,848,825                     | 89.46                      |
| 66021       | 9,938                    | 795                   | 152.5              | 28.78                      | 45.58                        | 15.11                      | 889,123         | 1,858,763                     | 89.47                      |
| 64451       | 2,400                    | 192                   | 154.2              | 28.78                      | 45.58                        | 15.14                      | 214,806         | 1,861,163                     | 89.50                      |
| 64493       | 14,688                   | 1,175                 | 156.5              | 28.78                      | 45.58                        | 15.64                      | 1,321,853       | 1,875,850                     | 90.00                      |
| 64446       | 43,138                   | 3,451                 | 157.3              | 28.78                      | 45.58                        | 16.12                      | 3,903,284       | 1,918,988                     | 90.48                      |

### 3.4.2.2 Lowland Hardwood

#### 3.4.2.2.1 Total Inventory (with exclusions)

ZCTA 66023 (Atchison County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Effingham region for lowland hardwood pulpwood total inventory. There are 87 Supply ZCTAs within 80 mile radius from ZCTA 66023 (Table 29). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$88.59 to \$99.83 (Figure 62, Figure 63).



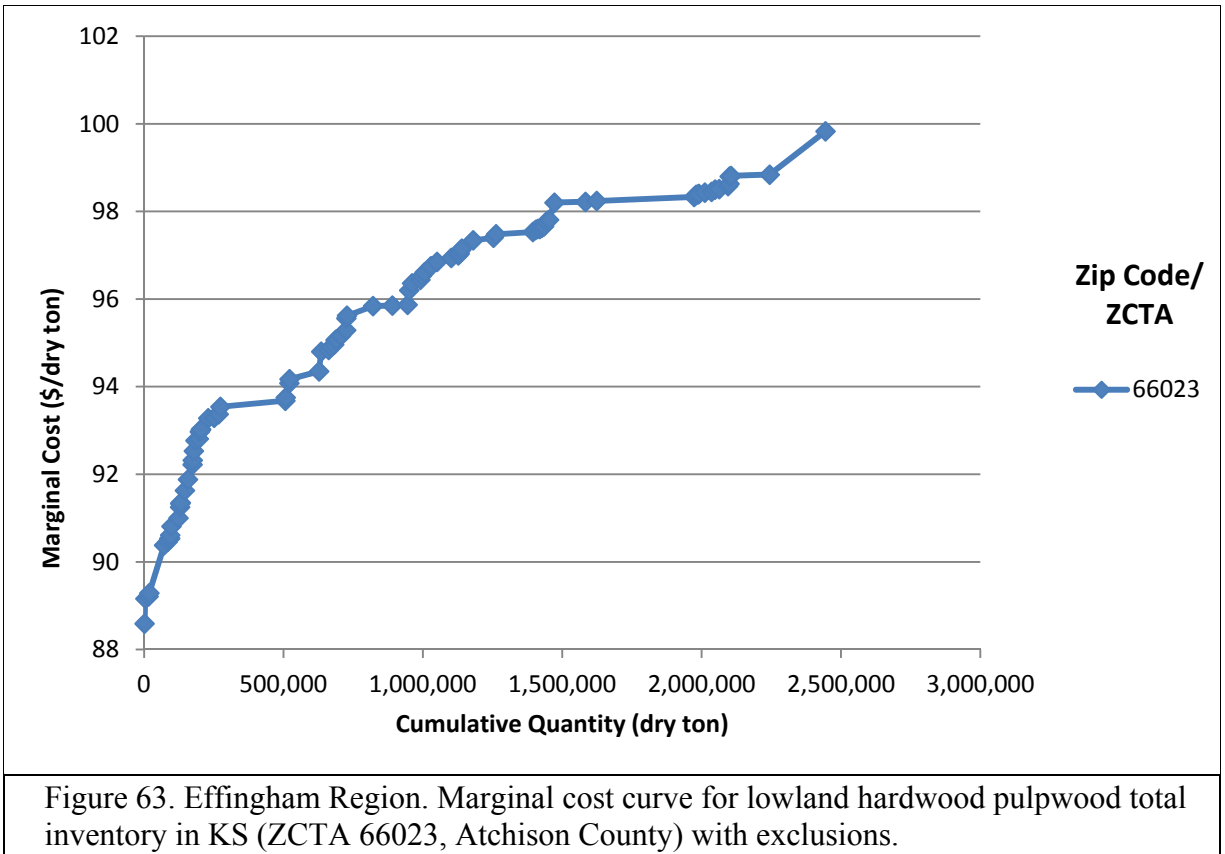


Table 29. Effingham Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66058       | 1,738                    | 139                   | 18.1               | 28.78                      | 54.92                        | 4.89                       | 153,931         | 1,738                         | 88.59                      |
| 66016       | 2,750                    | 220                   | 23.8               | 28.78                      | 54.92                        | 5.45                       | 245,177         | 4,488                         | 89.16                      |
| 66088       | 11,225                   | 898                   | 19.8               | 28.78                      | 54.92                        | 5.51                       | 1,001,403       | 15,713                        | 89.21                      |
| 66060       | 2,850                    | 228                   | 26.1               | 28.78                      | 54.92                        | 5.58                       | 254,466         | 18,563                        | 89.29                      |
| 66002       | 53,175                   | 4,254                 | 40.0               | 28.78                      | 54.92                        | 6.68                       | 4,806,171       | 71,738                        | 90.38                      |
| 66436       | 13,063                   | 1,045                 | 38.3               | 28.78                      | 54.92                        | 6.76                       | 1,181,611       | 84,800                        | 90.46                      |
| 66041       | 5,338                    | 427                   | 38.9               | 28.78                      | 54.92                        | 6.82                       | 483,183         | 90,138                        | 90.53                      |
| 66552       | 2,850                    | 228                   | 38.0               | 28.78                      | 54.92                        | 6.83                       | 258,008         | 92,988                        | 90.53                      |
| 66419       | 100                      | 8                     | 35.4               | 28.78                      | 54.92                        | 6.84                       | 9,054           | 93,088                        | 90.54                      |
| 66097       | 238                      | 19                    | 42.8               | 28.78                      | 54.92                        | 6.91                       | 21,521          | 93,325                        | 90.61                      |
| 66439       | 4,938                    | 395                   | 42.6               | 28.78                      | 54.92                        | 7.11                       | 448,388         | 98,263                        | 90.81                      |
| 66512       | 25,288                   | 2,023                 | 48.7               | 28.78                      | 54.92                        | 7.30                       | 2,301,205       | 123,550                       | 91.00                      |
| 66424       | 5,300                    | 424                   | 42.8               | 28.78                      | 54.92                        | 7.55                       | 483,622         | 128,850                       | 91.25                      |
| 66066       | 738                      | 59                    | 52.8               | 28.78                      | 54.92                        | 7.62                       | 67,353          | 129,588                       | 91.33                      |
| 66516       | 1,963                    | 157                   | 53.0               | 28.78                      | 54.92                        | 7.65                       | 179,284         | 131,550                       | 91.35                      |
| 64484       | 14,813                   | 1,185                 | 55.5               | 28.78                      | 54.92                        | 7.93                       | 1,357,310       | 146,363                       | 91.63                      |
| 66020       | 10,838                   | 867                   | 58.3               | 28.78                      | 54.92                        | 8.18                       | 995,752         | 157,200                       | 91.88                      |
| 66440       | 16,588                   | 1,327                 | 62.1               | 28.78                      | 54.92                        | 8.52                       | 1,529,700       | 173,788                       | 92.22                      |
| 66054       | 538                      | 43                    | 61.6               | 28.78                      | 54.92                        | 8.62                       | 49,622          | 174,325                       | 92.32                      |
| 66017       | 4,138                    | 331                   | 60.8               | 28.78                      | 54.92                        | 8.83                       | 382,848         | 178,463                       | 92.53                      |
| 66008       | 5,463                    | 437                   | 68.5               | 28.78                      | 54.92                        | 9.06                       | 506,733         | 183,925                       | 92.77                      |
| 64440       | 12,425                   | 994                   | 69.9               | 28.78                      | 54.92                        | 9.11                       | 1,153,143       | 196,350                       | 92.81                      |
| 66550       | 3,275                    | 262                   | 70.2               | 28.78                      | 54.92                        | 9.27                       | 304,478         | 199,625                       | 92.97                      |
| 66434       | 4,300                    | 344                   | 70.3               | 28.78                      | 54.92                        | 9.30                       | 399,930         | 203,925                       | 93.01                      |
| 66429       | 88                       | 7                     | 75.5               | 28.78                      | 54.92                        | 9.33                       | 8,140           | 204,013                       | 93.03                      |

Table 29. Effingham Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66087       | 25,900                   | 2,072                 | 77.0               | 28.78                      | 54.92                        | 9.58                       | 2,416,080       | 229,913                       | 93.28                      |
| 64098       | 21,638                   | 1,731                 | 78.0               | 28.78                      | 54.92                        | 9.59                       | 2,018,655       | 251,550                       | 93.29                      |
| 66618       | 16,013                   | 1,281                 | 80.1               | 28.78                      | 54.92                        | 9.66                       | 1,495,024       | 267,563                       | 93.37                      |
| 66532       | 6,075                    | 486                   | 78.3               | 28.78                      | 54.92                        | 9.84                       | 568,255         | 273,638                       | 93.54                      |
| 66073       | 233,013                  | 18,641                | 83.3               | 28.78                      | 54.92                        | 9.97                       | 21,827,852      | 506,650                       | 93.68                      |
| 66425       | 1,163                    | 93                    | 87.3               | 28.78                      | 54.92                        | 10.05                      | 108,987         | 507,813                       | 93.75                      |
| 66542       | 13,038                   | 1,043                 | 87.7               | 28.78                      | 54.92                        | 10.37                      | 1,226,519       | 520,850                       | 94.08                      |
| 66086       | 763                      | 61                    | 88.1               | 28.78                      | 54.92                        | 10.47                      | 71,804          | 521,613                       | 94.17                      |
| 64448       | 106,275                  | 8,502                 | 93.1               | 28.78                      | 54.92                        | 10.65                      | 10,027,272      | 627,888                       | 94.35                      |
| 66409       | 7,350                    | 588                   | 96.9               | 28.78                      | 54.92                        | 11.09                      | 696,752         | 635,238                       | 94.80                      |
| 66050       | 27,225                   | 2,178                 | 92.7               | 28.78                      | 54.92                        | 11.14                      | 2,582,094       | 662,463                       | 94.84                      |
| 66035       | 8,500                    | 680                   | 96.8               | 28.78                      | 54.92                        | 11.21                      | 806,755         | 670,963                       | 94.91                      |
| 64439       | 11,125                   | 890                   | 100.9              | 28.78                      | 54.92                        | 11.26                      | 1,056,420       | 682,088                       | 94.96                      |
| 66534       | 4,438                    | 355                   | 103.1              | 28.78                      | 54.92                        | 11.36                      | 421,820         | 686,525                       | 95.06                      |
| 64018       | 3,338                    | 267                   | 100.2              | 28.78                      | 54.92                        | 11.37                      | 317,314         | 689,863                       | 95.08                      |
| 66090       | 16,350                   | 1,308                 | 101.7              | 28.78                      | 54.92                        | 11.46                      | 1,555,902       | 706,213                       | 95.16                      |
| 64079       | 18,463                   | 1,477                 | 102.3              | 28.78                      | 54.92                        | 11.59                      | 1,759,320       | 724,675                       | 95.29                      |
| 66515       | 563                      | 45                    | 110.0              | 28.78                      | 54.92                        | 11.85                      | 53,751          | 725,238                       | 95.56                      |
| 66546       | 2,638                    | 211                   | 109.4              | 28.78                      | 54.92                        | 11.92                      | 252,197         | 727,875                       | 95.62                      |
| 64401       | 93,663                   | 7,493                 | 112.1              | 28.78                      | 54.92                        | 12.14                      | 8,976,778       | 821,538                       | 95.84                      |
| 64443       | 69,038                   | 5,523                 | 113.2              | 28.78                      | 54.92                        | 12.15                      | 6,617,513       | 890,575                       | 95.85                      |
| 68431       | 54,913                   | 4,393                 | 103.4              | 28.78                      | 54.92                        | 12.16                      | 5,264,333       | 945,488                       | 95.87                      |
| 64444       | 5,838                    | 467                   | 116.8              | 28.78                      | 54.92                        | 12.50                      | 561,557         | 951,325                       | 96.20                      |
| 64421       | 10,013                   | 801                   | 115.7              | 28.78                      | 54.92                        | 12.65                      | 964,758         | 961,338                       | 96.36                      |
| 68355       | 29,825                   | 2,386                 | 112.8              | 28.78                      | 54.92                        | 12.74                      | 2,876,346       | 991,163                       | 96.44                      |

Table 29. Effingham Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66414       | 5,250                    | 420                   | 120.2              | 28.78                      | 54.92                        | 12.82                      | 506,762         | 996,413                       | 96.53                      |
| 64454       | 10,538                   | 843                   | 122.9              | 28.78                      | 54.92                        | 12.90                      | 1,017,977       | 1,006,950                     | 96.61                      |
| 66006       | 22,250                   | 1,780                 | 124.5              | 28.78                      | 54.92                        | 13.04                      | 2,152,577       | 1,029,200                     | 96.75                      |
| 68337       | 22,000                   | 1,760                 | 130.8              | 28.78                      | 54.92                        | 13.15                      | 2,130,800       | 1,051,200                     | 96.85                      |
| 64436       | 51,038                   | 4,083                 | 124.7              | 28.78                      | 54.92                        | 13.24                      | 4,947,493       | 1,102,238                     | 96.94                      |
| 68376       | 25,113                   | 2,009                 | 130.0              | 28.78                      | 54.92                        | 13.30                      | 2,435,895       | 1,127,350                     | 97.00                      |
| 64492       | 5,138                    | 411                   | 128.0              | 28.78                      | 54.92                        | 13.33                      | 498,517         | 1,132,488                     | 97.04                      |
| 68433       | 4,488                    | 359                   | 132.2              | 28.78                      | 54.92                        | 13.42                      | 435,825         | 1,136,975                     | 97.12                      |
| 66537       | 3,138                    | 251                   | 133.0              | 28.78                      | 54.92                        | 13.44                      | 304,799         | 1,140,113                     | 97.15                      |
| 64485       | 40,363                   | 3,229                 | 129.9              | 28.78                      | 54.92                        | 13.64                      | 3,928,916       | 1,180,475                     | 97.34                      |
| 64430       | 73,188                   | 5,855                 | 133.3              | 28.78                      | 54.92                        | 13.70                      | 7,128,637       | 1,253,663                     | 97.40                      |
| 64483       | 9,175                    | 734                   | 135.3              | 28.78                      | 54.92                        | 13.78                      | 894,399         | 1,262,838                     | 97.48                      |
| 64490       | 131,888                  | 10,551                | 136.2              | 28.78                      | 54.92                        | 13.83                      | 12,862,987      | 1,394,725                     | 97.53                      |
| 66524       | 9,775                    | 782                   | 135.8              | 28.78                      | 54.92                        | 13.88                      | 953,877         | 1,404,500                     | 97.58                      |
| 64427       | 8,100                    | 648                   | 138.6              | 28.78                      | 54.92                        | 13.89                      | 790,542         | 1,412,213                     | 97.60                      |
| 64437       | 7,713                    | 617                   | 127.7              | 28.78                      | 54.92                        | 13.89                      | 752,708         | 1,420,313                     | 97.60                      |
| 64459       | 7,263                    | 581                   | 133.3              | 28.78                      | 54.92                        | 13.93                      | 709,024         | 1,427,575                     | 97.63                      |
| 68437       | 7,188                    | 575                   | 127.7              | 28.78                      | 54.92                        | 13.96                      | 701,929         | 1,434,763                     | 97.66                      |
| 68457       | 9,063                    | 725                   | 143.2              | 28.78                      | 54.92                        | 14.07                      | 886,045         | 1,443,825                     | 97.77                      |
| 64449       | 9,238                    | 739                   | 138.7              | 28.78                      | 54.92                        | 14.11                      | 903,563         | 1,453,063                     | 97.81                      |
| 64465       | 19,438                   | 1,555                 | 145.4              | 28.78                      | 54.92                        | 14.49                      | 1,908,678       | 1,472,500                     | 98.20                      |
| 68414       | 111,100                  | 8,888                 | 134.4              | 28.78                      | 54.92                        | 14.52                      | 10,912,637      | 1,583,600                     | 98.22                      |
| 66413       | 40,213                   | 3,217                 | 140.1              | 28.78                      | 54.92                        | 14.54                      | 3,950,538       | 1,623,813                     | 98.24                      |
| 64422       | 349,538                  | 27,963                | 145.5              | 28.78                      | 54.92                        | 14.62                      | 34,368,441      | 1,973,350                     | 98.33                      |
| 66092       | 7,163                    | 573                   | 144.1              | 28.78                      | 54.92                        | 14.68                      | 704,676         | 1,980,513                     | 98.38                      |

Table 29. Effingham Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66023, Atchison County) with exclusions.

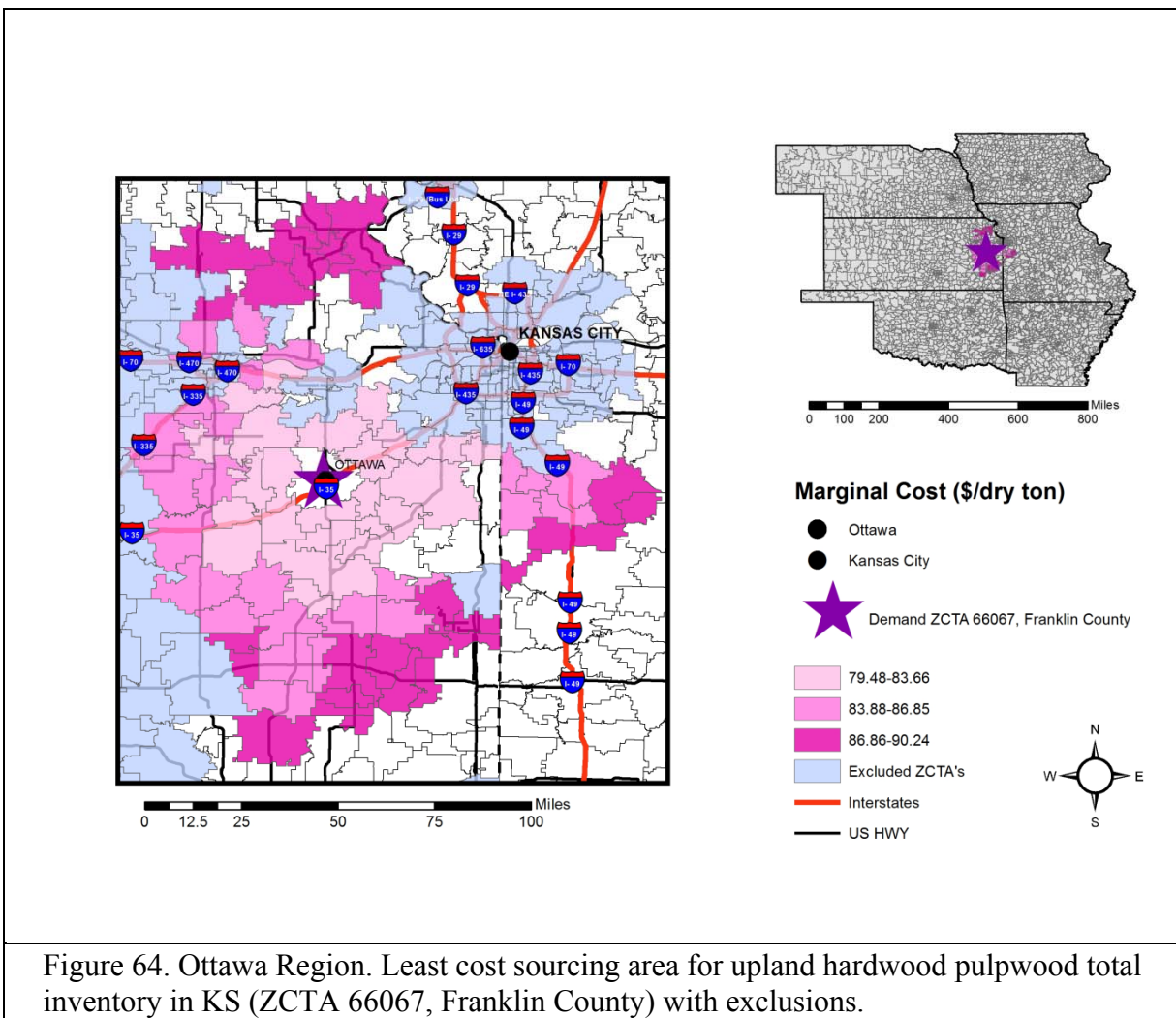
| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64480       | 6,738                    | 539                   | 149.6              | 28.78                      | 54.92                        | 14.69                      | 662,920         | 1,987,250                     | 98.39                      |
| 66451       | 3,650                    | 292                   | 151.5              | 28.78                      | 54.92                        | 14.70                      | 359,154         | 1,990,900                     | 98.40                      |
| 64473       | 21,113                   | 1,689                 | 146.3              | 28.78                      | 54.92                        | 14.72                      | 2,078,052       | 2,012,013                     | 98.43                      |
| 66067       | 23,775                   | 1,902                 | 145.8              | 28.78                      | 54.92                        | 14.74                      | 2,340,562       | 2,035,788                     | 98.45                      |
| 64423       | 12,888                   | 1,031                 | 151.4              | 28.78                      | 54.92                        | 14.79                      | 1,269,357       | 2,048,675                     | 98.50                      |
| 64494       | 14,750                   | 1,180                 | 146.2              | 28.78                      | 54.92                        | 14.80                      | 1,452,957       | 2,063,425                     | 98.51                      |
| 64048       | 31,575                   | 2,526                 | 148.9              | 28.78                      | 54.92                        | 14.87                      | 3,112,570       | 2,095,000                     | 98.58                      |
| 68442       | 5,375                    | 430                   | 151.3              | 28.78                      | 54.92                        | 14.93                      | 530,133         | 2,100,375                     | 98.63                      |
| 66543       | 500                      | 40                    | 150.0              | 28.78                      | 54.92                        | 15.09                      | 49,399          | 2,100,875                     | 98.80                      |
| 66021       | 5,313                    | 425                   | 152.5              | 28.78                      | 54.92                        | 15.11                      | 524,940         | 2,106,188                     | 98.81                      |
| 64451       | 138,188                  | 11,055                | 154.2              | 28.78                      | 54.92                        | 15.14                      | 13,658,892      | 2,244,375                     | 98.84                      |
| 64446       | 200,613                  | 16,049                | 157.3              | 28.78                      | 54.92                        | 16.12                      | 20,026,243      | 2,444,988                     | 99.83                      |

### 3.4.3 Ottawa

#### 3.4.3.1 Upland Hardwood

##### 3.4.3.1.1 Total Inventory (with exclusions)

ZCTA 66067 (Franklin County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Ottawa region for upland hardwood pulpwood total inventory. There are 77 Supply ZCTAs within 80 mile radius from ZCTA 66067 (Table 30). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$79.48 to \$90.24 (Figure 64, Figure 65).





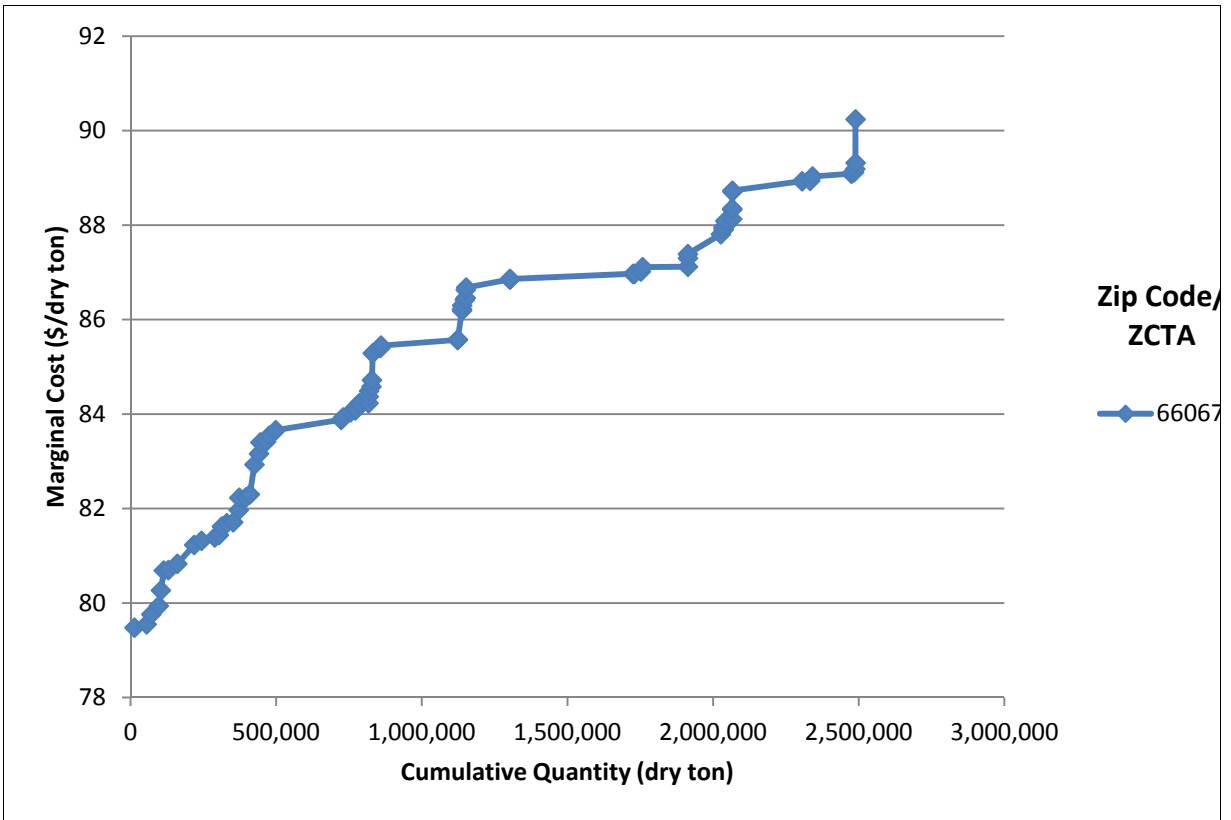


Figure 65. Ottawa Region. Marginal cost curve for upland hardwood pulpwood total inventory in KS (ZCTA 66067, Franklin County) with exclusions.

Table 30. Ottawa Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66092       | 13,400                   | 1,072                 | 21.9               | 28.78                      | 45.58                        | 5.12                       | 1,064,996       | 13,400                        | 79.48                      |
| 66006       | 41,588                   | 3,327                 | 24.8               | 28.78                      | 45.58                        | 5.19                       | 3,308,431       | 54,988                        | 79.55                      |
| 66078       | 15,875                   | 1,270                 | 27.0               | 28.78                      | 45.58                        | 5.40                       | 1,266,189       | 70,863                        | 79.76                      |
| 66076       | 26,050                   | 2,084                 | 23.9               | 28.78                      | 45.58                        | 5.58                       | 2,082,366       | 96,913                        | 79.94                      |
| 66080       | 7,225                    | 578                   | 36.4               | 28.78                      | 45.58                        | 5.90                       | 579,929         | 104,138                       | 80.27                      |
| 66021       | 9,938                    | 795                   | 40.1               | 28.78                      | 45.58                        | 6.33                       | 801,905         | 114,075                       | 80.69                      |
| 66079       | 15,588                   | 1,247                 | 34.9               | 28.78                      | 45.58                        | 6.34                       | 1,257,963       | 129,663                       | 80.70                      |
| 66524       | 30,925                   | 2,474                 | 42.0               | 28.78                      | 45.58                        | 6.47                       | 2,499,682       | 160,588                       | 80.83                      |
| 66071       | 57,900                   | 4,632                 | 44.9               | 28.78                      | 45.58                        | 6.87                       | 4,703,374       | 218,488                       | 81.23                      |
| 66528       | 25,013                   | 2,001                 | 41.1               | 28.78                      | 45.58                        | 6.96                       | 2,033,949       | 243,500                       | 81.32                      |
| 66032       | 45,788                   | 3,663                 | 52.9               | 28.78                      | 45.58                        | 7.02                       | 3,726,486       | 289,288                       | 81.39                      |
| 66095       | 14,088                   | 1,127                 | 49.3               | 28.78                      | 45.58                        | 7.07                       | 1,147,231       | 303,375                       | 81.44                      |
| 66042       | 10,000                   | 800                   | 50.1               | 28.78                      | 45.58                        | 7.26                       | 816,183         | 313,375                       | 81.62                      |
| 66510       | 17,113                   | 1,369                 | 56.6               | 28.78                      | 45.58                        | 7.33                       | 1,397,950       | 330,488                       | 81.69                      |
| 66025       | 22,025                   | 1,762                 | 54.3               | 28.78                      | 45.58                        | 7.35                       | 1,799,659       | 352,513                       | 81.71                      |
| 66083       | 18,900                   | 1,512                 | 59.8               | 28.78                      | 45.58                        | 7.61                       | 1,549,295       | 371,413                       | 81.97                      |
| 66543       | 1,575                    | 126                   | 49.9               | 28.78                      | 45.58                        | 7.87                       | 129,510         | 372,988                       | 82.23                      |
| 66064       | 24,000                   | 1,920                 | 54.4               | 28.78                      | 45.58                        | 7.87                       | 1,973,672       | 396,988                       | 82.24                      |
| 66033       | 12,588                   | 1,007                 | 60.0               | 28.78                      | 45.58                        | 7.93                       | 1,035,889       | 409,575                       | 82.30                      |
| 66871       | 15,663                   | 1,253                 | 69.0               | 28.78                      | 45.58                        | 8.56                       | 1,298,821       | 425,238                       | 82.93                      |
| 66050       | 15,538                   | 1,243                 | 69.6               | 28.78                      | 45.58                        | 8.79                       | 1,292,026       | 440,775                       | 83.16                      |
| 66013       | 5,050                    | 404                   | 78.0               | 28.78                      | 45.58                        | 9.04                       | 421,166         | 445,825                       | 83.40                      |
| 66091       | 19,488                   | 1,559                 | 78.3               | 28.78                      | 45.58                        | 9.06                       | 1,625,616       | 465,313                       | 83.42                      |
| 66537       | 9,938                    | 795                   | 77.1               | 28.78                      | 45.58                        | 9.18                       | 830,208         | 475,250                       | 83.54                      |

Table 30. Ottawa Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66409       | 23,263                   | 1,861                 | 77.4               | 28.78                      | 45.58                        | 9.30                       | 1,946,209       | 498,513                       | 83.66                      |
| 66073       | 224,500                  | 17,960                | 80.7               | 28.78                      | 45.58                        | 9.52                       | 18,830,589      | 723,013                       | 83.88                      |
| 66542       | 7,438                    | 595                   | 81.9               | 28.78                      | 45.58                        | 9.57                       | 624,243         | 730,450                       | 83.93                      |
| 66856       | 24,413                   | 1,953                 | 86.2               | 28.78                      | 45.58                        | 9.68                       | 2,051,732       | 754,863                       | 84.04                      |
| 66414       | 16,625                   | 1,330                 | 80.6               | 28.78                      | 45.58                        | 9.72                       | 1,397,877       | 771,488                       | 84.08                      |
| 64734       | 2,363                    | 189                   | 82.1               | 28.78                      | 45.58                        | 9.75                       | 198,705         | 773,850                       | 84.11                      |
| 66451       | 11,550                   | 924                   | 94.4               | 28.78                      | 45.58                        | 9.86                       | 972,785         | 785,400                       | 84.22                      |
| 66523       | 31,675                   | 2,534                 | 76.6               | 28.78                      | 45.58                        | 9.87                       | 2,668,085       | 785,625                       | 84.23                      |
| 66039       | 225                      | 18                    | 89.3               | 28.78                      | 45.58                        | 9.86                       | 18,951          | 817,300                       | 84.23                      |
| 66015       | 88                       | 7                     | 93.7               | 28.78                      | 45.58                        | 10.00                      | 7,382           | 817,388                       | 84.37                      |
| 66093       | 1,413                    | 113                   | 84.4               | 28.78                      | 45.58                        | 10.13                      | 119,348         | 818,800                       | 84.49                      |
| 66546       | 8,338                    | 667                   | 91.1               | 28.78                      | 45.58                        | 10.21                      | 705,145         | 827,138                       | 84.58                      |
| 64746       | 1,638                    | 131                   | 92.3               | 28.78                      | 45.58                        | 10.36                      | 138,725         | 828,775                       | 84.72                      |
| 64742       | 2,875                    | 230                   | 97.9               | 28.78                      | 45.58                        | 10.93                      | 245,215         | 831,650                       | 85.29                      |
| 66413       | 26,075                   | 2,086                 | 97.2               | 28.78                      | 45.58                        | 11.04                      | 2,226,739       | 857,725                       | 85.40                      |
| 66839       | 2,050                    | 164                   | 107.9              | 28.78                      | 45.58                        | 11.09                      | 175,176         | 859,775                       | 85.45                      |
| 66014       | 263,525                  | 21,082                | 97.5               | 28.78                      | 45.58                        | 11.21                      | 22,550,968      | 1,123,300                     | 85.57                      |
| 66749       | 175                      | 14                    | 110.0              | 28.78                      | 45.58                        | 11.22                      | 14,977          | 1,123,475                     | 85.58                      |
| 66512       | 14,425                   | 1,154                 | 118.9              | 28.78                      | 45.58                        | 11.83                      | 1,243,278       | 1,137,900                     | 86.19                      |
| 66751       | 63                       | 5                     | 120.6              | 28.78                      | 45.58                        | 11.86                      | 5,389           | 1,137,963                     | 86.22                      |
| 66010       | 350                      | 28                    | 112.0              | 28.78                      | 45.58                        | 11.93                      | 30,204          | 1,138,313                     | 86.30                      |
| 66618       | 9,138                    | 731                   | 120.3              | 28.78                      | 45.58                        | 12.06                      | 789,670         | 1,147,450                     | 86.42                      |
| 64701       | 3,113                    | 249                   | 115.2              | 28.78                      | 45.58                        | 12.10                      | 269,116         | 1,150,563                     | 86.46                      |
| 66748       | 263                      | 21                    | 126.6              | 28.78                      | 45.58                        | 12.27                      | 22,741          | 1,150,825                     | 86.63                      |

Table 30. Ottawa Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 64725       | 1,463                    | 117                   | 118.2              | 28.78                      | 45.58                        | 12.31                      | 126,765         | 1,152,288                     | 86.68                      |
| 66857       | 150,413                  | 12,033                | 127.8              | 28.78                      | 45.58                        | 12.48                      | 13,062,641      | 1,302,700                     | 86.85                      |
| 66755       | 188                      | 15                    | 131.0              | 28.78                      | 45.58                        | 12.50                      | 16,287          | 1,302,725                     | 86.86                      |
| 66761       | 25                       | 2                     | 130.8              | 28.78                      | 45.58                        | 12.50                      | 2,171           | 1,302,913                     | 86.86                      |
| 66056       | 422,375                  | 33,790                | 124.4              | 28.78                      | 45.58                        | 12.61                      | 36,734,466      | 1,725,288                     | 86.97                      |
| 64720       | 4,275                    | 342                   | 118.5              | 28.78                      | 45.58                        | 12.61                      | 371,816         | 1,729,563                     | 86.97                      |
| 66020       | 22,713                   | 1,817                 | 118.1              | 28.78                      | 45.58                        | 12.66                      | 1,976,442       | 1,752,275                     | 87.02                      |
| 66060       | 5,963                    | 477                   | 120.6              | 28.78                      | 45.58                        | 12.74                      | 519,372         | 1,758,238                     | 87.11                      |
| 64722       | 155,463                  | 12,437                | 127.9              | 28.78                      | 45.58                        | 12.75                      | 13,543,148      | 1,913,700                     | 87.12                      |
| 64747       | 63                       | 5                     | 130.5              | 28.78                      | 45.58                        | 12.94                      | 5,456           | 1,913,763                     | 87.30                      |
| 66758       | 75                       | 6                     | 125.6              | 28.78                      | 45.58                        | 13.02                      | 6,554           | 1,913,838                     | 87.39                      |
| 66767       | 113,038                  | 9,043                 | 142.6              | 28.78                      | 45.58                        | 13.44                      | 9,925,286       | 2,026,875                     | 87.81                      |
| 66440       | 9,463                    | 757                   | 142.2              | 28.78                      | 45.58                        | 13.53                      | 831,722         | 2,036,338                     | 87.90                      |
| 64739       | 38                       | 3                     | 140.6              | 28.78                      | 45.58                        | 13.58                      | 3,298           | 2,036,375                     | 87.94                      |
| 66732       | 50                       | 4                     | 135.0              | 28.78                      | 45.58                        | 13.60                      | 4,398           | 2,036,425                     | 87.96                      |
| 66016       | 5,775                    | 462                   | 134.5              | 28.78                      | 45.58                        | 13.73                      | 508,704         | 2,042,200                     | 88.09                      |
| 66088       | 23,538                   | 1,883                 | 142.6              | 28.78                      | 45.58                        | 13.77                      | 2,074,445       | 2,065,738                     | 88.13                      |
| 66716       | 350                      | 28                    | 140.1              | 28.78                      | 45.58                        | 13.96                      | 30,914          | 2,066,088                     | 88.33                      |
| 66772       | 50                       | 4                     | 141.5              | 28.78                      | 45.58                        | 13.99                      | 4,418           | 2,066,138                     | 88.35                      |
| 66775       | 75                       | 6                     | 146.8              | 28.78                      | 45.58                        | 14.35                      | 6,653           | 2,066,213                     | 88.71                      |
| 66720       | 325                      | 26                    | 157.1              | 28.78                      | 45.58                        | 14.37                      | 28,838          | 2,066,538                     | 88.73                      |
| 66754       | 239,363                  | 19,149                | 143.8              | 28.78                      | 45.58                        | 14.57                      | 21,286,644      | 2,305,900                     | 88.93                      |
| 66436       | 27,375                   | 2,190                 | 159.9              | 28.78                      | 45.58                        | 14.58                      | 2,434,868       | 2,333,275                     | 88.94                      |
| 66779       | 8,463                    | 677                   | 150.4              | 28.78                      | 45.58                        | 14.66                      | 753,377         | 2,341,738                     | 89.03                      |

Table 30. Ottawa Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66738       | 133,350                  | 10,668                | 159.1              | 28.78                      | 45.58                        | 14.73                      | 11,880,181      | 2,475,088                     | 89.09                      |
| 66023       | 8,613                    | 689                   | 145.9              | 28.78                      | 45.58                        | 14.75                      | 767,511         | 2,483,700                     | 89.12                      |
| 66769       | 4,600                    | 368                   | 154.7              | 28.78                      | 45.58                        | 14.83                      | 410,283         | 2,488,300                     | 89.19                      |
| 66002       | 925                      | 74                    | 150.7              | 28.78                      | 45.58                        | 14.95                      | 82,617          | 2,489,225                     | 89.32                      |
| 66041       | 88                       | 7                     | 157.9              | 28.78                      | 45.58                        | 15.88                      | 7,896           | 2,489,313                     | 90.24                      |

### 3.4.3.2 Lowland Hardwood

#### 3.4.3.2.1 Total Inventory (with exclusions)

ZCTA 66067 (Franklin County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Ottawa region for lowland hardwood pulpwood total inventory. There are 89 Supply ZCTAs within 80 mile radius from ZCTA 66067 (Table 31). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$88.82 to \$99.58 (Figure 66, Figure 67).

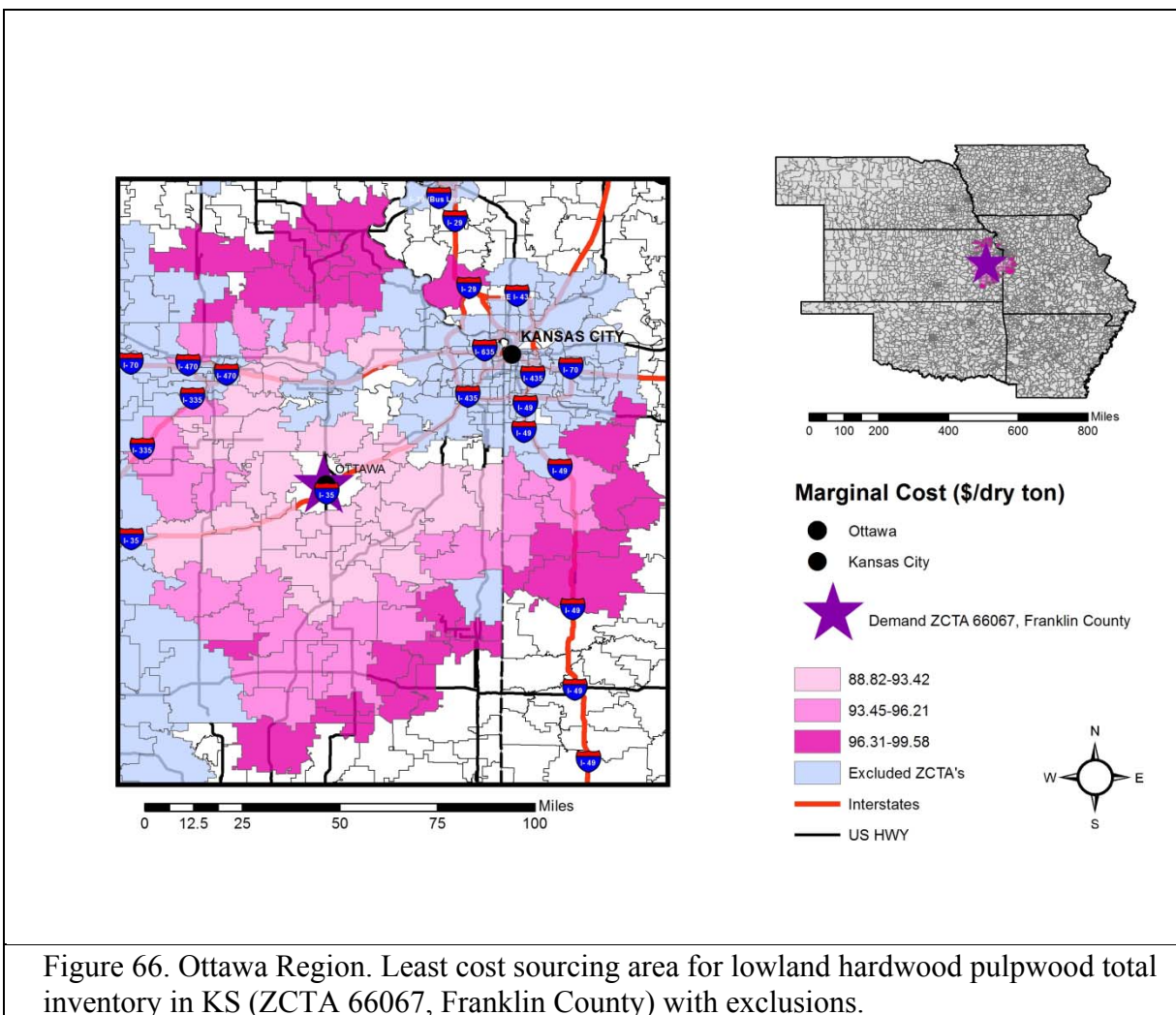


Figure 66. Ottawa Region. Least cost sourcing area for lowland hardwood pulpwood total inventory in KS (ZCTA 66067, Franklin County) with exclusions.

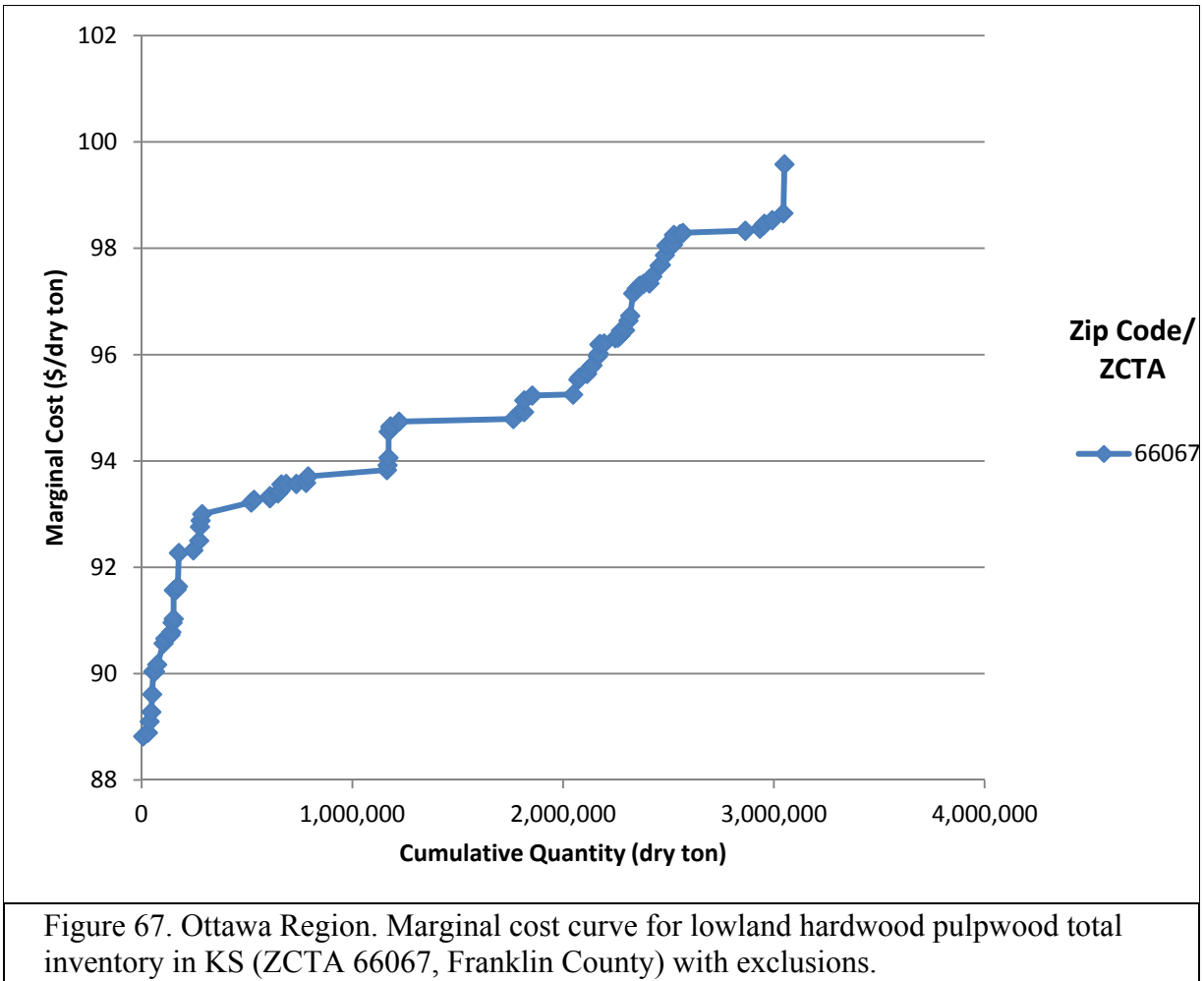


Table 31. Ottawa Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66092       | 7,163                    | 573                   | 21.9               | 28.78                      | 54.92                        | 5.12                       | 636,159         | 7,163                         | 88.82                      |
| 66006       | 22,250                   | 1,780                 | 24.8               | 28.78                      | 54.92                        | 5.19                       | 1,977,898       | 29,413                        | 88.89                      |
| 66078       | 8,488                    | 679                   | 27.0               | 28.78                      | 54.92                        | 5.40                       | 756,243         | 37,900                        | 89.10                      |
| 66076       | 8,225                    | 658                   | 23.9               | 28.78                      | 54.92                        | 5.58                       | 734,312         | 46,125                        | 89.28                      |
| 66080       | 3,863                    | 309                   | 36.4               | 28.78                      | 54.92                        | 5.90                       | 346,110         | 49,988                        | 89.61                      |
| 66079       | 8,338                    | 667                   | 34.9               | 28.78                      | 54.92                        | 6.34                       | 750,743         | 55,300                        | 90.04                      |
| 66021       | 5,313                    | 425                   | 40.1               | 28.78                      | 54.92                        | 6.33                       | 478,314         | 63,638                        | 90.04                      |
| 66524       | 9,775                    | 782                   | 42.0               | 28.78                      | 54.92                        | 6.47                       | 881,424         | 73,413                        | 90.17                      |
| 66071       | 30,975                   | 2,478                 | 44.9               | 28.78                      | 54.92                        | 6.87                       | 2,805,514       | 104,388                       | 90.57                      |
| 66528       | 7,900                    | 632                   | 41.1               | 28.78                      | 54.92                        | 6.96                       | 716,199         | 112,288                       | 90.66                      |
| 66032       | 24,500                   | 1,960                 | 52.9               | 28.78                      | 54.92                        | 7.02                       | 2,222,820       | 136,788                       | 90.73                      |
| 66095       | 4,450                    | 356                   | 49.3               | 28.78                      | 54.92                        | 7.07                       | 403,957         | 141,238                       | 90.78                      |
| 66042       | 5,350                    | 428                   | 50.1               | 28.78                      | 54.92                        | 7.26                       | 486,631         | 146,588                       | 90.96                      |
| 66510       | 5,400                    | 432                   | 56.6               | 28.78                      | 54.92                        | 7.33                       | 491,576         | 151,988                       | 91.03                      |
| 66543       | 500                      | 40                    | 49.9               | 28.78                      | 54.92                        | 7.87                       | 45,785          | 152,488                       | 91.57                      |
| 66064       | 12,838                   | 1,027                 | 54.4               | 28.78                      | 54.92                        | 7.87                       | 1,175,622       | 165,325                       | 91.58                      |
| 66033       | 6,738                    | 539                   | 60.0               | 28.78                      | 54.92                        | 7.93                       | 617,397         | 172,063                       | 91.64                      |
| 66871       | 4,950                    | 396                   | 69.0               | 28.78                      | 54.92                        | 8.56                       | 456,718         | 177,013                       | 92.27                      |
| 66053       | 68,713                   | 5,497                 | 68.9               | 28.78                      | 54.92                        | 8.61                       | 6,343,261       | 245,725                       | 92.32                      |
| 66050       | 27,225                   | 2,178                 | 69.6               | 28.78                      | 54.92                        | 8.79                       | 2,518,208       | 272,950                       | 92.50                      |
| 66091       | 3,763                    | 301                   | 78.3               | 28.78                      | 54.92                        | 9.06                       | 349,006         | 276,713                       | 92.76                      |
| 66537       | 3,138                    | 251                   | 77.1               | 28.78                      | 54.92                        | 9.18                       | 291,423         | 279,850                       | 92.88                      |
| 66409       | 7,350                    | 588                   | 77.4               | 28.78                      | 54.92                        | 9.30                       | 683,577         | 287,200                       | 93.00                      |
| 66073       | 233,013                  | 18,641                | 80.7               | 28.78                      | 54.92                        | 9.52                       | 21,721,122      | 520,213                       | 93.22                      |
| 66542       | 13,038                   | 1,043                 | 81.9               | 28.78                      | 54.92                        | 9.57                       | 1,216,041       | 533,250                       | 93.27                      |



Table 31. Ottawa Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66072       | 75,288                   | 6,023                 | 77.3               | 28.78                      | 54.92                        | 9.59                       | 7,024,100       | 608,538                       | 93.30                      |
| 66086       | 763                      | 61                    | 83.1               | 28.78                      | 54.92                        | 9.64                       | 71,175          | 609,300                       | 93.34                      |
| 66856       | 37,650                   | 3,012                 | 86.2               | 28.78                      | 54.92                        | 9.68                       | 3,515,949       | 646,950                       | 93.39                      |
| 66414       | 5,250                    | 420                   | 80.6               | 28.78                      | 54.92                        | 9.72                       | 490,474         | 652,200                       | 93.42                      |
| 64734       | 7,125                    | 570                   | 82.1               | 28.78                      | 54.92                        | 9.75                       | 665,821         | 659,325                       | 93.45                      |
| 66451       | 3,650                    | 292                   | 94.4               | 28.78                      | 54.92                        | 9.86                       | 341,511         | 662,975                       | 93.56                      |
| 66523       | 48,850                   | 3,908                 | 76.6               | 28.78                      | 54.92                        | 9.87                       | 4,571,088       | 685,325                       | 93.57                      |
| 66039       | 22,350                   | 1,788                 | 89.3               | 28.78                      | 54.92                        | 9.86                       | 2,091,216       | 734,175                       | 93.57                      |
| 66026       | 45,963                   | 3,677                 | 88.8               | 28.78                      | 54.92                        | 9.89                       | 4,301,735       | 780,138                       | 93.59                      |
| 66015       | 9,650                    | 772                   | 93.7               | 28.78                      | 54.92                        | 10.00                      | 904,274         | 789,788                       | 93.71                      |
| 66093       | 374,200                  | 29,936                | 84.4               | 28.78                      | 54.92                        | 10.13                      | 35,112,980      | 1,163,988                     | 93.83                      |
| 66546       | 2,638                    | 211                   | 91.1               | 28.78                      | 54.92                        | 10.21                      | 247,703         | 1,166,625                     | 93.92                      |
| 64746       | 4,963                    | 397                   | 92.3               | 28.78                      | 54.92                        | 10.36                      | 466,764         | 1,171,588                     | 94.06                      |
| 66066       | 738                      | 59                    | 97.0               | 28.78                      | 54.92                        | 10.85                      | 69,731          | 1,172,325                     | 94.55                      |
| 64742       | 8,688                    | 695                   | 97.9               | 28.78                      | 54.92                        | 10.93                      | 822,125         | 1,181,013                     | 94.63                      |
| 66429       | 88                       | 7                     | 105.9              | 28.78                      | 54.92                        | 10.95                      | 8,282           | 1,181,100                     | 94.65                      |
| 66413       | 40,213                   | 3,217                 | 97.2               | 28.78                      | 54.92                        | 11.04                      | 3,809,662       | 1,221,313                     | 94.74                      |
| 66839       | 542,375                  | 43,390                | 107.9              | 28.78                      | 54.92                        | 11.09                      | 51,413,166      | 1,763,688                     | 94.79                      |
| 66749       | 17,813                   | 1,425                 | 110.0              | 28.78                      | 54.92                        | 11.22                      | 1,690,832       | 1,796,763                     | 94.92                      |
| 66014       | 33,075                   | 2,646                 | 97.5               | 28.78                      | 54.92                        | 11.21                      | 3,139,317       | 1,814,575                     | 94.92                      |
| 66054       | 538                      | 43                    | 105.5              | 28.78                      | 54.92                        | 11.44                      | 51,137          | 1,815,113                     | 95.14                      |
| 64723       | 38,150                   | 3,052                 | 108.9              | 28.78                      | 54.92                        | 11.53                      | 3,633,037       | 1,853,263                     | 95.23                      |
| 66040       | 193,875                  | 15,510                | 110.3              | 28.78                      | 54.92                        | 11.54                      | 18,466,026      | 2,047,138                     | 95.25                      |
| 66512       | 25,288                   | 2,023                 | 118.9              | 28.78                      | 54.92                        | 11.83                      | 2,415,712       | 2,072,425                     | 95.53                      |
| 66751       | 6,500                    | 520                   | 120.6              | 28.78                      | 54.92                        | 11.86                      | 621,173         | 2,078,925                     | 95.57                      |

Table 31. Ottawa Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66010       | 34,738                   | 2,779                 | 112.0              | 28.78                      | 54.92                        | 11.93                      | 3,322,208       | 2,113,663                     | 95.64                      |
| 66618       | 16,013                   | 1,281                 | 120.3              | 28.78                      | 54.92                        | 12.06                      | 1,533,382       | 2,129,675                     | 95.76                      |
| 64701       | 9,400                    | 752                   | 115.2              | 28.78                      | 54.92                        | 12.10                      | 900,556         | 2,139,075                     | 95.80                      |
| 66748       | 25,713                   | 2,057                 | 126.6              | 28.78                      | 54.92                        | 12.27                      | 2,467,695       | 2,164,788                     | 95.97                      |
| 64725       | 4,438                    | 355                   | 118.2              | 28.78                      | 54.92                        | 12.31                      | 426,077         | 2,169,225                     | 96.02                      |
| 66857       | 2,613                    | 209                   | 127.8              | 28.78                      | 54.92                        | 12.48                      | 251,287         | 2,171,838                     | 96.19                      |
| 66761       | 3,050                    | 244                   | 130.8              | 28.78                      | 54.92                        | 12.50                      | 293,407         | 2,174,888                     | 96.20                      |
| 66755       | 19,388                   | 1,551                 | 131.0              | 28.78                      | 54.92                        | 12.50                      | 1,865,184       | 2,194,275                     | 96.21                      |
| 66056       | 53,025                   | 4,242                 | 124.4              | 28.78                      | 54.92                        | 12.61                      | 5,106,944       | 2,247,300                     | 96.31                      |
| 64720       | 12,900                   | 1,032                 | 118.5              | 28.78                      | 54.92                        | 12.61                      | 1,242,467       | 2,260,200                     | 96.32                      |
| 66020       | 10,838                   | 867                   | 118.1              | 28.78                      | 54.92                        | 12.66                      | 1,044,310       | 2,271,038                     | 96.36                      |
| 66097       | 238                      | 19                    | 119.6              | 28.78                      | 54.92                        | 12.68                      | 22,890          | 2,271,275                     | 96.38                      |
| 66060       | 2,850                    | 228                   | 120.6              | 28.78                      | 54.92                        | 12.74                      | 274,875         | 2,274,125                     | 96.45                      |
| 64722       | 19,513                   | 1,561                 | 127.9              | 28.78                      | 54.92                        | 12.75                      | 1,882,098       | 2,293,638                     | 96.46                      |
| 64747       | 16,763                   | 1,341                 | 130.5              | 28.78                      | 54.92                        | 12.94                      | 1,619,920       | 2,310,400                     | 96.64                      |
| 66758       | 7,925                    | 634                   | 125.6              | 28.78                      | 54.92                        | 13.02                      | 766,552         | 2,318,325                     | 96.73                      |
| 66767       | 14,188                   | 1,135                 | 142.6              | 28.78                      | 54.92                        | 13.44                      | 1,378,260       | 2,332,513                     | 97.15                      |
| 66440       | 16,588                   | 1,327                 | 142.2              | 28.78                      | 54.92                        | 13.53                      | 1,612,927       | 2,349,100                     | 97.24                      |
| 64739       | 10,488                   | 839                   | 140.6              | 28.78                      | 54.92                        | 13.58                      | 1,020,267       | 2,359,588                     | 97.28                      |
| 66732       | 5,650                    | 452                   | 135.0              | 28.78                      | 54.92                        | 13.60                      | 549,742         | 2,365,238                     | 97.30                      |
| 64070       | 16,750                   | 1,340                 | 146.2              | 28.78                      | 54.92                        | 13.63                      | 1,630,262       | 2,381,988                     | 97.33                      |
| 64080       | 27,163                   | 2,173                 | 148.5              | 28.78                      | 54.92                        | 13.63                      | 2,643,895       | 2,409,150                     | 97.34                      |
| 66016       | 2,750                    | 220                   | 134.5              | 28.78                      | 54.92                        | 13.73                      | 267,927         | 2,411,900                     | 97.43                      |
| 66088       | 11,225                   | 898                   | 142.6              | 28.78                      | 54.92                        | 13.77                      | 1,094,150       | 2,423,125                     | 97.47                      |
| 66716       | 34,875                   | 2,790                 | 140.1              | 28.78                      | 54.92                        | 13.96                      | 3,406,157       | 2,458,000                     | 97.67                      |

Table 31. Ottawa Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66067, Franklin County) with exclusions.

