Missouri Commodity Flow and Infrastructure Study

Prepared for:

Missouri Soybeans

MASBDA
Missouri Agricultural and Small Business Development Authority

Missouri Corn

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Bridging Your Research Needs.

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Executive Summary

This research study was commissioned by the Missouri Soybean Association and the Missouri Corn Growers Association to conduct an analysis of intrastate and interstate commodity flows and the associated infrastructure.

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost. The purpose of this research effort has been to: 1) understand the current infrastructure situation as it relates to moving farm commodities to market; 2) provide context to objectively assess the current status of the infrastructure; and 3) identify ways to improve the flow of farm commodities to market.

A critical element of this analysis is the development of a dynamic commodity flow analysis model. The model enabled the research team to dynamically determine draw areas for supply-deficit areas for corn, soybeans and grain sorghum. Interactive maps are available online for querying and/or exploring the data.

The research also includes a cost/benefit analysis discussing the impact of deteriorating bridges in an area important to the movement of large amounts of soybeans to two major processing plants and summarization of some results by federal congressional district.

Highlights of the research include:

- For major crops, production concentration is very pronounced throughout the state
- Because of their drawing power for exports (attractive basis), the Mississippi and, to a lesser extent, the Missouri rivers have a large impact on the flow of commodities into and throughout the state
- Counties which have large concentrations of livestock or renewable fuels plants are almost universally supply deficit, particularly for corn and grain sorghum
- There are significant levels of commodity storage, both on and off the farm, which has been increasing substantially in recent years
- Using dynamic flow analysis methodology, interesting flow patterns by crop by demand point were identified; interactive maps have been created to display these patterns
- Shipments of farm and related commodities in and out of Missouri continues to be dominated by trucks, but rail and barge also experience large volumes of shipments of farm and related commodities
- Commodity flows of Missouri produced commodities is complex and diverse. Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills.

Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

- Like many Midwestern states heavily reliant on agricultural production, Missouri has an extensive network of roads, rail and barge facilities. These assets lead to a major advantage over other domestic and international competitors.
- The cost/benefit analysis conducted estimates that allowing seven “poor” bridges in Buchanan County to degrade to the point that limiting weight restrictions are enforced will cost nearly $16 million per year in added time and transportation costs.

Background

Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities within and outside of Missouri. The study also identified those obstacles, bottlenecks, and challenges in the commodity transportation system in Missouri and provide data for better understanding future transportation needs.

Missouri County Map

Missouri is located in the middle section of the United States, about 1,000 miles from the eastern coast of the United States and 1,900 miles from the western coast of the United States and nearly equal distance from the Gulf of Mexico and the Canadian border. Missouri has 114 counties.

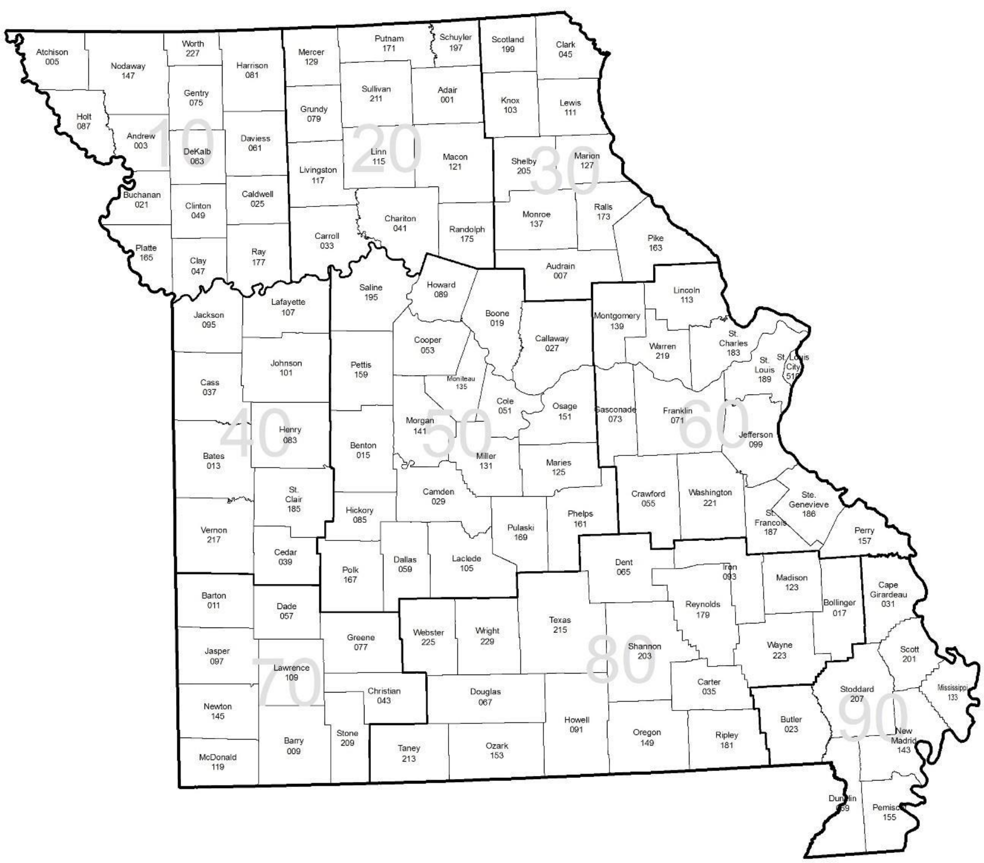


Figure 1, Missouri Counties

USDA Crop Reporting Districts

USDA has defined crop reporting districts for each of the counties and states in the United States. Missouri is organized into nine crop reporting districts with districts 10, 20, and 30 in northern Missouri; districts 40, 50, and 60 in the central areas of Missouri; and districts 70, 80, and 90 covering the southern counties and boot heel of Missouri. These crop reporting districts also are commonly referred to as crop reporting districts (CRDs).

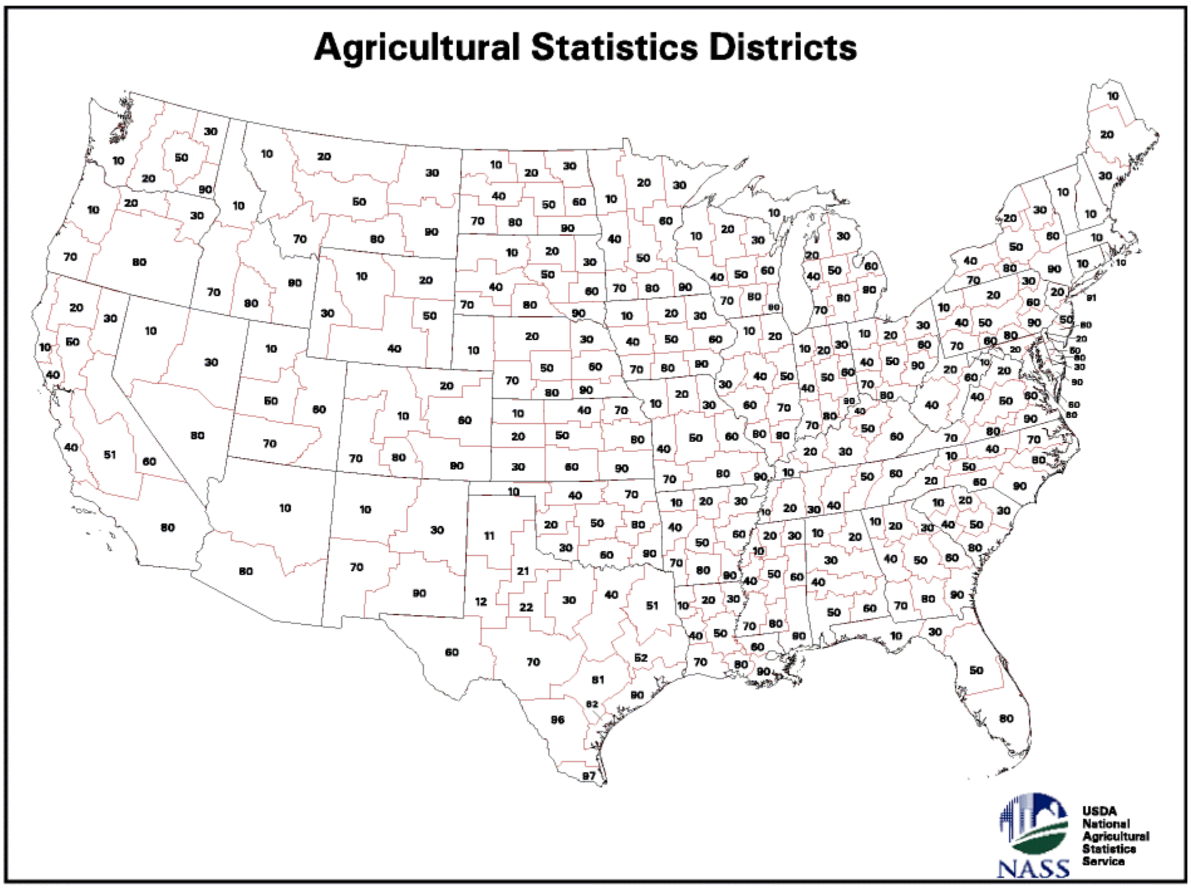


Figure 2, Agricultural Statistics Districts

The crop production mix in Missouri has been changing over the past 20 years. Whereas corn and soybean production are trending higher, sorghum and wheat production are trending lower. Corn production is increasing by 10.8 million bushels per year; soybean production increasing by 4.4 million bushels per year; grain sorghum production is decreasing by 1.2 million bushels per year; and wheat production is decreasing by 0.77 million bushels per year (see Figure 3 through Figure 6).

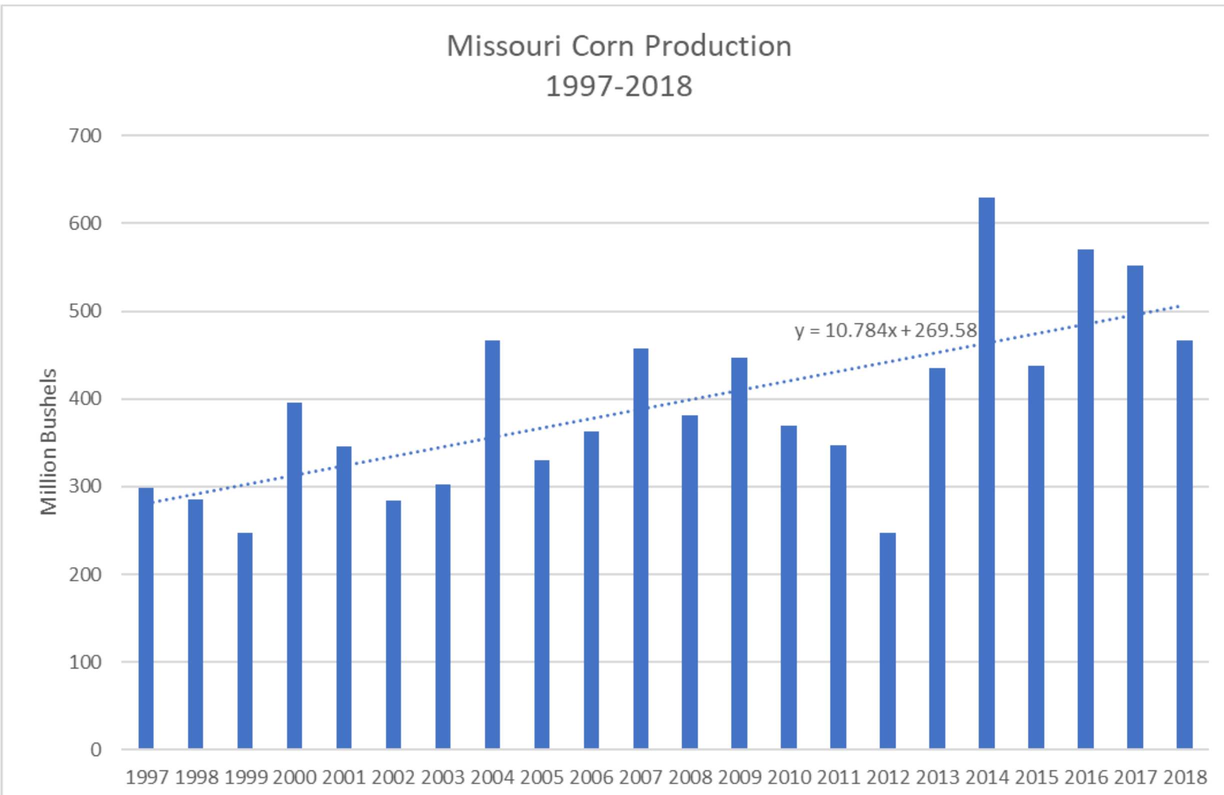


Figure 3, Missouri Corn Production 1997-2018

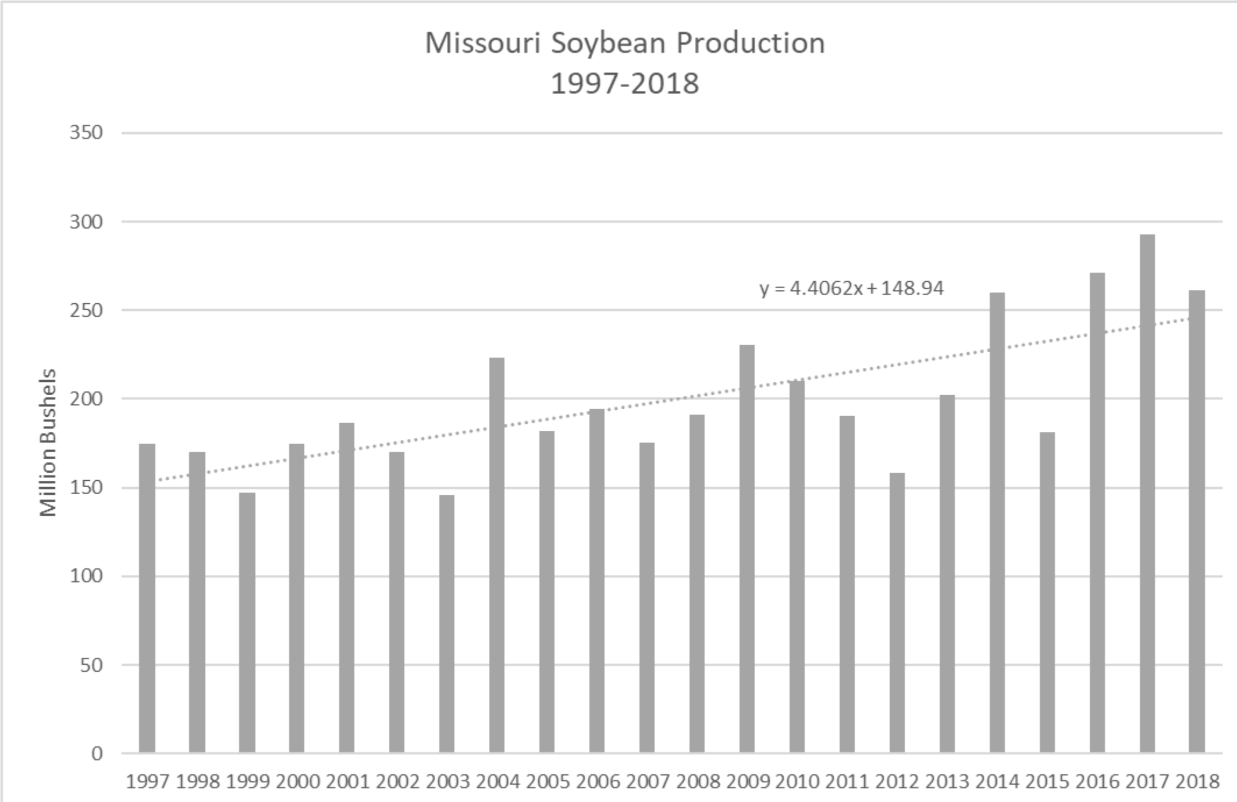


Figure 4, Missouri Soybean Production 1997-2018

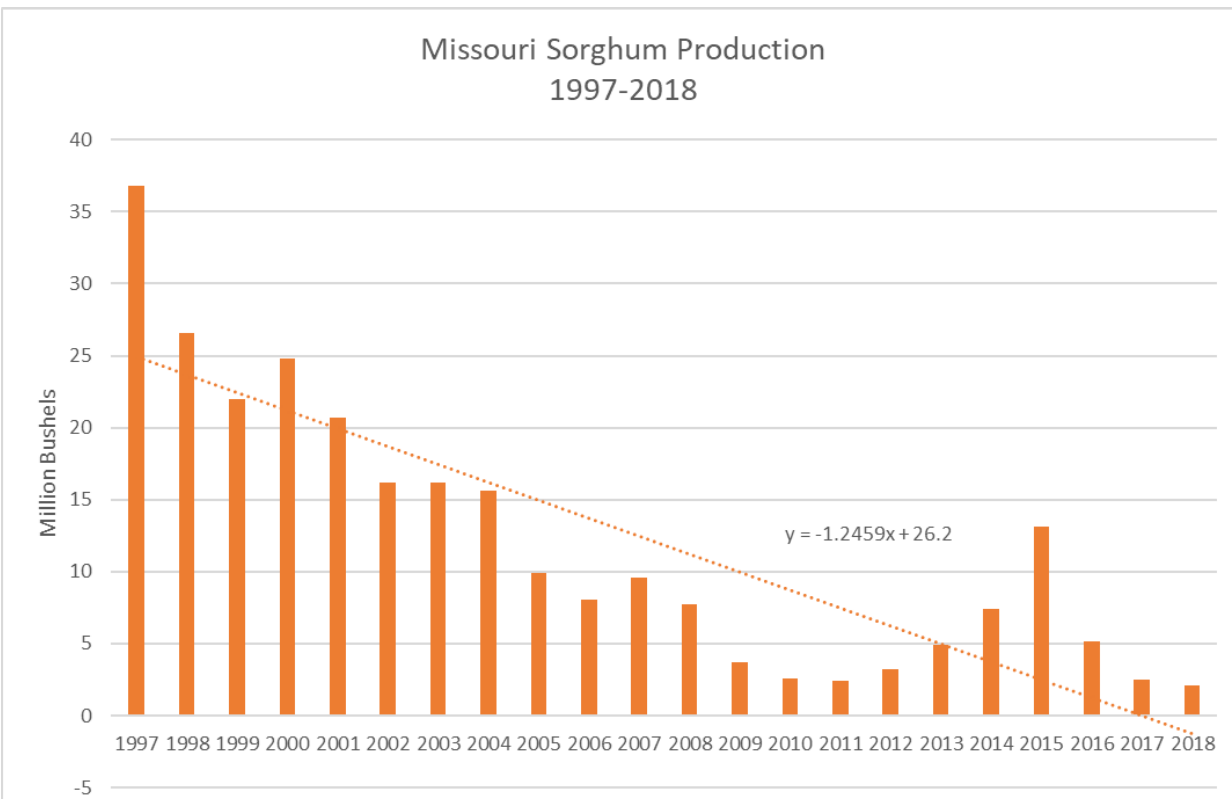


Figure 5, Missouri Sorghum Production 1997-2018

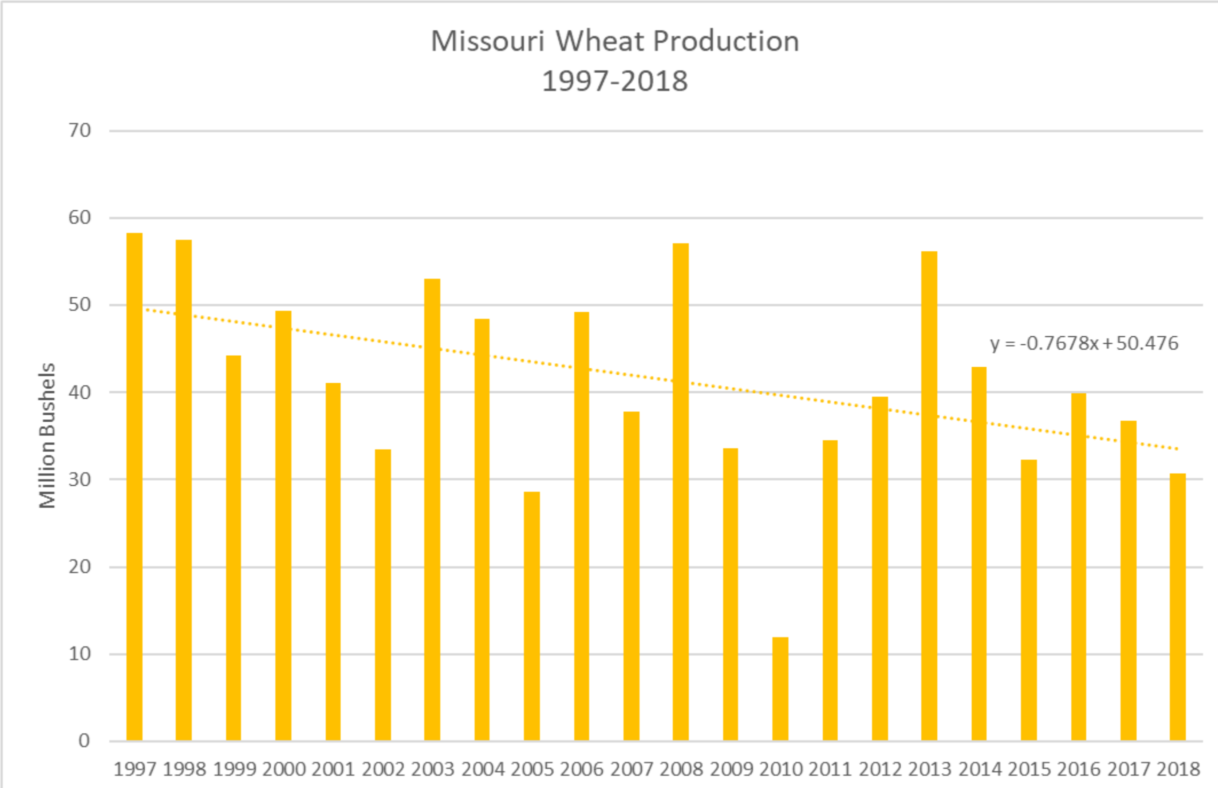


Figure 6, Missouri Wheat Production 1997-2018

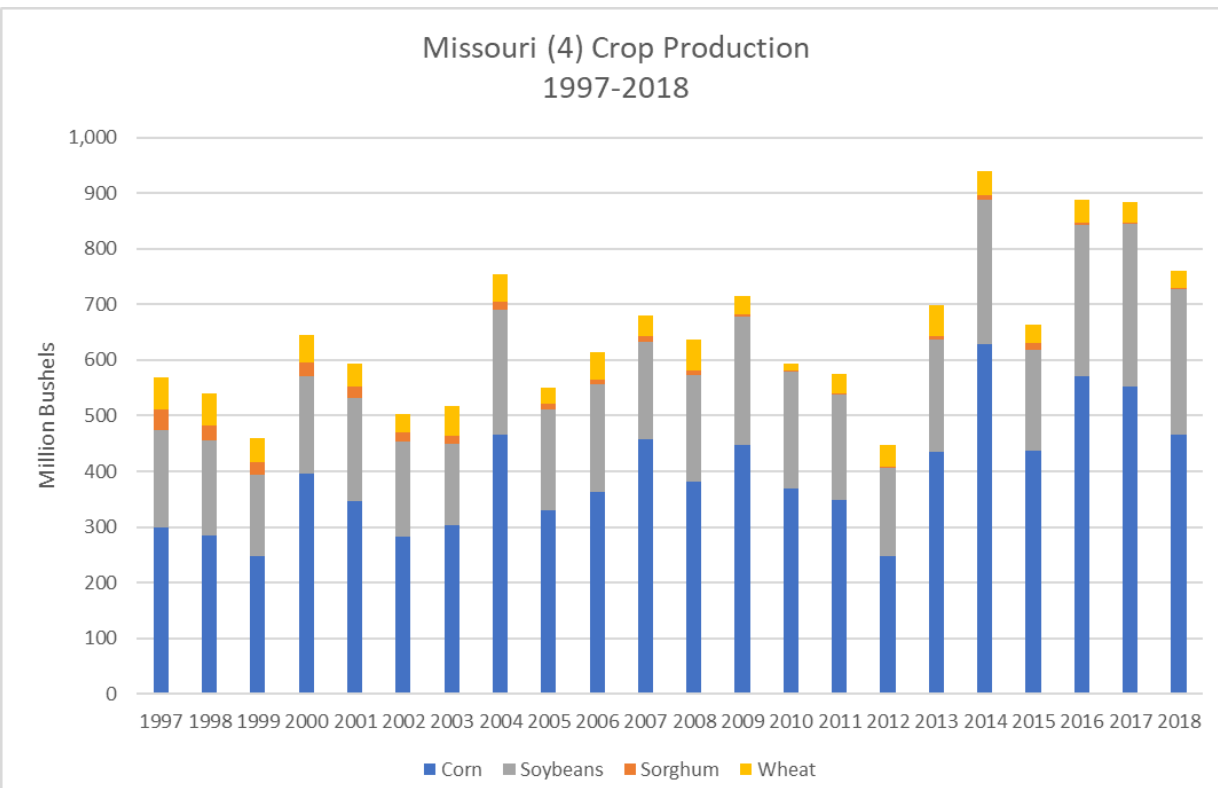


Figure 7, Missouri Crop Production 1997-2018 (Corn, Soybeans, Sorghum, and Wheat)

With the shift of production from grain sorghum and wheat to corn and soybeans, along with higher yields over time, there is an increasing trend for total annual crop tonnage in Missouri. From 1997 to present, total annual tonnage of crops in Missouri is increasing, on average, by 231,000 tons annually. In recent years, total crop tonnage has been between 12 million tons and 16.4 million tons.

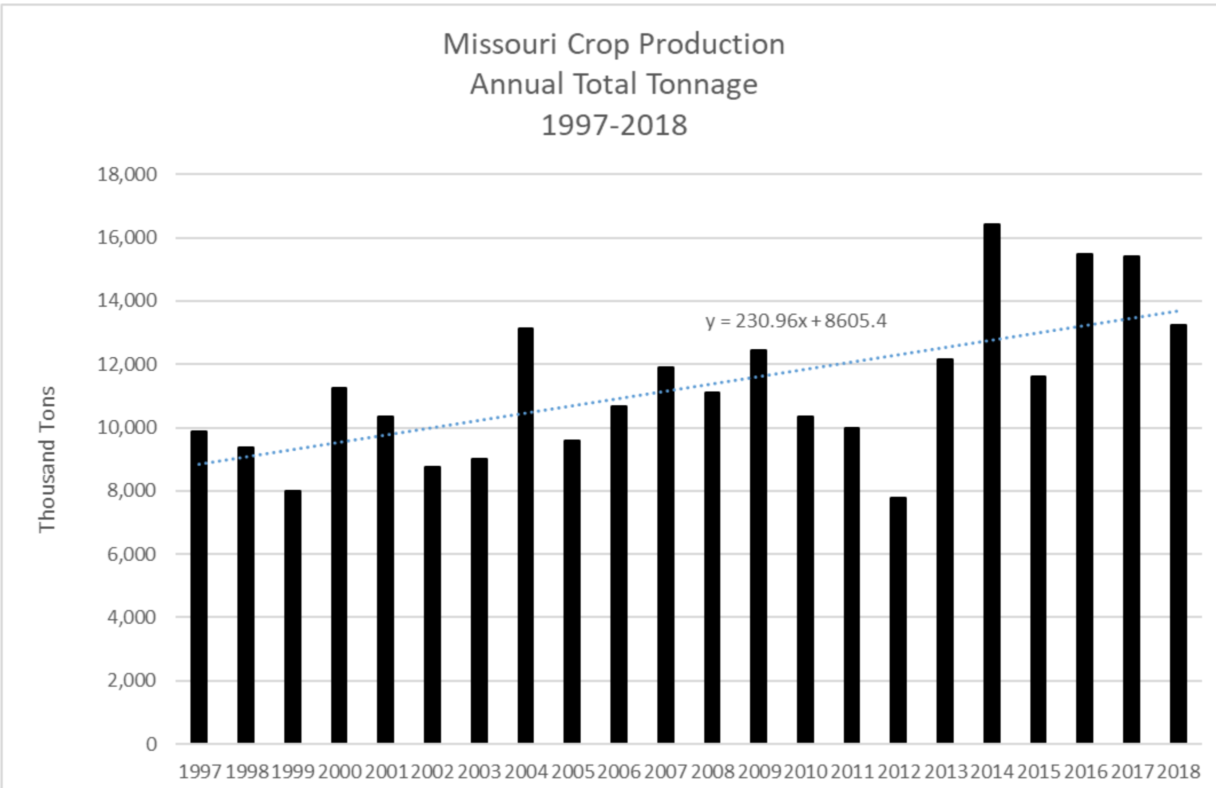


Figure 8, Missouri Crop Production Annual Total Tonnage 1997-2018

Missouri Crop Production and Primary Crop Utilization by County

The following maps have crop production and primary crop utilization data for 2017, which is the underlying year of reference for this analysis, particularly for the commodity flow component.

Corn

Corn Production 2017

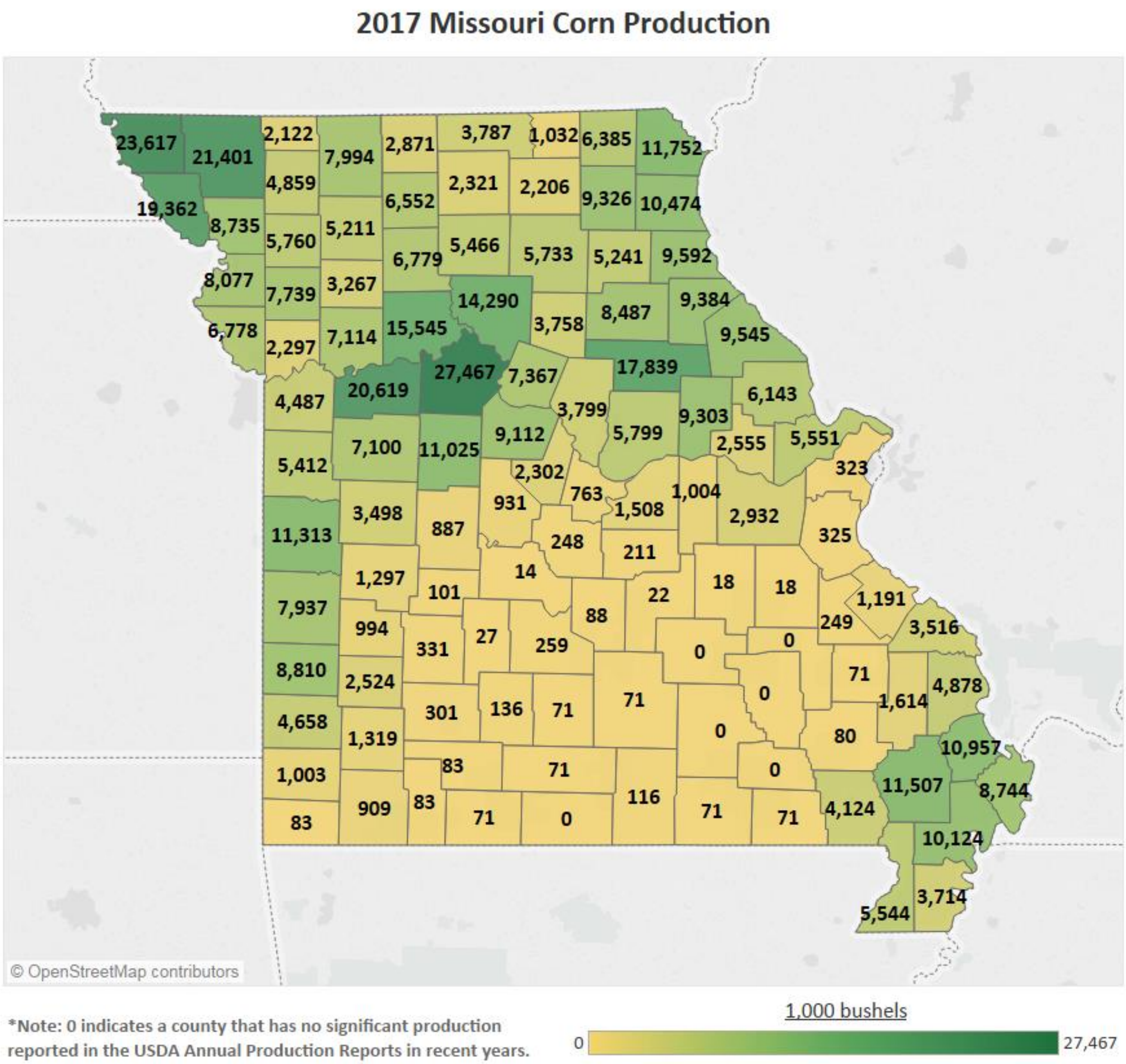


Figure 9, 2017 Missouri Corn Production

Corn production is primarily seen in the northern half of Missouri and in the "boot heel" counties, although USDA reports measurable corn production in all but six of Missouri's counties. Corn production is most prevalent in northwest Missouri, in the counties on either side of the Missouri River in west-central Missouri, in the counties along the Mississippi River in northeastern Missouri and in the Boot heel counties. There is little corn production in the Ozark Plateau region.

USDA does not report corn production data for every county in Missouri every year, but does report data for each crop reporting district in Missouri. Counties for which data were not reported by USDA in 2017 was calculated by DIS based on the historical share of production that a county has of its crop reporting district.

In 2017, Missouri had 4 counties with more than 20 million bushels of corn production (Atchison, Lafayette, Nodaway, and Saline); 11 counties with corn production between 10 million bushels and 20 million bushels; 60 counties with corn production between 1 and 10 million bushels and 39 counties with less than 1 million bushels of corn production.

Percent of Missouri 2017 Corn Production by County

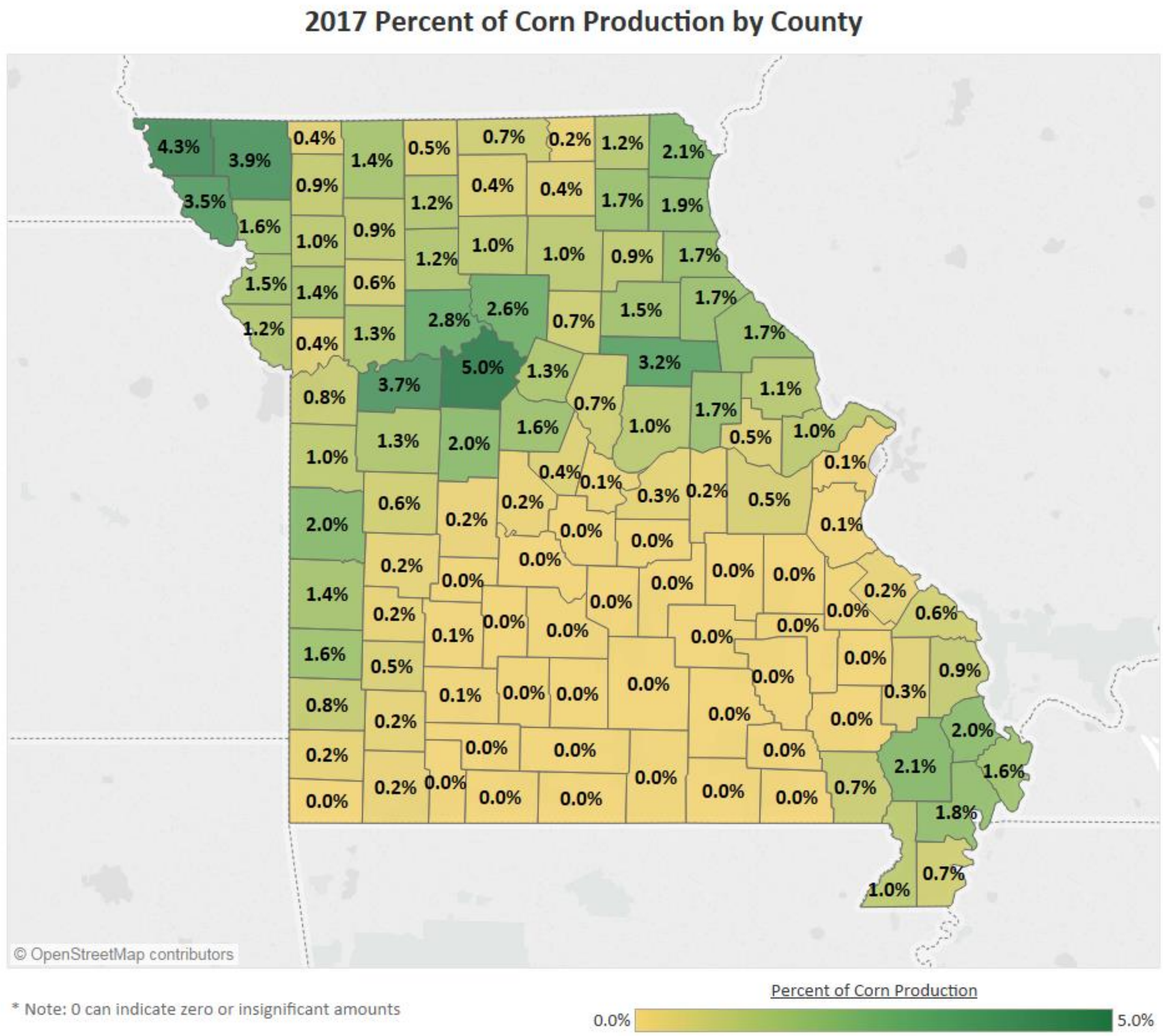


Figure 10, 2017 Percent of Missouri Corn Production by County

Another way to visualize the distribution of Missouri corn production is to see county-level production as a percent of total state production. Referring to Figure 10, Saline County accounts for 5% of Missouri corn production and is the only county to reach the 5% production share level. Saline County and the seven counties that surround Saline County account for 20.3% of Missouri's corn production and is the most concentrated area for corn production. The four counties in far northwest Missouri account for 13.3% of the state's corn production and is the second most concentrated area of corn production. The seven counties that border the Mississippi River north of St. Louis account for 9.5% of the state's corn production and are a significant source of corn for export shipments. Similarly, the six counties in the boot heel region account for 9.2% of Missouri's corn production and, with close proximity to the Mississippi River, primarily provide supplies for exports.

Corn Fed

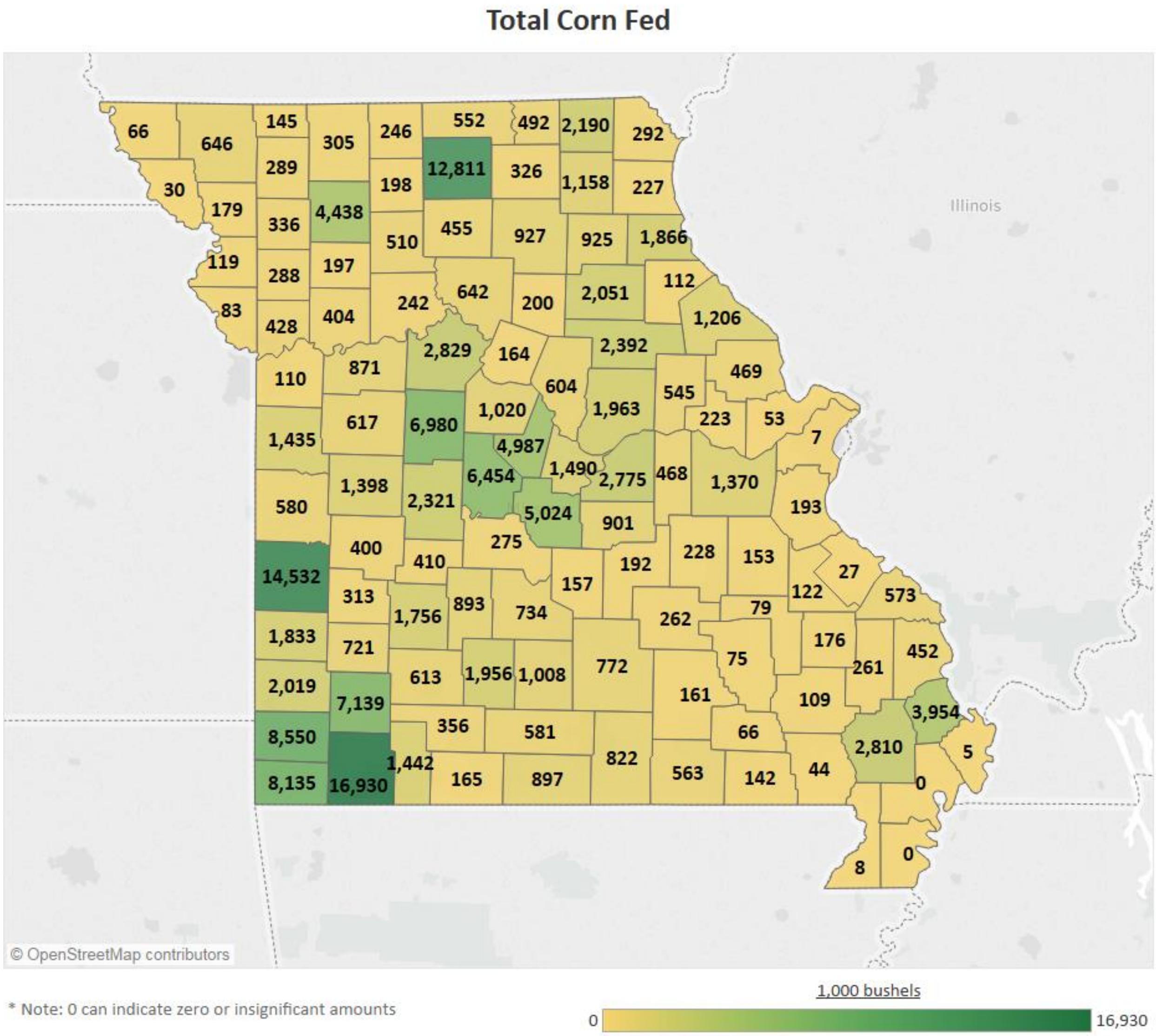


Figure 11, Corn Fed by County in 2017

Figure 11 shows that corn utilization is spread more evenly across the state although there are some high-use areas where there is an increased concentration of livestock and/or poultry production. According to other work completed by DIS, for Missouri as a whole, an estimated 30 percent of the corn grown in Missouri is used as livestock and poultry feed within the state. Of this 30 percent, by species, 6% is used for beef cattle, 11% for pork production, 3% for turkey production, 7% for broiler chicken production, 1% for dairy production, and 2% for egg layer production.

Net County Corn Balance

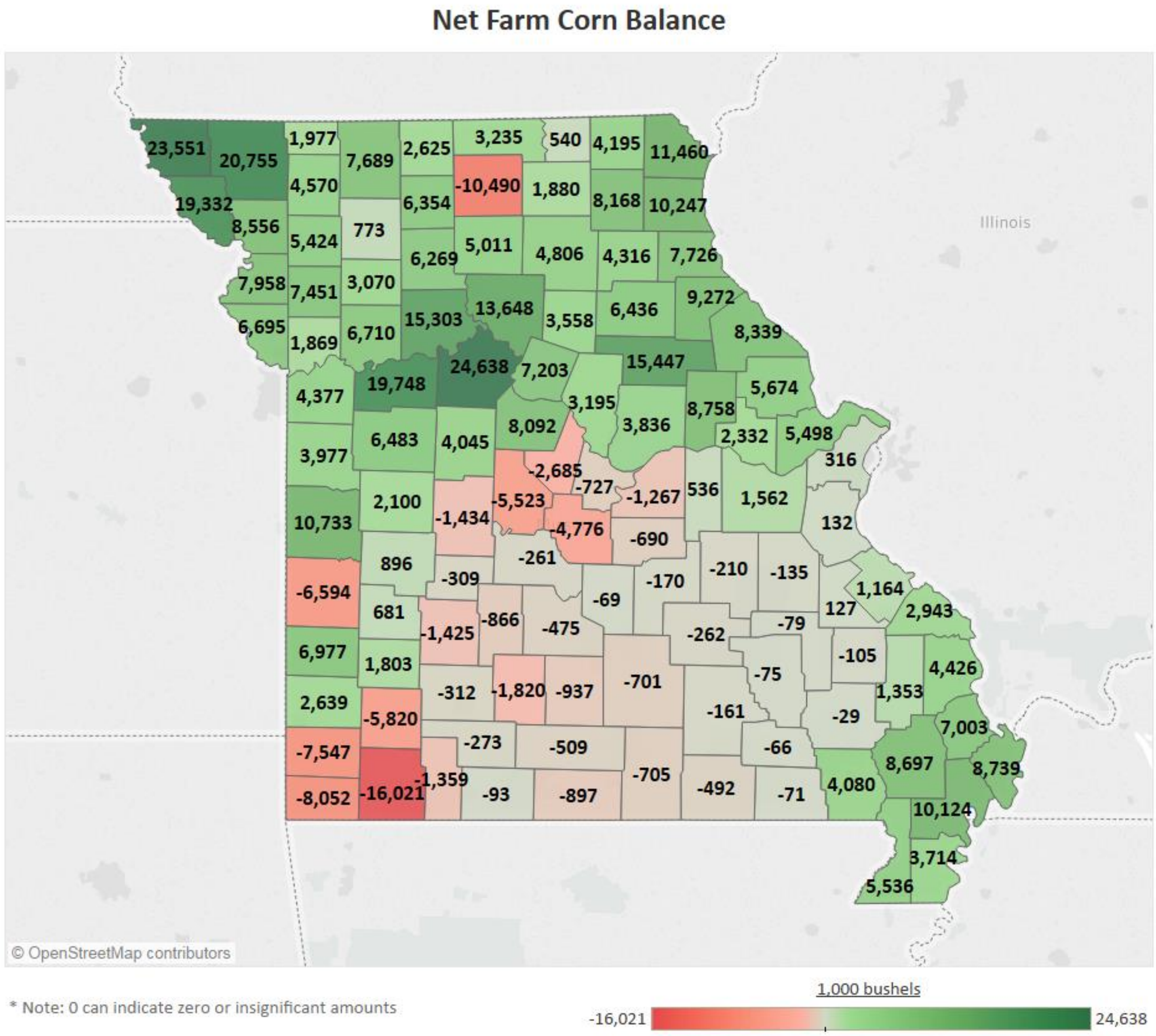


Figure 12, Net Corn Balance

After accounting for in-county feed demand, in Missouri, there are 72 corn "surplus" counties and 41 corn deficit counties (see Figure 12). Thirty-two of the corn deficit counties have relatively minor deficits of less than 2 million bushels per year (using 2017 as a base). Nine counties have significantly greater deficits with Barry County having the greatest corn deficit of more than 16 million bushels per year. Sullivan County has a deficit of 10 million bushels per year.

The greatest surplus corn counties with more than 20 million bushels beyond local usage needs (feed and ethanol) are Saline, Atchison, and Nodaway counties. Counties with 15 to 20 million bushels of corn available beyond local usage are: Audrain, Holt, and Lafayette. Counties with 10-15 million bushels available are: Bates, Carroll, Chariton, Clark, and Lewis.

Ethanol Processing

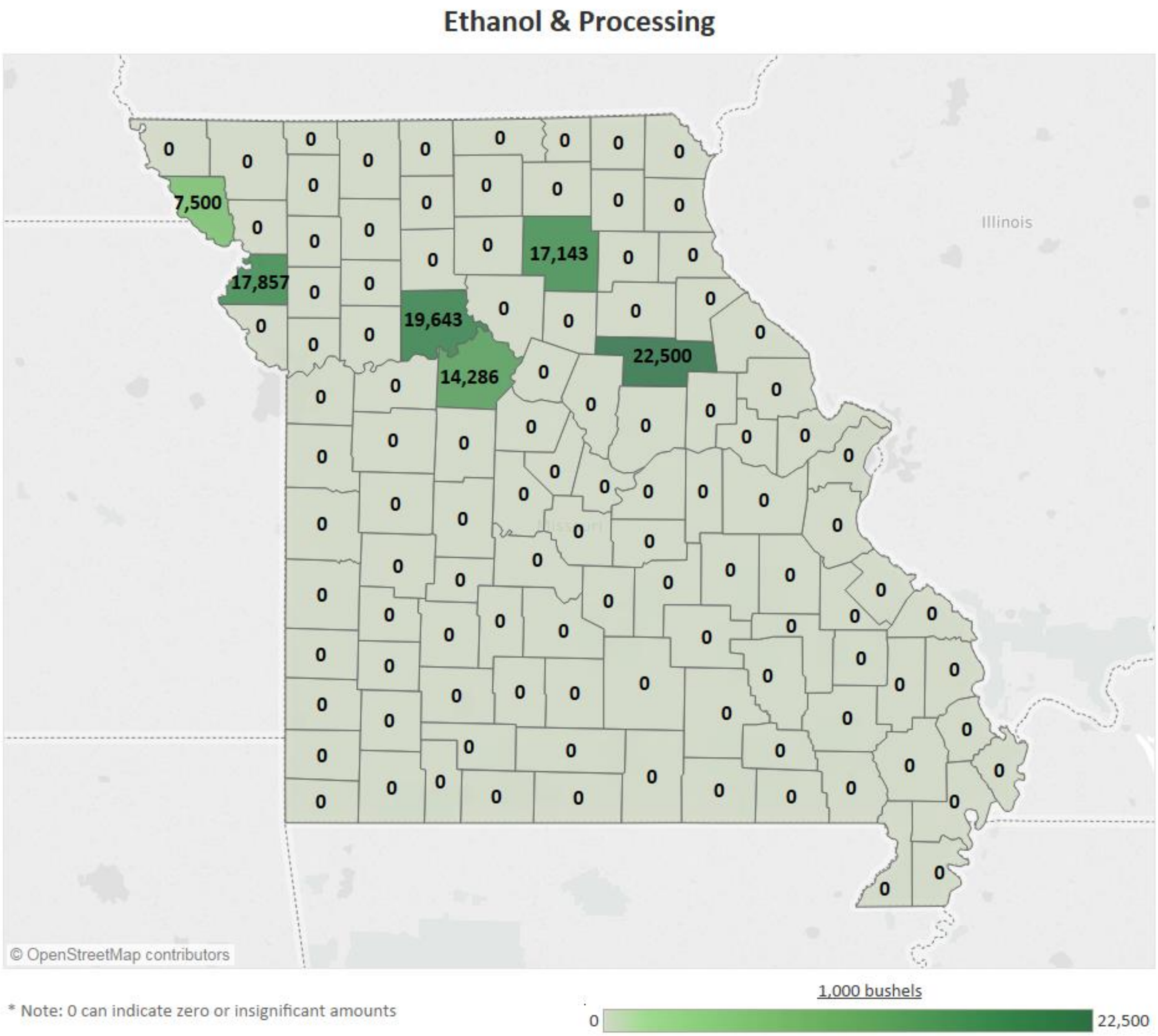


Figure 13 Ethanol Processing Capacity

Figure 13 shows that Missouri has ethanol production in 6 counties: Audrain, Buchanan, Carroll, Holt, Macon, and Saline. Combined, these plants use approximately 99 million bushels annually.

Corn Available for Outflows

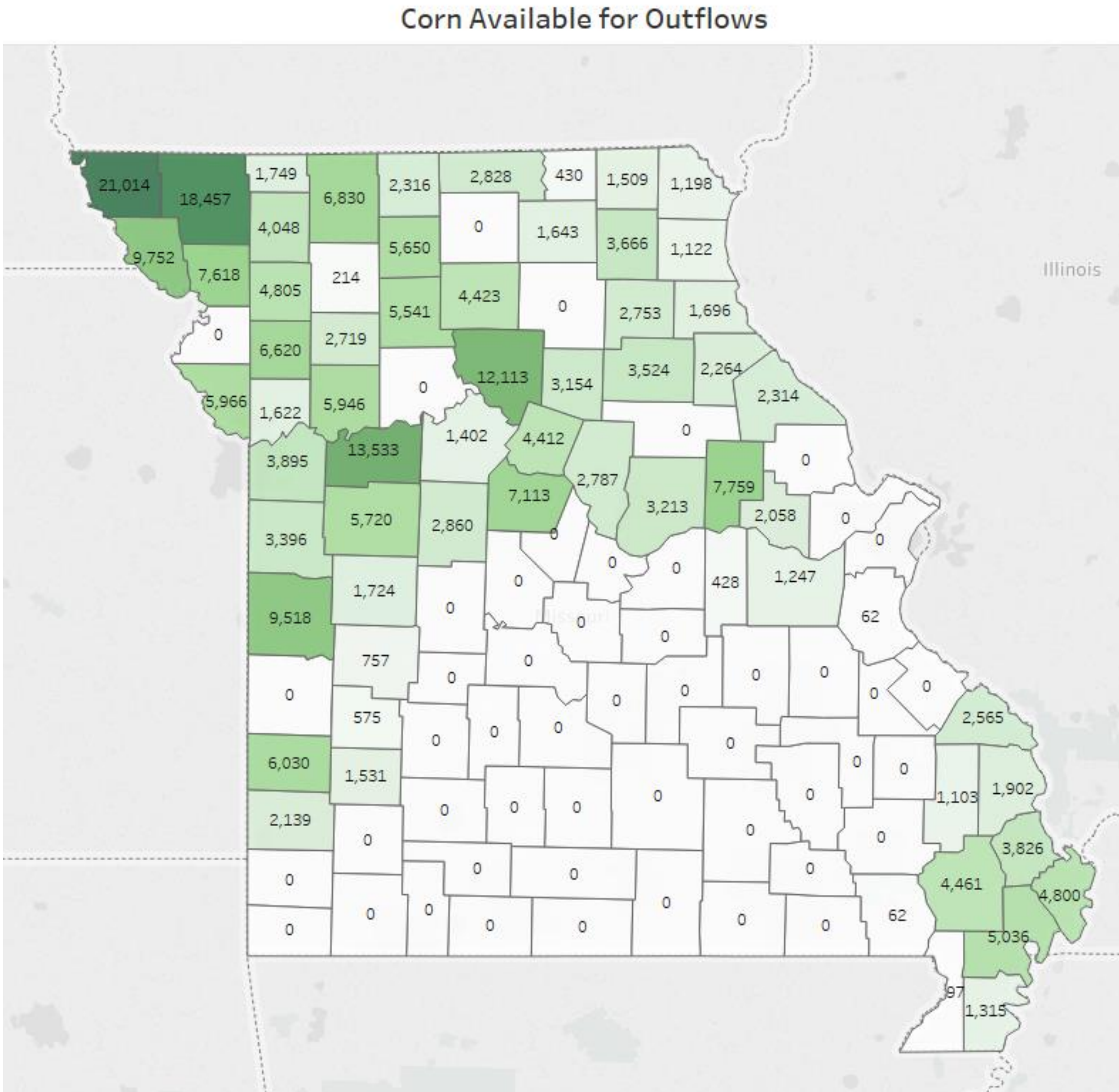


Figure 14 Corn Available for Outflows

Once in-county corn is used to satisfy (or partially satisfy) demand for feed and ethanol use, Figure 14 shows the amount of corn by county that is available to satisfy feed and ethanol demands in other counties.

In general, surplus corn from counties along the Mississippi River and the next tier of counties westward is shipped to export markets via river barges and railroad. Nearly all of that corn will move from farm to local grain elevators or directly to barge terminals via truck.

The ethanol plants in northern Missouri, and the feed demand in northern Missouri are satisfied by corn movement from adjacent counties. The vast majority of this corn moves by truck.

A significant portion of the feed mill demand for corn in southwestern Missouri moves via truck with corn from west central Missouri meeting those demands first, but corn from northwestern Missouri also flows to southwestern Missouri, northwest Arkansas and northeastern Oklahoma feed mills.

Feed Mill Inflows by County

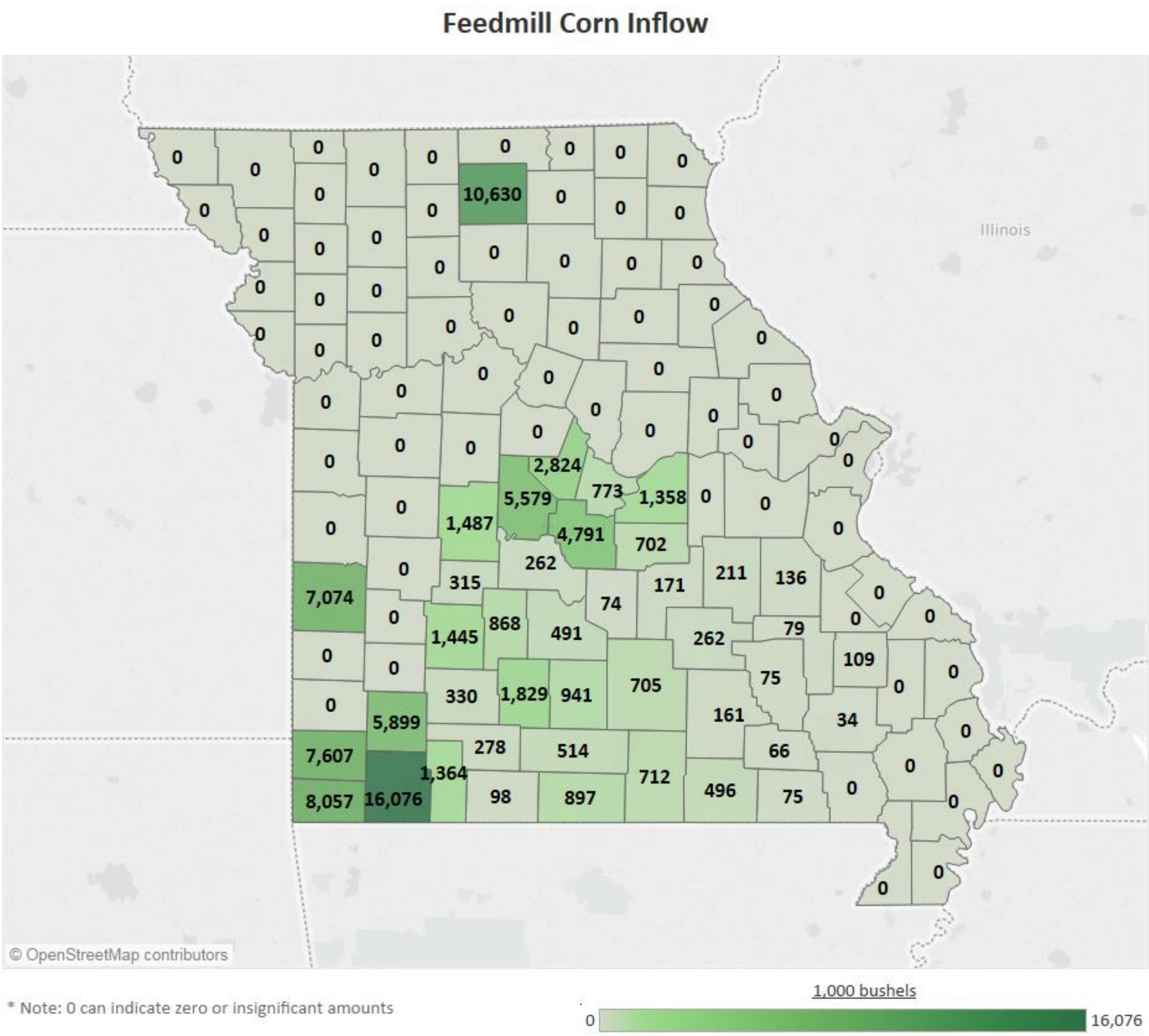


Figure 15, Feed Mill Inflows by County

Figure 15 shows counties in which feed mills need to secure corn from outside the county to meet feed needs are mostly located in central Missouri and southwestern Missouri (the exception being Sullivan County in northern Missouri. Additionally, most counties in the Ozarks need to bring in small to moderate amounts of corn for feed mills.

Corn Inflows for Ethanol Production

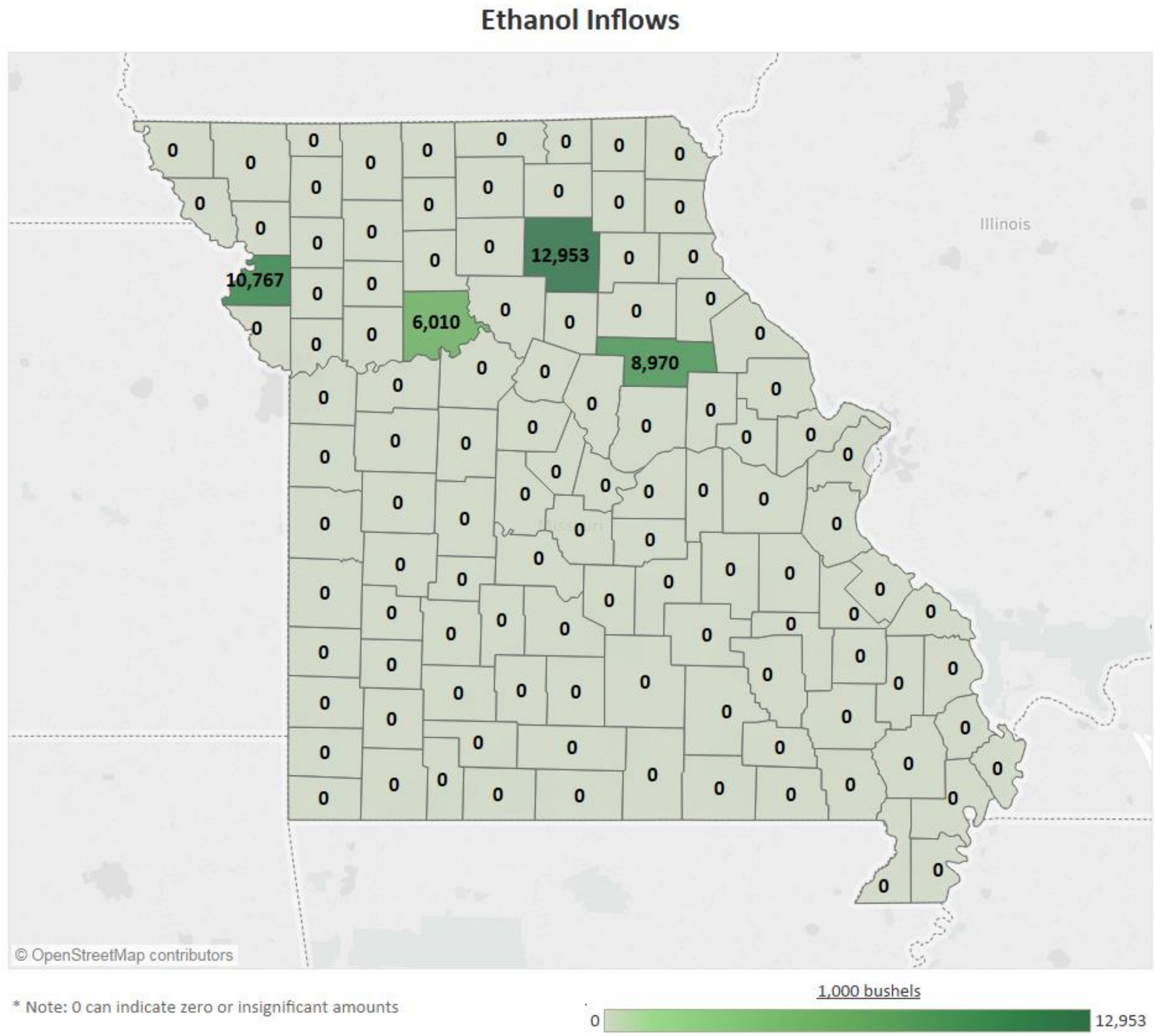


Figure 16, Ethanol Inflows

Figure 16 shows the counties that are corn deficit relative to the county's demand for corn for ethanol production. To satisfy ethanol production demand, Audrain County needs to import about 9 million bushels of corn annually, Buchanan County imports 10.8 million bushels, Carroll County imports 6 million bushels, and Macon County imports 13 million bushels. Holt County has sufficient in-county supplies of corn to meet its feed and ethanol demand with more than 8.4 million bushels available for movement out of county or to export. Saline County has sufficient in-county production to satisfy feed demand and usage for ethanol and still has 10 million bushels remaining for export.

Corn Inflows for Feed and Ethanol

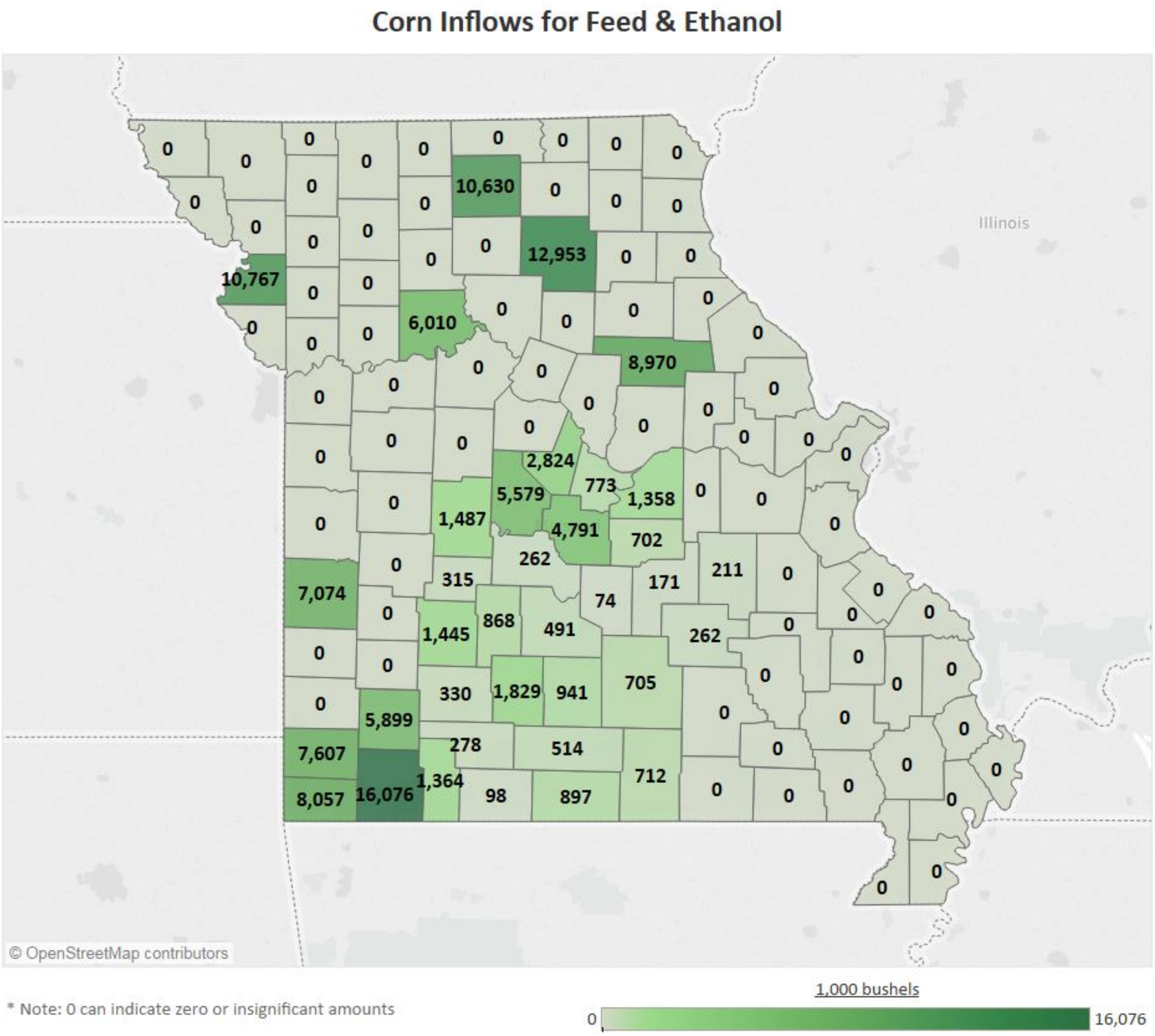


Figure 17, Corn Inflows for Feed mills and Ethanol Production

Figure 17 shows the Missouri counties that are corn deficit and need corn inflows to meet feed mill and ethanol production demand. There are 9 counties with relatively large combined net inflows of corn (more than 6 million bushels per year) to satisfy feed mills and ethanol production demand. These are Audrain, Barry, Buchanan, Carroll, McDonald, Macon, Newton, Sullivan, and Vernon. Lawrence, Morgan and Miller counties need inflows of 4.7 to 5.9 million bushels.

Corn Outflows for Feed and Ethanol

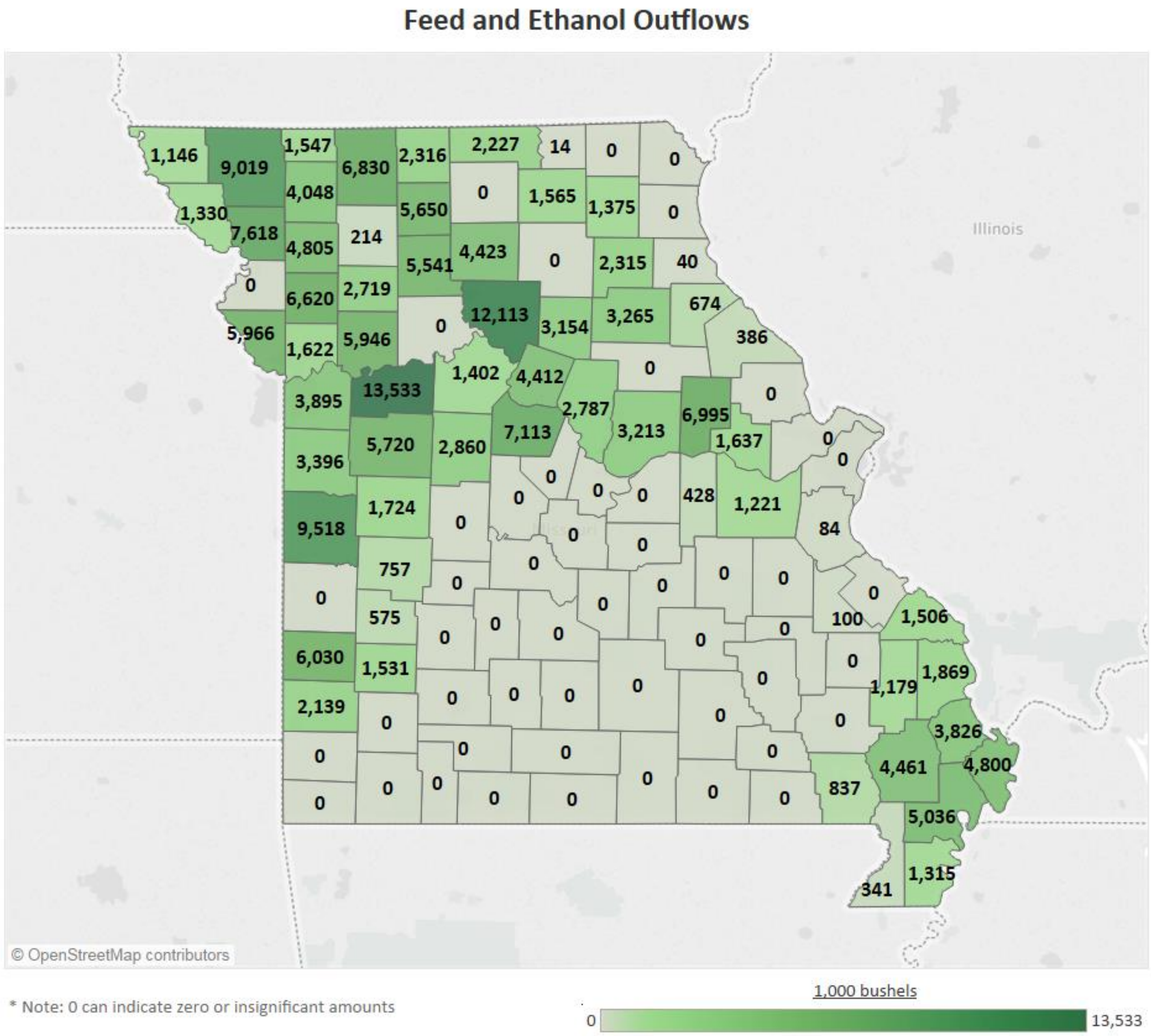


Figure 18 Corn Outflows for Feed and Ethanol

Figure 18 shows corn outflows for feed mill demand and ethanol production in other counties. The outflows can be to feed and ethanol production demands within Missouri or in other states. Lafayette and Chariton counties lead the way in sending corn to other counties, at 13 and 12 million bushels respectively. Other counties that provide at least 5 million bushels of corn to other counties are: Andrew, Nodaway, Bates, Barton, Clinton, Cooper, Grundy, Harrison, Johnson, Livingston, Montgomery, New Madrid, Platte, and Ray,

Corn Exports

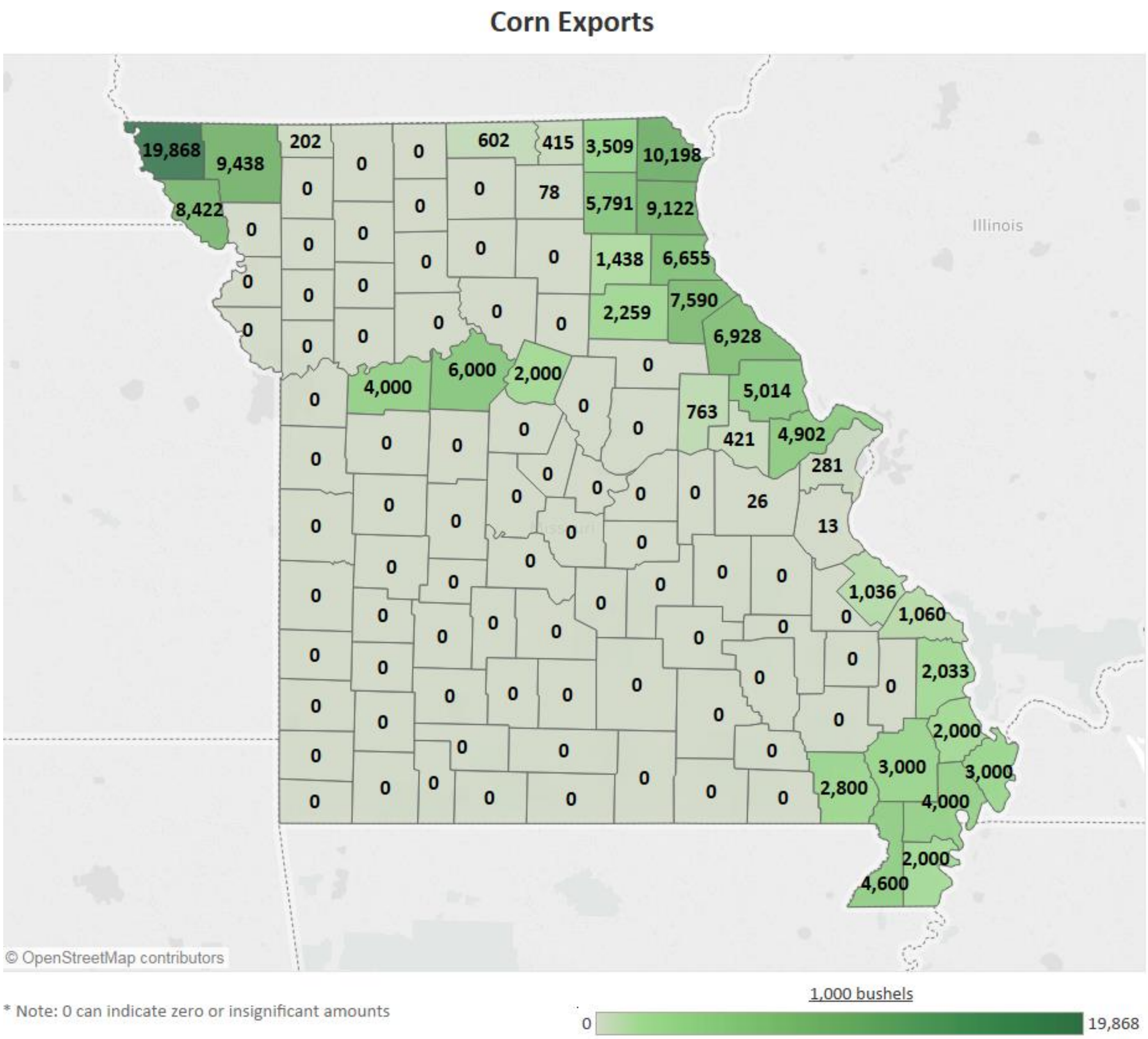


Figure 19, Corn Exports

Figure 19 shows estimated exports from Missouri counties for the 2017 marketing year. Based on 2017 data, Missouri exported 141 million bushels of corn. Atchison County had the most exported corn with 19.9 million bushels. Clark County was second in corn exports with 10.2 million bushels. A total of 35 Missouri counties have corn available for exports after satisfying domestic needs for in-county feeding, ethanol, and movement for domestic feed needs. Ten counties ship between 5 to 10 million bushels of corn for export; 16 counties ship between 1 million and 5 million bushels for export and eight counties ship between 13,000 and 1 million bushels for export.

Soybeans

Soybean Production 2017

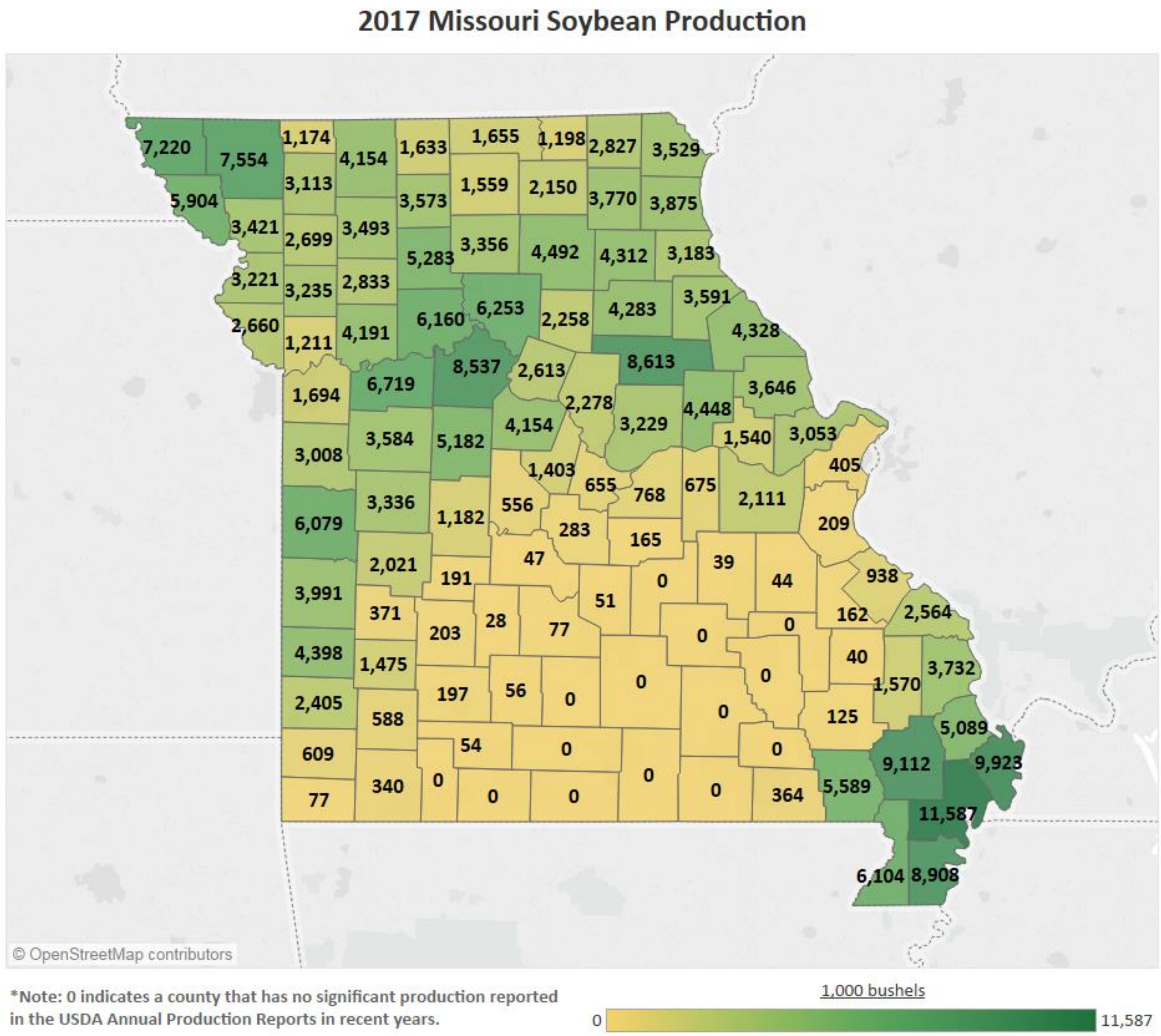


Figure 20, 2017 Missouri Soybean Production

Figure 20 shows that soybean production occurs in 99 of Missouri's counties with 17 counties producing more than 5 million bushels in 2017. New Madrid County led the state in production at more than 11 million bushels. The boot heel ag district produced 20.5% of Missouri's soybeans in 2017; the Northwest ag district produced 19.2%. Northeast Missouri produced 14.5% of the soybeans, Northcentral Missouri produced 13.5%, Central Missouri produced 10.8% and East Central Missouri produced 10.5%.

Percent of Missouri 2017 Soybean Production by County

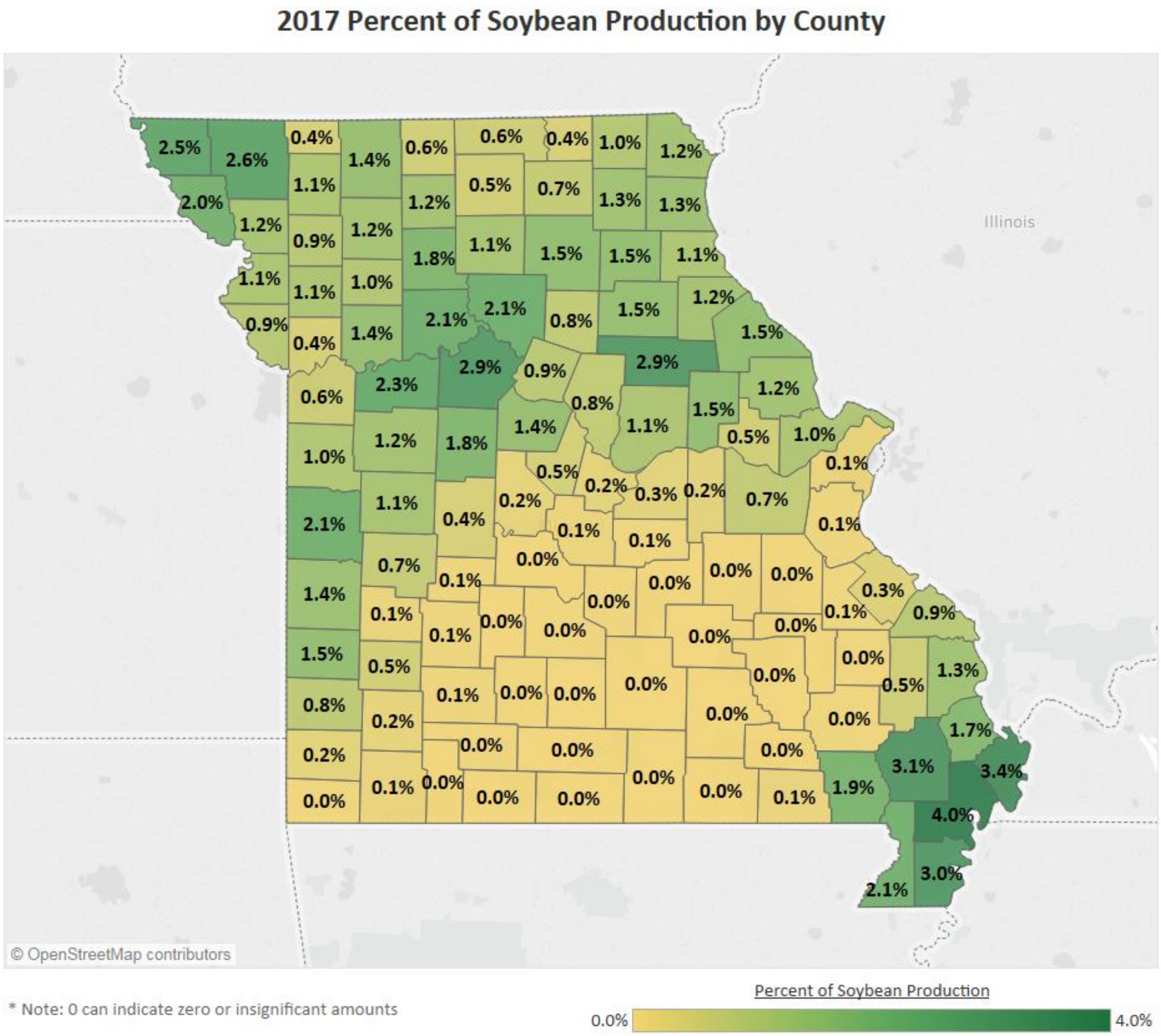


Figure 21, 2017 Percent of Soybean Production by County

Figure 21 shows that compared to corn (see Figure 10), there is less dominance of soybean production by any single county in Missouri. New Madrid County leads the state with 4% of Missouri's soybean production and is the only county to top 4% of production. There are only 3 counties (all in the boot heel region) with 3% to 3.9% of production and 10 counties with 2.0-2.9% of state production.

Soybean Processing

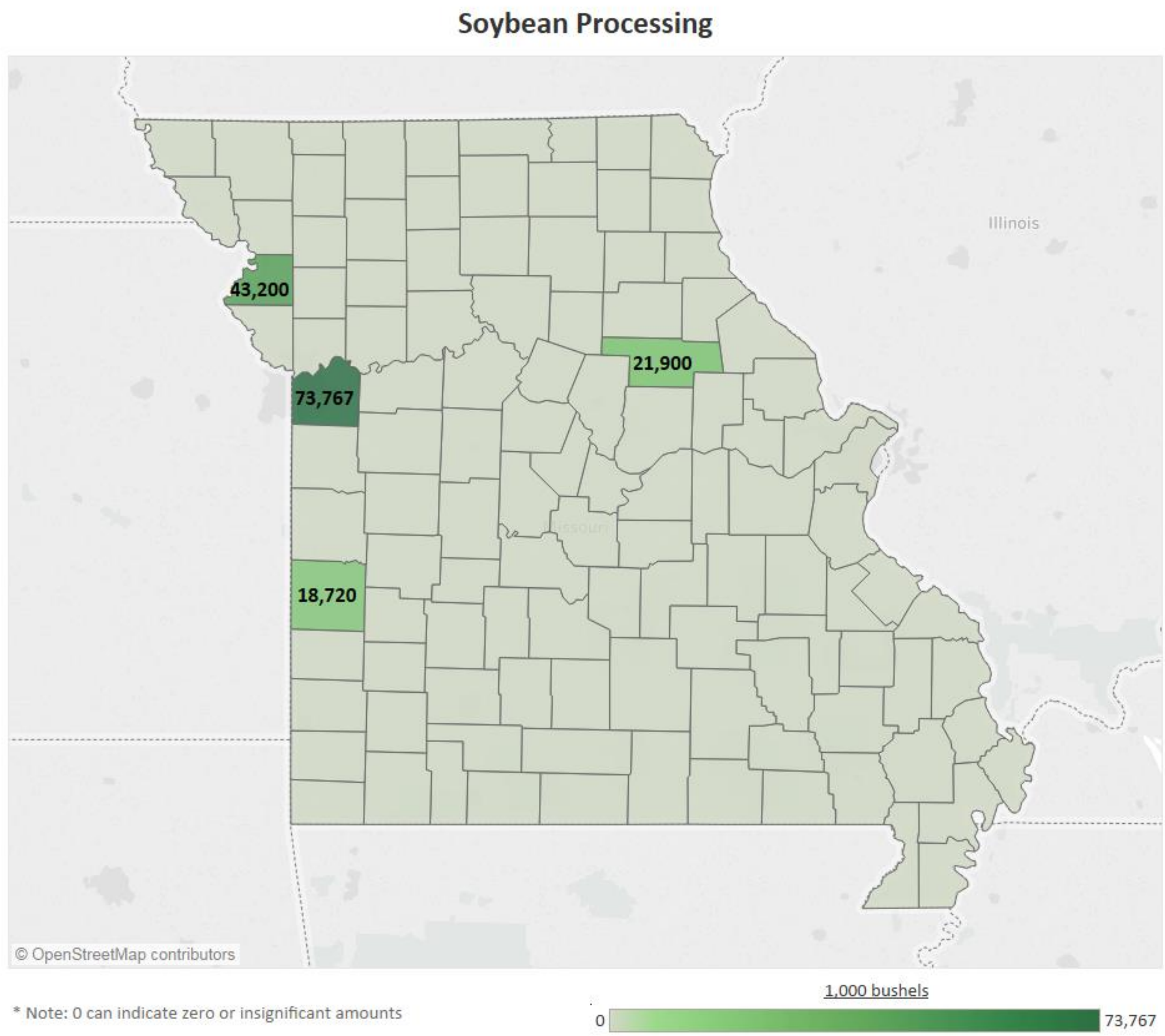


Figure 22 Soybean Processing in Missouri

Figure 22 shows the annual quantity of soybeans (1,000 bu) processed in each Missouri county. There are soybean crush facilities in 4 Missouri counties with 157.5 million bushels of total soybean crush capacity. Jackson County has estimated crush capacity of 73.8 million bushels; Buchanan County crush capacity is 43.2 million bushels; Audrain County has 21.9 million bushels of crush capacity and Vernon County has 18.7 million bushels of crush capacity.

Net County Soybean Balance

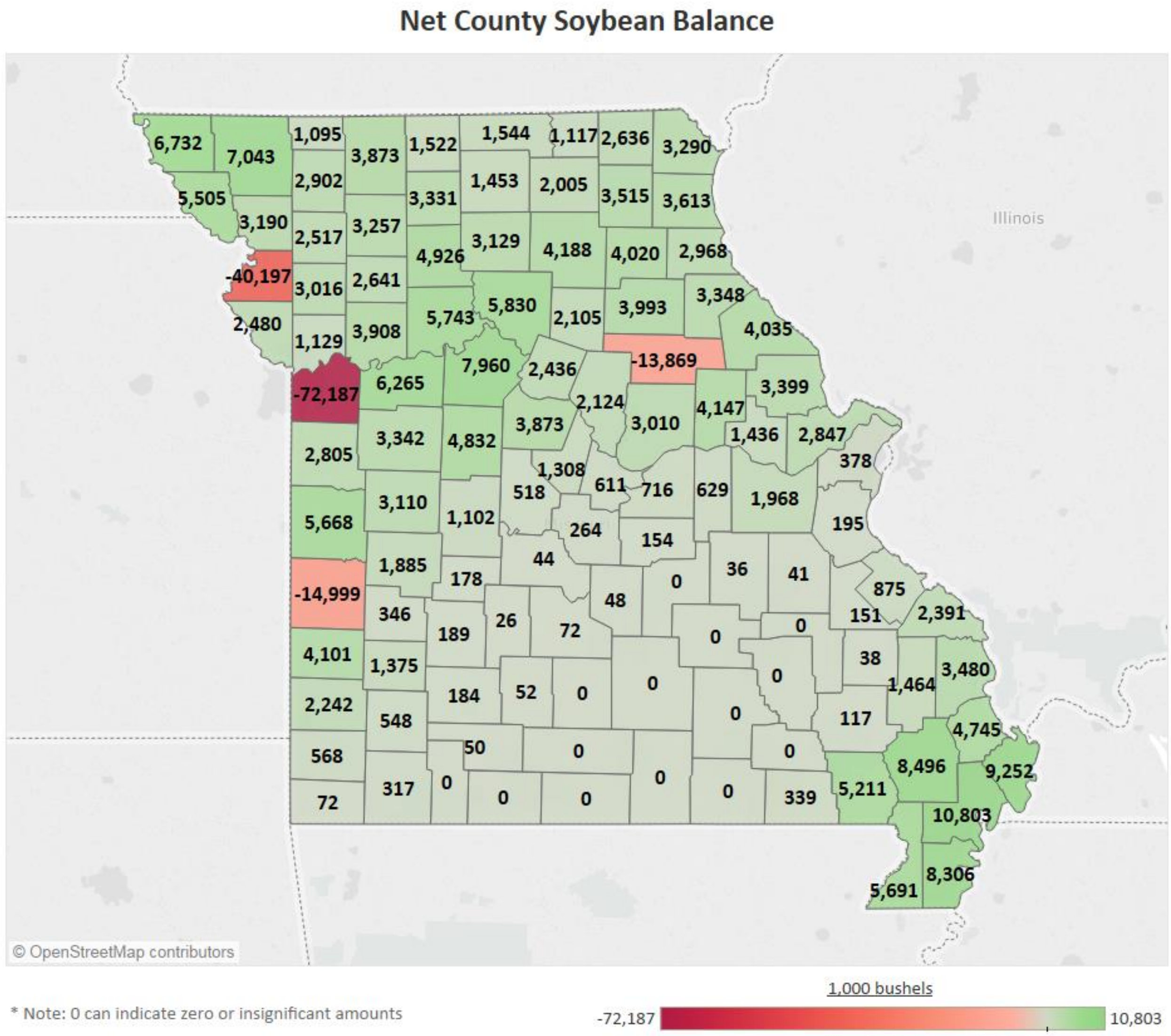


Figure 23, Net County Soybean Balance

Figure 23 shows the net balance for soybeans in a county after accounting for production, ending stocks, and in-county demand for crushing. Counties with negative numbers reflect demand points that require inflows of soybeans to meet that demand. Counties with positive numbers have soybeans that are available for outflows for either domestic crush in other counties or, if not claimed for that, for export.

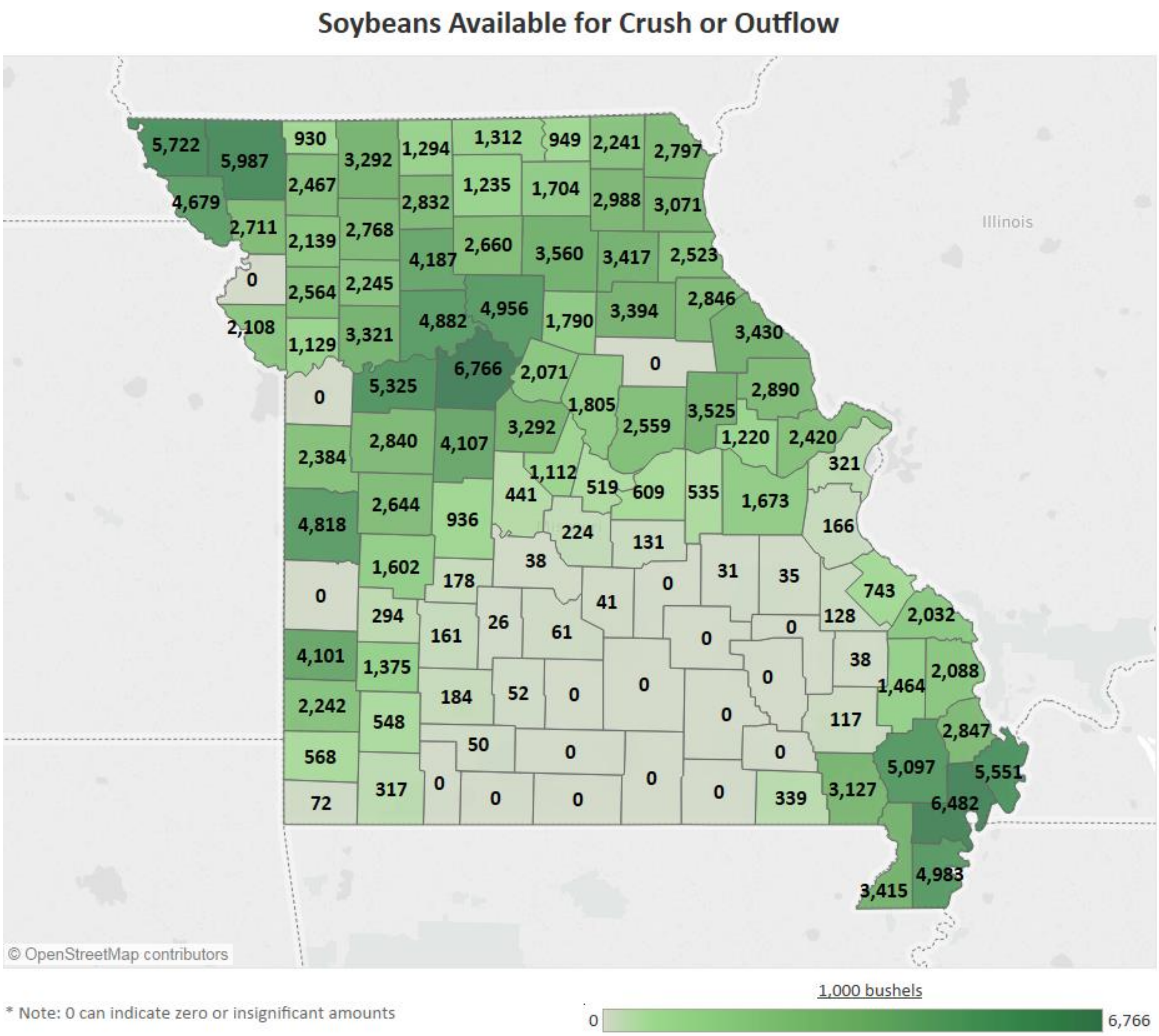


Figure 24, Soybeans Available for Crush or Outflow

Figure 24 shows the quantity of soybeans available for outflows to other counties for either domestic crush or exports. Soybeans within a county are allocated first to in-county demand for soybean crush, on-farm ending stocks or off-farm ending stocks.

Grain Sorghum

Missouri 2017 Grain Sorghum Production

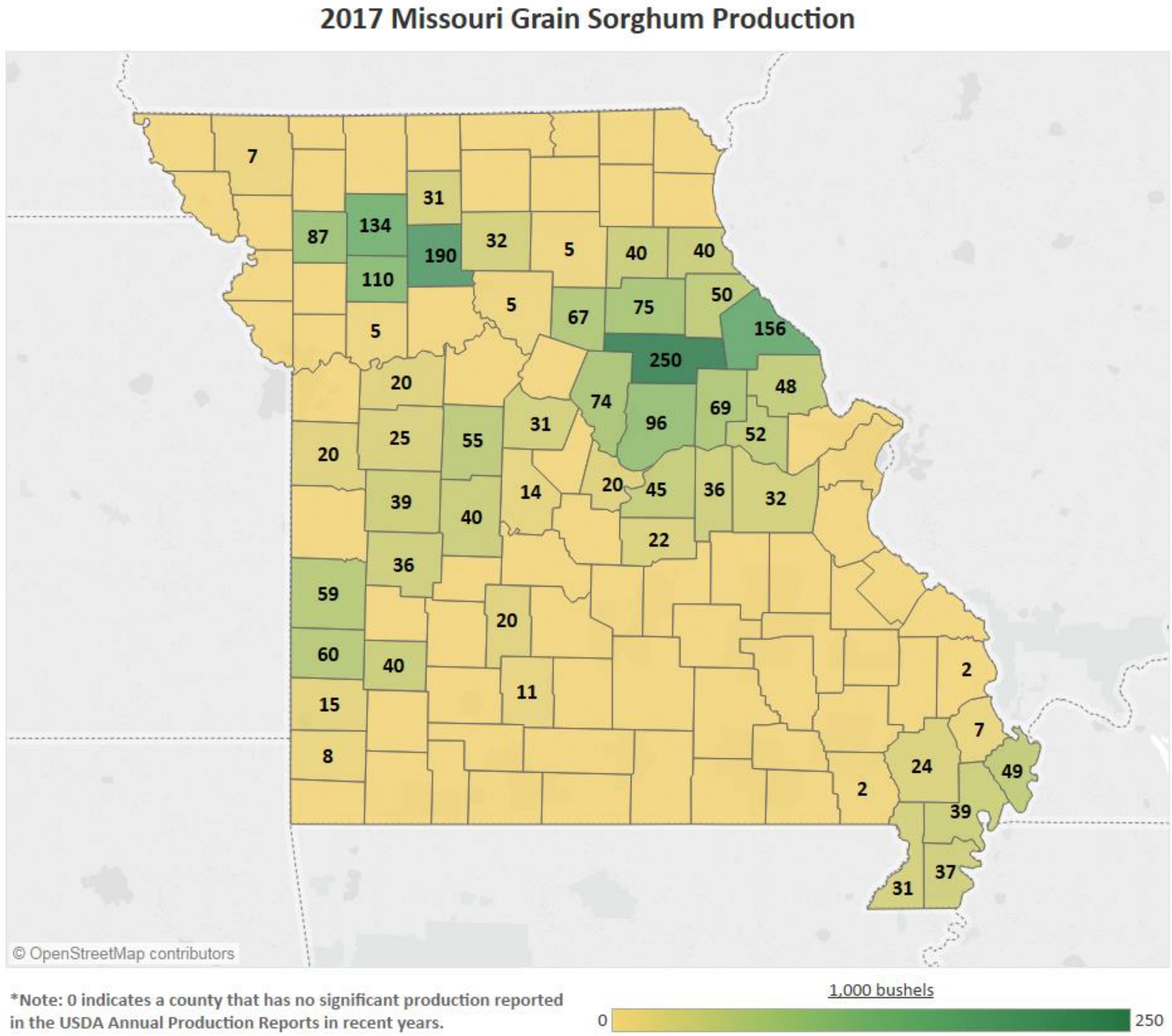


Figure 25 Missouri 2017 Grain Sorghum Production

Figure 25. Since 1990, USDA has reported grain sorghum production quantities for 84 of Missouri's 114 counties. Over the years, the number of counties for which USDA reports individual county grain sorghum production has declined. In 2017, USDA only reported grain sorghum production for one county, Osage. USDA did report grain sorghum production for 7 of the Crop Reporting Districts and reported districts 70 and 80 (southwest and southcentral districts) as a combined district number. DIS estimates that measurable grain sorghum production is occurring in 51 of Missouri counties and calculated county-level production based on county historical share of production at the Crop Reporting District level and based on DIS estimates of grain sorghum fed to livestock.

Missouri produced 2.461 million bushels of grain sorghum in 2017. By crop reporting district, the largest production area is in the northeastern district and east central Missouri district. Audrain, Livingstone, Pike, Daviess, and Caldwell and counties are the state's leading producers.

Percent of Missouri Grain Sorghum Production by County

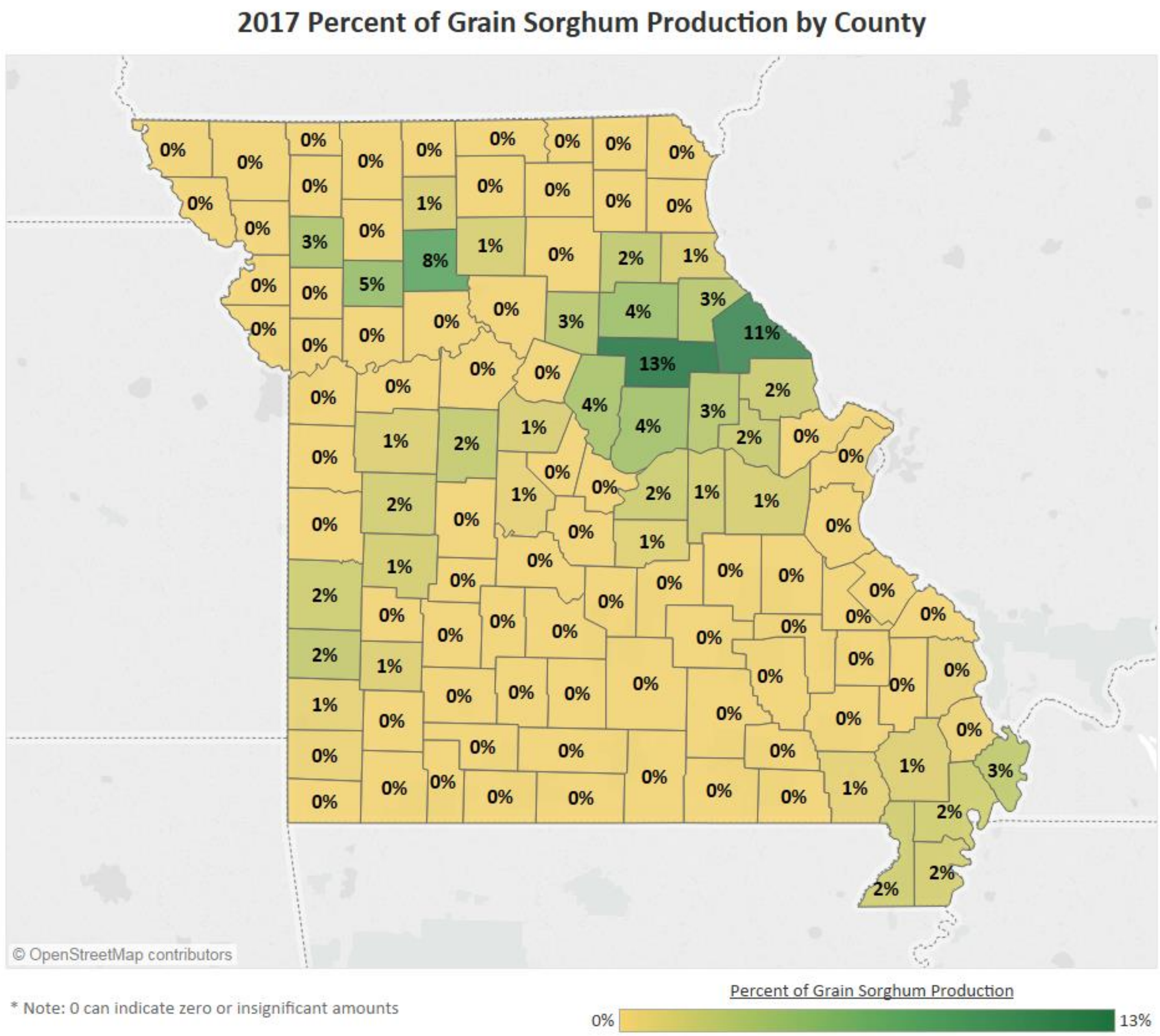


Figure 26, 2017 Percent of Grain Sorghum Production by County

Figure 26Grain sorghum production is concentrated in three areas of Missouri – east central Missouri, northwest Missouri, and the boot heel region.

Grain Sorghum Off-farm Stocks, Sept 1, 2018

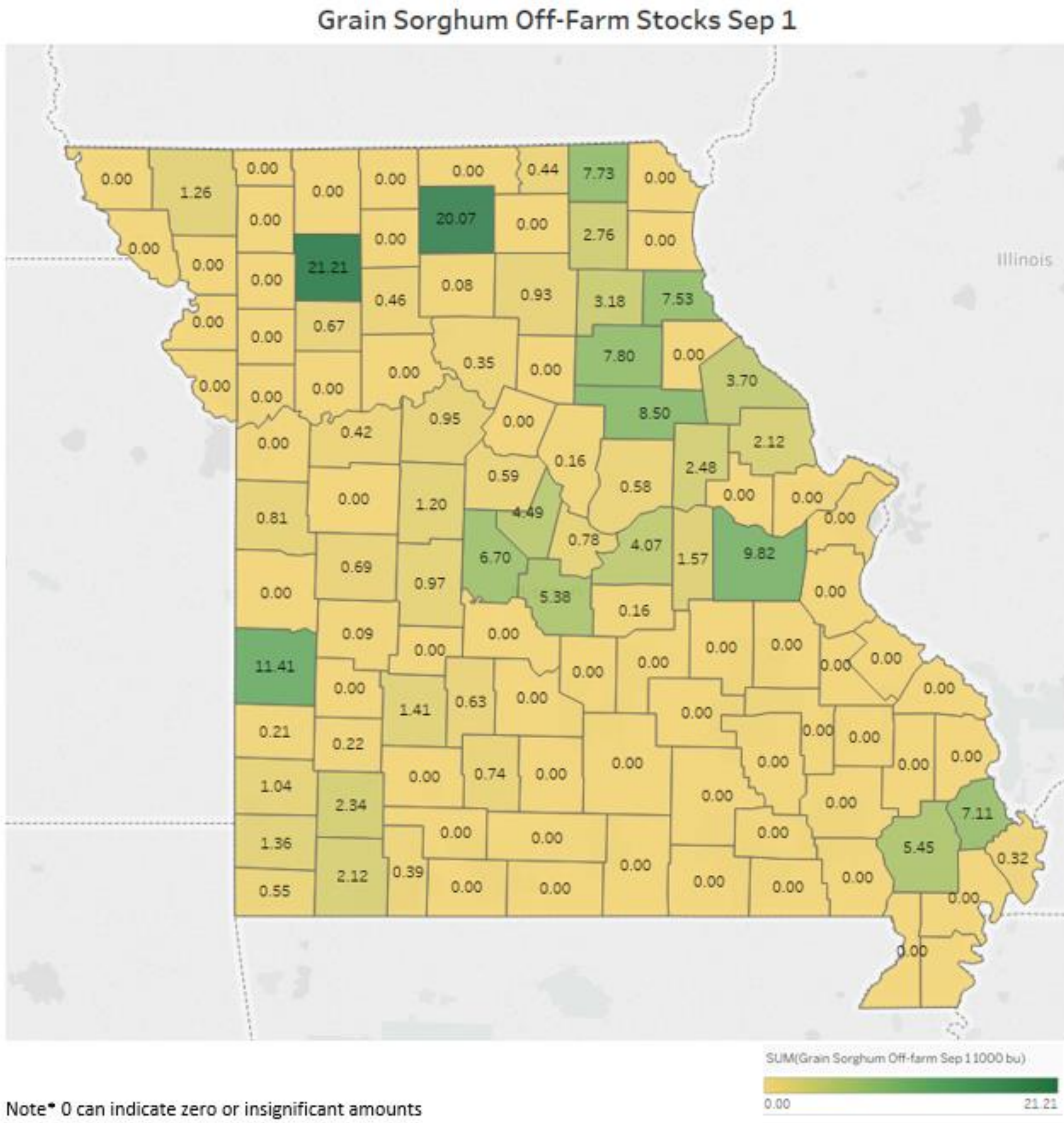


Figure 27 Grain Sorghum Off-farm Stocks Sept 1, 2018

Figure 27 shows estimated grain sorghum ending stocks in off-farm locations on September 1, 2018. USDA stocks data is available on a state-wide basis and was allocated to counties based on the percent of production in the county with an adjustment for counties that have significant inflows of grain sorghum for feed in which case 1 week of feed demand was assumed to be in storage on September 1.

Grain Sorghum On-farm Stocks, September 1, 2018

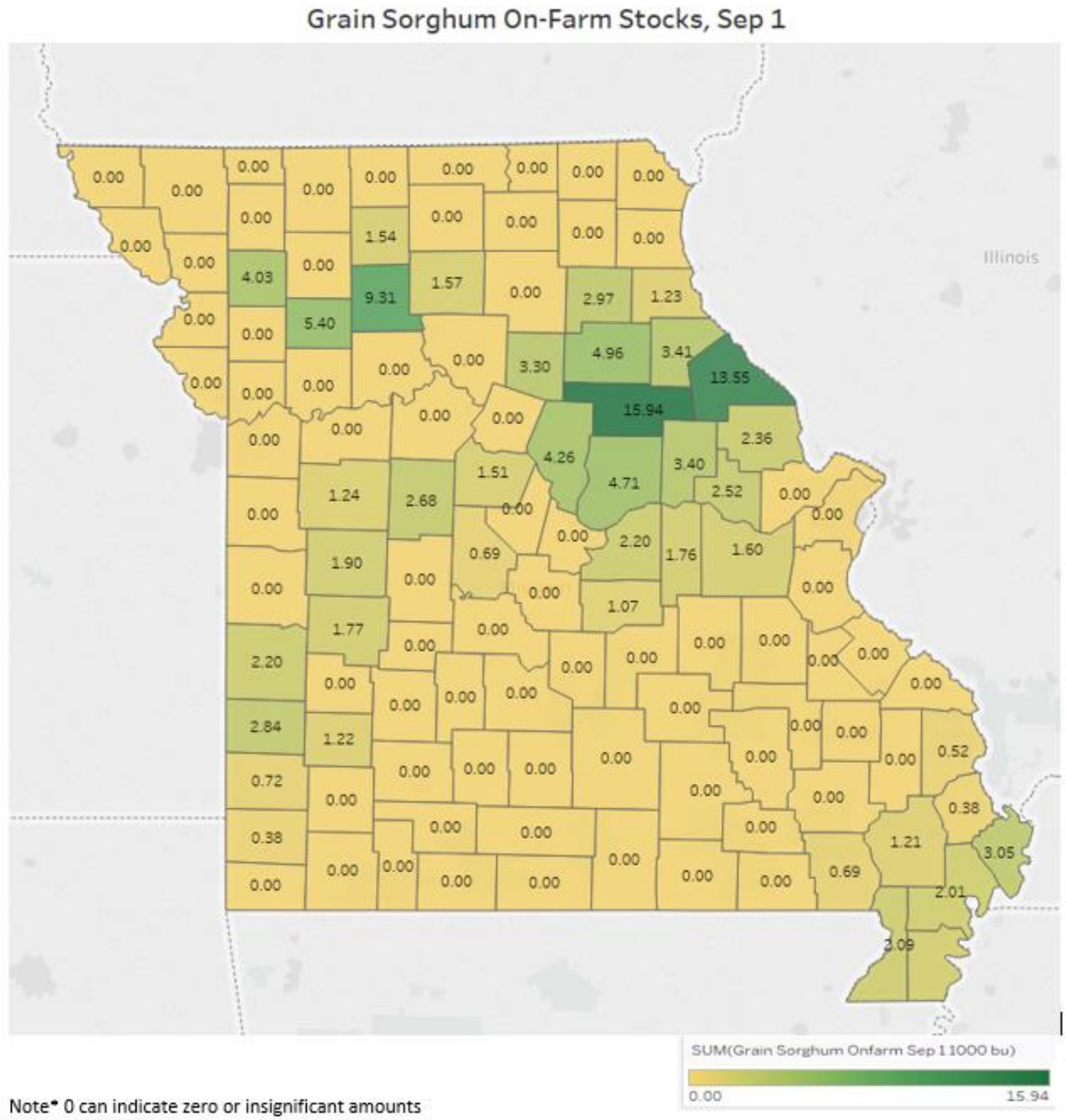


Figure 28 Grain Sorghum On-farm Stocks Sep 1

Figure 28 shows estimated on-farm grain sorghum stocks for September 1, 2018. USDA provides state-wide grain sorghum stocks data. County estimates of on-farm grain stocks are based on the percent of state-wide production in each county.

Wheat

Wheat Production 2017

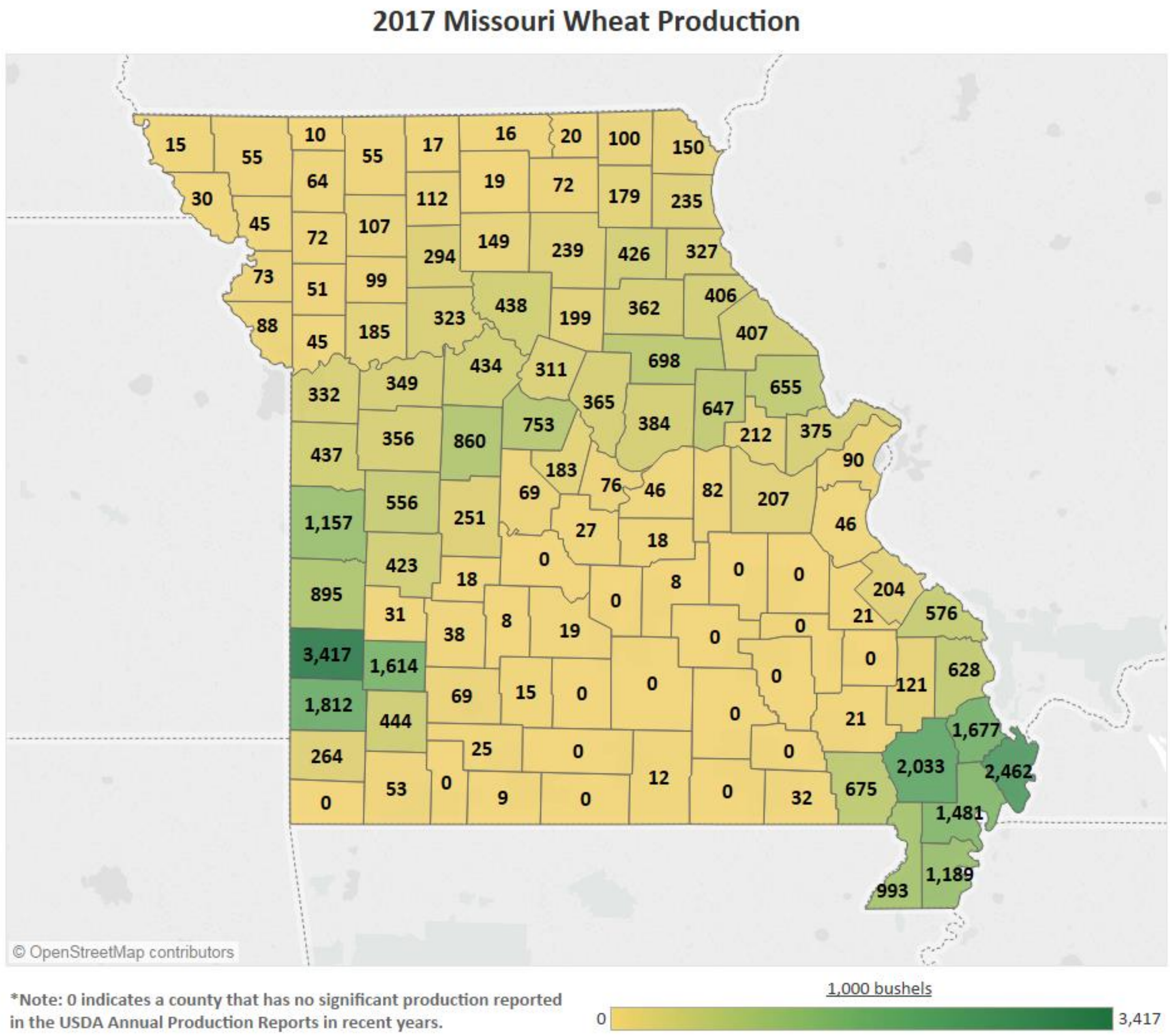


Figure 29, 2017 Missouri Wheat Production

Figure 29 shows 2017 wheat production in Missouri. While wheat is grown in nearly every county except in the Ozark Plateau, its significance in farm crop rotations has greatly diminished. Over the past 20 years, wheat production in Missouri has declined by nearly 50%. In 2017, only 9 counties produced more than 1 million bushels of wheat. Barton county is the leading producer of wheat in Missouri. To a large degree, wheat acreage has been displaced by corn and soybean acreage. In the Boot heel region, a significant portion of the wheat is cropped as part of a double cropping system with soybeans.