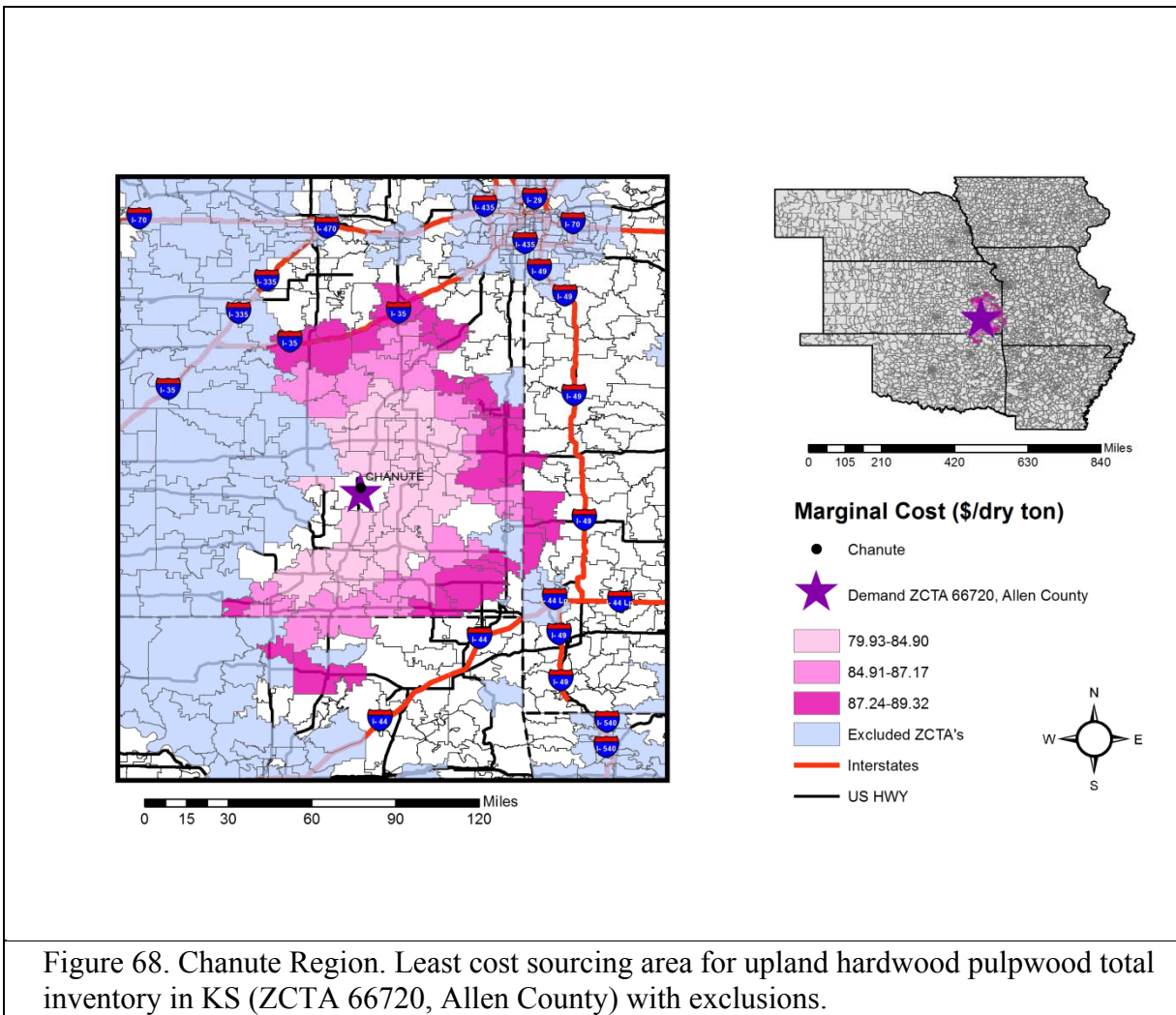
| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66772       | 5,938                    | 475                   | 141.5              | 28.78                      | 54.92                        | 13.99                      | 580,041         | 2,463,938                     | 97.69                      |
| 64079       | 18,463                   | 1,477                 | 155.0              | 28.78                      | 54.92                        | 14.17                      | 1,806,980       | 2,482,400                     | 97.87                      |
| 66775       | 7,488                    | 599                   | 146.8              | 28.78                      | 54.92                        | 14.35                      | 734,178         | 2,489,888                     | 98.05                      |
| 66720       | 32,200                   | 2,576                 | 157.1              | 28.78                      | 54.92                        | 14.37                      | 3,157,999       | 2,522,088                     | 98.07                      |
| 64745       | 3,425                    | 274                   | 152.9              | 28.78                      | 54.92                        | 14.55                      | 336,501         | 2,525,513                     | 98.25                      |
| 66754       | 30,050                   | 2,404                 | 143.8              | 28.78                      | 54.92                        | 14.57                      | 2,953,055       | 2,555,563                     | 98.27                      |
| 66436       | 13,063                   | 1,045                 | 159.9              | 28.78                      | 54.92                        | 14.58                      | 1,283,858       | 2,568,625                     | 98.29                      |
| 64730       | 296,225                  | 23,698                | 149.2              | 28.78                      | 54.92                        | 14.62                      | 29,126,814      | 2,864,850                     | 98.33                      |
| 66779       | 68,963                   | 5,517                 | 150.4              | 28.78                      | 54.92                        | 14.66                      | 6,783,574       | 2,933,813                     | 98.37                      |
| 66738       | 16,738                   | 1,339                 | 159.1              | 28.78                      | 54.92                        | 14.73                      | 1,647,489       | 2,950,550                     | 98.43                      |
| 66023       | 4,113                    | 329                   | 145.9              | 28.78                      | 54.92                        | 14.75                      | 404,903         | 2,954,663                     | 98.46                      |
| 66769       | 37,513                   | 3,001                 | 154.7              | 28.78                      | 54.92                        | 14.83                      | 3,696,207       | 2,992,175                     | 98.53                      |
| 66002       | 53,175                   | 4,254                 | 150.7              | 28.78                      | 54.92                        | 14.95                      | 5,246,071       | 3,045,350                     | 98.66                      |
| 66041       | 5,338                    | 427                   | 157.9              | 28.78                      | 54.92                        | 15.88                      | 531,511         | 3,050,688                     | 99.58                      |

### 3.4.4 Chanute

#### 3.4.4.1 Upland Hardwood

##### 3.4.4.1.1 Total Inventory (with exclusions)

ZCTA 66720 (Allen County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Chanute region for upland hardwood pulpwood total inventory. There are 84 Supply ZCTAs within 80 mile radius from ZCTA 66720 (Table 32). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$79.93 to \$89.32 (Figure 68, Figure 69).



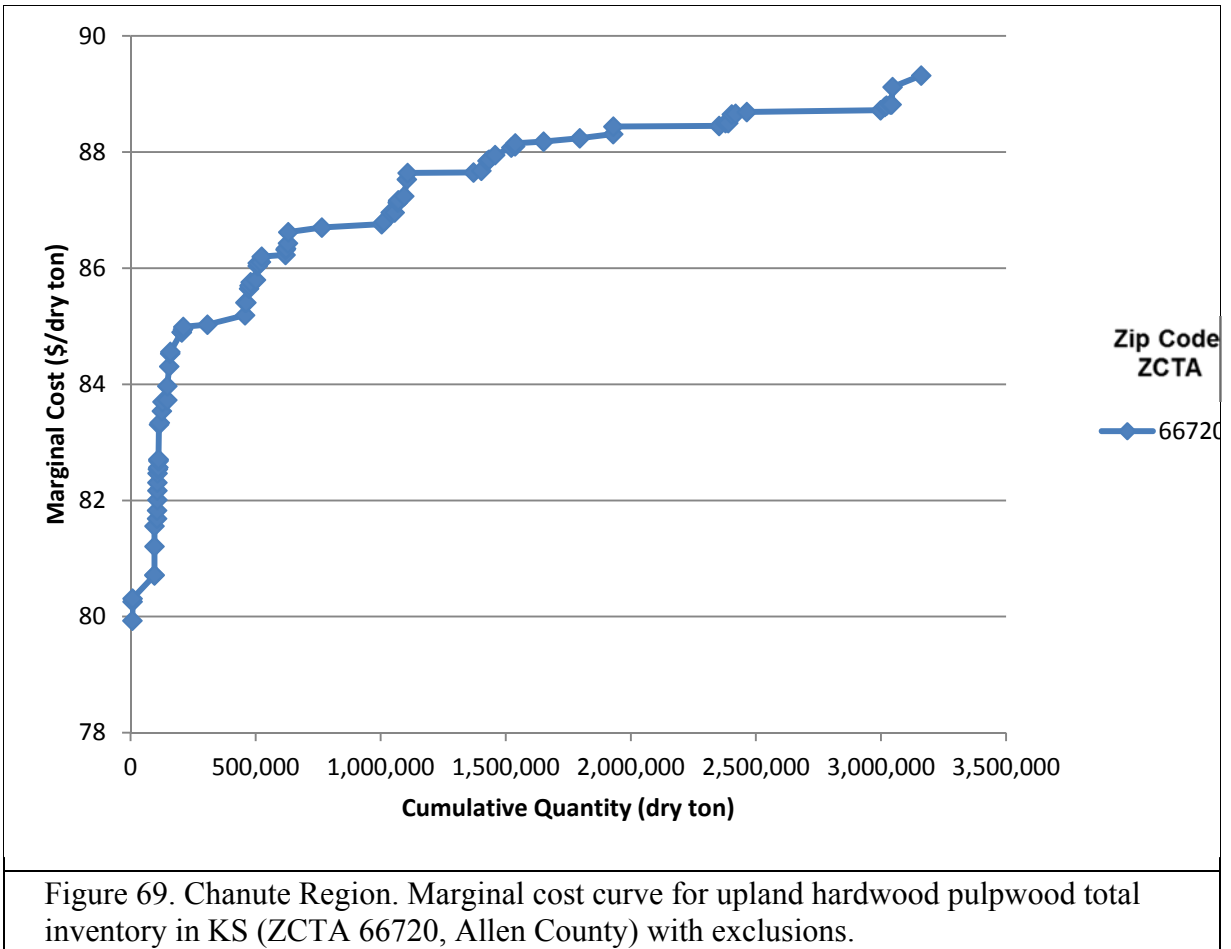


Table 32. Chanute Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66776       | 7,338                    | 587                   | 29.3               | 28.78                      | 45.58                        | 5.56                       | 586,461         | 7,338                         | 79.93                      |
| 66748       | 263                      | 21                    | 34.6               | 28.78                      | 45.58                        | 5.90                       | 21,069          | 7,600                         | 80.26                      |
| 66733       | 313                      | 25                    | 30.0               | 28.78                      | 45.58                        | 5.95                       | 25,098          | 7,913                         | 80.31                      |
| 66717       | 87,575                   | 7,006                 | 40.7               | 28.78                      | 45.58                        | 6.35                       | 7,068,312       | 95,488                        | 80.71                      |
| 66775       | 75                       | 6                     | 37.7               | 28.78                      | 45.58                        | 6.36                       | 6,054           | 95,563                        | 80.72                      |
| 66772       | 50                       | 4                     | 41.3               | 28.78                      | 45.58                        | 6.85                       | 4,061           | 95,613                        | 81.21                      |
| 66749       | 175                      | 14                    | 52.2               | 28.78                      | 45.58                        | 7.20                       | 14,273          | 95,788                        | 81.56                      |
| 67335       | 10,163                   | 813                   | 56.7               | 28.78                      | 45.58                        | 7.33                       | 830,218         | 105,950                       | 81.69                      |
| 66751       | 63                       | 5                     | 57.8               | 28.78                      | 45.58                        | 7.47                       | 5,114           | 106,013                       | 81.83                      |
| 66740       | 1,263                    | 101                   | 51.9               | 28.78                      | 45.58                        | 7.65                       | 103,543         | 107,275                       | 82.01                      |
| 66732       | 50                       | 4                     | 53.2               | 28.78                      | 45.58                        | 7.81                       | 4,108           | 107,325                       | 82.17                      |
| 66761       | 25                       | 2                     | 65.2               | 28.78                      | 45.58                        | 7.95                       | 2,058           | 107,350                       | 82.31                      |
| 66755       | 188                      | 15                    | 68.2               | 28.78                      | 45.58                        | 8.11                       | 15,463          | 107,538                       | 82.47                      |
| 67341       | 1,100                    | 88                    | 65.1               | 28.78                      | 45.58                        | 8.18                       | 90,794          | 108,638                       | 82.54                      |
| 66771       | 2,500                    | 200                   | 61.7               | 28.78                      | 45.58                        | 8.21                       | 206,426         | 111,138                       | 82.57                      |
| 66780       | 238                      | 19                    | 57.9               | 28.78                      | 45.58                        | 8.32                       | 19,637          | 111,375                       | 82.68                      |
| 67363       | 50                       | 4                     | 70.5               | 28.78                      | 45.58                        | 8.34                       | 4,135           | 111,425                       | 82.70                      |
| 66015       | 88                       | 7                     | 71.5               | 28.78                      | 45.58                        | 8.35                       | 7,237           | 111,513                       | 82.71                      |
| 66746       | 2,225                    | 178                   | 64.4               | 28.78                      | 45.58                        | 8.95                       | 185,362         | 113,738                       | 83.31                      |
| 67351       | 2,588                    | 207                   | 79.4               | 28.78                      | 45.58                        | 8.98                       | 215,636         | 116,325                       | 83.34                      |
| 66779       | 8,463                    | 677                   | 65.8               | 28.78                      | 45.58                        | 9.18                       | 706,933         | 124,788                       | 83.54                      |
| 67354       | 2,513                    | 201                   | 85.5               | 28.78                      | 45.58                        | 9.33                       | 210,289         | 127,300                       | 83.70                      |
| 66091       | 19,488                   | 1,559                 | 83.9               | 28.78                      | 45.58                        | 9.37                       | 1,631,679       | 146,788                       | 83.73                      |
| 66758       | 75                       | 6                     | 81.1               | 28.78                      | 45.58                        | 9.61                       | 6,298           | 146,863                       | 83.97                      |

Table 32. Chanute Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67357       | 7,463                    | 597                   | 89.1               | 28.78                      | 45.58                        | 9.94                       | 629,131         | 154,325                       | 84.31                      |
| 67301       | 4,050                    | 324                   | 93.6               | 28.78                      | 45.58                        | 10.17                      | 342,346         | 158,375                       | 84.53                      |
| 66039       | 225                      | 18                    | 95.1               | 28.78                      | 45.58                        | 10.20                      | 19,025          | 158,600                       | 84.56                      |
| 66716       | 350                      | 28                    | 97.4               | 28.78                      | 45.58                        | 10.53                      | 29,714          | 204,388                       | 84.90                      |
| 66032       | 45,788                   | 3,663                 | 104.1              | 28.78                      | 45.58                        | 10.53                      | 3,887,168       | 204,738                       | 84.90                      |
| 66753       | 4,350                    | 348                   | 92.3               | 28.78                      | 45.58                        | 10.59                      | 369,543         | 209,088                       | 84.95                      |
| 67330       | 1,538                    | 123                   | 102.2              | 28.78                      | 45.58                        | 10.63                      | 130,679         | 210,625                       | 84.99                      |
| 66734       | 96,350                   | 7,708                 | 86.5               | 28.78                      | 45.58                        | 10.67                      | 8,192,507       | 306,975                       | 85.03                      |
| 66857       | 150,413                  | 12,033                | 101.5              | 28.78                      | 45.58                        | 10.83                      | 12,813,718      | 457,388                       | 85.19                      |
| 66735       | 3,613                    | 289                   | 106.0              | 28.78                      | 45.58                        | 11.05                      | 308,548         | 458,800                       | 85.41                      |
| 66093       | 1,413                    | 113                   | 98.9               | 28.78                      | 45.58                        | 11.05                      | 120,643         | 462,413                       | 85.41                      |
| 67337       | 11,163                   | 893                   | 108.0              | 28.78                      | 45.58                        | 11.29                      | 956,059         | 473,575                       | 85.65                      |
| 66839       | 2,050                    | 164                   | 109.7              | 28.78                      | 45.58                        | 11.33                      | 175,677         | 475,625                       | 85.70                      |
| 66769       | 4,600                    | 368                   | 112.0              | 28.78                      | 45.58                        | 11.40                      | 394,506         | 480,225                       | 85.76                      |
| 74072       | 20,838                   | 1,667                 | 106.8              | 28.78                      | 45.58                        | 11.44                      | 1,787,911       | 501,063                       | 85.80                      |
| 66080       | 7,225                    | 578                   | 120.9              | 28.78                      | 45.58                        | 11.68                      | 621,662         | 508,288                       | 86.04                      |
| 67364       | 38                       | 3                     | 118.9              | 28.78                      | 45.58                        | 11.73                      | 3,228           | 508,325                       | 86.09                      |
| 66033       | 12,588                   | 1,007                 | 122.1              | 28.78                      | 45.58                        | 11.75                      | 1,083,881       | 520,913                       | 86.11                      |
| 67342       | 3,338                    | 267                   | 122.0              | 28.78                      | 45.58                        | 11.84                      | 287,695         | 524,250                       | 86.20                      |
| 66712       | 95,013                   | 7,601                 | 116.7              | 28.78                      | 45.58                        | 11.87                      | 8,193,242       | 619,263                       | 86.23                      |
| 66010       | 350                      | 28                    | 113.8              | 28.78                      | 45.58                        | 11.96                      | 30,211          | 619,613                       | 86.32                      |
| 67347       | 1,438                    | 115                   | 117.0              | 28.78                      | 45.58                        | 11.97                      | 124,109         | 621,050                       | 86.34                      |
| 67356       | 7,688                    | 615                   | 121.2              | 28.78                      | 45.58                        | 12.06                      | 664,395         | 628,738                       | 86.43                      |
| 67333       | 1,263                    | 101                   | 125.6              | 28.78                      | 45.58                        | 12.25                      | 109,353         | 630,000                       | 86.62                      |

Table 32. Chanute Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66756       | 134,313                  | 10,745                | 120.3              | 28.78                      | 45.58                        | 12.34                      | 11,644,996      | 764,313                       | 86.70                      |
| 66754       | 239,363                  | 19,149                | 123.9              | 28.78                      | 45.58                        | 12.40                      | 20,767,639      | 1,003,675                     | 86.76                      |
| 66711       | 8,225                    | 658                   | 124.8              | 28.78                      | 45.58                        | 12.43                      | 713,899         | 1,011,900                     | 86.80                      |
| 66724       | 27,750                   | 2,220                 | 125.9              | 28.78                      | 45.58                        | 12.60                      | 2,413,246       | 1,039,650                     | 86.96                      |
| 66078       | 15,875                   | 1,270                 | 131.5              | 28.78                      | 45.58                        | 12.60                      | 1,380,564       | 1,055,525                     | 86.96                      |
| 74083       | 12,188                   | 975                   | 124.5              | 28.78                      | 45.58                        | 12.77                      | 1,061,913       | 1,067,713                     | 87.13                      |
| 67355       | 1,250                    | 100                   | 130.8              | 28.78                      | 45.58                        | 12.80                      | 108,953         | 1,068,963                     | 87.16                      |
| 67332       | 1,338                    | 107                   | 135.7              | 28.78                      | 45.58                        | 12.81                      | 116,593         | 1,070,300                     | 87.17                      |
| 66701       | 23,913                   | 1,913                 | 135.4              | 28.78                      | 45.58                        | 12.88                      | 2,086,157       | 1,094,213                     | 87.24                      |
| 66042       | 10,000                   | 800                   | 138.0              | 28.78                      | 45.58                        | 13.17                      | 875,322         | 1,104,213                     | 87.53                      |
| 66741       | 2,988                    | 239                   | 134.0              | 28.78                      | 45.58                        | 13.28                      | 261,826         | 1,107,200                     | 87.64                      |
| 66014       | 263,525                  | 21,082                | 130.4              | 28.78                      | 45.58                        | 13.28                      | 23,096,971      | 1,370,725                     | 87.65                      |
| 66773       | 31,888                   | 2,551                 | 136.2              | 28.78                      | 45.58                        | 13.32                      | 2,796,003       | 1,402,613                     | 87.68                      |
| 66064       | 24,000                   | 1,920                 | 145.7              | 28.78                      | 45.58                        | 13.49                      | 2,108,513       | 1,426,613                     | 87.85                      |
| 64769       | 6,613                    | 529                   | 135.0              | 28.78                      | 45.58                        | 13.51                      | 581,072         | 1,433,225                     | 87.87                      |
| 66856       | 24,413                   | 1,953                 | 140.0              | 28.78                      | 45.58                        | 13.59                      | 2,147,048       | 1,457,638                     | 87.95                      |
| 66781       | 64,125                   | 5,130                 | 142.9              | 28.78                      | 45.58                        | 13.72                      | 5,648,058       | 1,521,763                     | 88.08                      |
| 66871       | 15,663                   | 1,253                 | 140.4              | 28.78                      | 45.58                        | 13.73                      | 1,379,813       | 1,537,425                     | 88.10                      |
| 66760       | 500                      | 40                    | 142.5              | 28.78                      | 45.58                        | 13.79                      | 44,076          | 1,537,925                     | 88.15                      |
| 66767       | 113,038                  | 9,043                 | 152.8              | 28.78                      | 45.58                        | 13.82                      | 9,968,142       | 1,650,963                     | 88.18                      |
| 74048       | 144,938                  | 11,595                | 150.3              | 28.78                      | 45.58                        | 13.88                      | 12,789,467      | 1,795,900                     | 88.24                      |
| 66738       | 133,350                  | 10,668                | 151.3              | 28.78                      | 45.58                        | 13.95                      | 11,776,636      | 1,929,250                     | 88.31                      |
| 64741       | 1,038                    | 83                    | 151.6              | 28.78                      | 45.58                        | 14.08                      | 91,758          | 1,930,288                     | 88.44                      |
| 66056       | 422,375                  | 33,790                | 142.8              | 28.78                      | 45.58                        | 14.09                      | 37,360,150      | 2,352,663                     | 88.45                      |



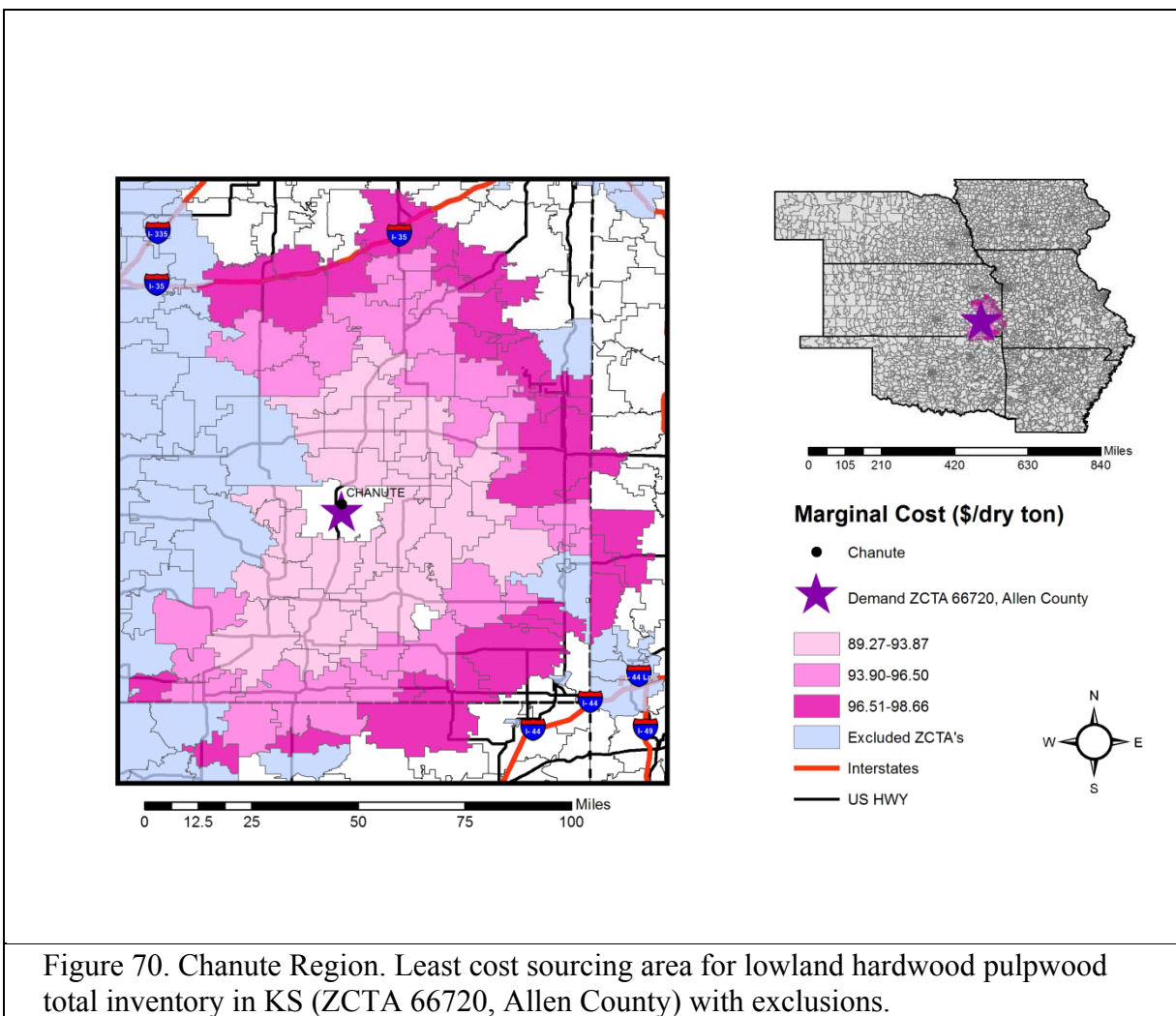
Table 32. Chanute Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66725       | 10,525                   | 842                   | 150.6              | 28.78                      | 45.58                        | 14.14                      | 931,484         | 2,378,700                     | 88.50                      |
| 64762       | 26,038                   | 2,083                 | 143.4              | 28.78                      | 45.58                        | 14.13                      | 2,304,242       | 2,389,225                     | 88.50                      |
| 66095       | 14,088                   | 1,127                 | 146.3              | 28.78                      | 45.58                        | 14.28                      | 1,248,800       | 2,403,313                     | 88.65                      |
| 66079       | 15,588                   | 1,247                 | 150.1              | 28.78                      | 45.58                        | 14.30                      | 1,382,014       | 2,418,900                     | 88.66                      |
| 66067       | 44,450                   | 3,556                 | 157.1              | 28.78                      | 45.58                        | 14.33                      | 3,942,261       | 2,463,350                     | 88.69                      |
| 67360       | 534,875                  | 42,790                | 147.3              | 28.78                      | 45.58                        | 14.36                      | 47,452,891      | 2,998,225                     | 88.72                      |
| 66510       | 17,113                   | 1,369                 | 155.7              | 28.78                      | 45.58                        | 14.42                      | 1,519,228       | 3,015,338                     | 88.78                      |
| 67336       | 6,838                    | 547                   | 157.8              | 28.78                      | 45.58                        | 14.44                      | 607,198         | 3,022,175                     | 88.80                      |
| 64832       | 15,100                   | 1,208                 | 151.2              | 28.78                      | 45.58                        | 14.45                      | 1,341,117       | 3,037,275                     | 88.82                      |
| 74029       | 5,563                    | 445                   | 153.2              | 28.78                      | 45.58                        | 14.46                      | 494,074         | 3,042,838                     | 88.82                      |
| 66728       | 3,838                    | 307                   | 158.2              | 28.78                      | 45.58                        | 14.76                      | 342,012         | 3,046,675                     | 89.12                      |
| 74369       | 114,150                  | 9,132                 | 153.7              | 28.78                      | 45.58                        | 14.96                      | 10,195,607      | 3,160,825                     | 89.32                      |

### 3.4.4.2 Lowland Hardwood

#### 3.4.4.2.1 Total Inventory (with exclusions)

ZCTA 66720 (Allen County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Chanute region for lowland hardwood pulpwood total inventory. There are 90 Supply ZCTAs within 80 mile radius from ZCTA 66720 (Table 33). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$89.27 to \$98.66 (Figure 70, Figure 71Figure 61).



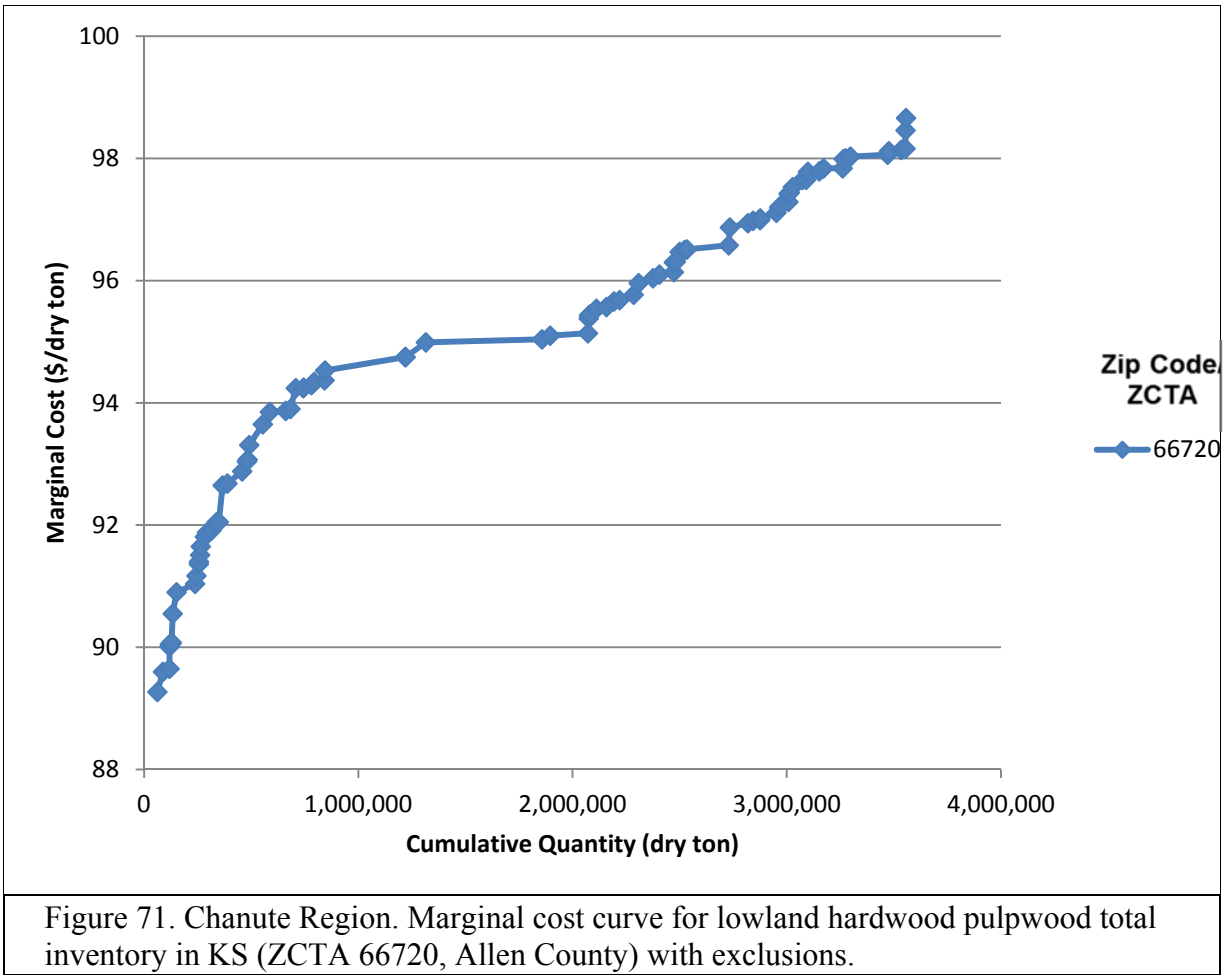


Figure 71. Chanute Region. Marginal cost curve for lowland hardwood pulpwood total inventory in KS (ZCTA 66720, Allen County) with exclusions.

Table 33. Chanute Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66776       | 62,138                   | 4,971                 | 29.3               | 28.78                      | 54.92                        | 5.56                       | 5,546,853       | 62,138                        | 89.27                      |
| 66748       | 25,713                   | 2,057                 | 34.6               | 28.78                      | 54.92                        | 5.90                       | 2,303,918       | 87,850                        | 89.60                      |
| 66733       | 30,625                   | 2,450                 | 30.0               | 28.78                      | 54.92                        | 5.95                       | 2,745,626       | 118,475                       | 89.65                      |
| 66714       | 175                      | 14                    | 43.0               | 28.78                      | 54.92                        | 6.31                       | 15,753          | 118,650                       | 90.01                      |
| 66717       | 1,513                    | 121                   | 40.7               | 28.78                      | 54.92                        | 6.35                       | 136,204         | 120,163                       | 90.05                      |
| 66775       | 7,488                    | 599                   | 37.7               | 28.78                      | 54.92                        | 6.36                       | 674,324         | 127,650                       | 90.06                      |
| 66710       | 338                      | 27                    | 39.9               | 28.78                      | 54.92                        | 6.38                       | 30,403          | 127,988                       | 90.08                      |
| 66772       | 5,938                    | 475                   | 41.3               | 28.78                      | 54.92                        | 6.85                       | 537,666         | 133,925                       | 90.55                      |
| 66749       | 17,813                   | 1,425                 | 52.2               | 28.78                      | 54.92                        | 7.20                       | 1,619,136       | 151,738                       | 90.90                      |
| 67335       | 86,063                   | 6,885                 | 56.7               | 28.78                      | 54.92                        | 7.33                       | 7,834,706       | 237,800                       | 91.04                      |
| 66751       | 6,500                    | 520                   | 57.8               | 28.78                      | 54.92                        | 7.47                       | 592,605         | 244,300                       | 91.17                      |
| 66740       | 10,763                   | 861                   | 51.9               | 28.78                      | 54.92                        | 7.65                       | 983,211         | 255,063                       | 91.36                      |
| 66757       | 813                      | 65                    | 58.2               | 28.78                      | 54.92                        | 7.70                       | 74,261          | 255,875                       | 91.40                      |
| 66732       | 5,650                    | 452                   | 53.2               | 28.78                      | 54.92                        | 7.81                       | 517,023         | 261,525                       | 91.51                      |
| 66761       | 3,050                    | 244                   | 65.2               | 28.78                      | 54.92                        | 7.95                       | 279,542         | 264,575                       | 91.65                      |
| 66755       | 19,388                   | 1,551                 | 68.2               | 28.78                      | 54.92                        | 8.11                       | 1,779,973       | 283,963                       | 91.81                      |
| 67341       | 9,313                    | 745                   | 65.1               | 28.78                      | 54.92                        | 8.18                       | 855,643         | 293,275                       | 91.88                      |
| 66771       | 21,188                   | 1,695                 | 61.7               | 28.78                      | 54.92                        | 8.21                       | 1,947,365       | 314,463                       | 91.91                      |
| 66780       | 23,525                   | 1,882                 | 57.9               | 28.78                      | 54.92                        | 8.32                       | 2,164,888       | 337,988                       | 92.02                      |
| 67363       | 1,063                    | 85                    | 70.5               | 28.78                      | 54.92                        | 8.34                       | 97,798          | 339,050                       | 92.05                      |
| 66015       | 9,650                    | 772                   | 71.5               | 28.78                      | 54.92                        | 8.35                       | 888,298         | 348,700                       | 92.05                      |
| 66746       | 18,213                   | 1,457                 | 64.4               | 28.78                      | 54.92                        | 8.95                       | 1,687,381       | 366,913                       | 92.65                      |
| 67351       | 21,888                   | 1,751                 | 79.4               | 28.78                      | 54.92                        | 8.98                       | 2,028,495       | 388,800                       | 92.68                      |
| 66779       | 68,963                   | 5,517                 | 65.8               | 28.78                      | 54.92                        | 9.18                       | 6,405,097       | 457,763                       | 92.88                      |

Table 33. Chanute Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67354       | 21,313                   | 1,705                 | 85.5               | 28.78                      | 54.92                        | 9.33                       | 1,982,867       | 479,075                       | 93.04                      |
| 66091       | 3,763                    | 301                   | 83.9               | 28.78                      | 54.92                        | 9.37                       | 350,177         | 482,838                       | 93.07                      |
| 66758       | 7,925                    | 634                   | 81.1               | 28.78                      | 54.92                        | 9.61                       | 739,506         | 490,763                       | 93.31                      |
| 67357       | 63,213                   | 5,057                 | 89.1               | 28.78                      | 54.92                        | 9.94                       | 5,919,627       | 553,975                       | 93.65                      |
| 66743       | 32,650                   | 2,612                 | 90.8               | 28.78                      | 54.92                        | 10.15                      | 3,064,198       | 586,625                       | 93.85                      |
| 67301       | 74,550                   | 5,964                 | 93.6               | 28.78                      | 54.92                        | 10.17                      | 6,998,052       | 661,175                       | 93.87                      |
| 66039       | 22,350                   | 1,788                 | 95.1               | 28.78                      | 54.92                        | 10.20                      | 2,098,623       | 683,525                       | 93.90                      |
| 66716       | 34,875                   | 2,790                 | 97.4               | 28.78                      | 54.92                        | 10.53                      | 3,286,545       | 708,025                       | 94.24                      |
| 66032       | 24,500                   | 1,960                 | 104.1              | 28.78                      | 54.92                        | 10.53                      | 2,308,797       | 742,900                       | 94.24                      |
| 67344       | 1,288                    | 103                   | 94.9               | 28.78                      | 54.92                        | 10.54                      | 121,341         | 744,188                       | 94.25                      |
| 66753       | 36,900                   | 2,952                 | 92.3               | 28.78                      | 54.92                        | 10.59                      | 3,479,422       | 781,088                       | 94.29                      |
| 67330       | 13,063                   | 1,045                 | 102.2              | 28.78                      | 54.92                        | 10.63                      | 1,232,255       | 794,150                       | 94.34                      |
| 66734       | 48,125                   | 3,850                 | 86.5               | 28.78                      | 54.92                        | 10.67                      | 4,541,528       | 842,275                       | 94.37                      |
| 66857       | 2,613                    | 209                   | 101.5              | 28.78                      | 54.92                        | 10.83                      | 246,963         | 844,888                       | 94.53                      |
| 66735       | 1,800                    | 144                   | 106.0              | 28.78                      | 54.92                        | 11.05                      | 170,554         | 1,219,088                     | 94.75                      |
| 66093       | 374,200                  | 29,936                | 98.9               | 28.78                      | 54.92                        | 11.05                      | 35,455,980      | 1,220,888                     | 94.75                      |
| 67337       | 94,513                   | 7,561                 | 108.0              | 28.78                      | 54.92                        | 11.29                      | 8,977,737       | 1,315,400                     | 94.99                      |
| 66839       | 542,375                  | 43,390                | 109.7              | 28.78                      | 54.92                        | 11.33                      | 51,545,720      | 1,857,775                     | 95.04                      |
| 66769       | 37,513                   | 3,001                 | 112.0              | 28.78                      | 54.92                        | 11.40                      | 3,567,550       | 1,895,288                     | 95.10                      |
| 74072       | 176,363                  | 14,109                | 106.8              | 28.78                      | 54.92                        | 11.44                      | 16,779,722      | 2,071,650                     | 95.14                      |
| 66080       | 3,863                    | 309                   | 120.9              | 28.78                      | 54.92                        | 11.68                      | 368,420         | 2,075,513                     | 95.38                      |
| 67364       | 763                      | 61                    | 118.9              | 28.78                      | 54.92                        | 11.73                      | 72,766          | 2,076,275                     | 95.43                      |
| 66033       | 6,738                    | 539                   | 122.1              | 28.78                      | 54.92                        | 11.75                      | 643,085         | 2,083,013                     | 95.45                      |
| 67342       | 28,300                   | 2,264                 | 122.0              | 28.78                      | 54.92                        | 11.84                      | 2,703,822       | 2,111,313                     | 95.54                      |

Table 33. Chanute Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66712       | 47,463                   | 3,797                 | 116.7              | 28.78                      | 54.92                        | 11.87                      | 4,536,186       | 2,158,775                     | 95.57                      |
| 66010       | 34,738                   | 2,779                 | 113.8              | 28.78                      | 54.92                        | 11.96                      | 3,322,953       | 2,193,513                     | 95.66                      |
| 67347       | 26,563                   | 2,125                 | 117.0              | 28.78                      | 54.92                        | 11.97                      | 2,541,442       | 2,220,075                     | 95.68                      |
| 67356       | 65,025                   | 5,202                 | 121.2              | 28.78                      | 54.92                        | 12.06                      | 6,227,198       | 2,285,100                     | 95.77                      |
| 67333       | 23,350                   | 1,868                 | 125.6              | 28.78                      | 54.92                        | 12.25                      | 2,240,603       | 2,308,450                     | 95.96                      |
| 66756       | 67,100                   | 5,368                 | 120.3              | 28.78                      | 54.92                        | 12.34                      | 6,444,389       | 2,375,550                     | 96.04                      |
| 66754       | 30,050                   | 2,404                 | 123.9              | 28.78                      | 54.92                        | 12.40                      | 2,887,898       | 2,405,600                     | 96.10                      |
| 66711       | 67,075                   | 5,366                 | 124.8              | 28.78                      | 54.92                        | 12.43                      | 6,448,387       | 2,472,675                     | 96.14                      |
| 66724       | 525                      | 42                    | 125.9              | 28.78                      | 54.92                        | 12.60                      | 50,560          | 2,473,200                     | 96.30                      |
| 66078       | 8,488                    | 679                   | 131.5              | 28.78                      | 54.92                        | 12.60                      | 817,393         | 2,481,688                     | 96.31                      |
| 74083       | 17,988                   | 1,439                 | 124.5              | 28.78                      | 54.92                        | 12.77                      | 1,735,293       | 2,499,675                     | 96.47                      |
| 67355       | 23,200                   | 1,856                 | 130.8              | 28.78                      | 54.92                        | 12.80                      | 2,238,870       | 2,522,875                     | 96.50                      |
| 67332       | 11,375                   | 910                   | 135.7              | 28.78                      | 54.92                        | 12.81                      | 1,097,838       | 2,534,250                     | 96.51                      |
| 66701       | 194,813                  | 15,585                | 135.4              | 28.78                      | 54.92                        | 12.88                      | 18,815,397      | 2,729,063                     | 96.58                      |
| 66042       | 5,350                    | 428                   | 138.0              | 28.78                      | 54.92                        | 13.17                      | 518,270         | 2,734,413                     | 96.87                      |
| 74042       | 83,963                   | 6,717                 | 134.3              | 28.78                      | 54.92                        | 13.23                      | 8,139,081       | 2,818,375                     | 96.94                      |
| 66741       | 24,400                   | 1,952                 | 134.0              | 28.78                      | 54.92                        | 13.28                      | 2,366,346       | 2,842,775                     | 96.98                      |
| 66014       | 33,075                   | 2,646                 | 130.4              | 28.78                      | 54.92                        | 13.28                      | 3,207,846       | 2,875,850                     | 96.99                      |
| 66773       | 600                      | 48                    | 136.2              | 28.78                      | 54.92                        | 13.32                      | 58,215          | 2,876,450                     | 97.02                      |
| 66072       | 75,288                   | 6,023                 | 139.5              | 28.78                      | 54.92                        | 13.41                      | 7,311,147       | 2,951,738                     | 97.11                      |
| 66064       | 12,838                   | 1,027                 | 145.7              | 28.78                      | 54.92                        | 13.49                      | 1,247,747       | 2,964,575                     | 97.20                      |
| 64769       | 5,138                    | 411                   | 135.0              | 28.78                      | 54.92                        | 13.51                      | 499,445         | 2,969,713                     | 97.22                      |
| 66856       | 37,650                   | 3,012                 | 140.0              | 28.78                      | 54.92                        | 13.59                      | 3,662,949       | 3,007,363                     | 97.29                      |
| 66781       | 1,225                    | 98                    | 142.9              | 28.78                      | 54.92                        | 13.72                      | 119,339         | 3,008,588                     | 97.42                      |

Table 33. Chanute Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 66720, Allen County) with exclusions.

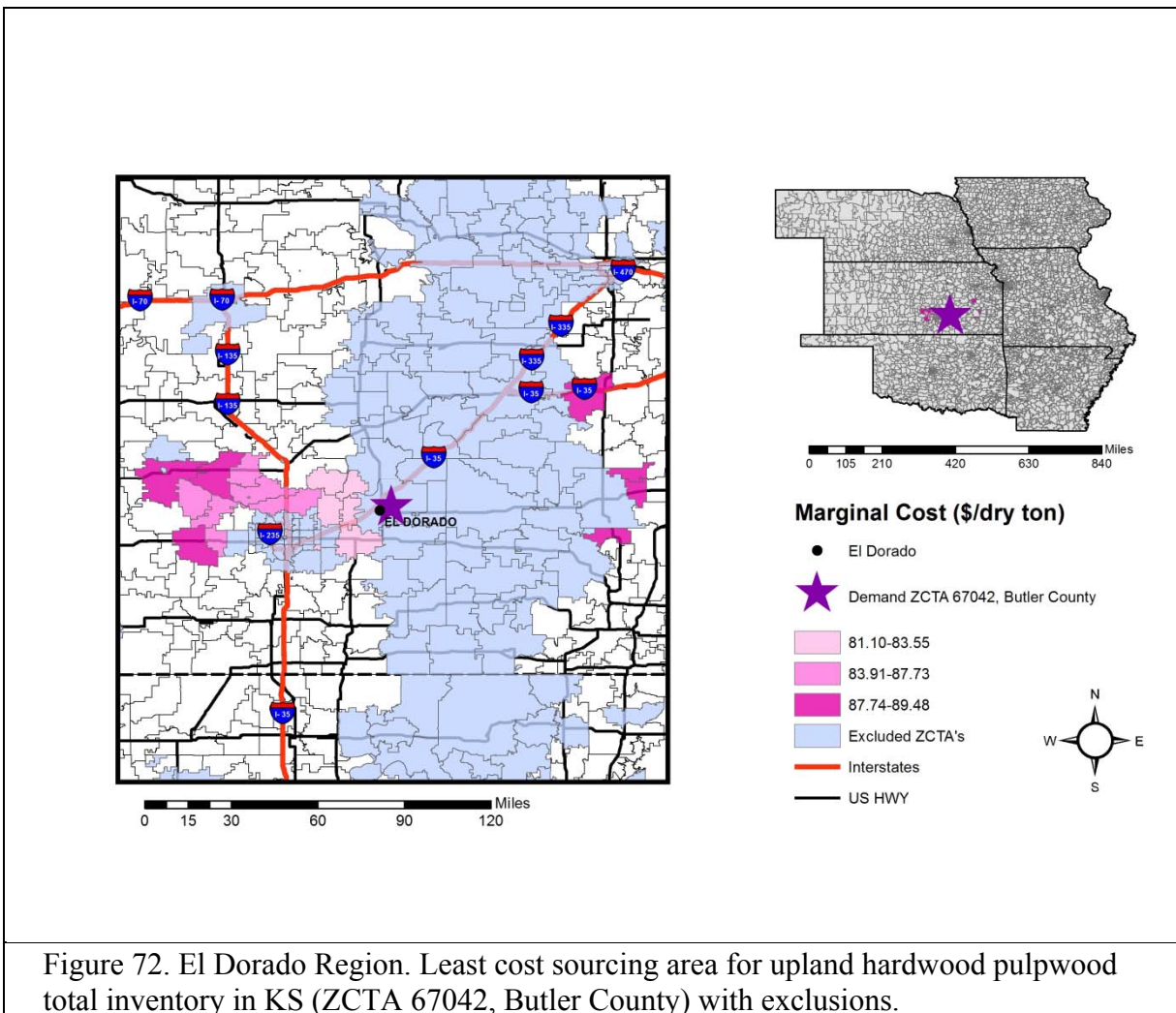
| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 66871       | 4,950                    | 396                   | 140.4              | 28.78                      | 54.92                        | 13.73                      | 482,315         | 3,013,538                     | 97.44                      |
| 66767       | 14,188                   | 1,135                 | 152.8              | 28.78                      | 54.92                        | 13.82                      | 1,383,639       | 3,027,725                     | 97.53                      |
| 66738       | 16,738                   | 1,339                 | 151.3              | 28.78                      | 54.92                        | 13.95                      | 1,634,493       | 3,073,688                     | 97.65                      |
| 66026       | 45,963                   | 3,677                 | 150.7              | 28.78                      | 54.92                        | 13.94                      | 4,488,037       | 3,090,425                     | 97.65                      |
| 64741       | 8,525                    | 682                   | 151.6              | 28.78                      | 54.92                        | 14.08                      | 833,593         | 3,098,950                     | 97.78                      |
| 66056       | 53,025                   | 4,242                 | 142.8              | 28.78                      | 54.92                        | 14.09                      | 5,185,493       | 3,151,975                     | 97.79                      |
| 66725       | 89,025                   | 7,122                 | 150.6              | 28.78                      | 54.92                        | 14.14                      | 8,710,463       | 3,172,200                     | 97.84                      |
| 64762       | 20,225                   | 1,618                 | 143.4              | 28.78                      | 54.92                        | 14.13                      | 1,978,770       | 3,261,225                     | 97.84                      |
| 66095       | 4,450                    | 356                   | 146.3              | 28.78                      | 54.92                        | 14.28                      | 436,041         | 3,265,675                     | 97.99                      |
| 66079       | 8,338                    | 667                   | 150.1              | 28.78                      | 54.92                        | 14.30                      | 817,096         | 3,274,013                     | 98.00                      |
| 66067       | 23,775                   | 1,902                 | 157.1              | 28.78                      | 54.92                        | 14.33                      | 2,330,677       | 3,297,788                     | 98.03                      |
| 67360       | 173,238                  | 13,859                | 147.3              | 28.78                      | 54.92                        | 14.36                      | 16,987,413      | 3,471,025                     | 98.06                      |
| 66510       | 5,400                    | 432                   | 155.7              | 28.78                      | 54.92                        | 14.42                      | 529,846         | 3,476,425                     | 98.12                      |
| 67336       | 57,875                   | 4,630                 | 157.8              | 28.78                      | 54.92                        | 14.44                      | 5,680,134       | 3,534,300                     | 98.14                      |
| 64832       | 11,738                   | 939                   | 151.2              | 28.78                      | 54.92                        | 14.45                      | 1,152,112       | 3,546,038                     | 98.16                      |
| 74029       | 8,200                    | 656                   | 153.2              | 28.78                      | 54.92                        | 14.46                      | 804,938         | 3,554,238                     | 98.16                      |
| 66728       | 63                       | 5                     | 158.2              | 28.78                      | 54.92                        | 14.76                      | 6,154           | 3,554,300                     | 98.46                      |
| 74369       | 2,375                    | 190                   | 153.7              | 28.78                      | 54.92                        | 14.96                      | 234,314         | 3,556,675                     | 98.66                      |

### 3.4.5 El Dorado

#### 3.4.5.1 Upland Hardwood

##### 3.4.5.1.1 Total Inventory (with exclusions)

ZCTA 67042 (Butler County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in El Dorado region for upland hardwood pulpwood total inventory. There are 19 Supply ZCTAs within 80 mile radius from ZCTA 67042 (Table 34). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$81.10 to \$89.48 (Figure 72, Figure 73).