Percent of Missouri Wheat Production by County

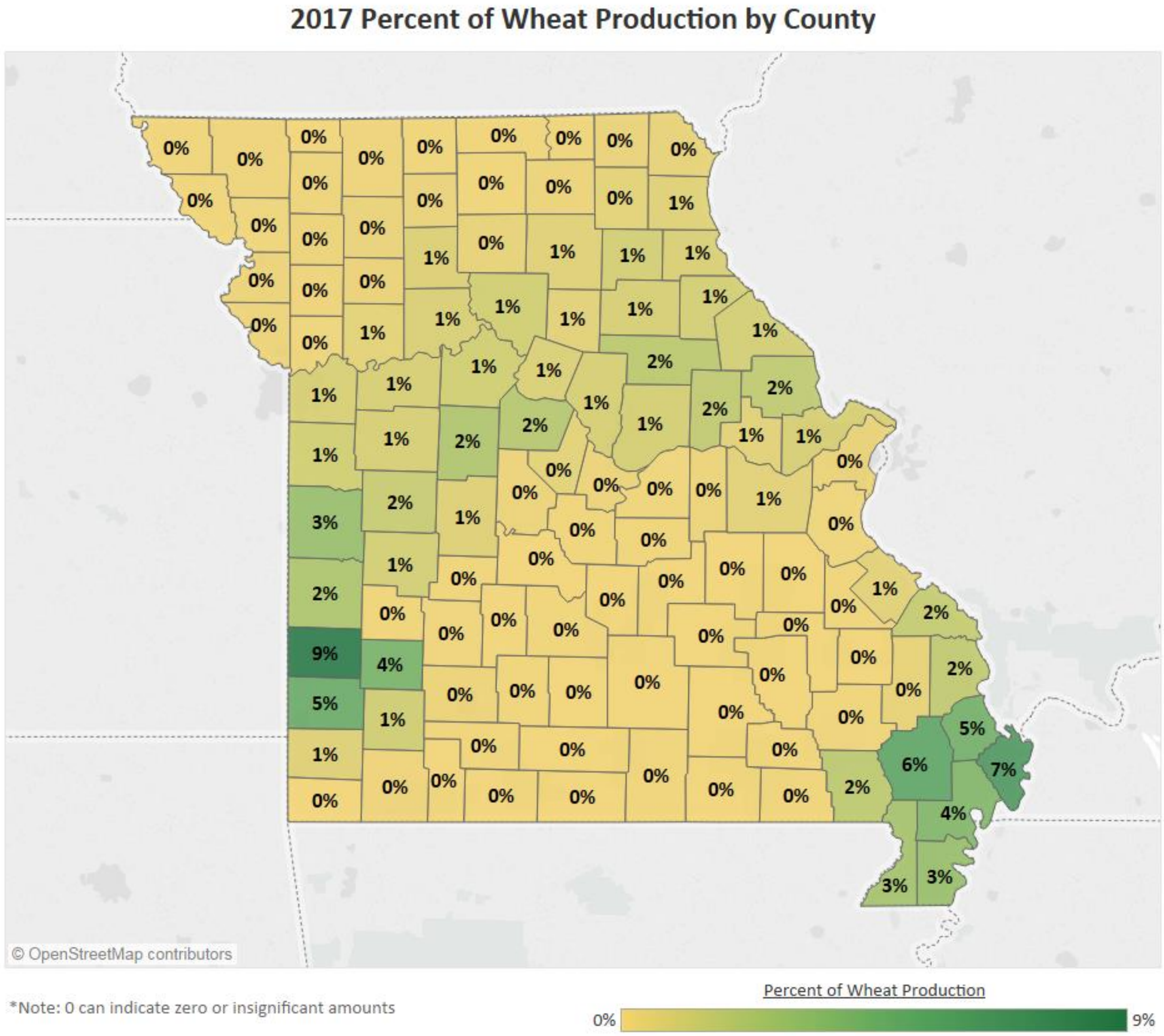


Figure 30, 2017 Percent of Wheat Production by County

Figure 30 shows the percent of state-side wheat production that is produced in each county. Barton county leads with 9% of Missouri wheat production. The eight counties in the crop reporting district that includes the Boot heel region produce one third of Missouri's wheat.

Total Grain Bushels Produced 2017

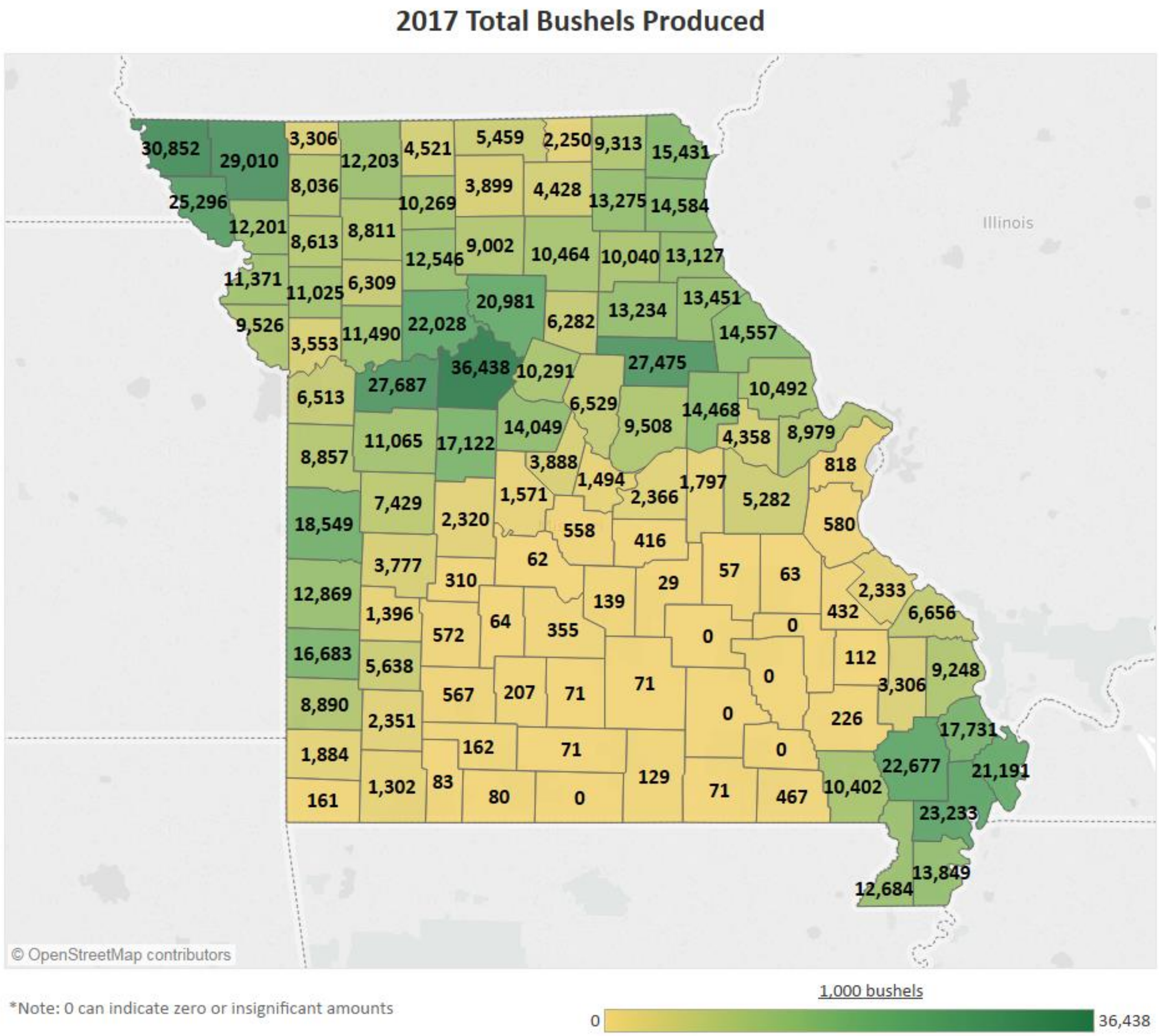


Figure 31, 2017 Total Bushels Produced

Figure 31 shows the total quantity of corn, grain sorghum, soybeans and wheat produced in each county in Missouri. In 2017, there were 884,296,000 bushels of grain produced in Missouri. Saline and Atchison counties produced more than 30 million total bushels of grain; 8 counties produced between 20 million bushels of grain to 30 million bushels of grain.

Storage and Grain Stocks

Missouri Grain Storage Capacity

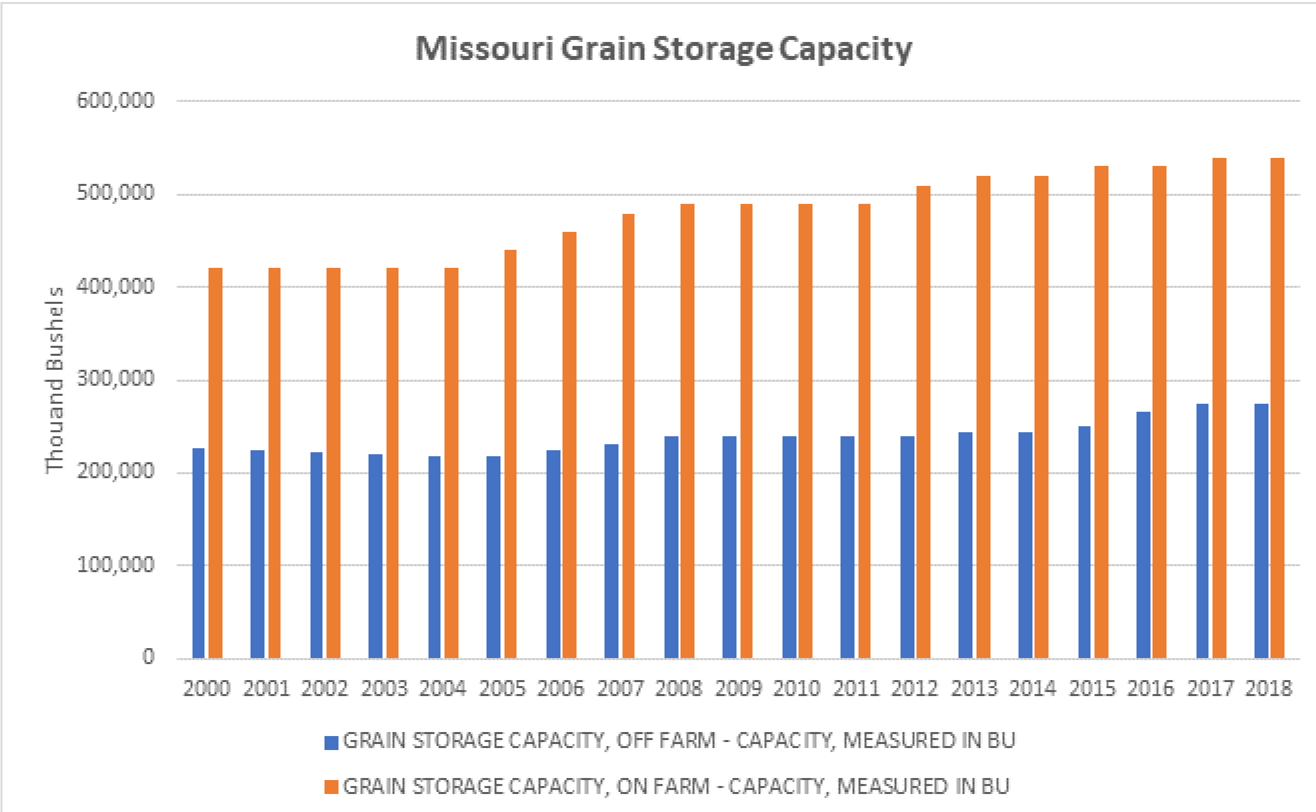


Figure 32 Missouri Grain Storage Capacity 2000-2018

Grain storage capacity in Missouri has increased from 645 million bushels in 2000 to 815 million bushels in 2018. Off-farm storage capacity has grown from 226 million bushels in 2000 to 275 million bushels in 2018. On-farm storage capacity during the same time grew from 420 million bushels to 540 million bushels over the same time period. The number of off-farm grain storage facilities (Figure 33) declined from 441 facilities in 2000 to 335 in 2018. Average capacity at off-farm grain storage facilities increased from 512,404 bushels in 2000 to 820,896 bushels in 2018.

Off-farm Storage

Number of Missouri Off-Farm Grain Storage Facilities

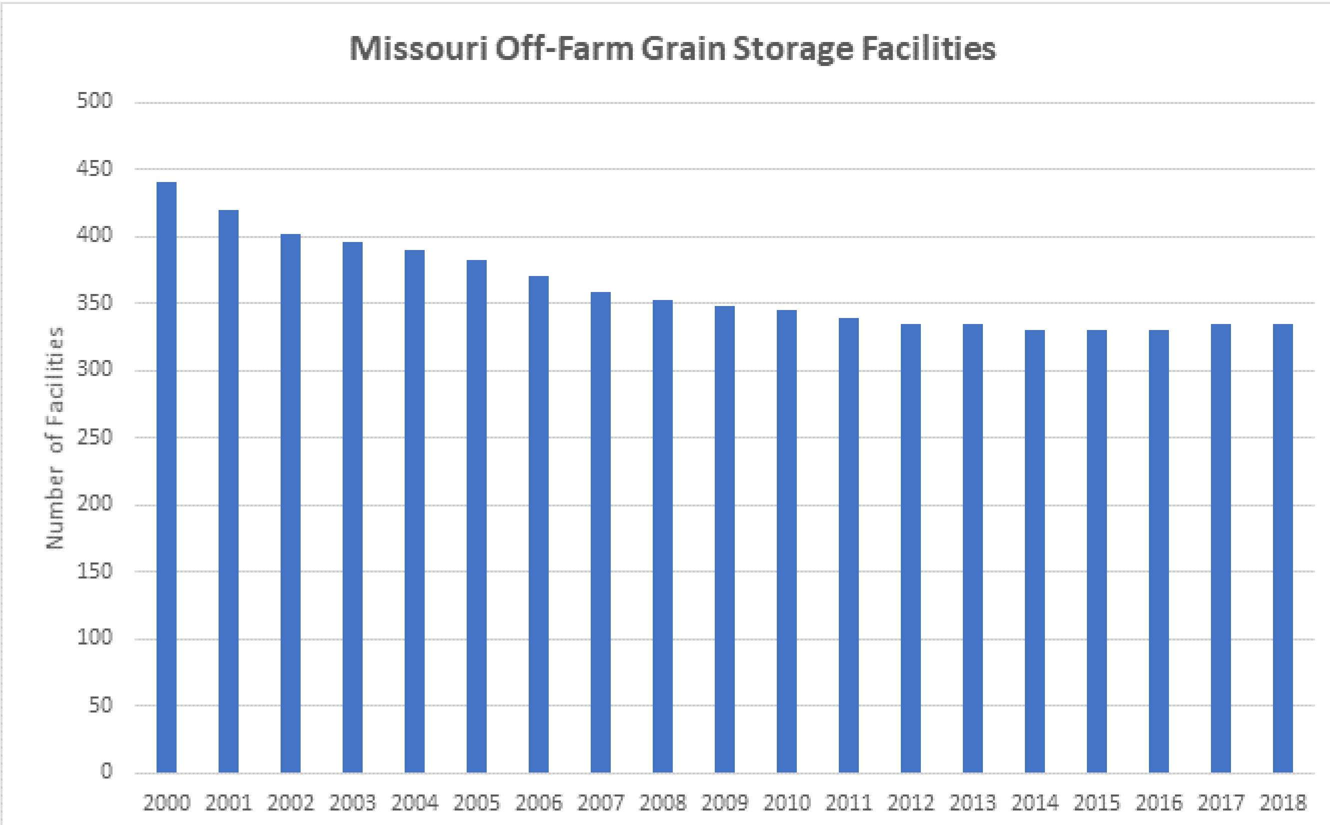


Figure 33 Missouri Off-Farm Grain Storage Facilities 2000-2018

Figure 33. The number of off-farm grain storage facilities (Figure 33) declined from 441 facilities in 2000 to 335 in 2018.

Missouri Off-farm Grain Storage Average Size of Facility

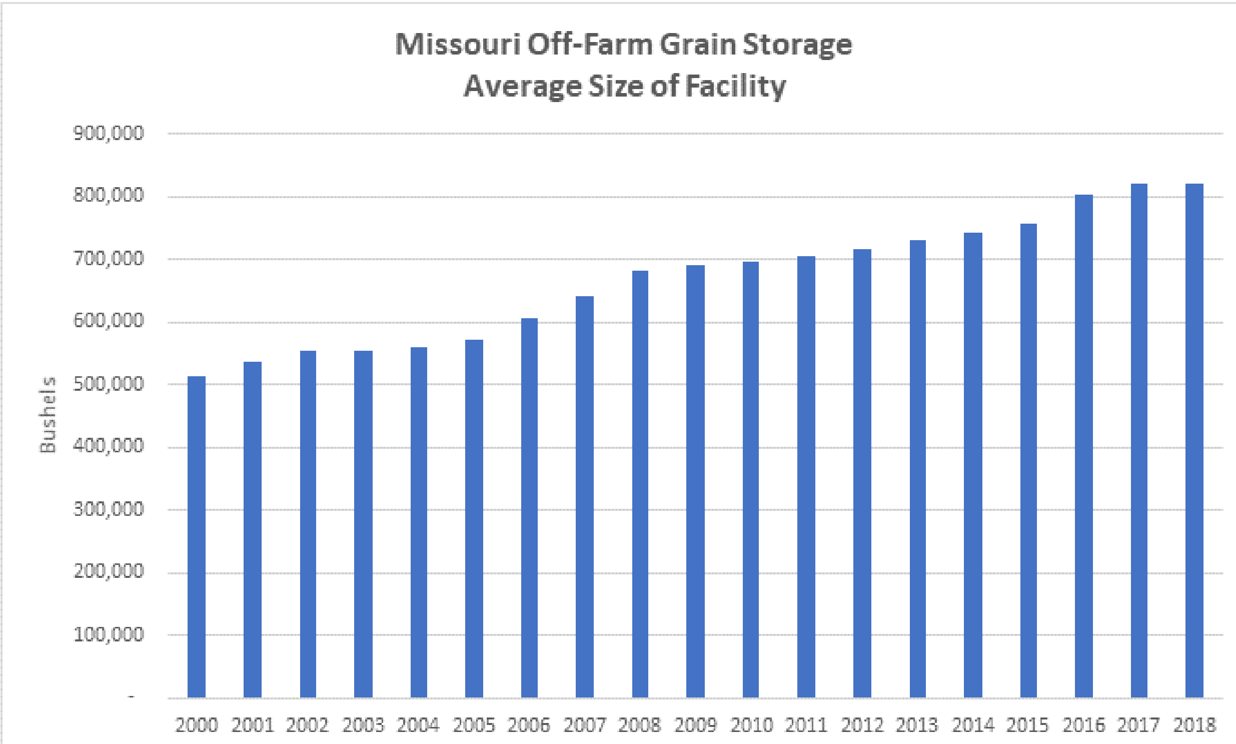


Figure 34 Missouri Off-Farm Grain Storage Average Capacity of Facility

Figure 34. Average capacity at off-farm grain storage facilities increased from 512,404 bushels in 2000 to 820,896 bushels in 2018.

Missouri On-farm Grain Storage Percent of Total Capacity

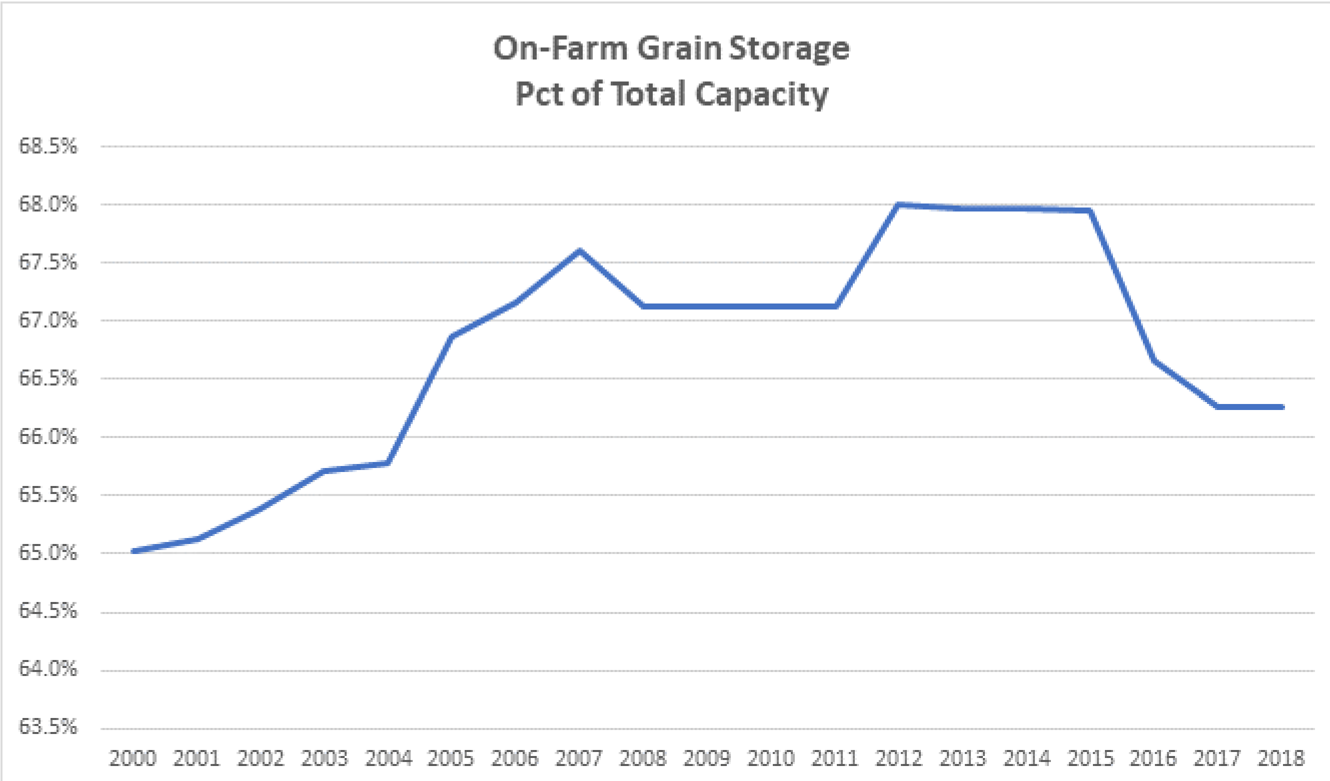


Figure 35 Missouri On-Farm Grain Storage Percent of Total Capacity

Figure 35. On average, on-farm grain storage makes up about 2/3 of Missouri grain storage capacity. Both off-farm and on-farm grain storage capacity have increased in recent years (see Figure 32), but expansion of off-farm grain storage capacity has out-paced build out of on-farm grain storage capacity in the past 3 years.

Missouri Off-farm Quarterly Total Grain Stocks 2001-2018 Marketing Years

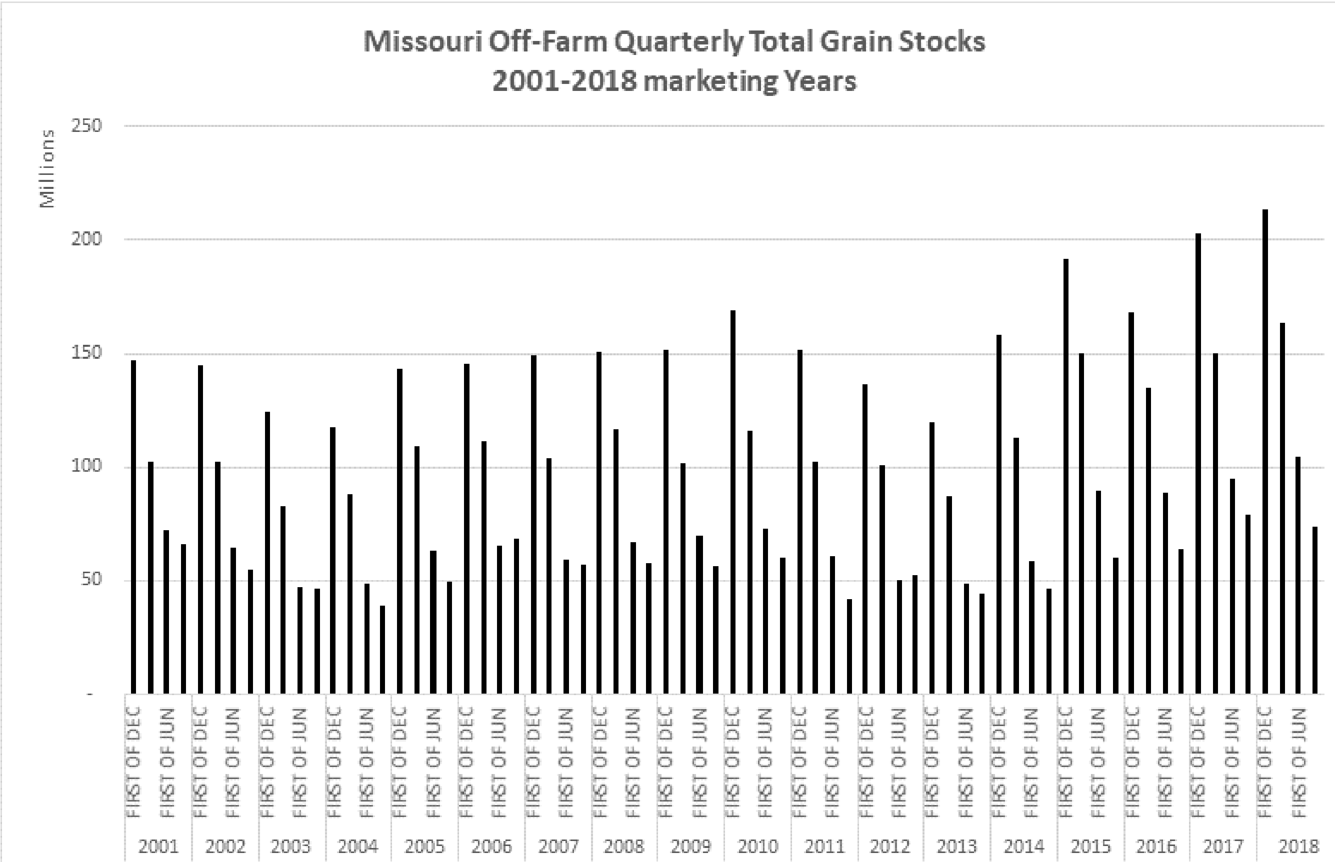


Figure 36 Missouri Off-Farm Quarterly Total Grain Stocks

Figure 36. Commercial, off-farm grain storage typically is fullest during the October to December corn, grain sorghum and soybean harvest period, and stocks tend to decline throughout the year. On average, Missouri commercial grain storage is 73% as full on March 1st compared to December 1st; 44% as full on Jun 1st; and 36% as full on September 1st as it was on the prior December 1st.

Missouri Off-Farm Quarterly Corn Stocks 2001-2018 Marketing Years

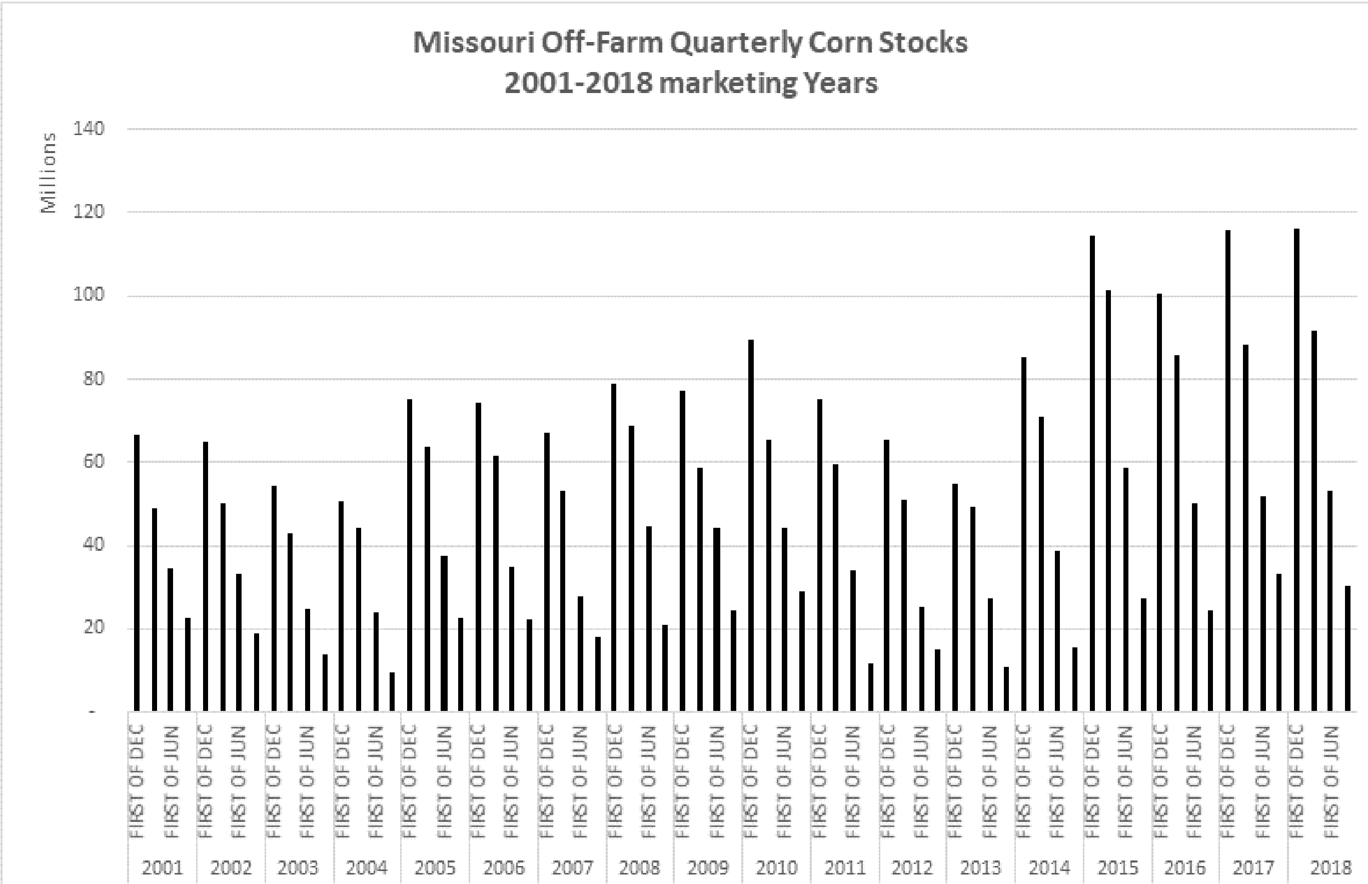


Figure 37 Missouri Quarterly Off-Farm Corn Stocks 2001-2018 Marketing Year

Figure 37. Missouri off-farm corn stocks are largest on December 1st, after the September-November harvest period. On average, Missouri commercial corn storage is 81% as full on March 1st compared to December 1st; 48% as full on Jun 1st; and 16% as full on September 1st as it was on the prior December 1st. In 2015, about 30 million bushels of corn storage was added to Missouri off-farm storage.

Missouri Off-farm Quarterly Soybean Stocks 2001-2018 Marketing Years

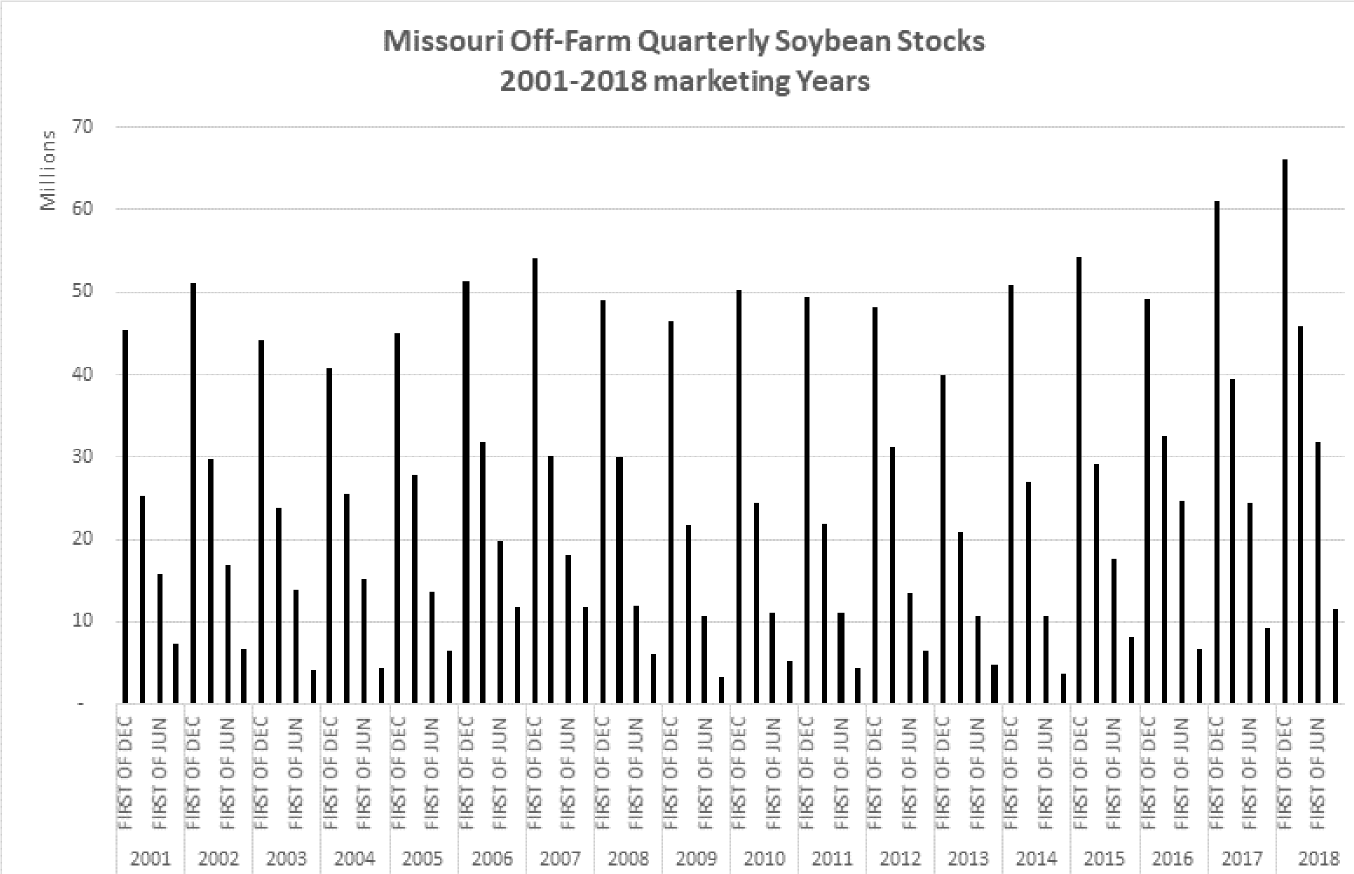


Figure 38 Missouri Off-Farm Quarterly Soybean Stocks 2001-2018 Marketing Years

Figure 38. Missouri off-farm soybean stocks are largest on December 1st, after the September-November harvest period. On average, Missouri commercial soybean storage is 57% as full on March 1st compared to December 1st; 32% as full on Jun 1st; and 13% as full on September 1st as it was on the prior December 1st.

Missouri Off-farm Quarterly Grain Sorghum Stocks 2001-2018 Marketing Years

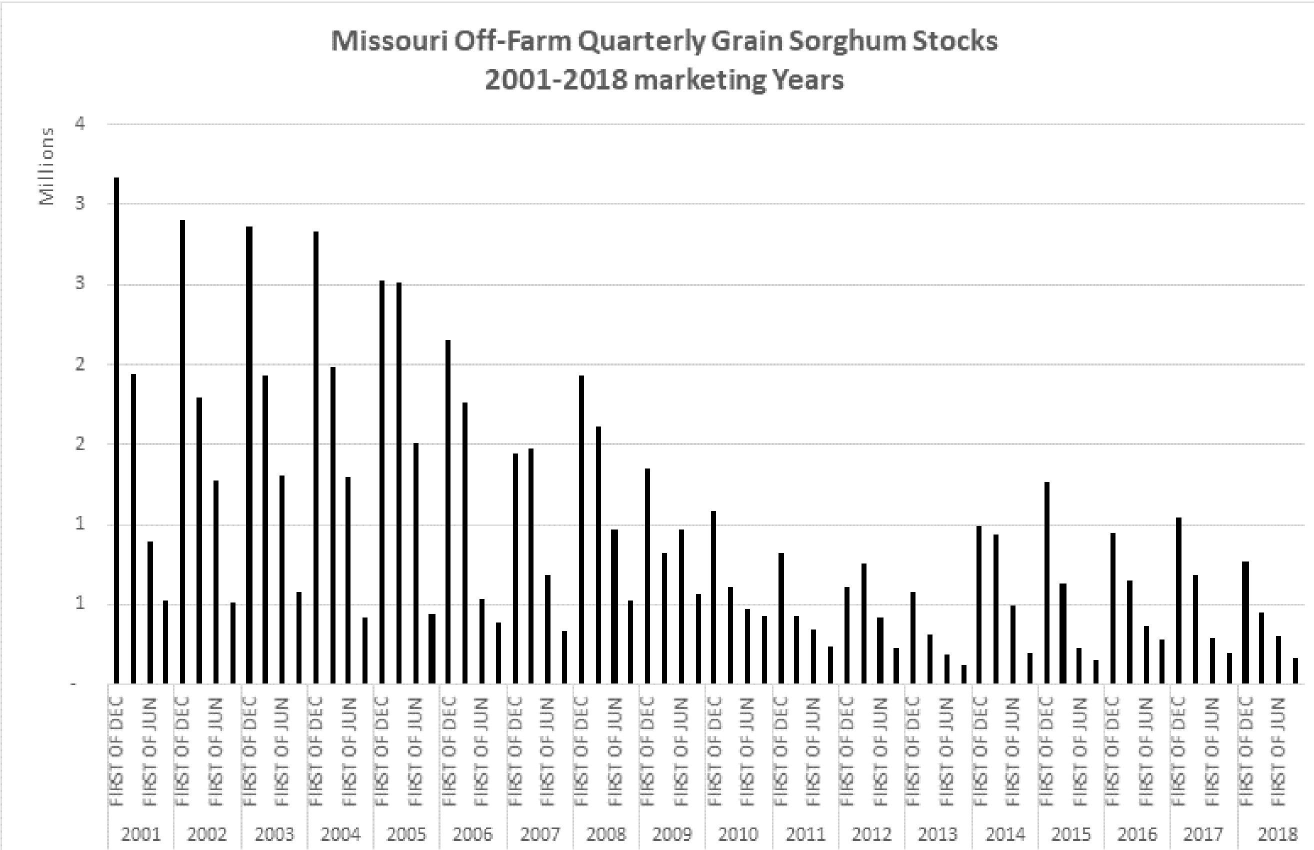


Figure 39 Missouri Off-Farm Quarterly Grain Sorghum Stocks

Figure 39. Missouri off-farm grain sorghum stocks are largest on December 1st, after the September-November harvest period. On average, Missouri commercial soybean storage is 73% as full on March 1st compared to December 1st; 43% as full on Jun 1st; and 24% as full on September 1st as it was on the prior December 1st. As can be seen in Figure 39, the overall level of Missouri off-farm grain sorghum put into storage declined sharply from 2001 through 2011. Stock levels increased moderately by 2014, but have declined again in the most recent years.

Missouri Off-farm Quarterly Wheat Stocks 2001-2018 Marketing Years

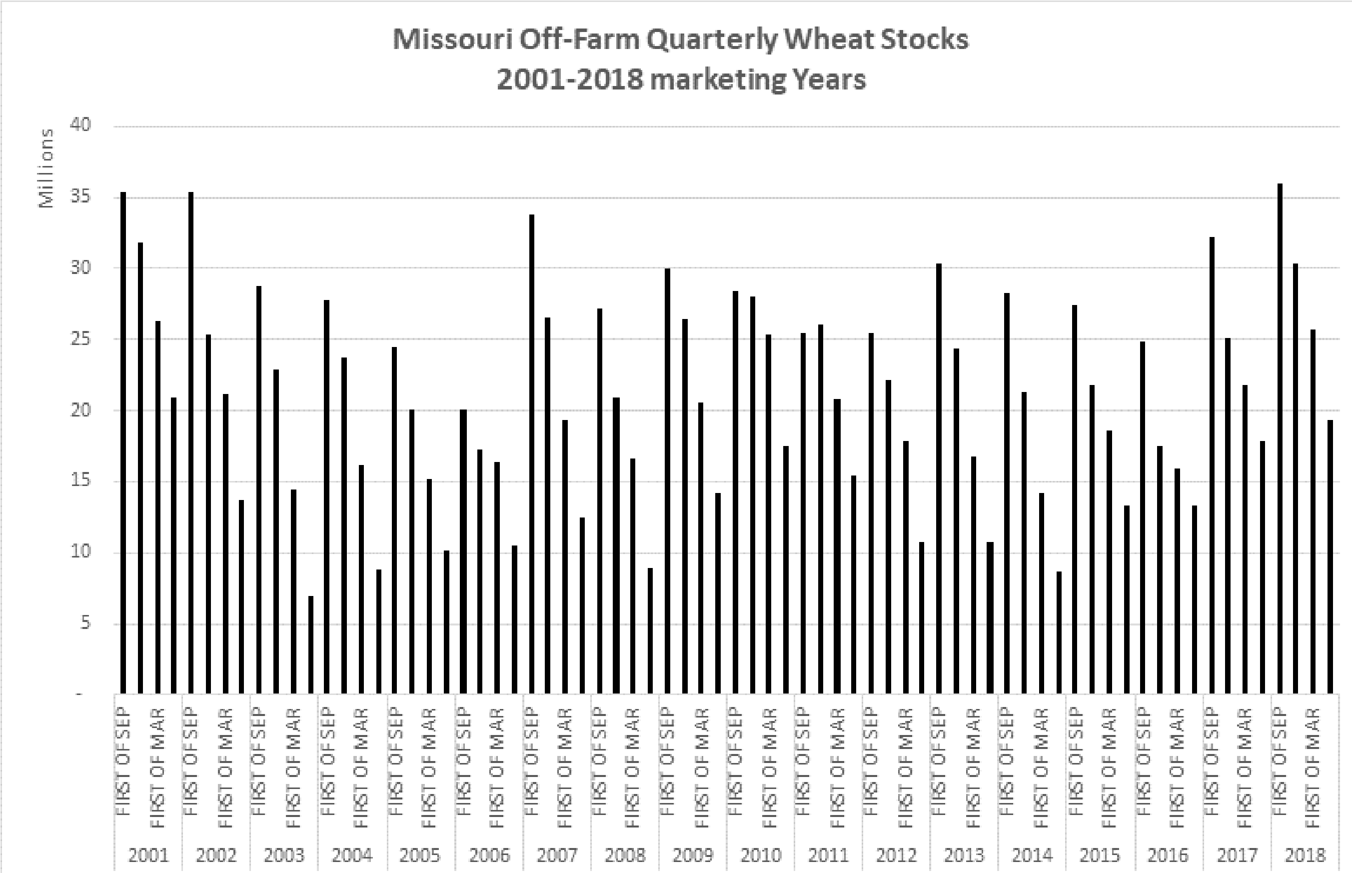


Figure 40 Missouri Off-farm Quarterly Wheat Stocks

Figure 40. Missouri off-farm grain wheat stocks are largest on September 1st, after the June-July harvest period. On average, Missouri commercial soybean storage is 83% as full on December 1st compared to September 1st; 66% as full on March 1st; and 45% as full on June 1st as it was on the prior September 1st. As can be seen in Figure 39, the overall level of Missouri off-farm wheat put into storage has remained fairly steady since 2001, although there appears to be slightly higher stock levels of wheat being held off-farm in recent years.

Total Off-farm Storage Capacity by County

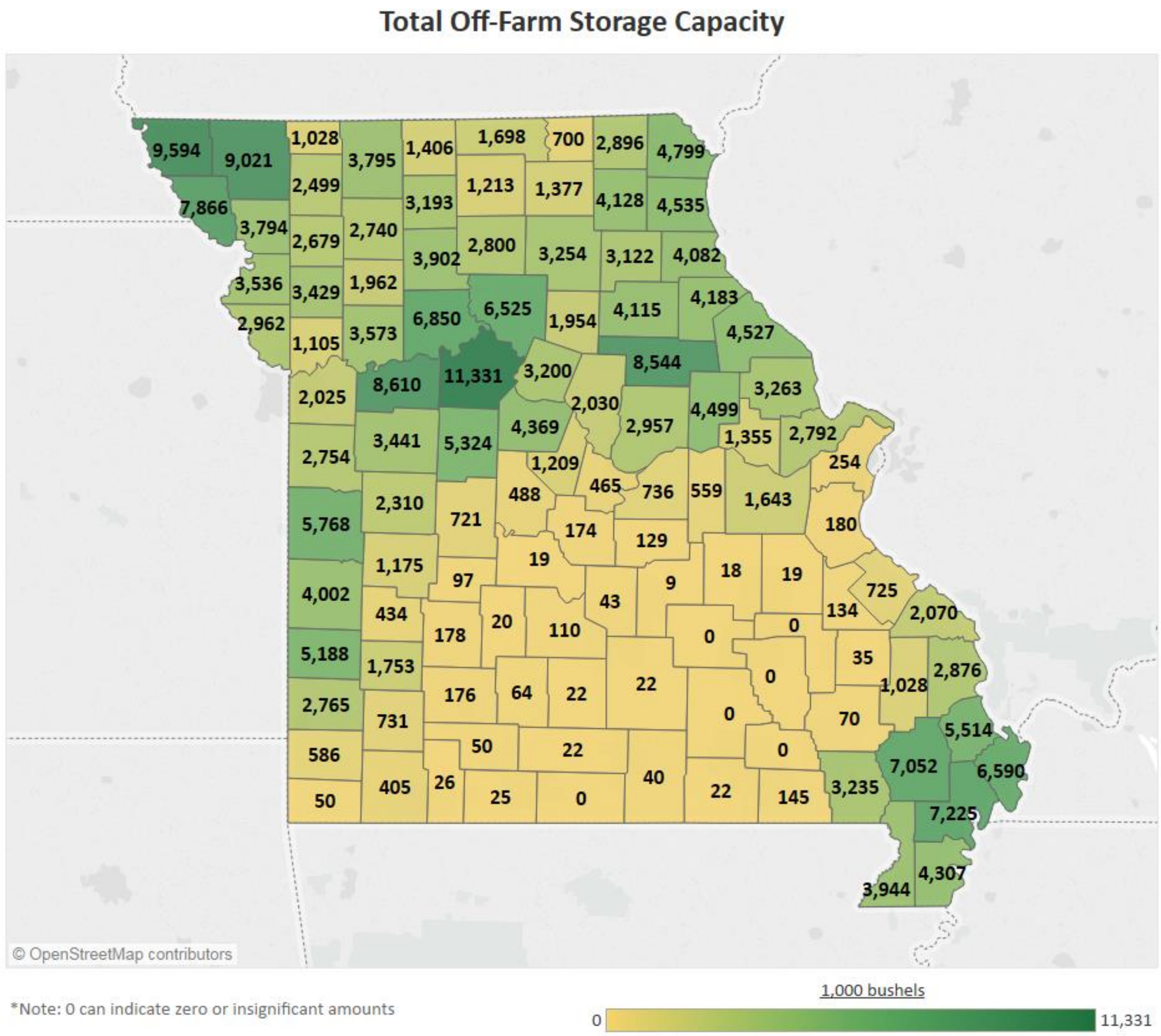


Figure 41, Total Off-Farm Storage Capacity

Figure 41. In 2018, USDA estimated Missouri off-farm storage capacity of 275 million bushels. In Figure 41, the off-farm storage capacity estimates are shown for counties in Missouri. The individual county estimates of off-farm storage capacity were calculated as each county's share of total grain bushels (corn, grain sorghum, soybeans and wheat) of Missouri total grain production.

Total Off-farm Storage Capacity by CRD

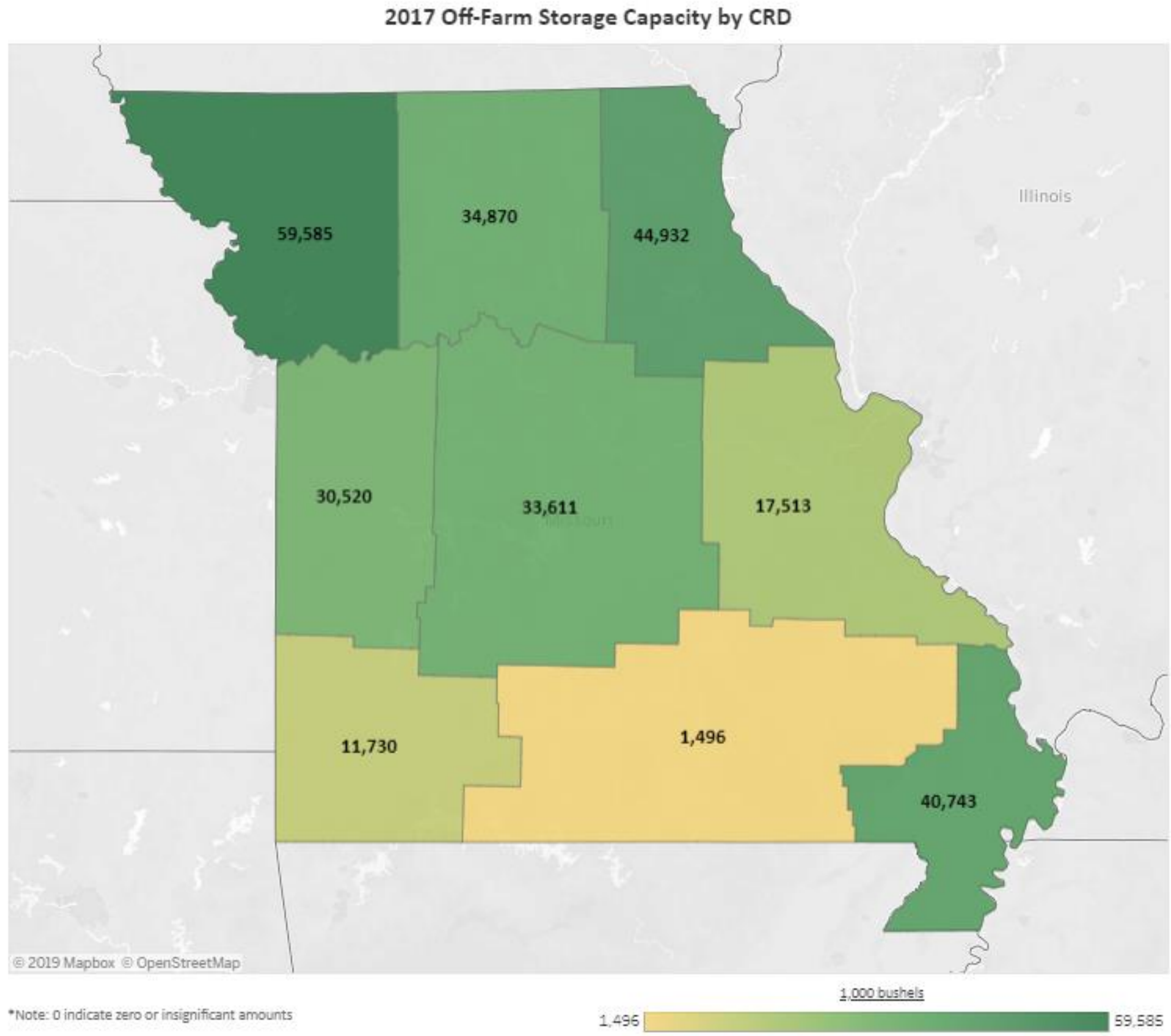


Figure 42, Off-Farm Storage Capacity by CRD

Figure 42 shows off-farm storage capacity aggregated to the crop reporting district level.

Off-farm Storage Capacity Used by CRD

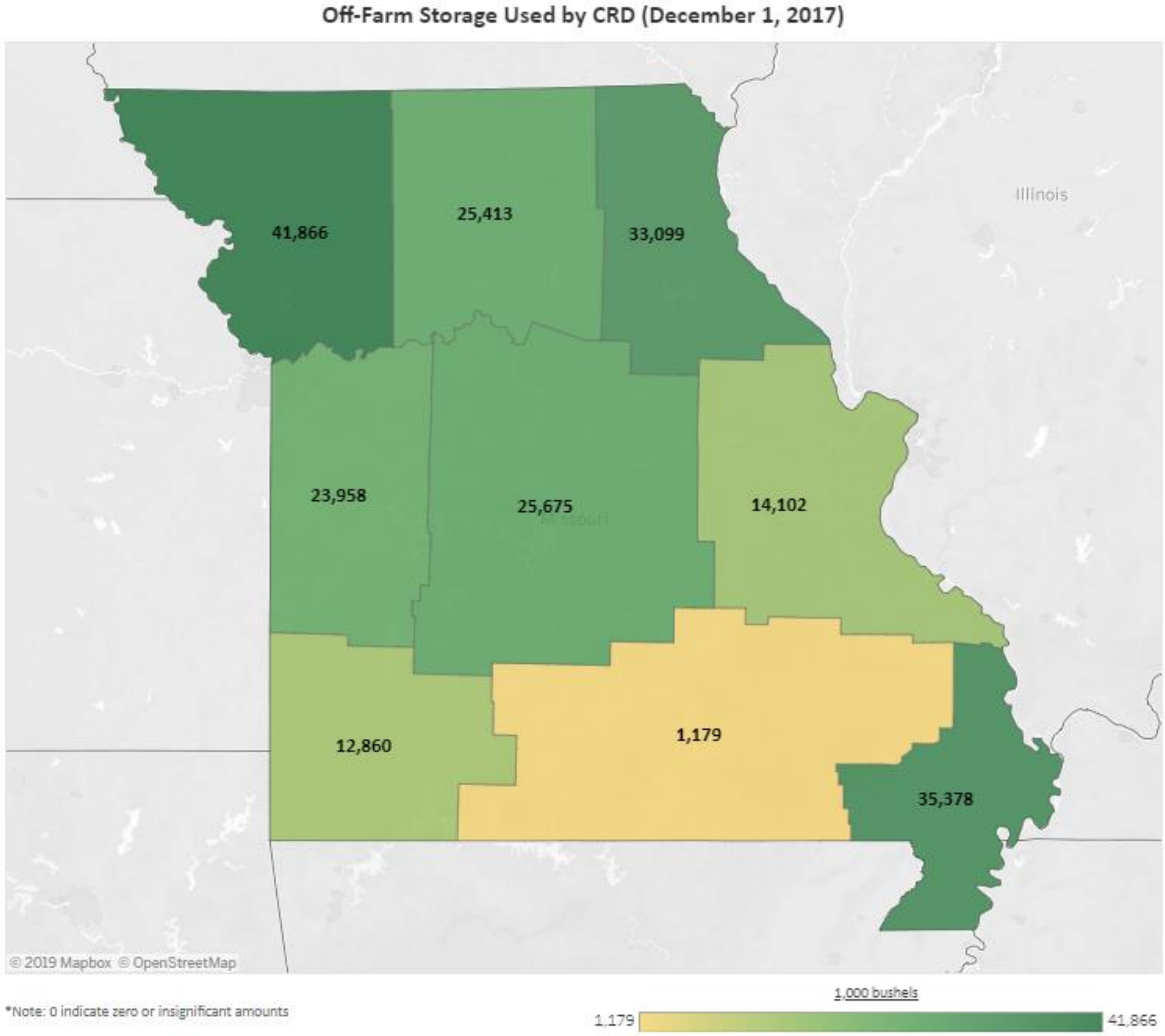


Figure 43, Off-Farm Storage Used by CRD (December 1, 2017)

Figure 43 shows the estimated total amount of grain in off-farm storage on December 1, 2017 by crop reporting district. These amounts are the sum of county level off-farm stocks of corn, grain sorghum, soybeans and wheat in off-farm storage on Dec 1.

Total Off-farm Grain Stocks December 1, 2017

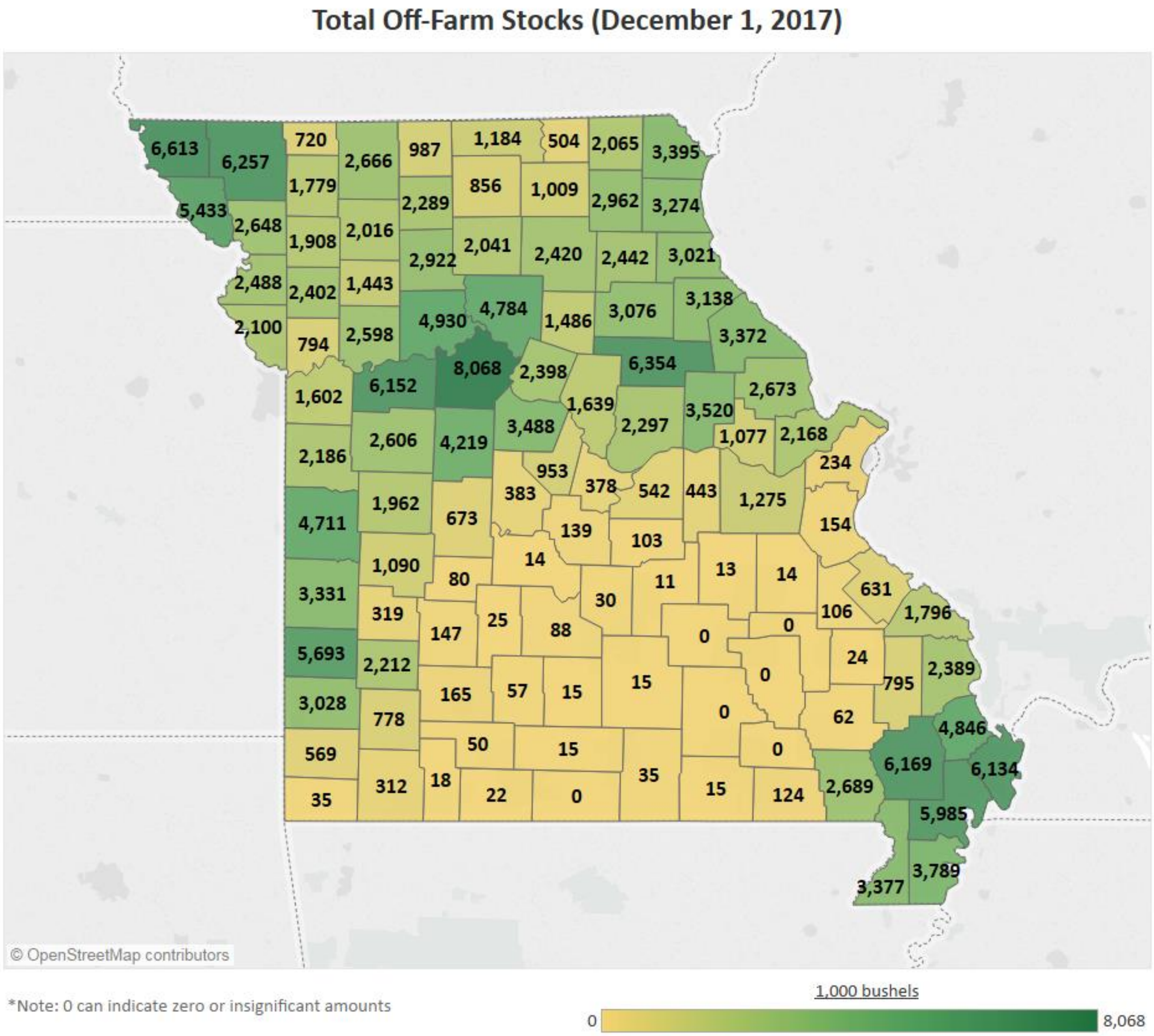


Figure 44, Total Off-Farm Stocks (Dec. 1, 2017)

Figure 44 shows total off-farm grain stocks (corn, grain sorghum, soybeans and wheat) for December 1, 2017. Off-farm grain stocks reach their peak during the September-November harvest period and consistently reach their annual reportable maximum in the December 1st report. There were 213.5 million bushels of grain in off-farm storage.