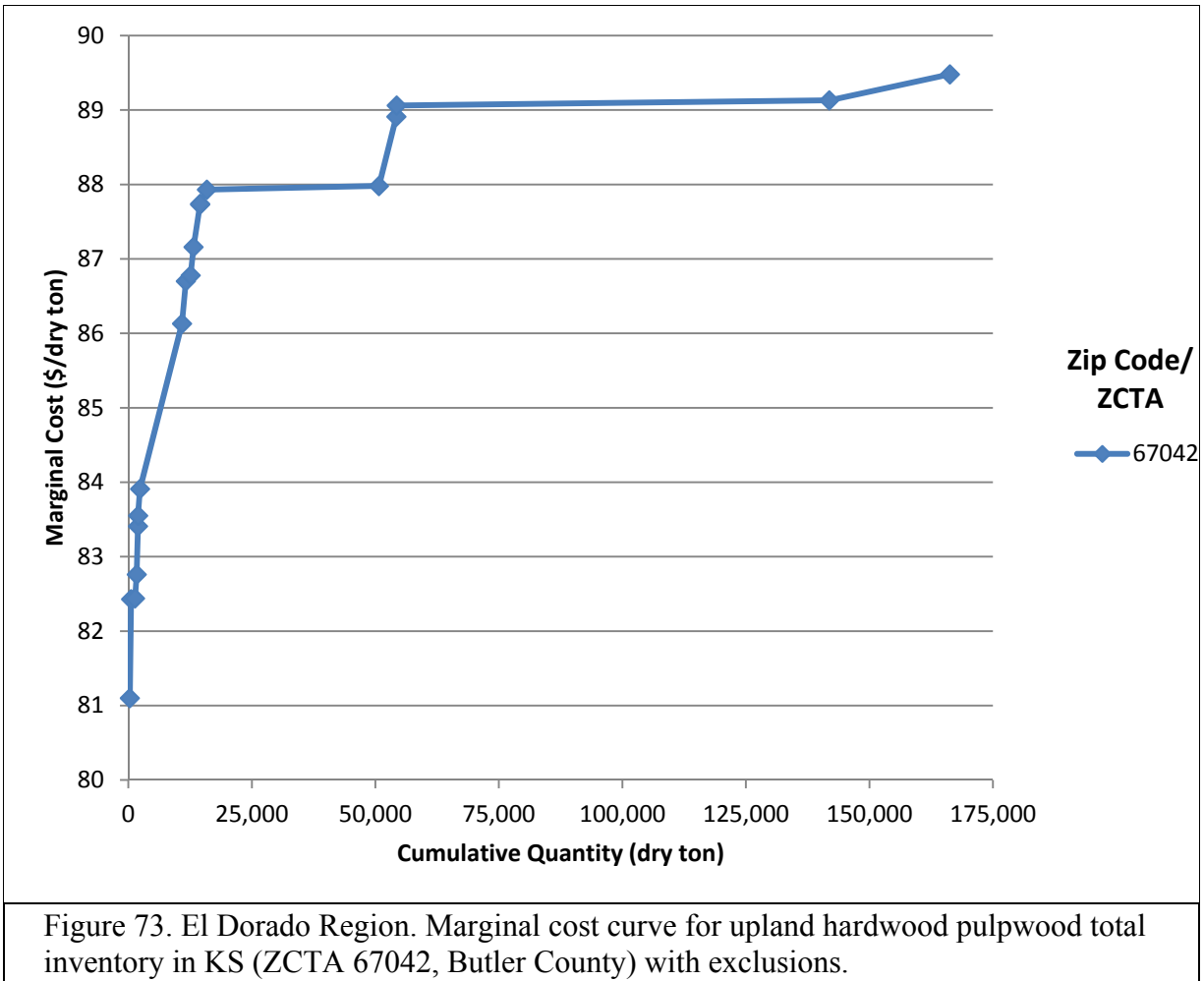


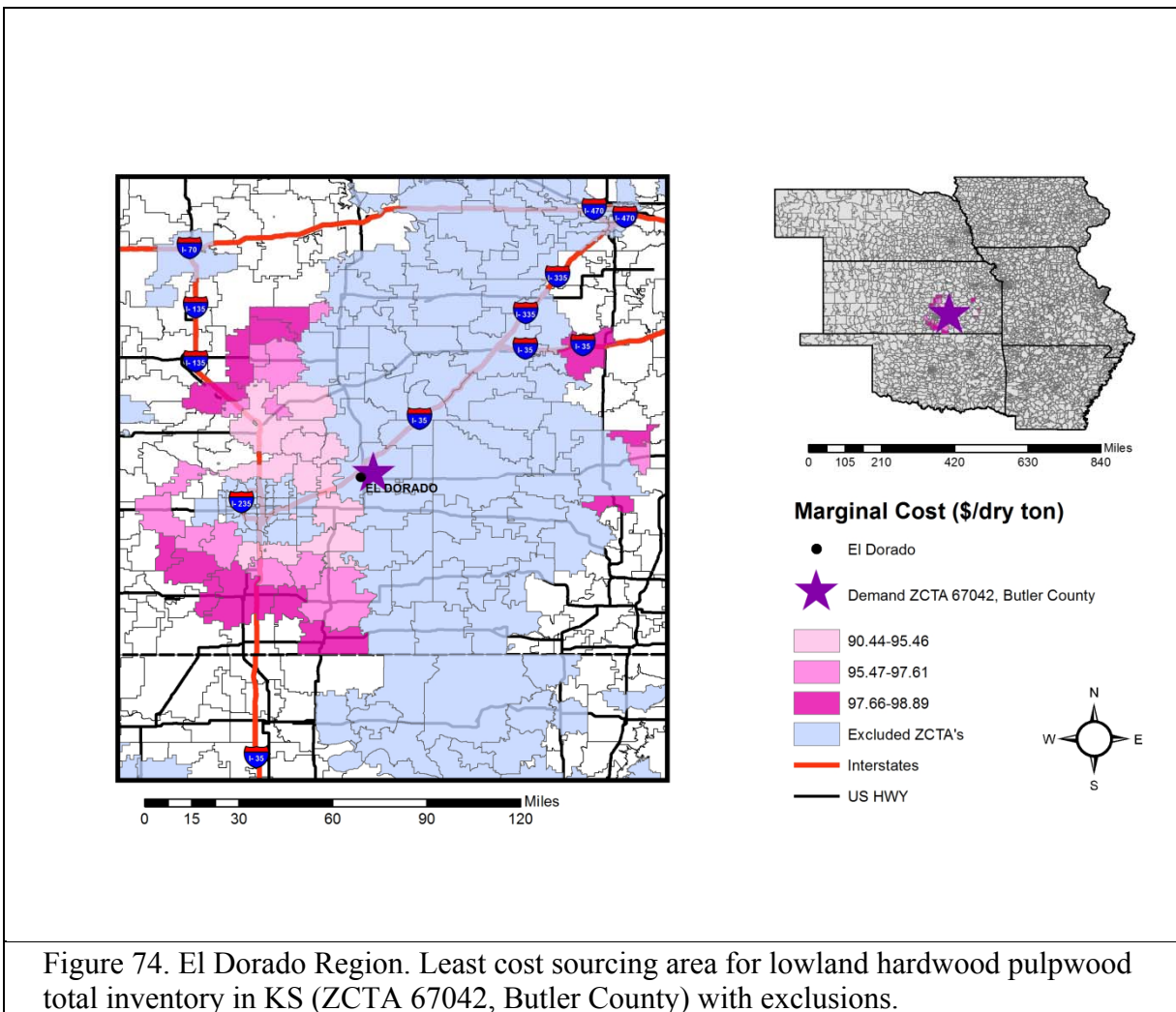
Table 34. El Dorado Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 67042, Butler County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67144       | 313                      | 25                    | 40.3               | 28.78                      | 45.58                        | 6.74                       | 25,345          | 313                           | 81.10                      |
| 67123       | 250                      | 20                    | 52.2               | 28.78                      | 45.58                        | 8.07                       | 20,607          | 563                           | 82.43                      |
| 67010       | 788                      | 63                    | 57.6               | 28.78                      | 45.58                        | 8.08                       | 64,921          | 1,350                         | 82.44                      |
| 67017       | 338                      | 27                    | 62.5               | 28.78                      | 45.58                        | 8.40                       | 27,931          | 1,688                         | 82.76                      |
| 67154       | 275                      | 22                    | 63.6               | 28.78                      | 45.58                        | 9.05                       | 22,937          | 1,963                         | 83.41                      |
| 67232       | 13                       | 1                     | 73.4               | 28.78                      | 45.58                        | 9.19                       | 1,044           | 1,975                         | 83.55                      |
| 67147       | 375                      | 30                    | 82.2               | 28.78                      | 45.58                        | 9.55                       | 31,465          | 2,350                         | 83.91                      |
| 67108       | 8,500                    | 680                   | 115.7              | 28.78                      | 45.58                        | 11.76                      | 732,079         | 10,850                        | 86.13                      |
| 67135       | 788                      | 63                    | 120.7              | 28.78                      | 45.58                        | 12.34                      | 68,279          | 11,638                        | 86.70                      |
| 67050       | 975                      | 78                    | 125.2              | 28.78                      | 45.58                        | 12.42                      | 84,612          | 12,613                        | 86.78                      |
| 67056       | 588                      | 47                    | 129.4              | 28.78                      | 45.58                        | 12.80                      | 51,208          | 13,200                        | 87.16                      |
| 67543       | 1,313                    | 105                   | 137.8              | 28.78                      | 45.58                        | 13.36                      | 115,141         | 14,513                        | 87.73                      |
| 66761       | 25                       | 2                     | 140.8              | 28.78                      | 45.58                        | 13.37                      | 2,193           | 14,538                        | 87.74                      |
| 67020       | 1,350                    | 108                   | 140.0              | 28.78                      | 45.58                        | 13.57                      | 118,703         | 15,888                        | 87.93                      |
| 67025       | 34,838                   | 2,787                 | 140.0              | 28.78                      | 45.58                        | 13.62                      | 3,065,056       | 50,725                        | 87.98                      |
| 67501       | 3,513                    | 281                   | 156.2              | 28.78                      | 45.58                        | 14.55                      | 312,313         | 54,238                        | 88.91                      |
| 66758       | 75                       | 6                     | 151.7              | 28.78                      | 45.58                        | 14.70                      | 6,680           | 54,313                        | 89.06                      |
| 66717       | 87,575                   | 7,006                 | 157.5              | 28.78                      | 45.58                        | 14.77                      | 7,805,734       | 141,888                       | 89.13                      |
| 66856       | 24,413                   | 1,953                 | 154.3              | 28.78                      | 45.58                        | 15.12                      | 2,184,543       | 166,300                       | 89.48                      |

### 3.4.5.2 Lowland Hardwood

#### 3.4.5.2.1 Total Inventory (with exclusions)

ZCTA 67042 (Butler County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in El Dorado region for lowland hardwood pulpwood total inventory. There are 39 Supply ZCTAs within 80 mile radius from ZCTA 67042 (Table 35). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$90.44 to \$98.89 (Figure 74, Figure 75).



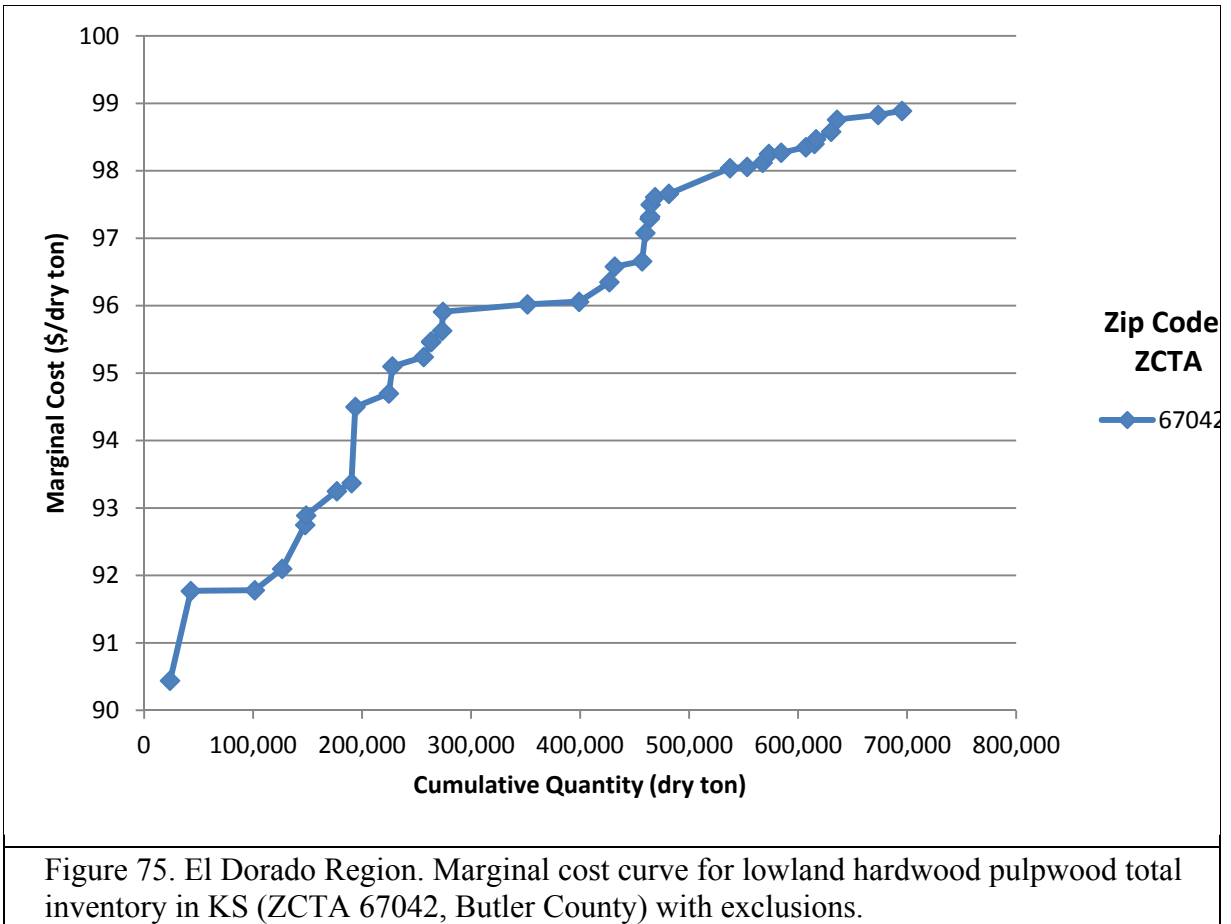


Table 35. El Dorado Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 67042, Butler County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67144       | 23,825                   | 1,906                 | 40.3               | 28.78                      | 54.92                        | 6.74                       | 2,154,811       | 23,825                        | 90.44                      |
| 67123       | 19,013                   | 1,521                 | 52.2               | 28.78                      | 54.92                        | 8.07                       | 1,744,762       | 42,838                        | 91.77                      |
| 67010       | 58,700                   | 4,696                 | 57.6               | 28.78                      | 54.92                        | 8.08                       | 5,387,470       | 101,538                       | 91.78                      |
| 67017       | 25,163                   | 2,013                 | 62.5               | 28.78                      | 54.92                        | 8.40                       | 2,317,423       | 126,700                       | 92.10                      |
| 67154       | 21,063                   | 1,685                 | 63.6               | 28.78                      | 54.92                        | 9.05                       | 1,953,508       | 147,763                       | 92.75                      |
| 67232       | 938                      | 75                    | 73.4               | 28.78                      | 54.92                        | 9.19                       | 87,085          | 148,700                       | 92.89                      |
| 67147       | 28,125                   | 2,250                 | 82.2               | 28.78                      | 54.92                        | 9.55                       | 2,622,611       | 176,825                       | 93.25                      |
| 67039       | 13,488                   | 1,079                 | 75.7               | 28.78                      | 54.92                        | 9.66                       | 1,259,296       | 190,313                       | 93.37                      |
| 67131       | 3,500                    | 280                   | 87.5               | 28.78                      | 54.92                        | 10.80                      | 330,762         | 193,813                       | 94.50                      |
| 67114       | 30,750                   | 2,460                 | 103.1              | 28.78                      | 54.92                        | 11.00                      | 2,911,990       | 224,563                       | 94.70                      |
| 66866       | 3,238                    | 259                   | 110.0              | 28.78                      | 54.92                        | 11.40                      | 307,902         | 227,800                       | 95.10                      |
| 67120       | 28,738                   | 2,299                 | 110.9              | 28.78                      | 54.92                        | 11.54                      | 2,736,923       | 256,538                       | 95.24                      |
| 67110       | 6,713                    | 537                   | 108.8              | 28.78                      | 54.92                        | 11.75                      | 640,759         | 263,250                       | 95.46                      |
| 67108       | 113                      | 9                     | 115.7              | 28.78                      | 54.92                        | 11.76                      | 10,740          | 263,363                       | 95.47                      |
| 67146       | 10,038                   | 803                   | 107.6              | 28.78                      | 54.92                        | 11.93                      | 959,919         | 273,400                       | 95.63                      |
| 67151       | 750                      | 60                    | 122.9              | 28.78                      | 54.92                        | 12.21                      | 71,934          | 274,150                       | 95.91                      |
| 67013       | 77,475                   | 6,198                 | 120.0              | 28.78                      | 54.92                        | 12.32                      | 7,439,287       | 351,625                       | 96.02                      |
| 67026       | 47,500                   | 3,800                 | 122.0              | 28.78                      | 54.92                        | 12.36                      | 4,562,932       | 399,125                       | 96.06                      |
| 67149       | 27,725                   | 2,218                 | 127.1              | 28.78                      | 54.92                        | 12.64                      | 2,671,235       | 426,850                       | 96.35                      |
| 67062       | 4,925                    | 394                   | 128.7              | 28.78                      | 54.92                        | 12.87                      | 475,634         | 431,775                       | 96.58                      |
| 67156       | 25,088                   | 2,007                 | 119.1              | 28.78                      | 54.92                        | 12.96                      | 2,425,029       | 456,863                       | 96.66                      |
| 66761       | 3,050                    | 244                   | 140.8              | 28.78                      | 54.92                        | 13.37                      | 296,087         | 459,913                       | 97.08                      |
| 67063       | 3,863                    | 309                   | 140.0              | 28.78                      | 54.92                        | 13.59                      | 375,790         | 463,775                       | 97.29                      |
| 67025       | 500                      | 40                    | 140.0              | 28.78                      | 54.92                        | 13.62                      | 48,661          | 464,275                       | 97.32                      |

Table 35. El Dorado Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 67042, Butler County) with exclusions.

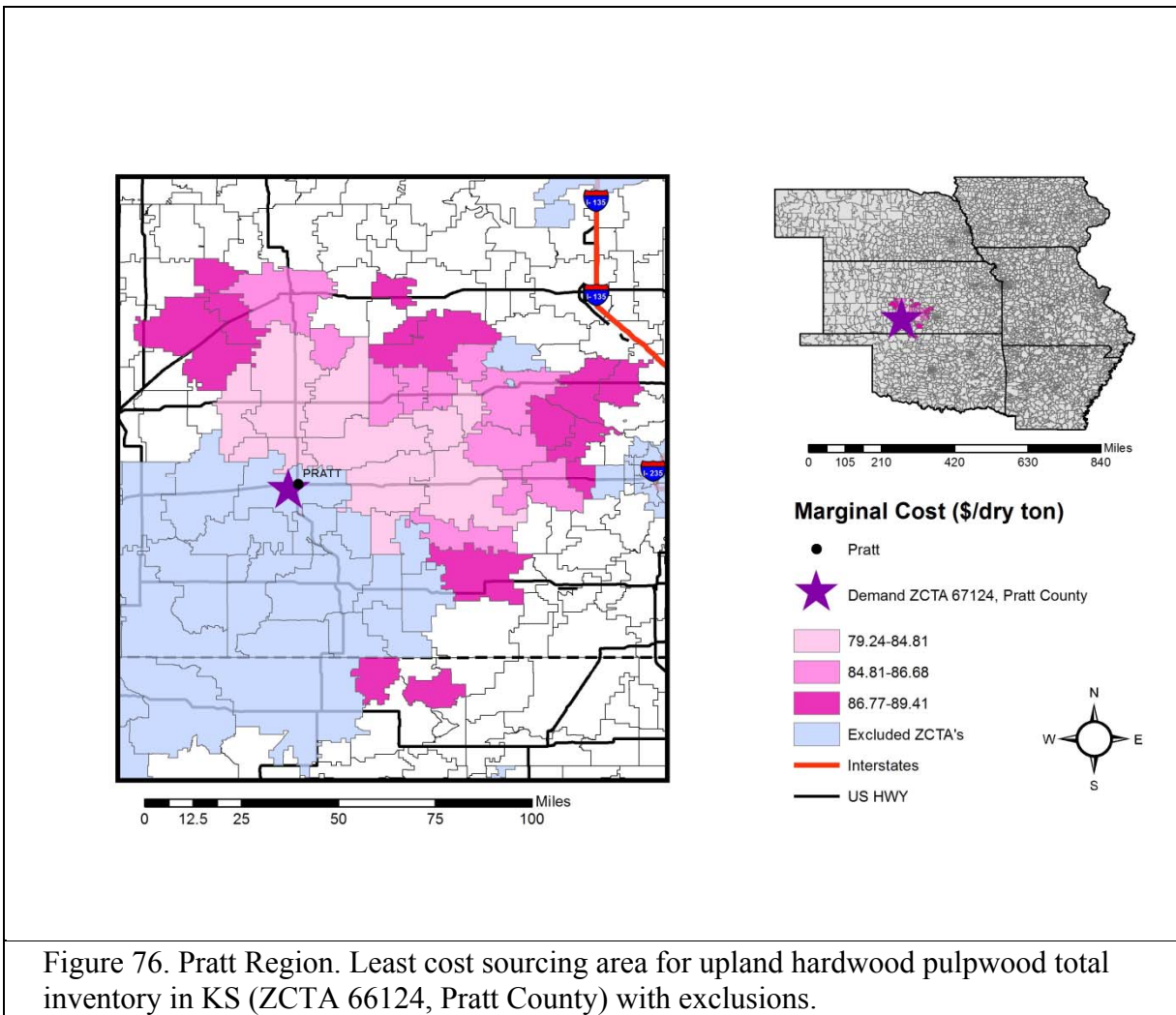
| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67475       | 375                      | 30                    | 141.6              | 28.78                      | 54.92                        | 13.80                      | 36,564          | 464,650                       | 97.50                      |
| 67073       | 4,200                    | 336                   | 146.0              | 28.78                      | 54.92                        | 13.91                      | 409,972         | 468,850                       | 97.61                      |
| 67107       | 12,600                   | 1,008                 | 146.0              | 28.78                      | 54.92                        | 13.96                      | 1,230,555       | 481,450                       | 97.66                      |
| 67152       | 56,050                   | 4,484                 | 148.6              | 28.78                      | 54.92                        | 14.34                      | 5,495,339       | 537,500                       | 98.04                      |
| 67428       | 15,738                   | 1,259                 | 154.2              | 28.78                      | 54.92                        | 14.35                      | 1,543,175       | 553,238                       | 98.06                      |
| 67106       | 14,175                   | 1,134                 | 150.3              | 28.78                      | 54.92                        | 14.42                      | 1,390,875       | 567,413                       | 98.12                      |
| 67119       | 5,788                    | 463                   | 151.2              | 28.78                      | 54.92                        | 14.54                      | 568,601         | 573,200                       | 98.25                      |
| 67438       | 11,350                   | 908                   | 150.6              | 28.78                      | 54.92                        | 14.56                      | 1,115,325       | 584,550                       | 98.27                      |
| 67031       | 22,525                   | 1,802                 | 151.1              | 28.78                      | 54.92                        | 14.64                      | 2,215,280       | 607,075                       | 98.35                      |
| 66758       | 7,925                    | 634                   | 151.7              | 28.78                      | 54.92                        | 14.70                      | 779,835         | 615,000                       | 98.40                      |
| 66717       | 1,513                    | 121                   | 157.5              | 28.78                      | 54.92                        | 14.77                      | 148,940         | 616,513                       | 98.47                      |
| 67103       | 13,750                   | 1,100                 | 156.2              | 28.78                      | 54.92                        | 14.87                      | 1,355,425       | 630,263                       | 98.58                      |
| 67483       | 5,500                    | 440                   | 157.7              | 28.78                      | 54.92                        | 15.06                      | 543,178         | 635,763                       | 98.76                      |
| 66856       | 37,650                   | 3,012                 | 154.3              | 28.78                      | 54.92                        | 15.12                      | 3,720,776       | 673,413                       | 98.83                      |
| 67005       | 21,925                   | 1,754                 | 152.4              | 28.78                      | 54.92                        | 15.19                      | 2,168,127       | 695,338                       | 98.89                      |

### 3.4.6 Pratt

#### 3.4.6.1 Upland Hardwood

##### 3.4.6.1.1 Total Inventory (with exclusions)

ZCTA 66124 (Pratt County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Pratt region for upland hardwood pulpwood total inventory. There are 35 Supply ZCTAs within 80 mile radius from ZCTA 66124 (Table 36). Marginal costs per dry ton of upland hardwood pulpwood total inventory in the region ranged from \$79.24 to \$89.41 (Figure 76, Figure 77).



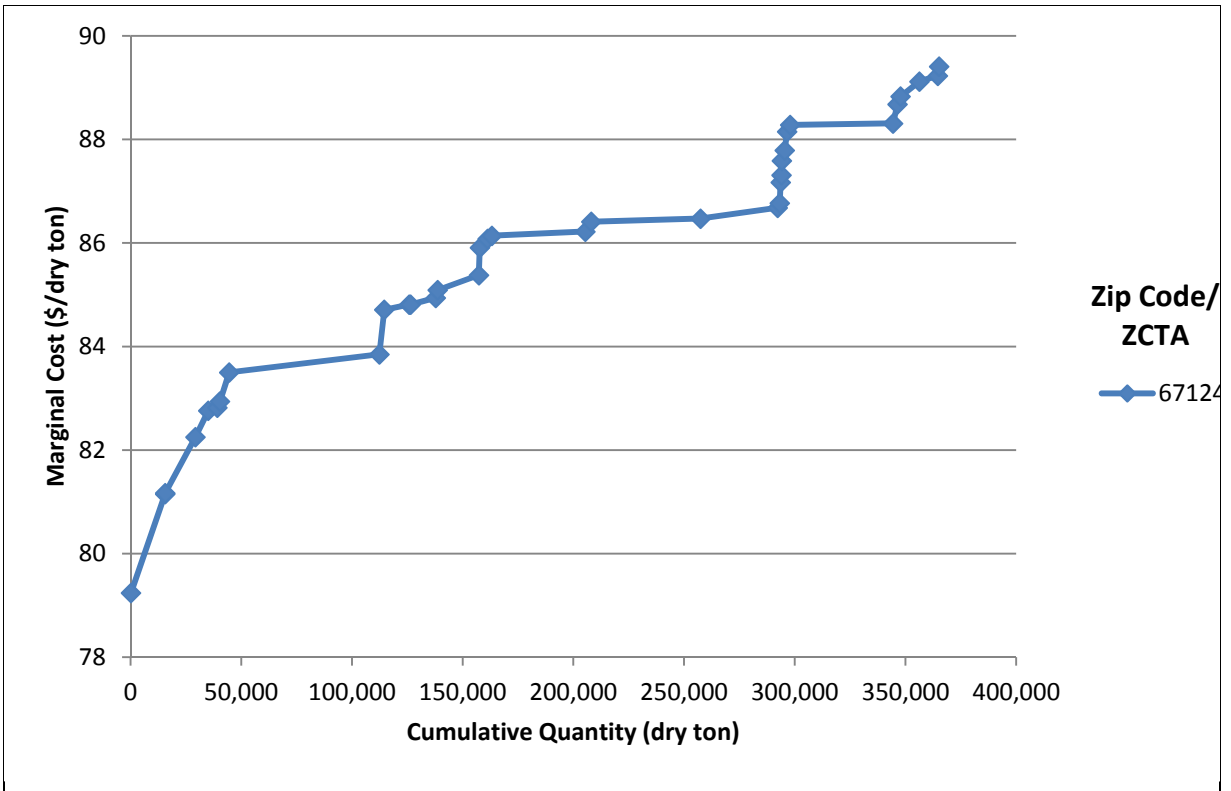


Figure 77. Pratt Region. Marginal cost curve for upland hardwood pulpwood total inventory in KS (ZCTA 67124, Pratt County) with exclusions.



Table 36. Pratt Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 67124, Pratt County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67066       | 175                      | 14                    | 20.3               | 28.78                      | 45.58                        | 4.88                       | 13,867          | 175                           | 79.24                      |
| 67035       | 15,438                   | 1,235                 | 44.8               | 28.78                      | 45.58                        | 6.78                       | 1,252,699       | 15,613                        | 81.15                      |
| 67021       | 50                       | 4                     | 40.8               | 28.78                      | 45.58                        | 6.81                       | 4,059           | 15,663                        | 81.17                      |
| 67583       | 13,625                   | 1,090                 | 56.0               | 28.78                      | 45.58                        | 7.89                       | 1,120,662       | 29,288                        | 82.25                      |
| 67576       | 5,813                    | 465                   | 68.6               | 28.78                      | 45.58                        | 8.40                       | 481,031         | 35,100                        | 82.76                      |
| 67578       | 4,075                    | 326                   | 68.2               | 28.78                      | 45.58                        | 8.46                       | 337,511         | 39,175                        | 82.82                      |
| 67557       | 1,188                    | 95                    | 69.3               | 28.78                      | 45.58                        | 8.58                       | 98,492          | 40,363                        | 82.94                      |
| 67112       | 4,188                    | 335                   | 68.3               | 28.78                      | 45.58                        | 9.13                       | 349,637         | 44,550                        | 83.50                      |
| 67068       | 67,825                   | 5,426                 | 82.3               | 28.78                      | 45.58                        | 9.49                       | 5,687,010       | 112,375                       | 83.85                      |
| 67514       | 2,225                    | 178                   | 86.1               | 28.78                      | 45.58                        | 10.35                      | 188,486         | 114,600                       | 84.71                      |
| 67566       | 650                      | 52                    | 92.7               | 28.78                      | 45.58                        | 10.45                      | 55,127          | 125,888                       | 84.81                      |
| 67581       | 11,288                   | 903                   | 94.4               | 28.78                      | 45.58                        | 10.44                      | 957,255         | 126,538                       | 84.81                      |
| 67545       | 11,288                   | 903                   | 96.3               | 28.78                      | 45.58                        | 10.58                      | 958,807         | 137,825                       | 84.94                      |
| 67568       | 875                      | 70                    | 99.8               | 28.78                      | 45.58                        | 10.73                      | 74,453          | 138,700                       | 85.09                      |
| 67111       | 18,663                   | 1,493                 | 99.3               | 28.78                      | 45.58                        | 11.02                      | 1,593,356       | 157,363                       | 85.38                      |
| 67510       | 400                      | 32                    | 110.1              | 28.78                      | 45.58                        | 11.55                      | 34,363          | 157,763                       | 85.91                      |
| 67501       | 3,513                    | 281                   | 107.1              | 28.78                      | 45.58                        | 11.72                      | 302,348         | 161,275                       | 86.08                      |
| 67530       | 1,975                    | 158                   | 115.8              | 28.78                      | 45.58                        | 11.78                      | 170,126         | 163,250                       | 86.14                      |
| 67570       | 42,163                   | 3,373                 | 107.2              | 28.78                      | 45.58                        | 11.86                      | 3,635,421       | 205,413                       | 86.22                      |
| 67561       | 2,675                    | 214                   | 111.6              | 28.78                      | 45.58                        | 12.05                      | 231,143         | 208,088                       | 86.41                      |
| 67142       | 49,363                   | 3,949                 | 105.3              | 28.78                      | 45.58                        | 12.11                      | 4,268,551       | 257,450                       | 86.47                      |
| 67025       | 34,838                   | 2,787                 | 121.3              | 28.78                      | 45.58                        | 12.31                      | 3,019,566       | 292,288                       | 86.68                      |
| 67050       | 975                      | 78                    | 125.2              | 28.78                      | 45.58                        | 12.41                      | 84,604          | 293,263                       | 86.77                      |
| 67550       | 375                      | 30                    | 120.8              | 28.78                      | 45.58                        | 12.81                      | 32,689          | 293,638                       | 87.17                      |
| 67511       | 400                      | 32                    | 132.1              | 28.78                      | 45.58                        | 12.95                      | 34,925          | 294,038                       | 87.31                      |

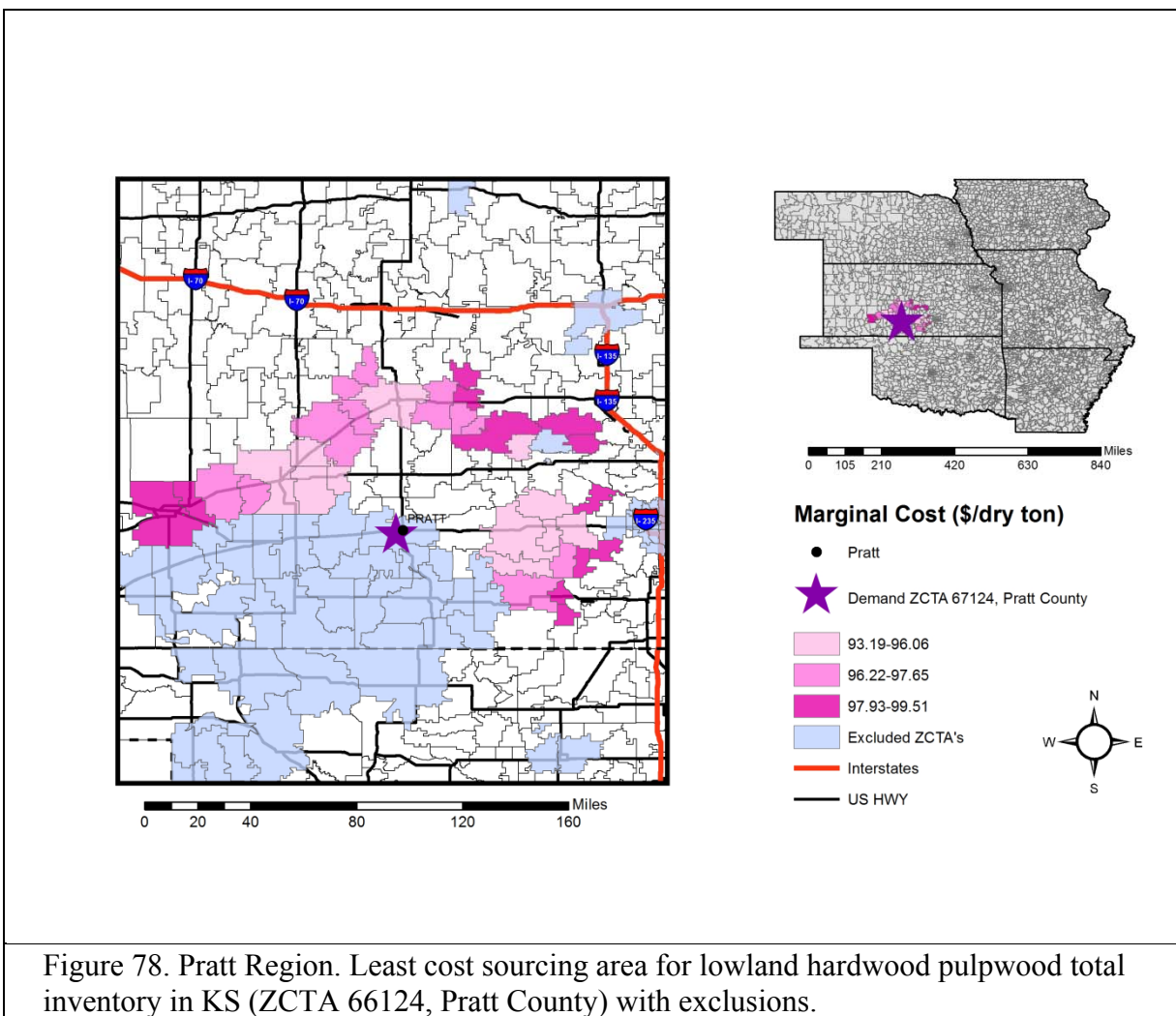
Table 36. Pratt Region. Supply ZCTAs for upland hardwood pulpwood total inventory in KS (demand ZCTA 67124, Pratt County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67567       | 150                      | 12                    | 137.8              | 28.78                      | 45.58                        | 13.22                      | 13,138          | 294,188                       | 87.59                      |
| 67512       | 1,275                    | 102                   | 129.4              | 28.78                      | 45.58                        | 13.43                      | 111,931         | 295,463                       | 87.79                      |
| 73722       | 1,125                    | 90                    | 140.1              | 28.78                      | 45.58                        | 13.78                      | 99,164          | 296,588                       | 88.15                      |
| 67543       | 1,313                    | 105                   | 141.6              | 28.78                      | 45.58                        | 13.92                      | 115,866         | 297,900                       | 88.28                      |
| 67058       | 46,500                   | 3,720                 | 131.2              | 28.78                      | 45.58                        | 13.95                      | 4,106,356       | 344,400                       | 88.31                      |
| 67524       | 2,063                    | 165                   | 152.9              | 28.78                      | 45.58                        | 14.31                      | 182,894         | 346,463                       | 88.68                      |
| 67020       | 1,350                    | 108                   | 146.5              | 28.78                      | 45.58                        | 14.46                      | 119,916         | 347,813                       | 88.83                      |
| 67108       | 8,500                    | 680                   | 156.7              | 28.78                      | 45.58                        | 14.76                      | 757,503         | 356,313                       | 89.12                      |
| 67579       | 8,313                    | 665                   | 150.0              | 28.78                      | 45.58                        | 14.87                      | 741,716         | 364,625                       | 89.23                      |
| 67056       | 588                      | 47                    | 156.0              | 28.78                      | 45.58                        | 15.05                      | 52,531          | 365,213                       | 89.41                      |

### 3.4.6.2 Lowland Hardwood

#### 3.4.6.2.1 Total Inventory (with exclusions)

ZCTA 66124 (Pratt County, KS) was chosen as a pre-determined demand ZCTA (from KS Forest Service) in Pratt region for lowland hardwood pulpwood total inventory. There are 34 Supply ZCTAs within 80 mile radius from ZCTA 66124 (Table 37). Marginal costs per dry ton of lowland hardwood pulpwood total inventory in the region ranged from \$93.19 to \$99.51 (Figure 78, Figure 61).



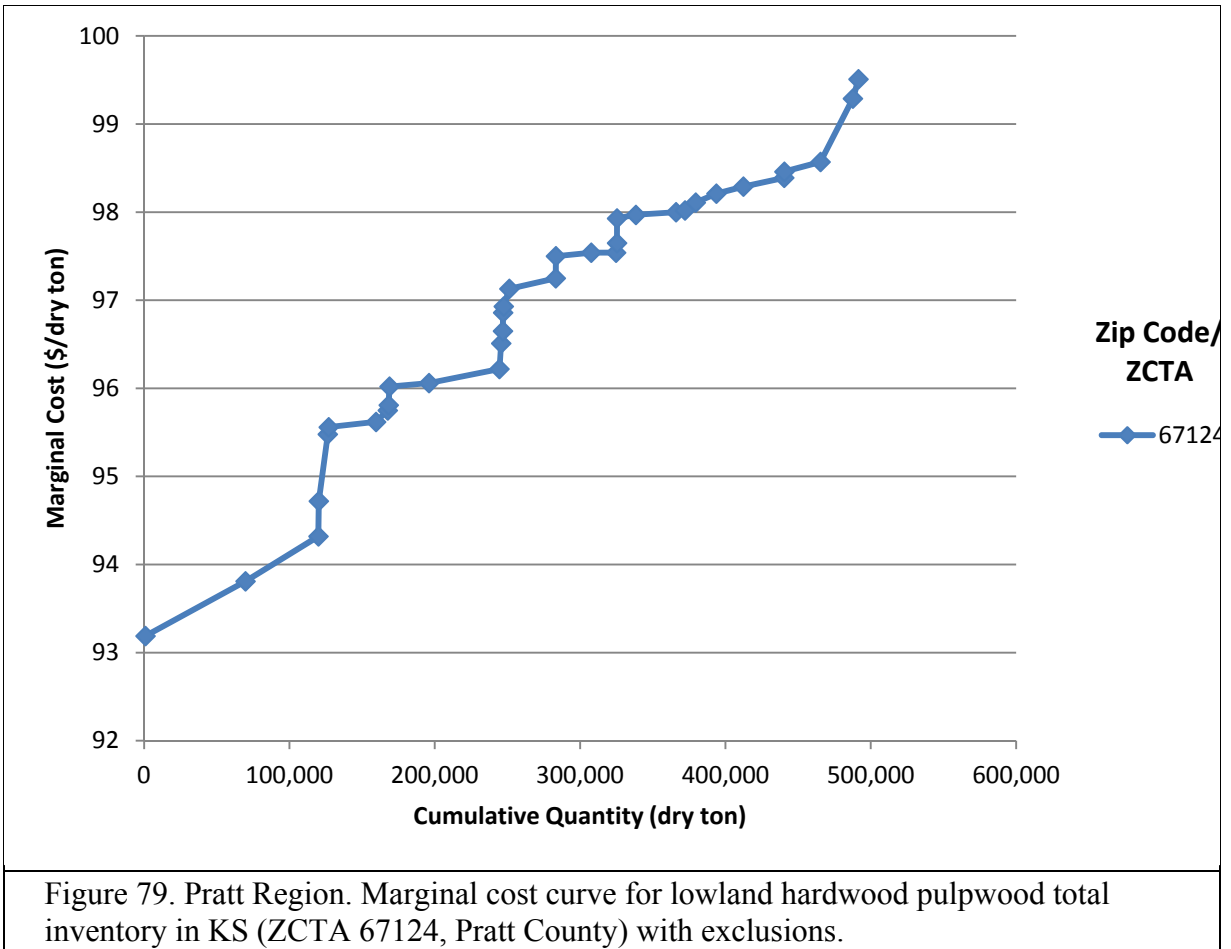


Figure 79. Pratt Region. Marginal cost curve for lowland hardwood pulpwood total inventory in KS (ZCTA 67124, Pratt County) with exclusions.

Table 37. Pratt Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 67124, Pratt County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67068       | 975                      | 78                    | 82.3               | 28.78                      | 54.92                        | 9.49                       | 90,859          | 975                           | 93.19                      |
| 67519       | 68,800                   | 5,504                 | 89.3               | 28.78                      | 54.92                        | 10.11                      | 6,454,392       | 69,775                        | 93.81                      |
| 67552       | 50,175                   | 4,014                 | 87.9               | 28.78                      | 54.92                        | 10.62                      | 4,732,577       | 119,950                       | 94.32                      |
| 67111       | 263                      | 21                    | 99.3               | 28.78                      | 54.92                        | 11.02                      | 24,864          | 120,213                       | 94.72                      |
| 67530       | 6,175                    | 494                   | 115.8              | 28.78                      | 54.92                        | 11.78                      | 589,591         | 126,388                       | 95.48                      |
| 67570       | 600                      | 48                    | 107.2              | 28.78                      | 54.92                        | 11.86                      | 57,339          | 126,988                       | 95.56                      |
| 67547       | 32,638                   | 2,611                 | 115.0              | 28.78                      | 54.92                        | 11.92                      | 3,120,748       | 159,625                       | 95.62                      |
| 67561       | 8,013                    | 641                   | 111.6              | 28.78                      | 54.92                        | 12.05                      | 767,191         | 167,638                       | 95.75                      |
| 67142       | 713                      | 57                    | 105.3              | 28.78                      | 54.92                        | 12.11                      | 68,268          | 168,350                       | 95.81                      |
| 67025       | 500                      | 40                    | 121.3              | 28.78                      | 54.92                        | 12.31                      | 48,008          | 168,850                       | 96.02                      |
| 67529       | 27,163                   | 2,173                 | 115.8              | 28.78                      | 54.92                        | 12.36                      | 2,609,305       | 196,013                       | 96.06                      |
| 67526       | 48,513                   | 3,881                 | 127.9              | 28.78                      | 54.92                        | 12.52                      | 4,667,880       | 244,525                       | 96.22                      |
| 67550       | 1,175                    | 94                    | 120.8              | 28.78                      | 54.92                        | 12.81                      | 113,400         | 245,700                       | 96.51                      |
| 67511       | 1,263                    | 101                   | 132.1              | 28.78                      | 54.92                        | 12.95                      | 122,026         | 246,963                       | 96.65                      |
| 67563       | 38                       | 3                     | 130.0              | 28.78                      | 54.92                        | 13.15                      | 3,632           | 247,000                       | 96.86                      |
| 67567       | 475                      | 38                    | 137.8              | 28.78                      | 54.92                        | 13.22                      | 46,040          | 247,475                       | 96.93                      |
| 67512       | 3,825                    | 306                   | 129.4              | 28.78                      | 54.92                        | 13.43                      | 371,522         | 251,300                       | 97.13                      |
| 67118       | 31,963                   | 2,557                 | 127.0              | 28.78                      | 54.92                        | 13.54                      | 3,108,219       | 283,263                       | 97.25                      |
| 67876       | 113                      | 9                     | 140.8              | 28.78                      | 54.92                        | 13.80                      | 10,969          | 283,375                       | 97.50                      |
| 67564       | 17,013                   | 1,361                 | 144.6              | 28.78                      | 54.92                        | 13.84                      | 1,659,474       | 307,688                       | 97.54                      |
| 67573       | 24,313                   | 1,945                 | 148.0              | 28.78                      | 54.92                        | 13.83                      | 2,371,322       | 324,700                       | 97.54                      |
| 67058       | 663                      | 53                    | 131.2              | 28.78                      | 54.92                        | 13.95                      | 64,693          | 325,363                       | 97.65                      |
| 67882       | 88                       | 7                     | 150.2              | 28.78                      | 54.92                        | 14.23                      | 8,569           | 325,450                       | 97.93                      |
| 67546       | 12,900                   | 1,032                 | 145.2              | 28.78                      | 54.92                        | 14.26                      | 1,263,759       | 338,350                       | 97.97                      |
| 67149       | 27,725                   | 2,218                 | 150.4              | 28.78                      | 54.92                        | 14.30                      | 2,717,158       | 366,075                       | 98.00                      |

Table 37. Pratt Region. Supply ZCTAs for lowland hardwood pulpwood total inventory in KS (demand ZCTA 67124, Pratt County) with exclusions.

| Supply ZCTA | Total Quantity (dry ton) | Number of Truck Loads | Round Trip (miles) | Resource Cost (\$/dry ton) | Harvesting Cost (\$/dry ton) | Trucking Cost (\$/dry ton) | Total Cost (\$) | Cumulative Quantity (dry ton) | Marginal Cost (\$/dry ton) |
|-------------|--------------------------|-----------------------|--------------------|----------------------------|------------------------------|----------------------------|-----------------|-------------------------------|----------------------------|
| 67524       | 6,175                    | 494                   | 152.9              | 28.78                      | 54.92                        | 14.31                      | 605,253         | 372,250                       | 98.02                      |
| 67801       | 7,375                    | 590                   | 155.2              | 28.78                      | 54.92                        | 14.41                      | 723,547         | 379,625                       | 98.11                      |
| 67106       | 14,175                   | 1,134                 | 149.5              | 28.78                      | 54.92                        | 14.50                      | 1,392,092       | 393,800                       | 98.21                      |
| 67522       | 18,600                   | 1,488                 | 144.7              | 28.78                      | 54.92                        | 14.59                      | 1,828,195       | 412,400                       | 98.29                      |
| 67427       | 28,063                   | 2,245                 | 157.9              | 28.78                      | 54.92                        | 14.69                      | 2,761,093       | 440,463                       | 98.39                      |
| 67108       | 113                      | 9                     | 156.7              | 28.78                      | 54.92                        | 14.76                      | 11,077          | 440,575                       | 98.46                      |
| 67579       | 24,825                   | 1,986                 | 150.0              | 28.78                      | 54.92                        | 14.87                      | 2,446,995       | 465,400                       | 98.57                      |
| 67036       | 22,300                   | 1,784                 | 156.9              | 28.78                      | 54.92                        | 15.58                      | 2,214,076       | 487,700                       | 99.29                      |
| 67049       | 3,850                    | 308                   | 157.3              | 28.78                      | 54.92                        | 15.81                      | 383,122         | 491,550                       | 99.51                      |

### 3.4.7 Comparative Analysis

#### 3.4.7.1 Upland Hardwood

Comparative Analysis of six US Forest Service FIA regions of interest for upland hardwood pulpwood total inventory revealed that Chanute, Ottawa, and Effingham regions have larger supply available within 80 mile one-way truck haul distance than the other regions of interest (Figure 80). ZCTA 66124 (Pratt County, Pratt region, KS) has the least marginal cost that ranged from \$79.24 to \$89.41.

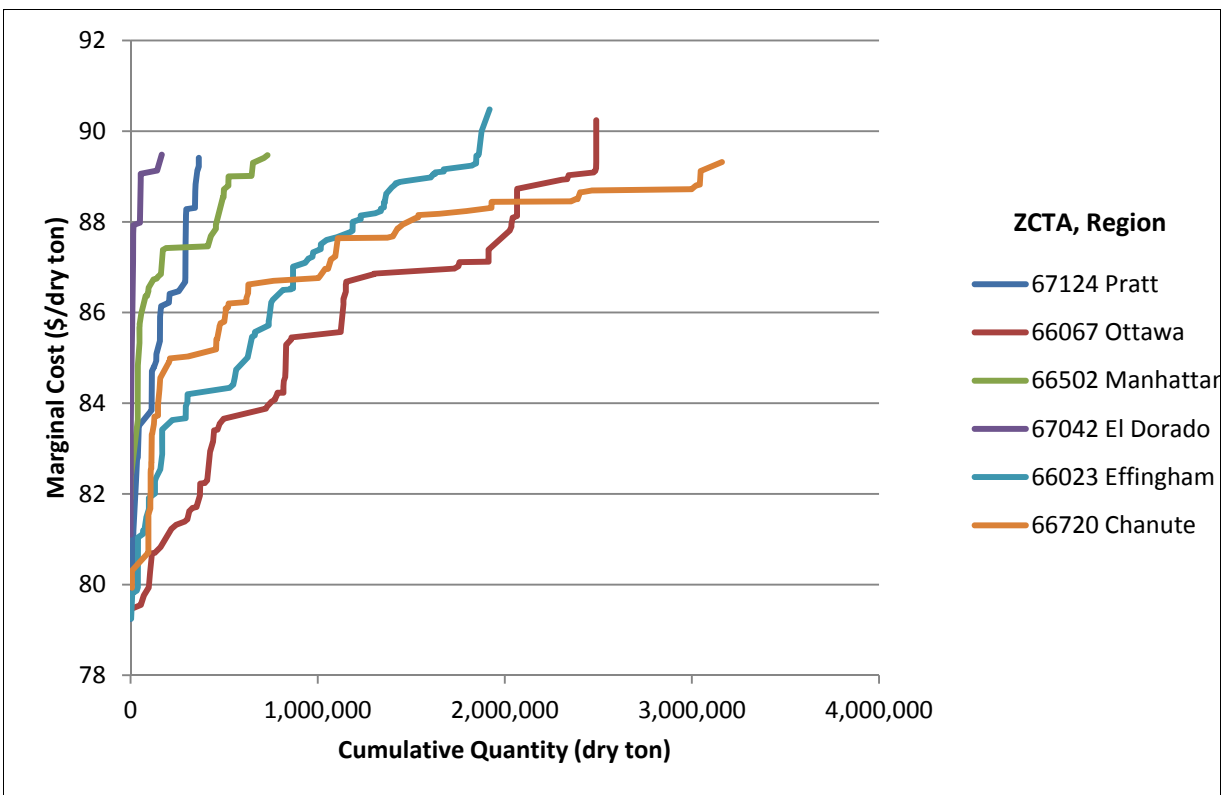
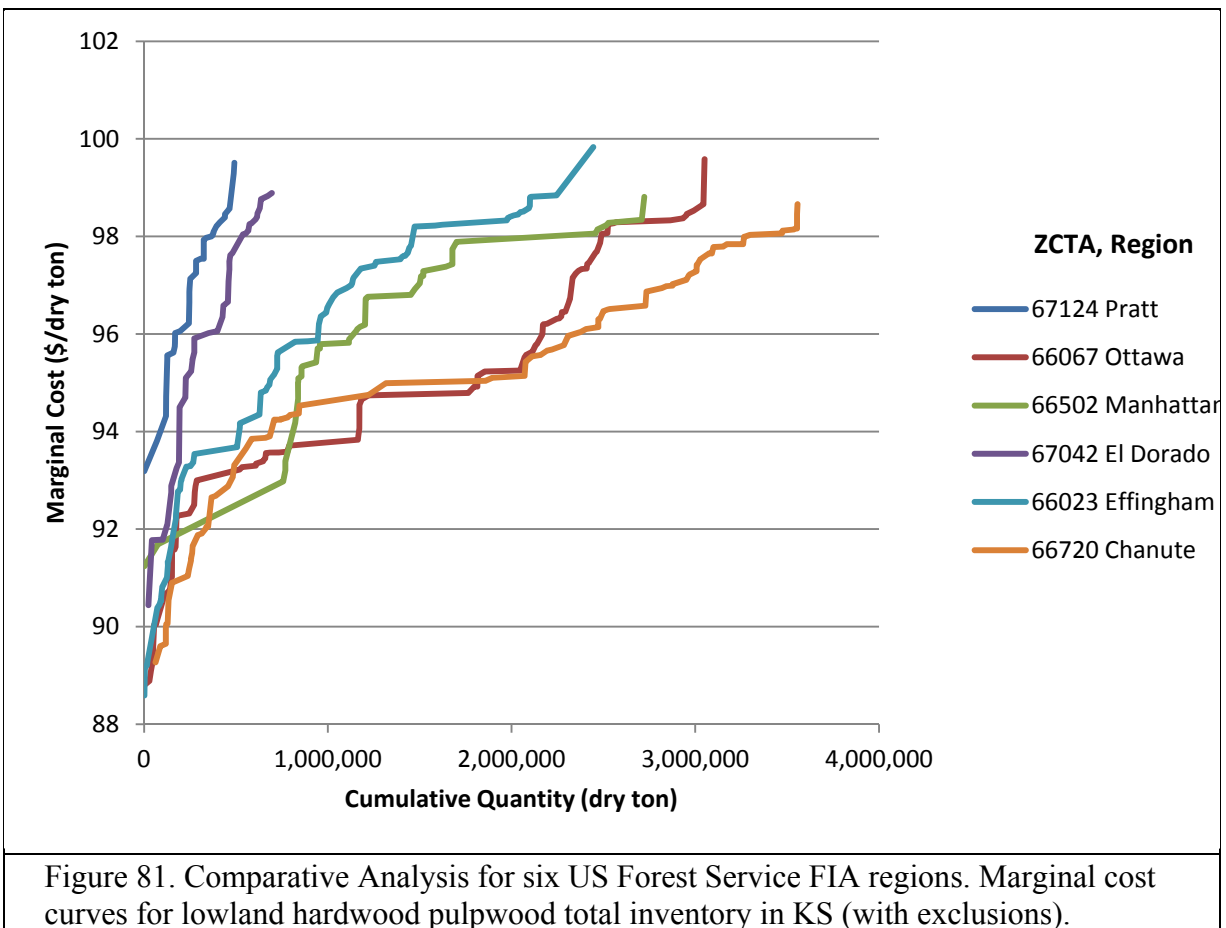


Figure 80. Comparative Analysis for six US Forest Service FIA regions. Marginal cost curves for upland hardwood pulpwood total inventory in KS (with exclusions).