Missouri Off-farm Corn Stocks, December 1, 2017

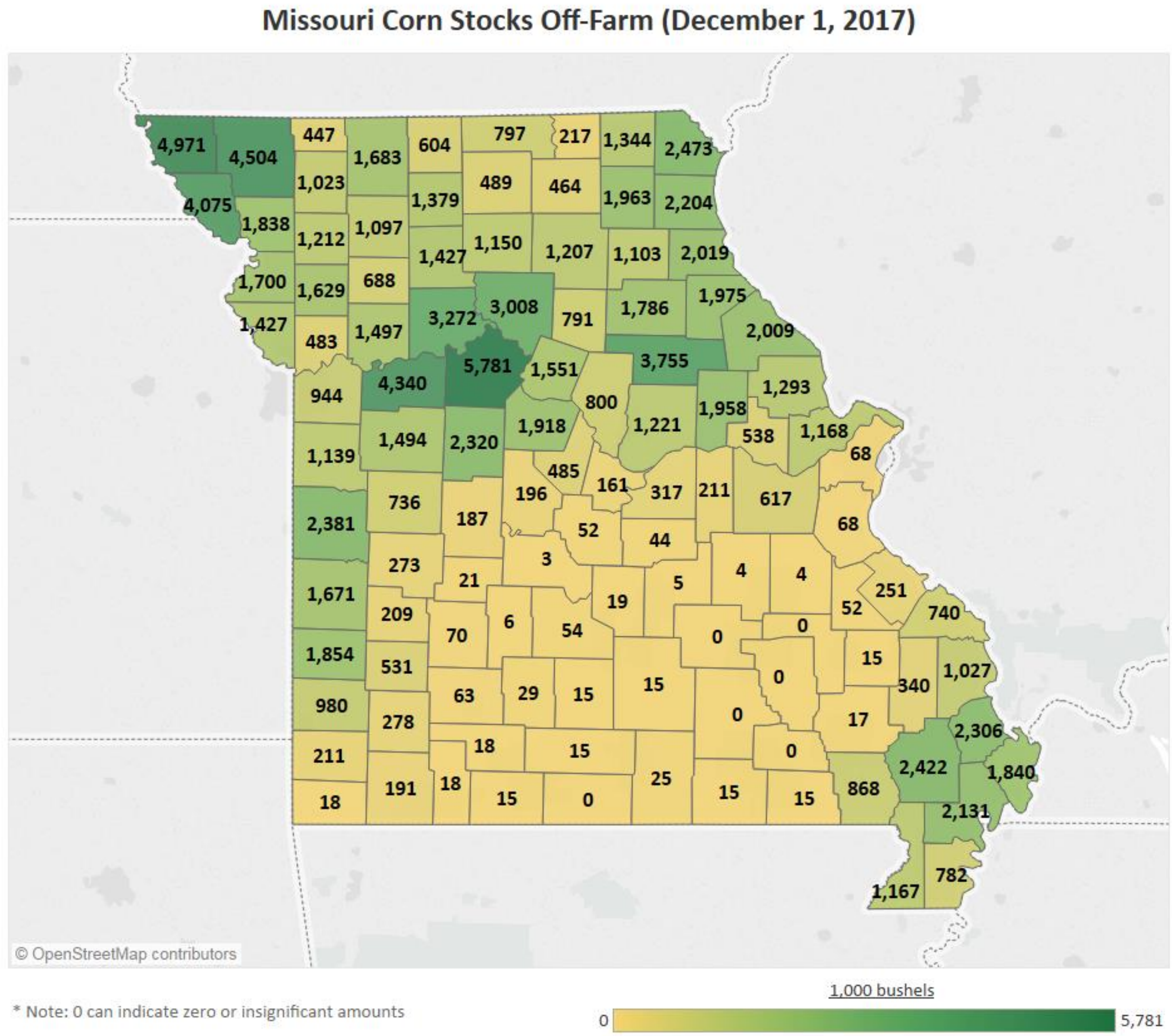


Figure 45, Missouri Corn Off-Farm Storage (Dec. 1, 2017)

Figure 45 show Missouri December 1 corn stocks for off-farm facilities. Corn stocks in storage are estimated by USDA at the state level for off-farm locations and on-farm locations. Off-farm stocks are allocated by percent of production in the county. While corn harvest can begin as early as late August in parts of Missouri, most corn is harvested in September, October and November. The December 1 grain stocks report conducted by USDA provides the first data check for reconciliation of carryover stocks, current year production and projected use for current year feed use.

Missouri Off-farm Soybean Stocks, December 1, 2017

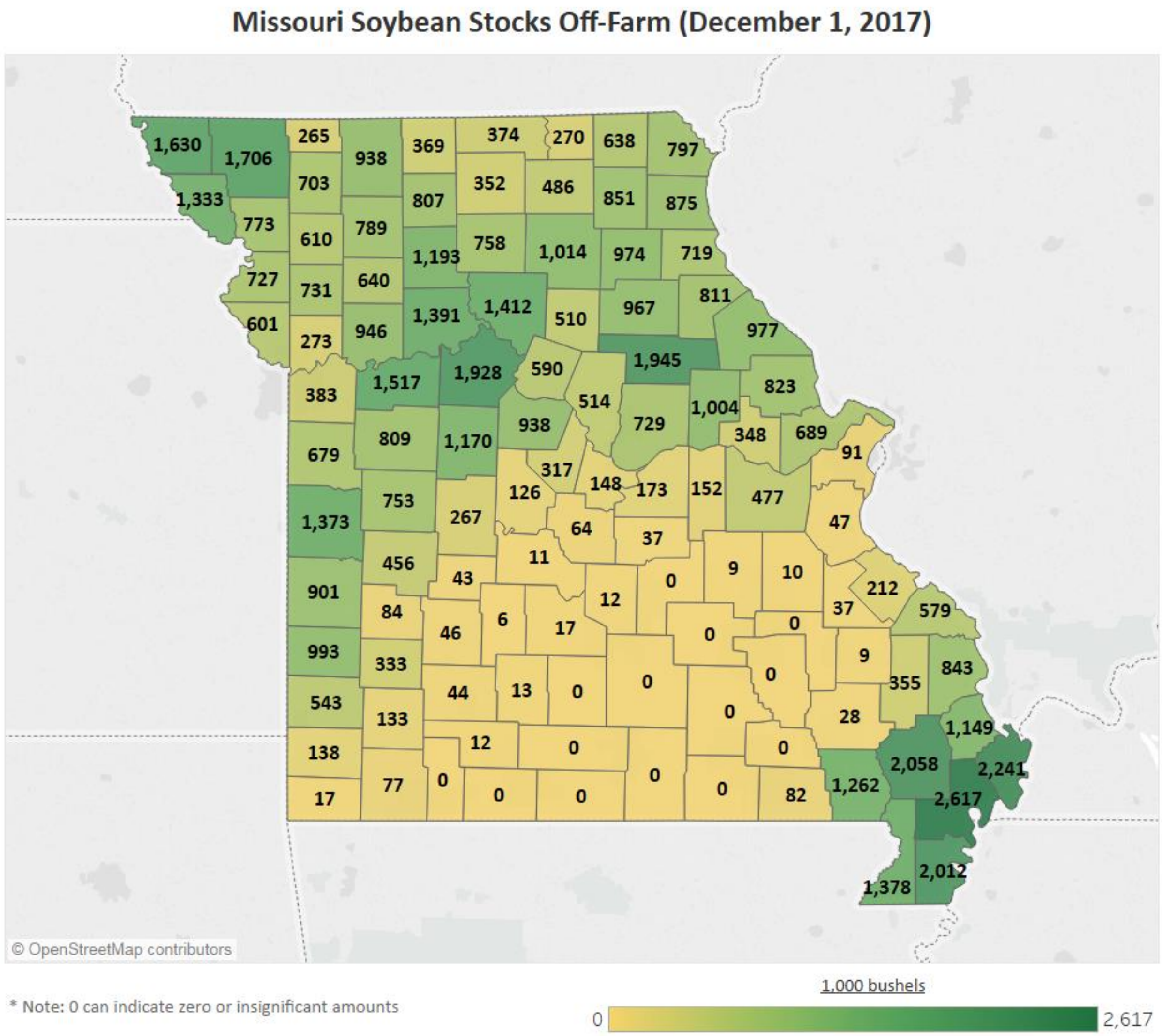


Figure 46, Missouri Soybean Stocks Off-Farm (Dec. 1, 2017)

Figure 46 shows Missouri's December 1, 2017 off-farm soybean stocks. USDA data provides stocks information on a state-wide basis. On December 1, 2017, off-farm soybean stocks were estimated by USDA to be 66,063,000 bushels. County level off-farm December 1 stocks of soybeans are estimated based on each county's share of soybean production.

Missouri Off-farm Grain Sorghum Stocks, December 1, 2017

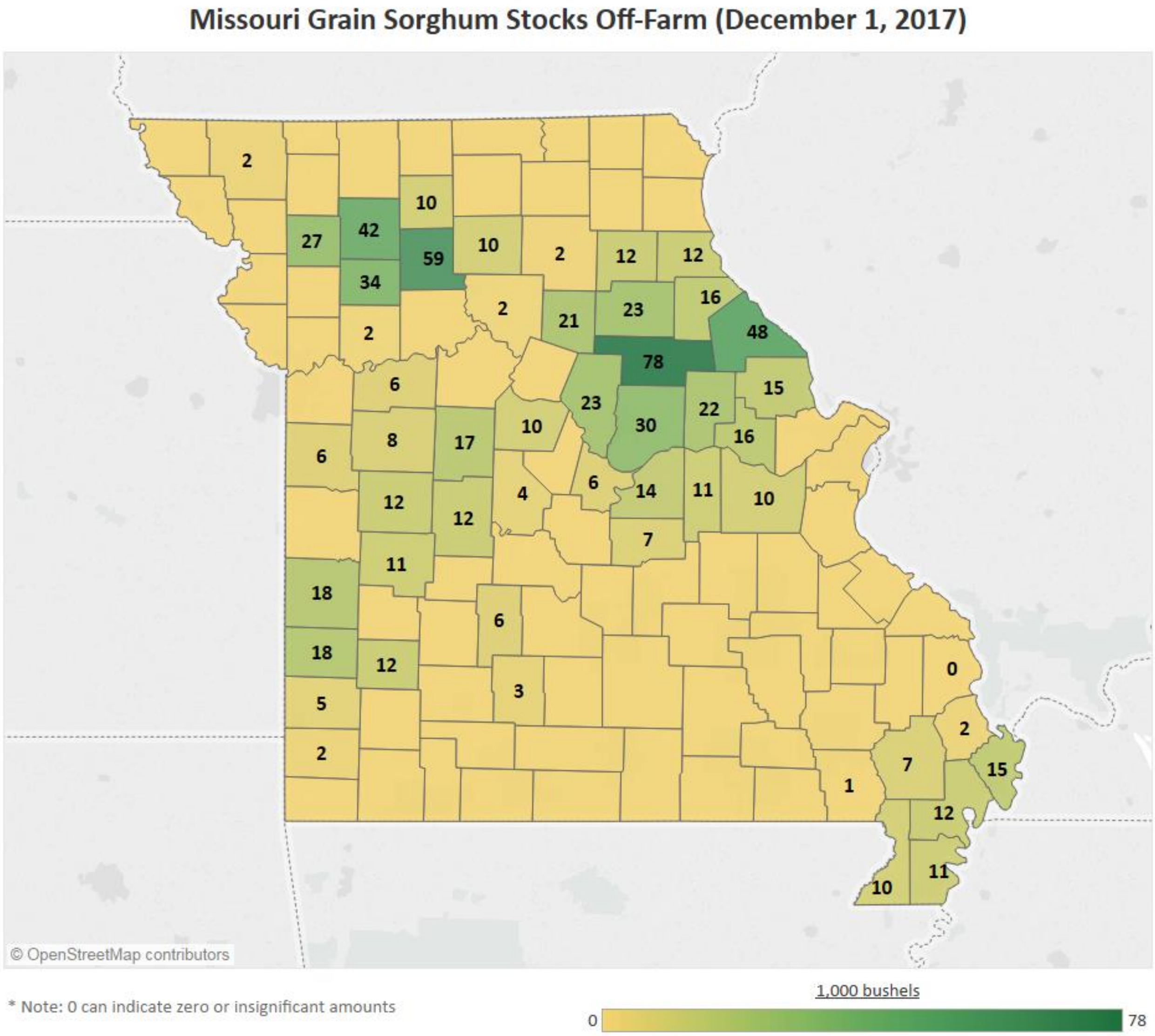


Figure 47, Missouri Grain Sorghum Stocks Off-Farm (Dec. 1, 2017)

Figure 47 shows Missouri off-farm grain sorghum stocks on December 1, 2017. USDA reported that Missouri off-farm grain sorghum stocks on December 1, 2017 were 763,000 bushels which was 31% of Missouri annual production. USDA provides grain sorghum stocks on a state-wide basis. County level off-farm grain stocks at the county level were calculated on the basis of each county's percent of statewide production.

Missouri Off-farm Wheat Stocks, December 1, 2017

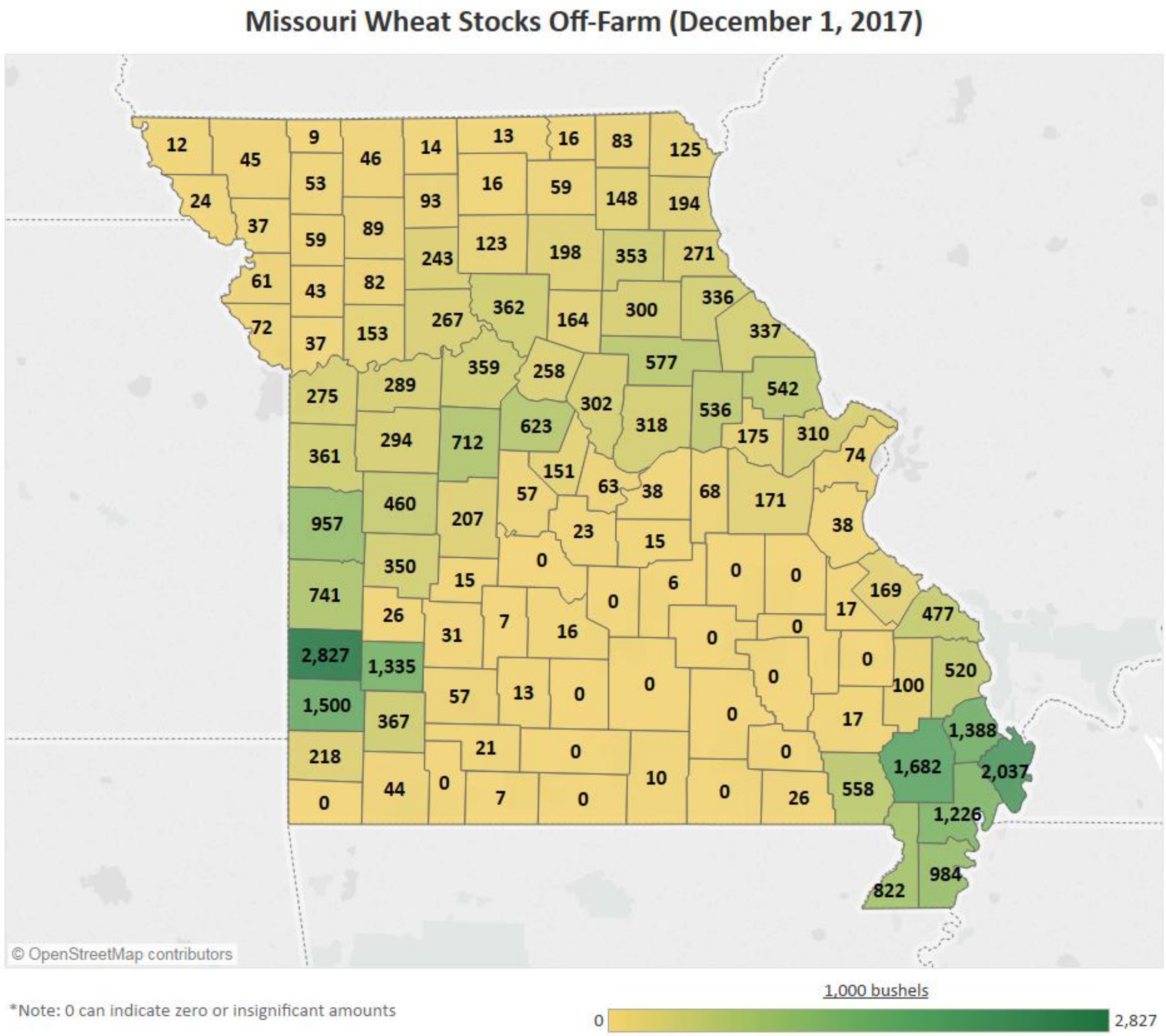


Figure 48, Missouri Wheat Stocks Off-Farm (Dec. 1, 2017)

Figure 48 shows Missouri off-farm wheat stocks on December 1, 2017. USDA estimated off-farm wheat stocks at 30.407 million bushels. County level off-farm wheat stocks were calculated accounting to the county's percent of state-wide production.

On-farm Storage

On-farm Grain Storage Capacity, 2012 Agricultural Census

2012 On-Farm Grain Storage Capacity

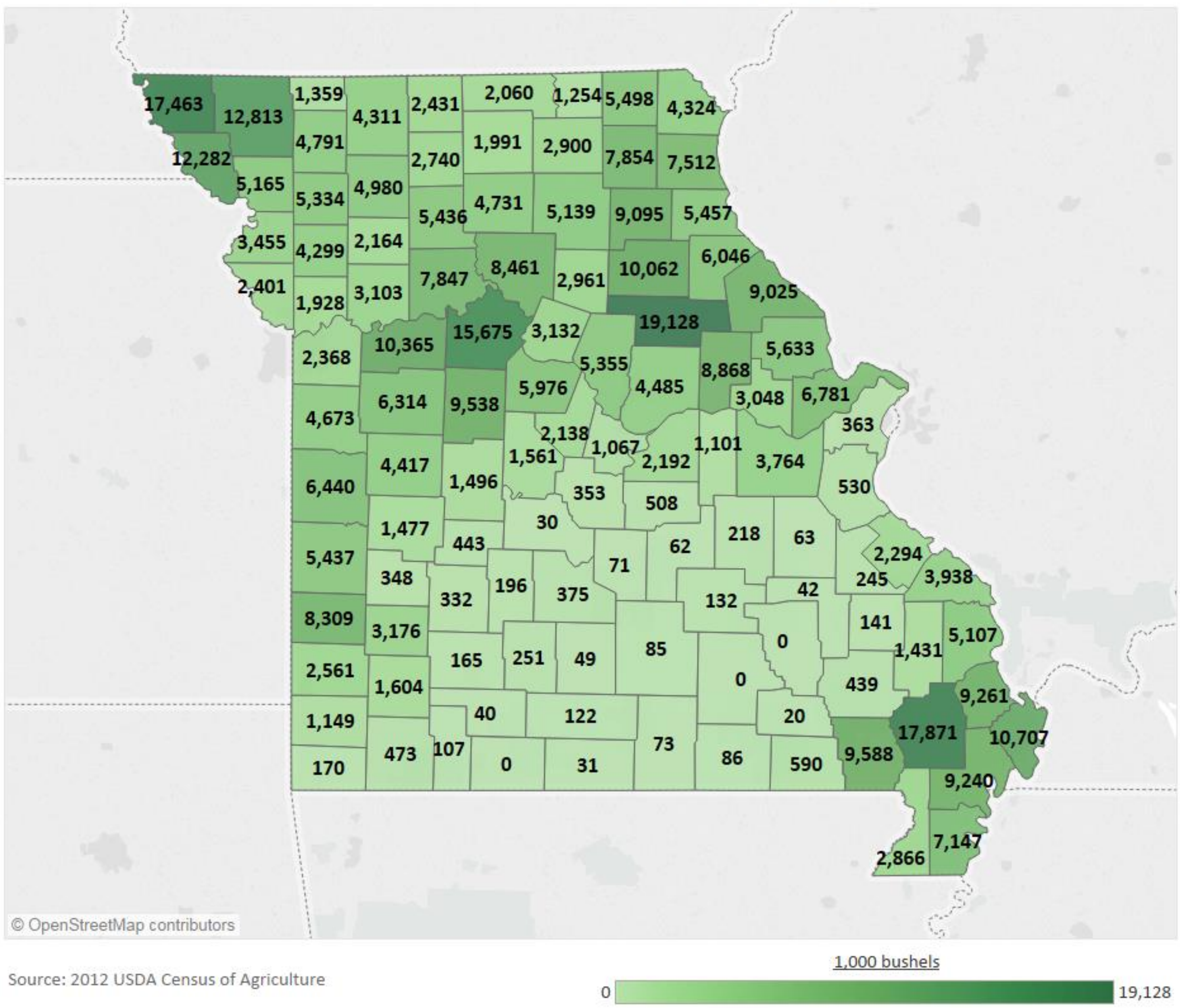


Figure 49, 2012 On-Farm Grain Storage Capacity

Figure 49. The 2012 Census of Agriculture collected county level data of on-farm grain storage. In 2012, according to the 2012 Ag Census, there was 444,502,766 bushels of on-farm storage in Missouri. Similar data were not collected in the 2017 Census of Agriculture.

On-farm Storage Capacity

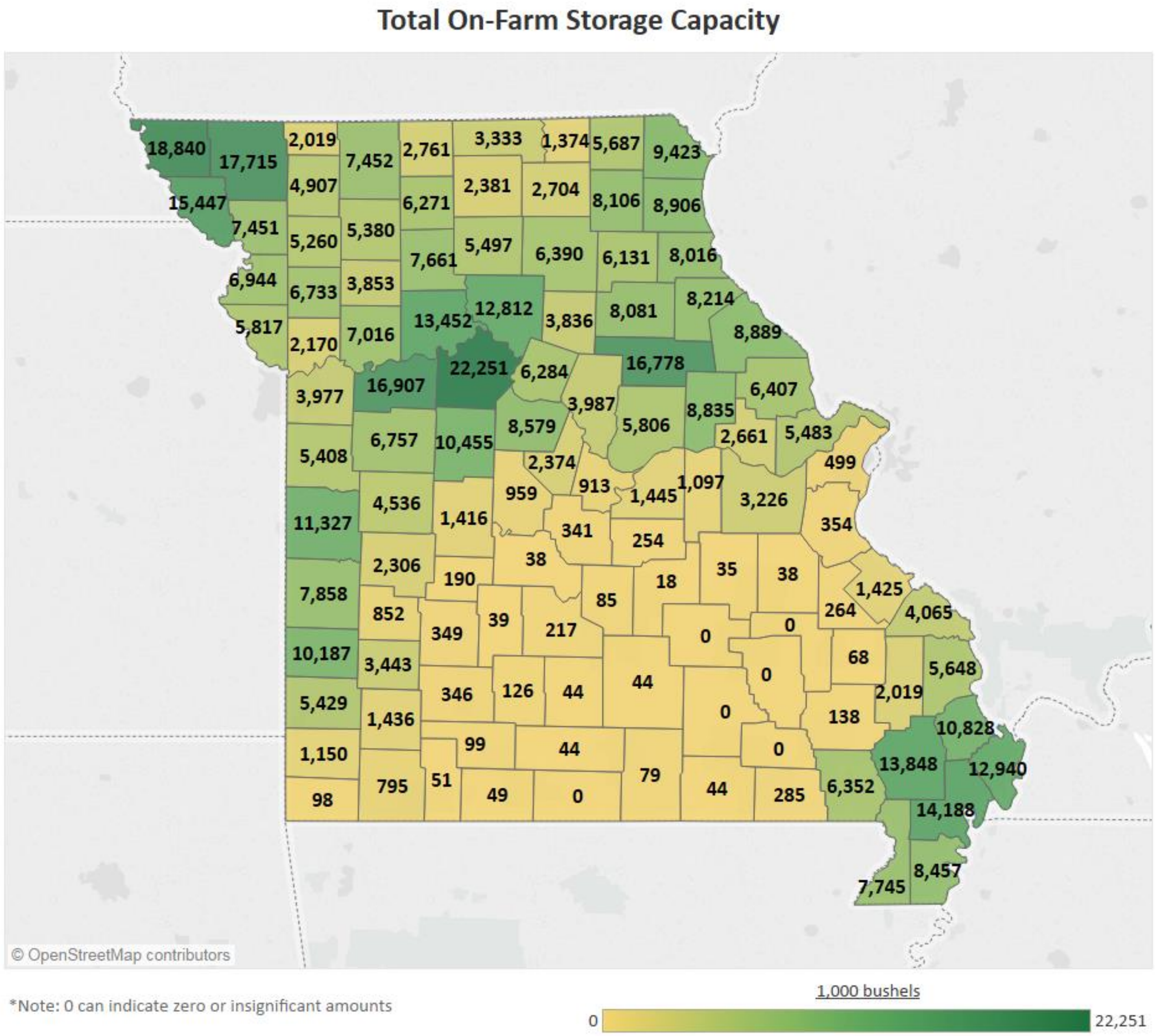


Figure 50, Total On-Farm Storage Capacity

Figure 50. In 2018, USDA estimated total on-farm grain storage capacity in Missouri of 540 million bushels. In the absence of updated county-specific data in the 2017 Ag Census, the county-level estimate of on-farm grain storage was calculated as each county's share of total grain production (corn, grain sorghum, soybean and wheat) for Missouri multiplied times the USDA annual estimate of on-farm grain storage for the state of Missouri.

On-farm Storage Used by CRD, December 1, 2017

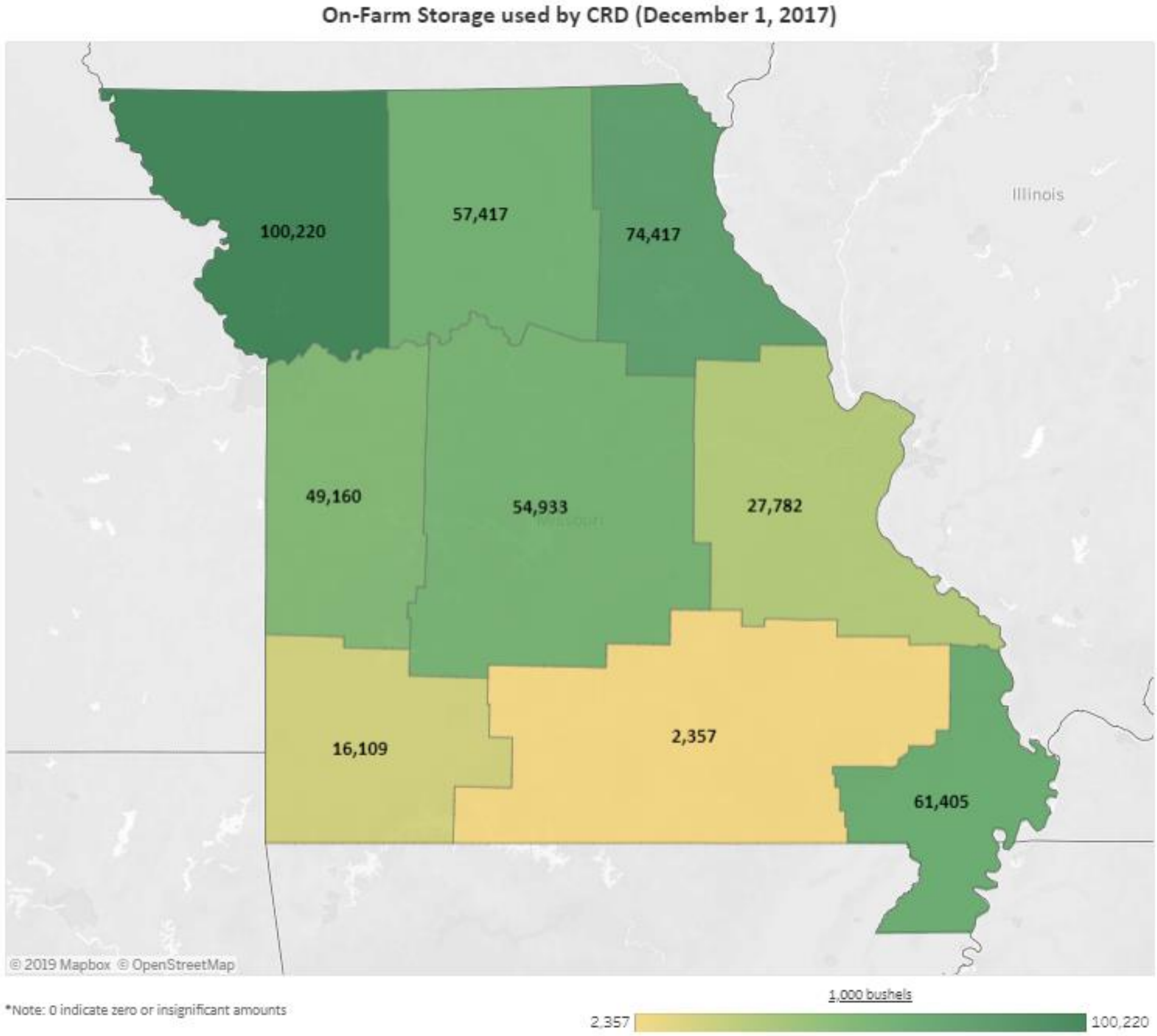


Figure 51, 2017 On-Farm Storage Used by CRD (December 1, 2017)

Figure 51 shows the total amount of on-farm storage that was used on December 1, 2017 aggregated to the crop reporting district level. State-wide, 443.8 million bushels of grain were being stored in on-farm storage. On December 1, 2017, 52% of Missouri on-farm grain was stored on farms in the three northern CRDs.

Grain in on-farm storage in December can flow several ways into the marketing system:

1. It can be fed on-farm
2. It can be moved to a local feed mill, custom milled and fed on-farm
3. It can go to a local elevator for further aggregation and distribution
4. It can go directly to a major processor like an ethanol plant

5. It can be shipped to a distant feed mill (a significant portion of Missouri corn and grain sorghum are shipped to feed-deficit areas in southwest Missouri, northwest Arkansas and eastern Oklahoma)
6. It can be shipped directly to an export facility on the Missouri or Mississippi Rivers or to a train loading elevator
7. It can be retained on the farm as buffer stocks and carried over to another marketing year

Total On-farm Grain Stocks, December 1, 2017

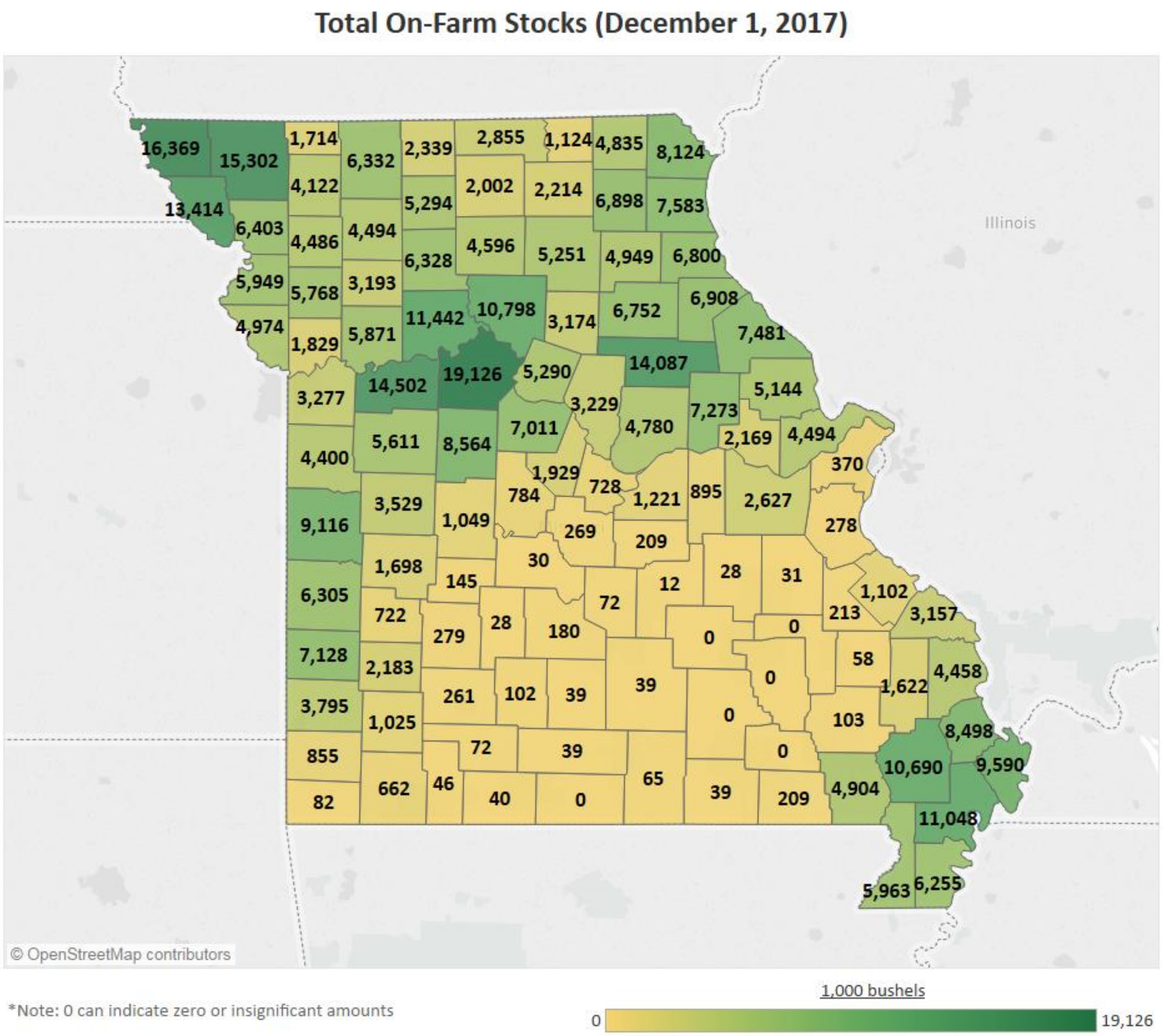


Figure 52, Total On-Farm Stocks (December 1, 2017)

Figure 52 shows the total grain stocks in on-farm storage on December 1, 2017. With corn, soybean and grain sorghum harvest in the September to November period, the USDA December 1st report of on-farm grain stocks typically captures the largest amount of on-farm grain in storage. Peak on-farm grain stocks probably happen sometime in late October or November, but the first reported data is the December 1st grain stocks report.

Missouri On-farm Corn Stocks, December 1, 2017

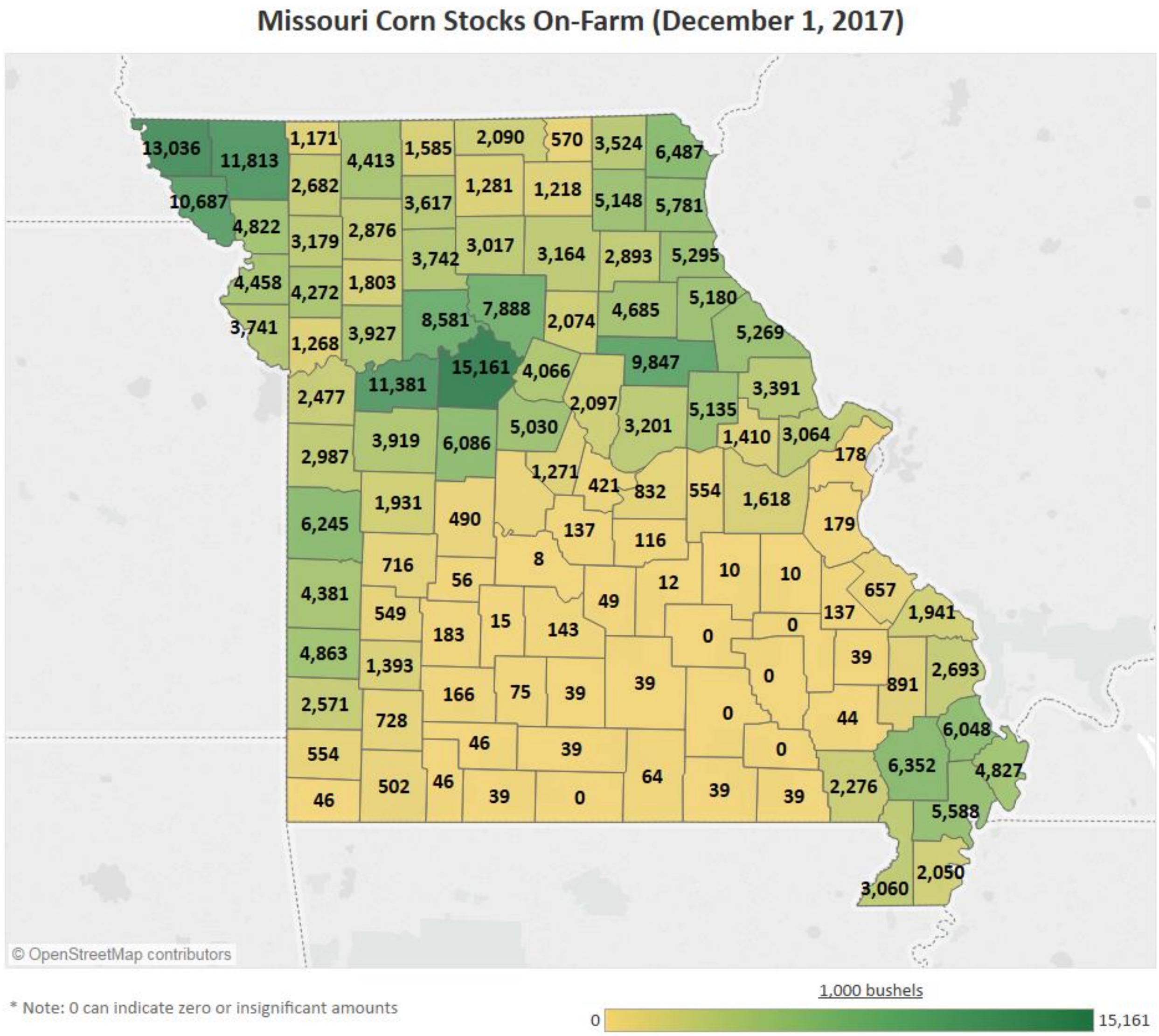


Figure 53 Missouri On-farm Corn Stocks, Dec 1

Figure 53 shows Missouri corn stocks in on-farm storage on December 1, 2017. USDA reported that there were 305 million bushels of corn in on-farm storage on December 1, 2017. County-level corn storage stocks were calculated based on each county's percentage of state production.

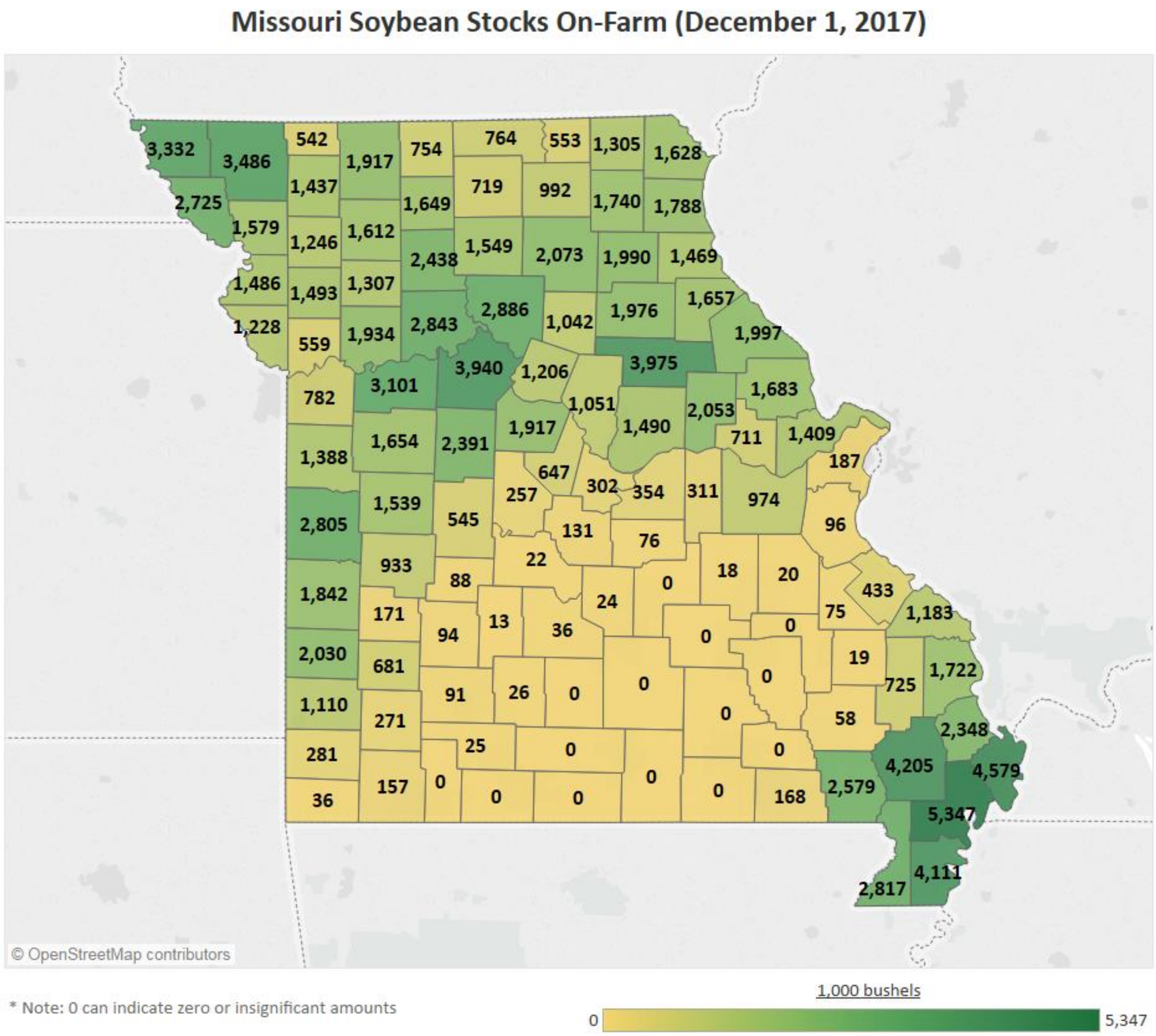


Figure 54, Missouri Soybean Stocks On-Farm (Dec. 1, 2017)

Figure 54 shows Missouri's on-farm soybean stocks on December 1, 2017. Missouri's December 1, on-farm soybean stocks were estimated by USDA to be 135 million bushels. County level on-farm December 1 stocks of soybeans are estimated based on each county's share of soybean production.

Missouri On-farm Grain Sorghum Stocks, December 1, 2017

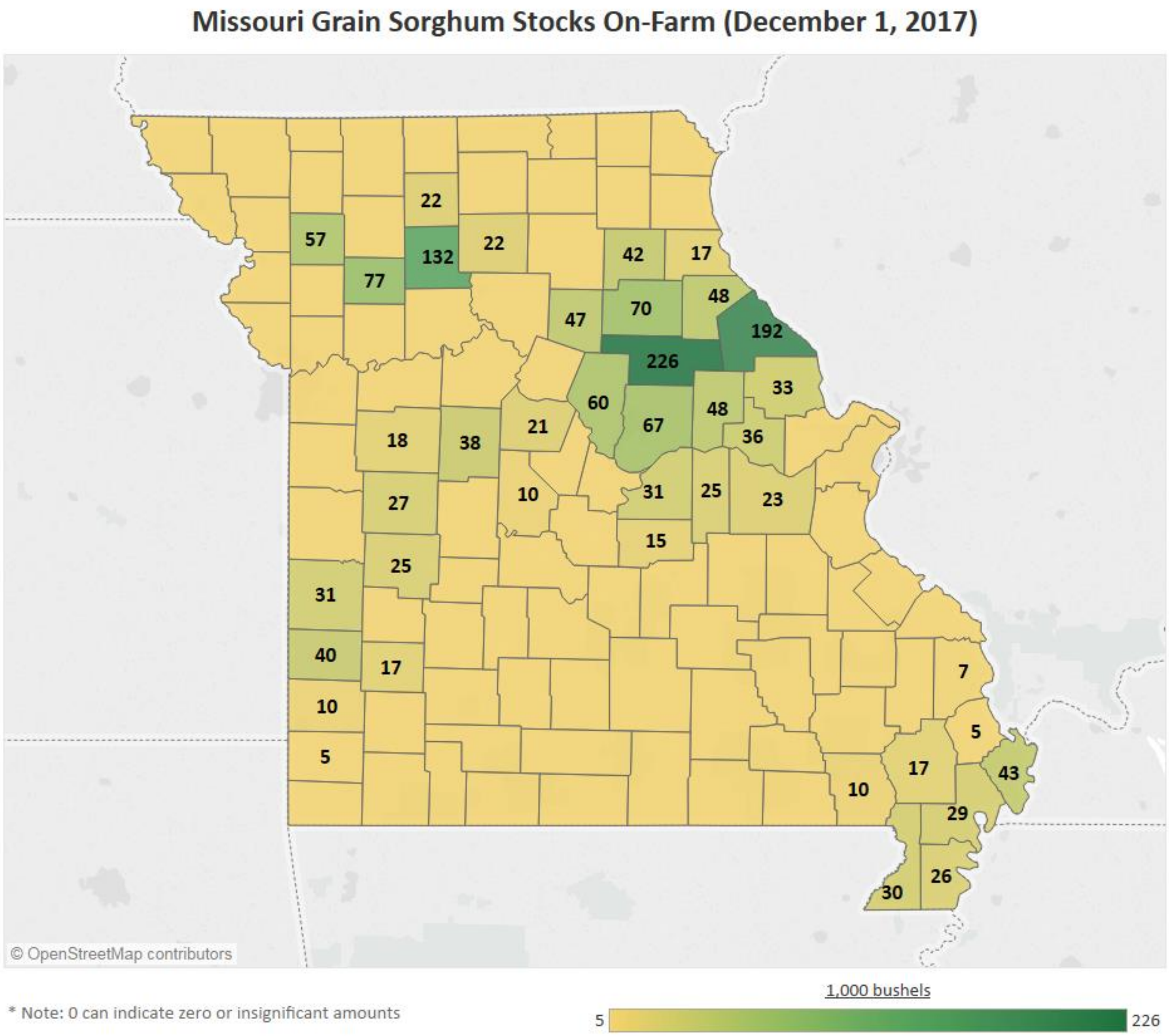


Figure 55, Missouri Grain Sorghum Stocks On-Farm (Dec. 1, 2017)

Figure 55 shows on-farm grain sorghum stocks on December 1, 2017. USDA reported that Missouri on-farm grain sorghum stocks on December 1, 2017 were 1.7 million bushels which was 69% of Missouri annual production. On-farm grain stocks were allocated to county-level stocks based on the estimate of the county's share if grain sorghum production.

Total December 1 grain sorghum stocks, off-farm and on-farm were 2,463,000 bushels, or 2,000 bushels more than estimated Missouri 2017 production. DIS estimates that Missouri feeds about 1.1 million bushels of grain sorghum to livestock and poultry per 3-month period. A significant portion of the on-farm storage of grain sorghum is fed on-farm.

Missouri On-farm Wheat Stocks, December 1, 2017

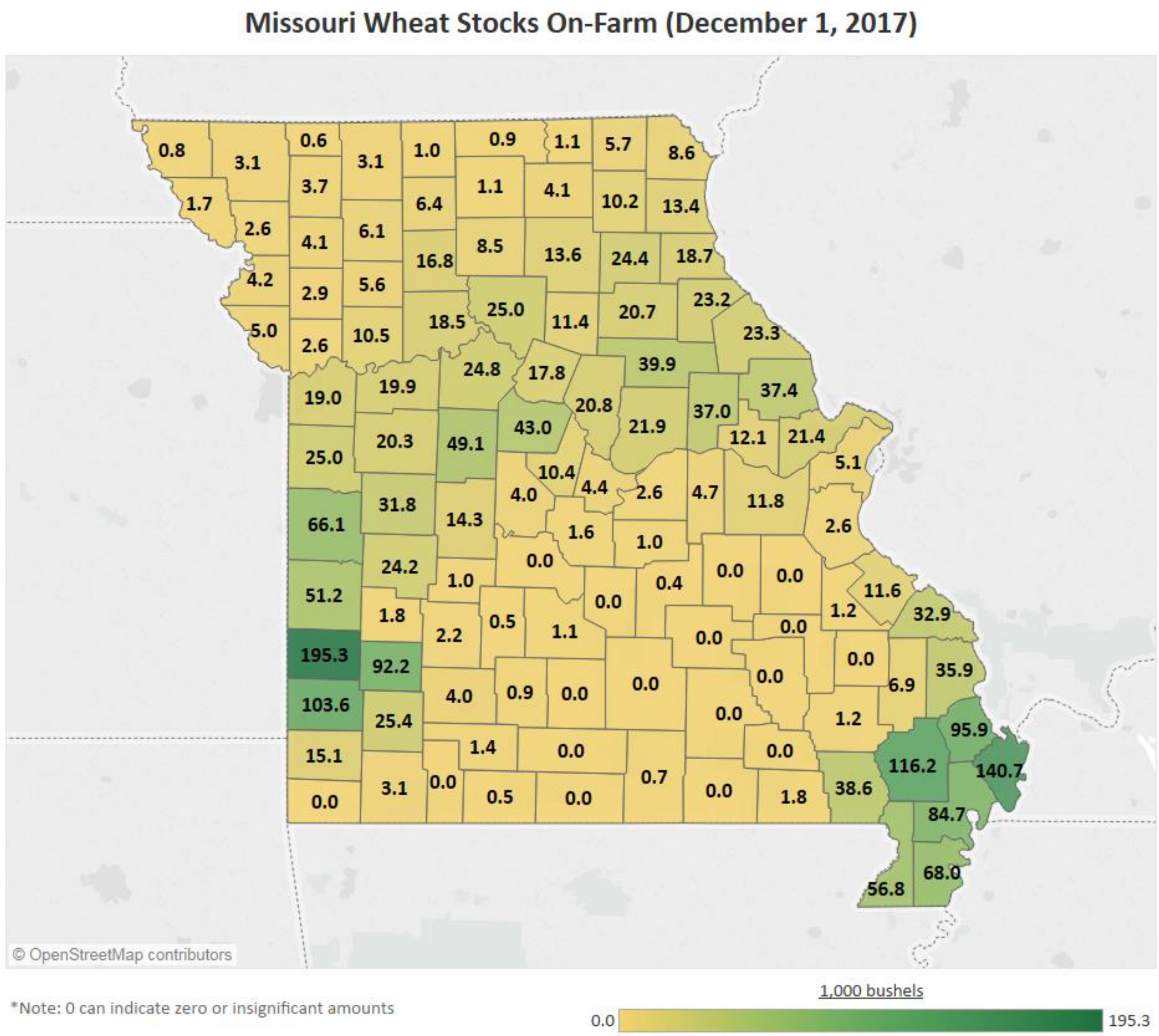


Figure 56, Missouri Wheat Stocks On-Farm (December 1, 2017)

Figure 56 shows on-farm wheat stocks on December 1, 2017. USDA estimated that Missouri had 2.1 million bushels of wheat in on-farm storage on December 1, 2017. County level wheat stocks were calculated based on each county's percentage of Missouri wheat production.

Results

The data analyzed and presented in this report is extensive and represents significant effort expended on research definition, methodology development and adoption, data gathering, analysis and synthesis and presentation of results. This section of the report presents the results according to major components, which are:

1. Commodity Flow
2. Infrastructure Utilization
3. Infrastructure Assessment
4. Cost/Benefit Analysis of Public Investment in Infrastructure
5. Summary by Federal Congressional District

Commodity Flow Analysis (Expanded Study Area)

Understanding how the four (corn, soybeans, grain sorghum and wheat) studied commodities flow from production to market (i.e., "end use" from a Missouri standpoint) was modeled using the following methodological framework:

1. Evaluate recent commodity production patterns
2. Determine whether commodity is likely to be stored on farm; if so, why?
    a. To be fed with or without farm-based processing
    b. To be sold (processed and/or exported)
3. Determine "local" level of geographic study (county or CRD)
4. Estimate local demand for commodity

To analyze corn flows for Missouri counties it is necessary to expand the area of both potential supply and demand as supplies from outside of Missouri are needed to satisfy demand in some counties and corn from some Missouri counties moves to demand points in neighboring states. For this analysis the area of consideration was expanded to include the full crop reporting district (CRD) for every county that borders Missouri. In addition, CRD "40" in Arkansas was added to the study area due to its demand draw on corn supplies from Missouri counties. Data tables for the graphics that follow are contained in the Appendix.

Corn Commodity Flow

Corn Production 2017

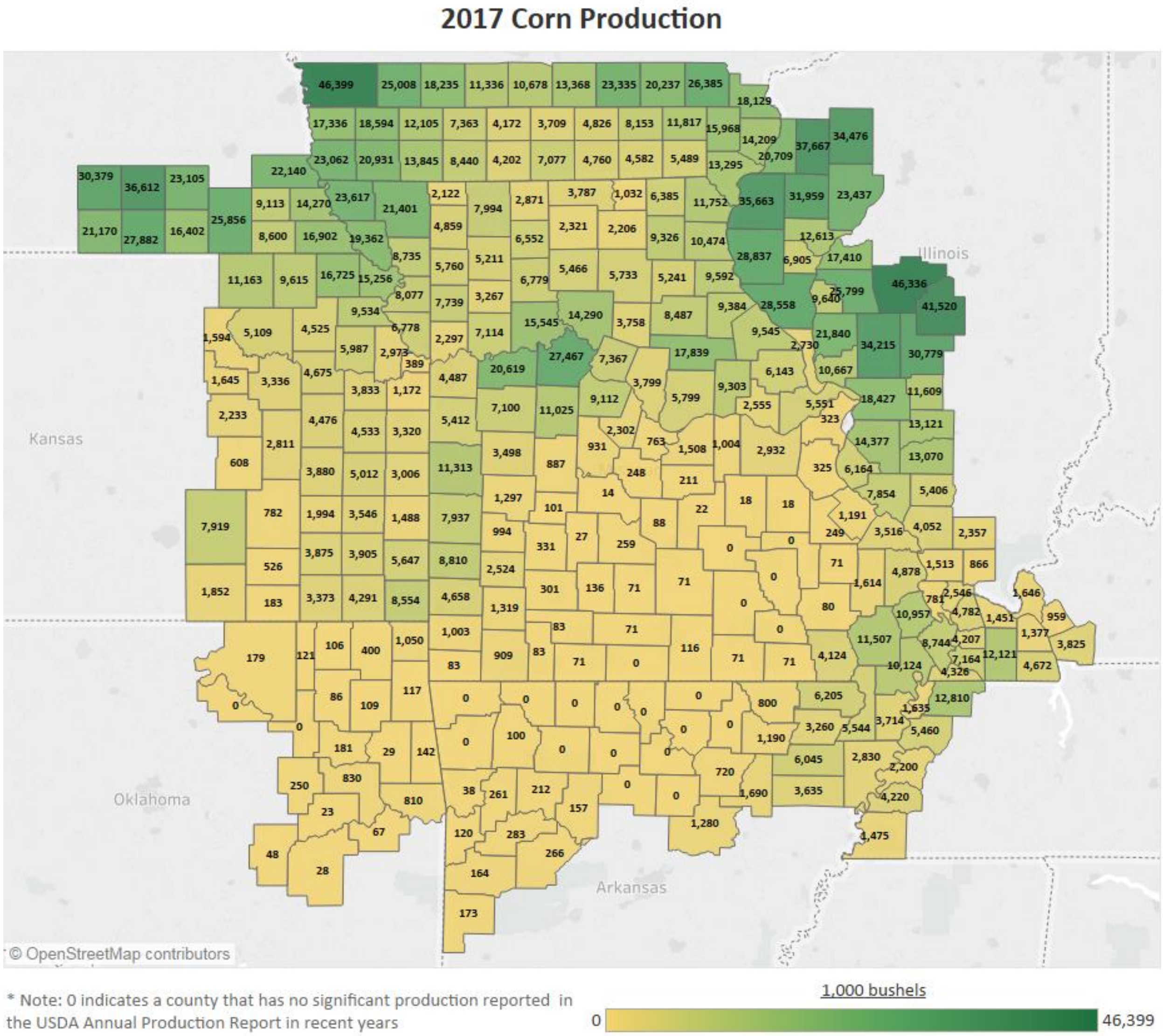


Figure 57, 2017 Corn Production

Figure 57 shows 2017 corn production at the county level for the expanded flow-study area.

Corn Off-farm Stocks, September 1, 2018

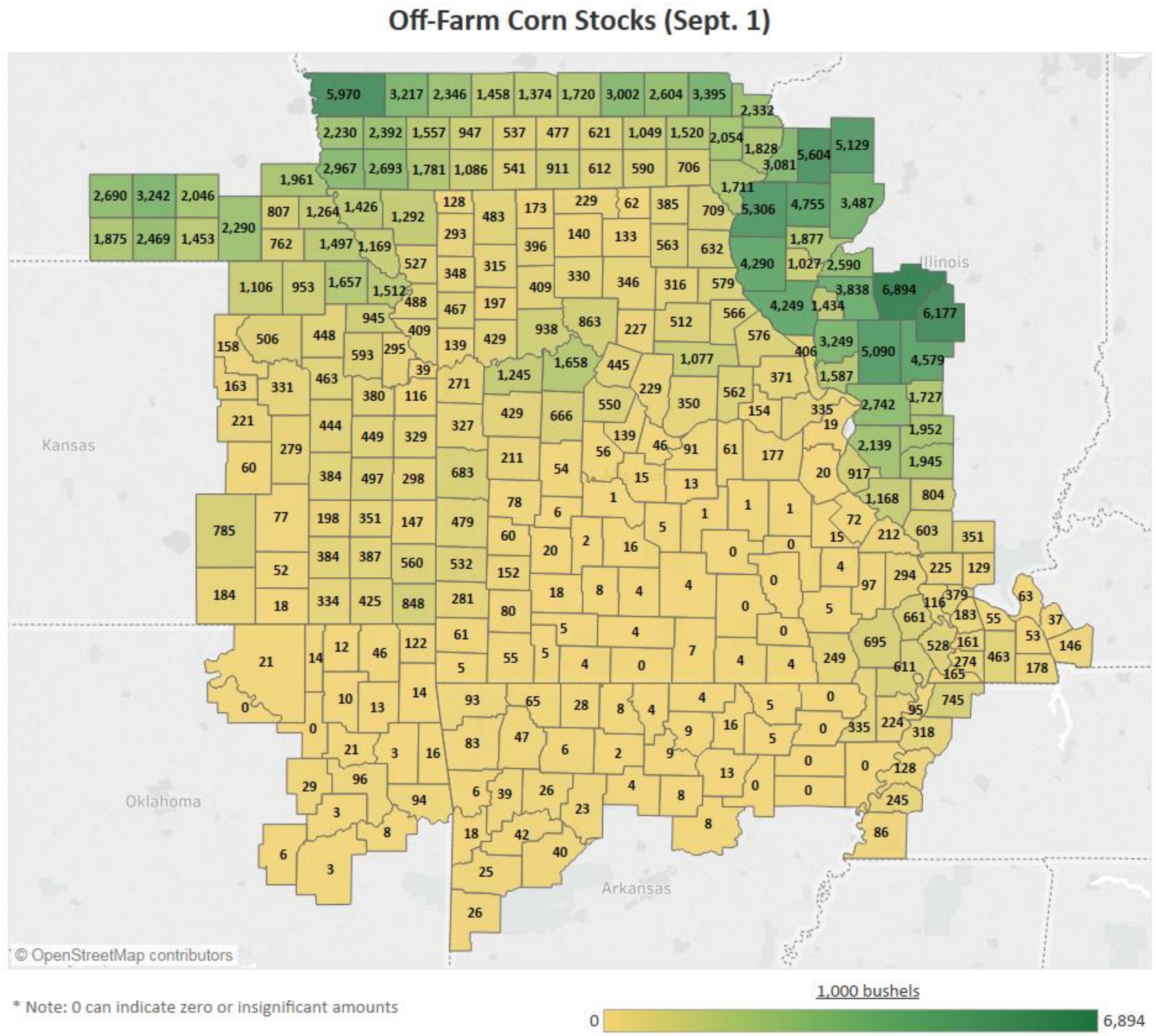


Figure 58, Off-Farm Corn Stocks (Sept. 1)

Figure 58 shows off-farm corn stocks for September 1, 2018. These represent the 2017 marketing year ending stocks. USDA reports stocks on a state-wide basis. County level stocks were calculated based on each county's share of state-wide production with an adjustment for counties that have significant corn inflows in which case 1 week of annual use was used as a working stocks level.