### 3.4.7.2 Lowland Hardwood

Comparative Analysis of six US Forest Service FIA regions of interest for lowland hardwood pulpwood total inventory revealed that Chanute, Ottawa, Manhattan, and Effingham regions have larger supply available within 80 mile one-way truck haul distance than the other regions of interest (Figure 81). ZCTA 66023 (Atchison County, Effingham region, KS) has the least marginal cost that ranged from \$88.59 to \$99.83.





## 4. CONCLUSIONS

The goal of the study was to advance the science and business economics of modeling the supply chain of cellulosic feedstocks in a geo-spatial context focusing on Kansas as the state with potential mill sites or ‘demand zones’; with Arkansas, Iowa, Missouri, Oklahoma, and Nebraska States as potential supply zones when mill sites in KS have procurement zones from surrounding states. The significant contribution of this research was improved modeling of the cellulosic feedstock supply chain and estimation of resources costs, harvesting costs, and transportation costs for 44 different types of cellulosic feedstocks. Another significant contribution was estimating the producers’ supply curves (marginal cost curves) and improving the imagery intelligence of sourcing areas associated with these supply curves. Estimating the costs for procuring cellulosic feedstocks from sourcing areas at the 5-digit zip code tabulation area (ZCTA) resolution provides invaluable insight for the six-state region’s policy makers, business planners, and investors.

Significant outcomes of the study were identifying low cost sourcing areas in the Kansas State. Least cost sourcing areas for **clean hardwood mill residues** were identified in south-east Kansas. ATC ranged from \$82.82 to \$84.69/dry ton. Least cost sourcing areas for **unclean hardwood mill residues** were also located in south-east Kansas. ATC ranged from \$46.45 to \$48.37/dry ton. Least cost sourcing areas for **“at-landing” hardwood logging residues** occurred in south-east Kansas. ATC ranged from \$21.37 to \$22.68/dry ton. Least cost sourcing areas for **“in-woods” hardwood logging residues** occurred in south-east Kansas. ATC ranged from \$192.75 to \$194.06/dry ton.

Least cost sourcing areas for upland **hardwood pulpwood** (using only the proportion of net growth of total inventory) were located in southeast Kansas. ATC ranged from \$83.95 to \$86.02/dry ton (\$100.74 to \$103.22/cord). Least cost sourcing areas for **upland hardwood pulpwood** (using only previous removals as the proportion of total inventory) were located in southeast Kansas. ATC ranged from \$91.14 to \$93.22/dry ton (\$109.37 to \$111.86/cord). Least cost sourcing areas for **upland hardwood pulpwood** (using the total standing inventory) were located in east and southeast Kansas. ATC ranged from \$79.05 to \$79.86/dry ton (\$94.86 to \$95.83/cord). Least cost sourcing areas for **lowland hardwood pulpwood** (using only the proportion of net growth of total inventory) were located in north-central Kansas. ATC ranged from \$92.92 to \$93.48/dry ton (\$111.50 to \$112.18/cord). Least cost sourcing areas for **mixed**

**natural softwood and hardwood pulpwood** (using the total standing inventory) were located in east Kansas. ATC ranged from \$82.02 to \$85.61/dry ton (\$98.42 to \$102.73/cord).

Least cost sourcing areas for **upland hardwood sawtimber** (total inventory of growing stock) were located in southeast Kansas when exclusion zones were applied. ATC ranged from \$144.55 to \$145.42/dry ton (\$451.72 to \$454.44/MBF). Least cost sourcing areas for **lowland hardwood sawtimber** (total inventory of growing stock) were located in north-east and central Kansas when exclusion zones were applied. ATC ranged from \$153.20 to \$154.60/dry ton (\$478.75 to \$483.13/MBF).

## 5. BIBLIOGRAPHY

Abt, R.C., 2008. Sub-regional timber supply model - data, model, and projection updates. Presentation at SOFAC IV. North Carolina State University. Raleigh, NC.

Abt, R.C., Cubbage, F.W. and Pacheco, G., 2000. Southern forest resource assessment using the Subregional Timber Supply (SRTS) model. *Forest Products Journal*, 50(4), pp.25-33.

Adams, D. and Haynes, R.W., 1996. The 1993 Timber Assessment Market Model: Structure, projections, and policy simulations. PNW-GTR-368. USDA Forest Serv., Pacific Northwest Forest and Range Expt. Sta., Portland, OR., pp.58.

Altman, I.J. and Johnson, T.G., 2008. The choice of organizational form as a non-technical barrier to agro-bioenergy industry development. *Biomass and Bioenergy*, 32(1), pp.28-34.

Bailey, R.G., 1995. Descriptions of ecoregions of the United States. Ogden, Utah: USDA Forest Service, Intermountain Region. Available at: <http://www.fs.fed.us/land/ecosysmgmt/>

Berwick, M. and Farooq, M., 2003. Trucking cost model for transportation managers. Upper Great Plains Transportation Institute, North Dakota State University. Fargo, ND.

Biomass Research and Development Board, 2008. Increasing feedstock production for biofuels economic drivers, environmental implications, and the role of research.

Blanchard, O.J. and Gali, J., 2007. The macroeconomic effects of oil price shocks: why are the 2000s so different from the 1970s? Proc. of NBER ME Conference on International Dimensions of Monetary Policy. S'Agaró, Catalonia, Spain. Available at: [http://www.crei.cat/people/gali/pdf\\_files/bgoil07wp.pdf](http://www.crei.cat/people/gali/pdf_files/bgoil07wp.pdf)

Caputo, J. 2009. Sustainable forest biomass: promoting renewable energy and forest stewardship. Environmental and Energy Study Institute Policy Paper. Washington, D.C. Available at: <http://www.eesi.org/>

Cubbage, F.W., Hogg, D.W., Harris, T.G. and Alig, R.J., 1990. Inventory projection with the Georgia Regional Timber Supply (GRITS) Model. *Southern Journal of Applied Forestry*, 14(3), pp.137-142.

DiPardo, J., 2000. Outlook for biomass ethanol production and demand. U.S. Energy Information Administration. Available at: [www.eia.doe.gov/oiaf/analysispaper/pdf/biomass.pdf](http://www.eia.doe.gov/oiaf/analysispaper/pdf/biomass.pdf)

Dykstra, D.P., 2008. Subject: estimating biomass collection costs for the “Billion-Ton Study” update. Memo: Estimating Forest Biomass Collection Costs for the Billion-Ton Study Update (BTS2).

Elbehri, A., 2007. The changing face of the U.S. grain system. Economic Research Service. U.S. Department of Agriculture, Washington, DC.

Energy Information Administration, 2008. International Energy Outlook. Report #:DOE/EIA-0484(2008). Available at: <http://www.eia.doe.gov/oiaf/ieo/world.html>

Energy Information Administration, 2016. Weekly retail on-highway diesel prices [data file]. Available at: <http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp>

Fight, R.D., Hartsough, B.R. and Noordijk, P., 2006. Users guide for FRCS: Fuel Reduction Cost Simulator software. Gen. Tech. Rep. PNW-GTR- 668. Portland, Research Station, Forest Service, U.S. Department of Agriculture. 23p. Available at: [http://www.fs.fed.us/pnw/pubs/pnw\\_gtr668.pdf](http://www.fs.fed.us/pnw/pubs/pnw_gtr668.pdf)

Galik, C.S, Abt, R.C. and Wu, Y., 2009. Forest biomass supply in the southeastern United States - implications for industrial roundwood and bioenergy production. *Journal of Forestry*, 107(2), pp.69-77.

Greene, W.D., Lanford, B.L. and Hool, J.N., 1987. Potential product volumes from 2nd thinnings of southern pine plantations. *Forest Products Journal*, 37(5), pp.8-12.

Hardle, W., 1990. Applied nonparametric regression. Cambridge University Press. New York, NY. 392p.

Holtzcher, M.A. and Lanford B.L., 1997. Tree diameter effects on cost and productivity of cut-to-length systems. *Forest Products Journal*. 47(3), pp.25-30.

Huang, X., 2010. Bayesian logistic regression models for siting biomass-using facilities. M.S. Thesis. The University of Tennessee. Knoxville. 149p. Available at: [http://trace.tennessee.edu/utk\\_gradthes/808](http://trace.tennessee.edu/utk_gradthes/808)

Jensen, K., Menard, J., English, B., Park, W. and Wilson, B., 2002. The wood transportation and resource analysis system (WTRANS): an analysis tool to assist wood residue producers and users. *Forest Products Journal*, 52(5), pp.27-33.

Johnson, J.M., Reicosky, D., Allmaras, R., Archer, D. and Wilhelm, W., 2006. A matter of balance: Conservation and renewable energy. *Journal of soil and water conservation*, 61(4), pp.120A-125A.

Karlen, D.L., Andrews, S.S., Wienhold, B.J., Doran, J.W., 2003. Soil quality: humankind's foundation for survival. *Journal of soil and water conservation*, 58, pp.171–179.

Lanford, B.L. and Stokes, B.J., 1996. Comparison of two thinning systems. 2. Productivity and costs. *Forest Products Journal*, 46(11-12), pp.47-53.

Langholtz, M., Carter, D.R., Marsik, M., and Schroder, R., 2006. Measuring the economics of biofuel availability. ArcUser Online (October-December 2006). Available at: <http://www.esri.com/news/arcuser/1006/biomass1of2.html>

Liu, X., 2009. A statistical analysis of key factors influencing the location of biomass-using facilities. M.S. Thesis. The University of Tennessee. Knoxville. 106p. Available at: [http://trace.tennessee.edu/utk\\_gradthes/539](http://trace.tennessee.edu/utk_gradthes/539)

Lunnan, A., 1997. Agriculture-based biomass energy supply - a survey of economic issues. *Energy Policy*, 25(6), pp.573-582.

Milbrandt, A., 2005. "A Geographic Perspective on the Current Biomass Resource Availability in the United States." NREL Technical Report NREL/TP-560-39181. Available at: <http://www.nrel.gov/docs/fy06osti/39181.pdf>

Miles, P.D. Wed Aug 05 10:40:23 MDT 2015. Forest Inventory EVALIDator web-application version 1.6.0.02. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. Available at: <http://apps.fs.fed.us/Evalidator/evalidator.jsp>

Mills, J.R. and Kincaid, J.C., 1992. The aggregate timber supply assessment system-ATLAS: A comprehensive timber projection model. Gen. Tech. Rept. PNW-GTR-281. USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Muth, D.J., Bryden, K.M. and Nelson, R.G., 2013. Sustainable agricultural residue removal for bioenergy: A spatially comprehensive US national assessment. *Applied Energy*, 102, pp.403-417.

National Land Cover Database, 2011. Available at: [http://www.mrlc.gov/nlcd11\\_data.php](http://www.mrlc.gov/nlcd11_data.php)

National Land Cover Database, 2001. Multi-Resolution Land Characteristics Consortium. Pixel Resolution: 30m\*30m).

Nelson, R.G., Walsh, M., Sheehan, J.J. and Graham, R., 2004. Methodology for estimating removable quantities of agricultural residues for bioenergy and bioproduct use. *Applied Biochemistry and Biotechnology*, 113-116, pp.13-26.

Nevins, C.G., 2009. Kentucky's Growing Gold. Kentucky Division of Forestry. Frankfort, KY. Vol. XLIX, No. 2.

Noon, C.E. and Daly, M.J., 1996. GIS-based biomass resource assessment with BRAVO. *Biomass and Bioenergy*, 10(2-3), pp.101-109.

North Country Organics. Available at: <http://www.norganics.com/applications/bushelwgt.pdf>

Oak Ridge National Laboratory, Biomass Energy Data Book. Available at: [http://cta.ornl.gov/bedb/appendix\\_a.shtml](http://cta.ornl.gov/bedb/appendix_a.shtml)

Parker, N., Tittmann, P., Hart, Q., Lay, M., Cunningham, J., Jenkins, B., Nelson, R., Skog, K., Milbrandt, A., Gray, E. and Schmidt, A., 2008. Strategic Assessment of Bioenergy Development

in the West: Spatial analysis and supply curve development. Final Report to the Western Governor's Association, prepared by the University of California-Davis, Sept.

Perdue, J.H., T.M. Young, and T.G. Rials. 2011. The Biomass Site Assessment Model – BioSAT. Final Report for U.S. Forest Service, Southern Research Station submitted by The University of Tennessee, Knoxville. 282p.

Perez-Verdin, G., Grebner, D.L. , Sun, C., Munn, I.A. , Schultz, E.B. and Matney, T.G., 2009. Woody biomass availability for bioethanol conversion in Mississippi. *Biomass and Bioenergy*, 33, pp.492-503.

Perlack, R.D., Wright, L.L., Turhollow, A.F., Graham, R.L., Stokes, B.J. and Erbach, D.C., 2005. Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply. Publication DOE/GO-102995-2135/ORNL TM-2005/66. OAR Ridge National Laboratory, OAR Ridge, TN. 60p. Available at: [http://feedstockreview.ornl.gov/pdf/billion\\_ton\\_vision.pdf](http://feedstockreview.ornl.gov/pdf/billion_ton_vision.pdf)

Pimentel, D., Moran, M.A., Fast, S., Weber, G., Bukantis, R., Balliett, L., Boveng, P., Cleveland, C., Hindman, S. and Young, M., 1981. Biomass energy from crop and forest residues. *Science*, 212(4499), pp.1110-1115.

Proctor, D.L., 1994. Grain storage techniques evolution and trends in developing countries. Food and Agriculture Services Bulletin 109. Food and Agriculture Organization of the United Nations (FAO). Available at: <http://www.fao.org/docrep/T1838E/T1838E00.htm#Contents>

Sedjo, R.A., 1997. The economics of forest-based biomass supply. *Energy Policy*, 25(6), pp.559-566.

Stokes, B.J., 1992. Harvesting small trees and forest residues. *Biomass and Bioenergy*, 2(1), pp.131- 147.

Tufts, R.A., Lanford, B.L., Greene, W.D. and Burrows, J.O., 1985. Auburn harvesting analyzer. The Compiler, 3(2), pp.14-15. Forest Resources Systems Institute, Florence, AL.

Tufts, R.A., Stokes, B.J. and Lanford, B.L., 1988. Productivity of grapple skidders in southern pine. *Forest Products Journal*, 38(10), pp.24-30.

Ugarte, D.G.D.L.T. and Ray, D.E., 2000. Biomass and bioenergy applications of the POLYSYS modeling framework. *Biomass and Bioenergy*, 18(4), pp.291-308.

Ugarte, D.L.T., English, B.C. and Jensen, K., 2007. Sixty billion gallons by 2030: Economic and agricultural impacts of ethanol and biodiesel expansion. *American Journal of Agricultural Economics*, 89(5), pp.1290-1295.

U.S. Bureau of Labor Statistics, 2009. Consumer Price Index (CPI) Inflation Calculator. Available at: [http://www.bls.gov/data/inflation\\_calculator.htm](http://www.bls.gov/data/inflation_calculator.htm)

U.S. Census Bureau, 2000a. Census 2000 County and County Equivalent Areas.

U.S. Census Bureau, 2000b. ZIP Code Tabulation Area (ZCTA) for Census 2000. Available at: <http://www.census.gov/en.html>

U.S. Department of Agriculture, Forest Service, 2014. Forest and inventory national database 3.0. Available at: <http://www.fia.fs.fed.us/tools-data/>

U.S. Department of Agriculture, Forest Service. 2012. Timber Product Output (TPO) Reports. Knoxville, TN: U.S. Department of Agriculture Forest Service, Southern Research Station. [http://srsfia2.fs.fed.us/php/tpo\\_2009/tpo\\_rpa\\_int1.php](http://srsfia2.fs.fed.us/php/tpo_2009/tpo_rpa_int1.php). [Date accessed: February 28, 2016].

U.S. Department of Agriculture, Forest Service. 2014. Timber Product Output (TPO) Reports. Knoxville, TN: U.S. Department of Agriculture Forest Service, Southern Research Station. [http://srsfia2.fs.fed.us/php/tpo\\_2009/tpo\\_rpa\\_int1.php](http://srsfia2.fs.fed.us/php/tpo_2009/tpo_rpa_int1.php). [Date accessed: February 28, 2016].

U.S. Department of Agriculture, Forest Service, 2008b. U.S. Forest Service research and development strategic plan, 2008-2012. Washington, D.C. 32p.

U.S. Department of Agriculture, Forest Service, 2008c. Woody biomass utilization strategy. U.S. Department of Agriculture, FS-899. GPO: Washington, D.C. 33p.

U.S. Department of Energy, 2011. U.S. billion-ton update, biomass supply for a bioenergy and bioproducts industry. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. 227p.

U.S. National Research Council, Library of Congress. 1982. United States - Canadian Tables of Composition. Available at: [http://books.nap.edu/openbook.php?record\\_id=1713&page=R2](http://books.nap.edu/openbook.php?record_id=1713&page=R2)

Walsh, M.E., 2008. US cellulosic biomass feedstock supplies and distribution. *M&E Biomass*. Available at: <http://ageconsearch.umn.edu/bitstream/7625/2/U.S.%20Biomass%20Supplies.pdf>

Wear, D.N. and Greis, J.G., 2002. Southern forest resource assessment-technical report.

Wear, D.N., Carter, D.R. and Prestemon, J., 2007. The US South's timber sector in 2005: A prospective analysis of recent change.

Wilhelm, W.W., Hess, J.R., Karlen, D.L., Johnson, J.M., Muth, D.J., Baker, J.M., Gollany, H.T., Novak, J.M., Stott, D.E. and Varvel, G.E., 2010. Review: Balancing limiting factors & economic drivers for sustainable Midwestern US agricultural residue feedstock supplies. *Industrial Biotechnology*, 6(5), pp.271-287.

Young, T.M. and Ostermeier, D.M., 1989. IFCHIPSS—The Industrial Fuel Chip Supply Simulation Model. Final Report for Contract with Southeastern Regional Biomass Energy Program as administered by the Tennessee Valley Authority. 141p.

Young, T.M., Ostermeier, D.M., Thomas, J.D. and Brooks, R.T., 1991. The economic availability of woody biomass for the Southeastern United States. *Bioresources Technology*, 37(1), pp.7-16.

Young, T.M., Ostermeier, D.M., Thomas, J.D. and Brooks, R.T., Jr, 1991. Computer model simulates supply, cost of chips. *Forest Industries*, 118(8), pp.20-21.



## **APPENDIX A. USDA FOREST SERVICE ECOREGIONS AND FOREST TYPES**

## **ECOREGIONS**

### **Arkansas Valley**

A region of mostly forested valleys and ridges, the physiography of the Arkansas Valley is much less irregular than that of the Boston Mountains to the north and the Ouachita Mountains to the south, but is more irregular than the ecological regions to the west and east. About one fourth of the region is grazed and roughly one tenth is cropland. In the Arkansas Valley, even streams that have been relatively unimpacted by human activities have considerably lower dissolved oxygen levels, and hence support different biological communities, than those of most of the adjacent regions.

### **Boston Mountains**

In contrast to the nearby Ouachita Mountains region which comprises folded and faulted linear ridges mostly covered by pine forests, the Boston Mountains ecological region consists of a deeply dissected sandstone and shale plateau, originally covered by oak-hickory forests. Red oak, white oak, and hickory remain the dominant vegetation types in this region, although shortleaf pine and eastern red cedar are found in many of the lower areas and on some south- and west-facing slopes. The region is sparsely populated and recreation is a principal land use.

### **Central Great Plains**

The Central Great Plains are slightly lower, receive more precipitation, and are somewhat more irregular than the High Plains to the west. Once a grassland, with scattered low trees and shrubs in the south, much of this ecological region is now cropland, the eastern boundary of the region marking the eastern limits of the major winter wheat growing area of the United States. Subsurface salt deposits and leaching contribute to high salinity found in some streams.

### **Central Irregular Plains**

The Central Irregular Plains have a mix of land use and are topographically more irregular than the Western Corn Belt Plains to the north, where most of the land is in crops. The region, however, is less irregular and less forest covered than the ecoregions to the south and east. The potential natural vegetation of this ecological region is a grassland/forest mosaic with wider forested strips along the streams compared to Western Corn Belt Plains to the north. The mix of land use activities in the Central Irregular Plains includes mining operations of high-sulfur bituminous coal. The disturbance of these coal strata in southern Iowa and northern Missouri has degraded water quality and affected aquatic biota.

### **Cross Timbers**

The Cross Timbers ecoregion is a transition area between the once prairie, now winter wheat growing regions to the west, and the forested low mountains or hills of eastern Oklahoma and Texas. The region does not possess the arability and suitability for crops such as corn and soybeans that are common in the Central Irregular Plains to the northeast. Transitional “cross-timbers” (little bluestem grassland with scattered blackjack oak and post oak trees) is the native vegetation, and presently rangeland and pastureland comprise the predominant land cover, with some areas of woodland. Oil extraction has been a major activity in this region for over eighty years.

### **Driftless Area**

The hilly uplands of the Driftless Area easily distinguish it from surrounding ecoregions. Much of the area consists of a deeply dissected, loess-capped, bedrock dominated plateau. The region is also called the Paleozoic Plateau because the landscape's appearance is a result of erosion through rock strata of Paleozoic age. Although there is evidence of glacial drift in the region, its influence on the landscape has been minor compared to adjacent ecoregions. In contrast to adjacent ecoregions, the Driftless Area has few lakes, most of which are reservoirs with generally high trophic states. Livestock and dairy farming are major land uses and have had a major impact on stream quality.

### **East Central Texas Plains**

Also called the Post Oak Savanna or the Claypan Area, this region of irregular plains was originally covered by post oak savanna vegetation, in contrast to the more open prairie-type regions to the north, south, and west and the pine forests to the east. The boundary with South Central Plains is a subtle transition of soils and vegetation. Many areas have a dense, underlying clay pan affecting water movement and available moisture for plant growth. The bulk of this region is now used for pasture and range.

### **Flint Hills**

The Flint Hills is a region of rolling hills with relatively narrow steep valleys, and is composed of shale and cherty limestone with rocky soils. In contrast to surrounding ecological regions that are mostly in cropland, most of the Flint Hills region is grazed by beef cattle. The Flint Hills mark the western edge of the tallgrass prairie, and contain the largest remaining intact tallgrass prairie in the Great Plains.

### **High Plains**

Higher and drier than the Central Great Plains to the east, and in contrast to the irregular, mostly grassland or grazing land of the Northwestern Great Plains to the north, much of the High Plains is characterized by smooth to slightly irregular plains having a high percentage of cropland. Grama-buffalo grass is the potential natural vegetation in this region as compared to mostly wheatgrass-needlegrass to the north, Trans-Pecos shrub savanna to the south, and taller grasses to the east. The northern boundary of this ecological region is also the approximate northern limit of winter wheat and sorghum and the southern limit of spring wheat.

### **Interior River Valleys and Hills**

The Interior River Lowland is made up of many wide, flat-bottomed terraced valleys, forested valley slopes, and dissected glacial till plains. In contrast to the generally rolling to slightly irregular plains in adjacent ecological regions to the north (Central Corn Belt Plains), east (Eastern Corn Belt Plains) and west (Central Irregular Plains, Western Corn Belt Plains), where most of the land is cultivated for corn and soybeans, a little less than half of this area is in cropland, about 30 percent is in pasture, and the remainder is in forest. Bottomland deciduous forests and swamp forests were common on wet lowland sites, with mixed oak and oak-hickory forests on uplands. Paleozoic sedimentary rock is typical and coal mining occurs in several areas.

### **Mississippi Alluvial Plain**

This riverine ecoregion extends from southern Illinois, at the confluence of the Ohio River with

the Mississippi River, south to the Gulf of Mexico. It is mostly a broad, flat alluvial plain with river terraces, swales, and levees providing the main elements of relief. Soils are typically finer-textured and more poorly drained than the upland soils of adjacent South Central Plains and Mississippi Valley Loess Plains, although there are some areas of coarser, better-drained soils. Winters are mild and summers are hot, with temperatures and precipitation increasing from north to south. Bottomland deciduous forest vegetation covered the region before much of it was cleared for cultivation. Presently, most of the northern and central parts of the region are in cropland and receive heavy treatments of insecticides and herbicides. Soybeans, cotton, and rice are the major crops.

### **Mississippi Valley Loess Plains**

This ecoregion stretches from near the Ohio River in western Kentucky to Louisiana. It consists primarily of irregular plains, some gently rolling hills, and near the Mississippi River, bluffs. Thick loess is one of the distinguishing characteristics. The bluff hills in the western portion contain soils that are deep, steep, silty, and erosive. Flatter topography is found to the east, and streams tend to have less gradient and more silty substrates than in the Southeastern Plains ecoregion. To the east, upland forests dominated by oak, hickory, and both loblolly and shortleaf pine, and to the west on bluffs some mixed and southern mesophytic forests, were the dominant natural vegetation. Agriculture is now the typical land cover in the Kentucky and Tennessee portion of the region, while in Mississippi there is a mosaic of forest and cropland.

### **Nebraska Sandhills**

The Nebraska Sandhills comprise one of the most distinct and homogenous ecoregions in North America. One of the largest areas of grass stabilized sand dunes in the world, this region is generally devoid of cropland agriculture and except for some riparian areas in the north and east, the region is treeless. Large portions of this ecoregion contain numerous lakes and wetlands and have a lack of streams. The area is sparsely populated; however, large cattle ranches are found throughout the region.

### **Northern Glaciated Plains**

The Northern Glaciated Plains ecoregion is characterized by a flat to gently rolling landscape composed of glacial drift. The subhumid conditions foster a grassland transitional between tall and shortgrass prairie. High concentrations of temporary and seasonal wetlands create favorable conditions for waterfowl nesting and migration. Although the till soils are very fertile, agricultural success is subject to annual climatic fluctuations.

### **Northwestern Glaciated Plains**

The Northwestern Glaciated Plains ecoregion is a transitional region between the generally more level, moister, more agricultural Northern Glaciated Plains to the east and the generally more irregular, dryer, Northwestern Great Plains to the west and southwest. The western and southwestern boundary roughly coincides with the limits of continental glaciation. Pocking this ecoregion is a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as Prairie Potholes.

### **Northwestern Great Plains**

The Northwestern Great Plains ecoregion encompasses the Missouri Plateau section of the Great

Plains that is mostly unglaciated. It is a semiarid rolling plain of shale, siltstone, and sandstone punctuated by occasional buttes and badlands. Rangeland is common, but spring wheat and alfalfa farming also occur; native grasslands, persist in areas of steep or broken topography. Agriculture is restricted by the erratic precipitation and limited opportunities for irrigation.

### **Ouachita Mountains**

The Ouachita Mountains ecological region is made up of sharply defined east-west trending ridges, formed through erosion of compressed sedimentary rock formations. The Ouachitas are structurally different from the Boston Mountains, more folded and rugged than the lithologically distinct Ozark Highlands, and physiographically unlike the Arkansas Valley, South Central Plains, and Mississippi Alluvial Plain. Potential natural vegetation is oak-hickory-pine forest, which contrasts with the oak-hickory forest that dominates Ozark Highlands and the northern part of the Boston Mountains. Most of this region is now in loblolly and shortleaf pine. Commercial logging is the major land use in the region.

### **Ozark Highlands**

The Ozark Highlands ecoregion has a more irregular physiography and is generally more forested than adjacent regions, with the exception of the Boston Mountains to the south. Soils are mostly derived from cherty carbonate rocks. Cambrian and Ordovician dolomite and sandstone comprise the dominant bedrock in the interior of the region with Mississippian limestone underlying the western outer regions. Karst features, including caves, springs, and spring-fed streams are found throughout most of the Ozark Highlands. The majority of the region is forested; oak is the predominant forest type but mixed stands of oak and pine are also common, with pine concentrations greatest to the southeast. Less than one fourth of the core of this region has been cleared for pasture and cropland, but half or more of the periphery, while not as agricultural as bordering ecological regions, is in cropland and pasture.

### **South Central Plains**

Locally termed the “piney woods”, this region of mostly irregular plains represents the western edge of the southern coniferous forest belt. Once blanketed by a mix of pine and hardwood forests, much of the region is now in loblolly and shortleaf pine plantations. Only about one sixth of the region is in cropland, primarily within the Red River floodplain, while about two thirds of the region is in forests and woodland. Lumber, pulpwood, oil and gas production are major economic activities.

### **Southwestern Tablelands**

The southwestern Tablelands flank the High Plains with red hued canyons, mesas, badlands, and dissected river breaks. Unlike most adjacent Great Plains ecological regions, little of the Southwestern Tablelands is in cropland. Much of this region is in sub-humid grassland and semiarid range land. The potential natural vegetation is grama-buffalo grass with some mesquite-buffalo grass in the southeast, juniper-scrub oak-midgrass savanna on escarpment bluffs, and shinnery (midgrass prairie with open low and shrubs) along the Canadian River.

### **Western Corn Belt Plains**

Once mostly covered with tallgrass prairie, over 80 percent of the Western Corn Belt Plains is now used for cropland agriculture and much of the remainder is in forage for livestock. A combination

of nearly level to gently rolling glaciated till plains and hilly loess plains, an average annual precipitation of 26 to 37 inches, which occurs mainly in the growing season, and fertile, warm, moist soils make this one of the most productive areas of corn and soybeans in the world. Agricultural practices have contributed to environmental issues, including surface and groundwater contamination from fertilizer and pesticide applications as well as concentrated livestock production.

## **FOREST TYPES**

### **Upland hardwood**

Stands that have at least 10 percent stocking and classed as an oak-hickory or maple-beech-birch forest type.

### **Lowland hardwood**

Stands that have at least 10 percent stocking with a forest type of oak-gum-cypress or elm-ash-cottonwood.

### **Natural Softwood** (a.k.a. Natural Pine)

Stands that (a) have not been artificially regenerated, (b) are classed as a pine or other softwood forest type, and (c) have at least 10 percent stocking.

### **Mixed Natural Softwood and Hardwood**

Stands in which hardwoods constitute a plurality of the stocking but in which pines account for 25 to 50 percent of the stocking.

### **Pine Plantation**

Stands that (a) have been artificially regenerated by planting or direct seeding, (b) are classed as a pine or other softwood forest type, and (c) have at least 10 percent stocking.

## **CITATIONS**

Ecoregions:

Primary distinguishing characteristics of level III ecoregions of the continental United States. United States Environmental Protection Agency. September, 2013.

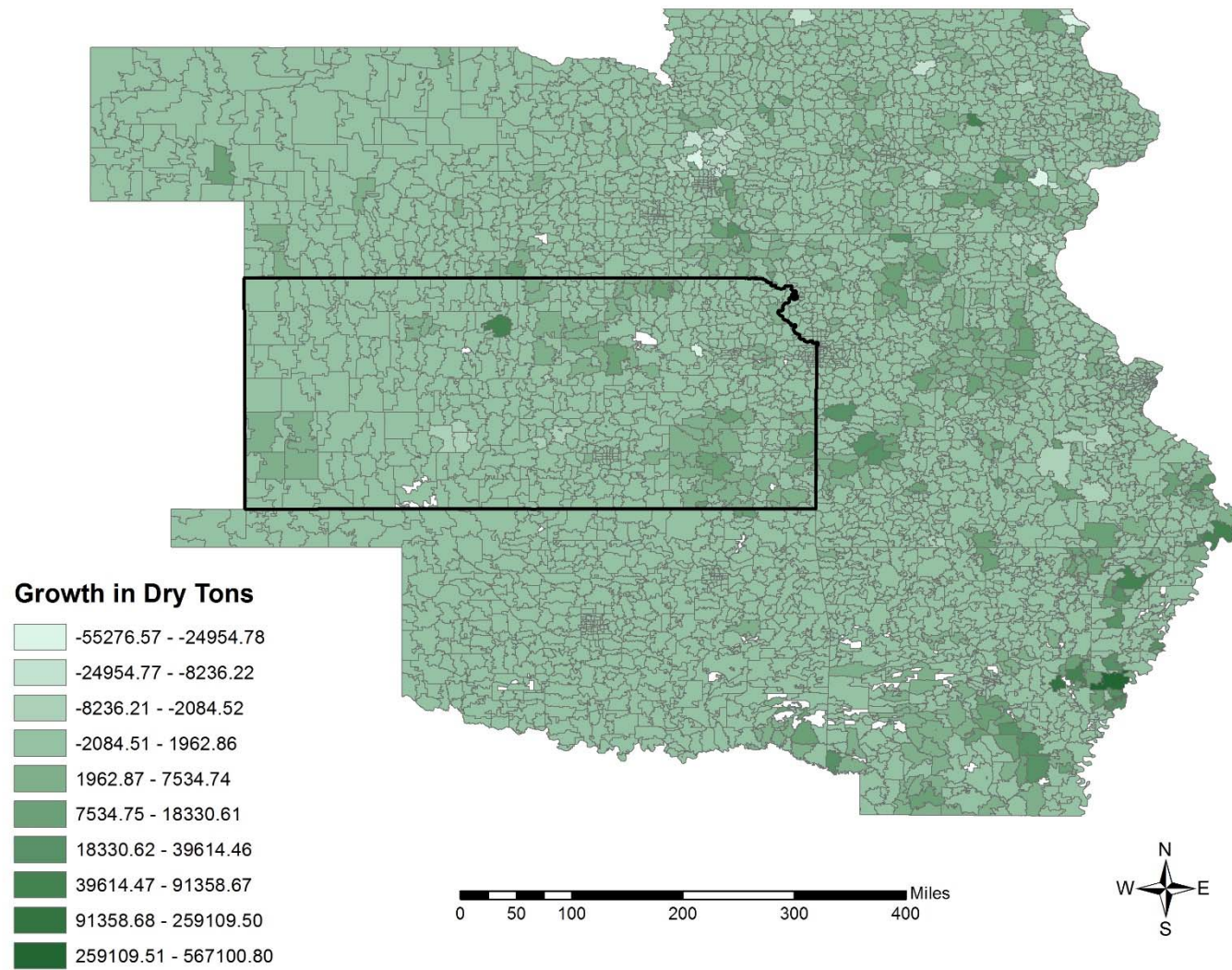
Forest Types:

Various forest resource bulletins published by the U.S. Forest Service, Forest Inventory and Analysis unit of the Southern Research Station, Asheville, NC.

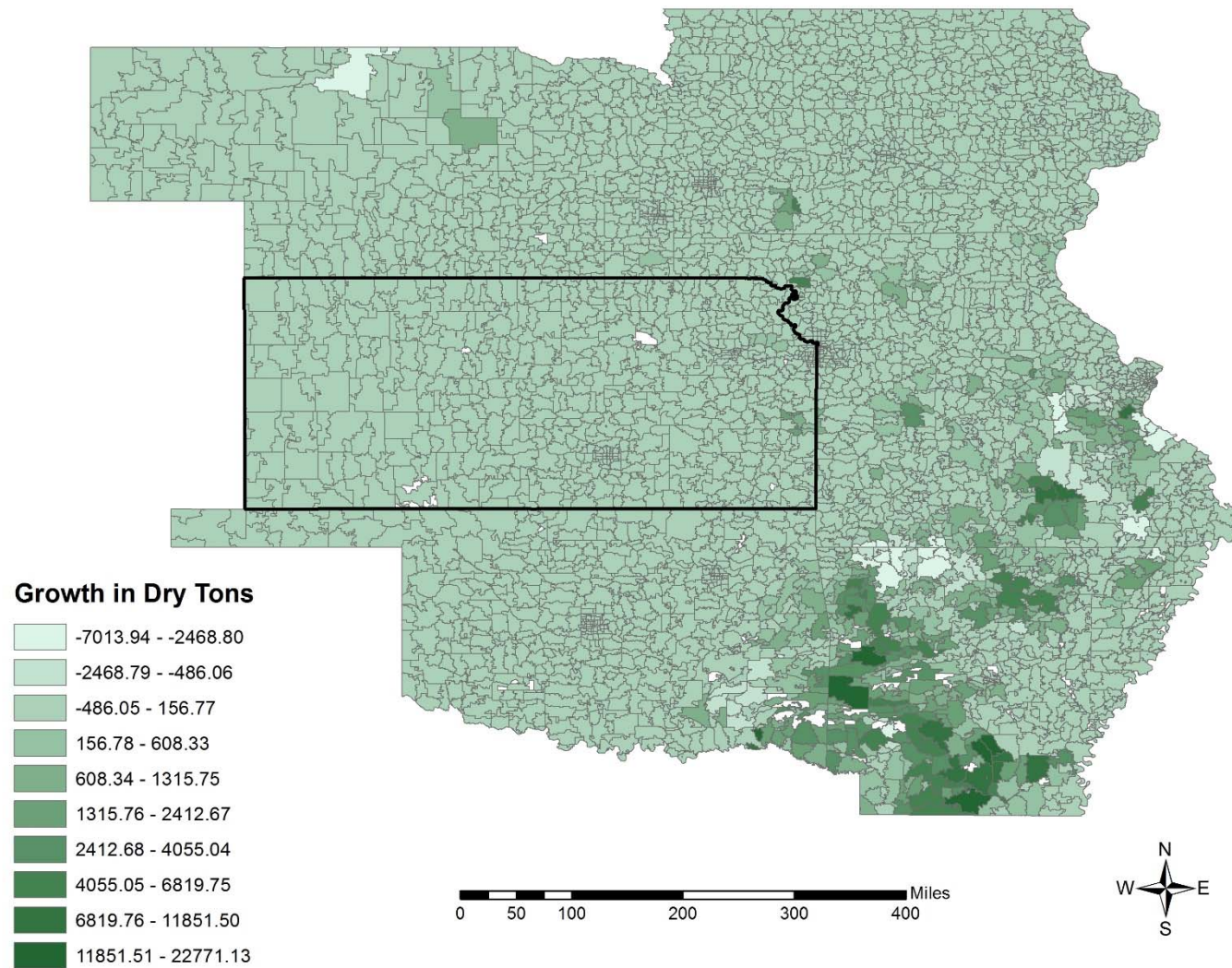
## **APPENDIX B**

Regional (Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma States) ZCTA maps for Merchantable trees (roundwood). Pulpwood and sawtimber (growth, removals, and volume in pine plantations, lowland and upland hardwood, softwood and mixed wood).