Corn On-farm Stocks, September 1, 2018

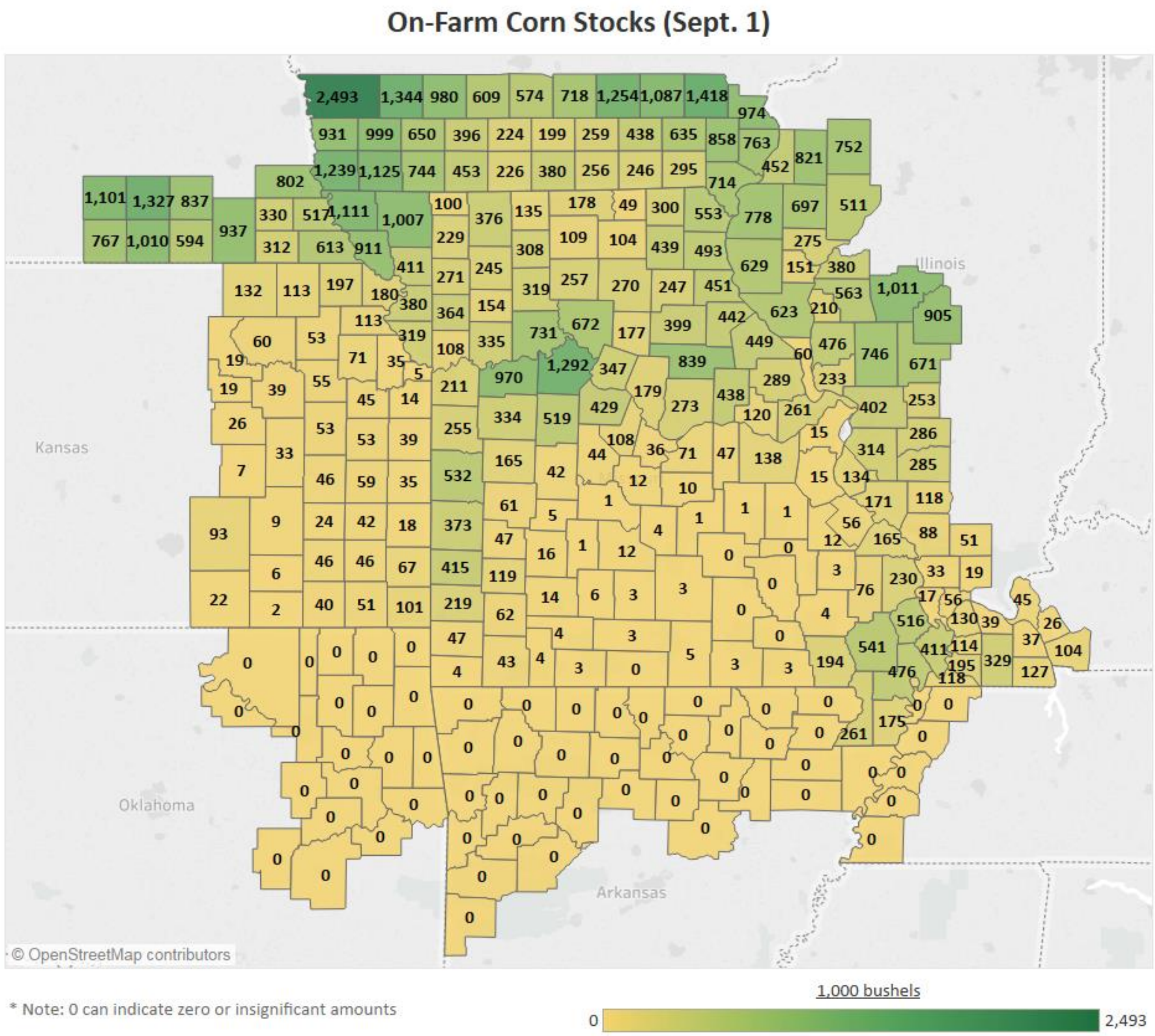


Figure 59, On-Farm Corn Stocks (Sept. 1)

Figure 59 shows on-farm corn stocks for September 1, 2018. USDA reports on-farm stocks on a state-wide basis. County-level stocks were calculated based on each county's share of state corn production.

Total Corn Fed

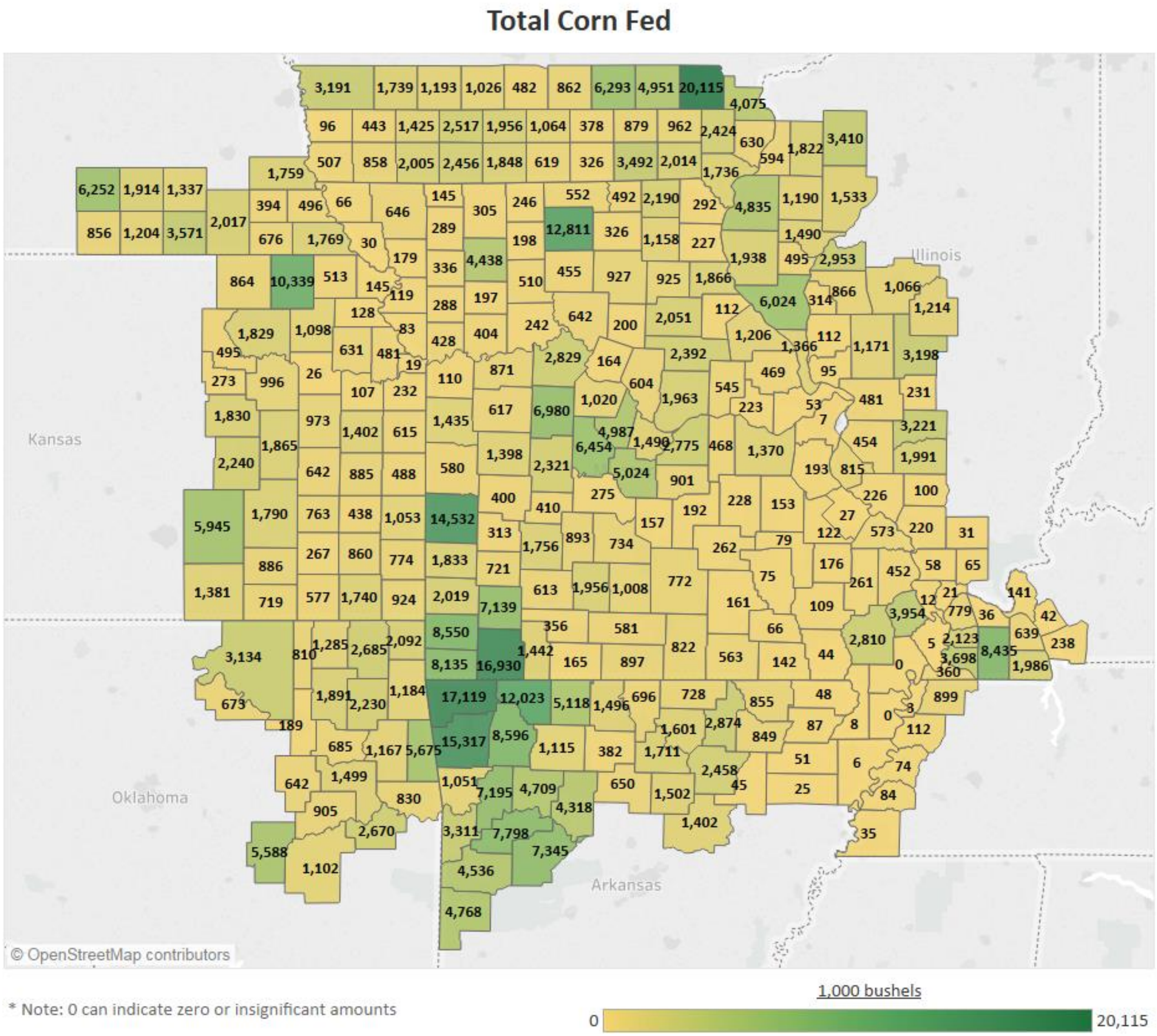


Figure 60 Total Corn Fed

Figure 60 shows the total corn fed by county for the expanded study area. Corn fed was calculated based on USDA livestock inventory numbers and feed ration factors developed by DIS in prior research for each of the major livestock species, and adapted to feed rations in each state.

Net Corn Balance

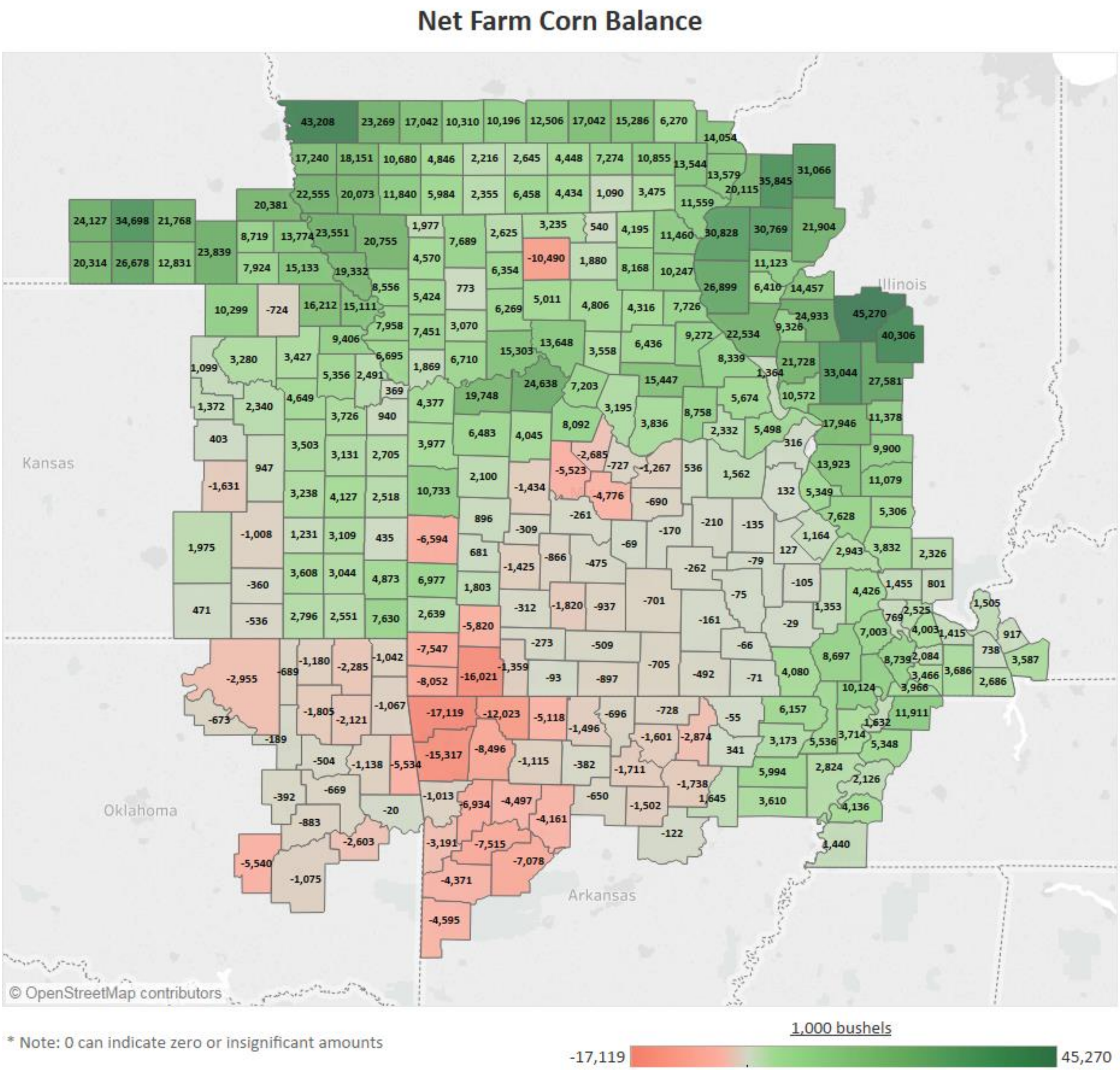


Figure 61, Net Farm Corn Balance

Figure 61 shows the net corn balance for the counties in the study area after satisfying in-county feed demand, in-county ethanol demand, and adjusting for ending stocks being held on-farm and off-farm within the county.

Feed mill Corn Inflow

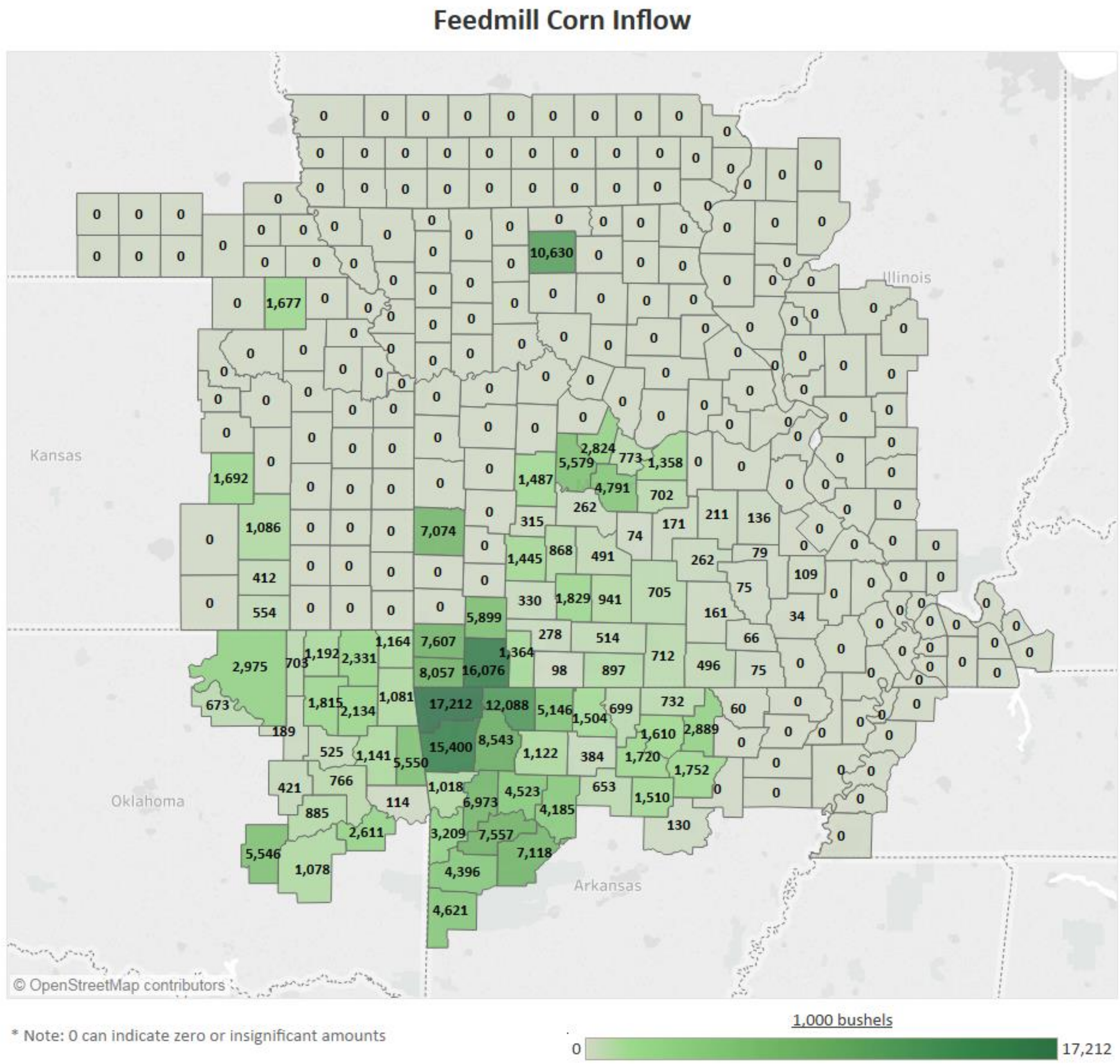


Figure 62, Feed mill Corn Inflow

Figure 62 shows the quantities of corn in thousands of bushels that will be needed to flow into a county to satisfy feed demands for the livestock in the county.

Ethanol & Processing

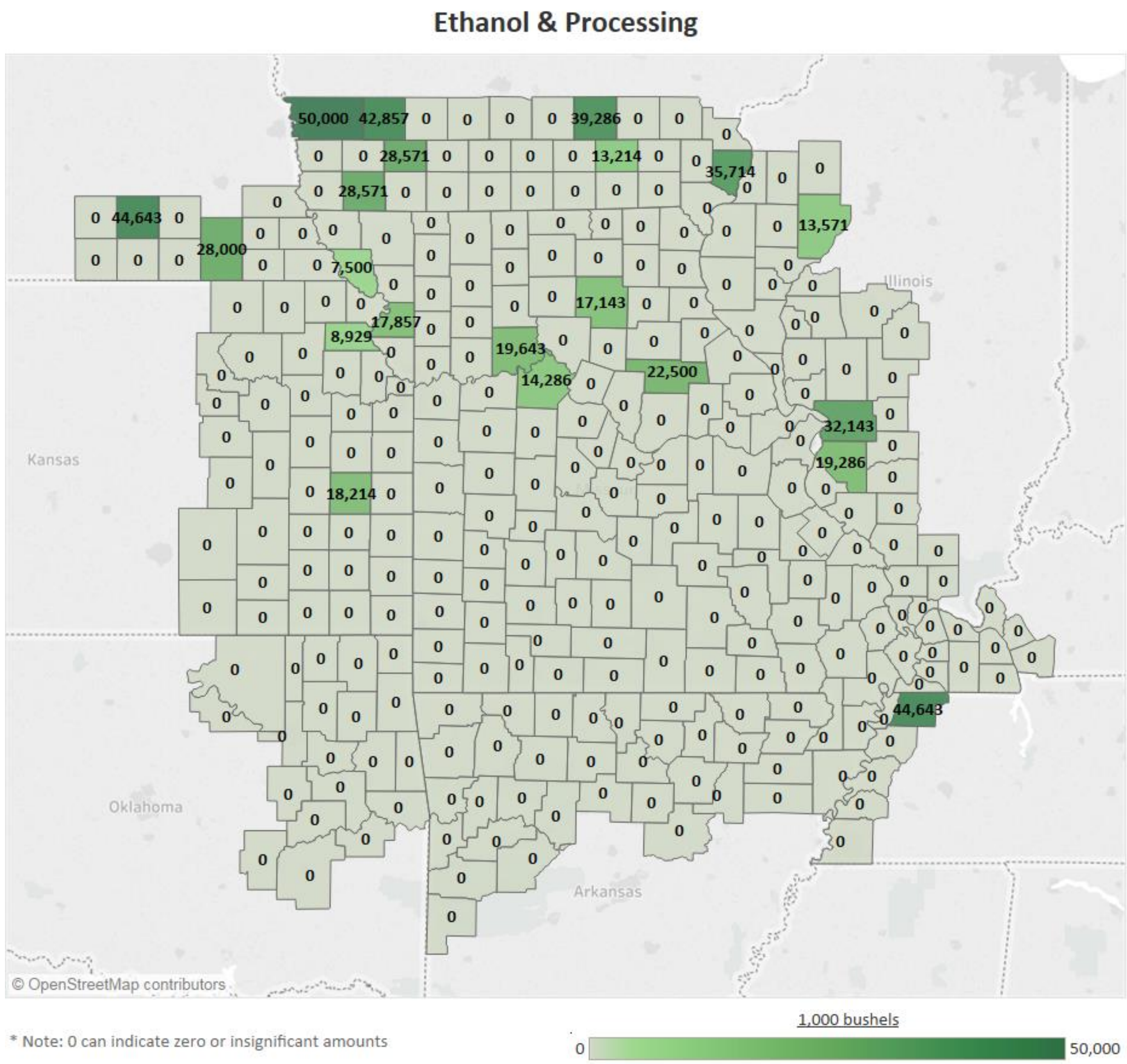


Figure 63, Ethanol & Processing

Figure 63. shows the operating capacities for the 15 operating ethanol facilities In the surrounding counties of the adjacent CRDs of the expanded flow-study area.

Ethanol Inflows

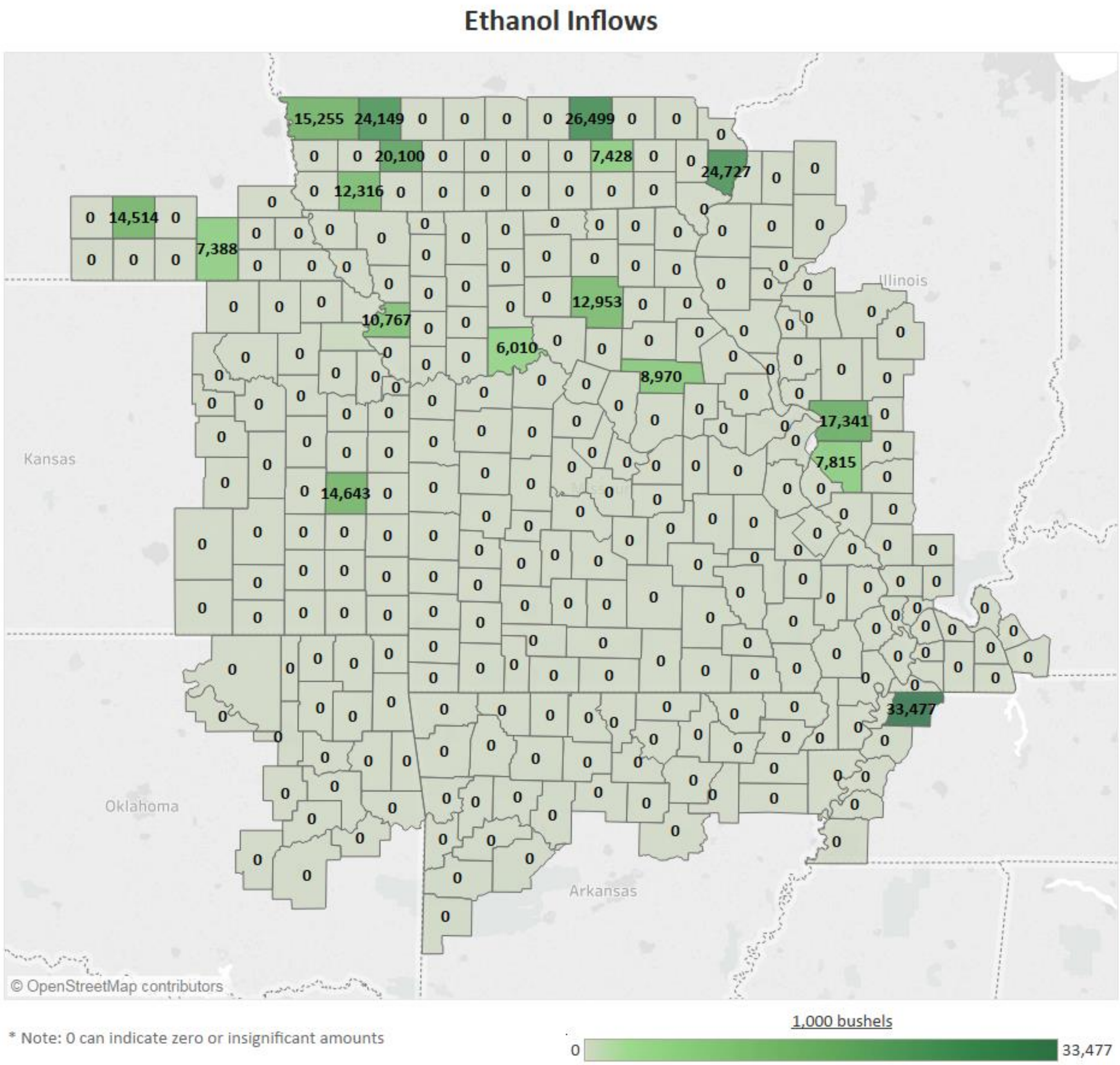


Figure 64, Ethanol Inflows

Figure 64 shows the corn inflows that are needed from other counties to meet the needs of the ethanol plants in the expanded study area.

County Corn Inflow Needs

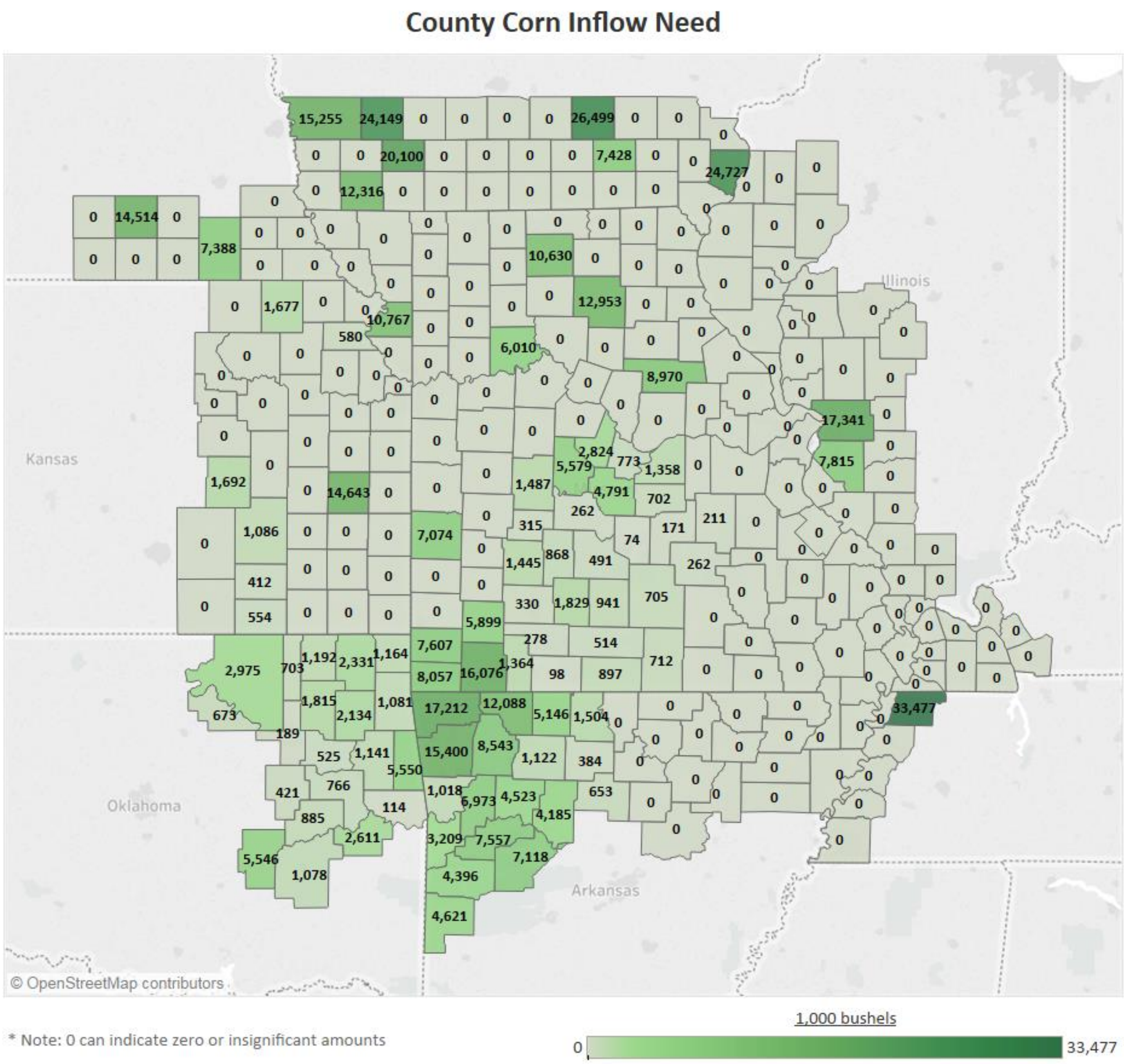


Figure 65, County Corn Inflow Need

Figure 65 shows the calculated corn inflows needed to meet both feed mill and ethanol demand that cannot be satisfied by corn supplies from within the county. Of note is the substantial corn inflow needs for feed in southwest Missouri, northeast Oklahoma and northwest Arkansas. The commodity flow algorithm developed by DIS and run on a SAS operating loop satisfied these corn needs by allocating the closest available supplies on a looping basis until the needs are fully satisfied.

Total Corn Inflow

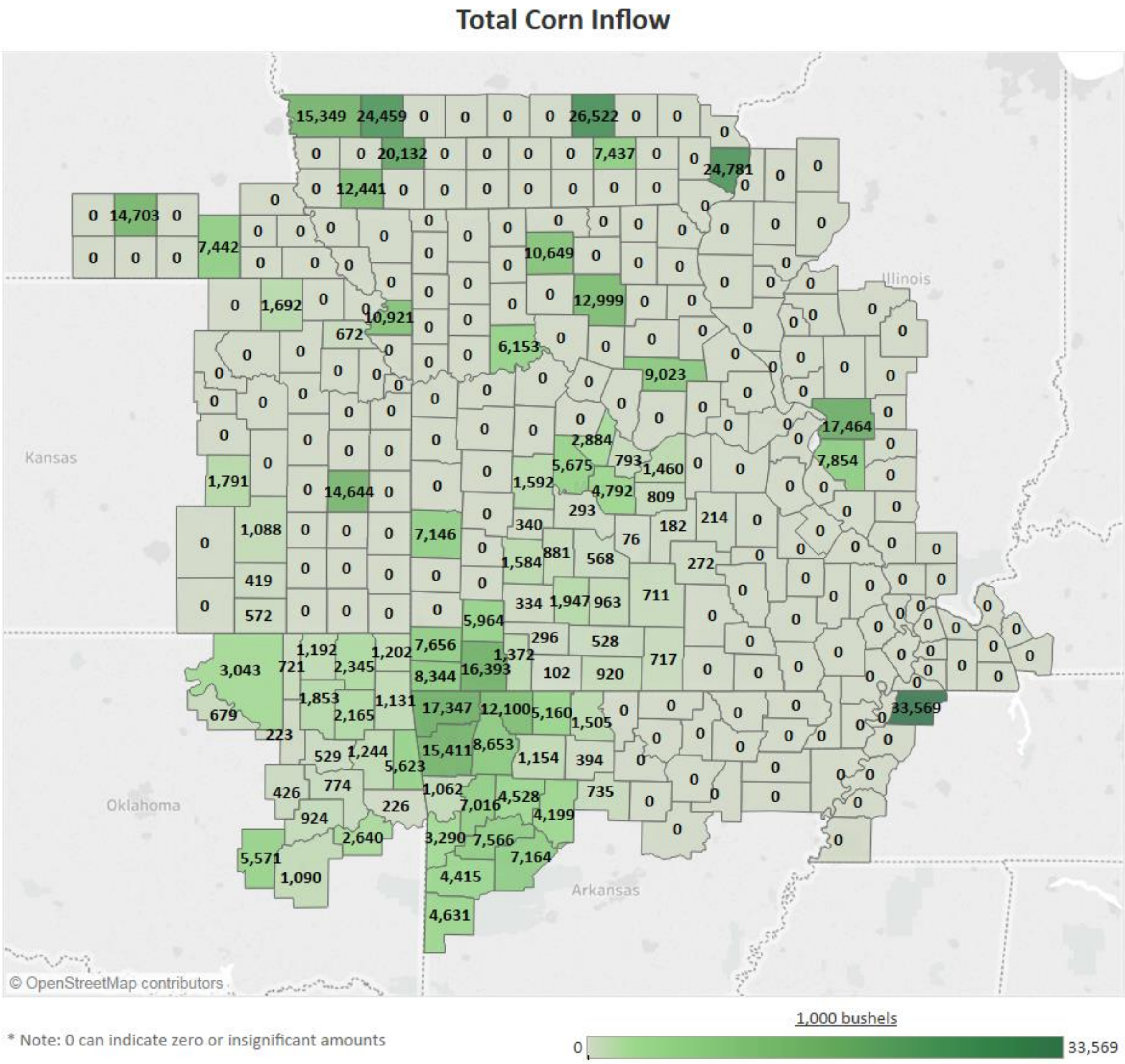


Figure 66, Total Corn Inflow

Figure 66 shows the total amounts that were allocated to the demand locations by the SAS looping process. Supplies were distributed within each county on an equal distance basis according to the number of 10-square mile centroids that exist within each county. In the simulation, the bushels associated with each of the centroids were unitary, thus when the bushels from a centroid are claimed by a demand point, all the bushels from that centroid are allocated to the demand. This lumpiness of supplies results in a minor over-allocation to demand points. In aggregate, a total over allocation of about 0.9% occurred.

Feed and Ethanol Outflows

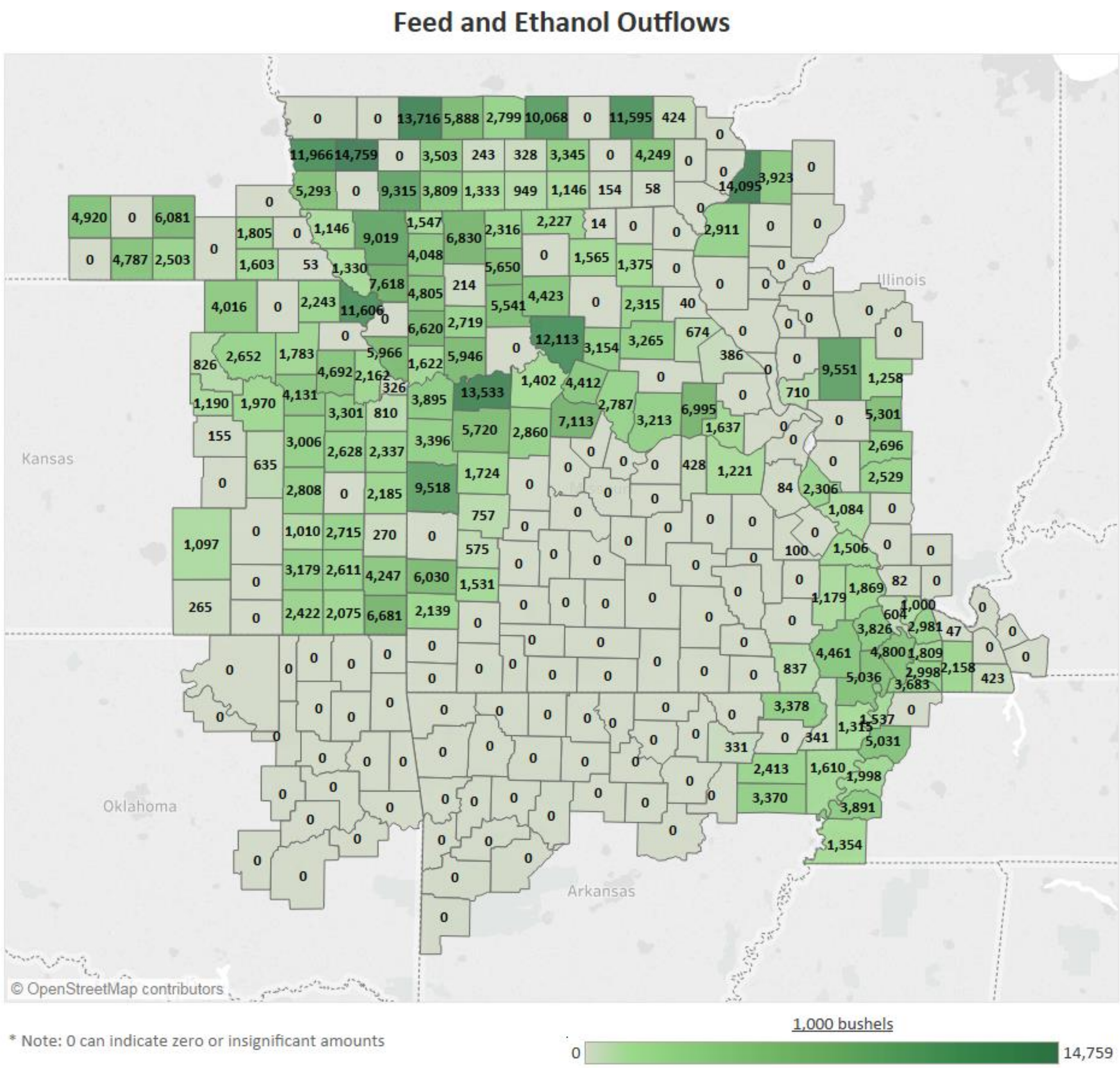


Figure 67, Feed and Ethanol Outflows

Figure 67 shows the amount of corn claimed from a county to meet feed mill and ethanol demand in other counties.

Corn Exports

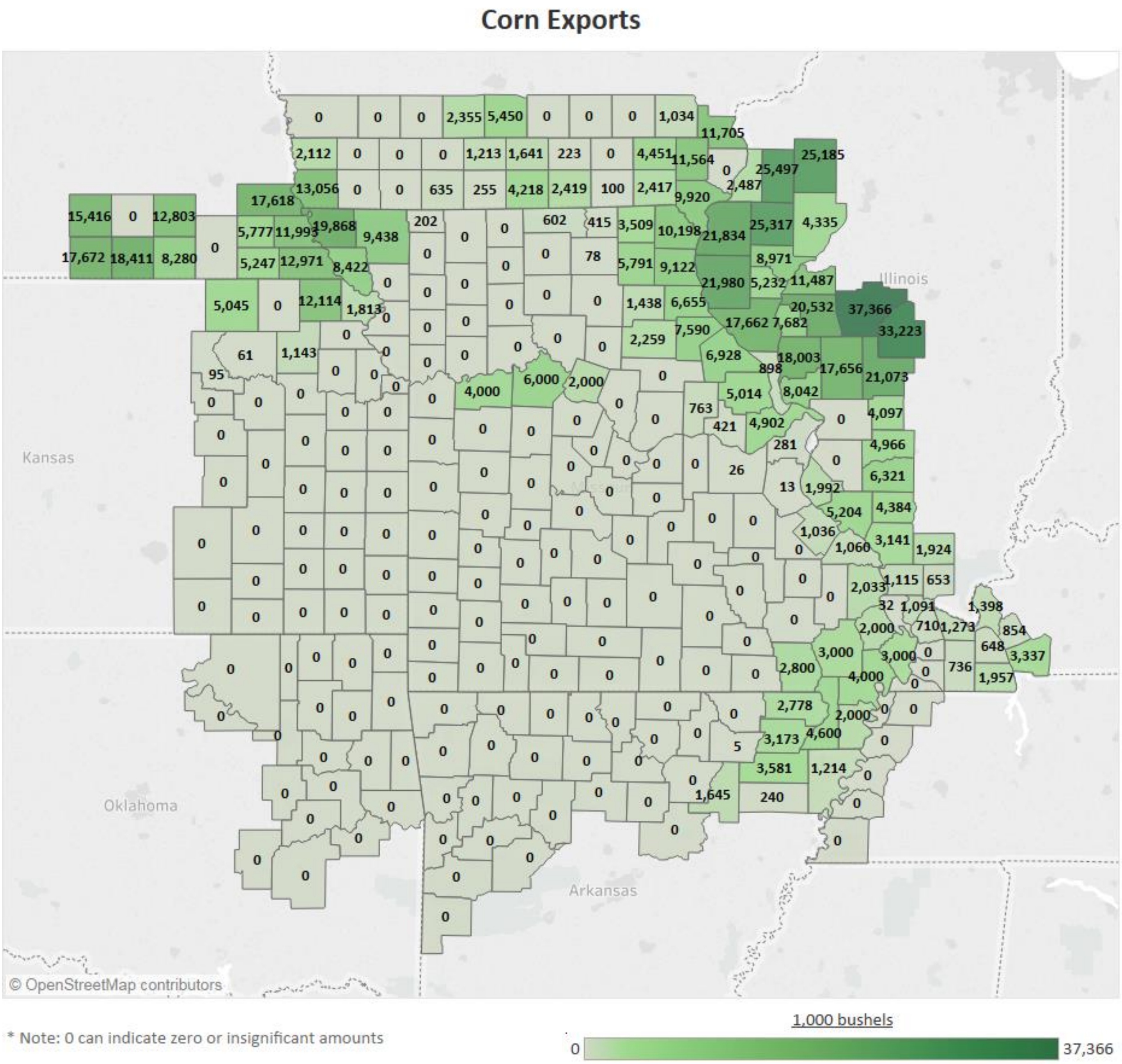


Figure 68, Corn Exports

Figure 68 shows the calculated amounts of corn that are exported from counties within the expanded study area. For counties along the Mississippi River a base amount of corn was "pre-allocated" to exports so that the program could not draw all corn supplies from river-adjacent counties into distant feed and ethanol demand. The data in Figure 68 includes both these pre-allocated amounts and all residual amounts that were not claimed by in-county feed demand, in-county storage stocks, or claimed by another county to satisfy feed and ethanol demand.

Dynamic Flow Analysis Methodology

An important component of this analysis is the development of methodology to dynamically determine draw areas for supply-deficit areas. This was accomplished by taking the following steps for each crop conducive to this type of analysis:

1. By crop, determine whether analysis will be conducted at county or CRD level (analysis unit)
2. Determine geographic center (centroid) of each 10-square mile parcel in study area
3. Determine geographic center (centroid) of each analysis unit in study area
4. Determine net available supply for each analysis unit (county or CRD)
    a. Categorize each analysis unit as Surplus or Deficit
        i. Surplus analysis units: Supply Points
        ii. Deficit analysis units: Demand Points
5. Equally divide county (CRD) surplus to each centroid within its boundaries
6. Assign county (CRD) deficit to centroid of county (CRD)
7. If applicable, determine “preferential” demand points (ethanol plants, large animal production areas, areas near the Mississippi River, etc.)
8. Conduct Dynamic Flow Analysis
    a. Calculate distance from every remaining supply point to every remaining demand point
    b. Randomize all demand points
    c. Run a SAS loop (“looping”) to allow all demand points to “claim” nearest supply point
    d. Repeat steps 8a-8c until all demand point deficits are satisfied (reduced to 0)
9. Create data files, maps, charts and other visuals to illustrate:
    a. Demand points and their relative level of demand
    b. All supply points and their relative level of supply
    c. “Claimed” supply points, categorized by assigned demand point
    d. Remaining supply points
    e. Movement of commodities from supply points to demand points

Map images are included in a crop’s respective “dynamic flow analysis” section. We have also completed online, interactive maps for querying/exploring the same data which supports these map images. These interactive maps can be found here for **corn**, for **soybeans** and for **grain sorghum** and will be updated and enhanced when needed.

Corn Dynamic Flow Analysis

Corn Supply per 10-Square Miles

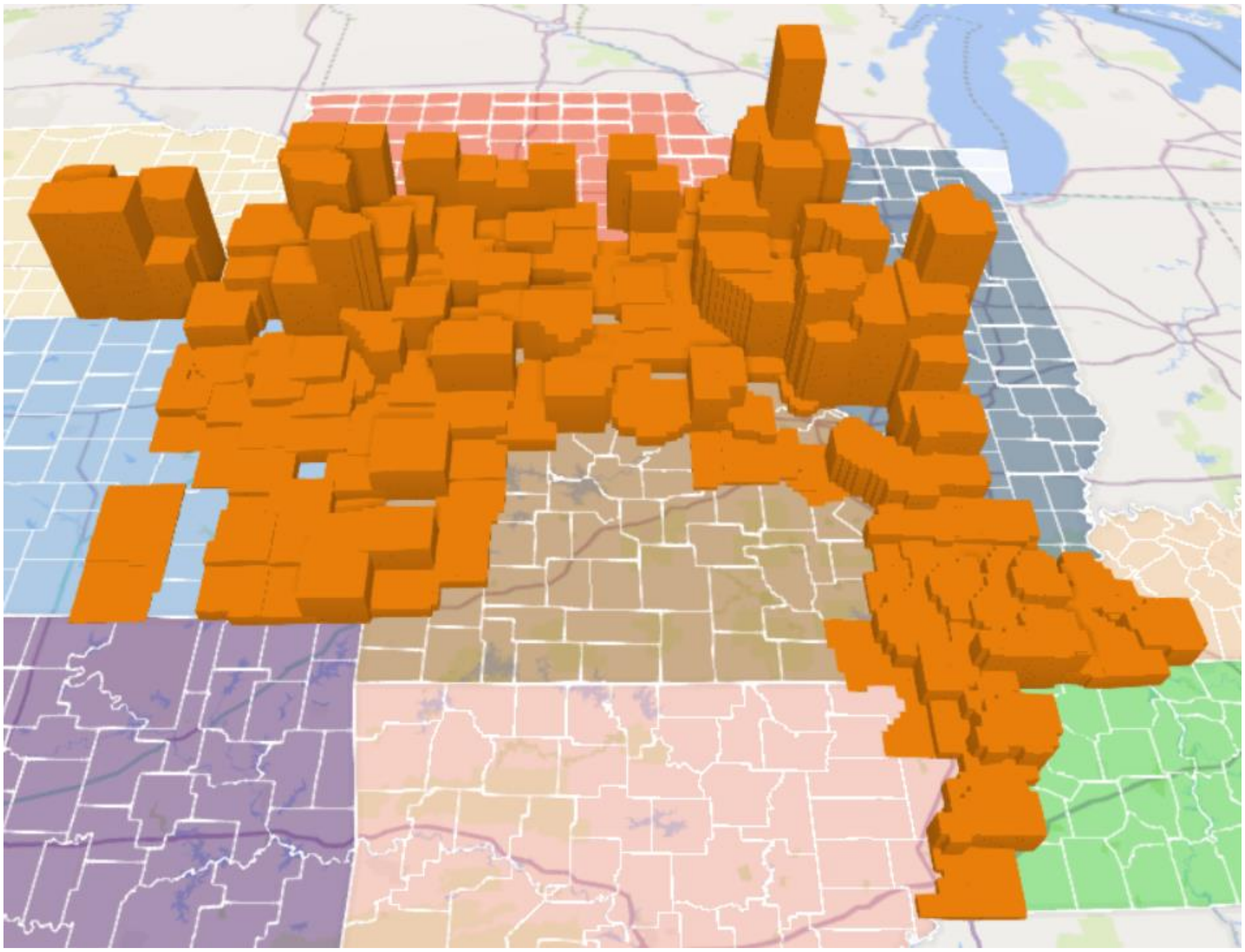


Figure 69, Corn Supply per 10 Square Miles

Figure 69 shows the quantity of corn associated with each of the 10-square mile centroids. The total quantity of corn available for outflows from a county were equally divided among the centroids of the county.

Corn Deficit County Demand Points

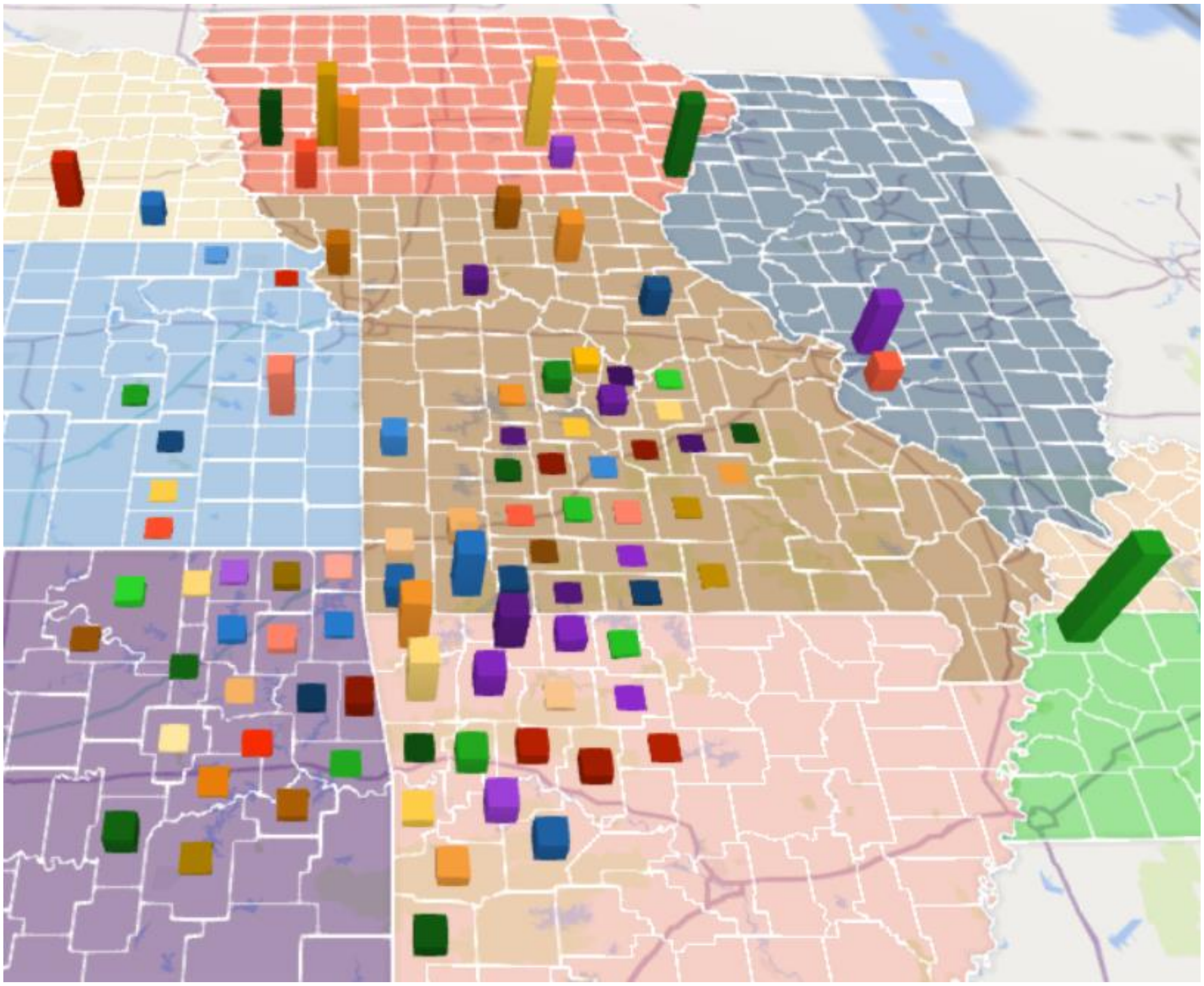


Figure 70, Corn Demand Points

Figure 70 shows the corn demand counties and the height of the bar shows the relative quantity of the demand with a taller bar indicating more inflows needed to satisfy demand points in the county.

Claimed Corn Supply Map

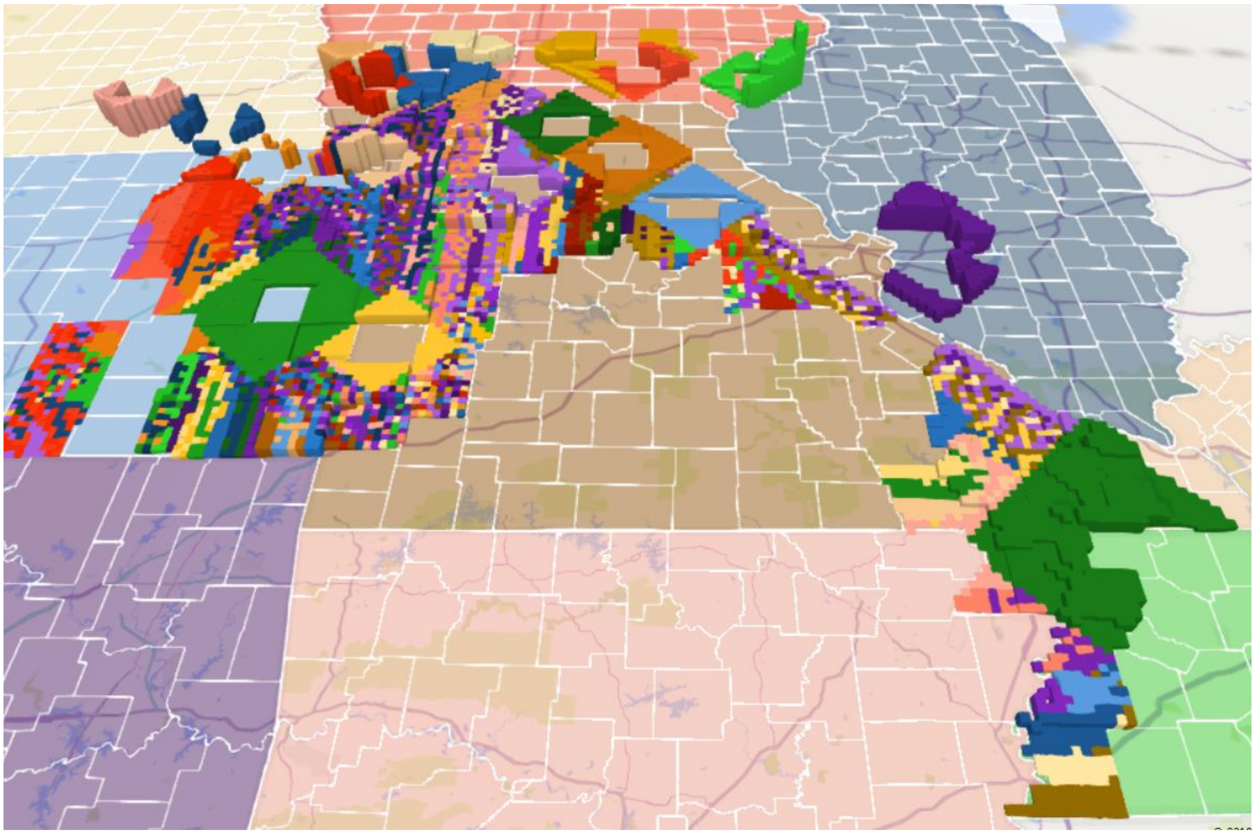


Figure 71, Claimed Corn Supply

Figure 71 shows the full pattern of claimed corn supplies with the various colors each associated with a particular demand point. Each pixel represents the county demand point that claimed the corn from that centroid and the height of the pixel represents the amount of corn in that 10-square mile area.

Remaining Corn Supply -- Corn Exports

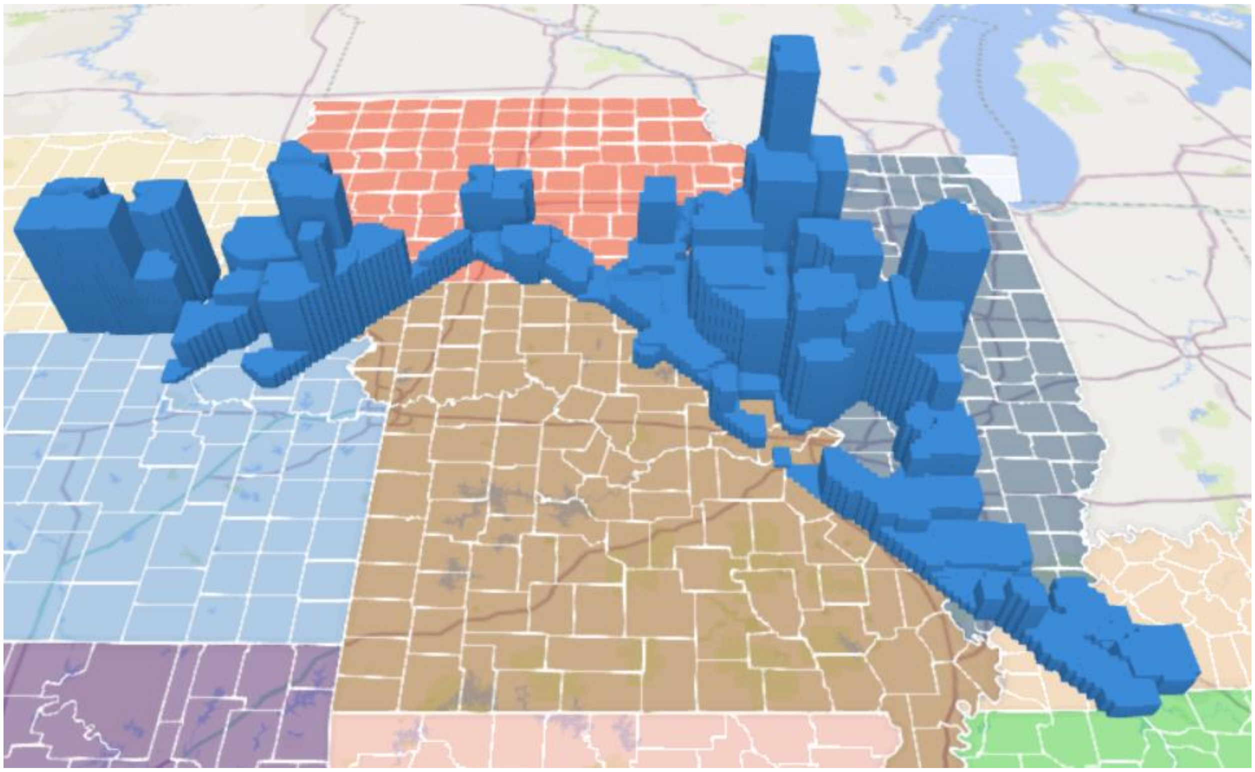


Figure 72, Remaining Corn Supply

Figure 72 shows the remaining corn supplies after allocations to in-county feed demand, in-county storage stocks, and outflows to meet feed mill and ethanol demand in other counties. Remaining stocks reflect the quantities that are exported.

Soybean Commodity Flow

Soybean Production 2017

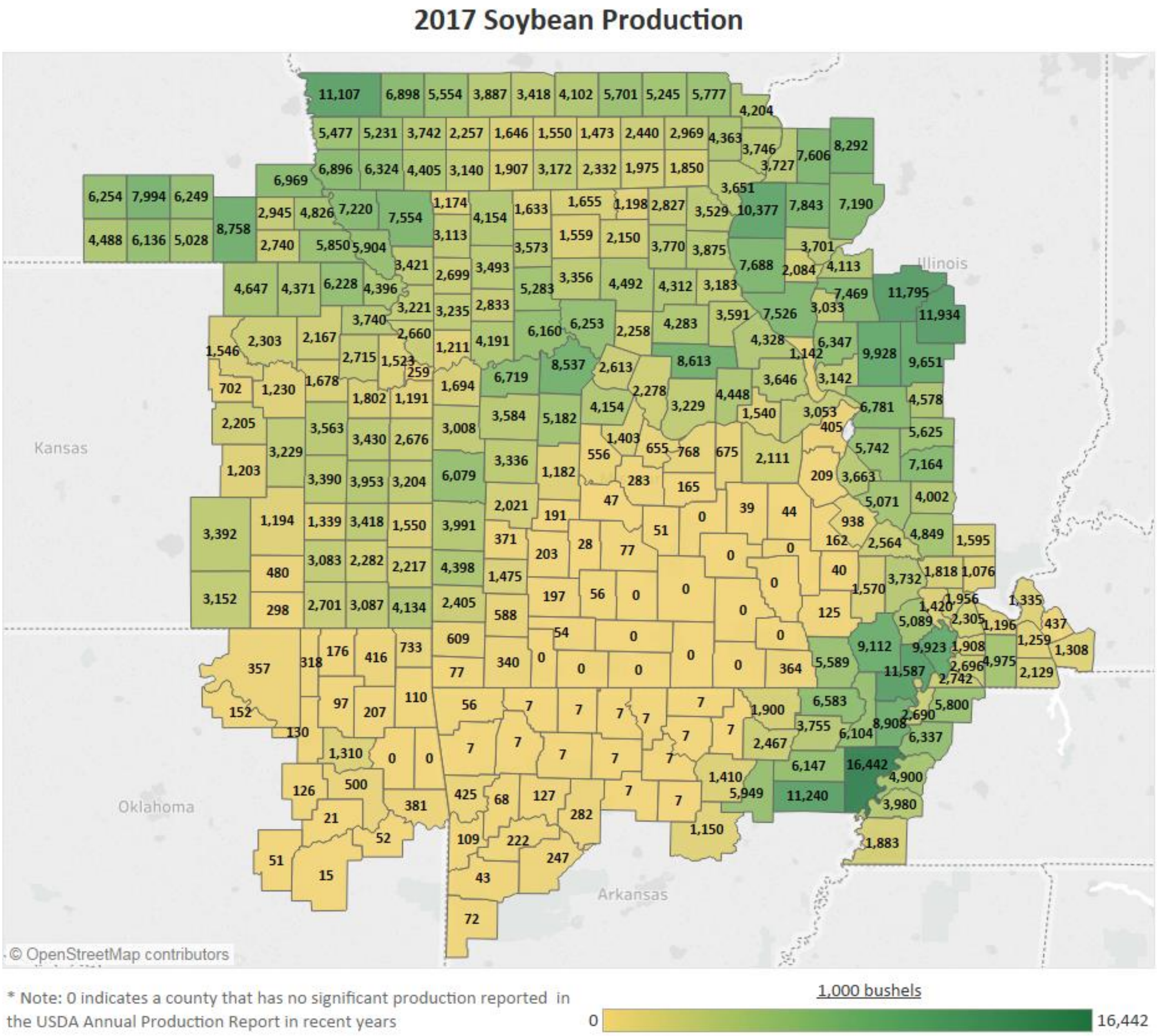


Figure 73, 2017 Soybean Production

Figure 73 shows 2017 soybean production for all counties in the expanded flow-study area. Soybean production is reported by USDA at the state, CRD and county level, although data for some CRDs and counties is combined with other counties to comply with USDA's non-disclosure policies. For instances where county data was unpublished, DIS allocated production from the combined county data of CRDs based on historical county shares of production.

Soybean Processing Demand

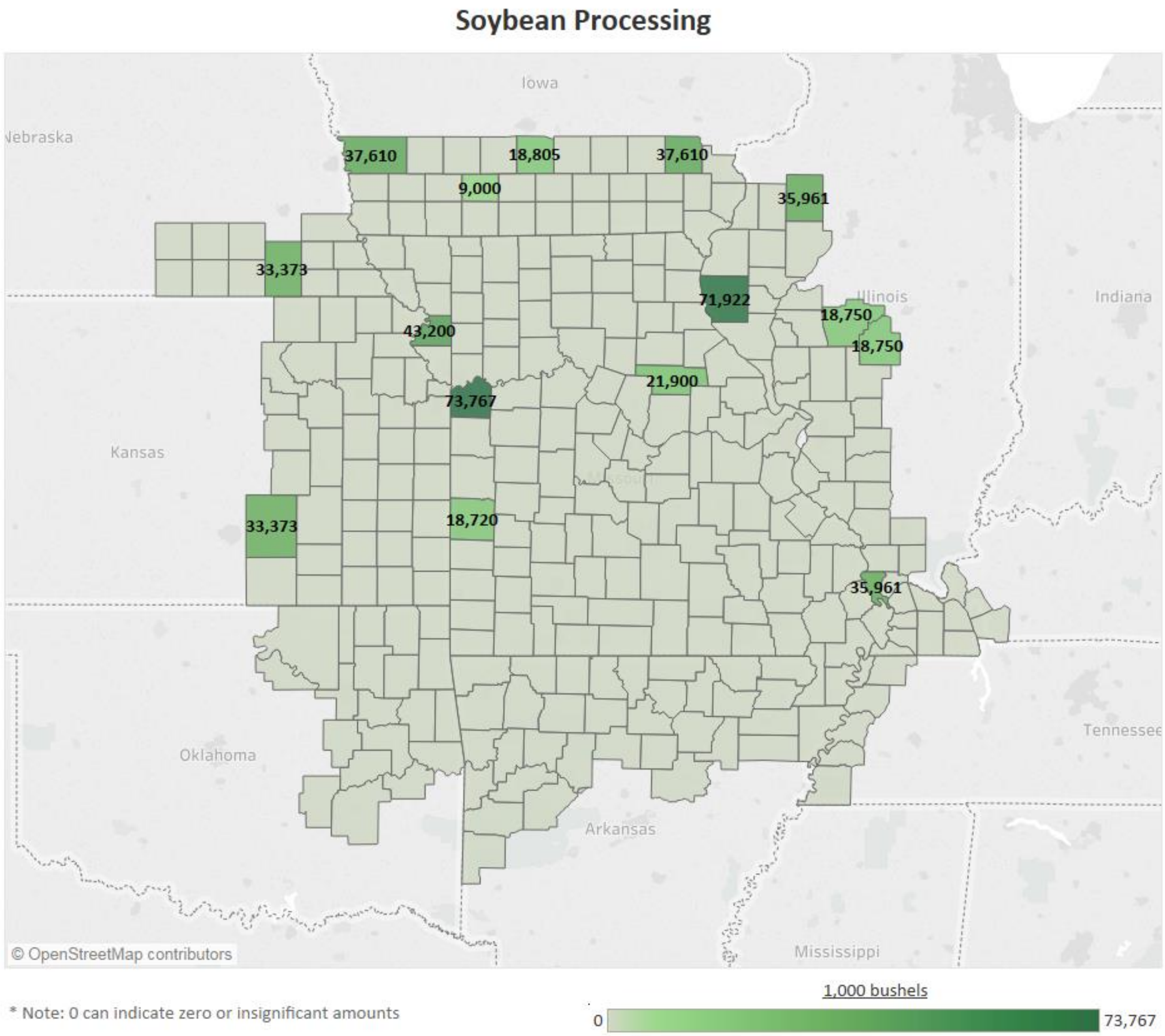


Figure 74, Soybean Processing

Figure 74 shows the counties in the expanded analysis area that have soybean processing plants and the total annual processing demand of the plant(s) in the county. Data for soybean processing capacity was gathered from multiple data sources and in some instances was calculated as an average share of the plant capacity for the reporting area that USDA uses to report soybean crush data.

Soybean Net County Supply/Demand Balance

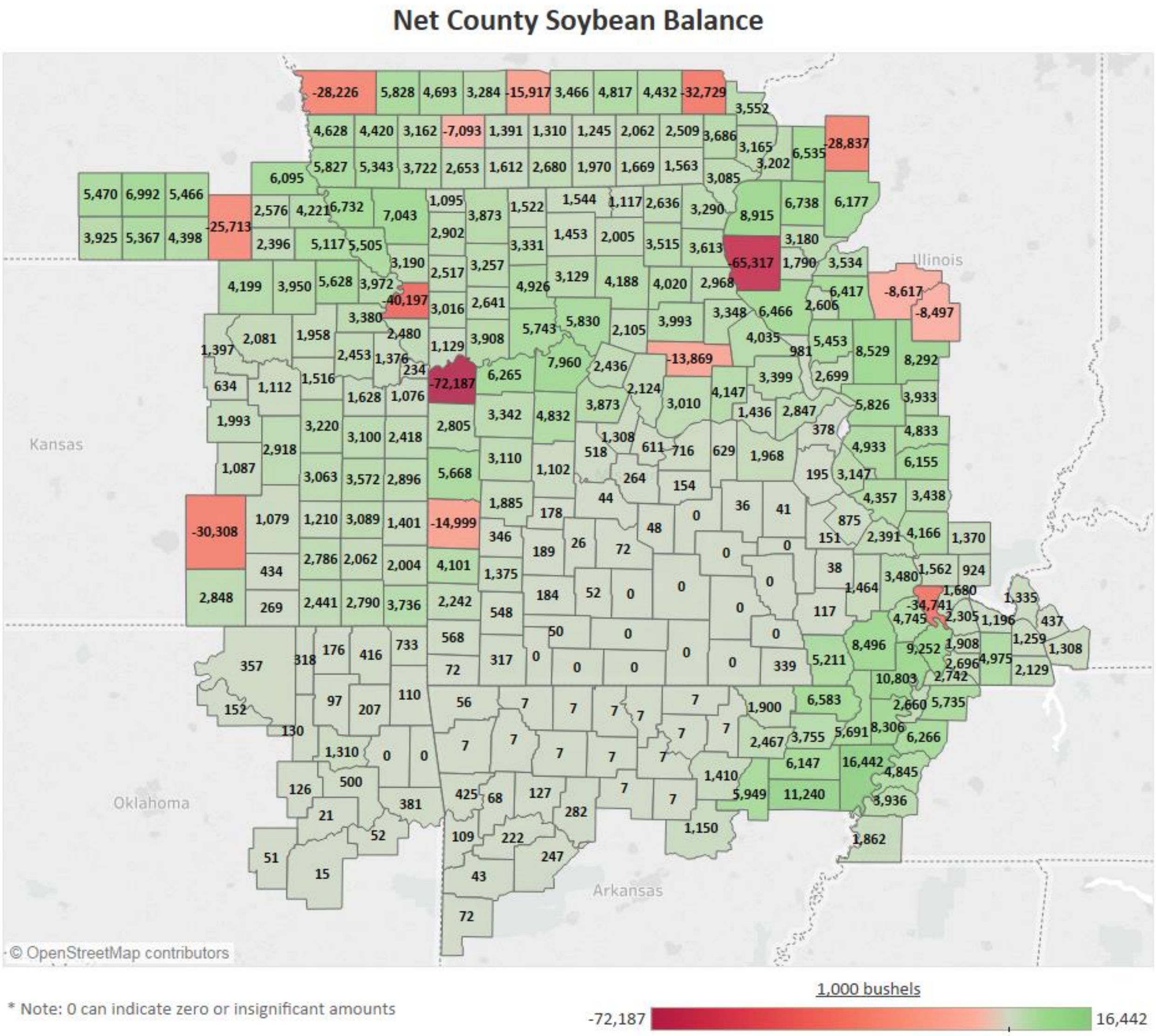


Figure 75 Net County Soybean Balance

Figure 75 shows the net county soybean balance. Negative numbers indicate counties that need inflows of soybeans to meet in-county demand. Positive numbers indicate counties that have soybeans available for outflows to other counties or for exports. Net county soybean balance is calculated from production in the county minus the quantity held in ending stocks and the demand for soybean processing in the county.

Soybeans Available for Outflow

Soybeans Available for Crush or Outflow

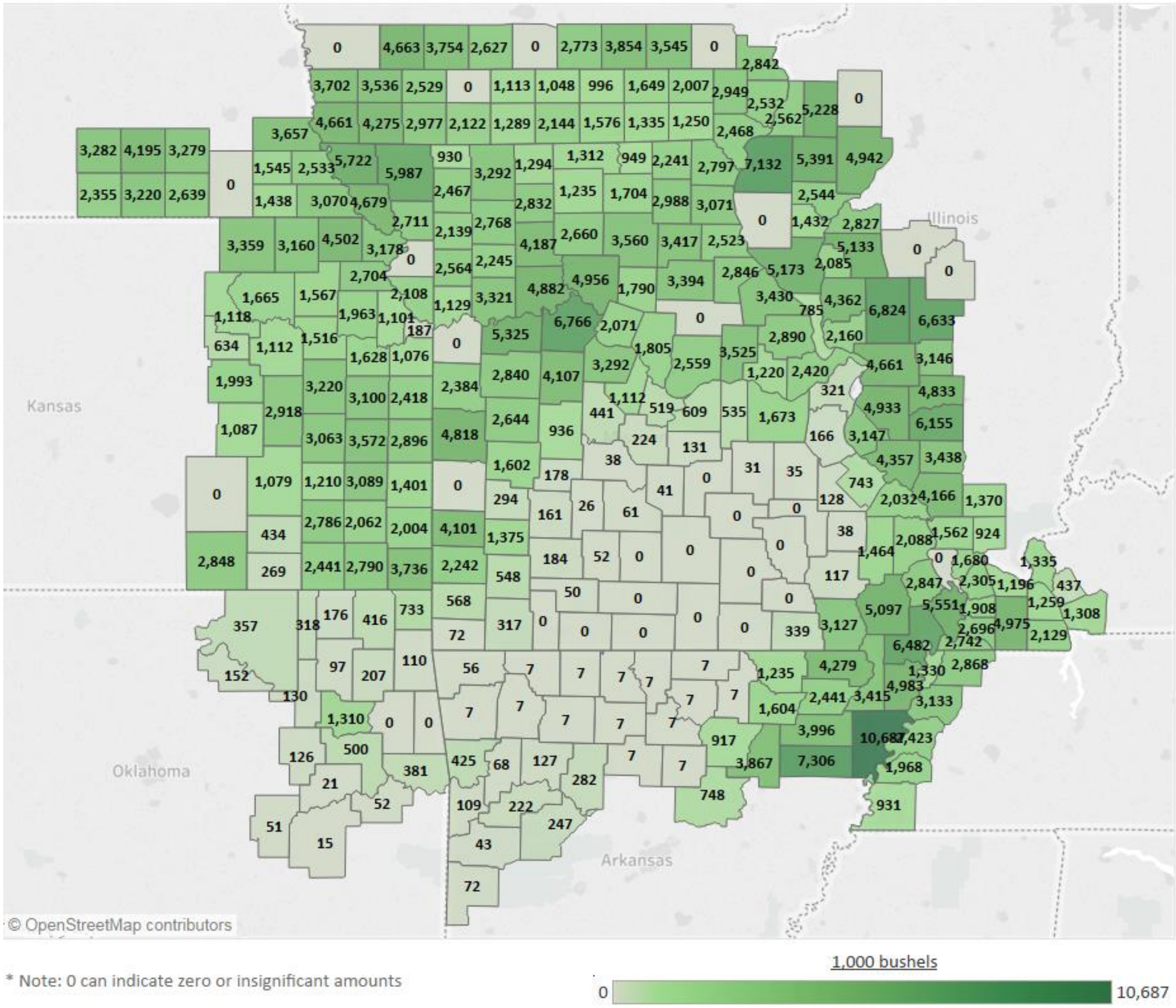


Figure 76 Soybeans Available for Crush or Outflow

Figure 76 shows the counties and quantities of soybeans in counties that are available for outflows to meet demand in other counties. Quantities that are not claimed by demand in county or claimed by demand points in other counties will be reflected in quantities allocated to exports.

Soybean Inflows Needed

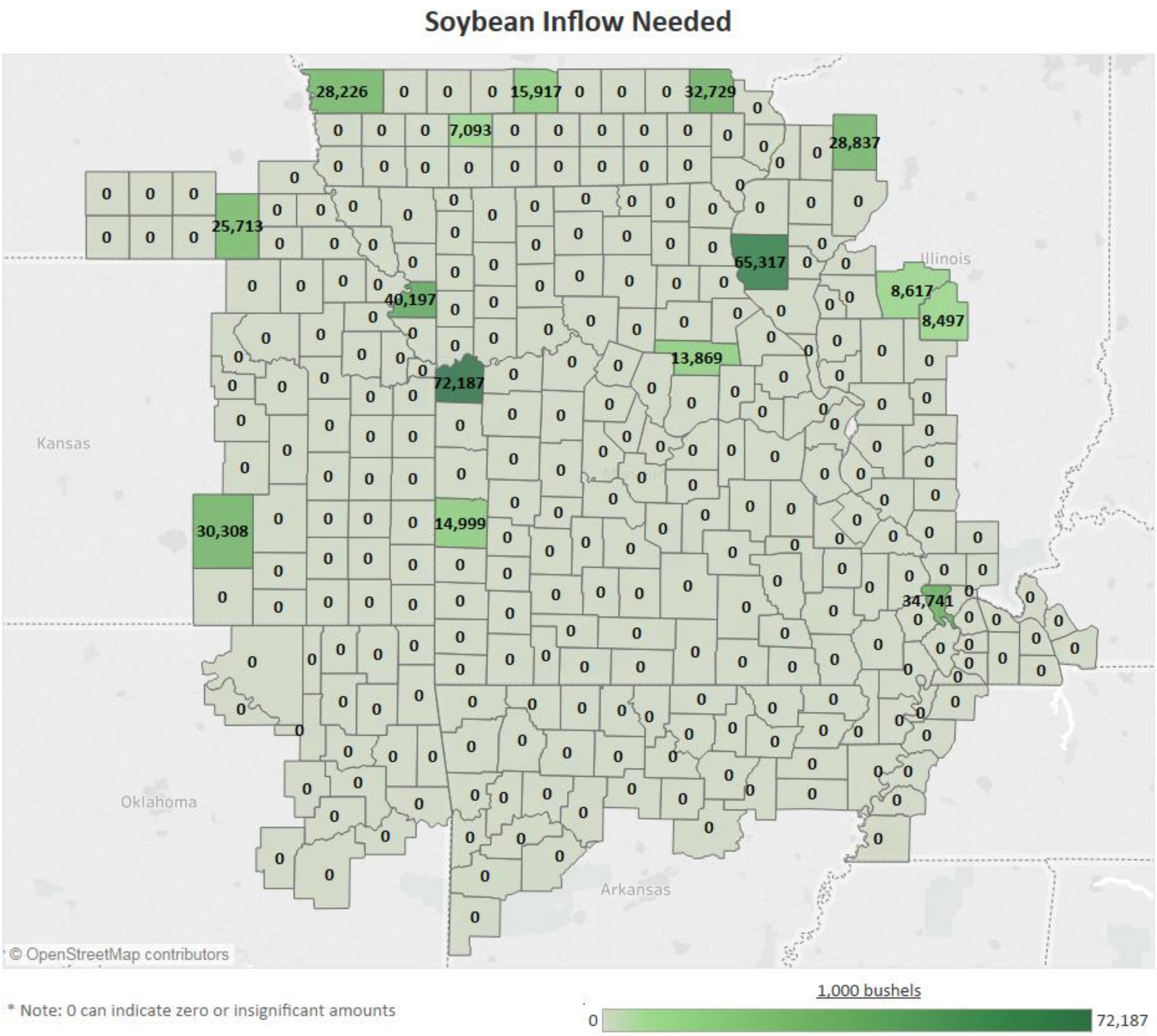


Figure 77, Soybean Inflow Needed

Figure 77 shows the inflows needed to meet demand needs for soybean crush plants. In-county supplies were first allocated to ending stocks and to use in the in-county soybean processing plant. Some counties that have soybean processing plants have sufficient in-county soybeans to satisfy the needs of the processing plant in the county. The counties in Figure 77 still have need for more inflows of soybeans to meet the needs of the soybean processing plant(s) in the county. Quantities shown reflect the needed amount of inflows.

Soybean Outflows for Crush

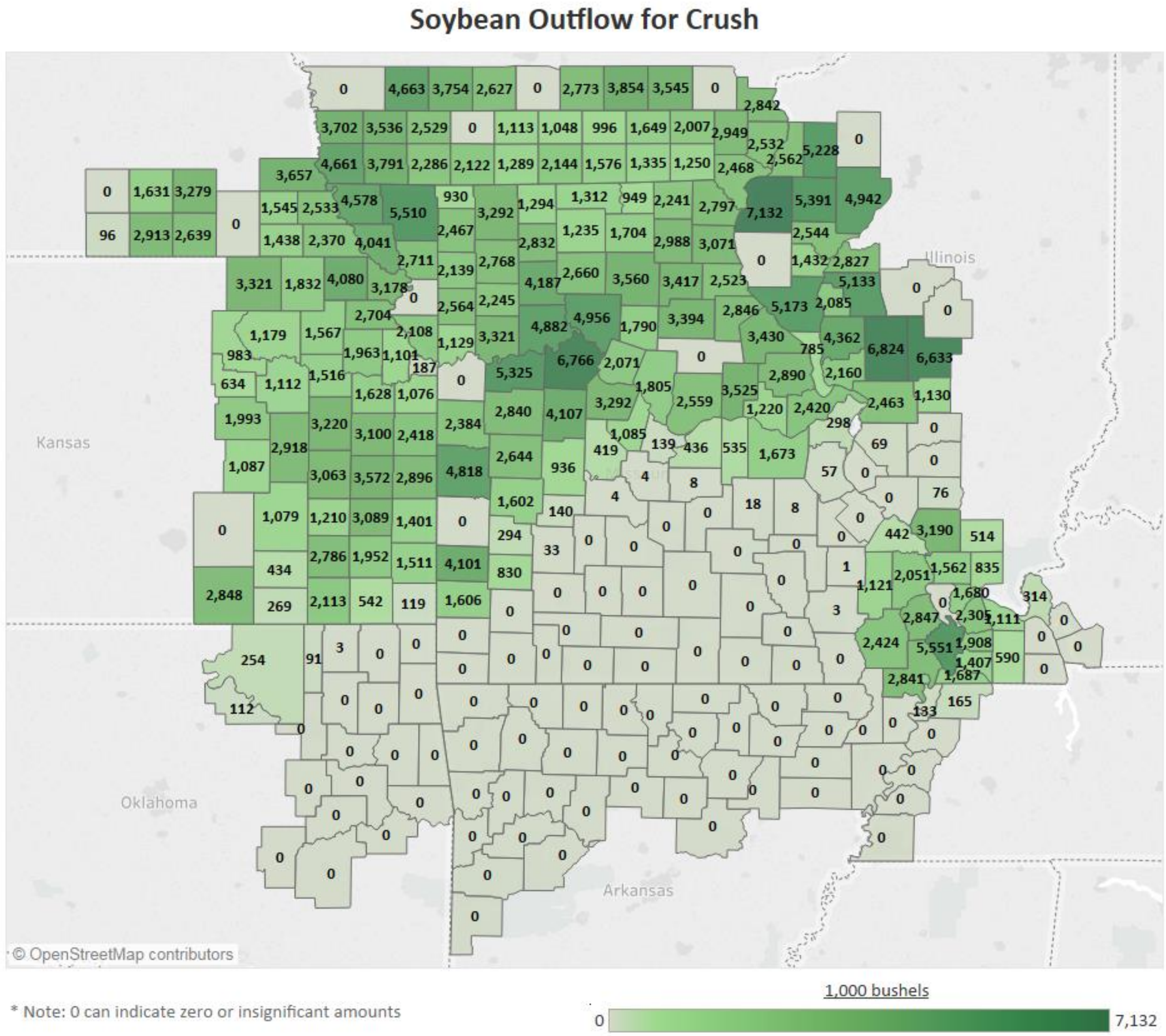


Figure 78, Soybean Outflow for Crush

Figure 78 shows the quantities of soybeans by county that flow to another county to meet domestic soybean crush demand.

Soybean Exports

Total Soybeans Allocated to Exports

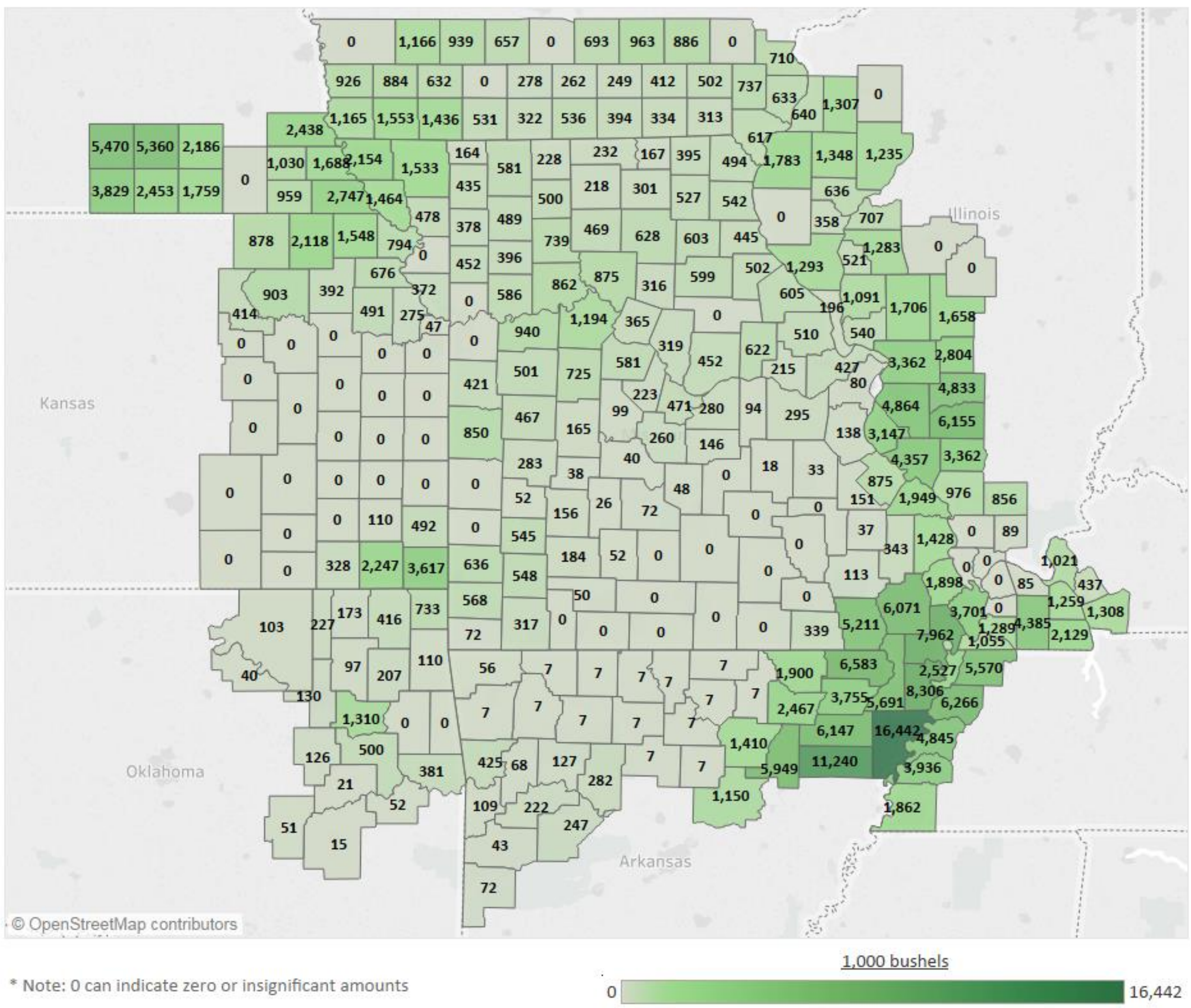


Figure 79, Total Soybeans Allocated to Exports

Figure 79 shows the counties and associated quantities of soybeans that are not used in domestic soybean crush facilities or held in on-farm or off-farm ending stocks. Soybeans that are not claimed by one of these domestic uses are exported.

Soybean Dynamic Flow Analysis

Soybean Supply per 10 Square Miles

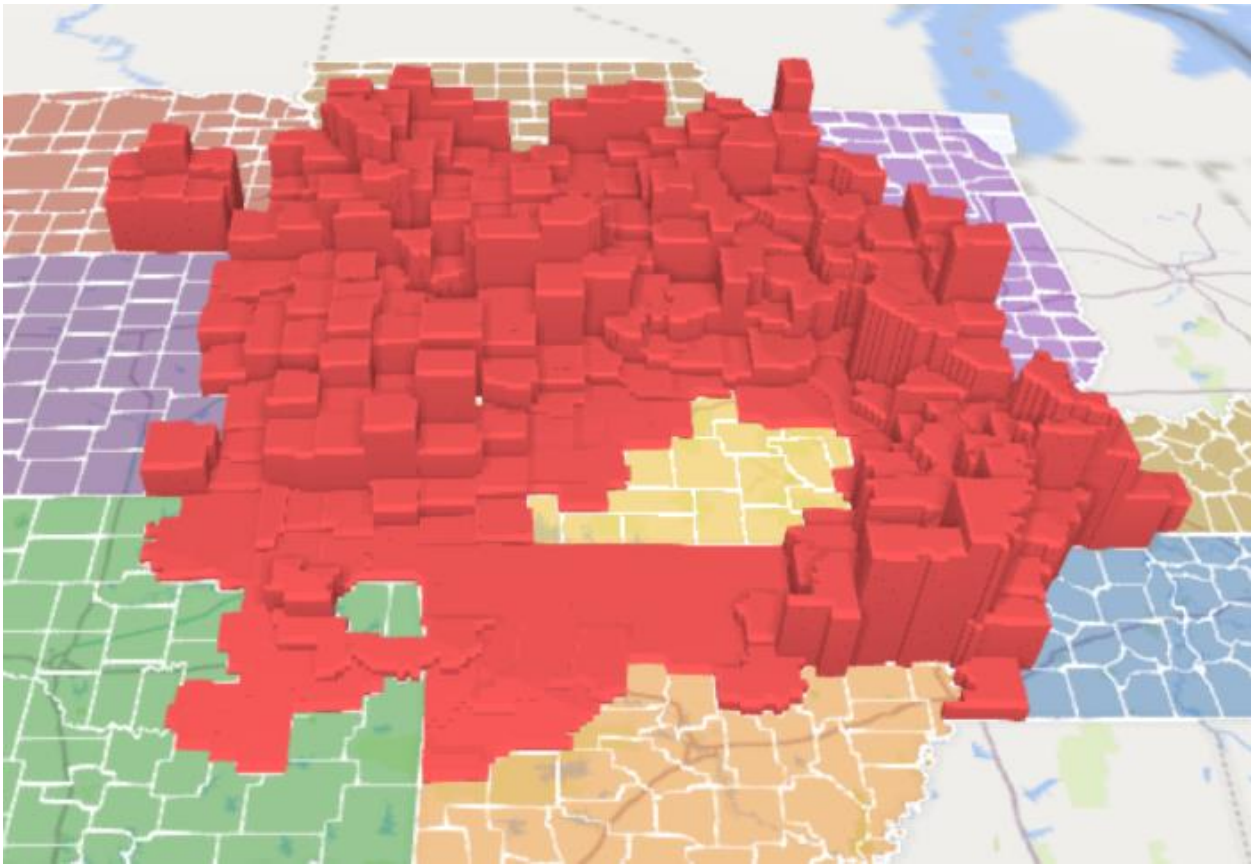


Figure 80, Soybean Supply per 10 Square Miles

Figure 80 shows soybean supplies available for outflows for each of the centroids in each county. Soybean supplies available in each county for outflow were allocated equally to the centroids within a county.

Soybean Demand Points

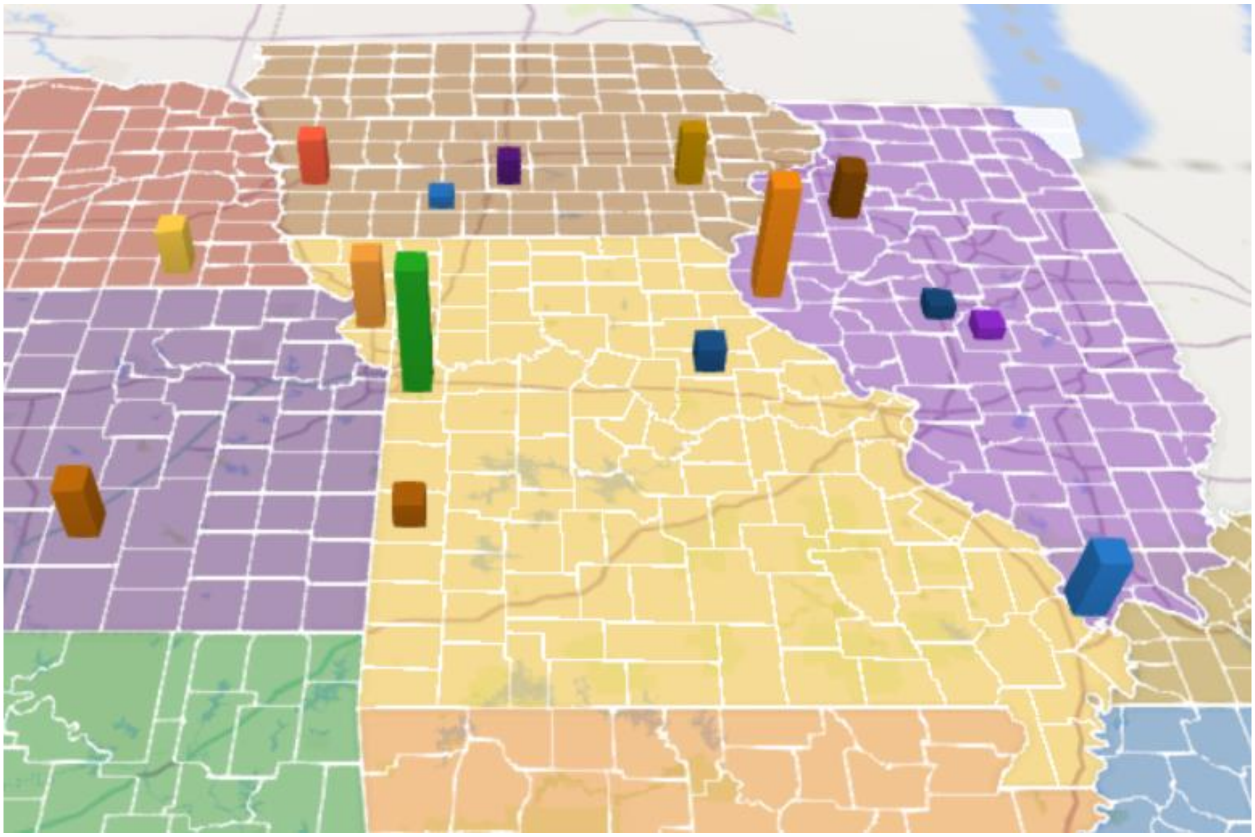


Figure 81, Soybean Demand Points

Figure 81 shows the counties with soybean inflow needs. These needs are represented by a single demand point for the county and the height of the bar reflects the quantity of inflow needed for the county. The bars are color coded so that claimed supply points can be aggregated to a particular demand point.

Claimed Soybean Supply Map

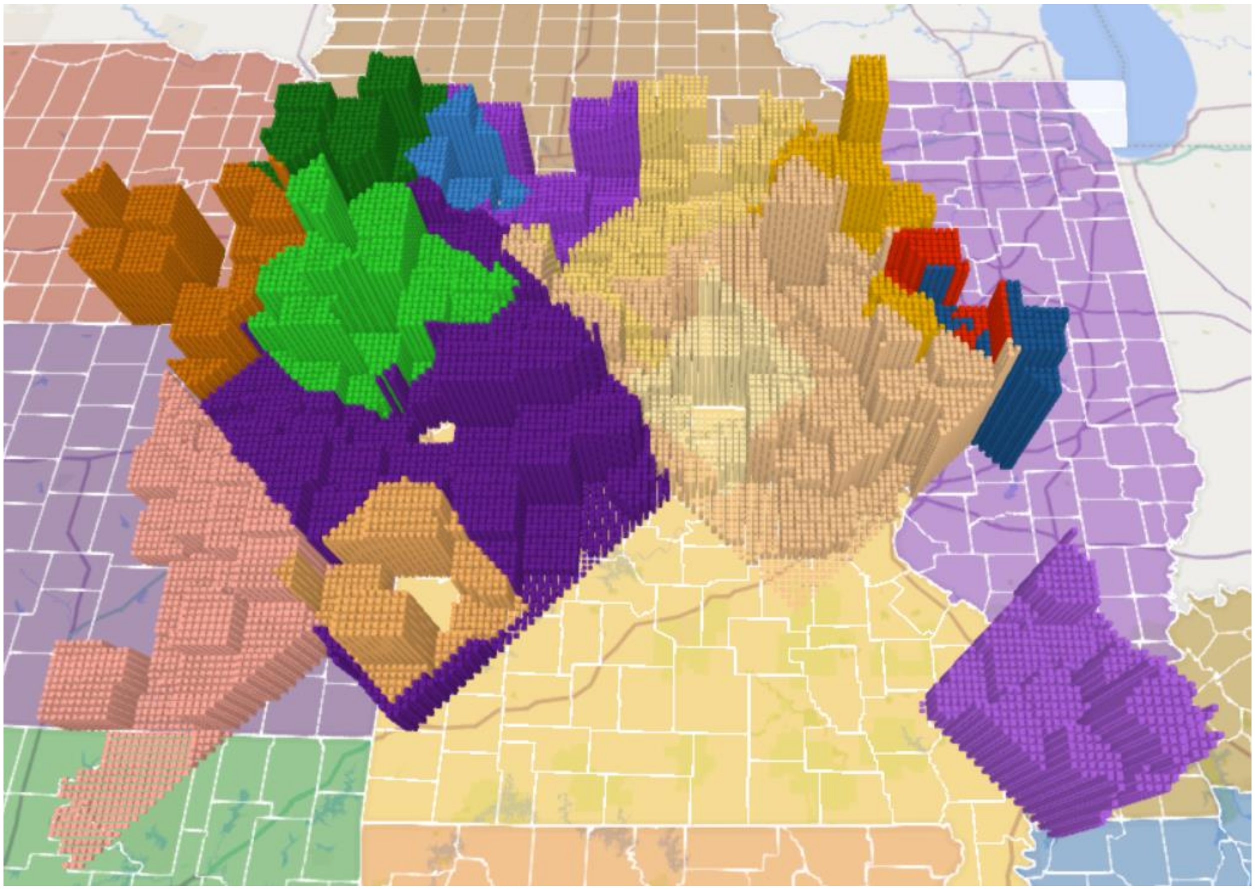


Figure 82, Claimed Soybean Supply

Figure 82 shows the demand pattern for soybeans by each of the demand points in the study area. The greater the height of the bar the greater the quantity of soybeans claimed from a particular centroid supply point. The color coding identifies the supply area for each individual demand point.

Soybean Exports

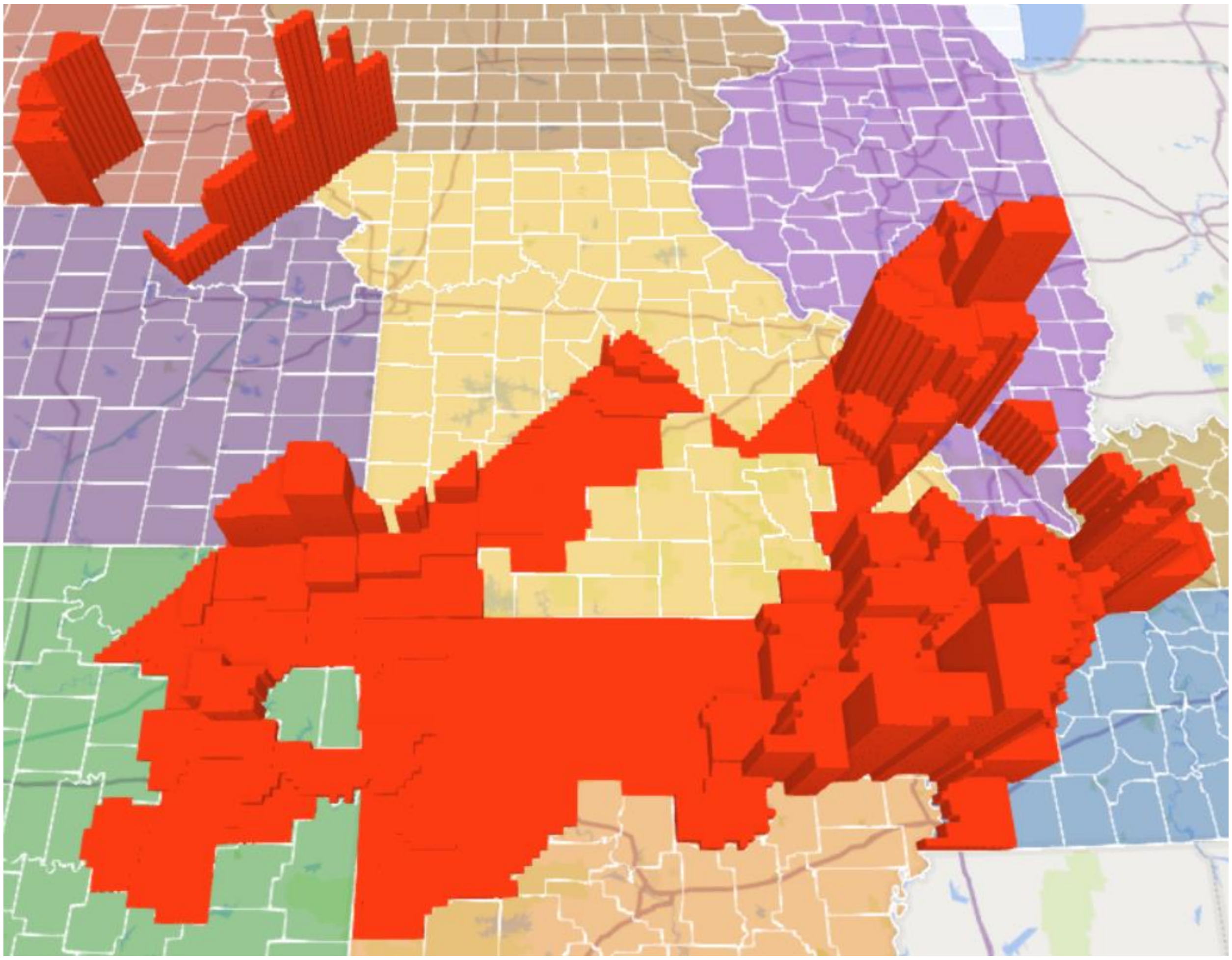


Figure 83, Remaining Soybean Supply

Figure 83 shows the remaining soybean supply points after all domestic demands are satisfied. The remaining soybean supplies represent exported soybeans. Figure 83 represents the likely county locations that are major producers of soybeans for exports.

Grain Sorghum Commodity Flow Analysis

The grain sorghum commodity flow analysis was conducted at the crop reporting district aggregation level. County-specific data is unpublished for the majority of grain sorghum producing counties, but data is available at the crop reporting district level.

Grain Sorghum Supply by CRD

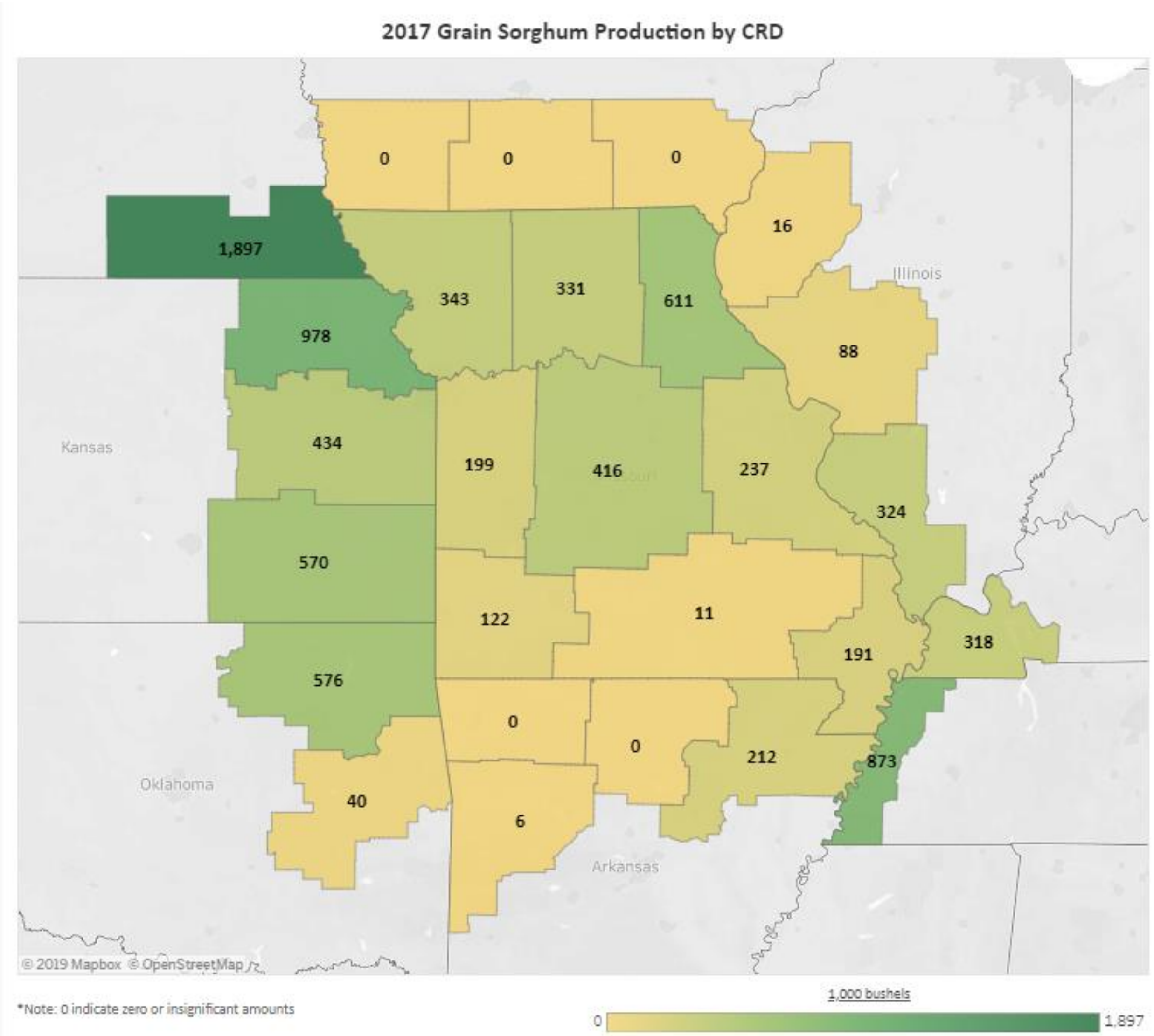


Figure 84, 2017 Grain Sorghum Production by CRD

Figure 84 shows 2017 grain sorghum production by crop reporting district.

Grain Sorghum Off-Farm Stocks (Sept 1, 2018) by CRD

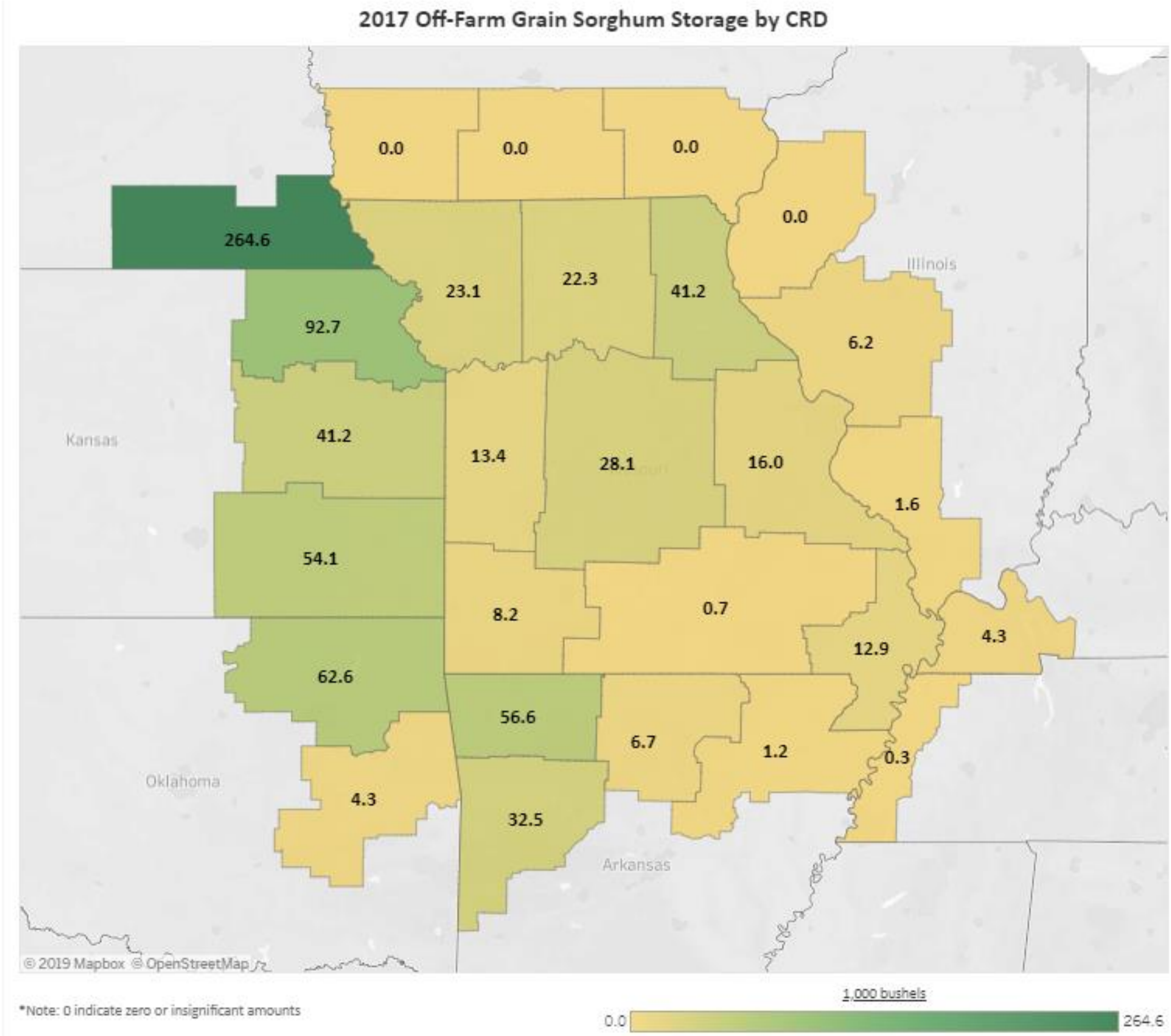


Figure 85, 2017 Off-Farm Grain Sorghum Storage by CRD

Error! Reference source not found. shows grain sorghum marketing year ending stocks held in off-farm locations allocated to the crop reporting districts. Data for stocks in off-farm storage are available on a state-wide basis. Grain sorghum stocks in off-farm storage were allocated based on the CRD percentage of state-wide production, with an adjustment for feed inflow areas. For areas that have significant inflows of grain sorghum for feed demand, a minimum of 1 week of feed demand was allocated to September 1 ending stocks.

Grain Sorghum On-Farm Stocks (Sept 1, 2018) by CRD

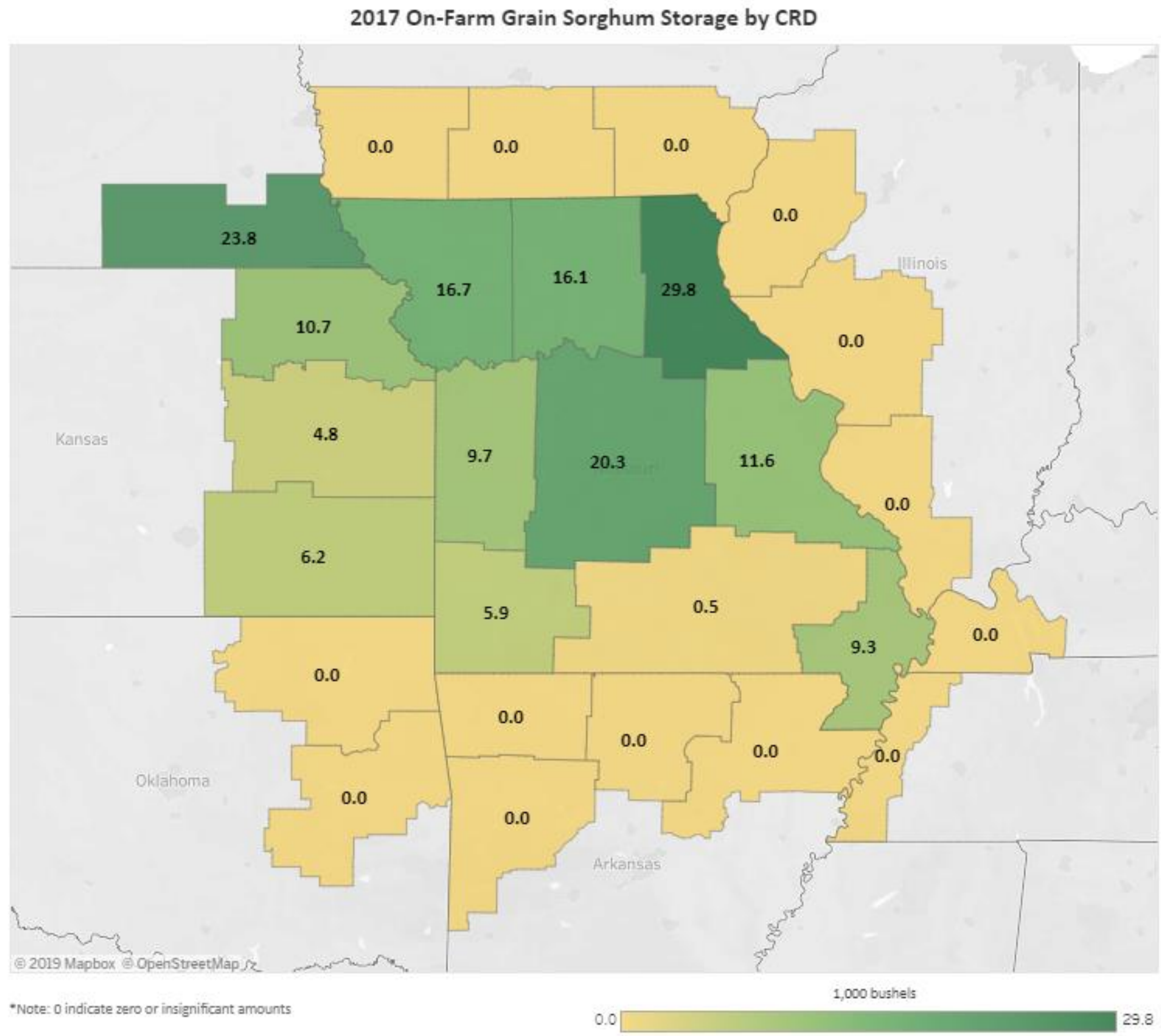


Figure 86, 2017 On-Farm Grain Sorghum Storage by CRD

Figure 86 shows on-farm grain sorghum ending stocks for September 1, 2018. Grain sorghum on-farm stocks data is available on a state-wide basis. On-farm grain sorghum stocks were allocated to CRDs based on the percentage of state-wide production of grain sorghum in the CRD.

Grain Sorghum Fed (by CRD)

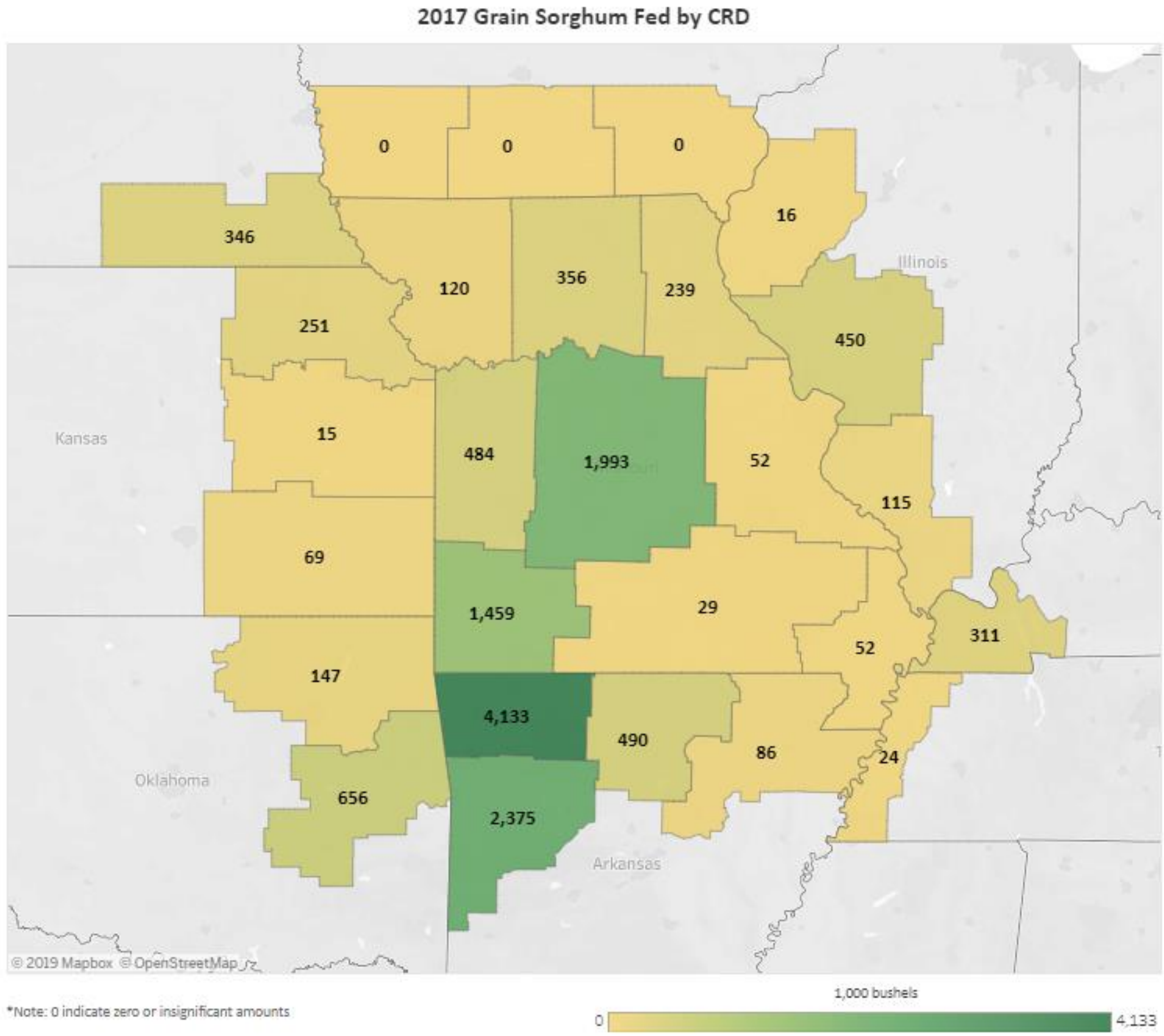


Figure 87, 2017 Grain Sorghum Fed by CRD

Error! Reference source not found. shows the relative amounts of grain sorghum that is estimated to be fed in each CRD.

Grain Sorghum Exported on Mississippi River by CRD

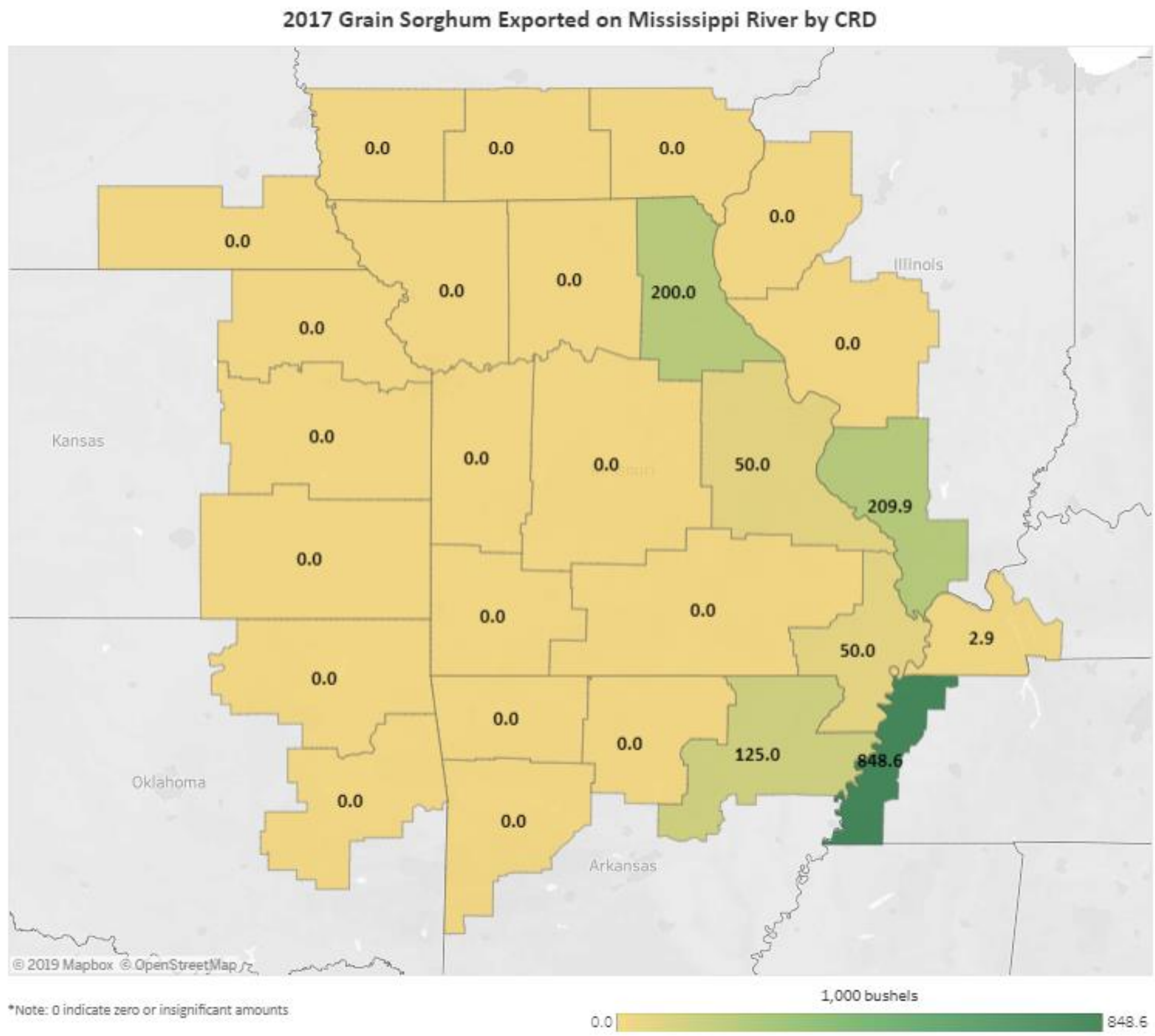


Figure 88, 2017 Grain Sorghum Exported on Mississippi River by CRD

Figure 88 shows estimated amounts of grain sorghum that leaves each CRD for export on the Mississippi River. These estimates were not calculated as a residual as the study area as a whole has large net inflows of grain sorghum for feed. The export estimates are the result of best professional judgment of the share of production in CRDs that border the Mississippi River that are exported.