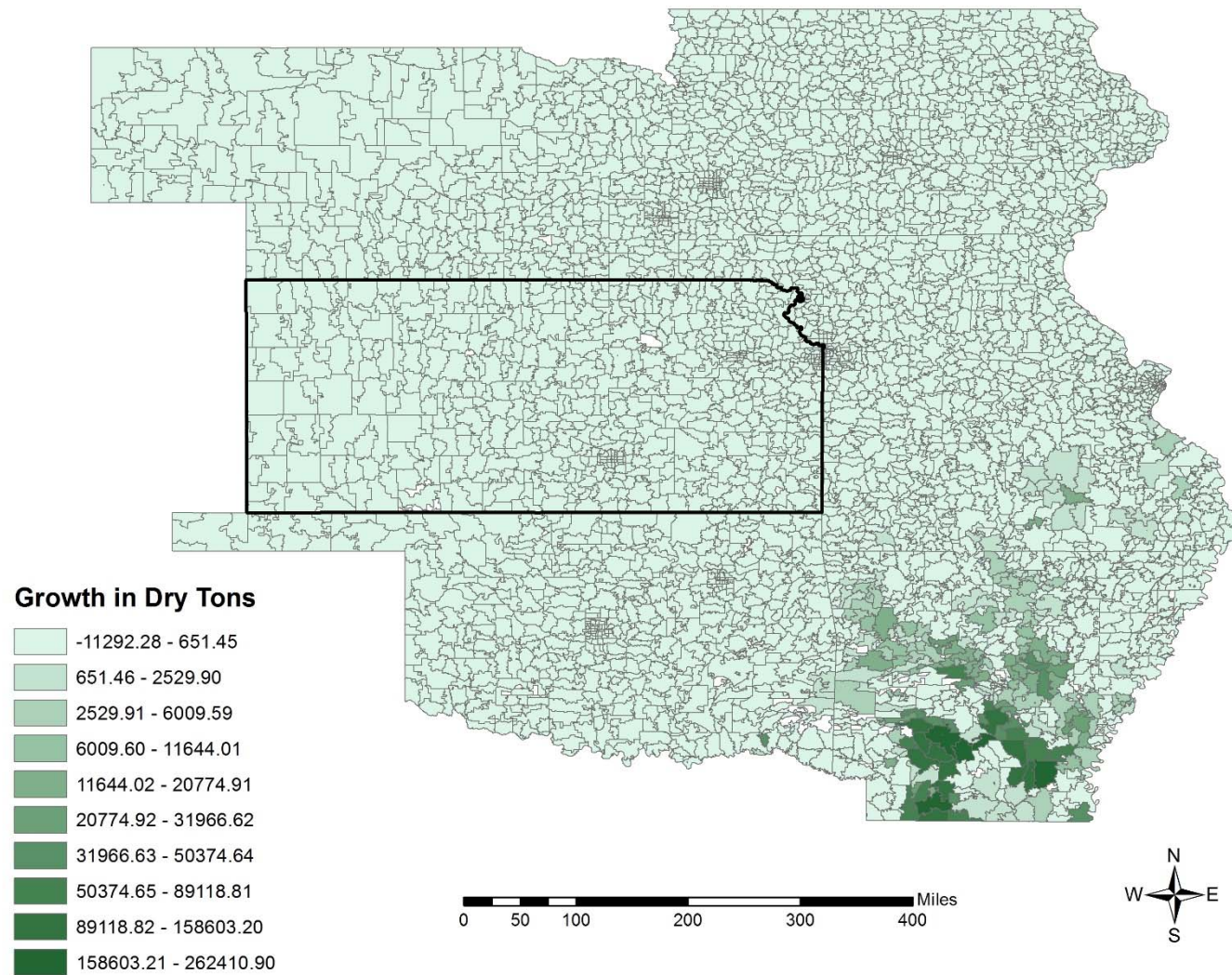


**Figure B1. Regional ZCTA map. Pulpwood Growth in Lowland Hardwood in dry tons.**

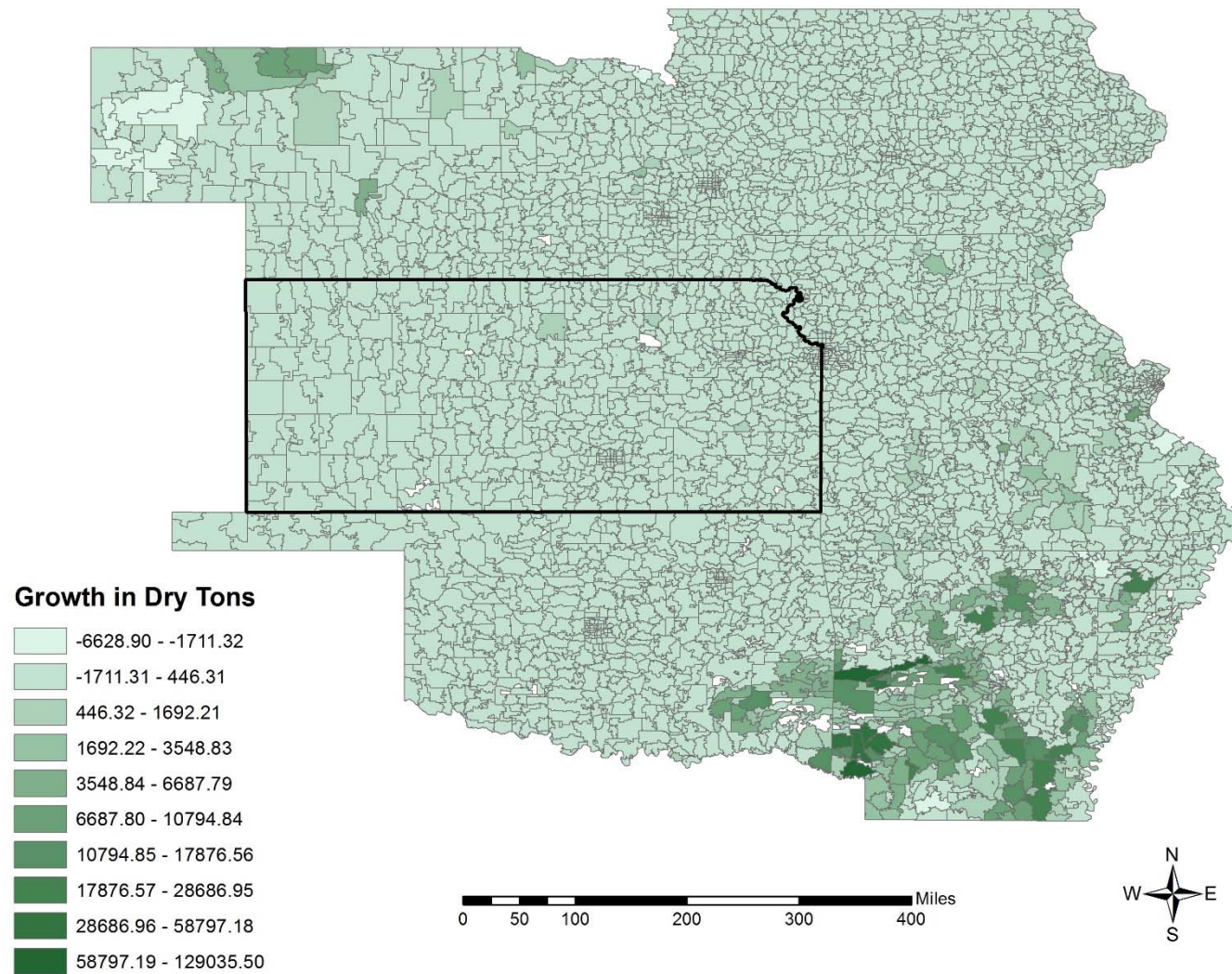


**Figure B2. Regional ZCTA map. Pulpwood Growth in Mixed Wood in dry tons.**



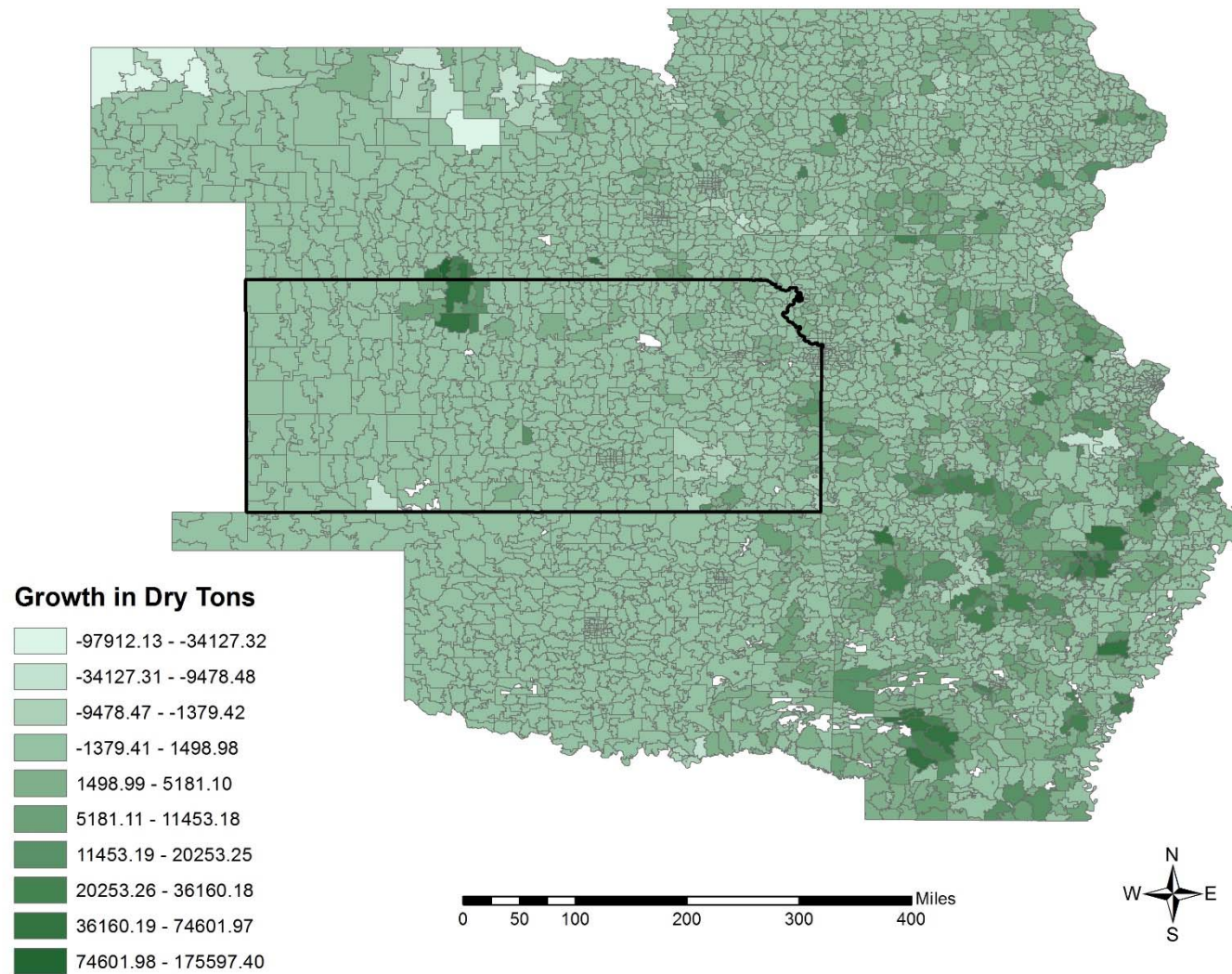


**Figure B3. Regional ZCTA map. Pulpwood Growth in Pine Plantations in dry tons.**

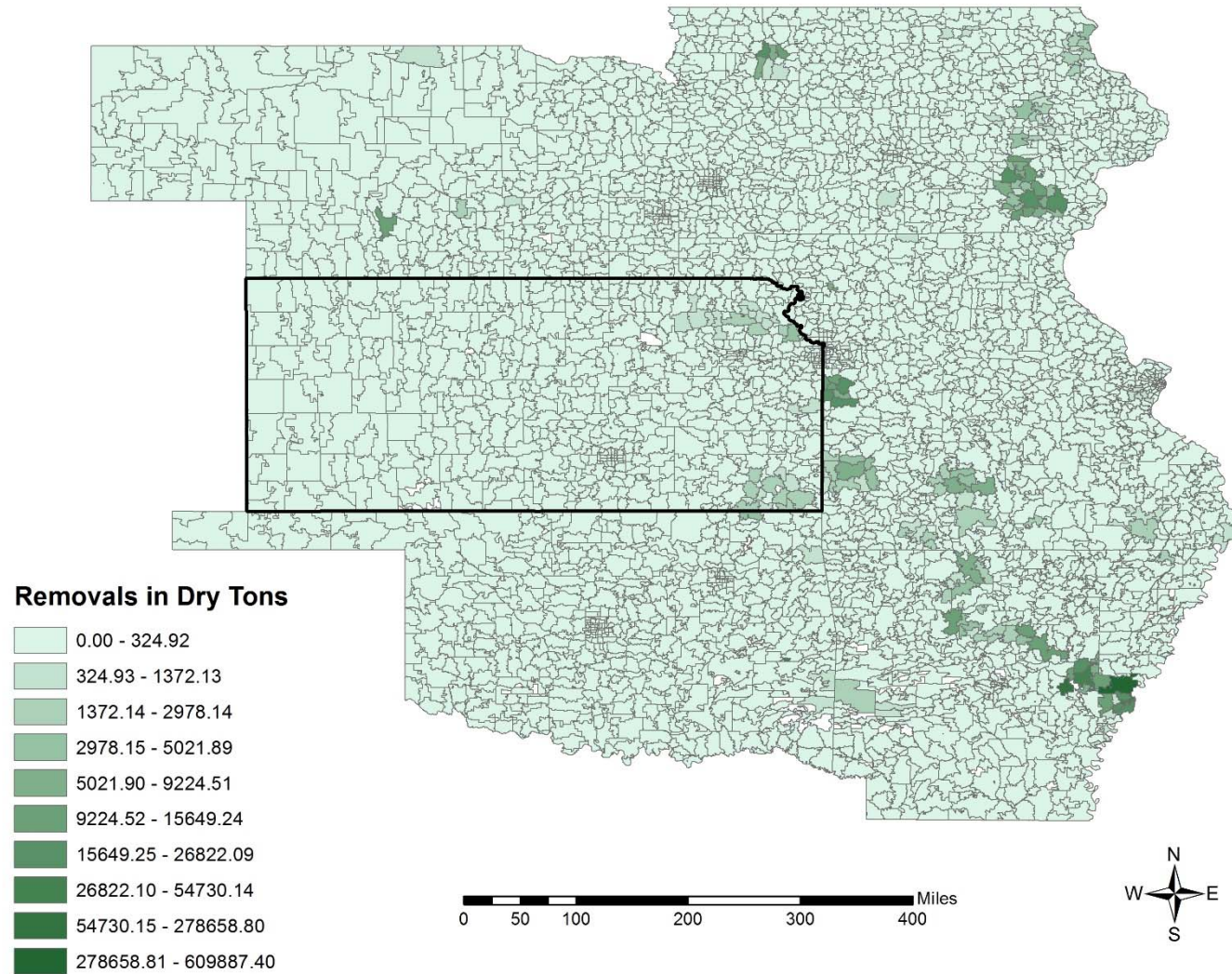


**Figure B4. Regional ZCTA map. Pulpwood Growth in Softwood in dry tons.**



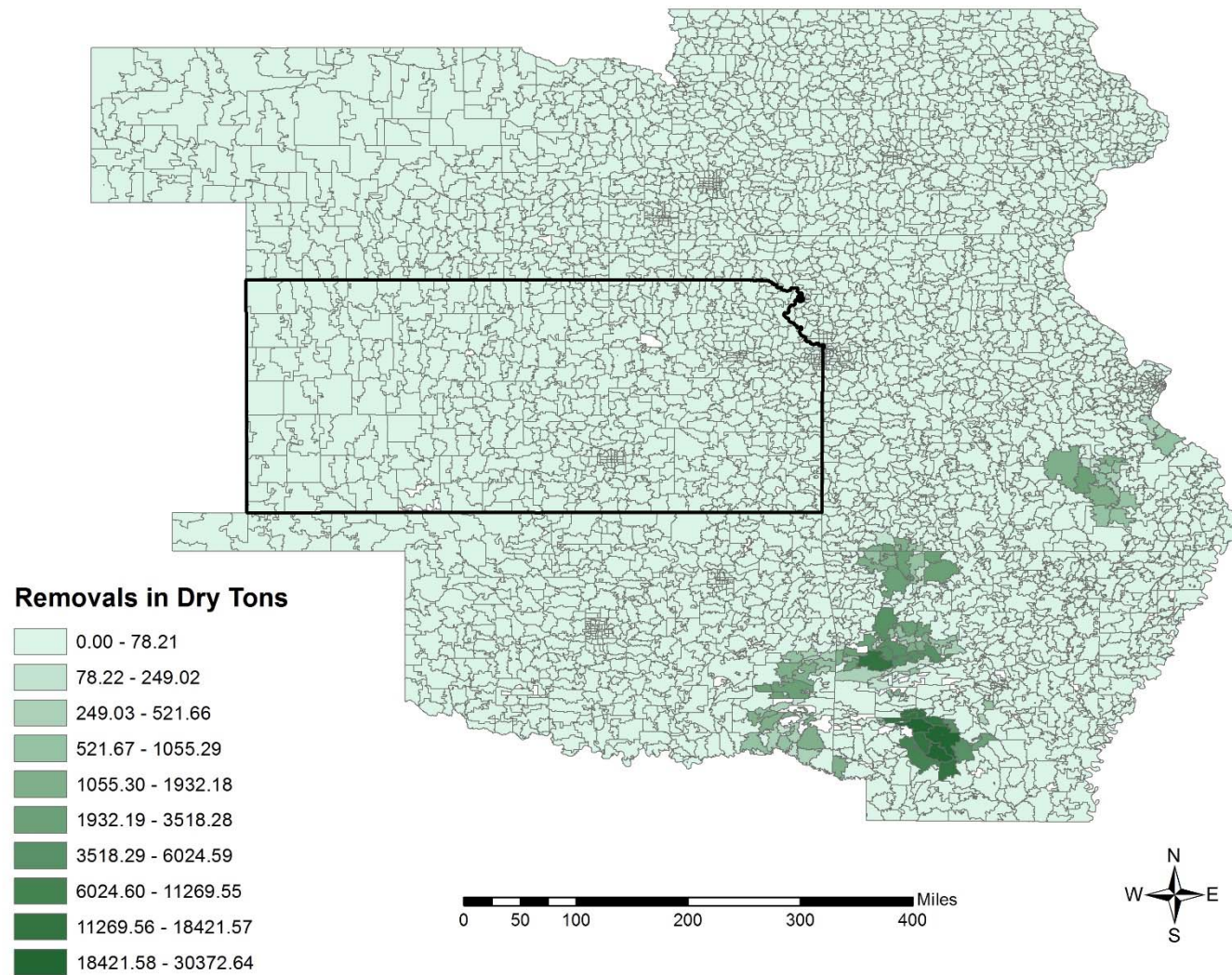


**Figure B5. Regional ZCTA map. Pulpwood Growth in Upland Hardwood in dry tons.**

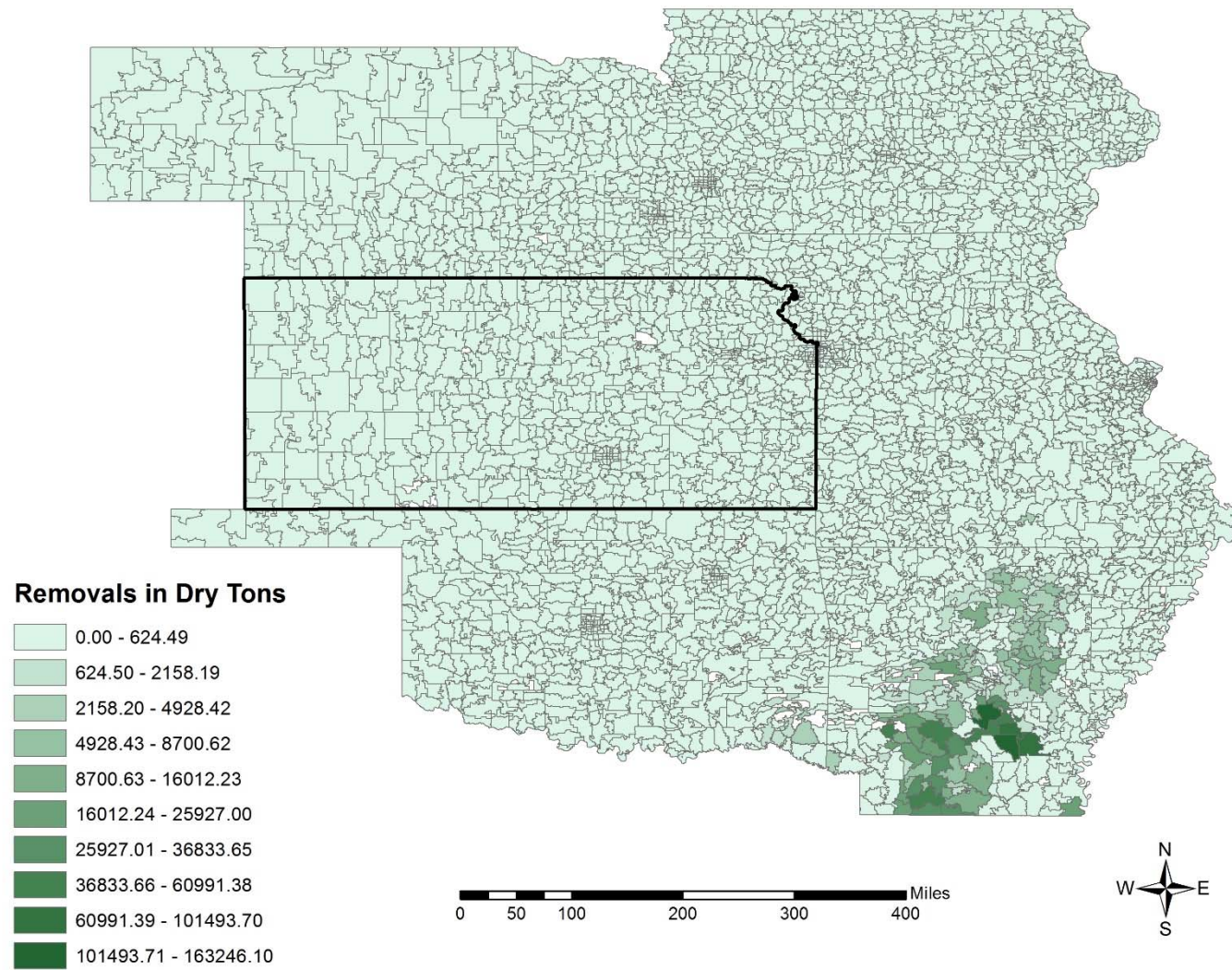


**Figure B6. Regional ZCTA map. Pulpwood Removals in Lowland Hardwood in dry tons.**



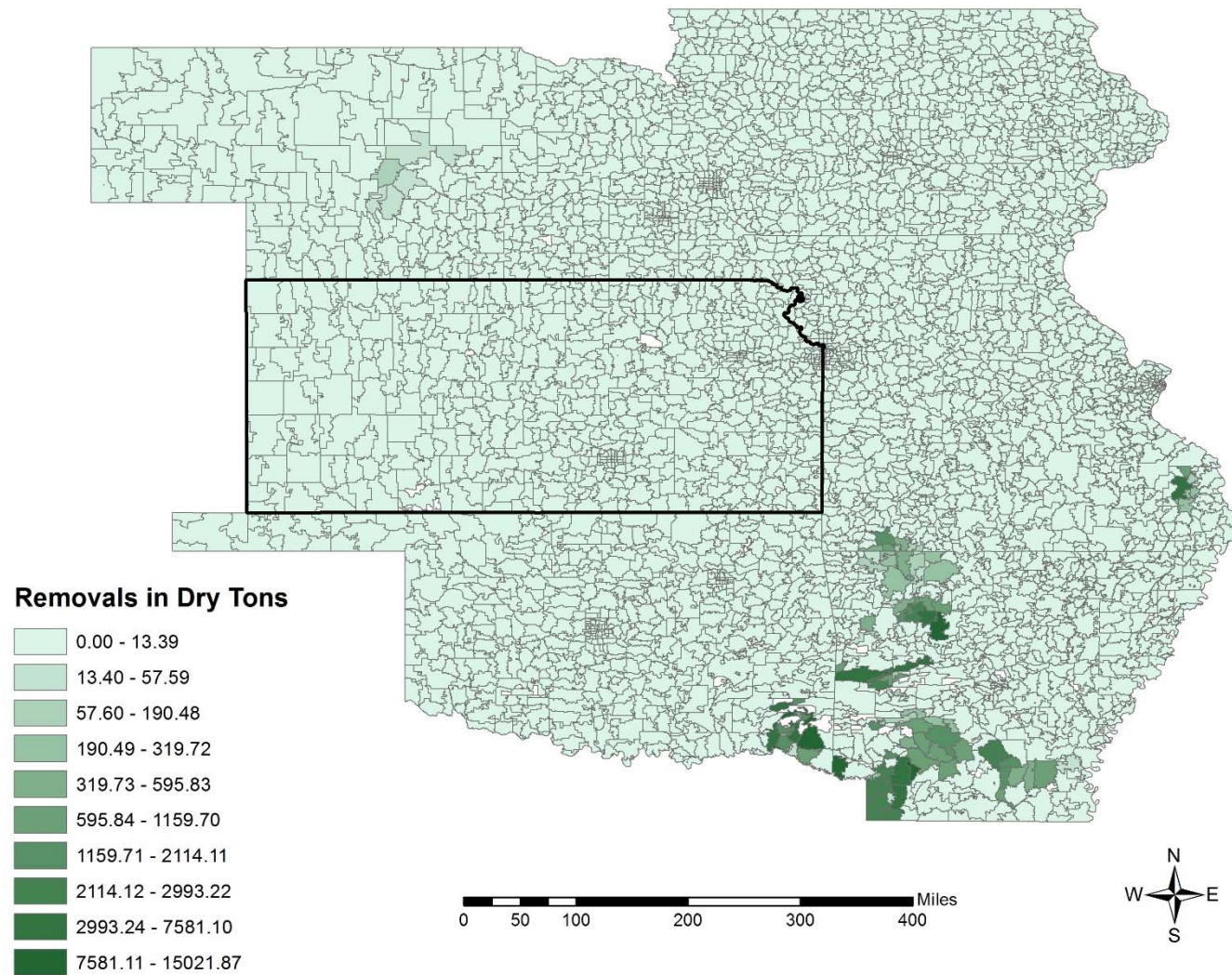


**Figure B7. Regional ZCTA map. Pulpwood Removals in Mixed Wood in dry tons.**

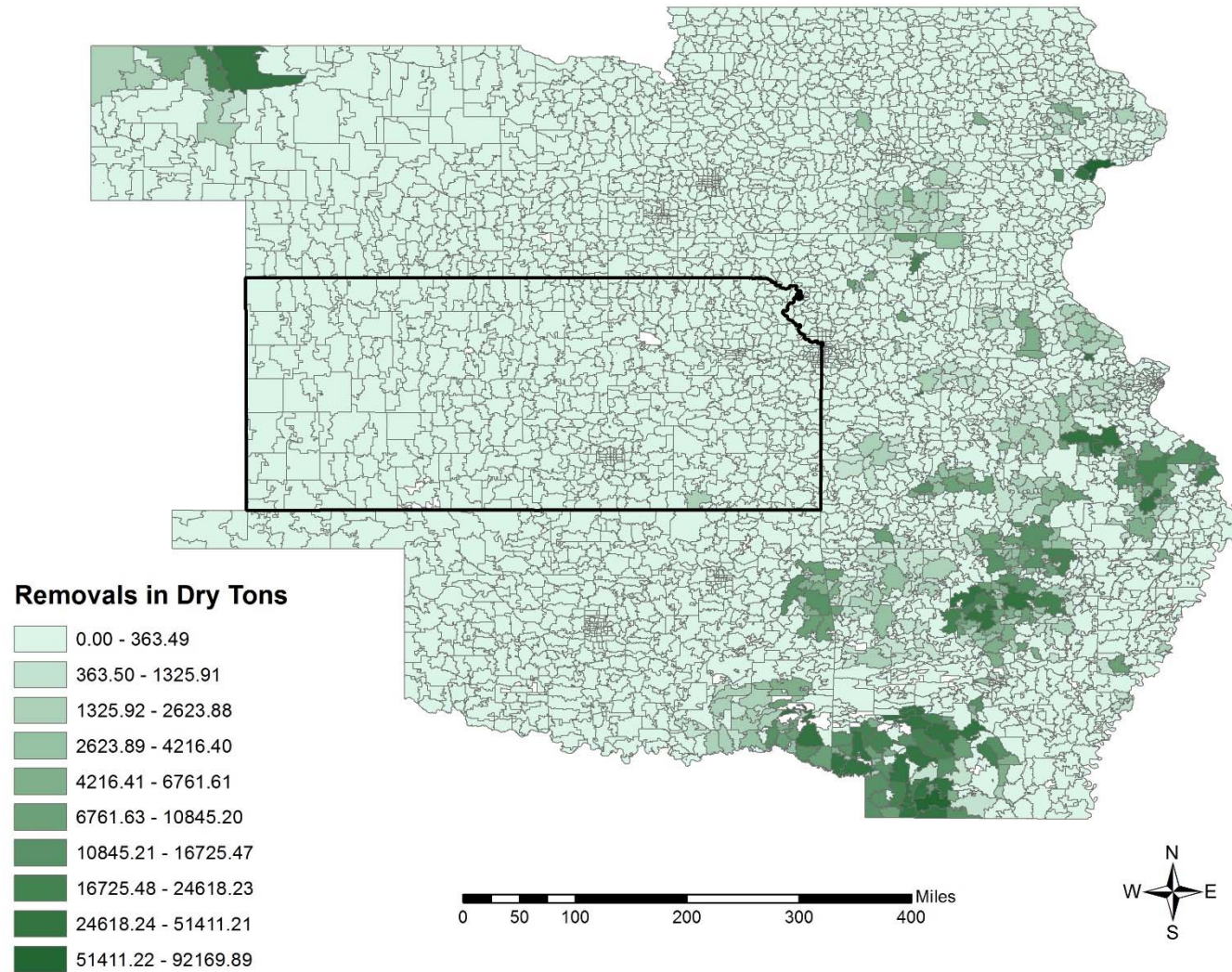


**Figure B8. Regional ZCTA map. Pulpwood Removals in Pine Plantations in dry tons.**



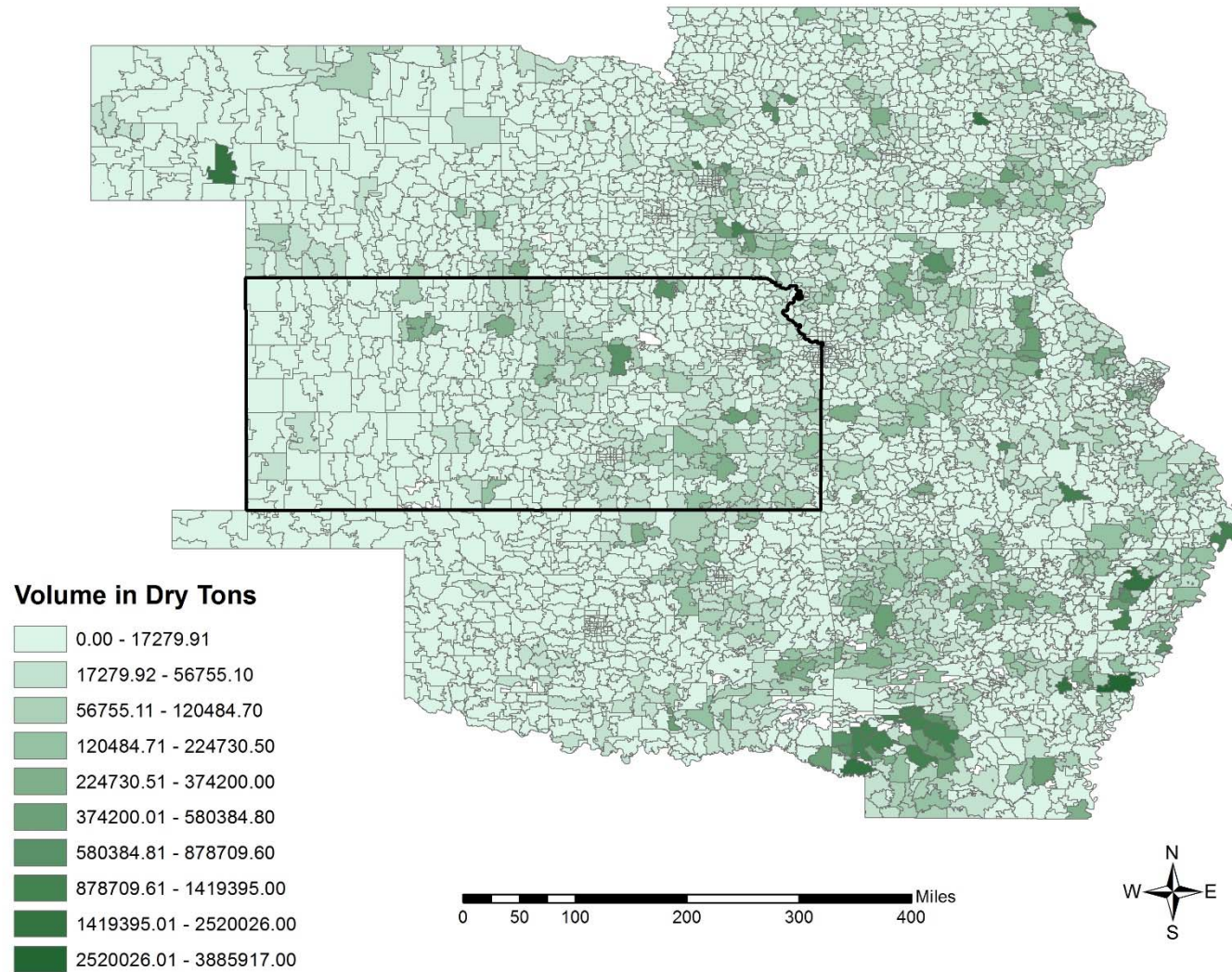


**Figure B9. Regional ZCTA map. Pulpwood Removals in Softwood in dry tons.**

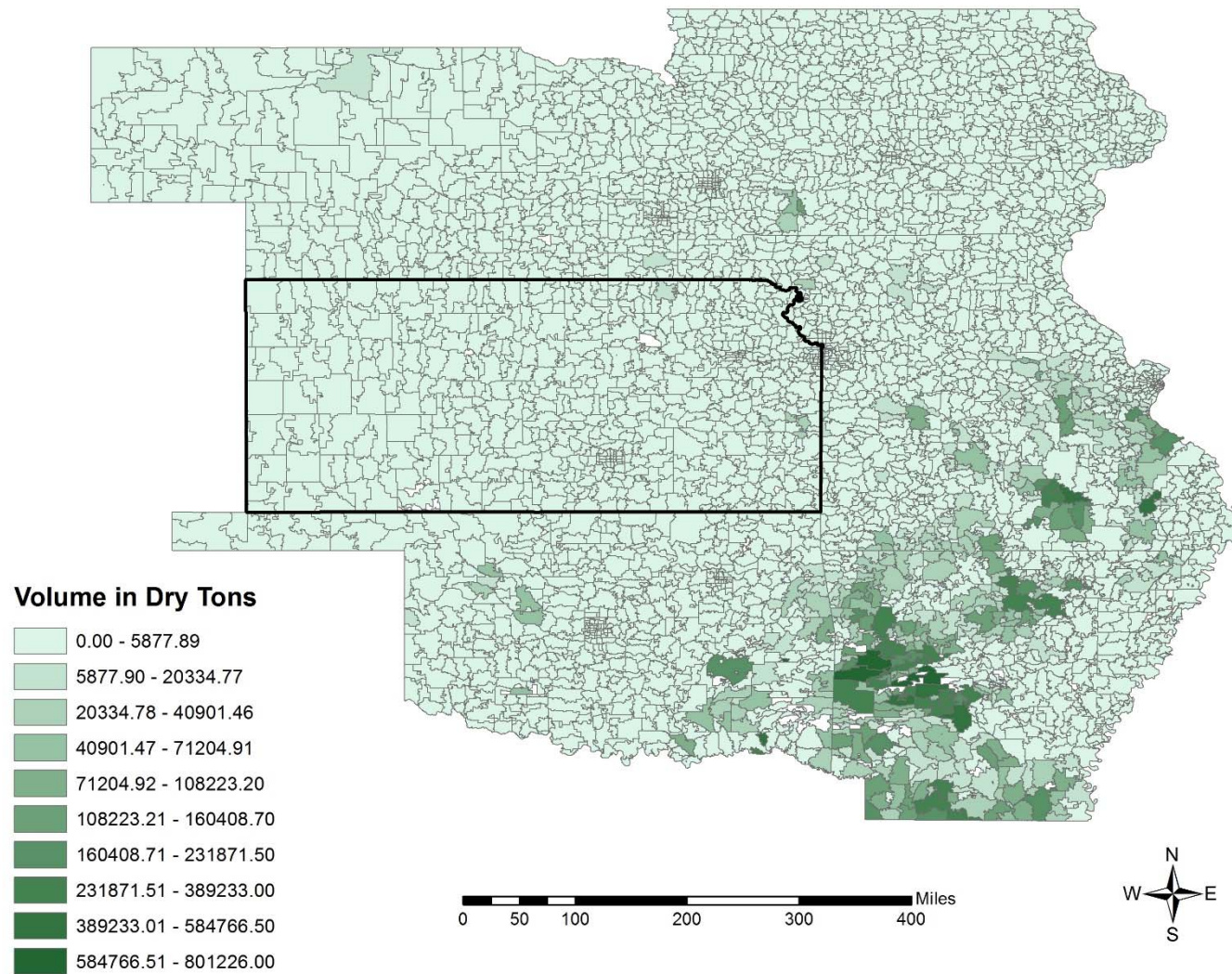


**Figure B10. Regional ZCTA map. Pulpwood Removals in Upland Hardwood in dry tons.**



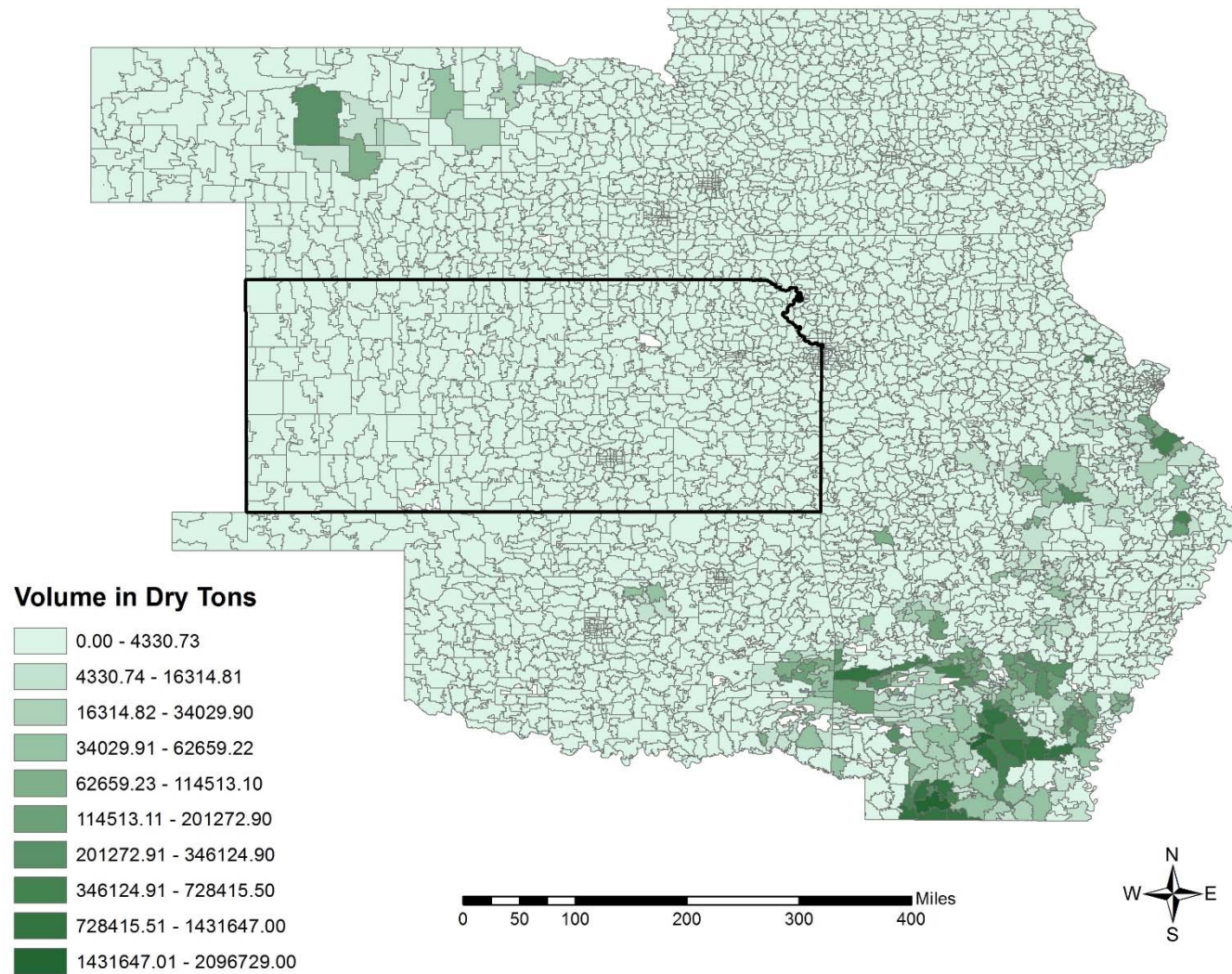


**Figure B11. Regional ZCTA map. Pulpwood Volume in Lowland Hardwood in dry tons.**

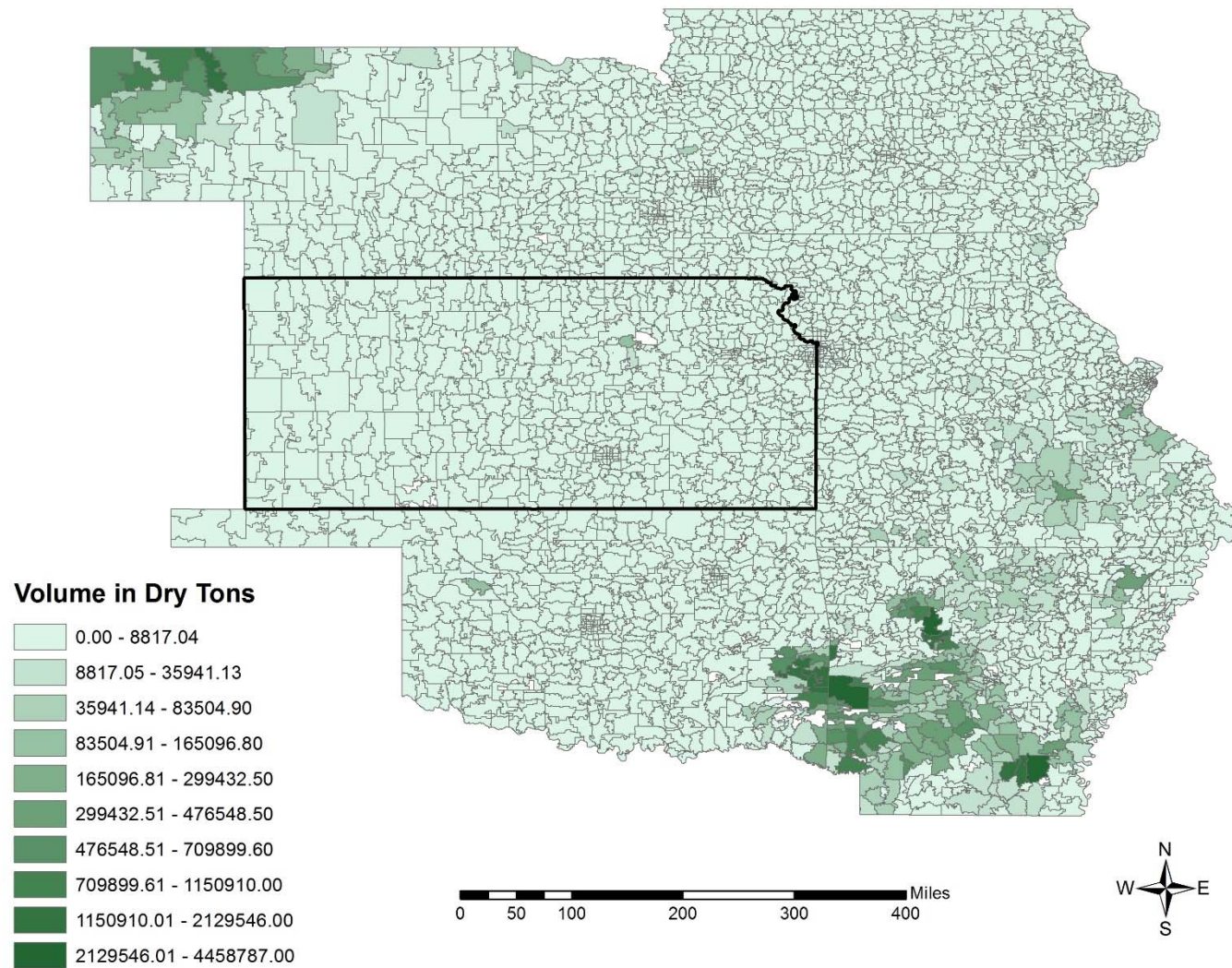


**Figure B12. Regional ZCTA map. Pulpwood Volume in Mixed Wood in dry tons.**



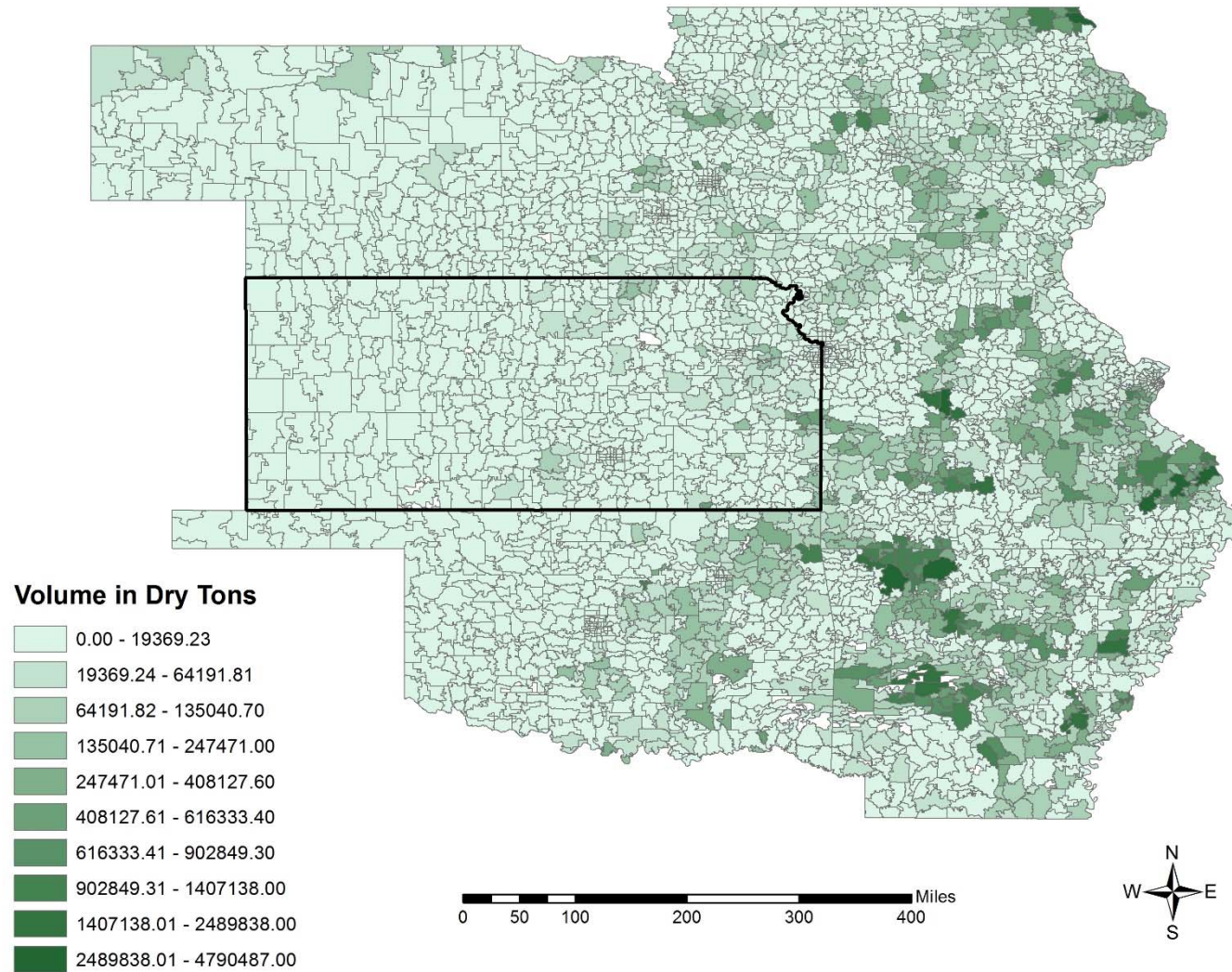


**Figure B13. Regional ZCTA map. Pulpwood Volume in Pine Plantations in dry tons.**

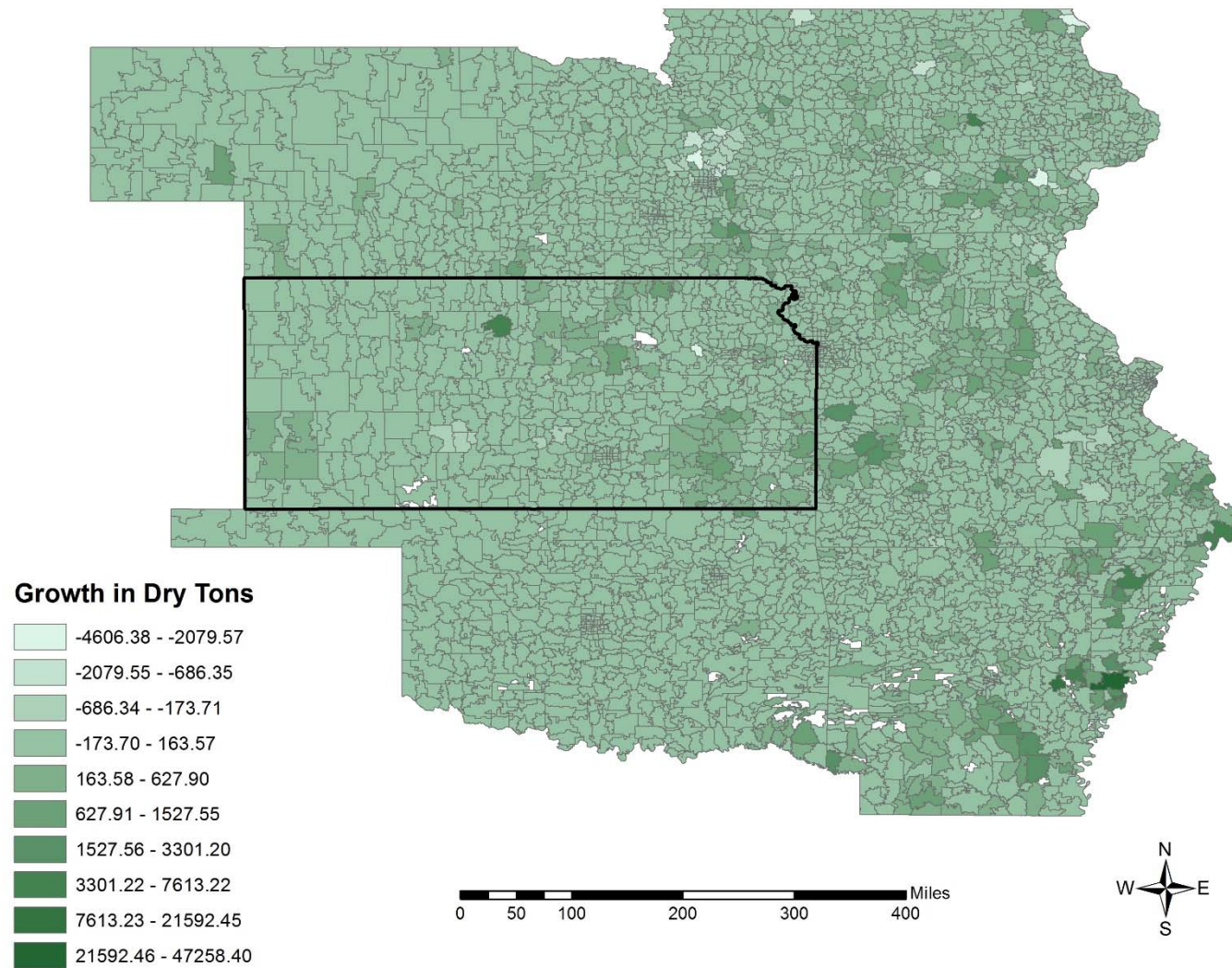


**Figure B14. Regional ZCTA map. Pulpwood Volume in Softwood in dry tons.**



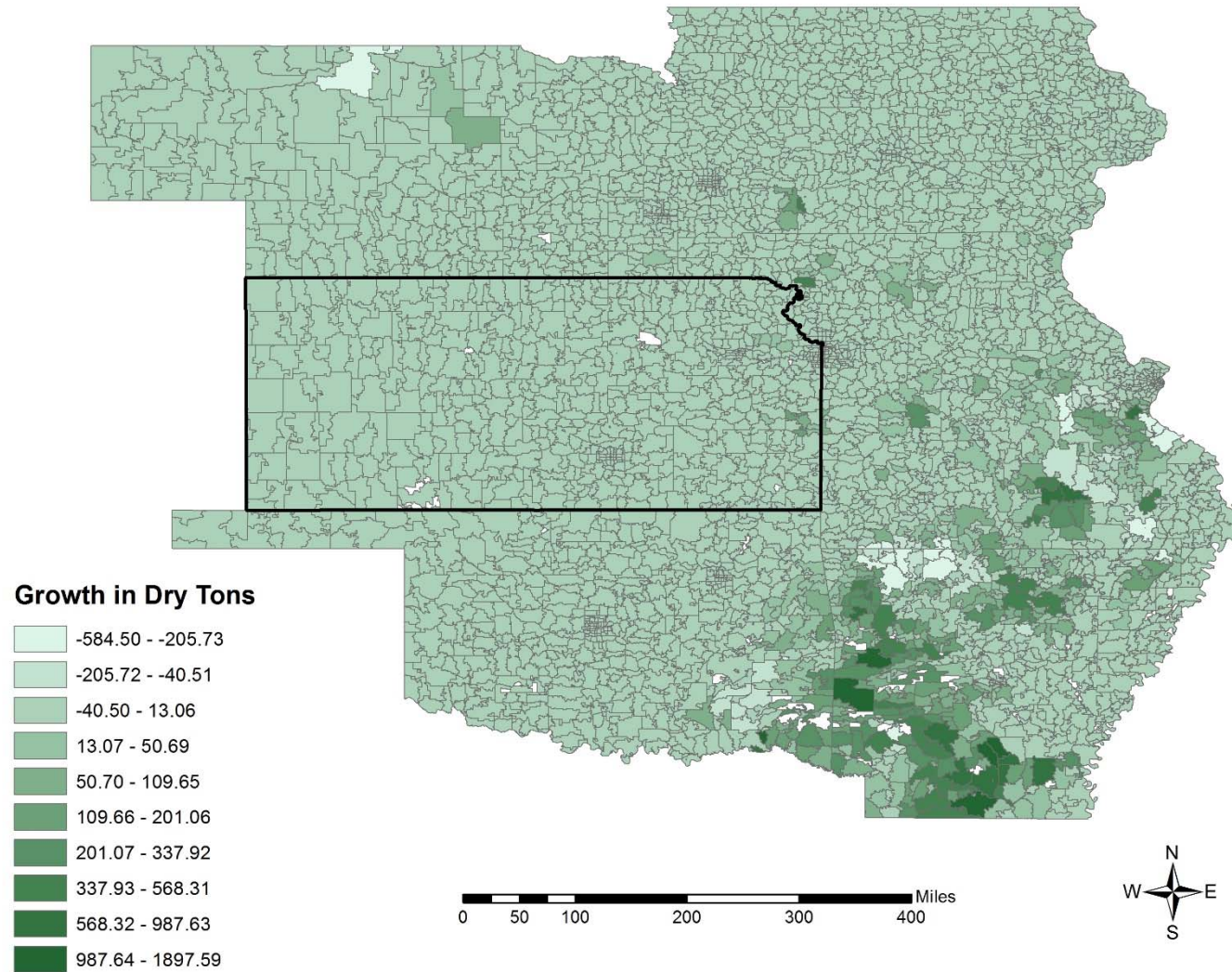


**Figure B15. Regional ZCTA map. Pulpwood Volume in Upland Hardwood in dry tons.**

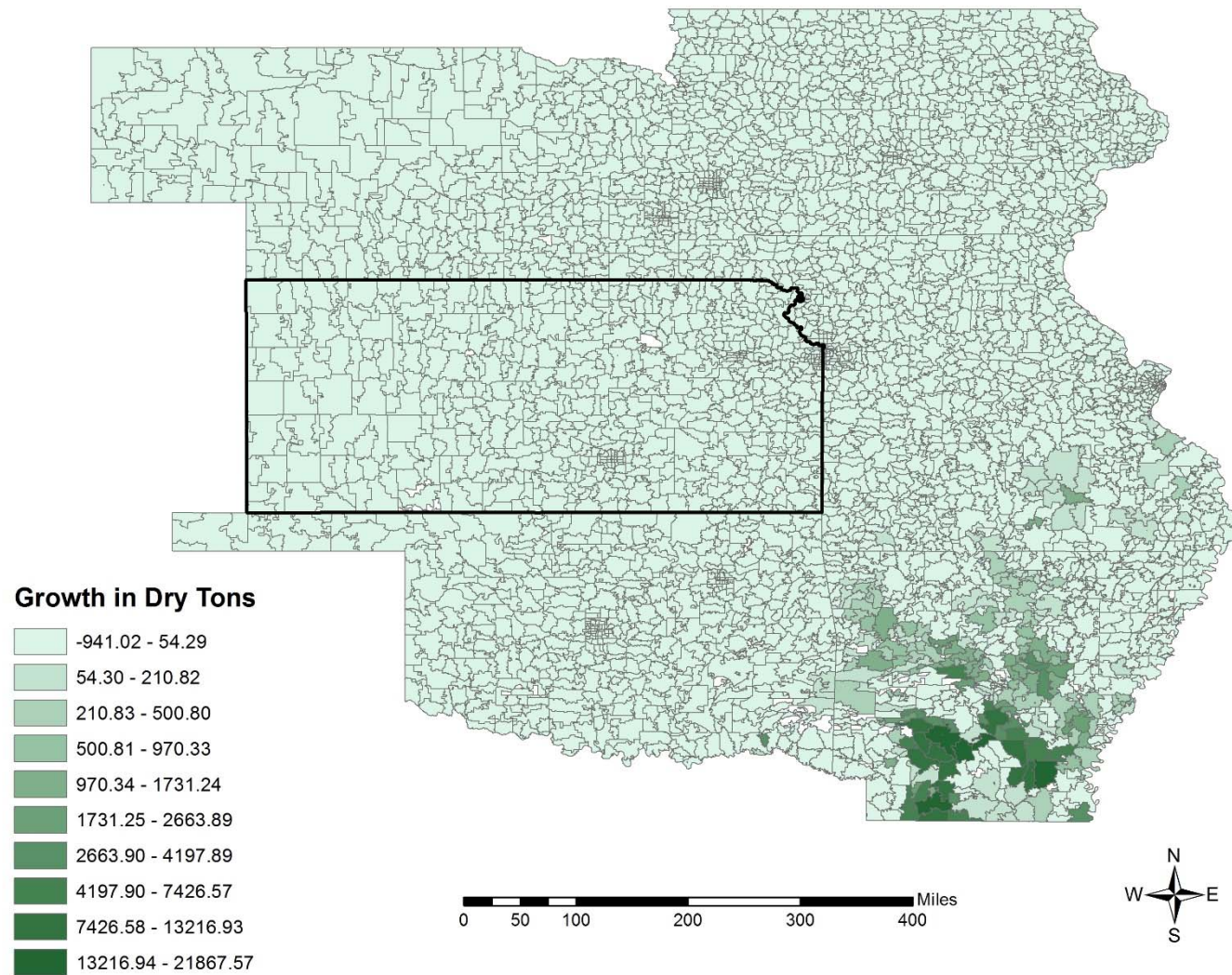


**Figure B16. Regional ZCTA map. Sawtimber Growth in Lowland Hardwood in dry tons.**



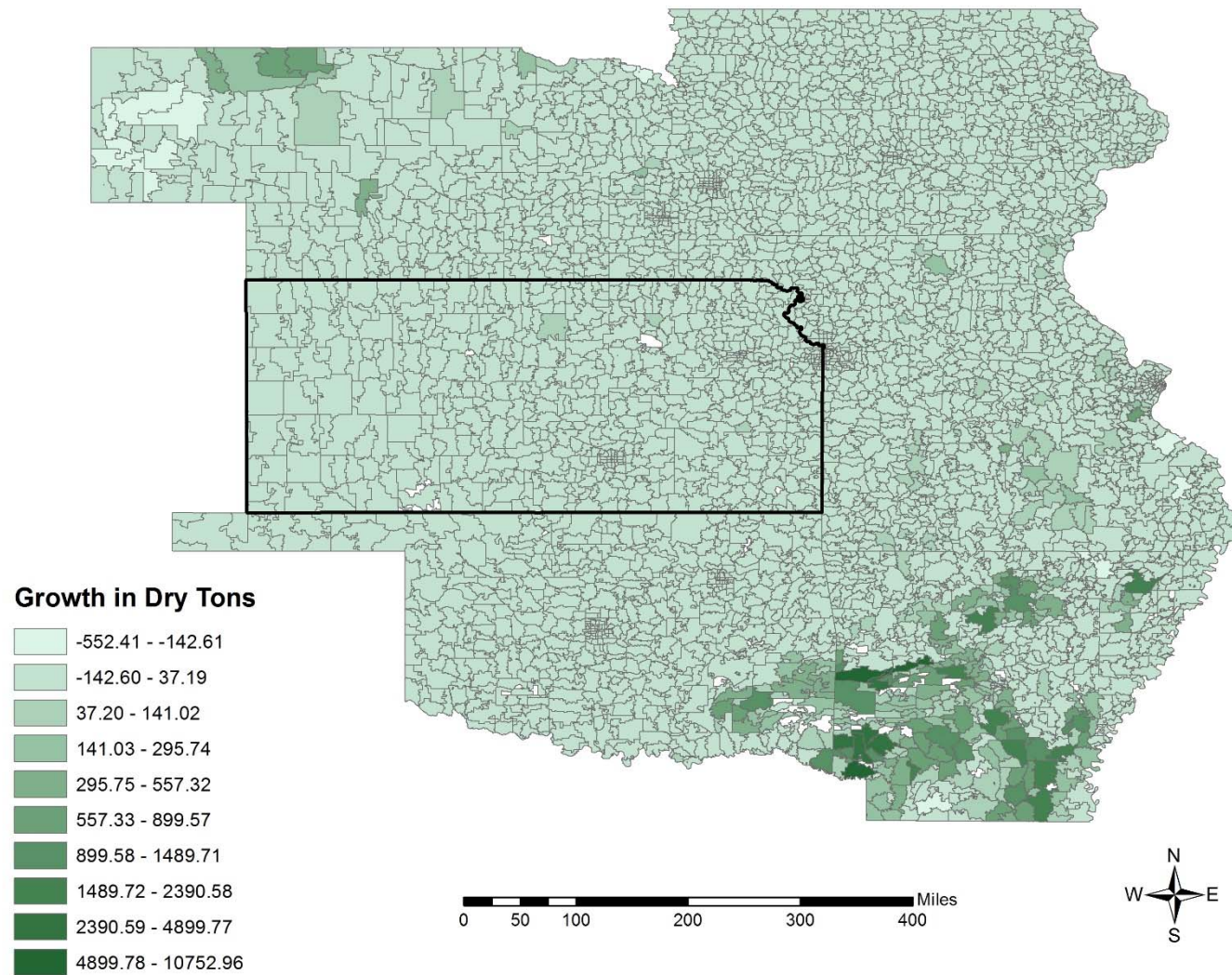


**Figure B17. Regional ZCTA map. Sawtimber Growth in Mixed Wood in dry tons.**

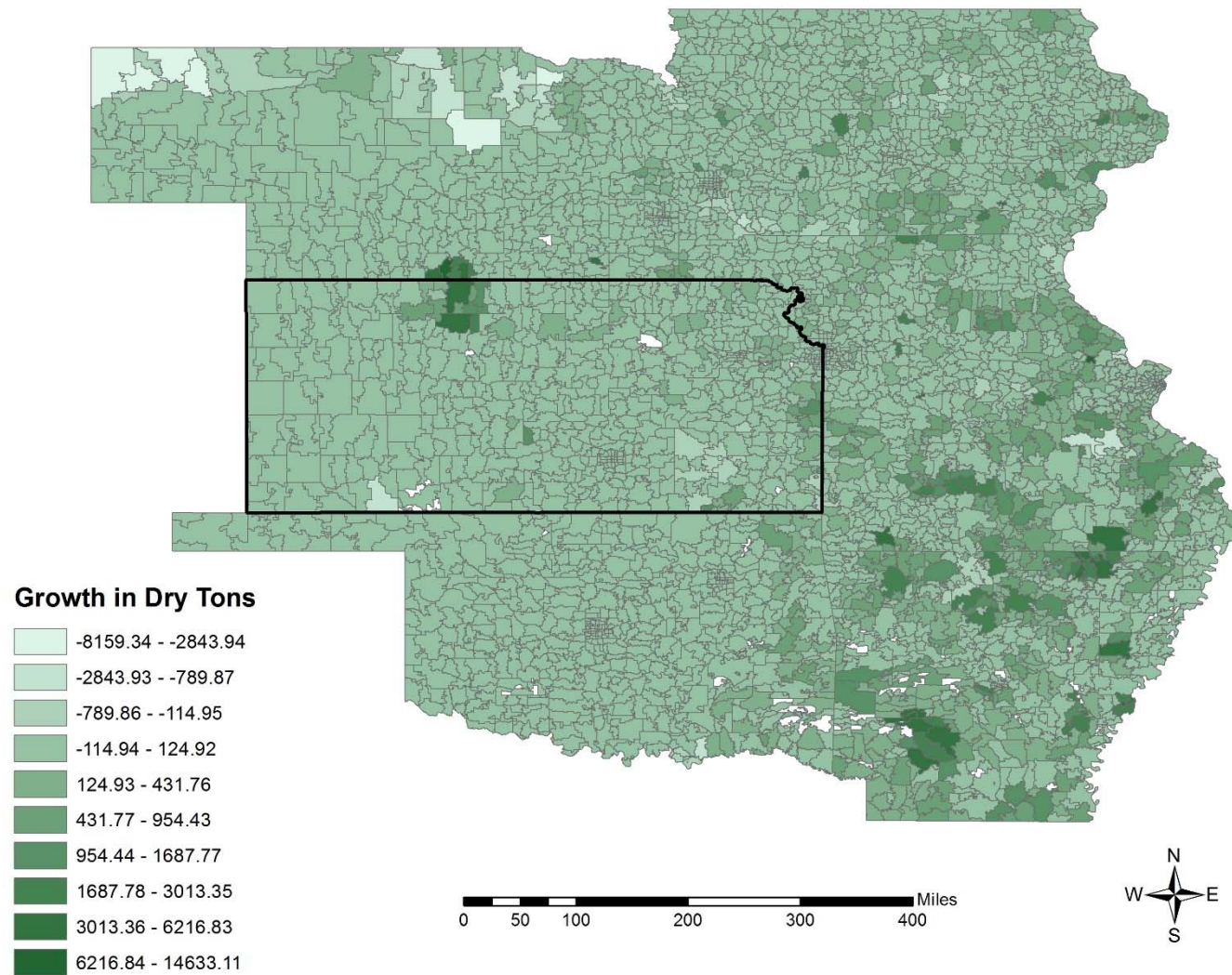


**Figure B18. Regional ZCTA map. Sawtimber Growth in Pine Plantations in dry tons.**



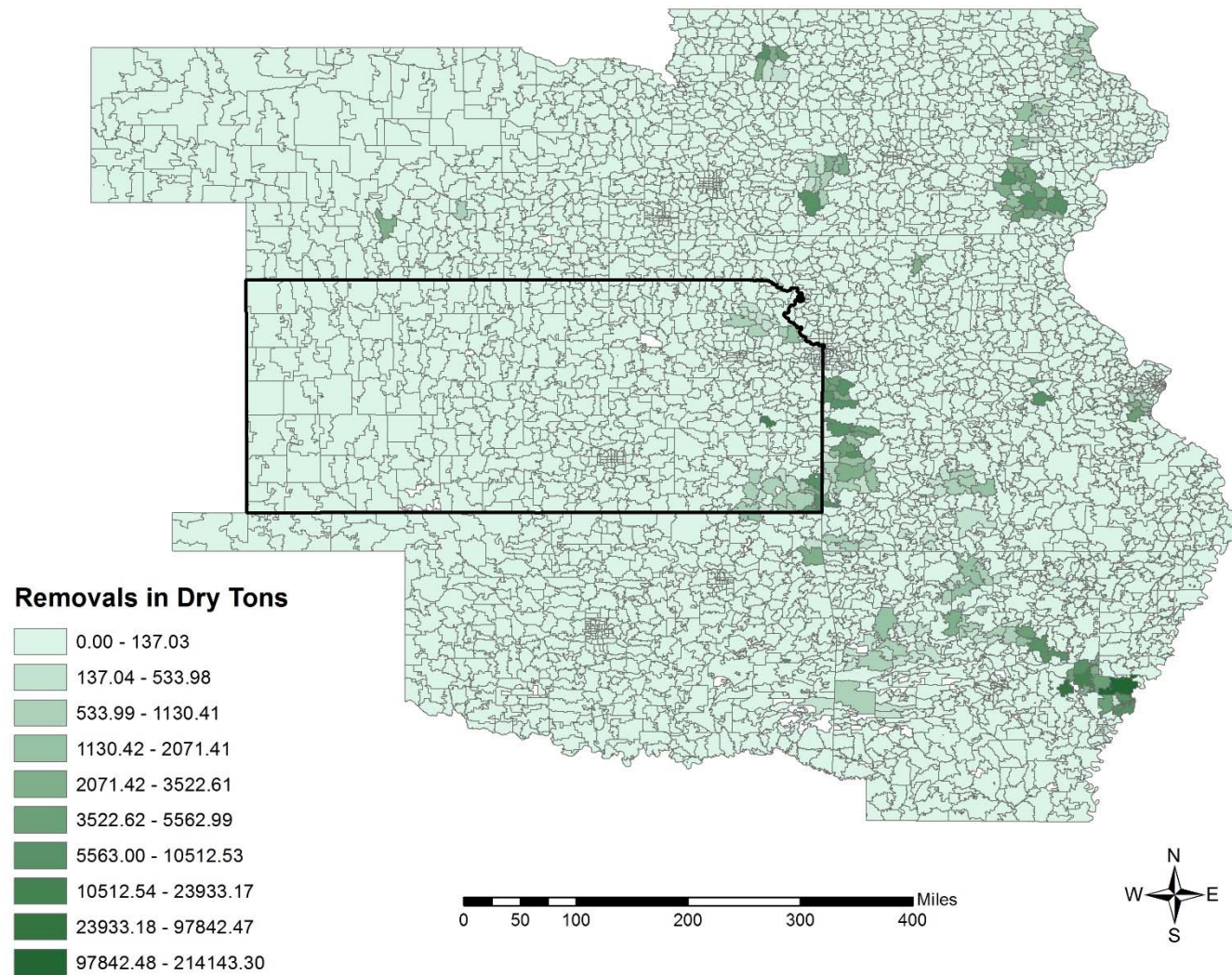


**Figure B19. Regional ZCTA map. Sawtimber Growth in Softwood in dry tons.**

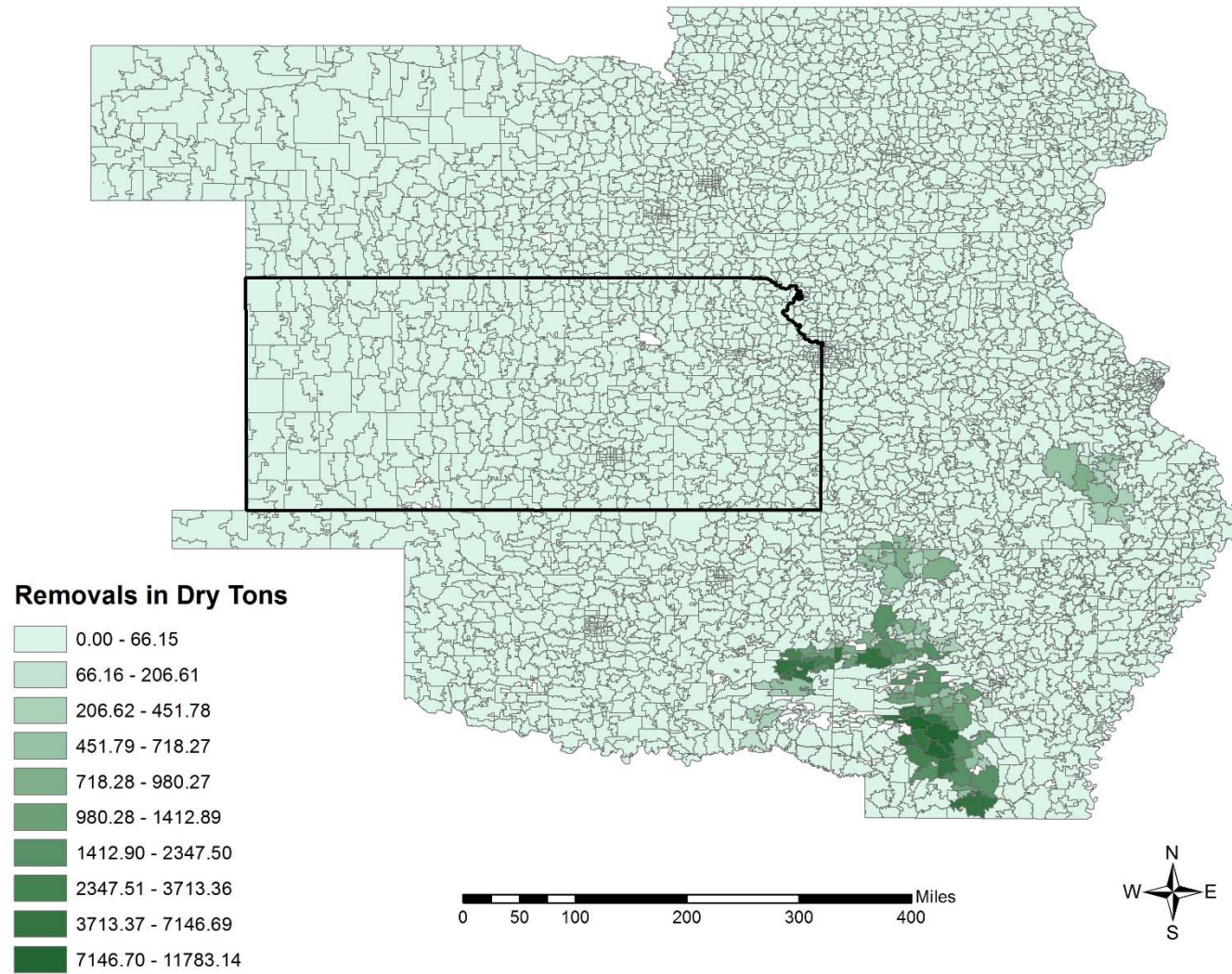


**Figure B20. Regional ZCTA map. Sawtimber Growth in Upland Hardwood in dry tons.**



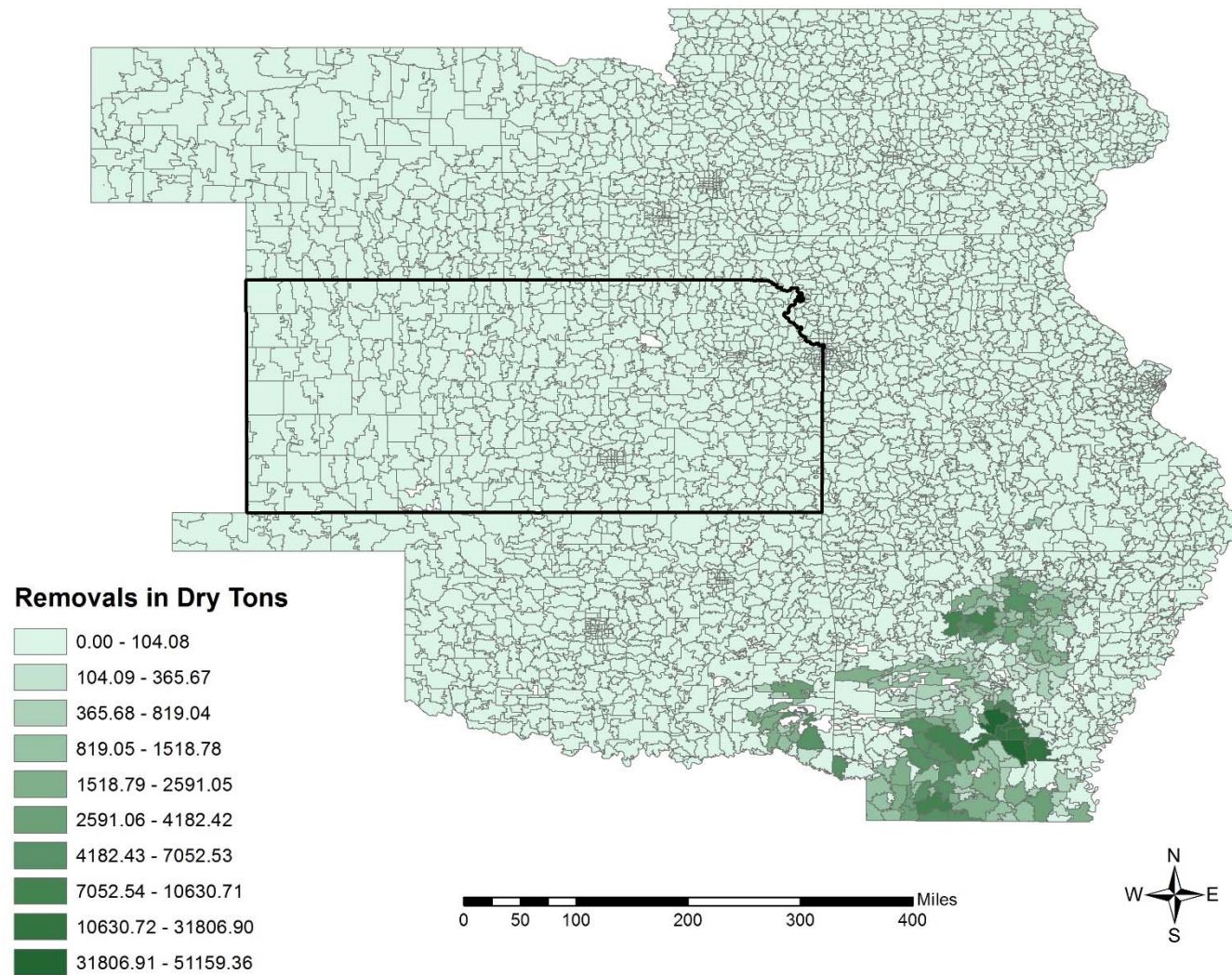


**Figure B21. Regional ZCTA map. Sawtimber Removals in Lowland Hardwood in dry tons.**

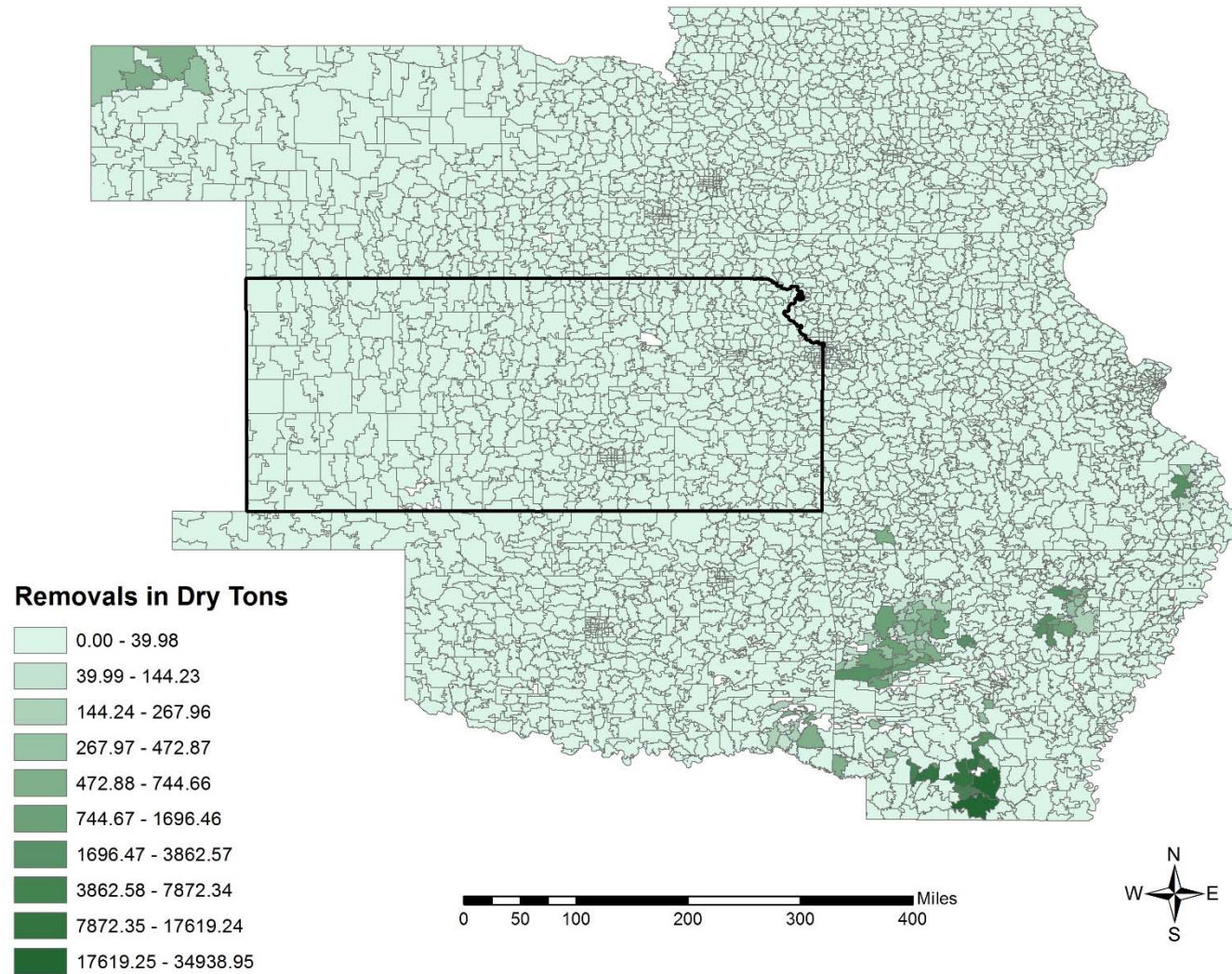


**Figure B22. Regional ZCTA map. Sawtimber Removals in Mixed Wood in dry tons.**



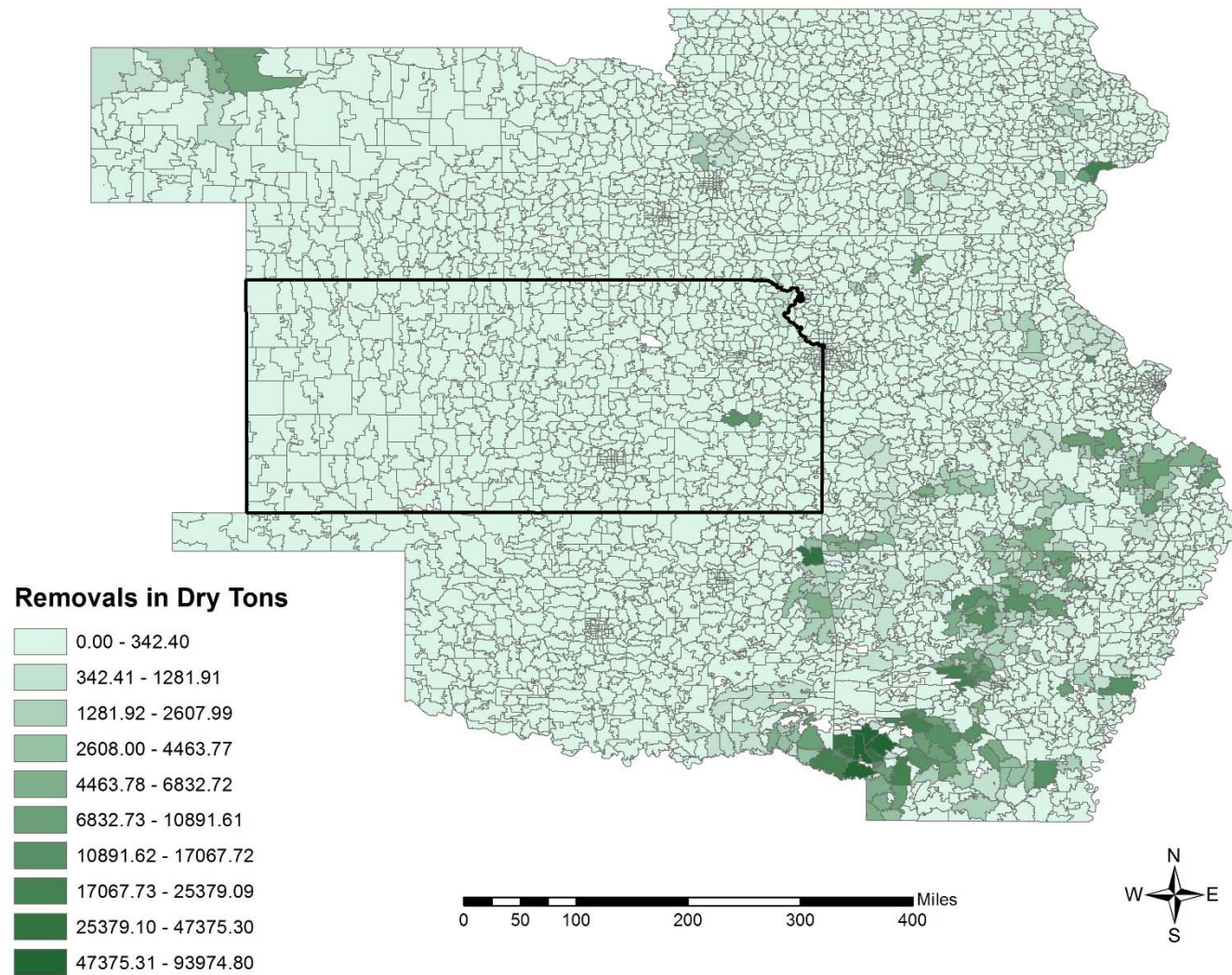


**Figure B23. Regional ZCTA map. Sawtimber Removals in Pine Plantations in dry tons.**

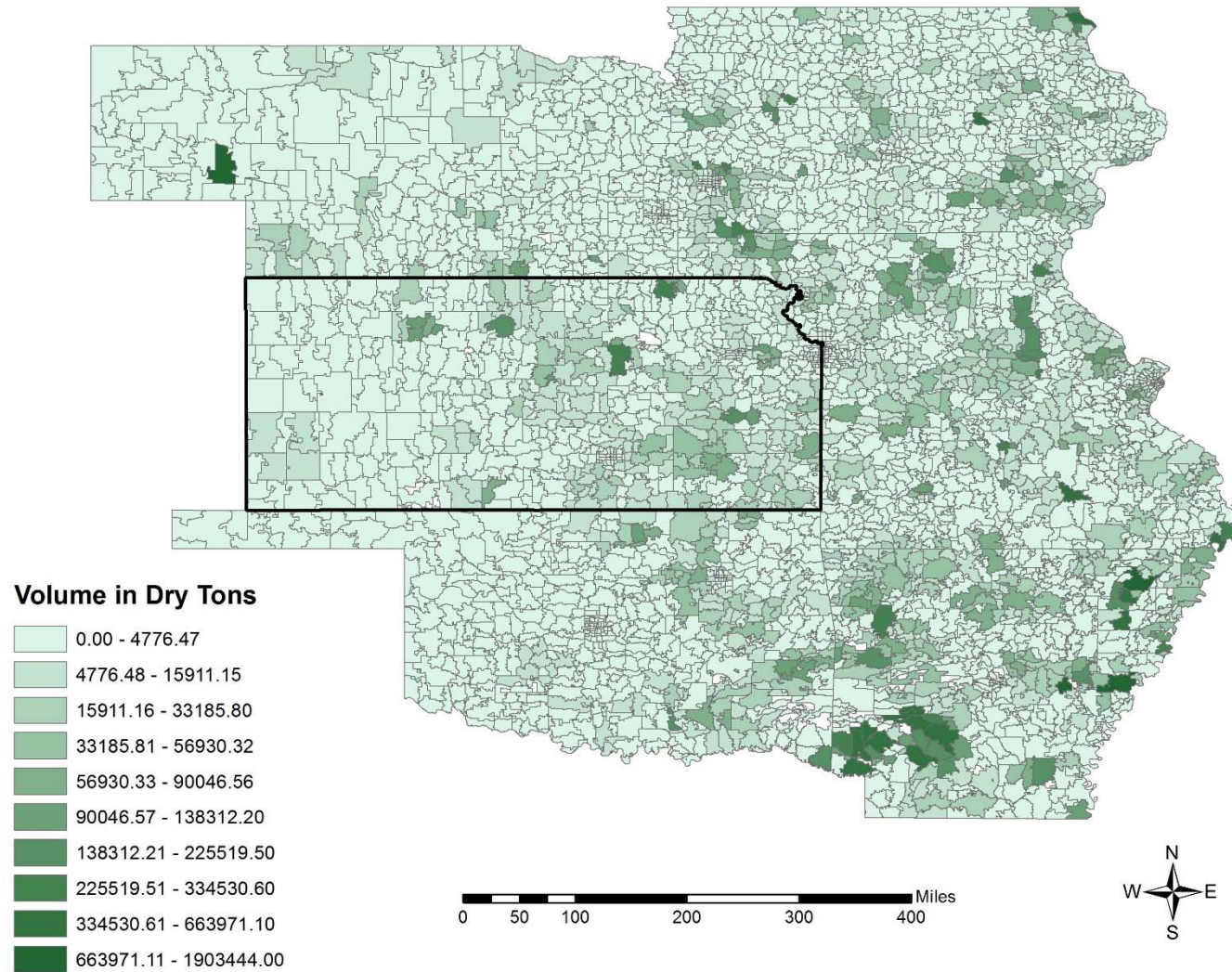


**Figure B24. Regional ZCTA map. Sawtimber Removals in Softwood in dry tons.**



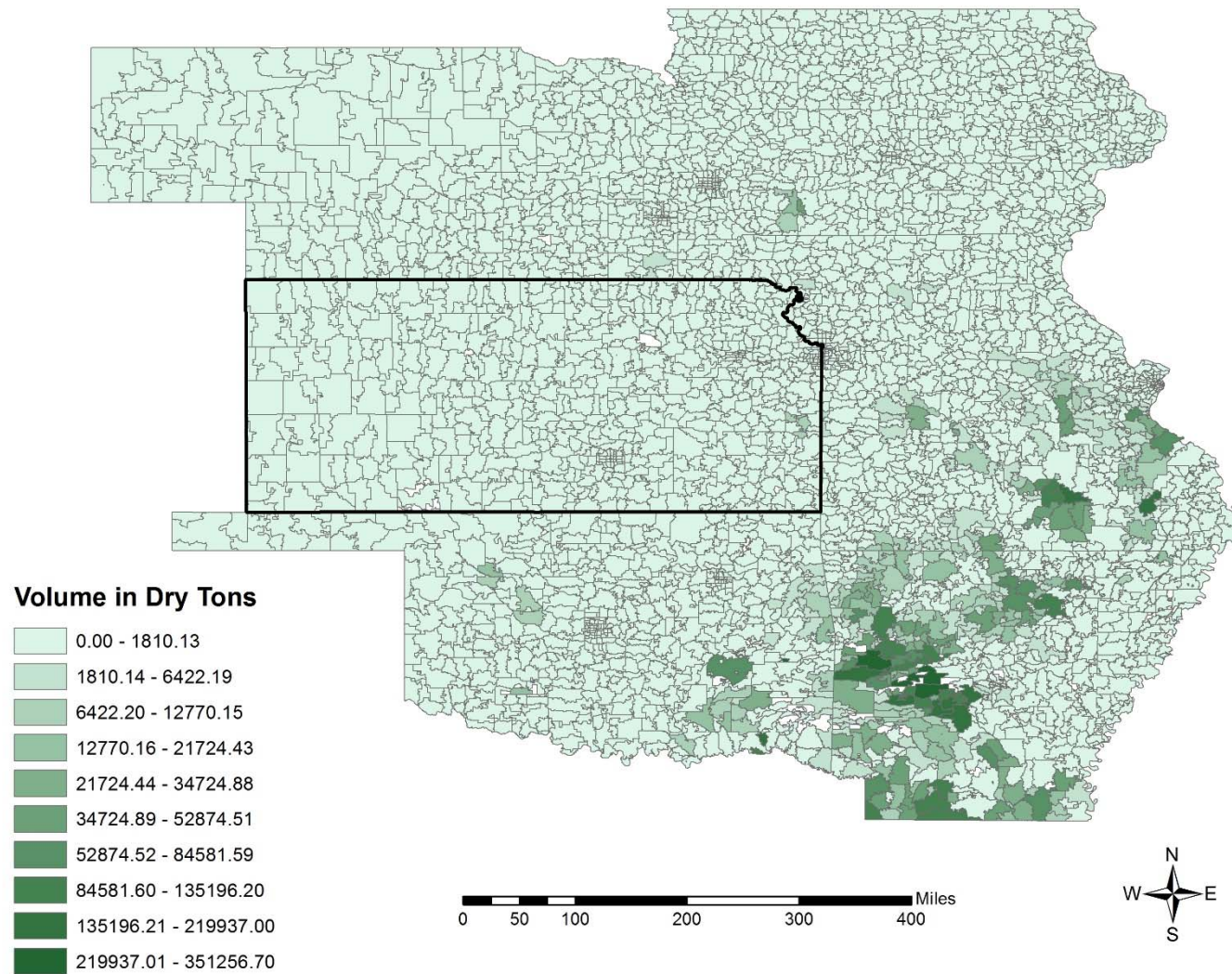


**Figure B25. Regional ZCTA map. Sawtimber Removals in Upland Hardwood in dry tons.**

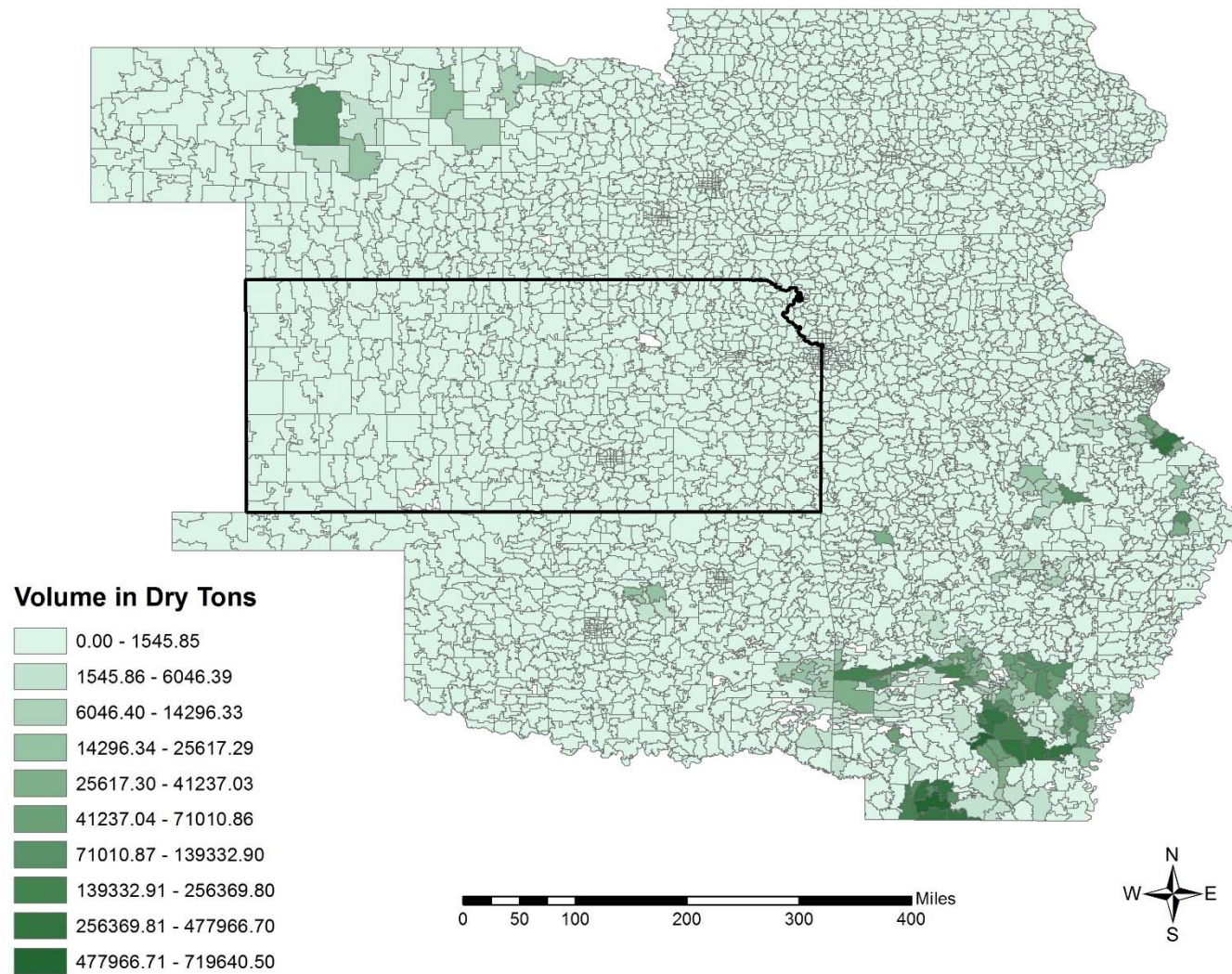


**Figure B26. Regional ZCTA map. Sawtimber Volume in Lowland Hardwood in dry tons.**



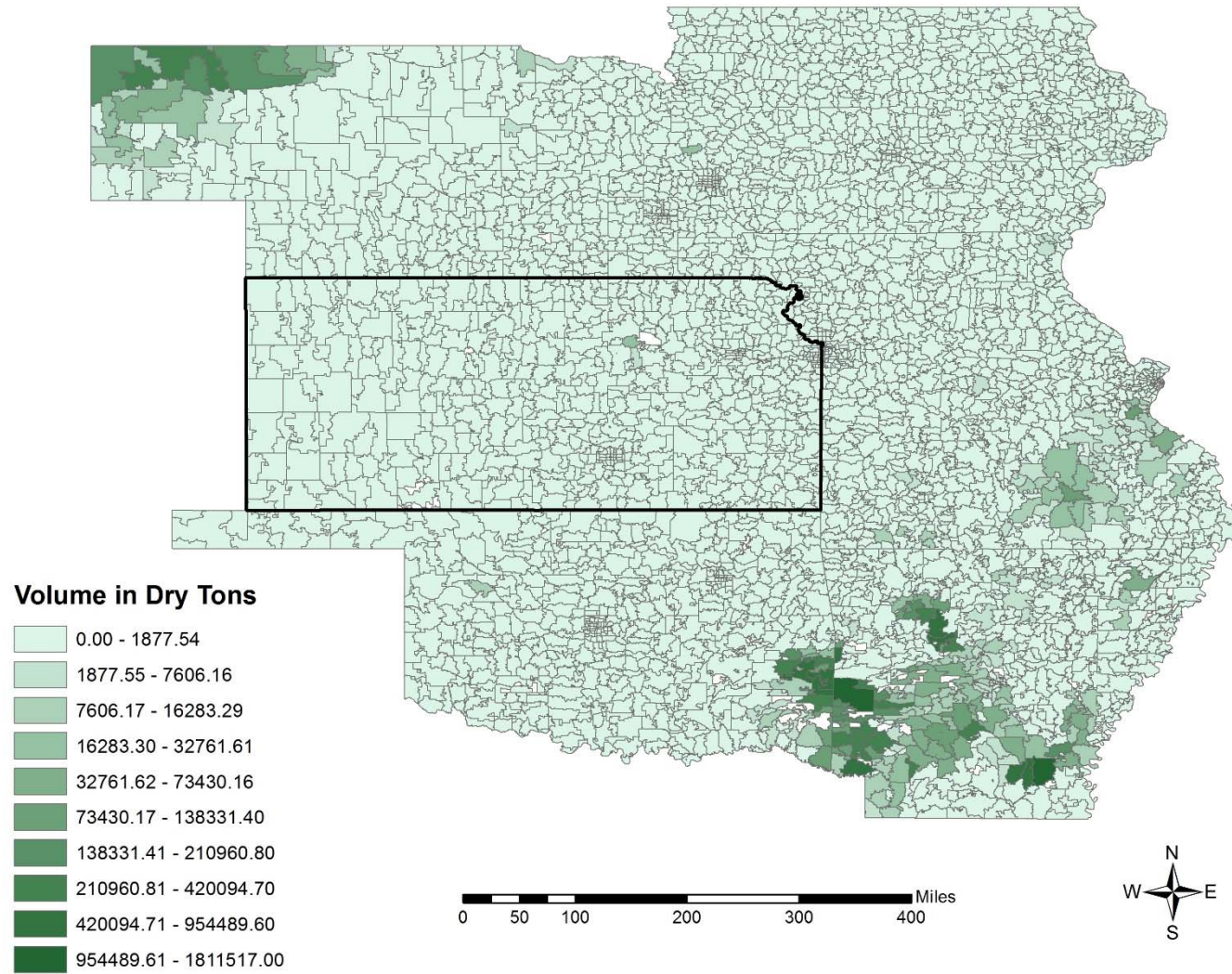


**Figure B27. Regional ZCTA map. Sawtimber Volume in Mixed Wood in dry tons.**

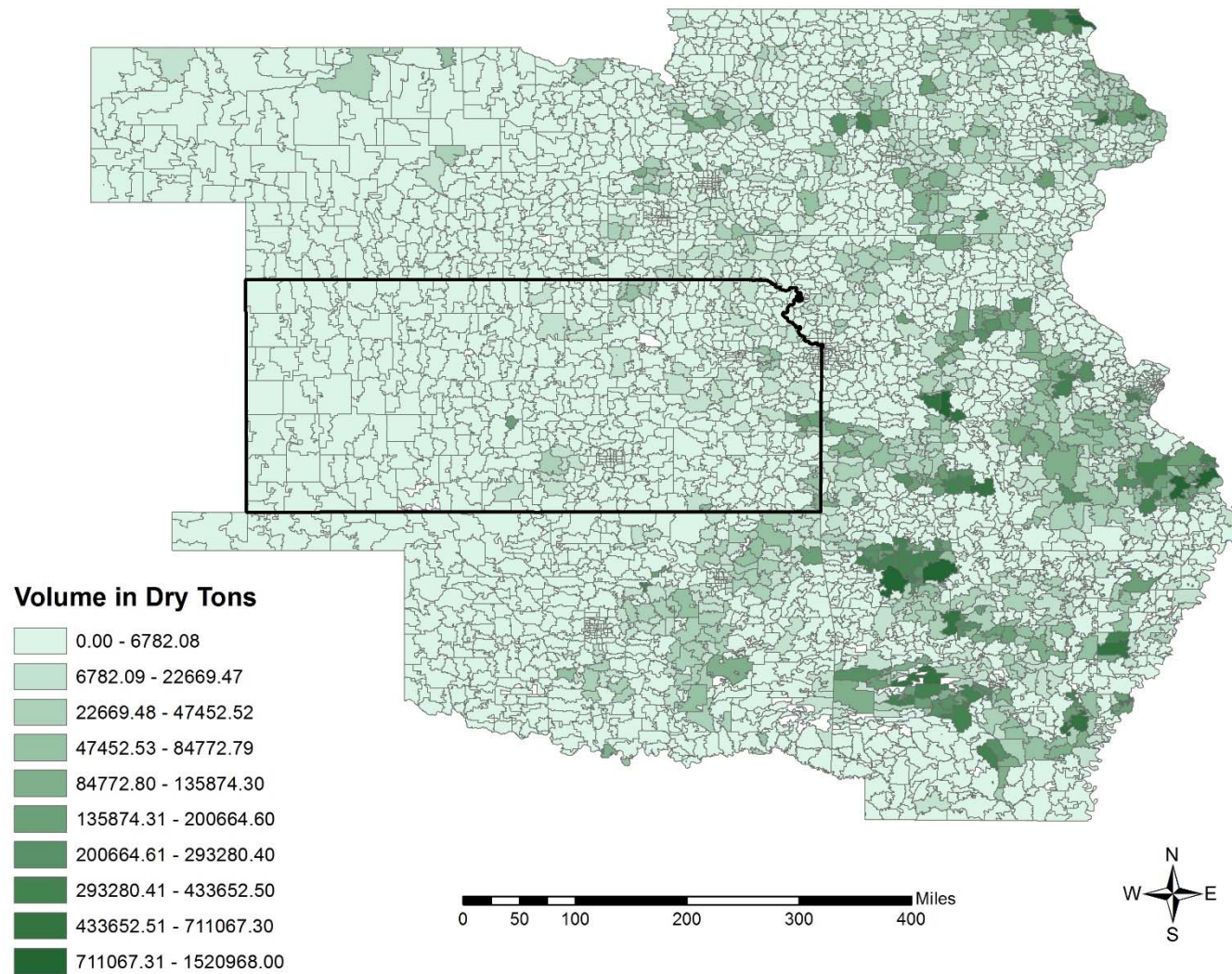


**Figure B28. Regional ZCTA map. Sawtimber Volume in Pine Plantations in dry tons.**





**Figure B29. Regional ZCTA map. Sawtimber Volume in Softwood in dry tons.**

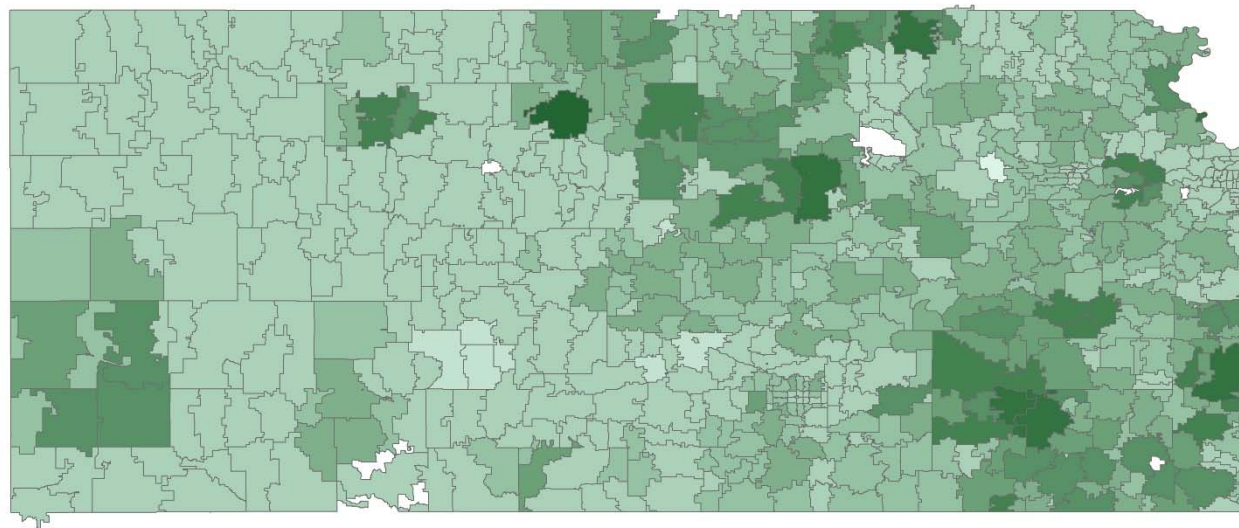


**Figure B30. Regional ZCTA map. Sawtimber Volume in Upland Hardwood in dry tons.**

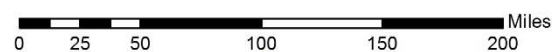
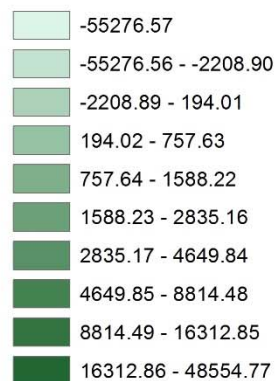
## **APPENDIX C**

Kansas ZCTA maps for Merchantable trees (roundwood). Pulpwood and sawtimber (growth, removals, and volume in pine plantations, lowland and upland hardwood, softwood and mixed wood).

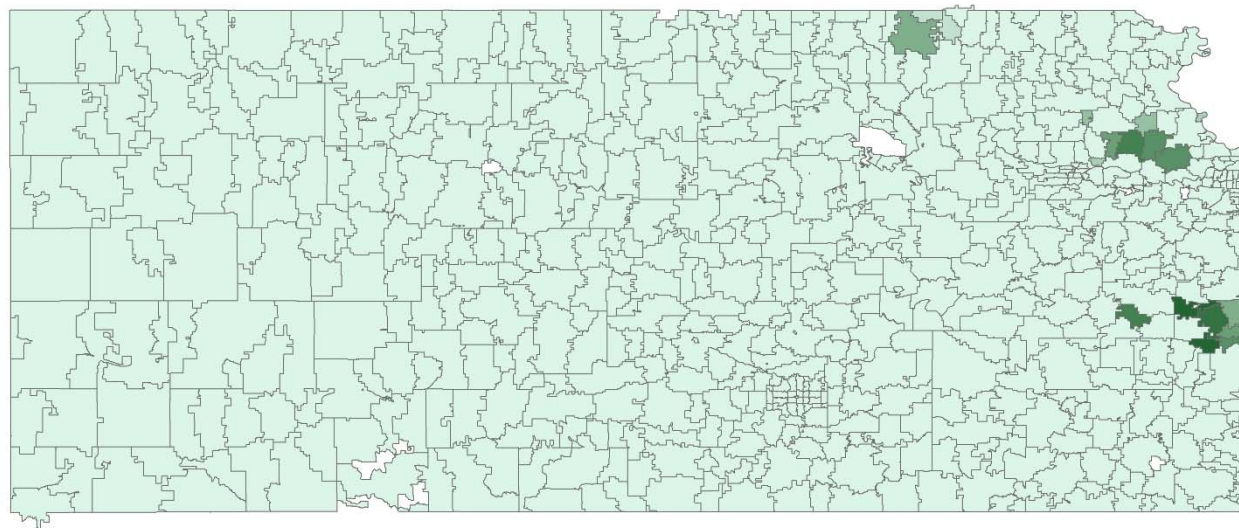




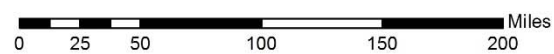
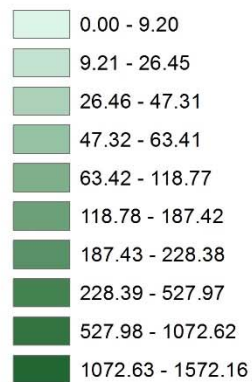
### Growth in Dry Tons



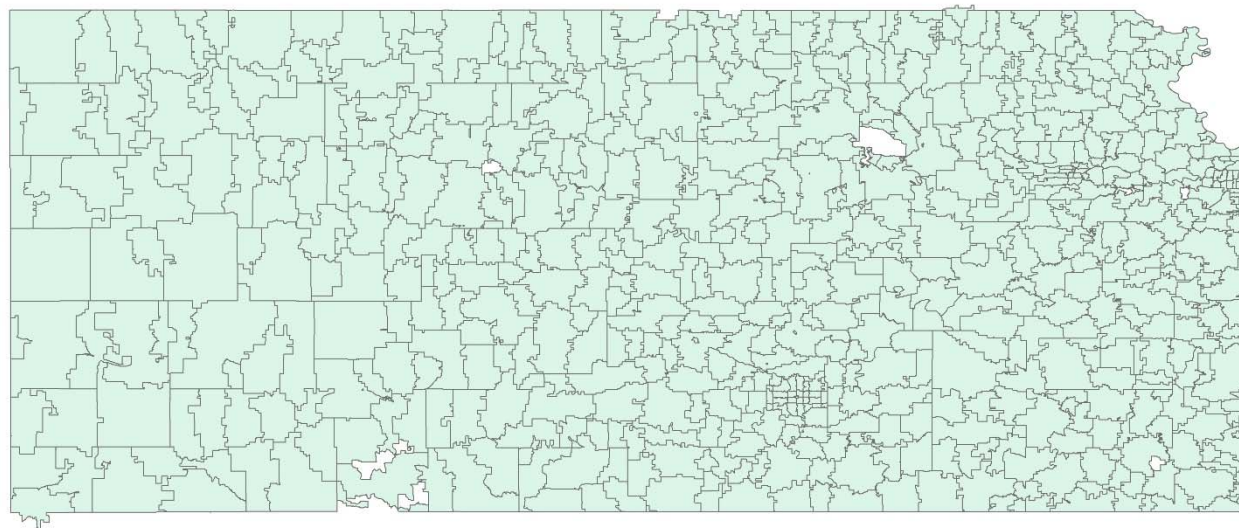
**Figure C1. Kansas ZCTA map. Pulpwood Growth in Lowland Hardwood in dry tons.**



### Growth in Dry Tons



**Figure C2. Kansas ZCTA map. Pulpwood Growth in Mixed Wood in dry tons.**



**Growth in Dry Tons**

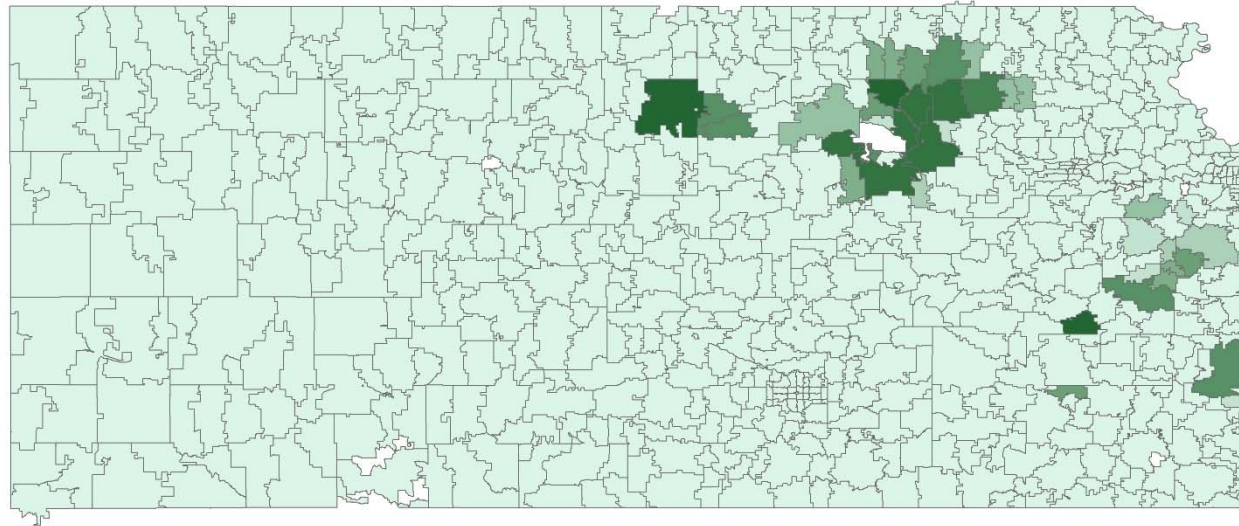
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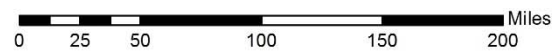
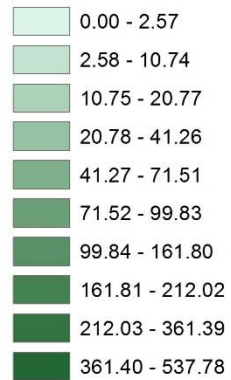
0 25 50 100 150 200 Miles



**Figure C3. Kansas ZCTA map. Pulpwood Growth in Pine Plantations in dry tons.**

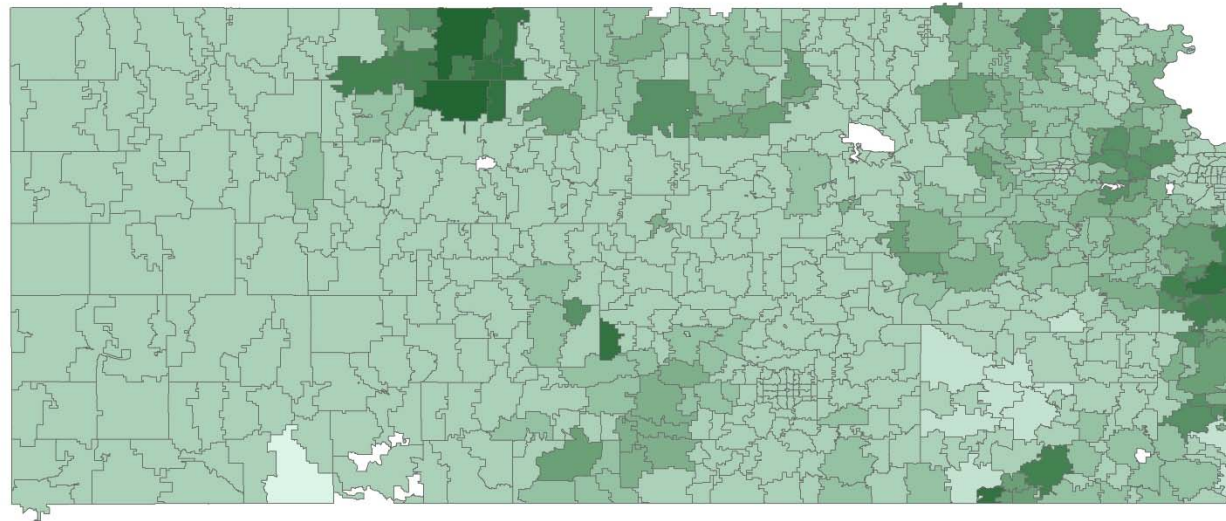


**Growth in Dry Tons**

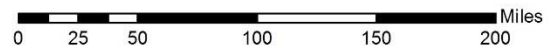
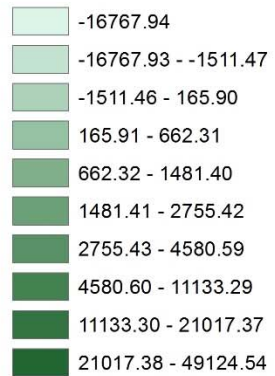


**Figure C4. Kansas ZCTA map. Pulpwood Growth in Softwood in dry tons.**

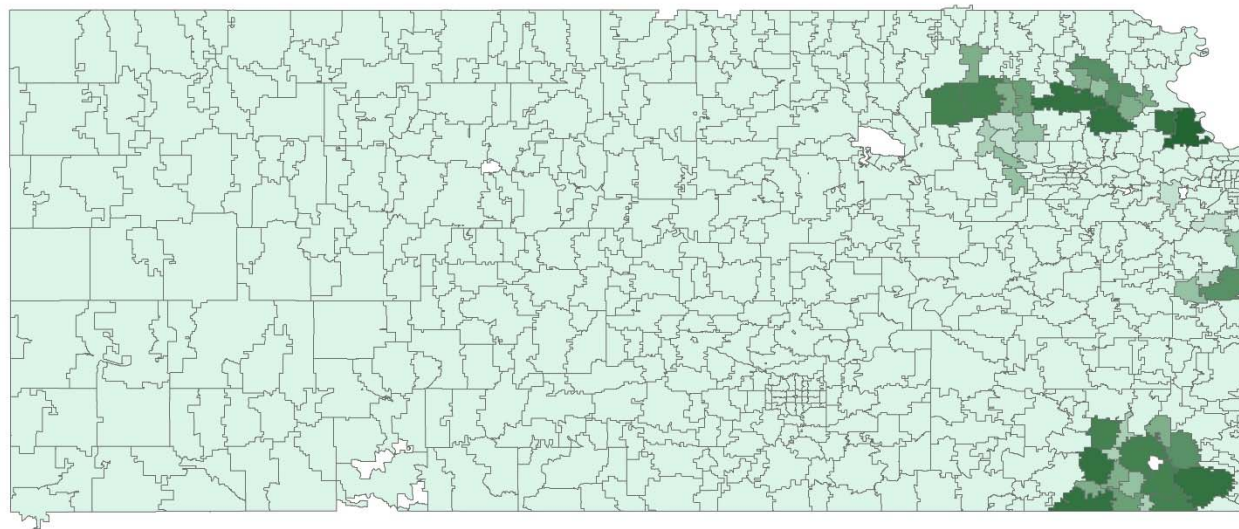




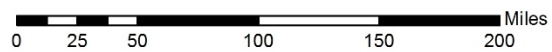
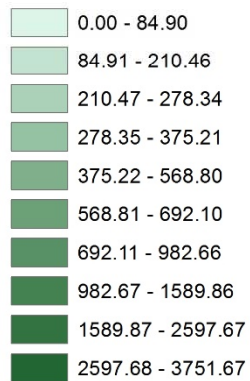
### Growth in Dry Tons