Grain Sorghum Net Balance by CRD

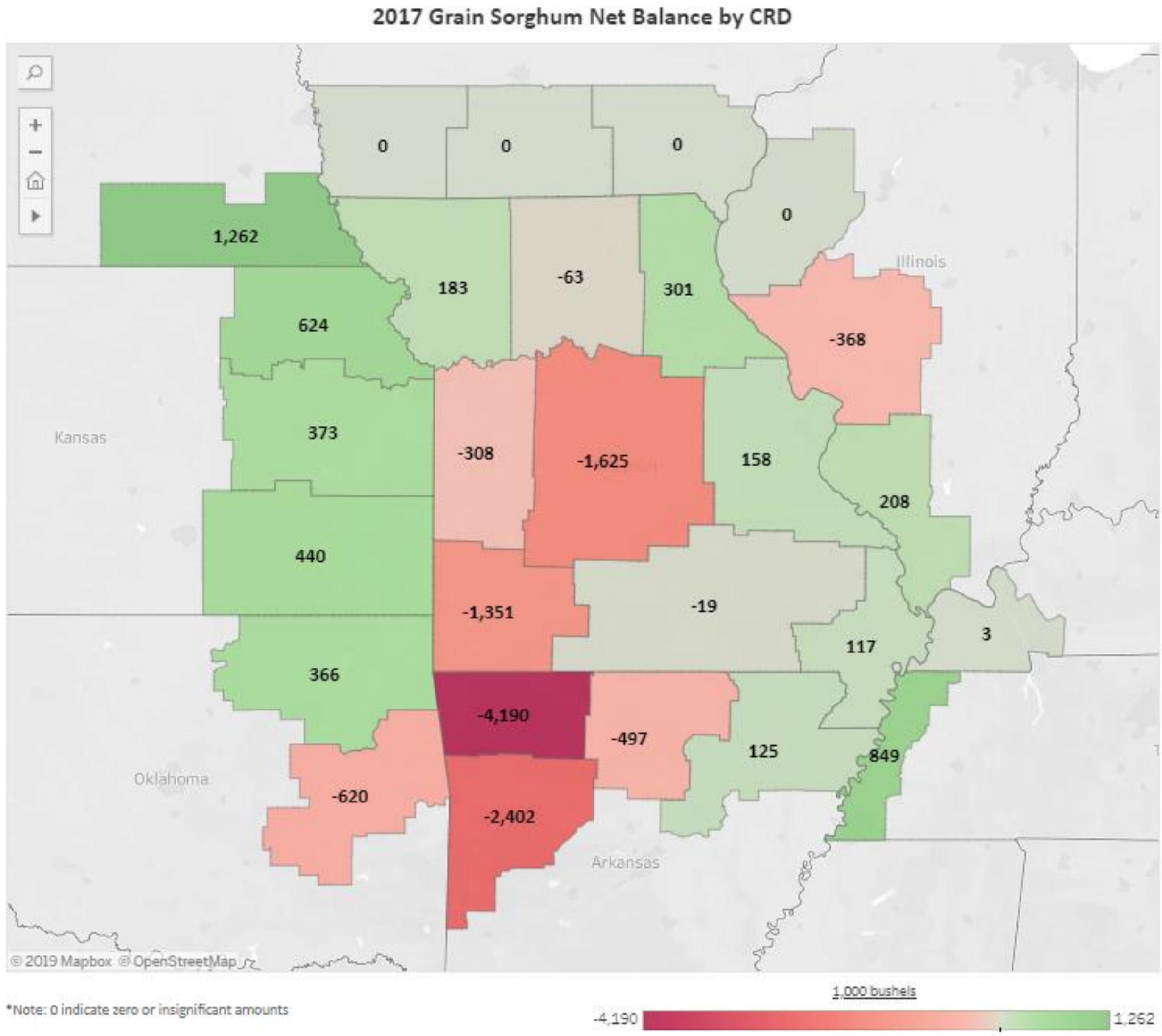


Figure 89, 2017 Grain Sorghum Net Balance by CRD

Error! Reference source not found. shows the net balance of grain sorghum by CRD. A positive number indicates that there is more grain sorghum in that CRD than is needed for feed in the CRD. A negative number indicates that more grain sorghum is fed in the CRD than is grown there.

Southwestern Missouri, northeastern Oklahoma, and northwestern Arkansas all have significant net inflows of grain sorghum for feed use. Eastern Kansas has significant outflows of grain sorghum for feed, much of which travels south or southeast to Missouri, Oklahoma and Arkansas.

Note: this map is the result of a preliminary flow estimate and will be updated in the final report

Grain Sorghum Outflows for Feed by CRD

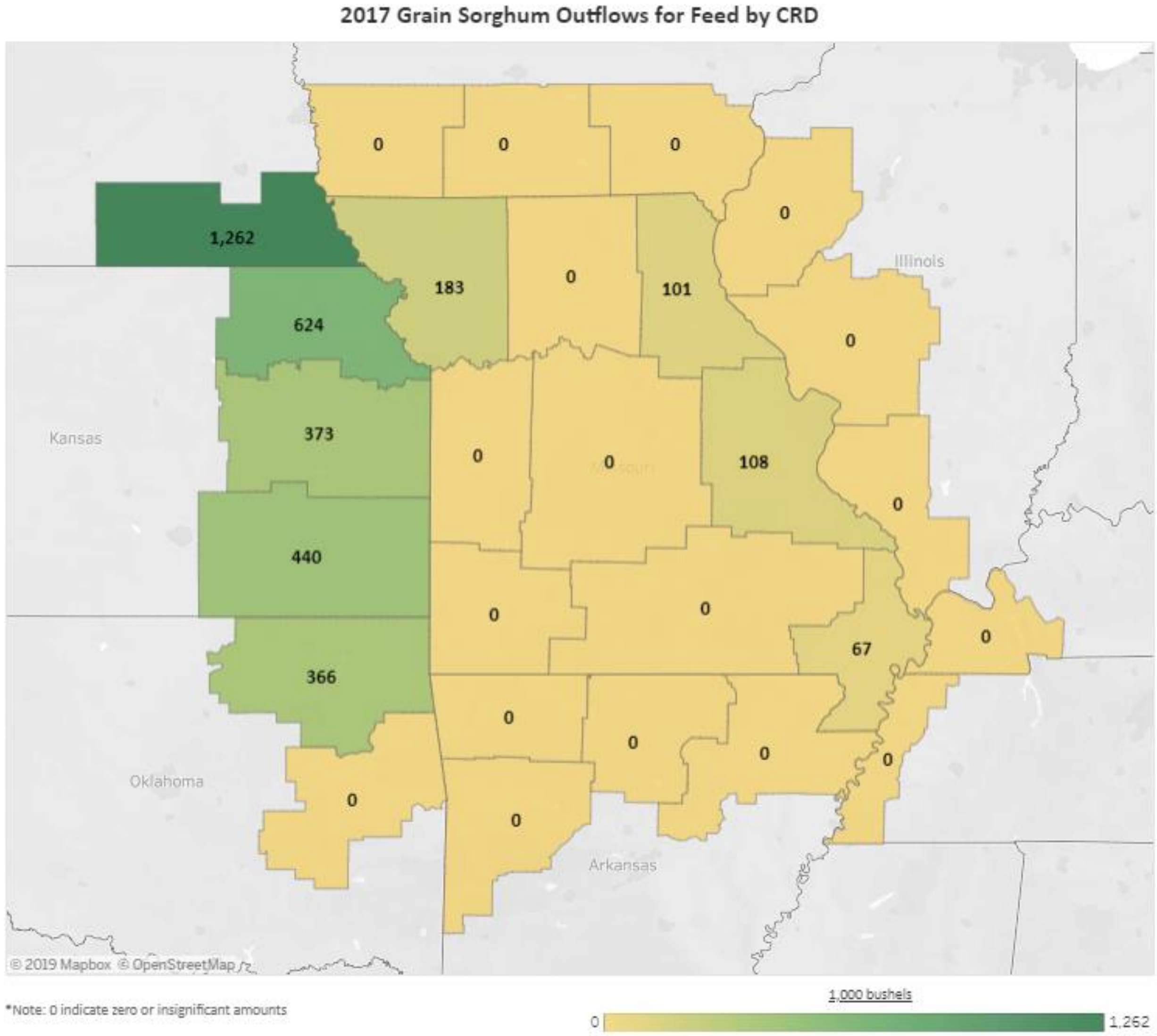


Figure 90, Grain Sorghum Outflows for Feed by CRD

Figure 90 shows grain sorghum outflows for feed use by CRD. The primary sources of grain sorghum for feed use in southern Missouri, northeastern Oklahoma and northwestern Arkansas is production in eastern Kansas and southeastern Nebraska. Grain sorghum is likely pulled from additional CRDs in central and western Kansas to satisfy grain sorghum feed needs in the poultry growing areas of southwestern Missouri, northeastern Oklahoma and northwestern Arkansas.

Grain Sorghum Dynamic Flow Analysis

Grain Sorghum Supply per 10 Square Miles

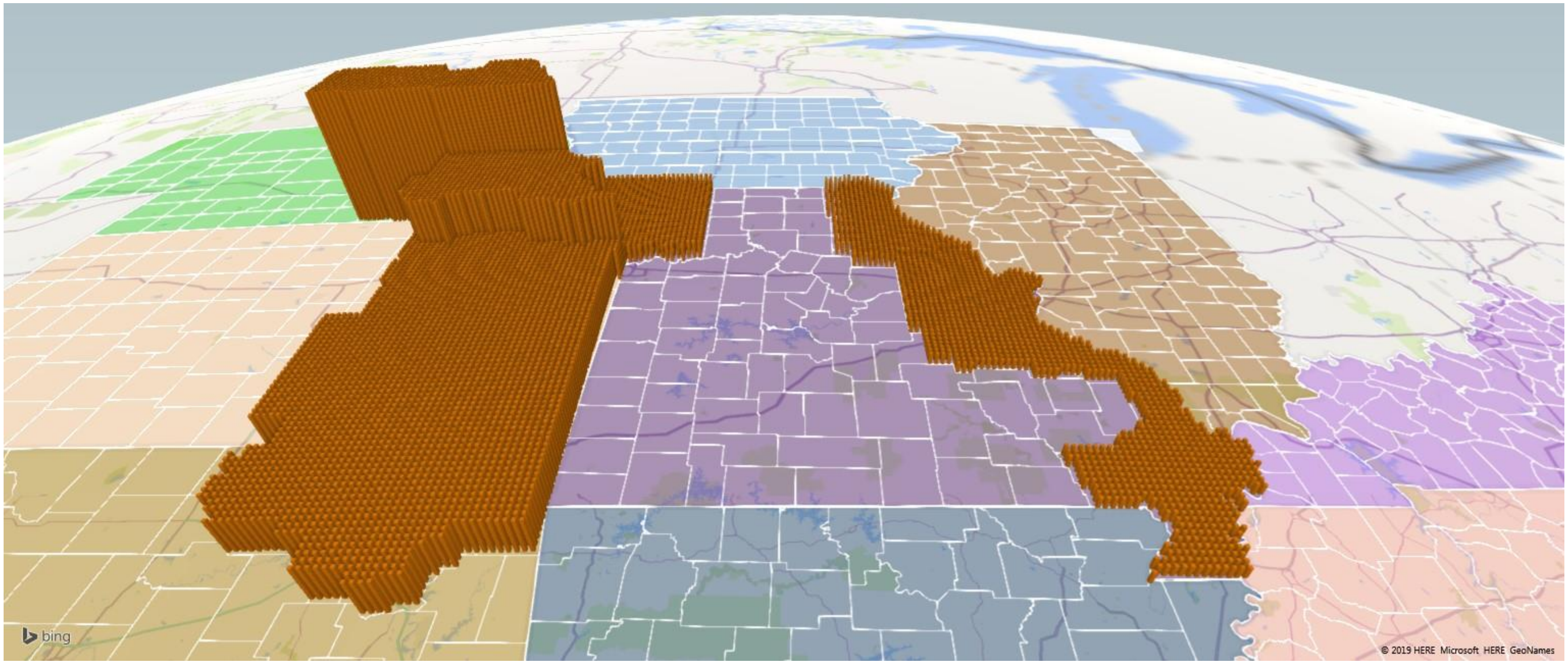


Figure 91, Grain Sorghum Supply per 10 Square Miles

Figure 91 shows grain sorghum supplies available for outflows for each of the centroids in each county. Grain sorghum supplies available in each county for outflow were allocated equally to the centroids within a county.

Grain Sorghum Demand Points

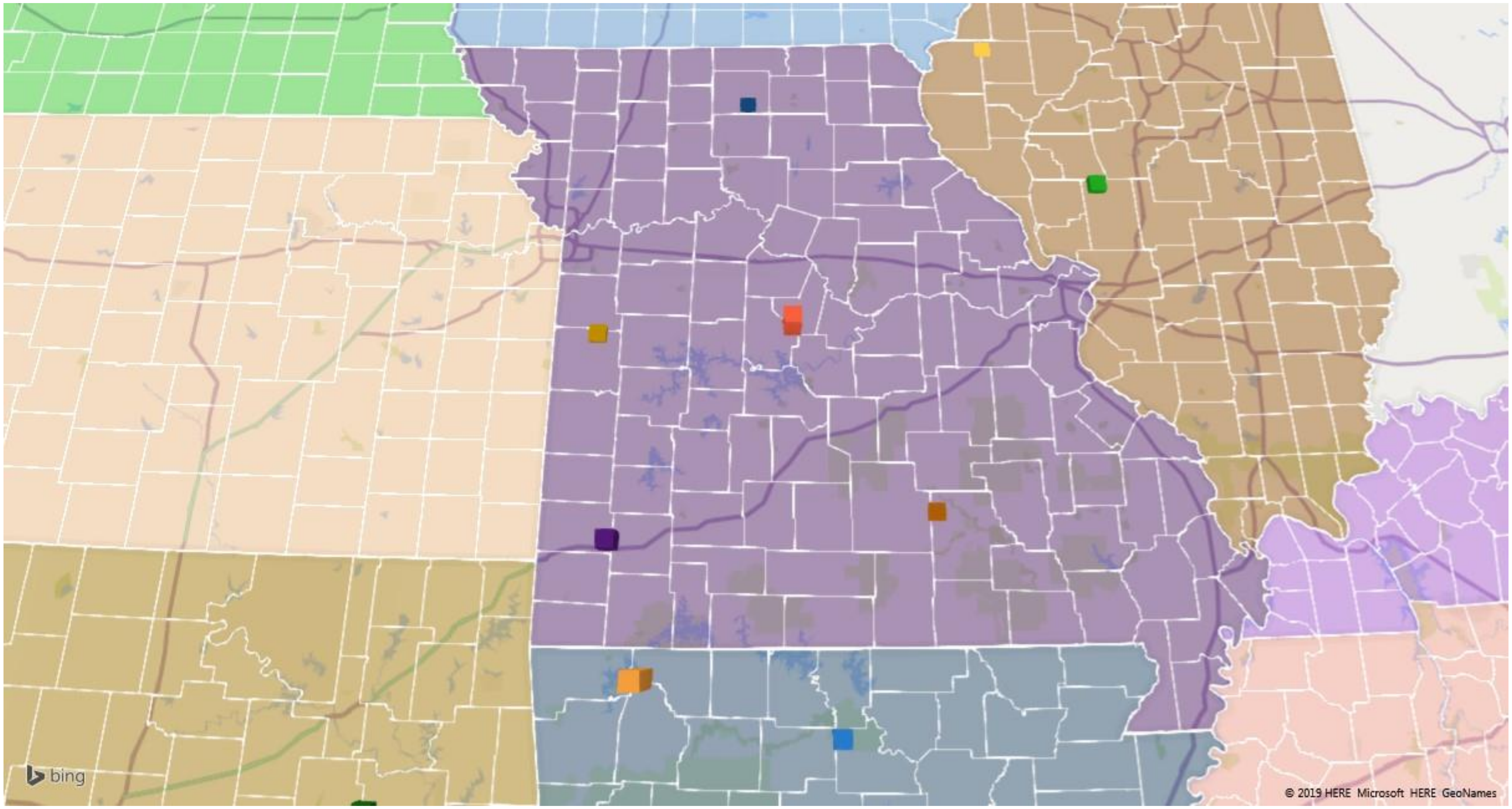


Figure 92, Grain Sorghum Demand Points

Figure 92 shows the counties with grain sorghum inflow needs. These needs are represented by a single demand point for the county and the height of the bar reflects the quantity of inflow needed for the county. The bars are color coded so that claimed supply points can be aggregated to a particular demand point.

Claimed Grain Sorghum Supply Map

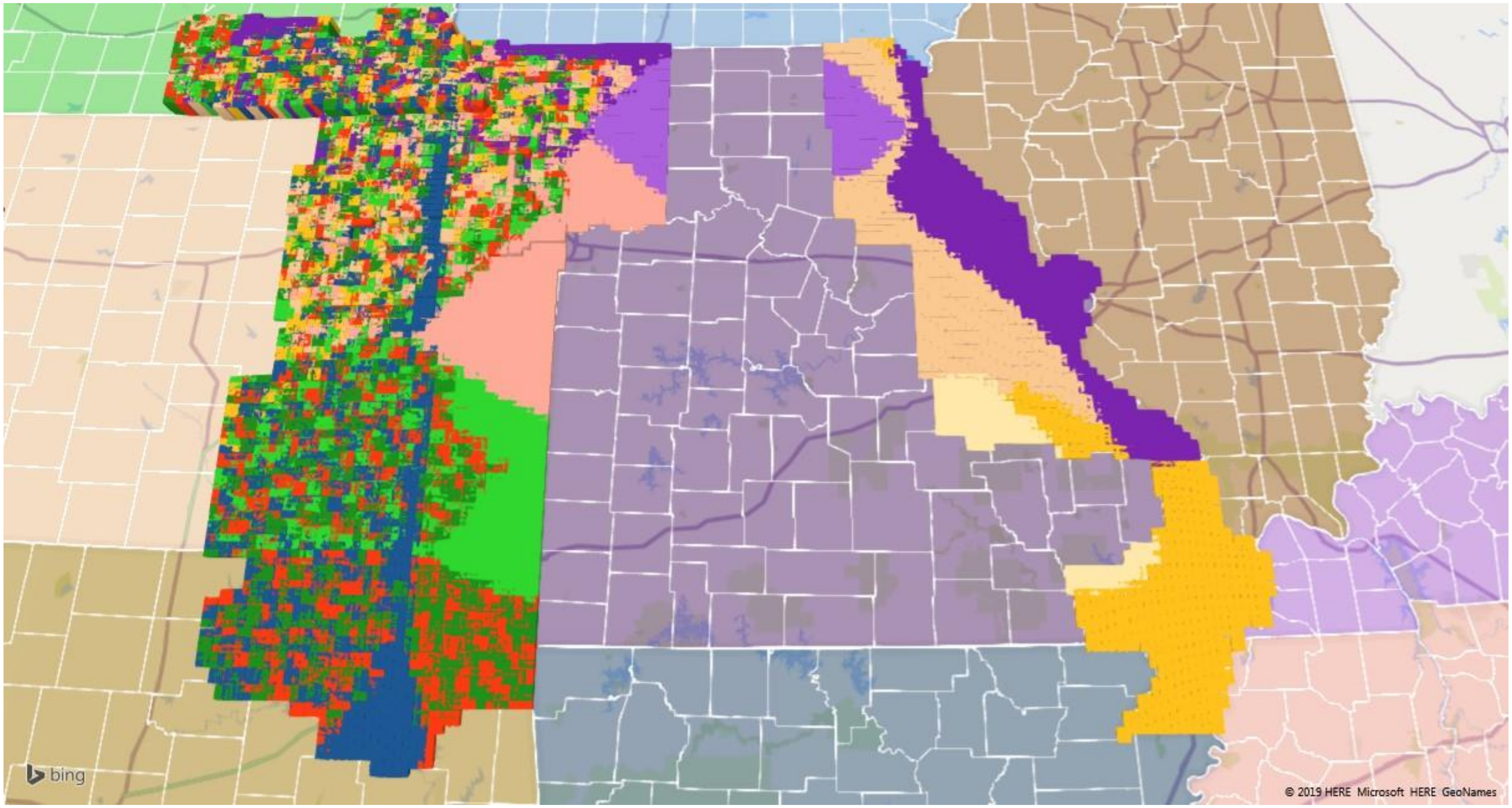


Figure 93, Claimed Grain Sorghum Supply

Figure 93 shows the demand pattern for grain sorghum by each of the demand points in the study area. The greater the height of the bar the greater the quantity of grain sorghum claimed from a particular centroid supply point. The color coding identifies the supply area for each individual demand point.

Wheat Commodity Flow Analysis

The commodity flow analysis for wheat is different than the analysis for corn, grain sorghum and soybeans due to the differences in end uses of wheat. Corn, soybeans and grain sorghum tend to be treated and used as singular classes of grain. Wheat has 6 main classifications (Hard Red Winter, Hard Red Spring, Hard White, Soft White, Soft Red Winter and Durum). Each of these classes of wheat tends to be used for different food products. Some wheat mills will mill multiple classes of wheat depending on the end product(s) and flour mixes that they are making. In addition, multiple classes of wheat may be grown within a single state and even within a single county.

The majority of wheat grown in Missouri is soft-red winter wheat. But, hard red winter wheat is also grown in various counties in the western part of the state. USDA does not provide data on the classes of wheat grown in Missouri, nor does it provide any information regarding the classes of wheat that are milled by the milling facilities located in Missouri. In addition, much of the county wheat production data is unpublished or published in a combined county form. More accurate data tends to be available for CRDs.

For these reasons, the wheat commodity flow analysis summarizes the wheat production, ending stocks, and milling use by CRD. The flow information provided summarizes net inflows needed per CRD and net outflows that occur per CRD, but insufficient information was available to assess the breakout of flows that go for domestic milling, where those flows go nor the amount of flows that enter export markets.

Wheat Production by CRD

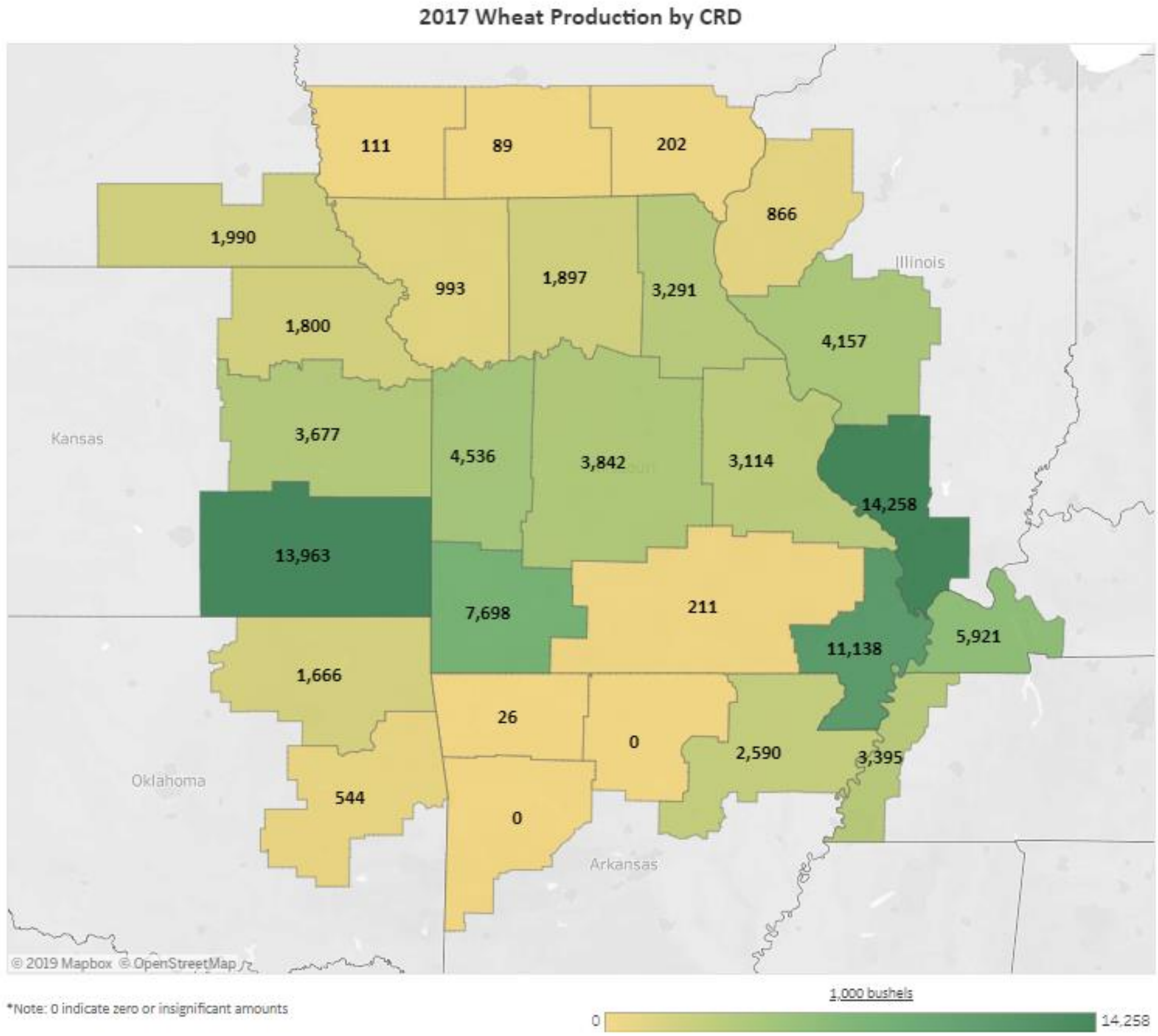


Figure 94, 2017 Wheat Production by CRD

Figure 94 shows 2017 wheat production by CRD area as reported by USDA. In some cases, wheat production at the CRD level was reported by USDA in a combined format with another CRD. In such cases, DIS allocated wheat production to unpublished CRDs based on historical share of state production of those CRDs.

Data on production of wheat by class is not published for counties or CRDs in this flow-study area. The primary wheat grown in the eastern 2/3 of Missouri, in Illinois and in Arkansas is soft red winter wheat. Both soft red winter wheat and hard red winter wheat are grown in areas of western Missouri and eastern Kansas with more hard red winter wheat being grown the further west the location of the CRD.

Wheat Off-farm Stocks by CRD, June 1, 2018

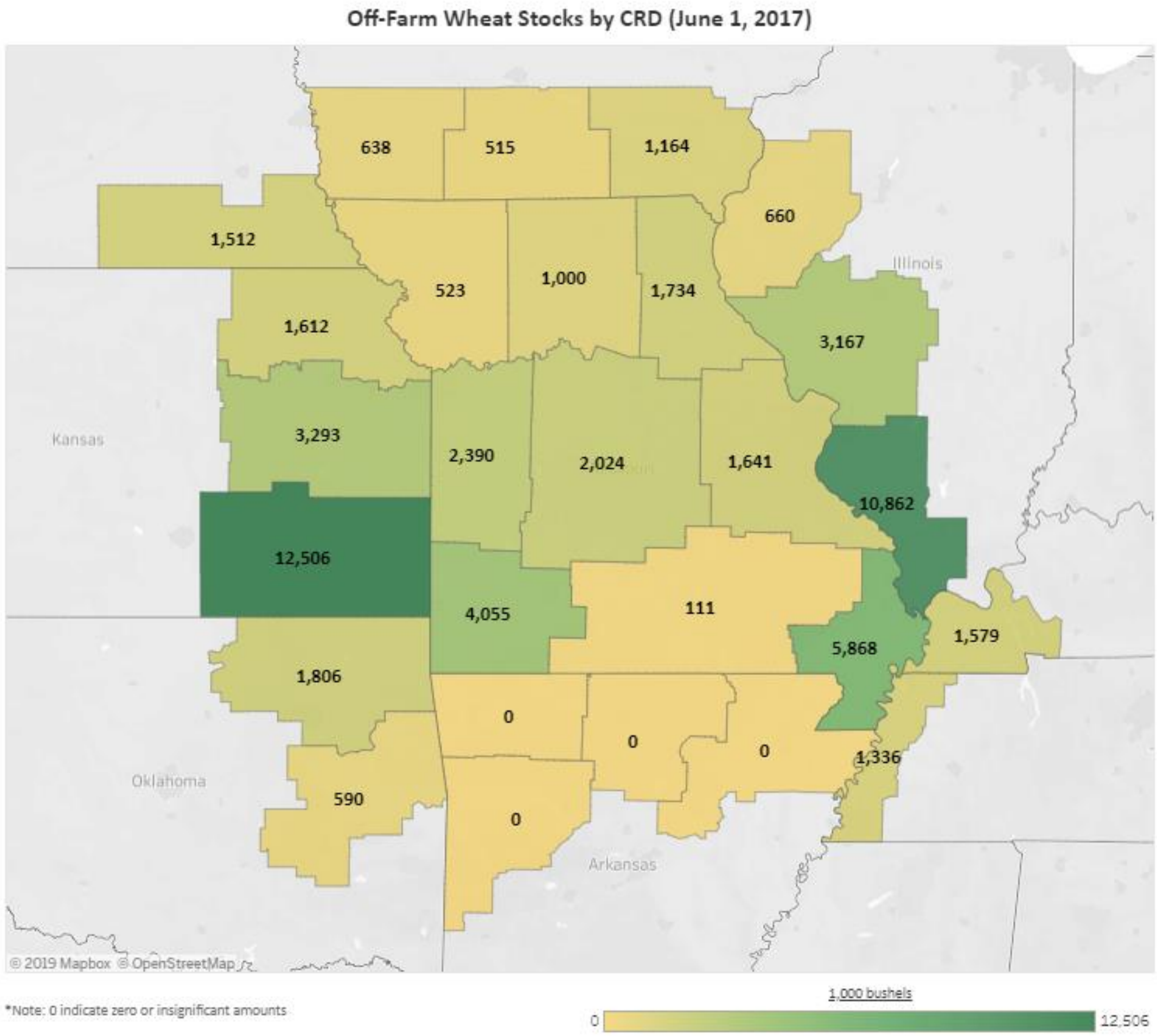


Figure 95, Off-Farm Wheat Stocks by CRD (June 1, 2017)

Figure 95 shows Off-farm wheat stocks on June 1, 2018. The breakdown of these wheat stocks by class of wheat is not published by USDA.

Wheat tends to move from farm storage and from country elevator storage to storage at terminal elevators and wheat mills somewhat early in the marketing year, especially in major corn and soybean growing areas. It is highly likely that actual off-farm storage stocks of wheat are higher in the CRD which contain Kansas City, St. Louis, Omaha and other major milling areas than is shown on this map.

Wheat On-farm Stocks by CRD, June 1, 2018

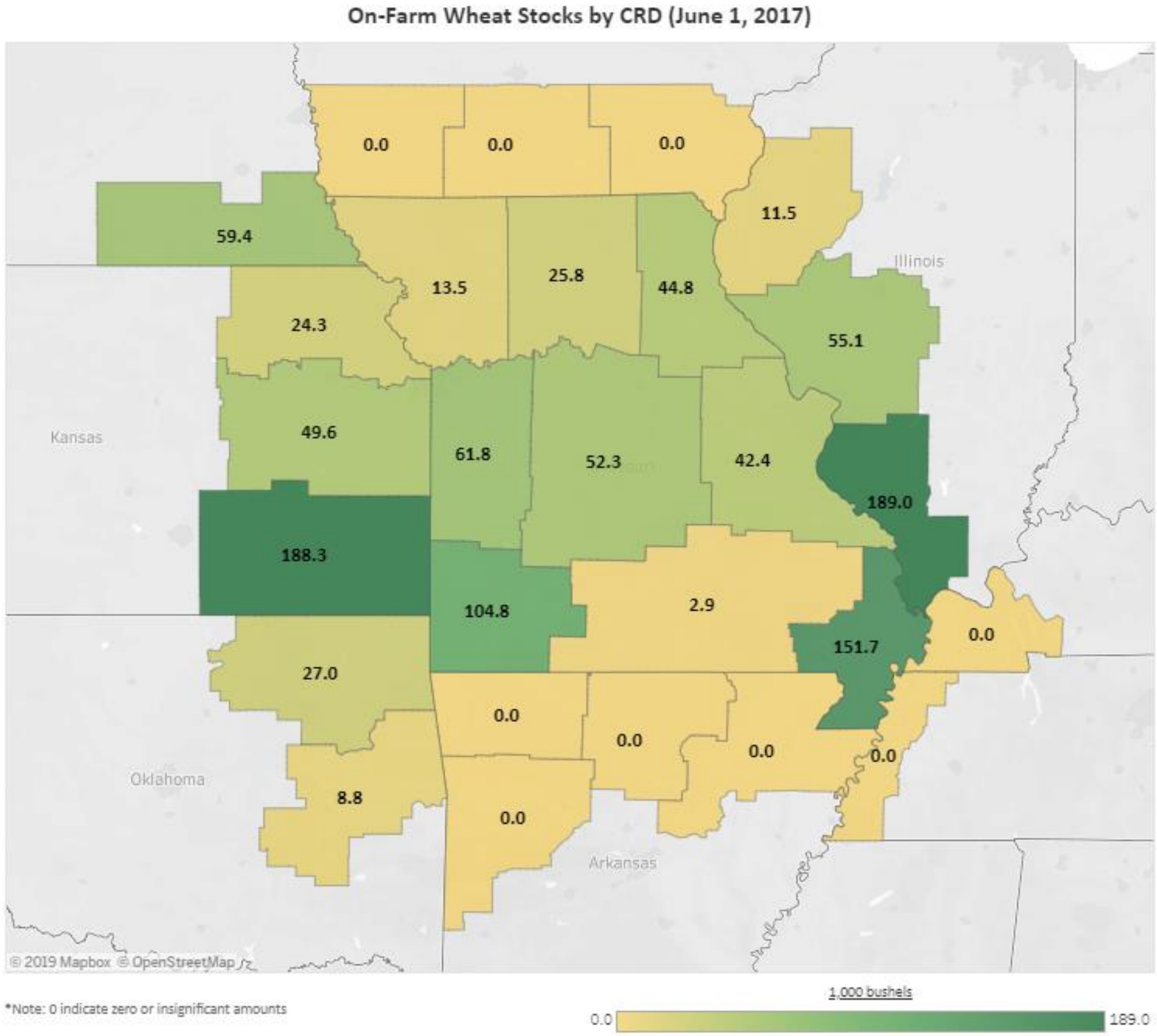


Figure 96, On-Farm Wheat Stocks by CRD (June 1, 2017)

Figure 96 shows the estimate of on-farm wheat stocks on June 1, 2018. USDA publishes state-wide stocks data. CRD level wheat stocks are estimated based on the share of state wheat production of the CRD.

Wheat Available for Milling and Export by CRD

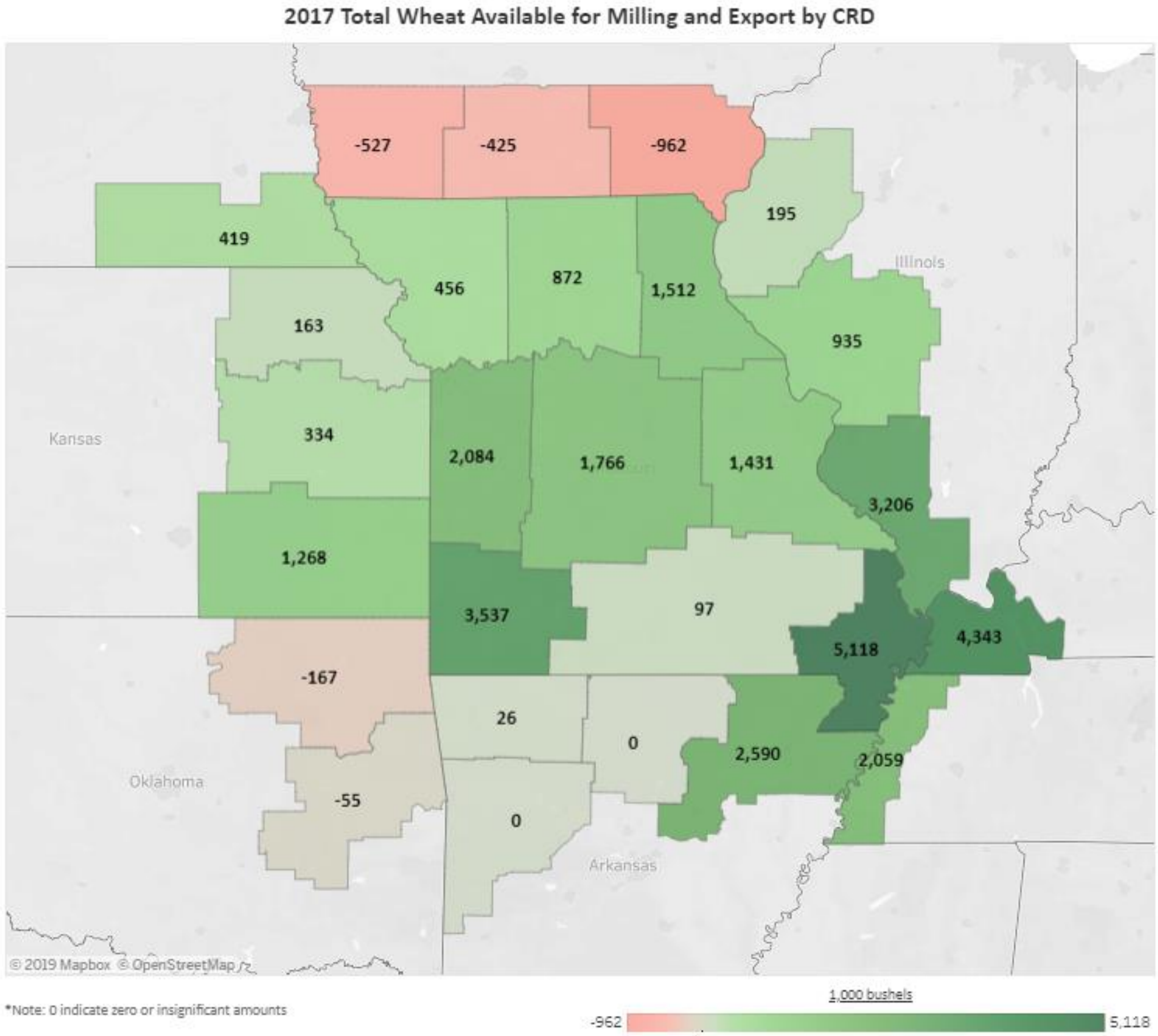


Figure 97, 2017 Total Wheat Available for Milling and Export by CRD

Figure 97 shows the quantities of wheat available per CRD for milling or other outflows such as export shipments. Negative numbers represent areas that have net inflows of wheat.

Wheat Milling Usage Estimate by CRD

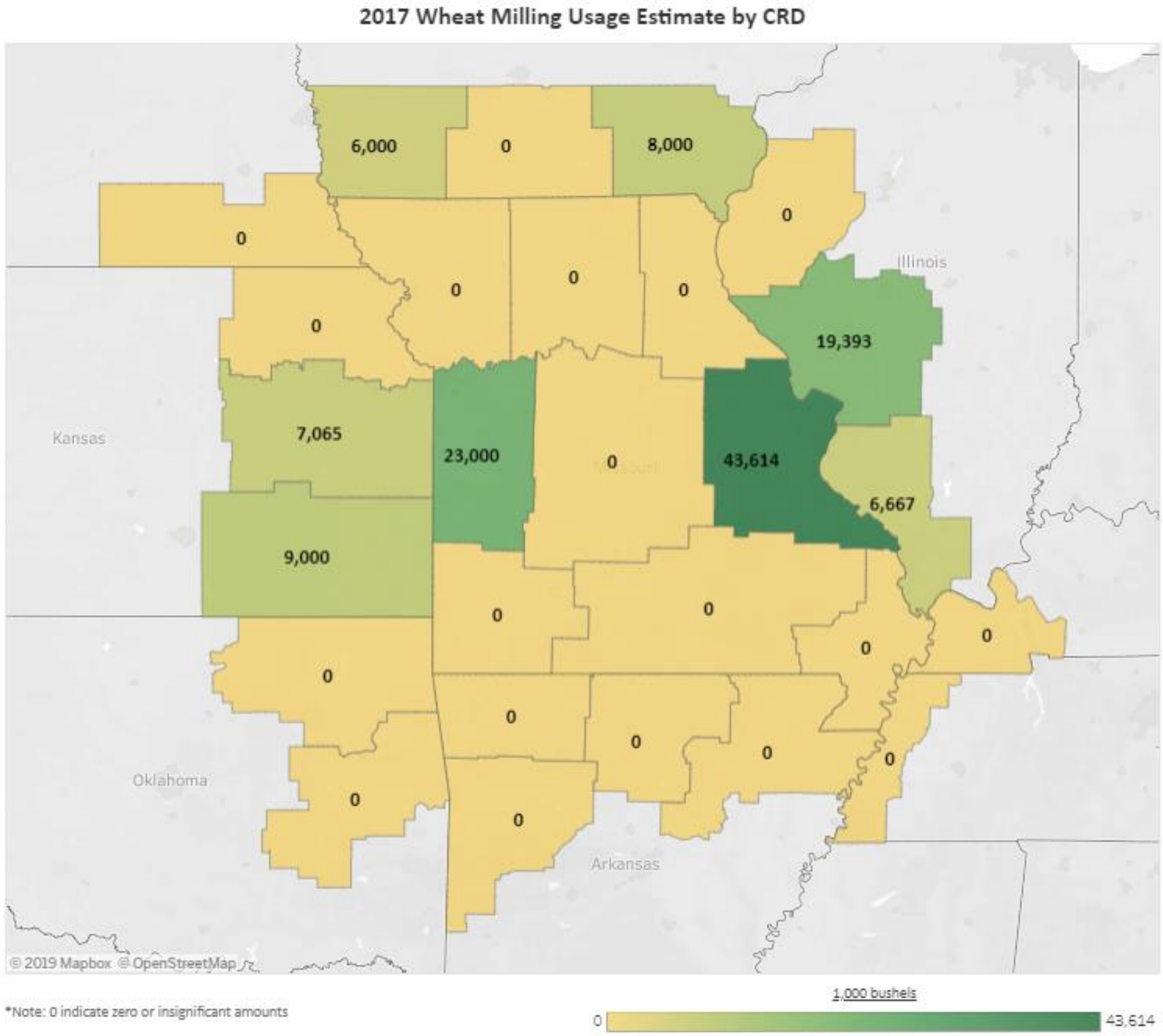


Figure 98, 2017 Wheat Milling Usage Estimate by CRD

Figure 98 shows wheat milling use estimated from USDA reports on milling by milling reporting areas (combined states in most cases, and combinations of many states in the case of Arkansas. USDA published data does not provide a breakout of milling use by class of wheat.

Wheat Net Inflows by CRD

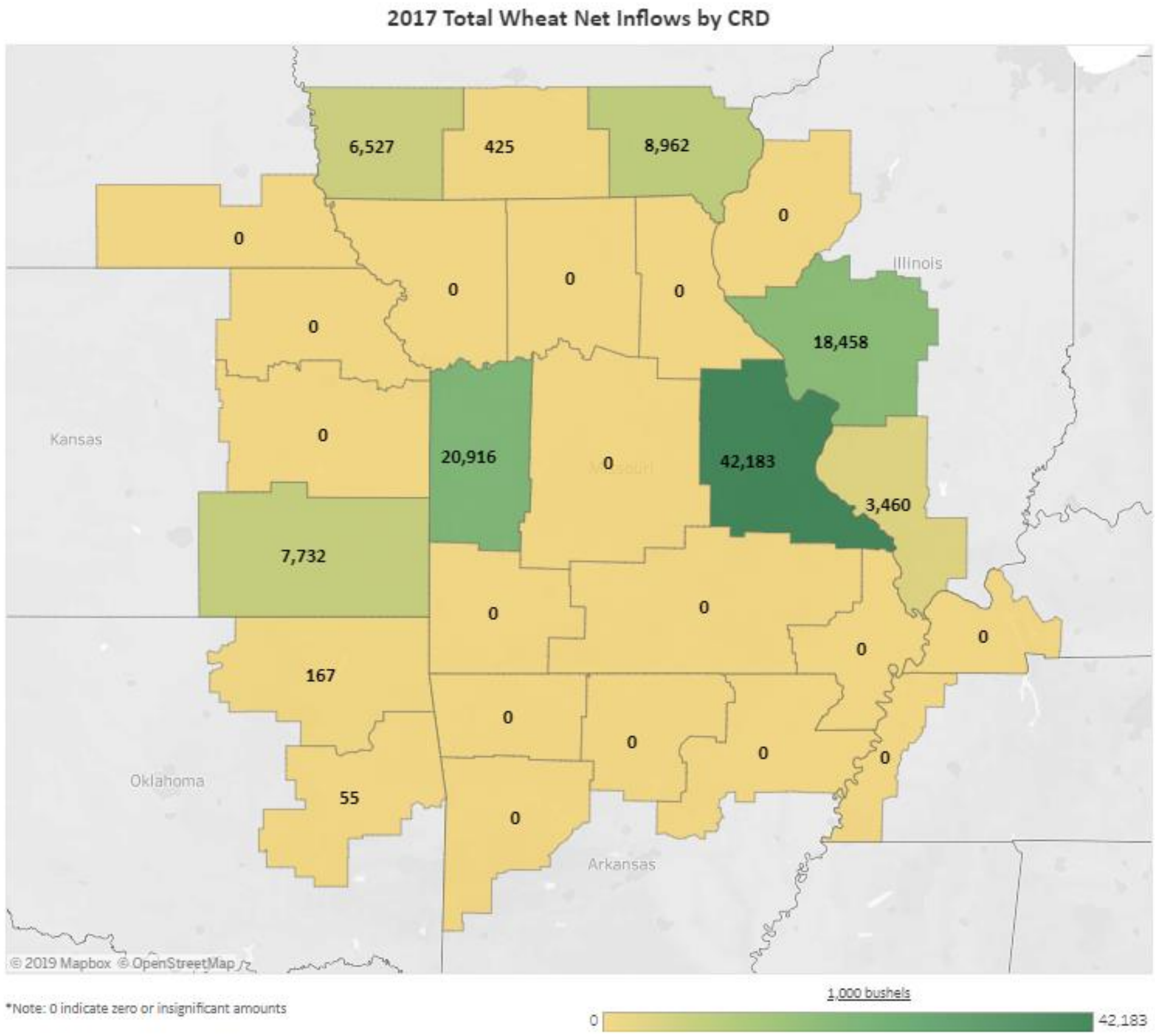


Figure 99, 2017 Total Wheat Net Inflows by CRD

Figure 99 shows the wheat inflows that are needed by CRD based on overall wheat supply, stocks and milling capacity. Due to milling of multiple classes of wheat within the CRDS, it is likely that total flows of wheat exceed these estimates as some classes of wheat which are milled in a CRD may not even be grown within the CRD.

Wheat Outflows by CRD

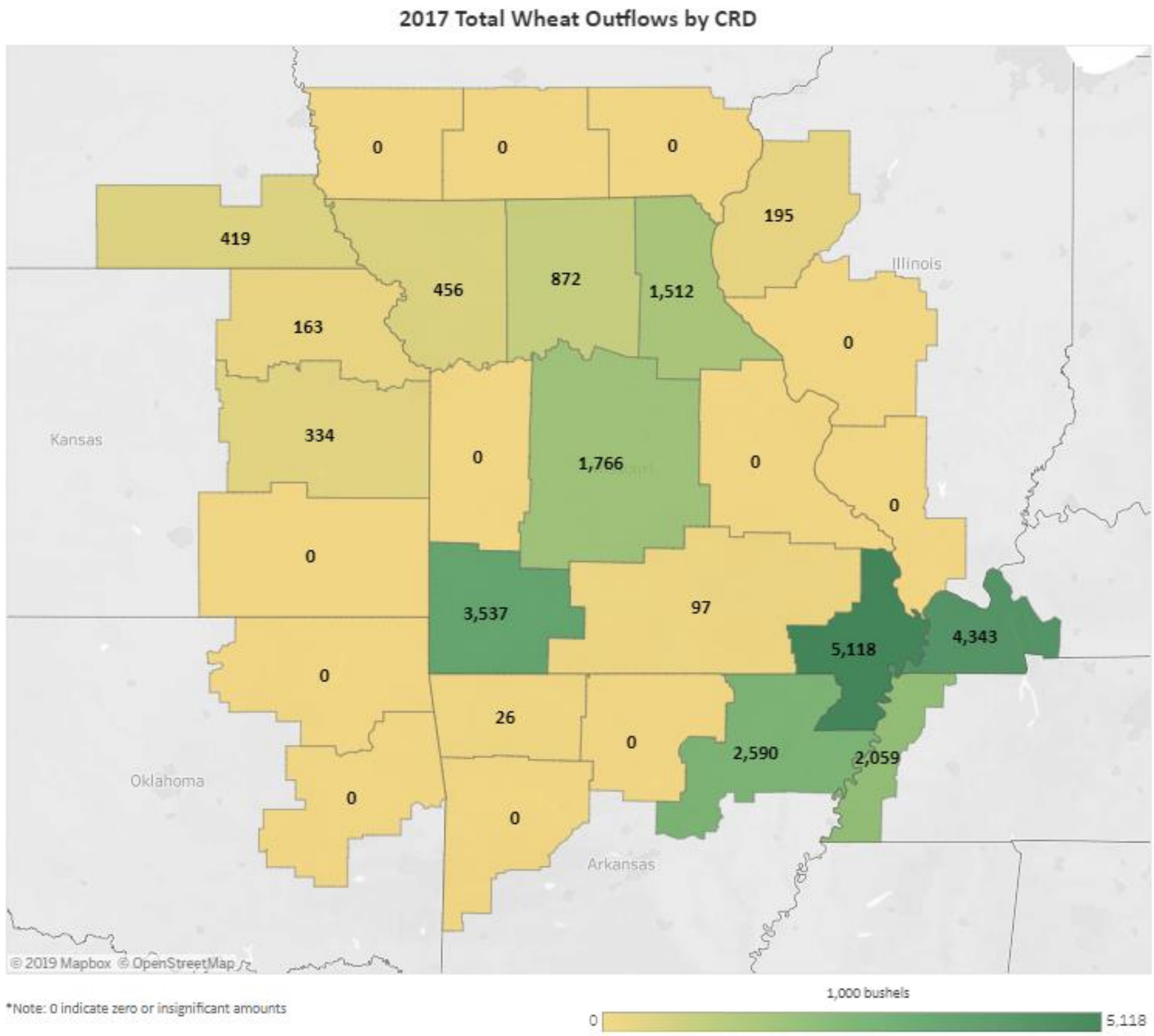


Figure 100, 2017 Total Wheat Outflows by CRD

Figure 100 shows estimated total wheat outflows by CRD. USDA published data does not provide a means to distinguish whether the flows from the CRDs are for domestic milling or for export. It is highly likely that a significant portion of the wheat outflows from the CRDs that lie along the Mississippi River send a significant portion of that wheat into export markets. Likewise it is likely that wheat grown in northern Missouri tends to move to mills in Omaha, Kansas City or St. Louis.

To further define flows of wheat into domestic milling markets and export markets would require a mill and elevator level surveys to assess the movement profiles from these locations.

Infrastructure Utilization

We utilized data published on Freight Analysis Framework Version 4 (FAF4) from the Bureau of Transportation Statistics of the U.S. Department of Transportation. Using the FAF4 database, we have complied the following 6 different categories of Missouri exports, Missouri imports and within Missouri agricultural trade flows.

1. Annual Shipments from the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016 (Figure 101).
2. Annual Shipments from the State of Missouri in Ton-miles (millions) by Commodity by Mode 2013-2016 (Figure 102).
3. Annual Shipments to the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016 (Figure 104).
4. Annual Shipments to the State of Missouri in Ton-miles (millions) by Commodity by Mode 2013-2016 (Figure 105).
5. Annual Shipments within the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016 (Figure 107).
6. Annual Shipments within the State of Missouri in Ton-miles (millions) by Commodity by Mode 2013-2016 (Figure 108).

We have looked at five major categories of agricultural commodities for this analysis for Missouri:

1. **Cereal Grains:** this includes wheat, corn, rye, barley, oats, grain sorghum, rice, and other cereal grains.
2. **Agricultural Products and Oilseeds:** this includes oilseeds such as soybeans, peanuts, linseed, sunflower seeds, cottonseed, mustard seed, and vegetables, fruits, and nuts.
3. **Animal Feed, Eggs, Honey, and Other Products of Animal Origin:** this includes oil cake such as soybean meal and other solid residues from the manufacture of vegetable fats or oils.
4. **Milled Grain Products and Preparations and Bakery Products:** this includes wheat flour, milled rice, corn flour, and milled cereals.
5. **Other Prepared Foodstuffs, Fats and Oils:** this includes dairy products, animal or vegetable fats and oils including soybean oil, canola oil, and corn oil.

We considered four different modes of transportation for Missouri.

1. Truck
2. Rail
3. Barge
4. Multi-modal

Figure 101 shows Missouri annual outbound quantities of agricultural commodities from 2013 to 2016. There were 35.2 million tons of agricultural commodities shipped out of Missouri in 2016. The largest annual outbound shipment category in quantity (1,000 tons) was cereal grains, representing approximately 48 percent of total shipments. Other prepared foodstuffs, fats and oils (hereafter as Fats and Oils) was the second highest category accounting for nearly 19 percent. The animal feed, eggs, honey, and other products of animal origin ("Animal Feed") category accounted for 14 percent, milled grain products and preparations, and bakery products ("Milled Grain Products") accounted 10 percent and agricultural products oil seeds ("oilseeds") category represented nearly 9 percent. By mode of transportation measured in quantity (1,000 tons), truck was the highest (49 percent), followed by rail (31 percent), barge (16 percent) and multi-modal (4 percent) in 2016.

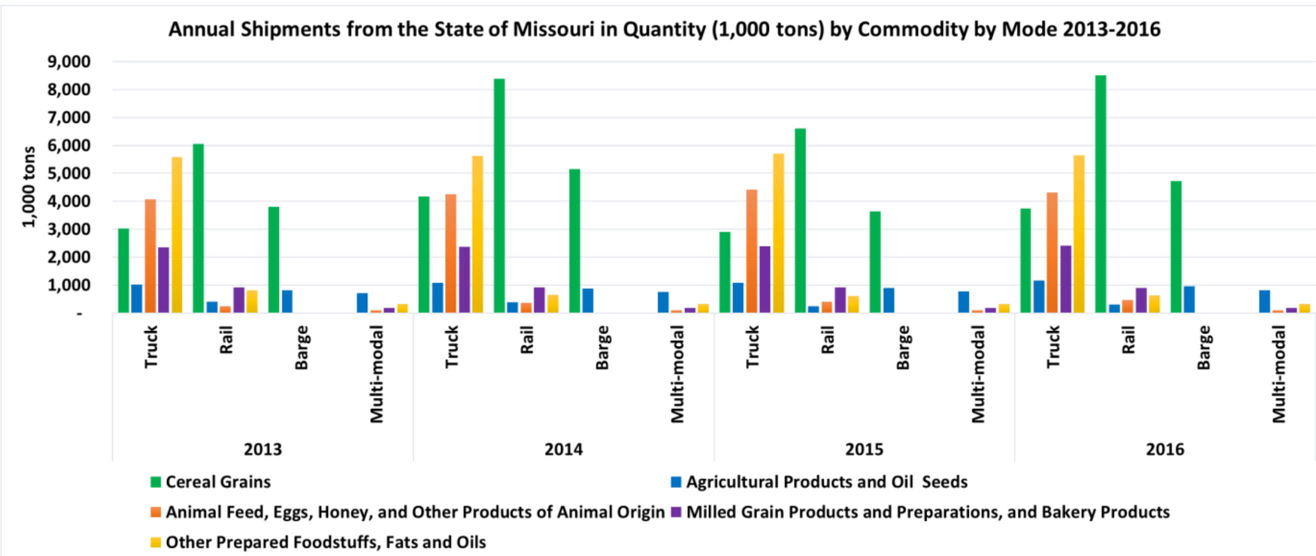


Figure 101, Annual Shipments from the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016

Figure 102 shows Missouri annual shipments of outbound agricultural commodities in ton-miles (millions) from 2013 to 2016. There were 20.5 billion total ton-miles outbound shipments from Missouri in 2016. With 43 percent, truck had the highest share (8.8 billion ton-miles). The second highest share was rail accounting for 33% (6.8 billion ton-miles) and barge accounted for 21 percent (4.4 billion ton-miles). The share for multi-modal was approximately 3 percent (0.6 billion ton-miles).

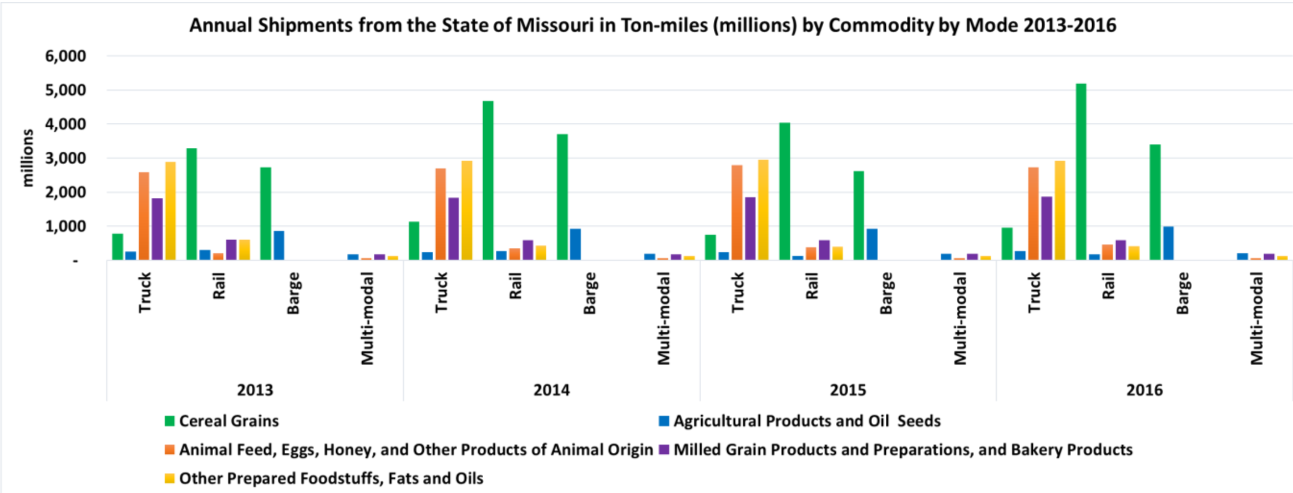


Figure 102, Annual Shipments from the State of Missouri in Ton-miles (million) by Commodity by Mode 2013-2016

At the state level, Figure 103 shows comparisons of total annual truck, rail and barge shipments in quantity (1,000 tons) from the State of Missouri to areas outside the state from 2013 to 2016. As seen in linear trend lines for each mode, the Missouri outbound shipments from trucks has increased by approximately 273,000 tons each year from 2013 to 2016. The quantity of rail shipments has annually increased by 528,000 tons for the same period. The annual shipments from barge has increased by 161,000 tons each year, on average.