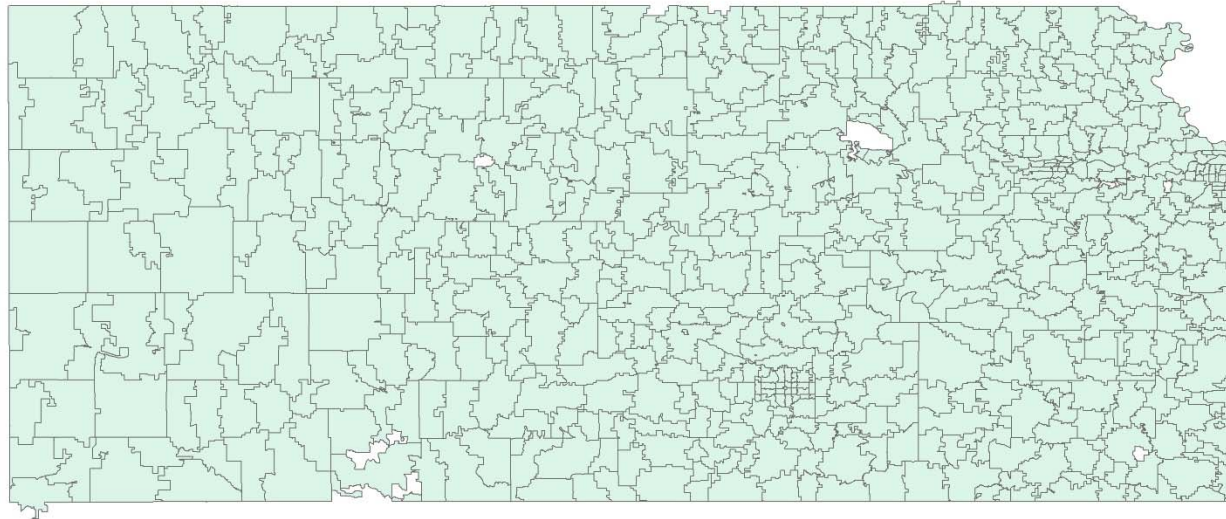
**Figure C5. Kansas ZCTA map. Pulpwood Growth in Upland Hardwood in dry tons.**



**Removals in Dry Tons**



**Figure C6. Kansas ZCTA map. Pulpwood Removals in Lowland Hardwood in dry tons.**



**Removals in Dry Tons**

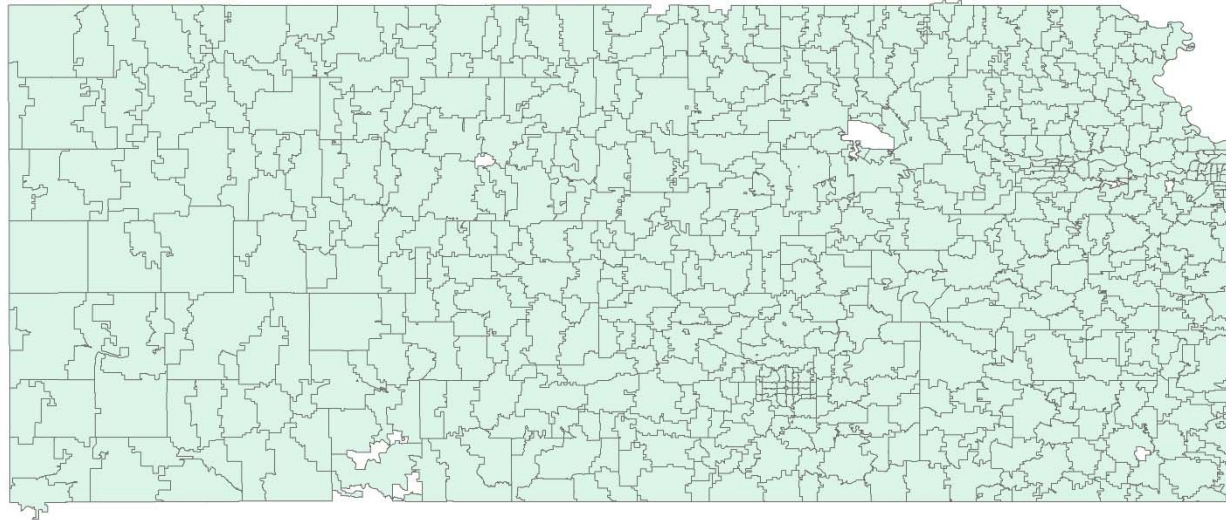
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0 25 50 100 150 200 Miles



**Figure C7. Kansas ZCTA map. Pulpwood Removals in Mixed Wood in dry tons.**





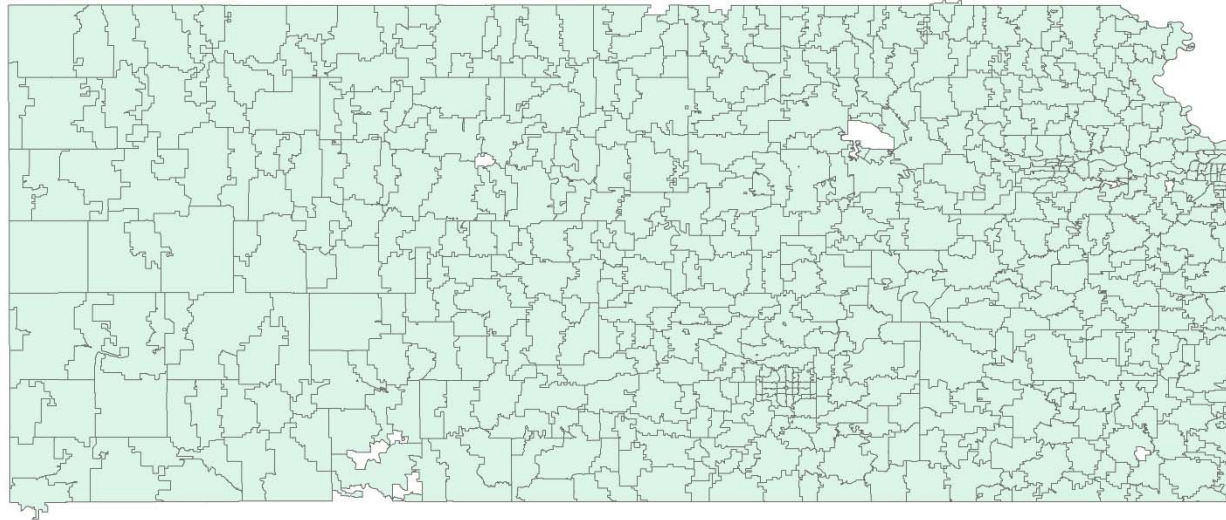
**Removals in Dry Tons**

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**Figure C8. Kansas ZCTA map. Pulpwood Removals in Pine Plantations in dry tons.**



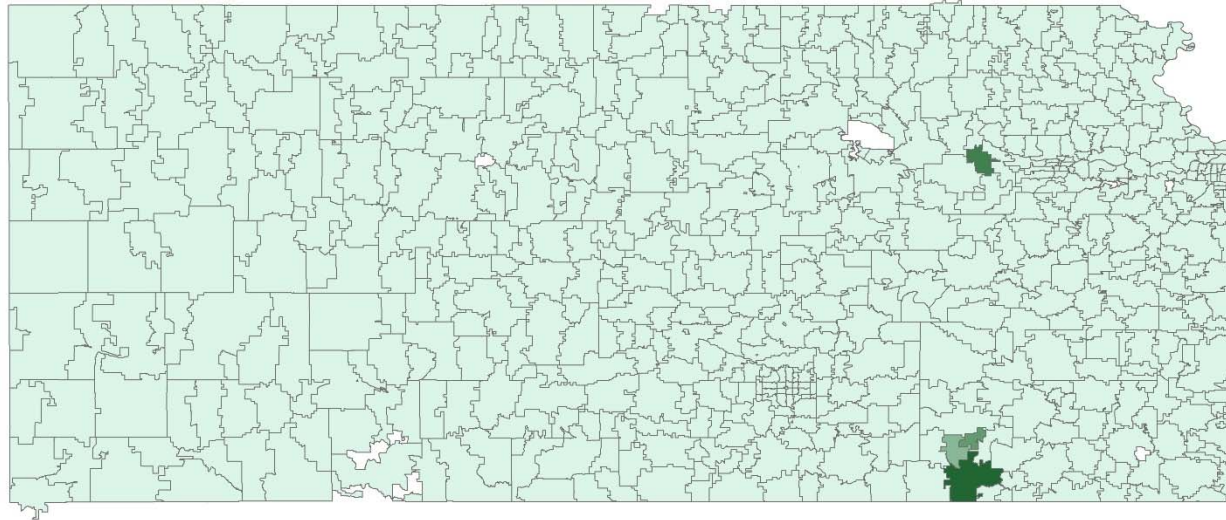
**Removals in Dry Tons**

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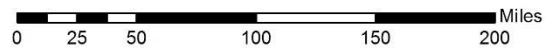
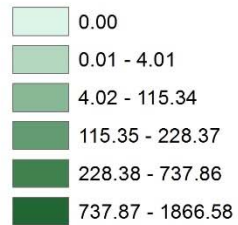
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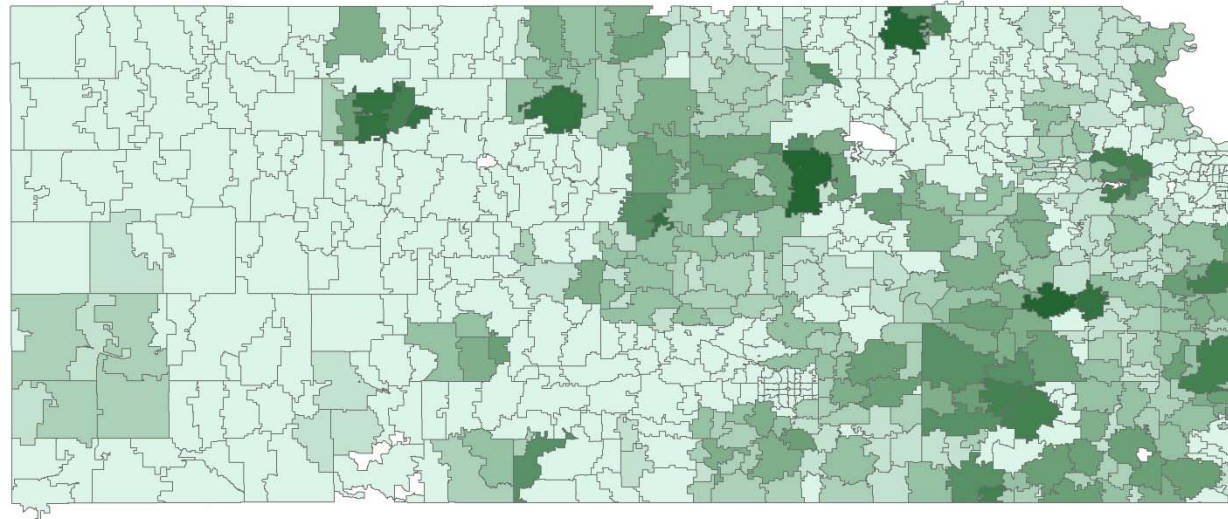
**Figure C9. Kansas ZCTA map. Pulpwood Removals in Softwood in dry tons.**



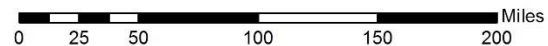
**Removals in Dry Tons**



**Figure C10. Kansas ZCTA map. Pulpwood Removals in Upland Hardwood in dry tons.**

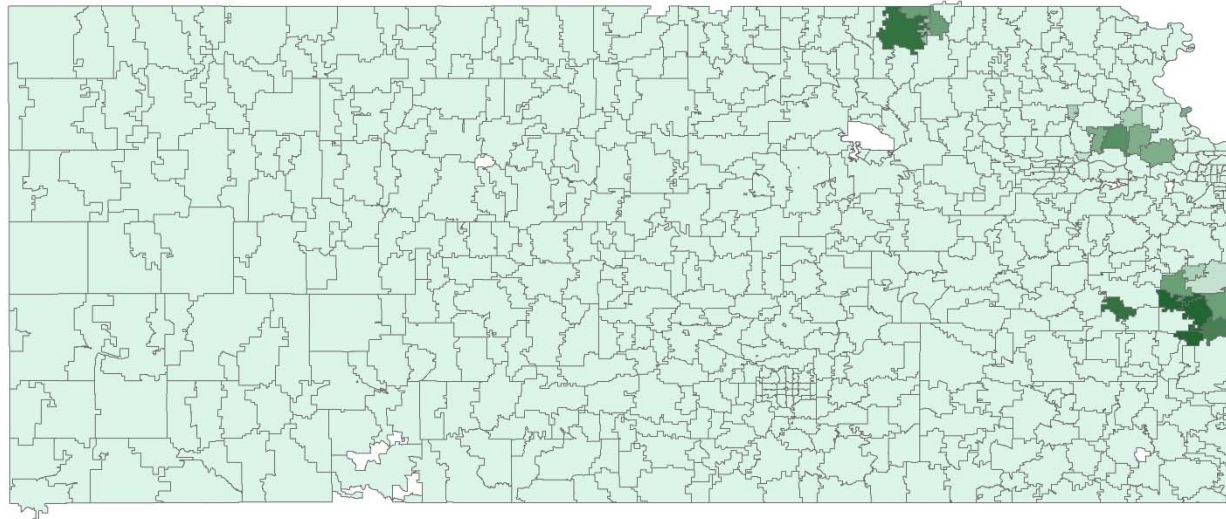


**Volume in Dry Tons**

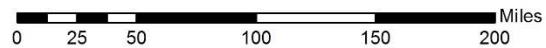
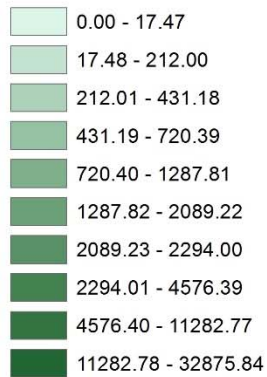


**Figure C11. Kansas ZCTA map. Pulpwood Volume in Lowland Hardwood in dry tons.**

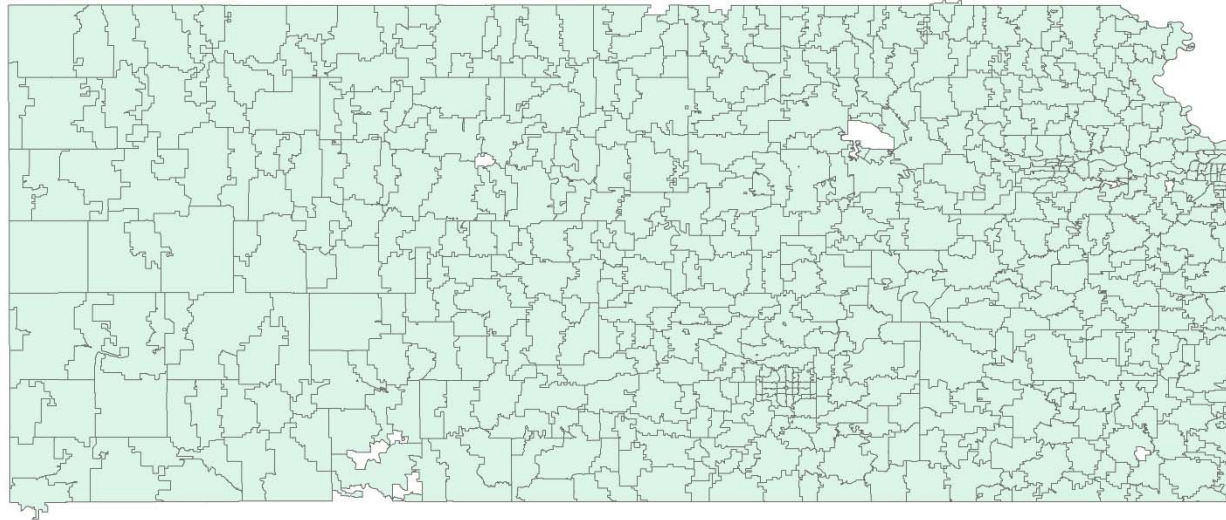




**Volume in Dry Tons**



**Figure C12. Kansas ZCTA map. Pulpwood Volume in Mixed Wood in dry tons.**



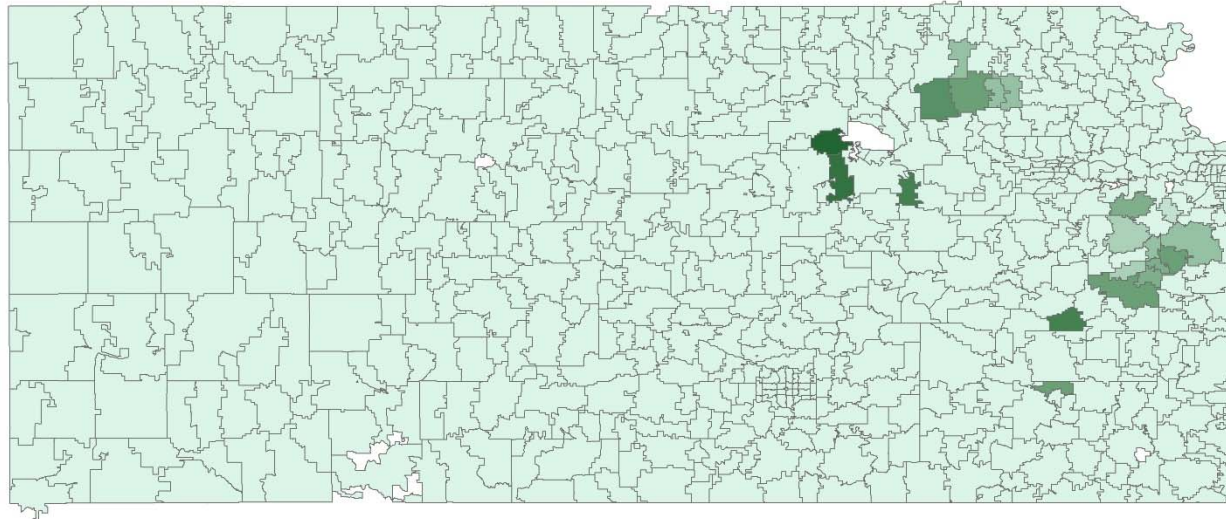
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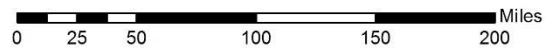
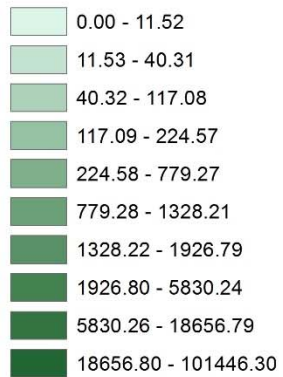
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**Figure C13. Kansas ZCTA map. Pulpwood Volume in Pine Plantations in dry tons.**

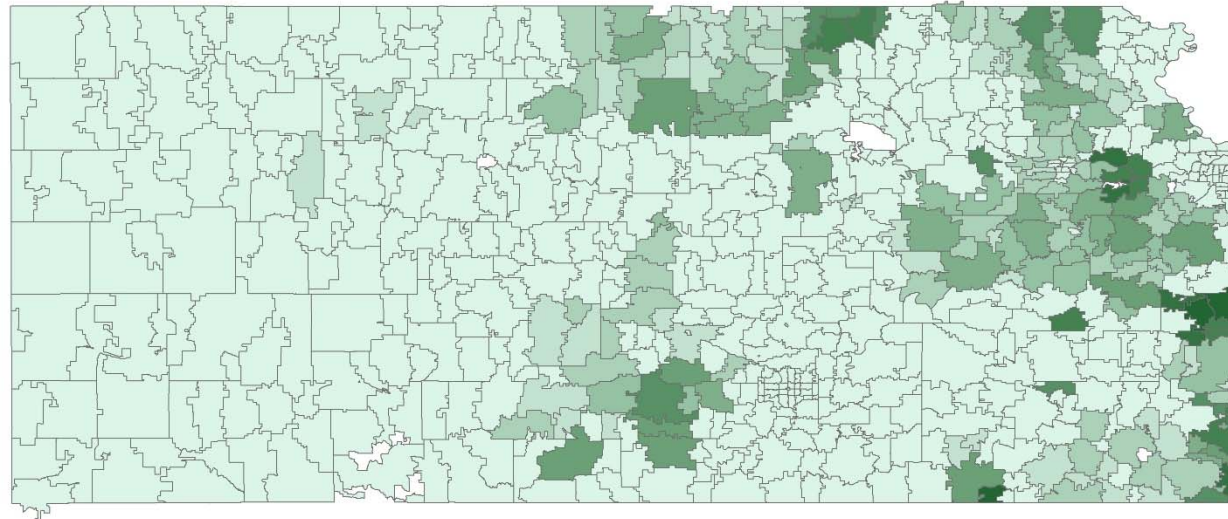


**Volume in Dry Tons**

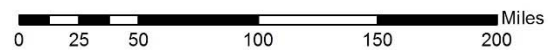


**Figure C14. Kansas ZCTA map. Pulpwood Volume in Softwood in dry tons.**

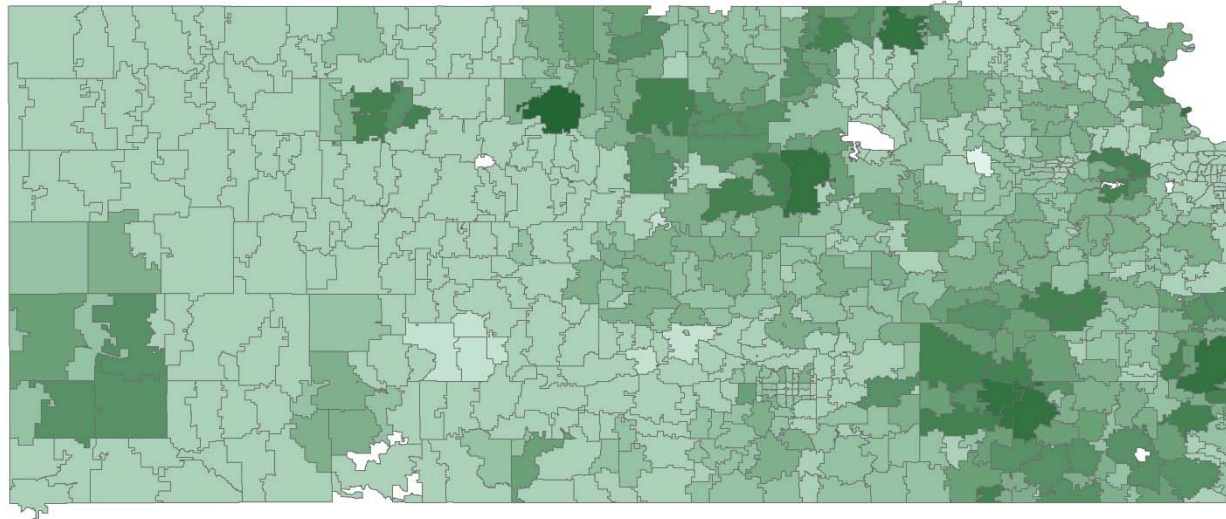




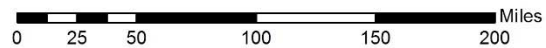
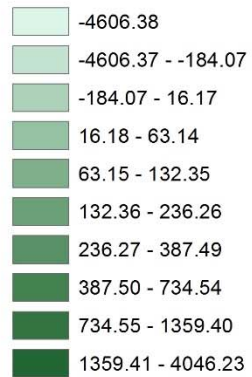
**Volume in Dry Tons**



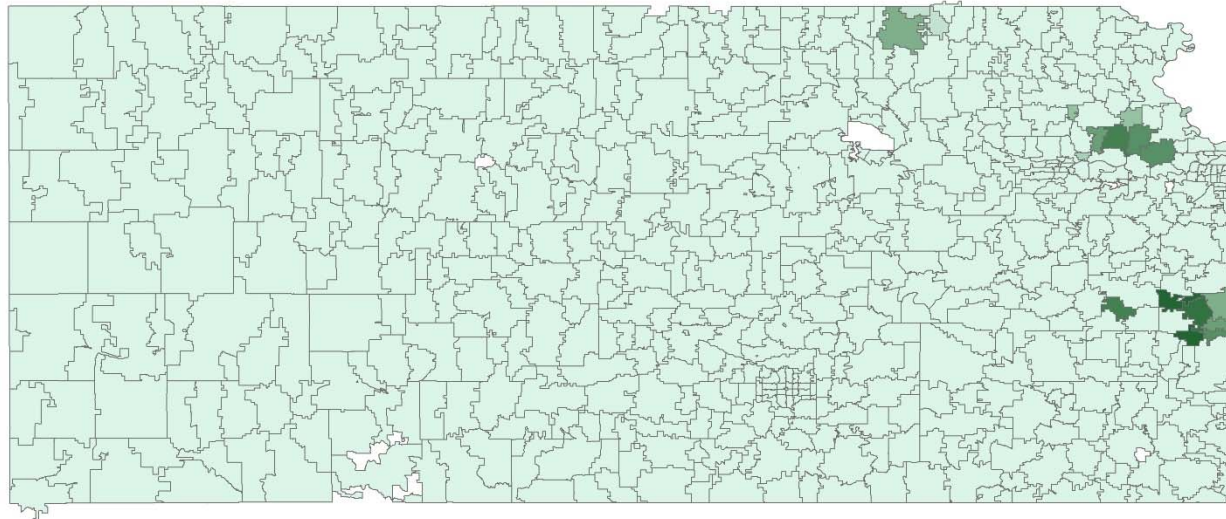
**Figure C15. Kansas ZCTA map. Pulpwood Volume in Upland Hardwood in dry tons.**



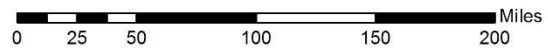
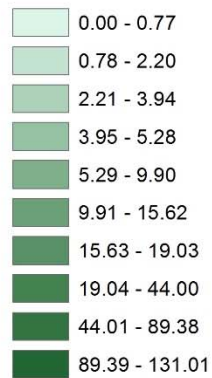
### Growth in Dry Tons



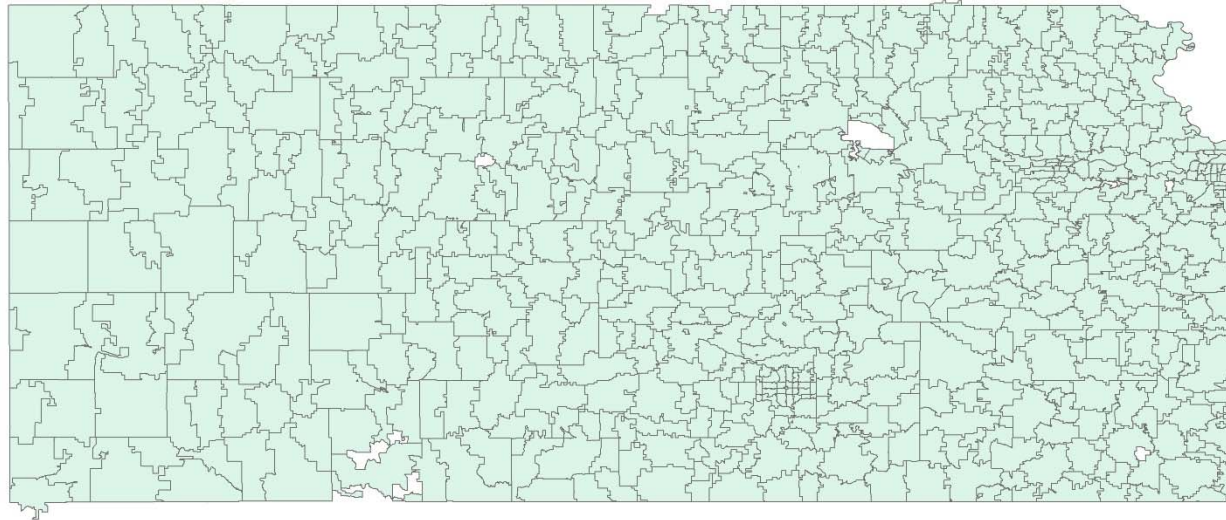
**Figure C16. Kansas ZCTA map. Sawtimber Growth in Lowland Hardwood in dry tons.**



### Growth in Dry Tons



**Figure C17. Kansas ZCTA map. Sawtimber Growth in Mixed Wood in dry tons.**



**Growth in Dry Tons**

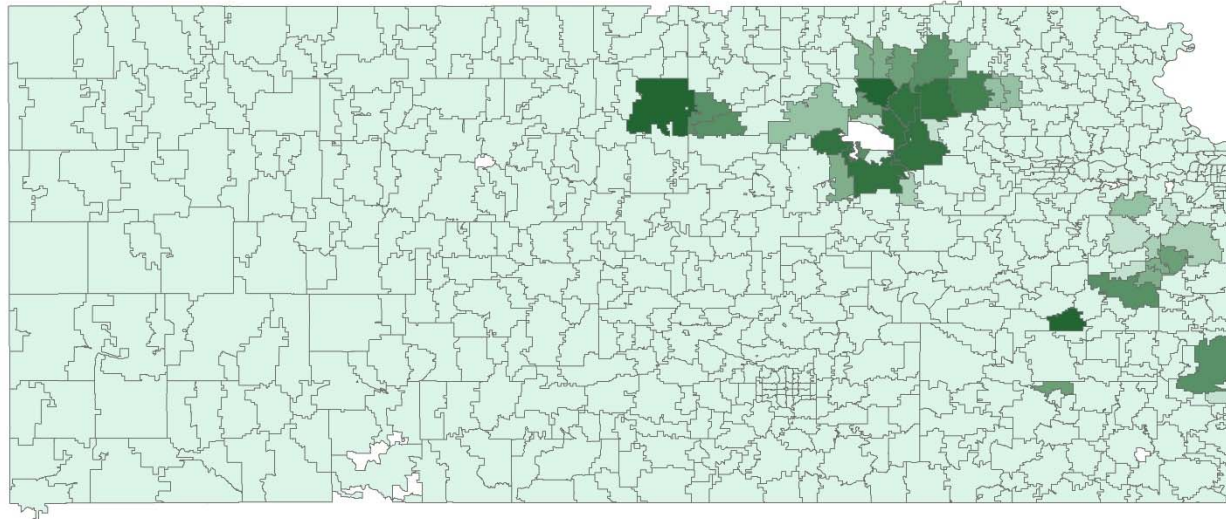
0.00

0 25 50 100 150 200 Miles

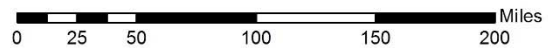
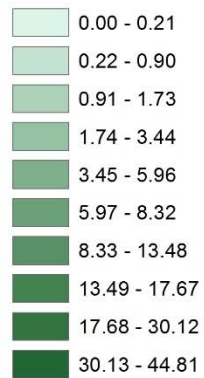


**Figure C18. Kansas ZCTA map. Sawtimber Growth in Pine Plantations in dry tons.**

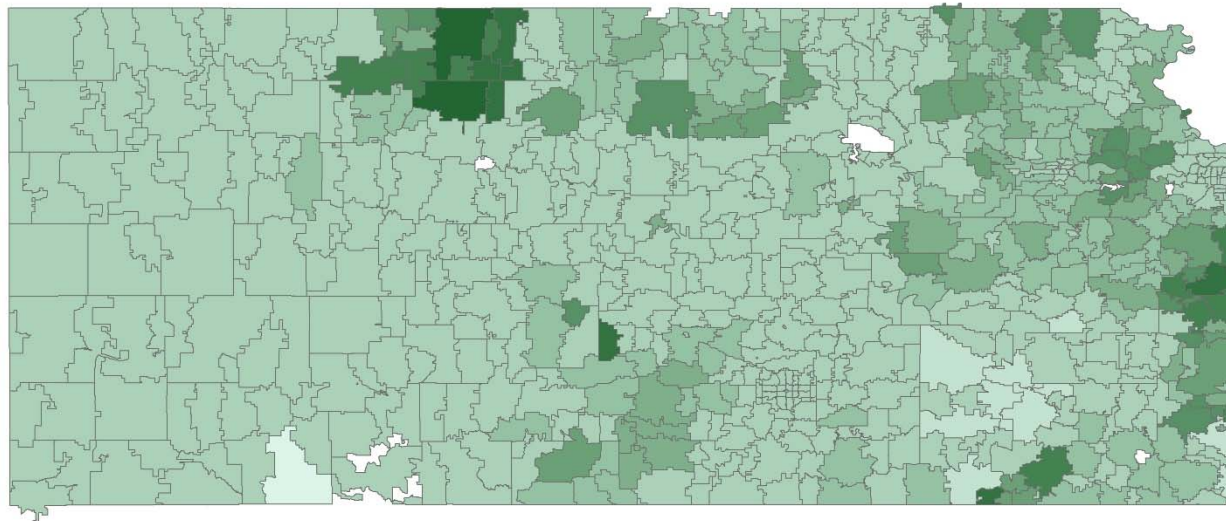




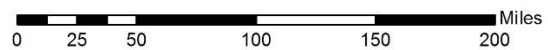
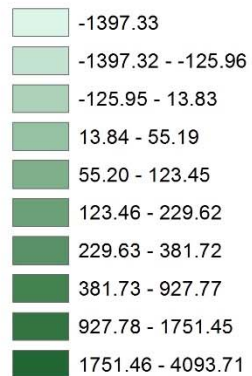
### Growth in Dry Tons



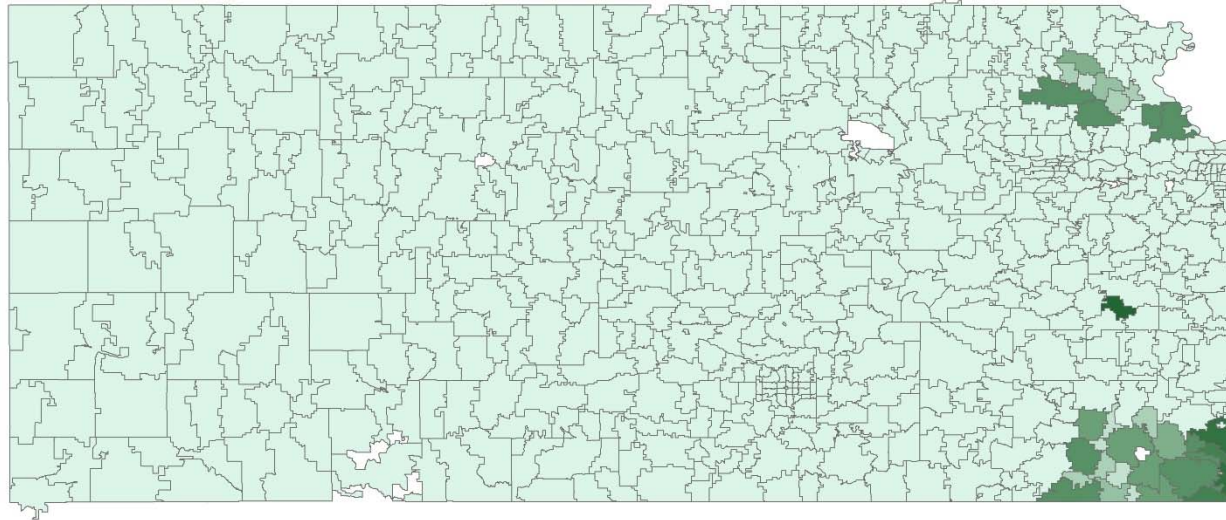
**Figure C19. Kansas ZCTA map. Sawtimber Growth in Softwood in dry tons.**



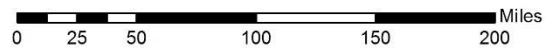
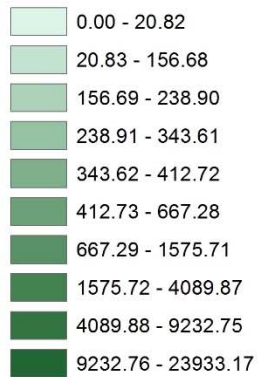
### Growth in Dry Tons



**Figure C20. Kansas ZCTA map. Sawtimber Growth in Upland Hardwood in dry tons.**

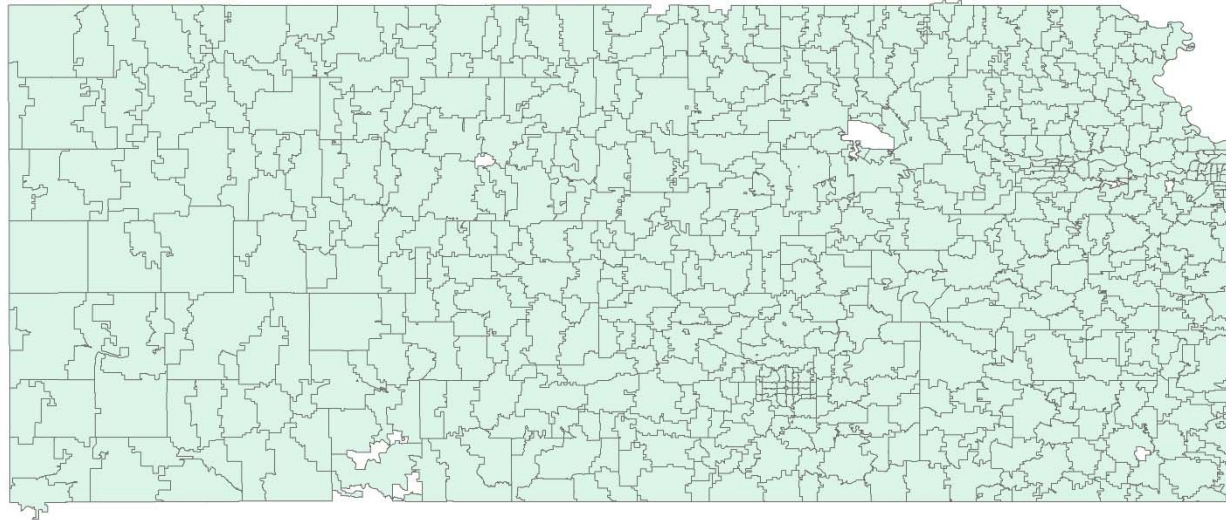


### Removals in Dry Tons

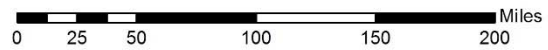


**Figure C21. Kansas ZCTA map. Sawtimber Removals in Lowland Hardwood in dry tons.**

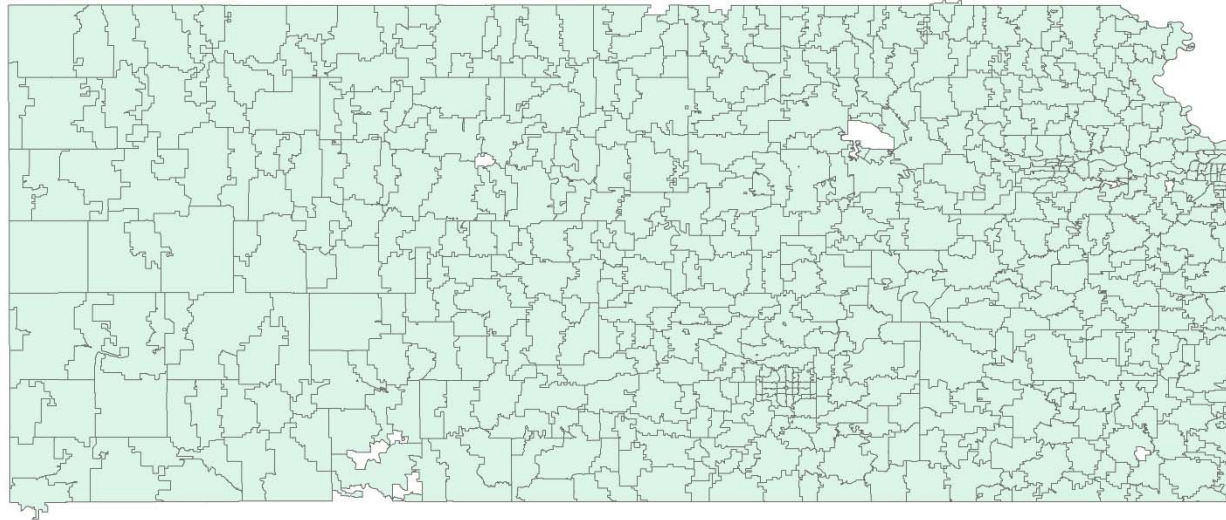




**Removals in Dry Tons**



**Figure C22. Kansas ZCTA map. Sawtimber Removals in Mixed Wood in dry tons.**



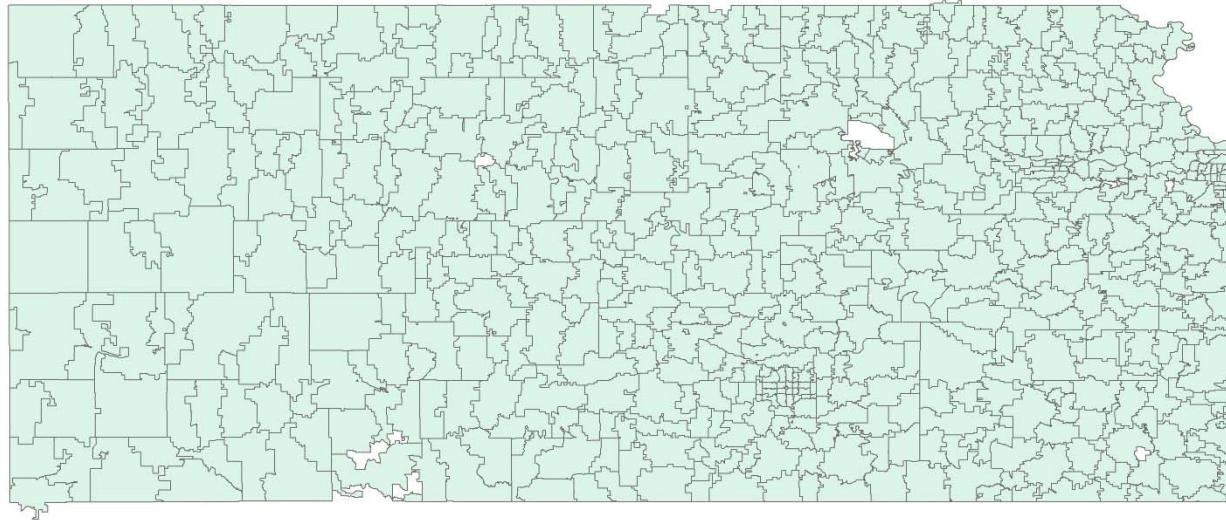
**Removals in Dry Tons**

0.00

0 25 50 100 150 200 Miles



**Figure C23. Kansas ZCTA map. Sawtimber Removals in Pine Plantations in dry tons.**



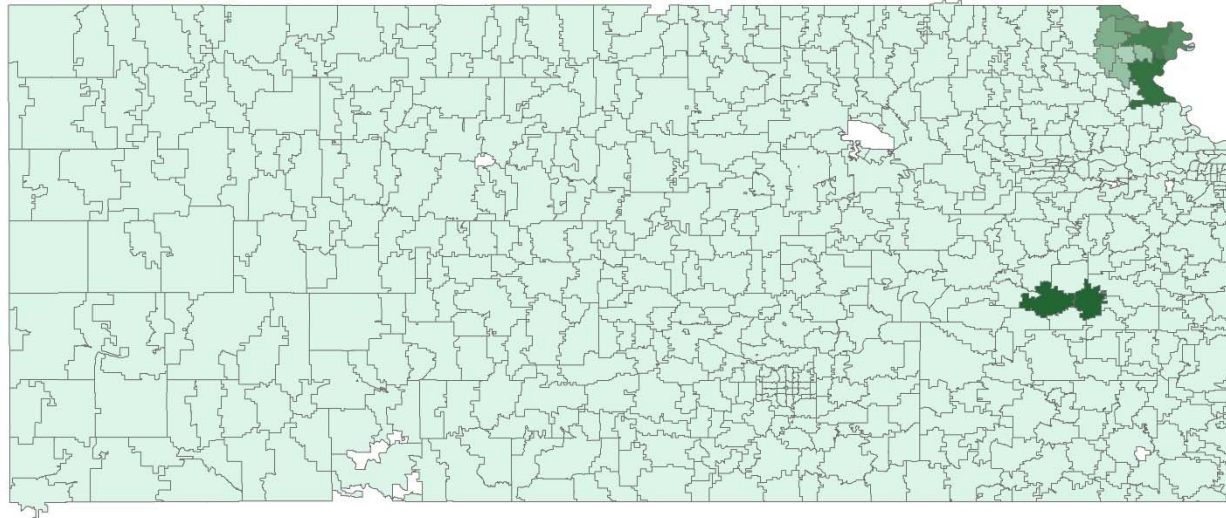
**Removals in Dry Tons**

0.00

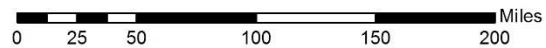
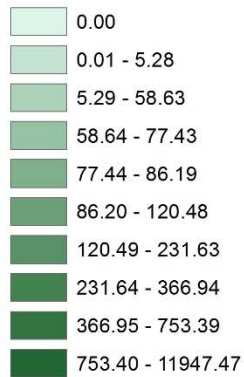
0 25 50 100 150 200 Miles



**Figure C24. Kansas ZCTA map. Sawtimber Removals in Softwood in dry tons.**

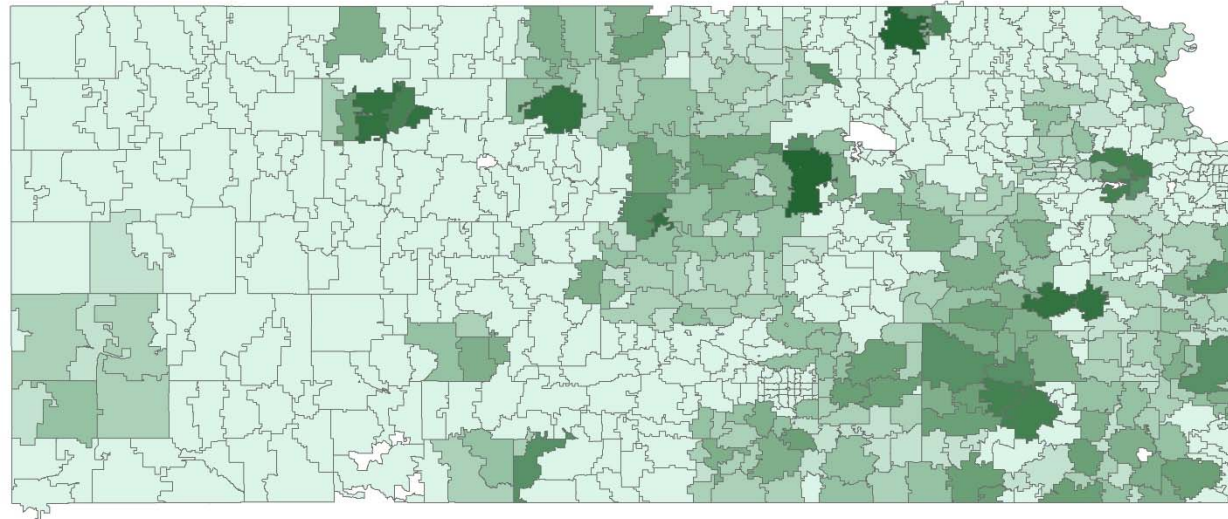


### Removals in Dry Tons

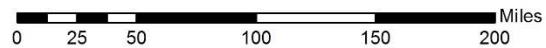
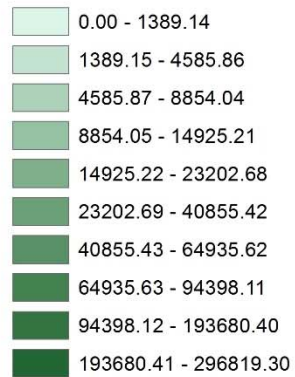


**Figure C25. Kansas ZCTA map. Sawtimber Removals in Upland Hardwood in dry tons.**

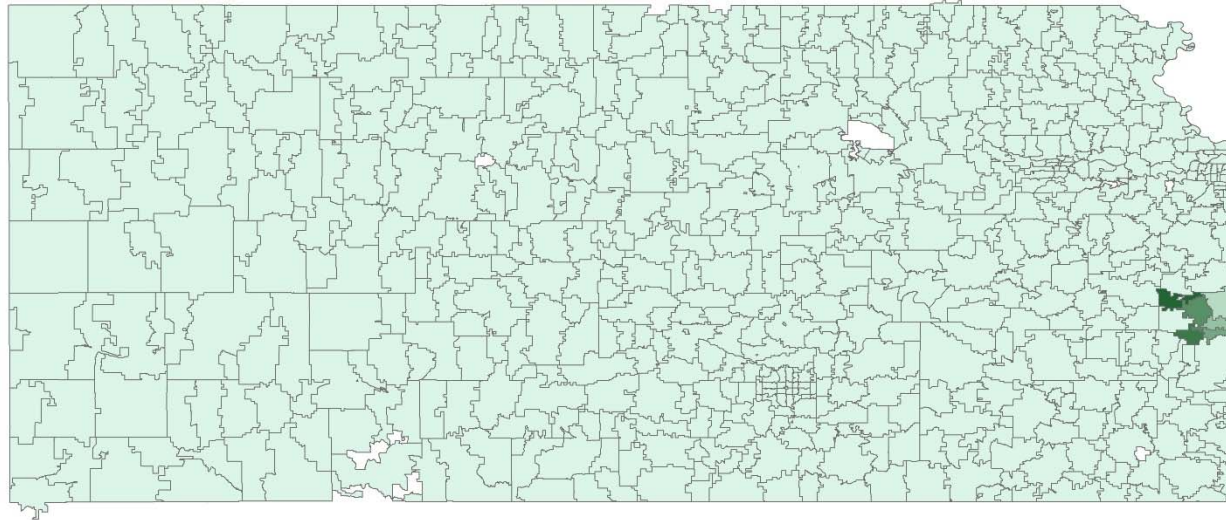




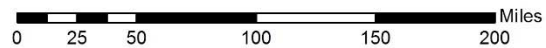
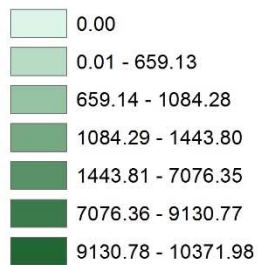
### Volume in Dry Tons



**Figure C26. Kansas ZCTA map. Sawtimber Volume in Lowland Hardwood in dry tons.**

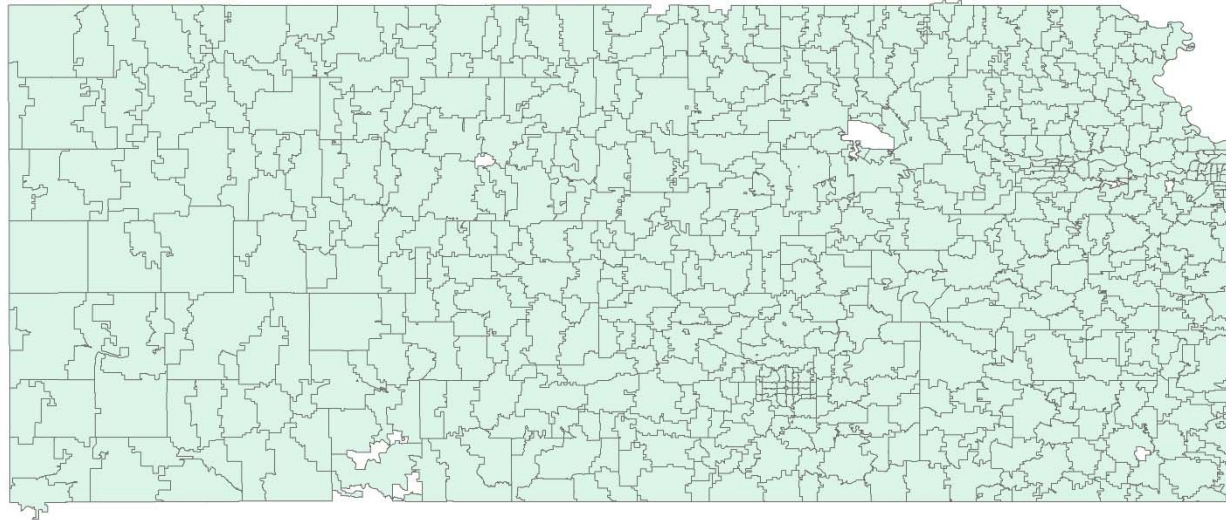


**Volume in Dry Tons**



**Figure C27. Kansas ZCTA map. Sawtimber Volume in Mixed Wood in dry tons.**





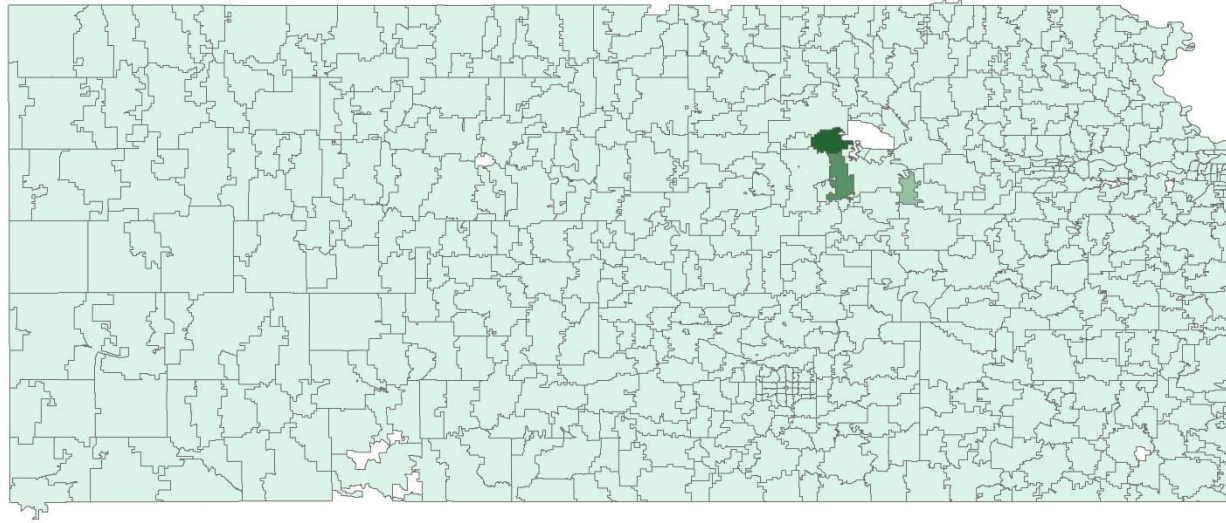
**Volume in Dry Tons**

0.00

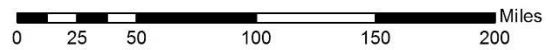
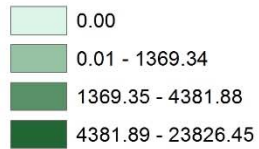
0 25 50 100 150 200 Miles



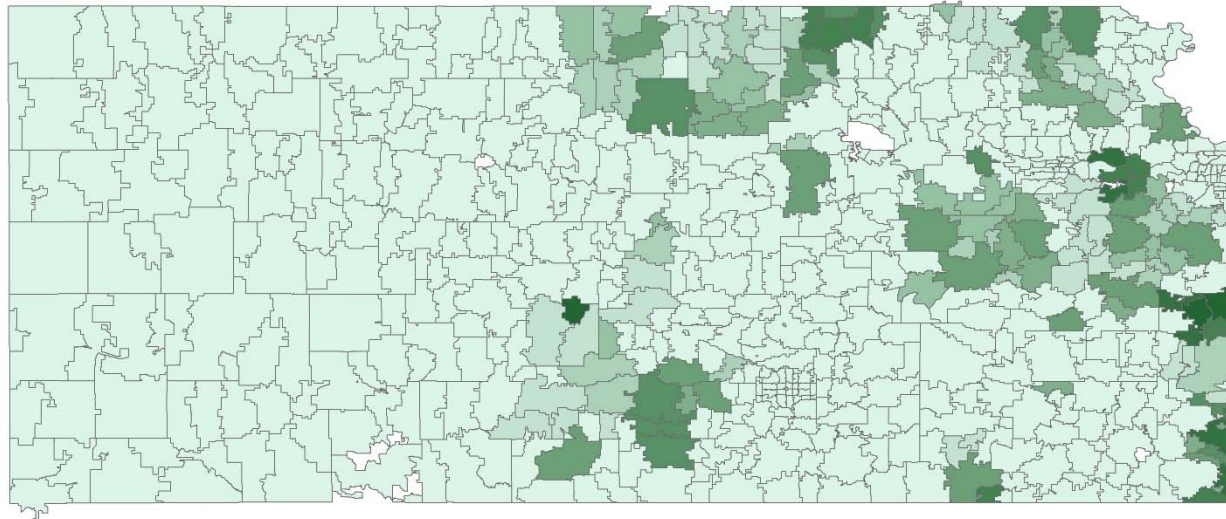
**Figure C28. Kansas ZCTA map. Sawtimber Volume in Pine Plantations in dry tons.**



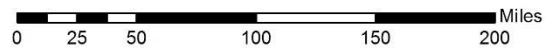
**Volume in Dry Tons**



**Figure C29. Kansas ZCTA map. Sawtimber Volume in Softwood in dry tons.**



### Volume in Dry Tons

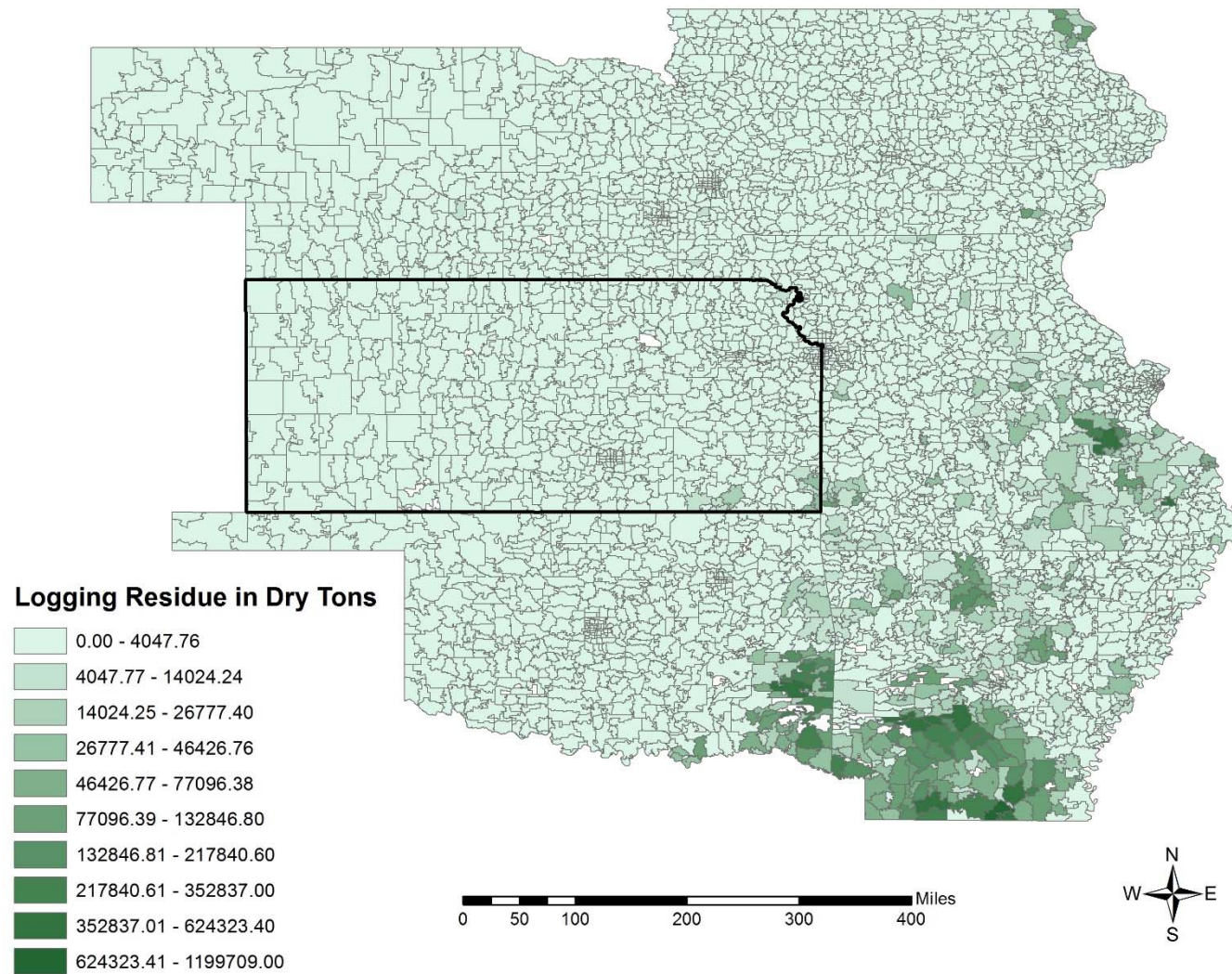


**Figure C30. Kansas ZCTA map. Sawtimber Volume in Upland Hardwood in dry tons.**

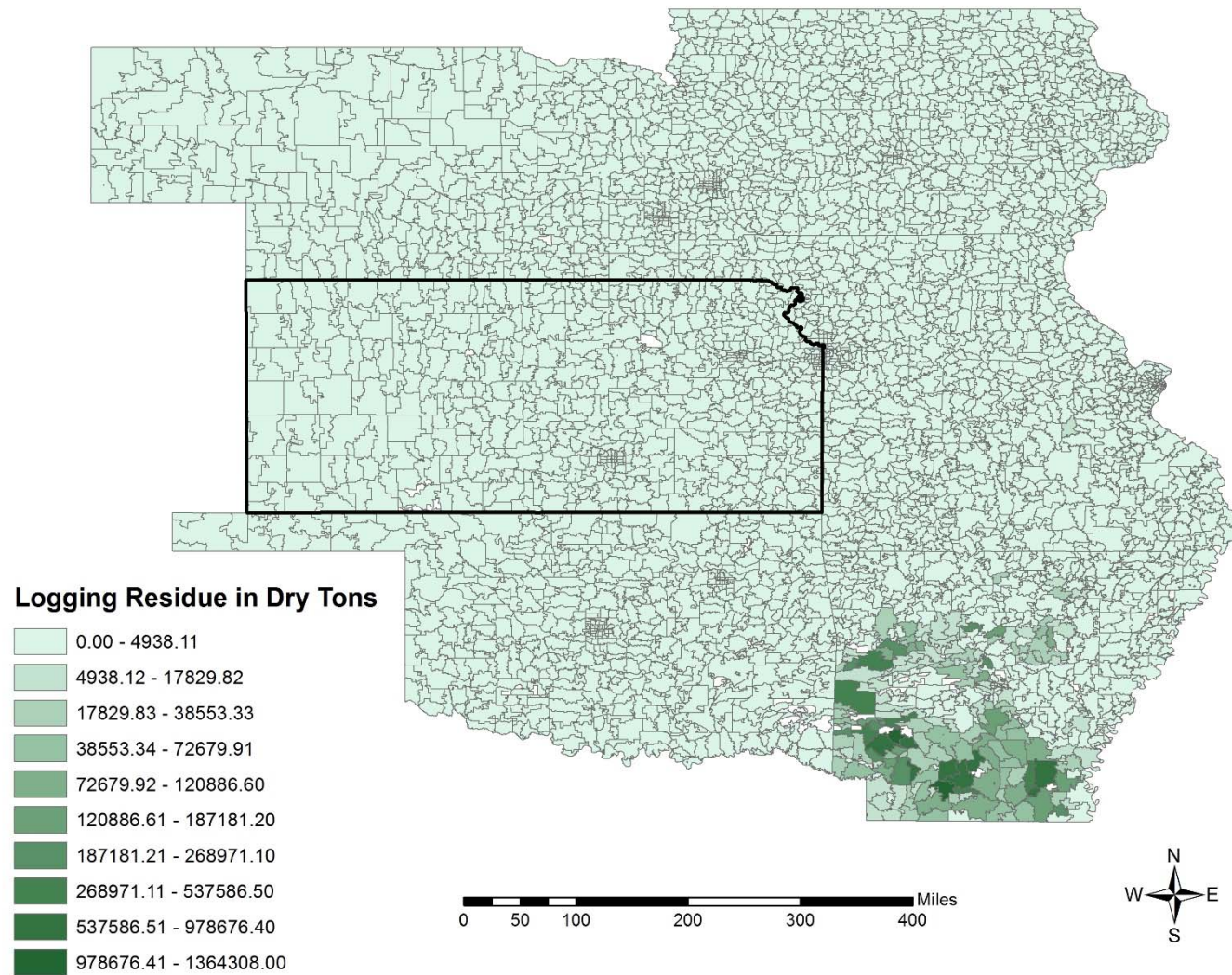
## **APPENDIX D**

Regional (Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma States) ZCTA maps for hardwood and softwood Logging residues (“at-landing” and “in-woods”).



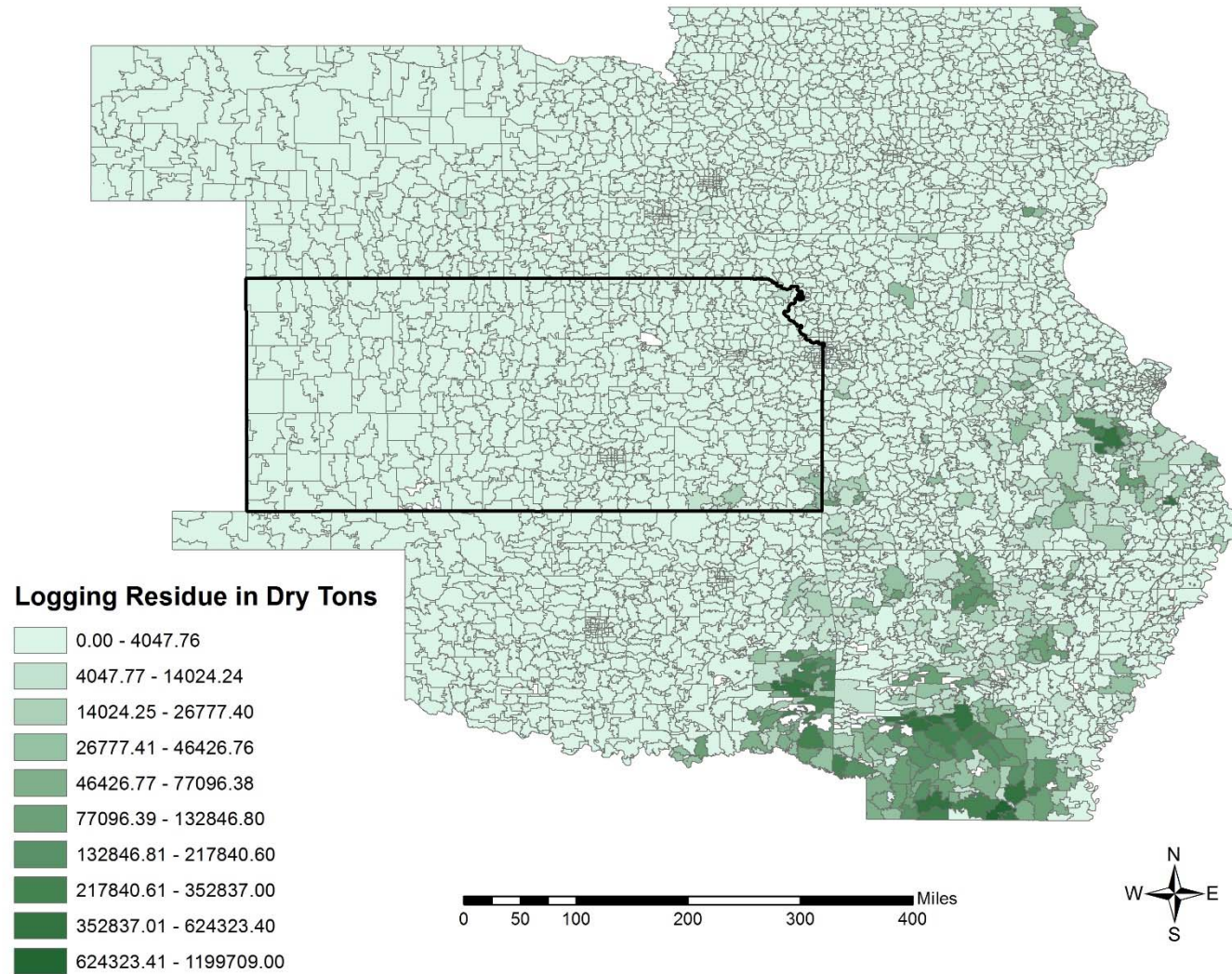


**Figure D1. Regional ZCTA map. Logging Residue “at-landing” Hardwood in dry tons.**

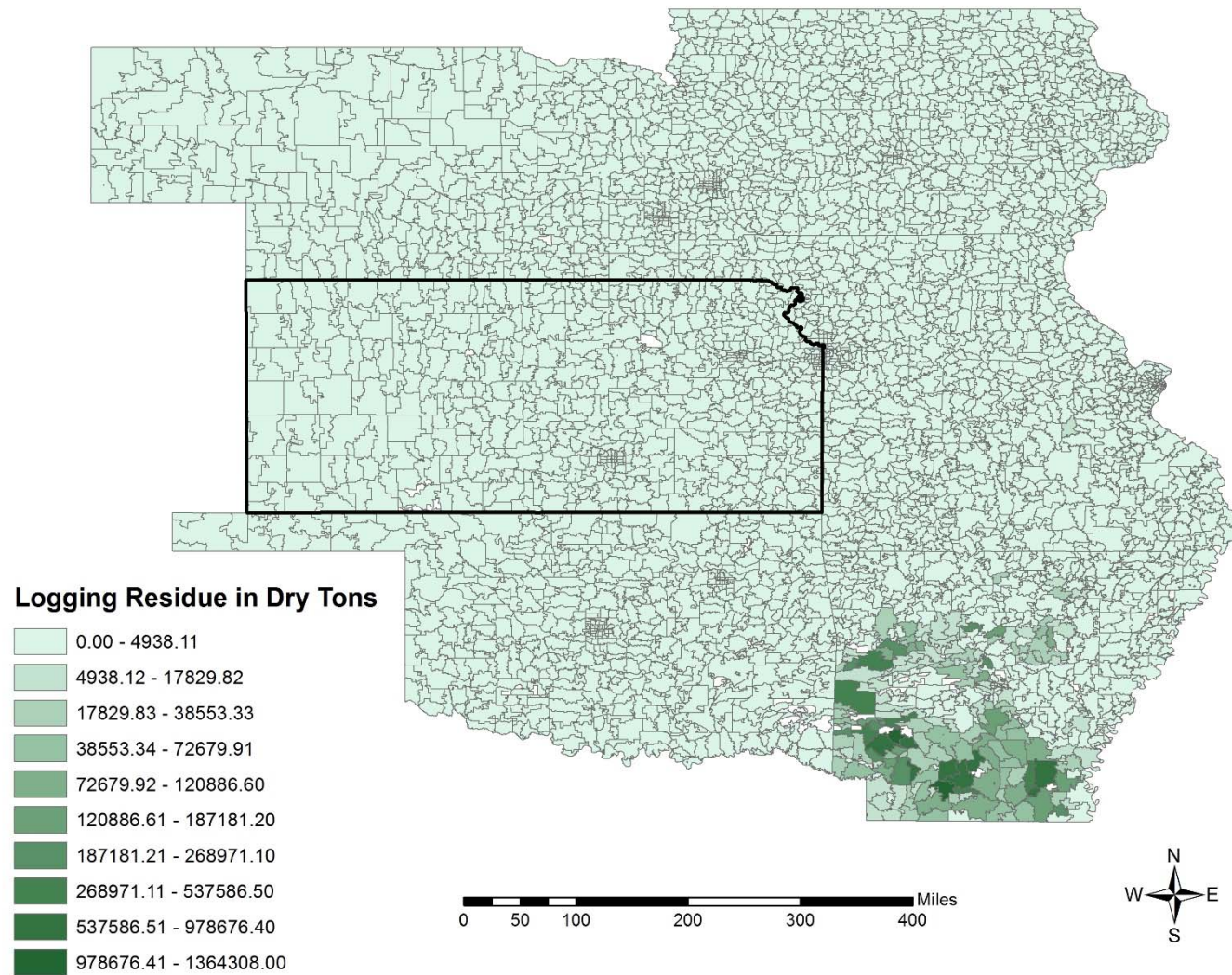


**Figure D2. Regional ZCTA map. Logging Residue “at-landing” Softwood in dry tons.**





**Figure D3. Regional ZCTA map. Logging Residue “in-woods” Hardwood in dry tons.**

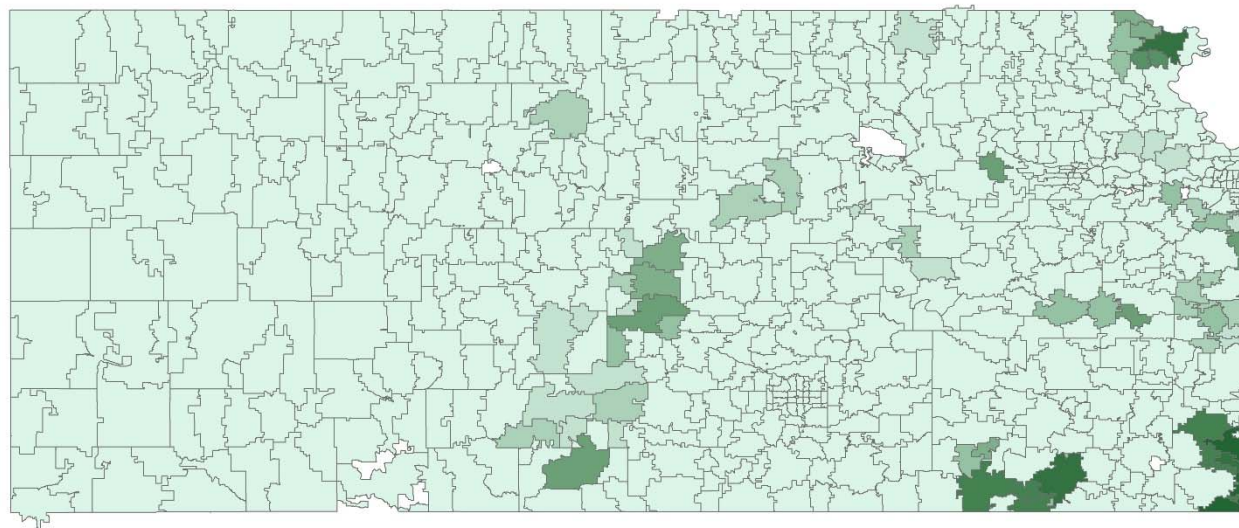


**Figure D4. Regional ZCTA map. Logging Residue “in-woods” Softwood in dry tons.**

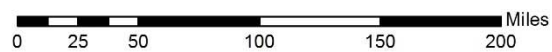
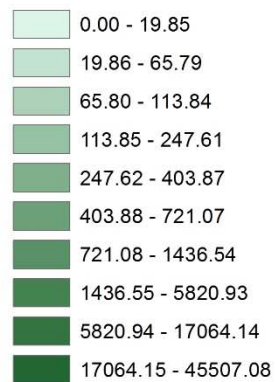
## **APPENDIX E**

Kansas ZCTA maps for hardwood and softwood Logging residues (“at-landing” and “in-woods”).

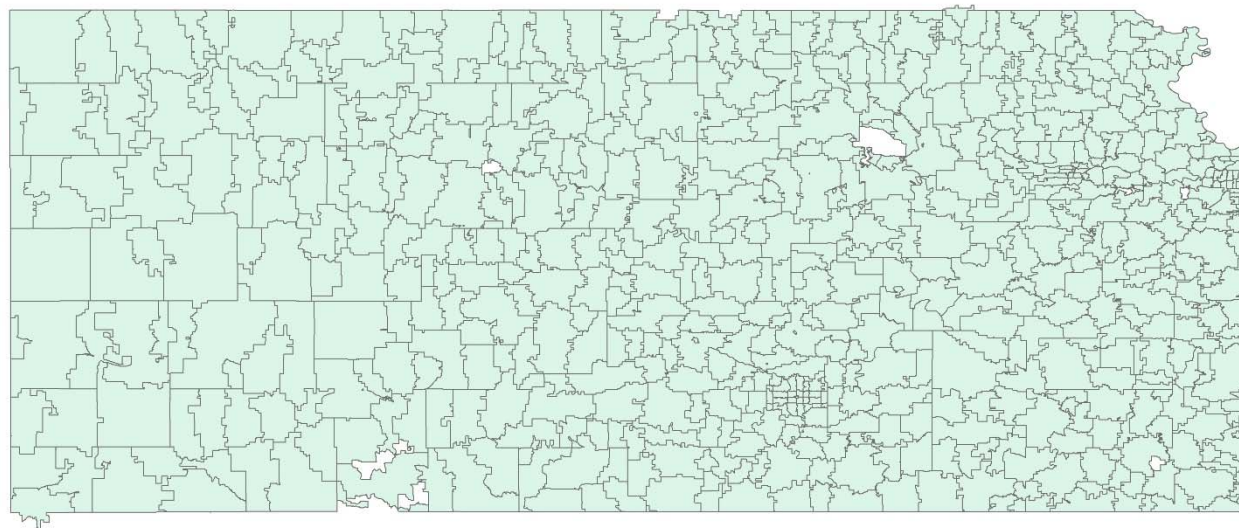




### Logging Residue in Dry Tons



**Figure E1. Kansas ZCTA map. Logging Residue “at-landing” Hardwood in dry tons.**



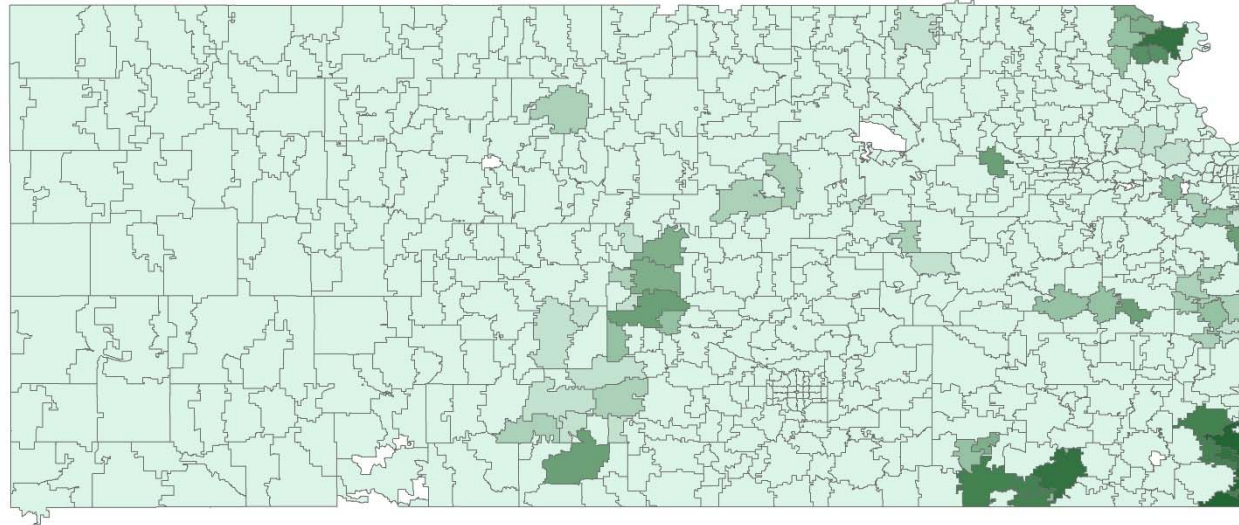
**Logging Residue in Dry Tons**

0.00

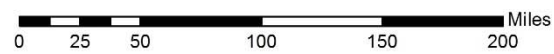
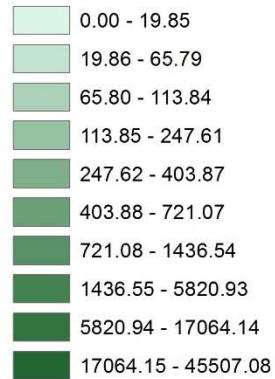
0 25 50 100 150 200 Miles



**Figure E2. Kansas ZCTA map. Logging Residue “at-landing” Softwood in dry tons.**

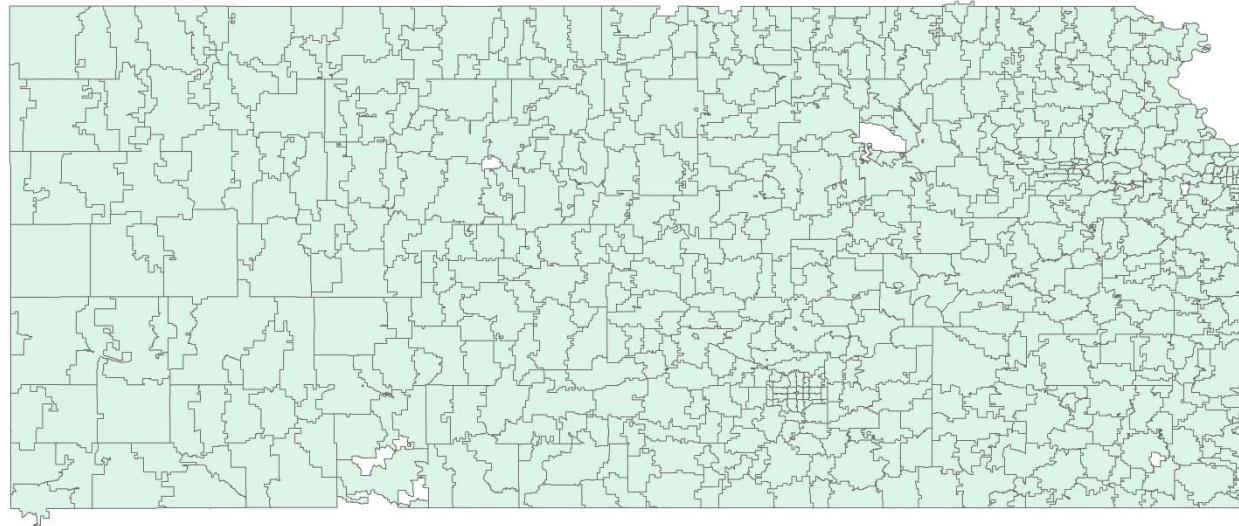


### Logging Residue in Dry Tons



**Figure E3. Kansas ZCTA map. Logging Residue “in-woods” Hardwood in dry tons.**





**Logging Residue in Dry Tons**

0.000000

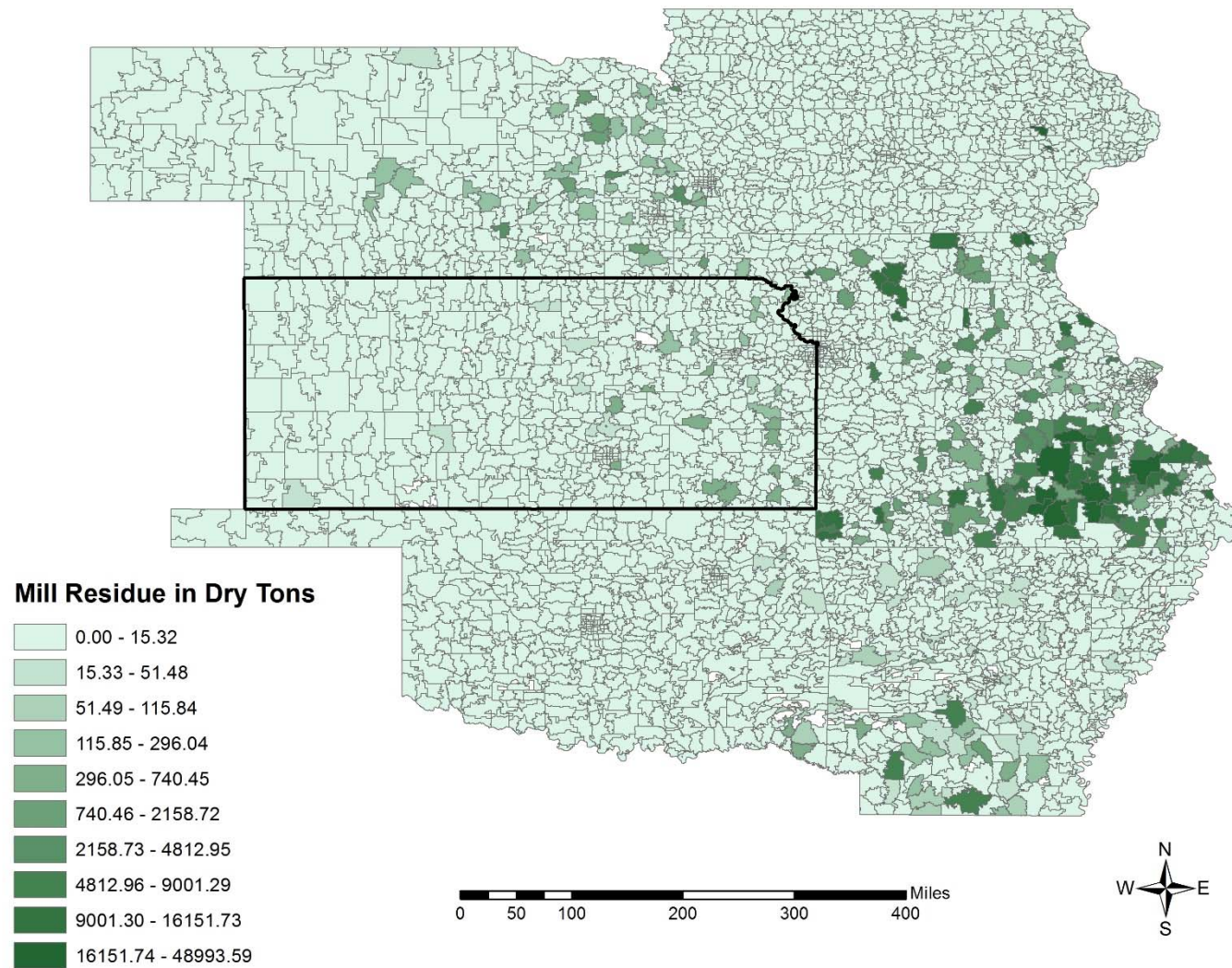
0 25 50 100 150 200 Miles



**Figure E4. Kansas ZCTA map. Logging Residue “in-woods” Softwood in dry tons.**

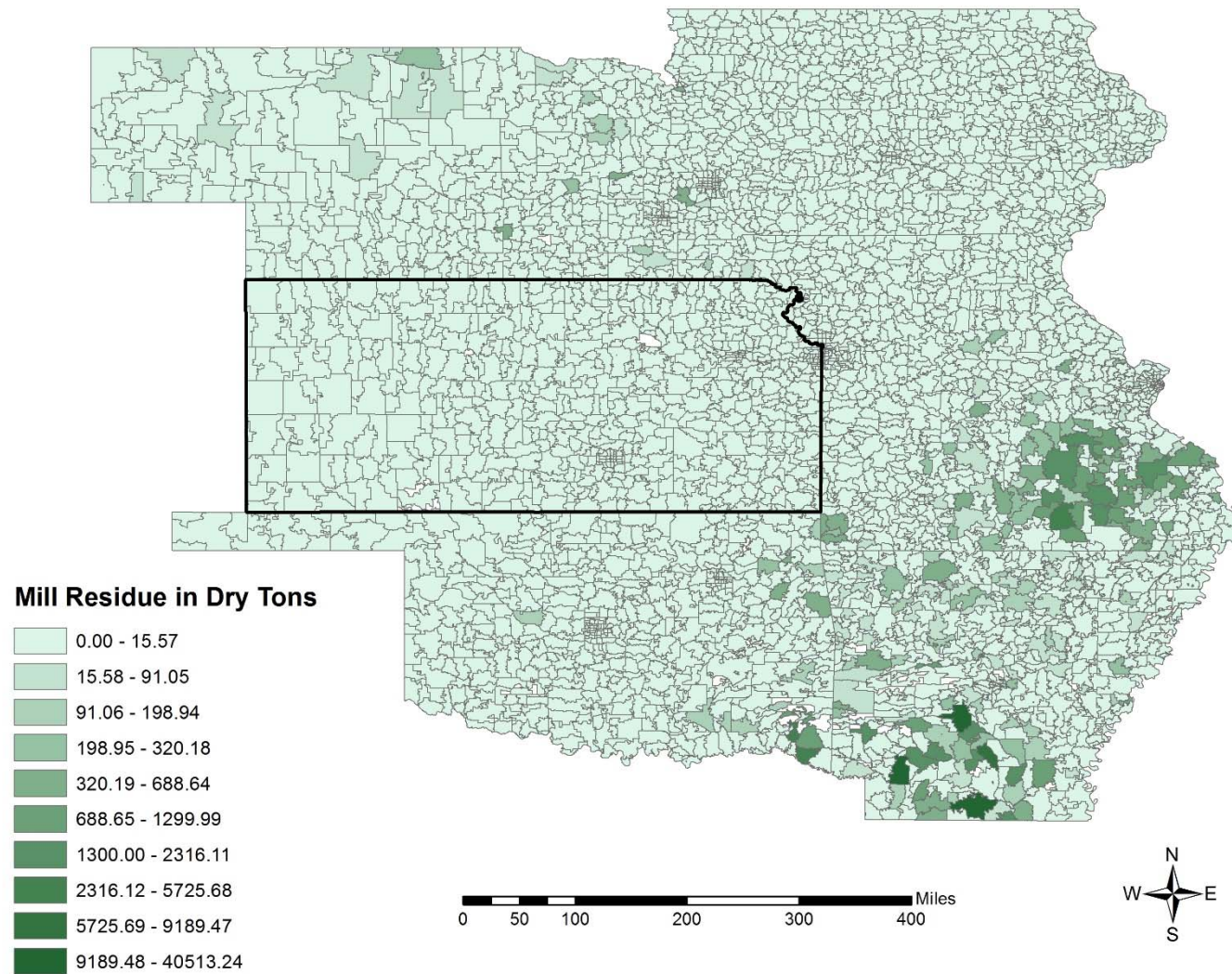
## **APPENDIX F**

Regional (Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma States) ZCTA maps for hardwood and softwood Mill residues (“clean” and “unclean”).

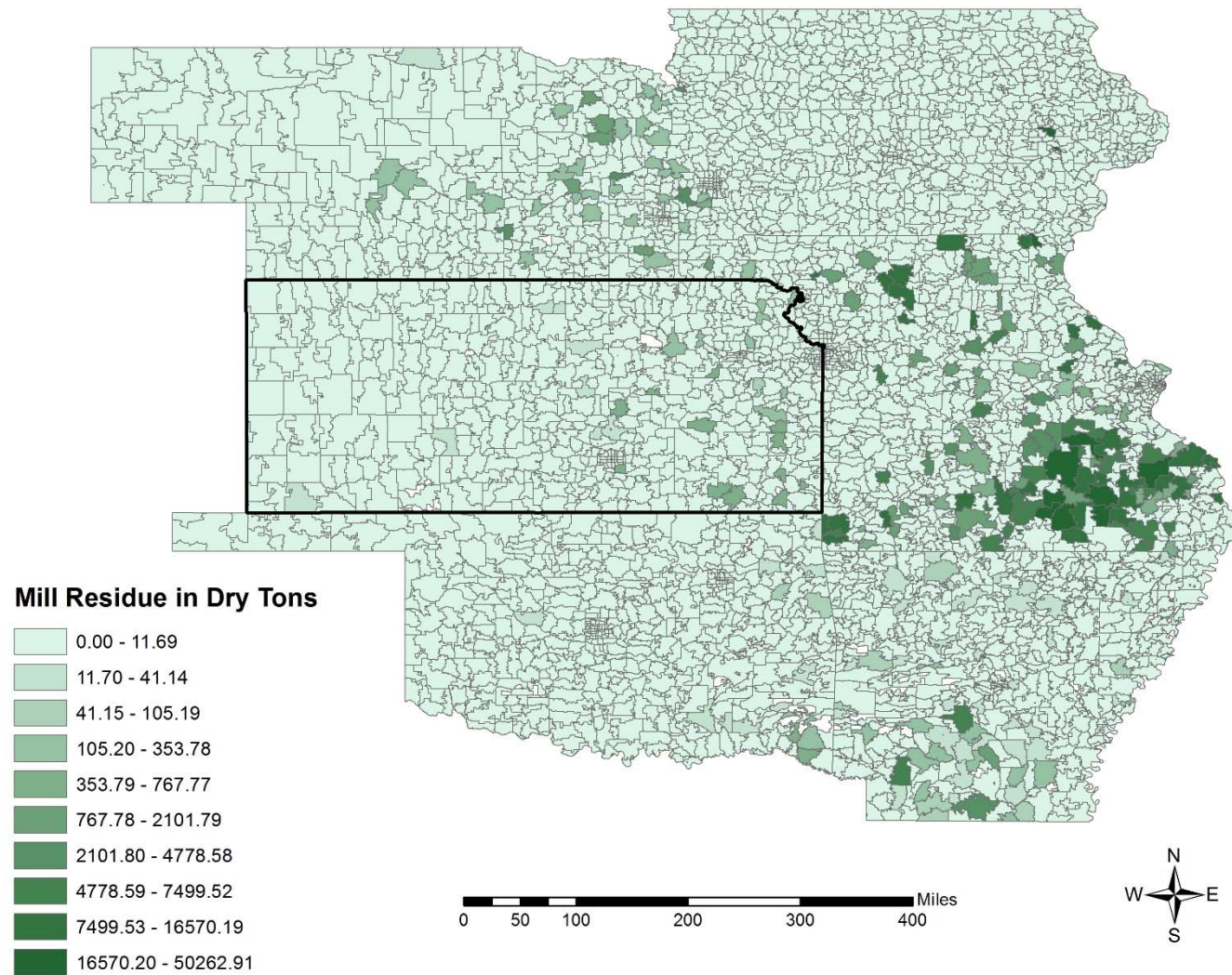


**Figure F1. Regional ZCTA map. Mill Residue Clean Hardwood in dry tons.**



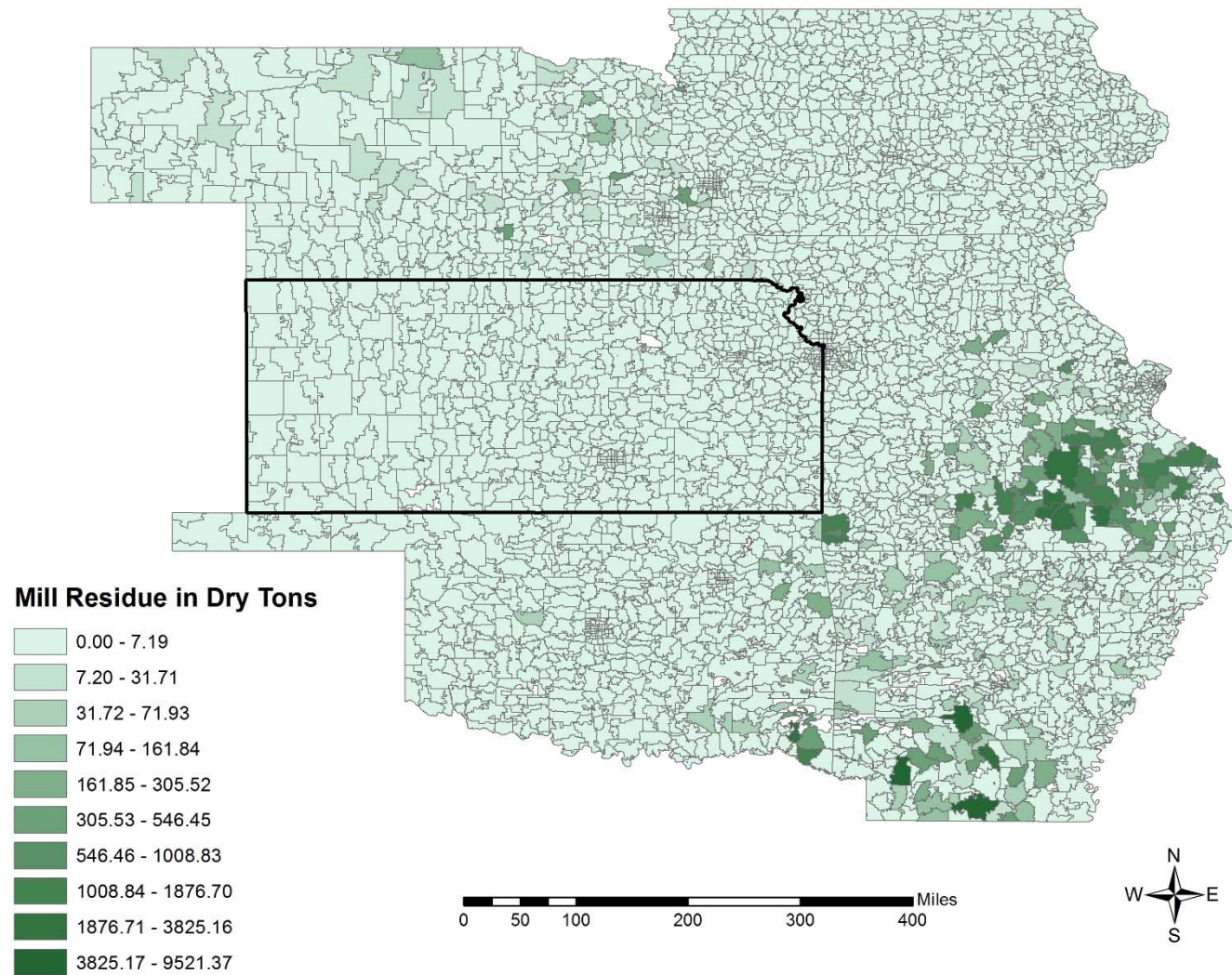


**Figure F2. Regional ZCTA map. Mill Residue Clean Softwood in dry tons.**



**Figure F3. Regional ZCTA map. Mill Residue Unclean Hardwood in dry tons.**



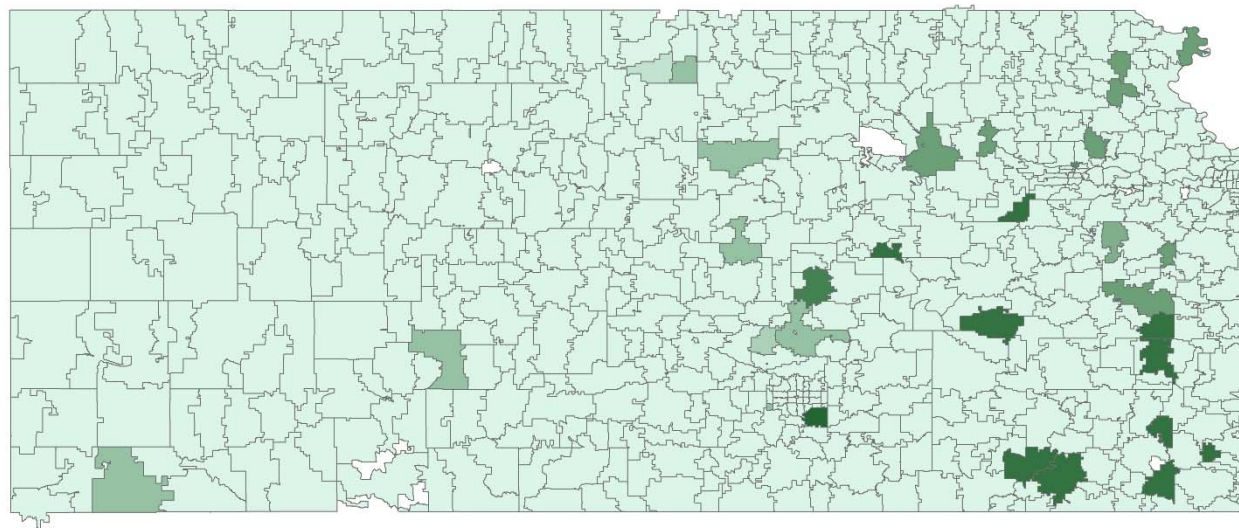


**Figure F4. Regional ZCTA map. Mill Residue Unclean Softwood in dry tons.**

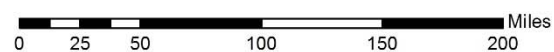
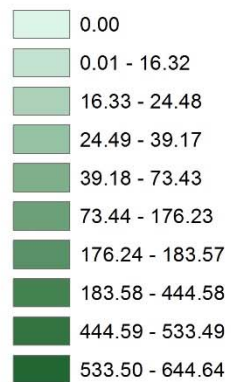


## **APPENDIX G**

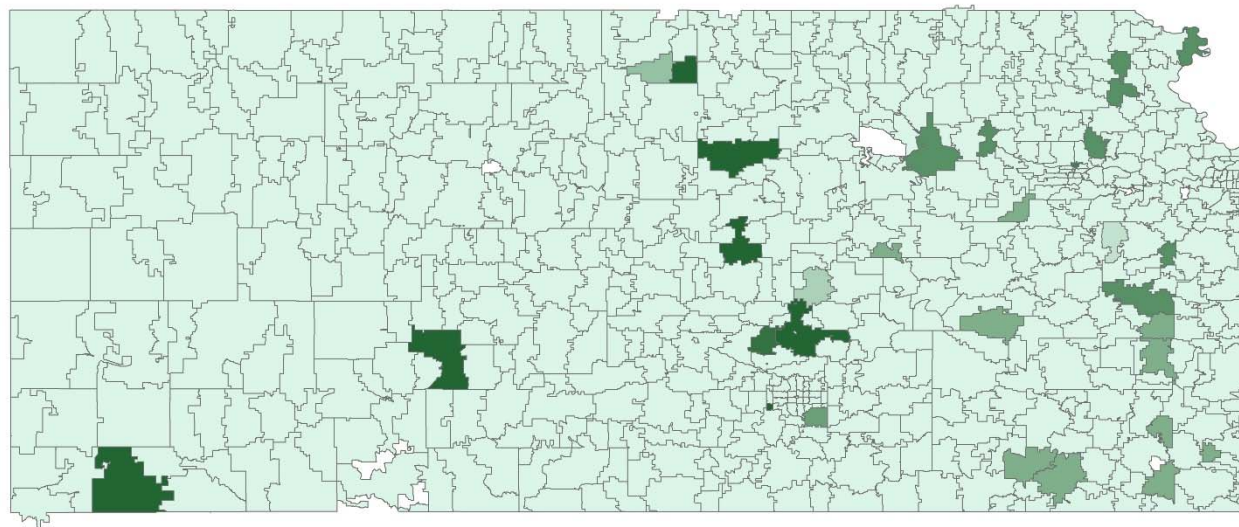
Kansas ZCTA maps for hardwood and softwood Mill residues (“clean” and “unclean”).



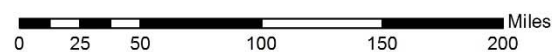
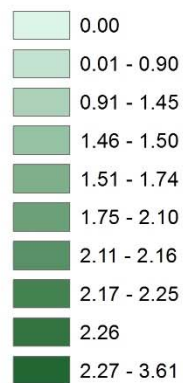
### Mill Residue in Dry Tons



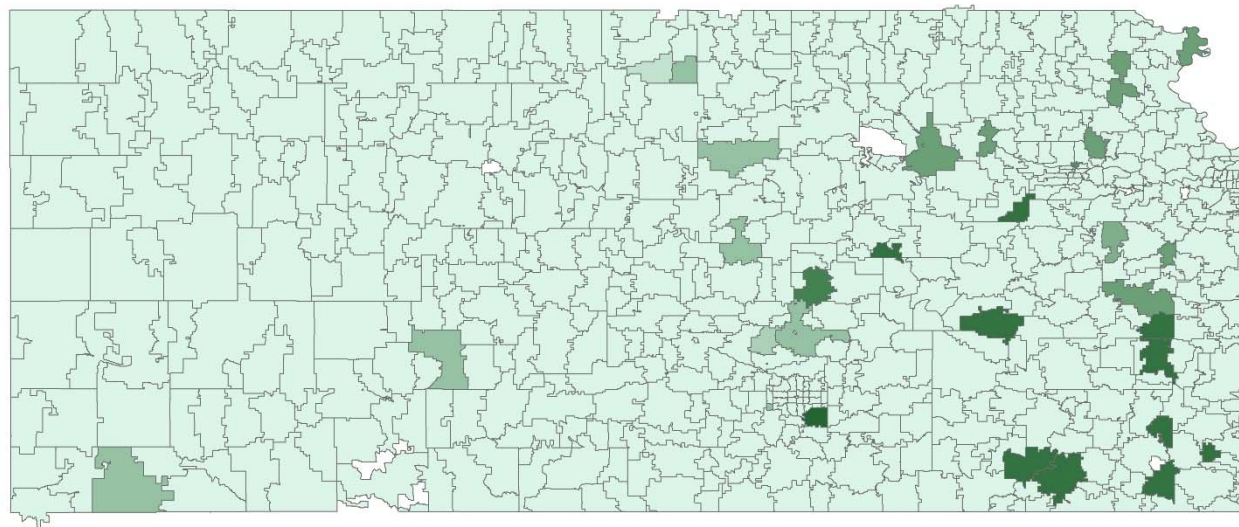
**Figure G1. Kansas ZCTA map. Mill Residue Clean Hardwood in dry tons.**



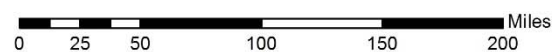
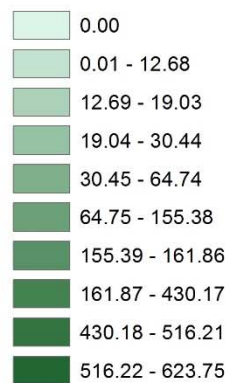
### Mill Residue in Dry Tons



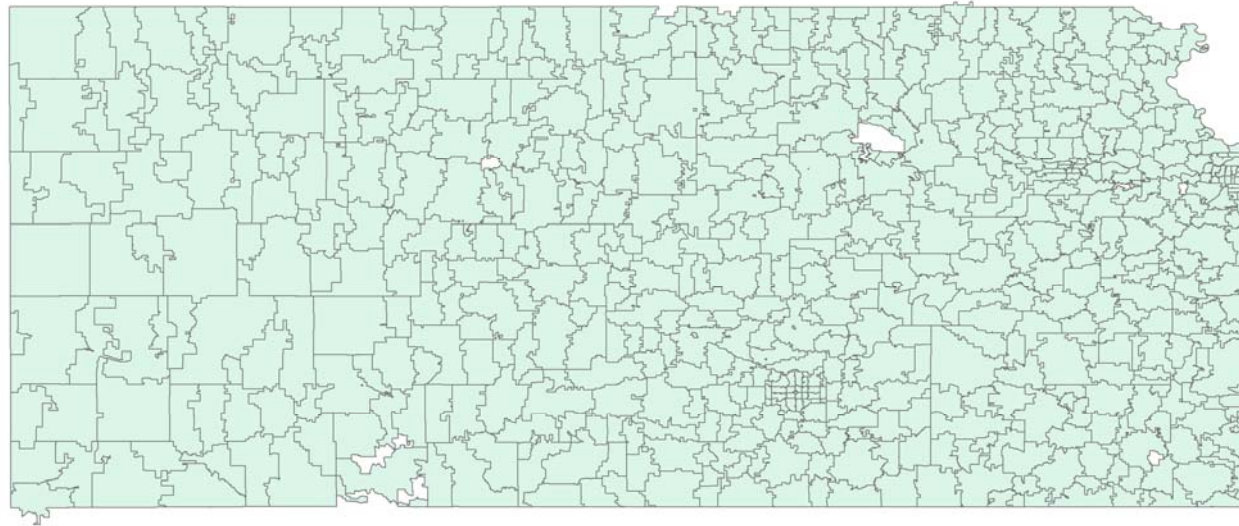
**Figure G2. Kansas ZCTA map. Mill Residue Clean Softwood in dry tons.**



**Mill Residue in Dry Tons**



**Figure G3. Kansas ZCTA map. Mill Residue Unclean Hardwood in dry tons.**



**Logging Residue in Dry Tons**

0.000000

0 25 50 100 150 200 Miles



**Figure G4. Kansas ZCTA map. Mill Residue Unclean Softwood in dry tons.**