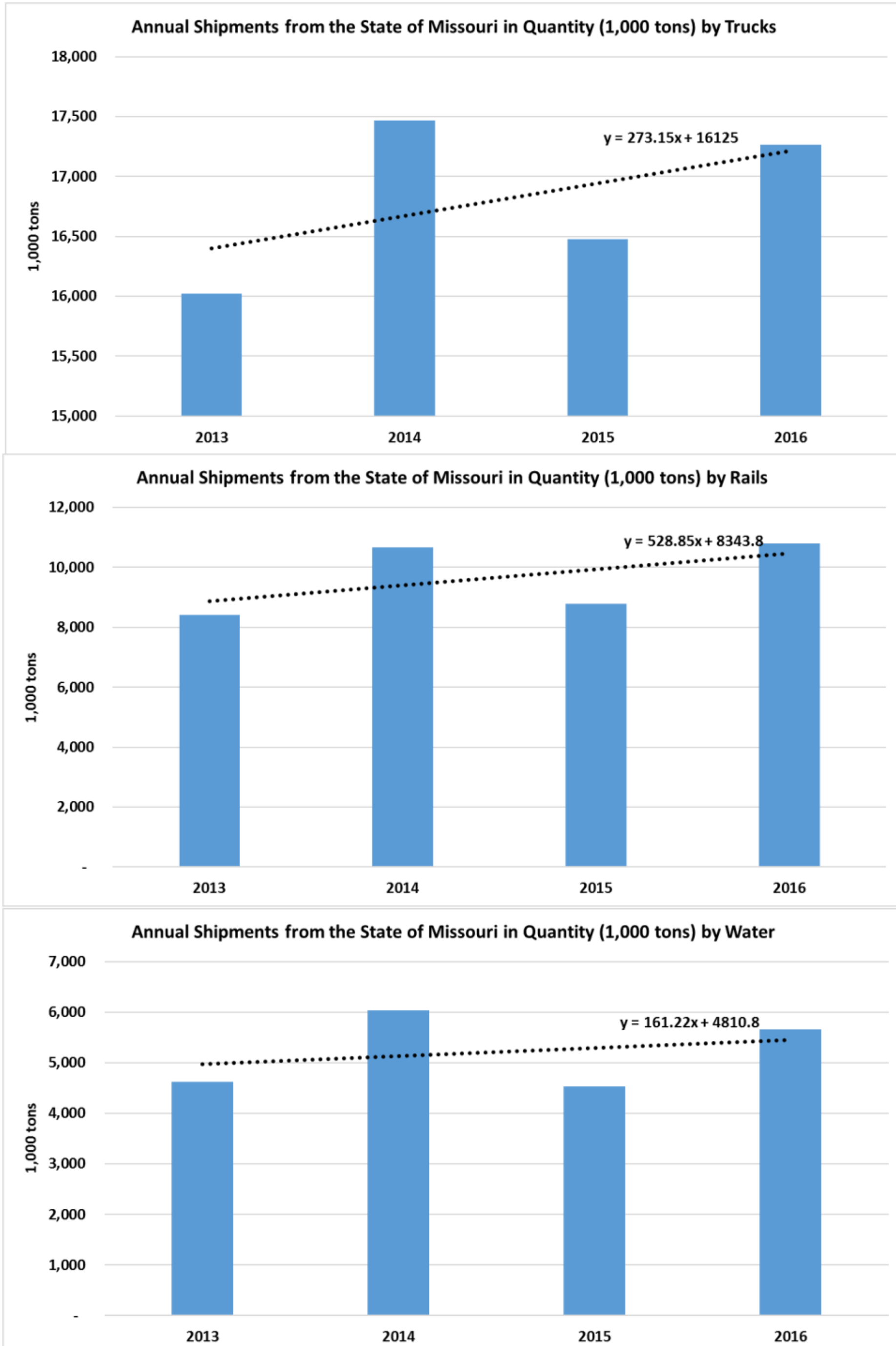


Figure 103, Comparison of Annual Shipments from the State of Missouri in Quantity (1,000 tons) by Mode 2013-2016

Figure 104 shows Missouri annual inbound quantities (1,000 tons) of agricultural commodities from 2013 to 2016. There were 15.2 million tons of agricultural commodities shipped into Missouri in 2016. The largest annual inbound shipment category was oilseeds, which represented approximately 30 percent of total inbound shipments. Fats and Oils were the second highest category, accounting for nearly 29 percent. Cereal grains accounted for 22 percent, animal feed accounted for 10 percent and milled grain products was at 8 percent. By mode of transportation in quantity, truck was the highest (52 percent), followed by rail (24 percent), multi-modal (23 percent) and barge (16 percent) in 2016.

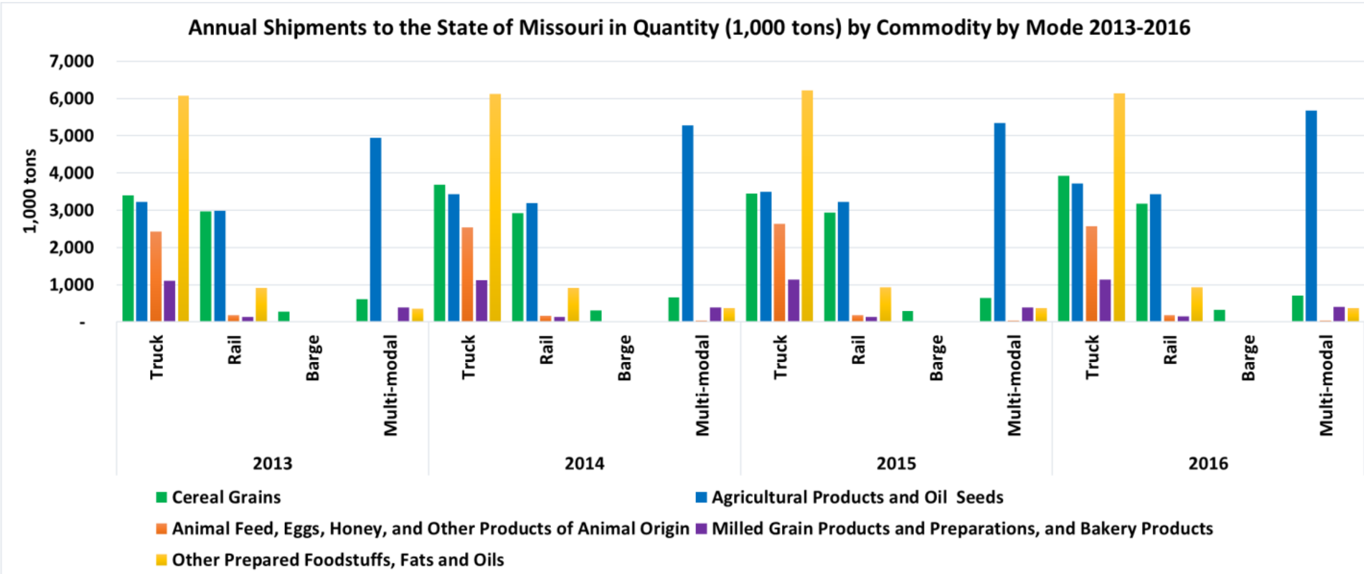


Figure 104, Annual Shipments to the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016

Figure 105 shows Missouri annual inbound shipments of agricultural commodities in ton-miles (millions) from 2013 to 2016. There were 15.2 billion total ton-miles inbound shipments to Missouri in 2016. Truck has the highest share 52 percent (7.8 billion ton-miles). The second highest share was rail, accounting for 24% (3.7 billion ton-miles) and the Multi-modal accounted 23 percent (5.6 billion ton-miles). The share for barge was approximately 1 percent (0.1 billion ton-miles).

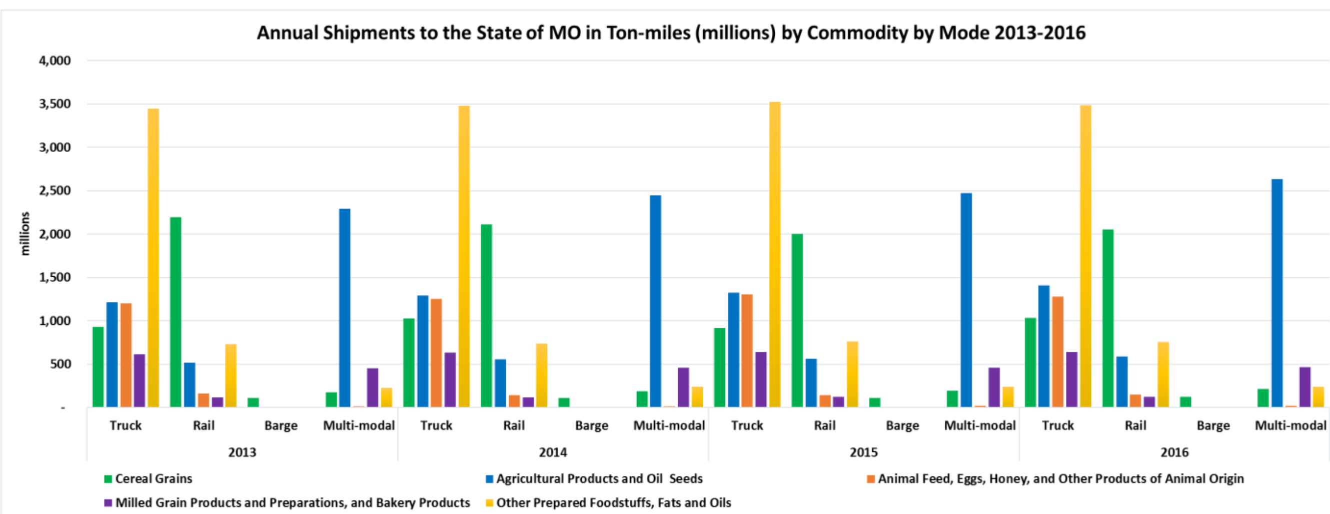


Figure 105, Annual Shipments to the State of Missouri in Ton-miles (millions) by Commodity by Mode 2013-2016

Figure 106 shows a comparison of total (quantity) annual truck, rail and barge shipments separately into the State of Missouri from 2013 to 2016. As seen in linear trend lines for each mode, the Missouri inbound shipments from truck transportation have increased by approximately 381,000 tons on average each year from 2013 to 2016. The quantity of inbound rail shipments has increased by 217,000 tons on average each year for the same period. The annual inbound shipments from barge have increased by 11,000 tons on average each year.

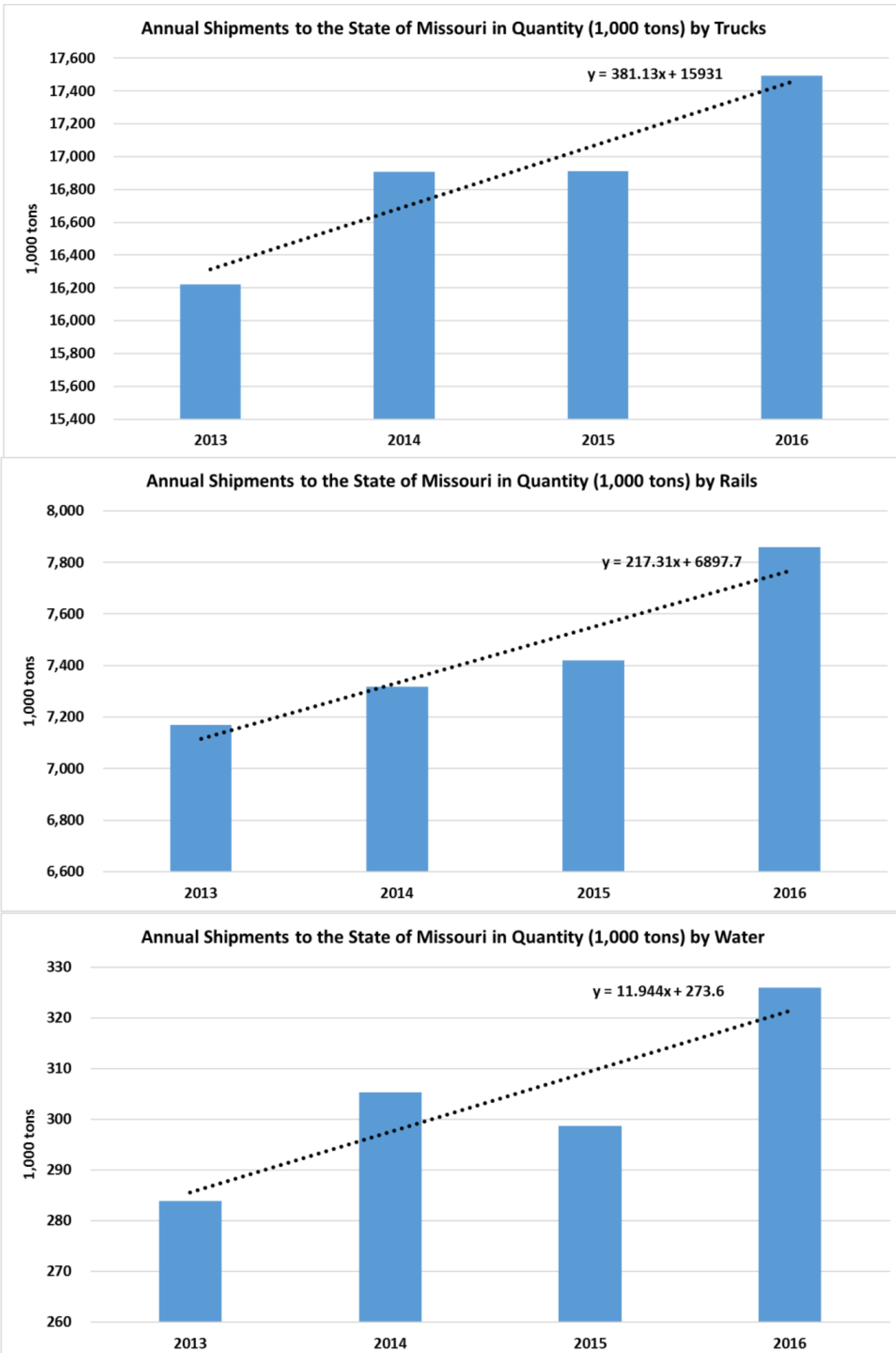


Figure 106, Comparison of Annual Shipments to the State of Missouri in Quantity (1,000 tons) by Mode 2013-2016

Figure 107 shows Missouri annual agricultural commodities flows within Missouri from 2013 to 2016. There were 51.3 million tons of agricultural commodities transported within Missouri in 2016. The largest annual movement within Missouri was cereal grains, accounting for nearly 57 percent. Oilseeds were 16 percent, animal feed was 13 percent, fats and oils were 11 percent and milled grain products was 3 percent. By mode of transportation in quantity, truck accounted for a large majority (91 percent) and rail, barge and multi-modal each accounted for nearly 3 percent in 2016.

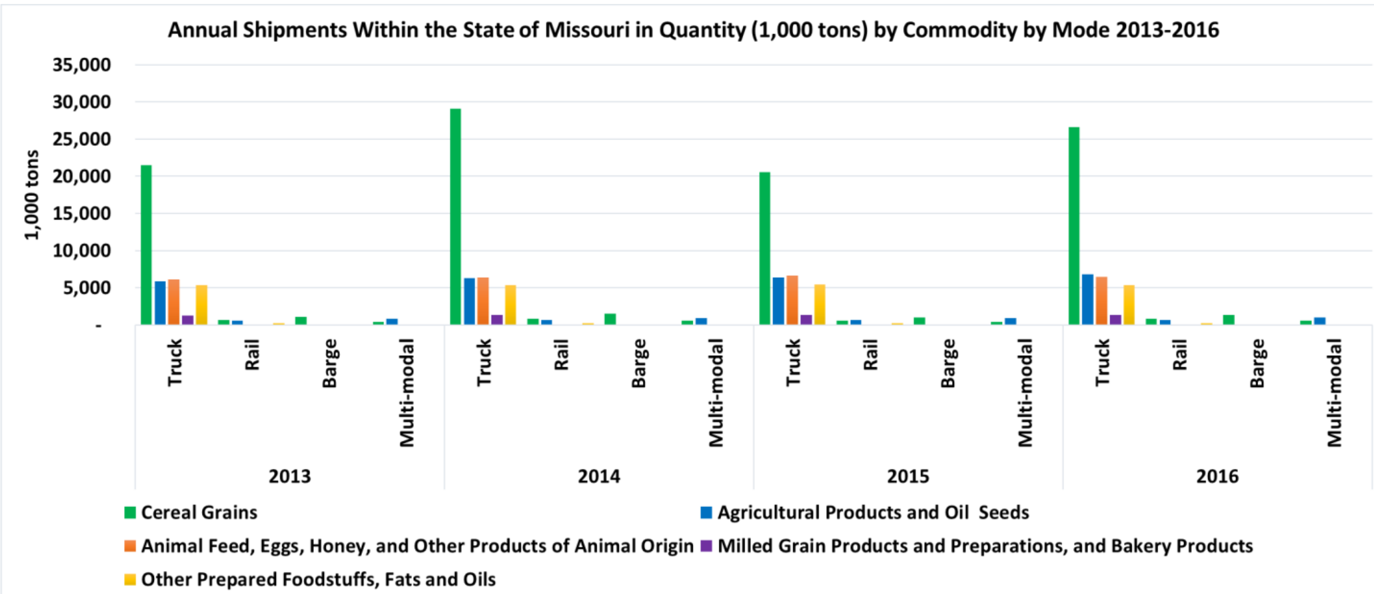


Figure 107, Annual Shipments within the State of Missouri in Quantity (1,000 tons) by Commodity by Mode 2013-2016

Figure 108 shows annual shipments of agricultural commodities within the State of Missouri in ton-miles (millions) from 2013 to 2016. There were 3.2 billion total ton-miles shipped within Missouri in 2016. Truck has the highest share 89 percent (2.8 billion ton-miles). The second highest share was multi-modal, accounting for 7 percent (0.2 billion ton-miles) and both rail and water accounted for 2 percent each.

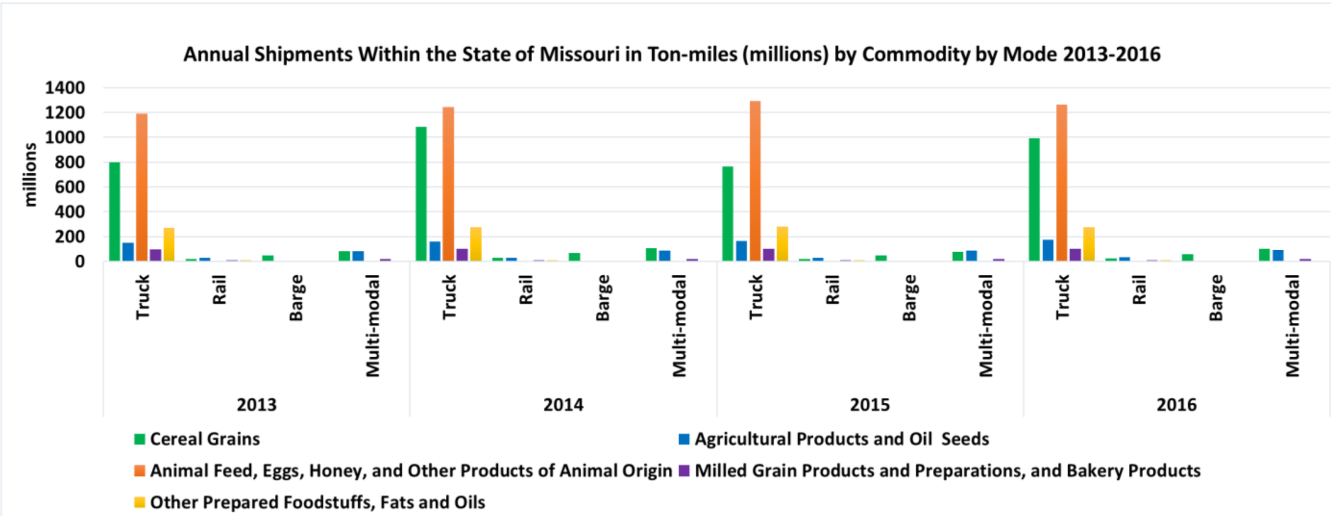


Figure 108, Annual Shipments Within the State of Missouri in Ton-miles (millions) by Commodity by Mode 2013-2016

Figure 109 shows a comparison of total annual truck shipments in quantity within the State of Missouri from 2013 to 2016. As seen in the linear trend line, truck shipments within the state of Missouri has increased by approximately 1,133 thousand tons in each year, on average, from 2013 to 2016.

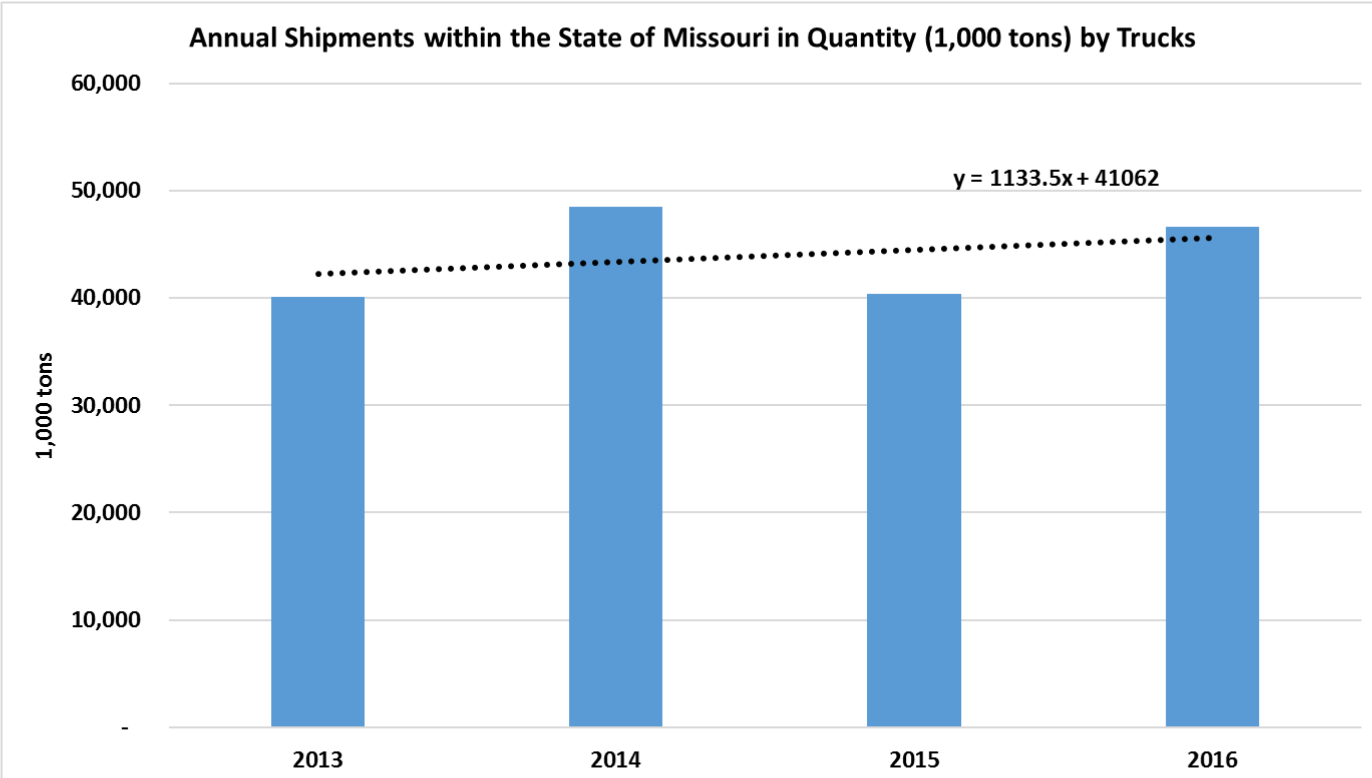


Figure 109, Annual Shipments within the State of Missouri in Quantity (1,000 tons) by Trucks 2013-2016

Infrastructure Assessment

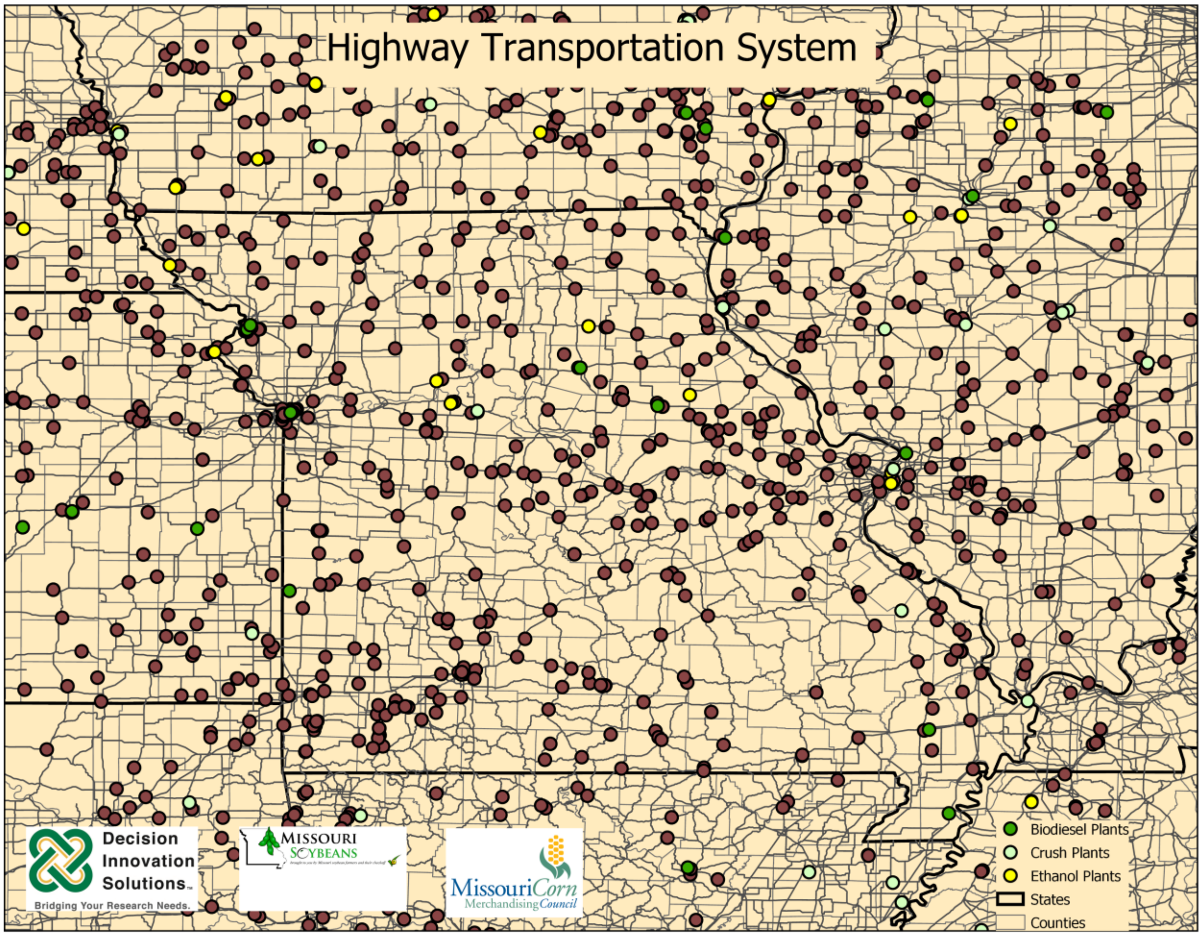


Figure 110, Highway Transportation System

Missouri has an extensive primary and secondary road system. The primary road system features Interstate 70 which traverses the state east-west from St. Louis to Kansas City and Interstates 29, 35, 49, and 55 which traverse the state north-south, although primarily crossing the western side of the state. In addition, Interstate 44 traverses the state northeast-southwest connecting St. Louis, Springfield and Joplin.

Major US-Highways include US 61 which traverses the state north-south on the eastern side of the state, US 63 which traverses the state north-south in the center of the state, US 65 which traverses the state north-south through the western third of the state, and US 67 which connects St. Louis with Poplar Bluff.

Major east-west US highways include US 136 across northern Missouri, US 36 which connects St. Joseph, Missouri to Hannibal, Missouri, US 24 which connects Quincy, IL to Kansas City, US 50 which connects St. Louis, Missouri to Kansas City, but runs about 20-30 miles south of

Interstate 70, US 60 which runs across southern Missouri connecting Cape Girardeau with Springfield and Neosho and US 160 which connects Poplar Bluff with West Plains and Branson.

US 54 runs northeast-southwest from Bowling Green to Nevada, Missouri. In addition, there are thousands of miles of state highways and paved county highways that are integral to the farm to market road system within Missouri.

As Figure 110 shows, there are more than 300 grain handling facilities scattered across Missouri that provide a solid network of first handlers for local farm grain and oilseeds and satisfy necessary aggregation functions for supplying corn, grain sorghum, wheat and soybeans to processors, millers, feed mills and export loading facilities on a year-round basis.

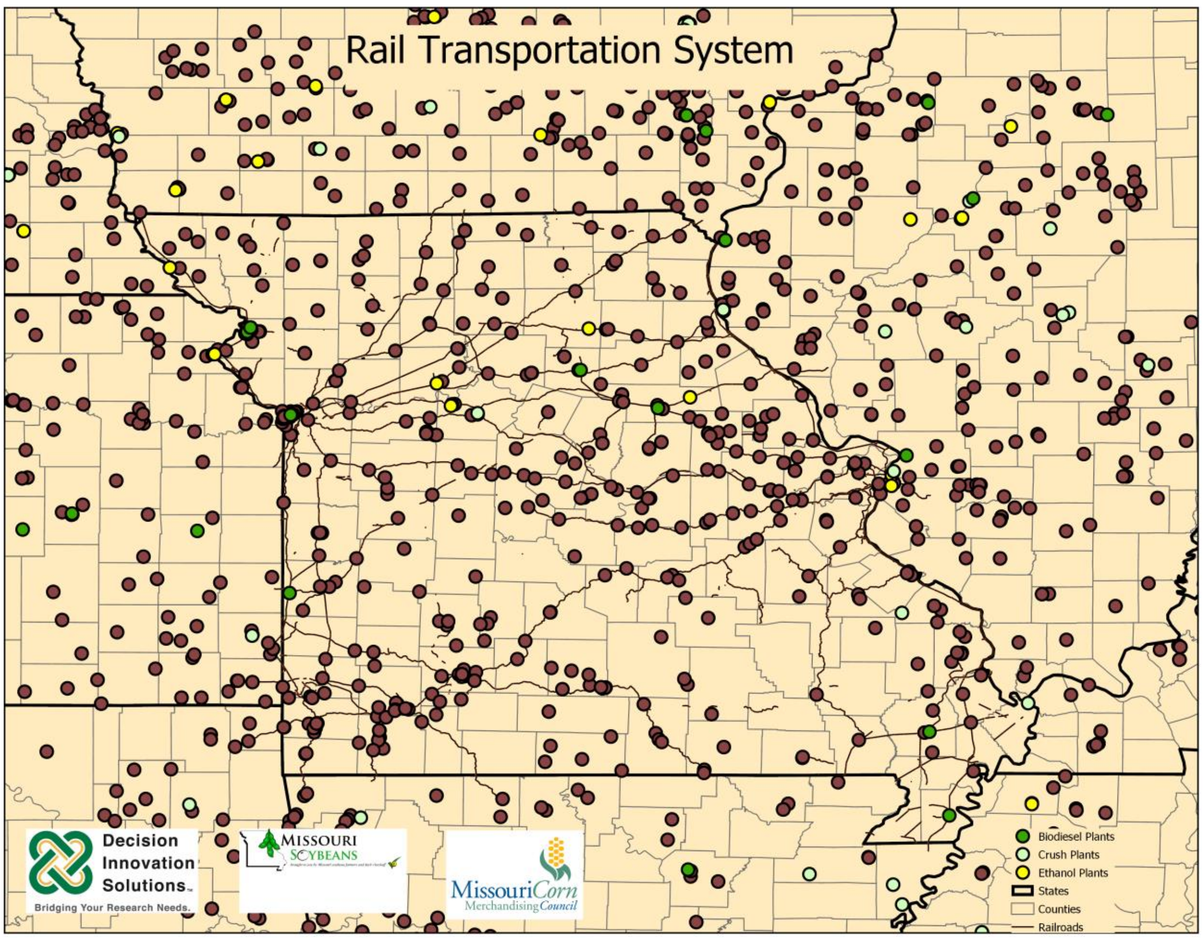


Figure 111, Rail Transportation System

Missouri has significant rail transportation assets as shown in Figure 111. Nearly all ethanol, soybean crush, biodiesel and wheat milling facilities are located on existing rail lines. Some major grain facilities also have rail service available as do some of the larger feed mills. This is particularly true in the St. Joseph, Kansas City, St. Louis processing areas. Nearly all ethanol facilities have active rail service and some of the larger feed mills in southwest Missouri have rail service. However, over the years, active rail service to many country elevators has declined or been discontinued.

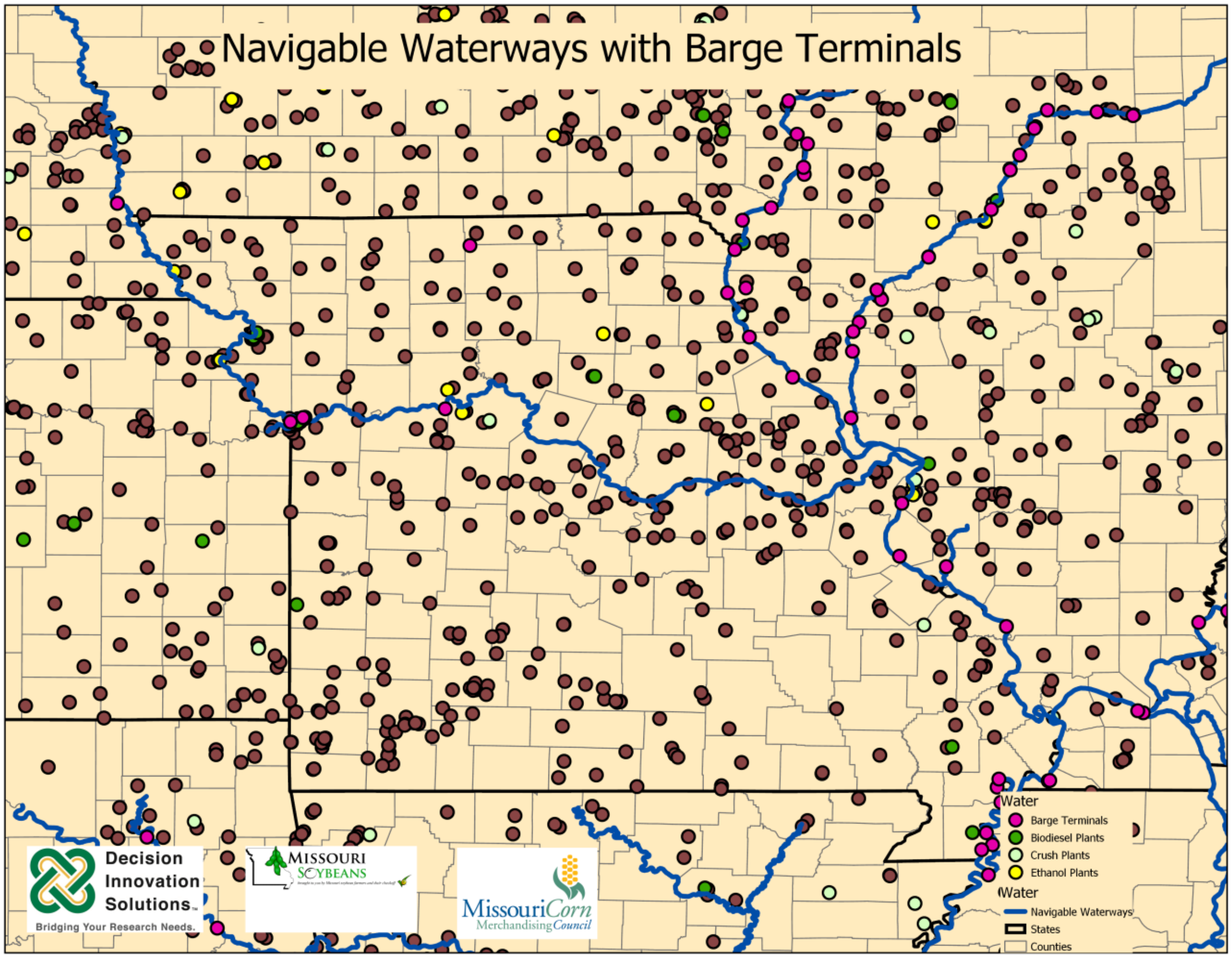


Figure 112, Navigable Waterways with Barge Terminals

The Mississippi River borders Missouri along its full eastern border. There are barge terminals at 16 locations along the Mississippi River (although some are located on the Illinois side of the river). The Missouri River provides the western border for northwestern Missouri and then transects the State of Missouri from Kansas City to St. Louis passing through major grain and soybean producing areas in west-central Missouri, Jefferson City, Missouri, and areas of east-central Missouri. There are four barge loading facilities located on the Missouri River servicing Missouri farms: one in southeastern Nebraska, several in Kansas City and one in Saline County.

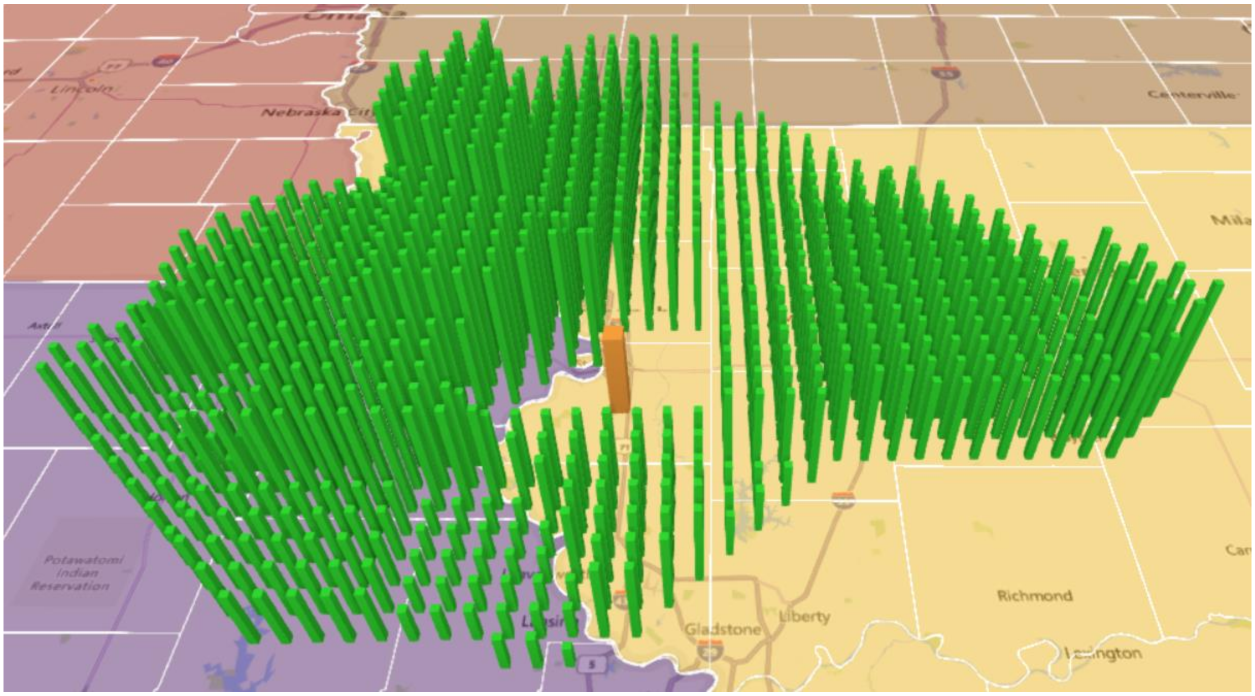
Cost/Benefit Analysis of Public Investment in Infrastructure

In deciding whether a capital investment is the best and highest use of funds, one must determine the tradeoffs of doing nothing versus utilizing available or borrowed funds. On a basic level, this process is rather straightforward. Applied in the context of this effort, we intend to analyze several bridges in Buchanan which are rated as "poor" according to definitions used by National Bridge Inspection Standards (NBIS). The following framework will be used to conduct this cost/benefit analysis:

1. **Define the base scenario:** The "no action" case—the continued operation of current bridges without any investments.
2. **Identify project alternatives:** These can vary from major rehabilitation of existing bridges to new construction, full reconstruction, or replacement.
3. **Defined time period:** Determine analysis period over which the life cycle costs and benefits of all of the alternatives will be measured.
4. **Analyze traffic scenarios:** Analyze traffic effects that the alternative would have on the future traffic to calculate the project costs and benefits.
5. **Economics:** Including investment costs, hours of delay, traffic diversion costs, and other effects of each alternative relative to the base case.

Base Scenario

There are a few counties in Missouri that are large demanders of soybeans for processing. Buchanan County is estimated to require 40.2 million bushels of soybeans per year, split between two plants in St. Joseph and less than two miles apart along the Missouri River: AGP and Ventura Foods soy processing. There are significant amounts of soybeans grown within 100 miles of this location, many of which find their way to these two plants. These two plants are estimated to draw soybeans from twenty-four counties in four states (Missouri, Iowa, Nebraska and Kansas). The share of soybeans split between that sourced within the state and states outside of Missouri is 67% (26.8 million bushels) in Missouri to 33% (13.4 million bushels) outside of Missouri.



The ability of soybeans grown in this region to be efficiently transported to these processing plants is critical to maintaining the competitiveness of the value chain. One of the largest determinants of competitiveness is infrastructure, specifically roads and bridges. As stated previously, we have chosen to focus on the condition of bridges.

According to the National Bridge Inspection Standards (NBIS)1, condition ratings are used to describe an existing bridge or culvert compared with its condition if it were new. The ratings are based on the materials, physical condition of the deck (riding surface), the superstructure (supports immediately beneath the driving surface) and the substructures (foundation and supporting posts and piers). General condition ratings range from 0 (failed condition) to 9 (excellent).

Through periodic safety inspections, data is collected on the condition of the primary components of a structure. Condition ratings, based on a scale of 0-9, are collected for the following components of a bridge. A condition rating of 4 or less on one of the following items will deem a bridge as structurally deficient.

- The **bridge deck**, including the wearing surface
- The **superstructure**, including all primary load-carrying members and connections
- The **substructure**, considering the abutments and all piers
- The lower of the three ratings is the overall rating of the bridge:

[1] https://www.modot.org/common-bridge-terms

1. Imminent Failure
2. Critical/Closed
3. Serious
4. Poor
5. Fair
6. Satisfactory
7. Good
8. Very Good
9. Excellent

Using the "Condition Ratings" scale above, in Buchanan County, there are seven bridges rated as "poor". The assumption is that, while these bridges are not yet limiting "weight-restricted" (trucks carrying full loads (less than 90,000 lbs) of soybeans can still pass on all bridges), bridges in poor condition in the area will eventually cause inefficiencies, whether due to distance of haul or elapsed time per haul, in delivery of soybeans to these two plants. The following seven bridges in Buchanan County are classified as being in "poor" condition are:

Table 1, Bridges in Buchanan County Classified as "Poor"

Bridge #	Feature	Route	Year Built	ADT	Deck	Super	Sub	Culvert	Minimum	Designation
A0782	PLATTE RVR	US 36 W	1962	4,956	3	5	5	N	3	POOR
A0700	IS 29	COOK RD E	1962	5,594	4	7	6	N	4	POOR
A0701	IS 29	GENE FIELD RD E	1962	7,819	4	7	6	N	4	POOR
A2822	US 36	RT AC S	1973	11,439	4	5	6	N	4	POOR
A2001	CONTRARY CR	RT U E	1967	2,511	4	6	6	N	4	POOR
A3032	US 59, CST ATCHISON ST,,	IS 229 S	1979	1,311	6	4	5	N	4	POOR
L0319	IS 229, CST 6TH ST, CST,	US 36 E	1951	20,389	6	5	4	N	4	POOR

As shown in Figure 113, all but one of the bridges (denoted as blue columns) classified as poor are on major highways (U.S. 36) and interstates (I-29 and I-229). Of note, these seven bridges do not have limiting weight-restrictions in place; in other words, these bridges can still safely handle full, 40-ton trucks. However, if these bridges were to deteriorate to the point of requiring a restrictive weight-limitation, the location and associated importance of these bridges would negatively impact the delivery of soybeans grown in the region. Less efficient (shorter, lower speed limit, etc.) routes would need to be followed to deliver to the two processors.

Figure 113, Bridges in Buchanan County Classified as "Poor"

Using data and discussion presented above, the base scenario becomes:

- Maintenance, but no major renovations or replacements are made to the seven bridges in Buchanan County classified as “poor”
- At some future date, limiting weight-restrictions are applied to the bridges
- Limiting weight-restrictions cause logistical inefficiencies to develop within the soy value chain

Project Alternatives

Project alternatives to the base scenario include the following:

- A major renovation of the bridges occurs, effectively restoring the bridges collective rating to an average of 7, or “good”
- Replacement of the bridges occurs, effectively restoring the bridges collective rating to an average of 9, or “excellent”

While knowing the cost to renovate or replace the seven bridges in Buchanan County would be helpful, it is beyond the scope of this effort. However, estimating the inefficiencies to the movement of goods on highways in the county from not preemptively remedying the bridges will provide valuable information to decisionmakers. In other words, knowing the cost can be used to prioritize the use of public funds on deteriorating bridges.

Time Period

If only maintenance is made on identified bridges, it is difficult to predict when a given bridge may need to have a limiting weight-restriction applied to it. This is because the passage of time, weather, frequency and size of loads and total traffic all vary by time, location and intensity. For the sake of continuing the analysis, we assume some future date wherein all seven bridges have a restricting weight-limitation applied, which in turn increases the average length of one-way haul by ten miles.

Traffic Scenarios

All data obtained for this cost/benefit analysis has come from the Missouri Department of Transportation (MODOT). A file was obtained which shows all 1,194 bridges in Missouri with their accompanying locations, age, average daily traffic (ADT), rated weight capacity and condition of the deck, superstructure and substructure. Subsequent communication with MODOT yielded the estimated percentage of truck traffic (all goods, not just soybeans) which crosses all bridges in Buchanan County.

Thirty-five bridges in Buchanan County have:

- Nearly 6,500 ADT, ranging from 44 to 22,466.
- Applying the estimated truck percentages (ranging from 1% to 25% of ADT, averaging 11%) to these figures yields an average of 643 truck crossing per day, ranging from 2 to 2,020.
- An estimated 8.2 million annualized truck crossings

Filtering the bridges to include only the seven Buchanan County bridges classified as “poor”, the following data points are estimated:

- ADT of 7,717, ranging from 1,311 to 20,389
- Applying the estimated truck percentages (ranging from 4% to 19% of ADT, averaging 8.4%) to these figures yields an average of 497 truck crossing per day, ranging from 126 to 1,019.
- An estimated 1.3 million annualized truck crossings

Economics

To understand the economic impact of less efficient transportation of goods to market, we make the following assumptions:

- Maintenance, but no major renovations or replacements are made to the seven bridges in Buchanan County classified as “poor”
- Limiting weight-restrictions are applied to the bridges
- Limiting weight-restrictions cause logistical inefficiencies to develop, causing, on average, an extra 10 miles to be added (one way) to each haul; this assumes half of trucks crossing bridges are returning empty and not concerned with being overweight on return trips.
- On average amongst all types of freight, cost per loaded mile is $2.50

- On an annual basis, total loaded trucks crossing “poor” bridges in Buchanan County is 635,000; this assumes half of trucks crossing bridges are returning empty and not concerned with being overweight on return trips.

Using the above assumptions, the total cost to allowing bridges to deteriorate to the point of requiring a restrictive weight-limitation would be $15.9 million per year. Changes in assumptions that would materially affect this estimate would be:

- Return-trip truck traffic is actually loaded, thereby also requiring changes in return routes to avoid limiting weight-restricted bridges
- Differences in cost per loaded mile are significantly more or less than $2.50
- One-way detours are significantly more or less than ten miles

Impact on Freight Rates

In this section, we developed an economic model to better understand factors which influence barge and rail rates for export-bound grain from Missouri to the Louisiana's Gulf. The amount of barge usage is determined by the actions of buyers and sellers in a market in which both players use relevant information to establish an equilibrium price and level of service. Similarly, the amount of rail usage is determined by the same kind of interaction between buyers and sellers of rail services to determine the rail rates and the number of rail cars. To address each individual market, we developed two separate demand equation for each sector and the competitive interaction between barge and rail demand is addressed in econometric estimation.

Monthly spot barge rates for grain shipments from Missouri along the Mississippi River to the Gulf were obtained from the Transportation and Marketing Programs of USDA’s Agricultural Marketing Service (USDA-AMS). Barge rates are expressed as percent of tariff. The same data source provided the total monthly volume of grain barge shipments in tonnage from Missouri along the Mississippi River to the Gulf. Total grain exports from the Gulf (Tons) were collected from USDA-AMS. The Pacific Northwest-Gulf corn price spread was calculated using price data collected from USDA-AMS. The spread between the two locations’ cash prices were computed by subtracting the Gulf price from that of Pacific Northwest. Data on rail movements was provided by a private consulting firm based in Indiana. The variables of interest were rail rates ($/ton-mile), tonnage shipped, and the origin and destination points (OD Pairs). The commodities of interest were corn, soybeans, and wheat. The origin point of interest was Kansas City, Missouri and the selected destination points were New Orleans, Louisiana and Portland, Oregon. The time coverage was 2004 to 2018 and each variable was converted to a monthly average. Notice that all the estimated coefficients are representing in log form.

The Ordinary Least Squares (OLS) was applied to obtain the estimated coefficients of two demand equations, and the F-test was used to determine whether the models are significantly appropriate; p-values of the F-test were less than 0.05 for both demand equations, which denotes significance.

Model

The model consists of two demand equations. Demand equation 1 represents the barge industry and demand equation 2 represents rail industry for transporting grains from Missouri to Gulf. Each respective demand equation is designed to determine the factors that affect barge and rail usage. We assume an inverse relationship between barge or rail rates and the demand for barge or rail services assuming all other influences are constant (i.e., *ceteris paribus*).

Demand Equation 1:

$$BR_t = Intercept + \alpha_1 BR_{t-1} + \alpha_2 MOGU_{t+1} + \alpha_3 TG_{t+2} + \alpha_4 CS_{t-2} + \alpha_5 RR_t + \alpha_6 I(Season) + \varepsilon$$

Demand Equation 2:

$$RR_t = Intercept' + \beta_1 RR_{t-1} + \beta_2 BR_t + \beta_3 RT_{t+1} + \beta_4 CS_{t-2} + \beta_5 TG_{t+2} + \beta_6 I(Season) + \varepsilon'$$

Where,

BR_t = Current month barge rate (% of Tariff);

BR_{t-1} = Previous month barge rate;

$MOGU_{t+1}$ = Next month barge shipments from Missouri to the Gulf (Tons);

TG_{t+2} = Total grain exports from the Gulf in two months later (Tons);

CS_{t-2} = Pacific Northwest to Gulf corn price spreads in two months ago ($/Bushel);

RR_t = Current month Missouri to Gulf rail rate ($/Ton per Mile);

RT_{t+1} = Next month Missouri to Gulf rail shipments (Tons);

I(Season) = Indicator variable for each season; and α and β are parameters for each variable.

Demand Equation 1 links barge rates (BR) to total barge shipments from Missouri to the Gulf in tonnage (MOGU), total grain exports from the Gulf (TG), Pacific Northwest to Gulf corn price spreads (CS), Missouri to Gulf rail rates (RR), and Indicator variable for each season (I(Season)).

Demand Equation 2 links rail rates (RR) to Missouri to Gulf rail shipments (RT), barge rates (BR), Pacific Northwest to Gulf corn price spreads (CS), total grain exports from the Gulf (TG), and Indicator variable for each season (I(Season)).

The expectation of the results from the two-equation demand model are summarized below.

Demand Equation 1:

- Barge rates and Barge shipments from Missouri to the Gulf are expected to have inverse relationship indicating higher barge rates would lead to lower quantities of barge shipments.
- Barge rates are expected to have positive relationship with total US grain exported from the major ports such as Gulf. Higher demand for US grains from the foreign partners should increase the demand for barge transportation and will increase the barge rates.
- Corn price spread between Gulf to Pacific Northwest and barge rates should be related positively because a higher spread would indicate higher relative prices in the Gulf region (demanding more corn shipments) relative to the Pacific Northwest.
- Barge rates are expected to have positive relationship with rail rates as barge and rail transportation ought to substitute each other in the grain transportation market.
- We assume grain barge shipments are seasonal as grain shipments generally increase during the harvest season and decrease thereafter.

Demand Equation 2:

- Rail rates and rail shipments from Missouri to the Gulf are expected to have inverse relationship indicating higher rail rates would lead to lower quantities of rail shipments to the Gulf region.
- Rail rates and barge rates are expected to have a positive relationship as rail and barge transportation should substitute each other in the grain transportation market.
- Rail rates should have a positive relationship with total US grain exported from the Gulf region because it is a significant point of origin for international shipments. Higher demand for US grains from the foreign partners should increase the demand for rail transportation and will increase rail rates.
- Rail rates and the corn price spread between the Gulf to Pacific Northwest should be related positively because a higher spread would indicate higher relative prices in the Gulf region (demanding more corn shipments) relative to the Pacific Northwest.

Results

The estimated results are shown in Table 2 and Table 3 for the demand equation 1 and demand equation 2 respectively.

Table 2: Parameter estimates for demand equation 1 (Barge demand)

	Estimate	P-value
Intercept	1.0042	0.4718
BR_{t-1}	**0.7149***	**<0.0000001**
$MOGU_{t+1}$	**-0.2491***	**0.0005**
TG_{t+2}	**0.2344***	**0.0162**
CS_{t-2}	-0.0188	0.7749
RR_{t}	-0.0166	0.7857
Summer	**0.1534***	**0.0017**
Fall	**0.3029***	**0.0000005**
Winter	0.0027	0.9553

Note: * denotes significant at the 5% level based on the estimated coefficients.

The Adjusted R-squared is 0.70, which indicates the empirical model depicted in the demand equation 1 explained 70 percent of total variation in barge rates. The estimated coefficient for the previous month's barge rate is positive and statistically significant indicating the previous month's barge rate significantly influences the current month barge rates. The estimated coefficient for the next month's barge shipments from Missouri to the Gulf is negative and statistically significant. This indicates the (expected) inverse relationship between current barge rates and total next month barge shipments. The higher the barge rates, the lower the quantity demand for barge shipments.

The estimated coefficient for total grain exports from the Gulf two months later is positive and statistically significant. This indicates that barge rates are significantly and positively influenced by the level of export shipments from the Gulf. The estimated parameters for the Pacific Northwest to Gulf corn price spreads (two months ago) and Missouri to Gulf rail rate (current month) show unexpected negative signs and are statistically insignificant. The seasonal dummy variable estimates show positive signs and statistical significance for the Summer and Fall seasons. This indicates barge rates are higher in summer and fall months compared to the other two seasons.

Table 3: Parameter estimates for demand equation 2 (Rail demand)

	Estimate	P-value

Intercept	**2.3501**	**0.0228**
RR_{t-1}	**0.7431***	**<0.000001**
BR_t	-0.0070	0.8484
RT_{t+1}	**-0.2405***	**0.0032**
CS_{t-2}	**0.9096***	**0.0484**
TG_{t+2}	-0.1125	0.0664
Summer	-0.0267	0.4807
Fall	-0.0276	0.5567
Winter	0.0449	0.1930

Note: * denotes significant at the 5% level based on the estimated coefficients.

The Adjusted R-squared for the rail demand equation is 0.77 indicating the demand equation 2 explains 77 percent of total variation of rail rates. The lagged one-month rail rates coefficient is positive and statistically significant showing the previous month rail rates significantly influence current month rail rates. The estimates for current barge rates and the next month's Missouri to Gulf rail shipments show unexpected negative signs. However, the estimated parameter for the two-month lagged Pacific Northwest to Gulf corn price spreads shows positive (expected) sign and statistically significant. This shows that rail rates will be higher when there is a significant spread between the Gulf prices and Pacific Northwest prices, which derives more rail demand to transport grains from Missouri. All other variables including seasonal dummies do not show any statistical significance in the rail demand equation.

Summary by Federal Congressional District

The section contains key information related to movement of commodities in Missouri's eight congressional districts. A state level summary is also provided.

MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

STATE TOTALS

Missouri Soybeans · Missouri Corn · MASBDA · Decision Innovation Solutions

Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 552,556,000 BUSHELS

SOYBEANS: 292,545,000 BUSHELS

GRAIN SORGHUM: 2,461,000 BUSHELS

WHEAT: 36,746,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills. Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

LIVESTOCK:
CORN: 167,694,000 BUSHELS • GRAIN SORGHUM: 4,782,000 BUSHELS

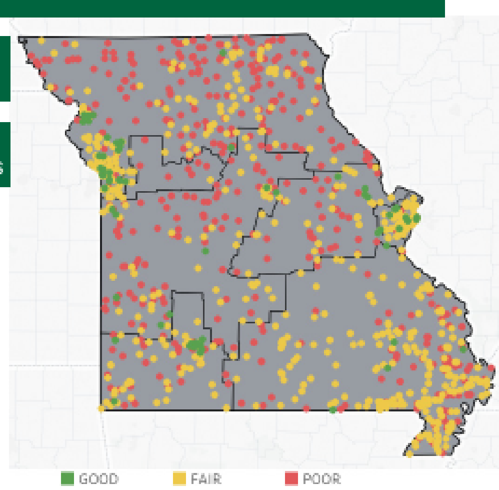
STORAGE *(ON & OFF-FARM)*:
CORN: 59,356,000 BUSHELS • SOYBEANS: 19,783,000 BUSHELS • WHEAT: 19,846,000 BUSHELS
GRAIN SORGHUM: 286,000 BUSHELS

EXPORTS:
CORN: 141,466,000 BUSHELS • SOYBEANS: 78,384,000 BUSHELS

FURTHER PROCESSING:
CORN: 98,929,000 BUSHELS • SOYBEANS: 190,960,000 BUSHELS

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, there are 85 bridges in good condition, 659 in fair condition, and 450 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 1

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PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 32,000 BUSHELS

SOYBEANS: 41,000 BUSHELS

GRAIN SORGHUM: -

WHEAT: 9,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills. Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

LIVESTOCK:
CORN: 1,000 BUSHELS • GRAIN SORGHUM: -

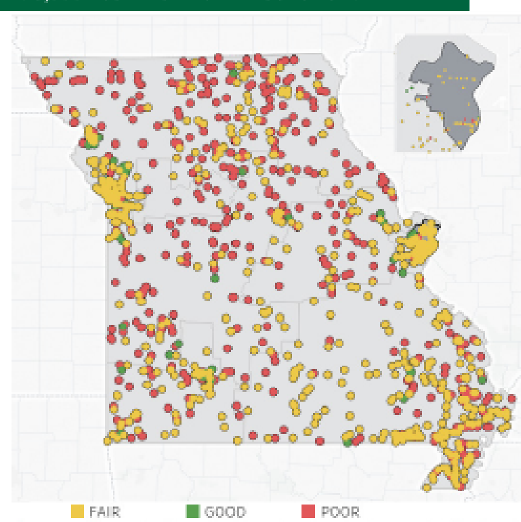
STORAGE *(ON & OFF-FARM)*:
CORN: 3,000 BUSHELS • SOYBEANS: 3,000 BUSHELS • WHEAT: 5,000 BUSHELS • GRAIN SORGHUM: -

EXPORTS:
CORN: 28,000 BUSHELS • SOYBEANS: 8,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: -

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 1, there are 4 bridges in good condition, 46 in fair condition, and 13 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 2

Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 291,000 BUSHELS

SOYBEANS: 365,000 BUSHELS

GRAIN SORGHUM: -

WHEAT: 81,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills. Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

LIVESTOCK:
CORN: 6,000 BUSHELS • GRAIN SORGHUM: -

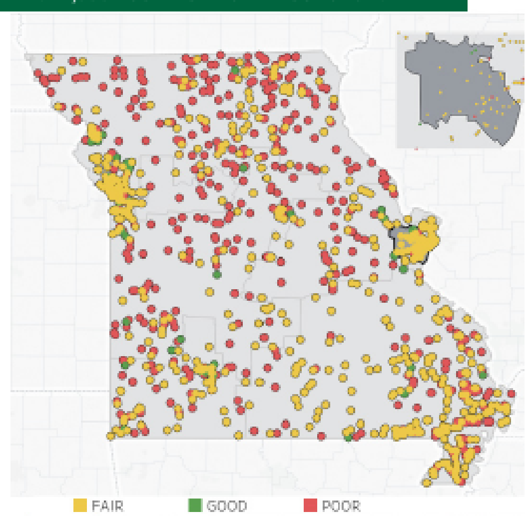
STORAGE *(ON & OFF-FARM)*:
CORN: 31,000 BUSHELS • SOYBEANS: 25,000 BUSHELS • WHEAT: 44,000 BUSHELS • GRAIN SORGHUM: -

EXPORTS:
CORN: 253,000 BUSHELS • SOYBEANS: 72,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: -

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 2, there are 8 bridges in good condition, 46 in fair condition, and 5 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 3

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Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 36,150,000 BUSHELS

SOYBEANS: 20,668,000 BUSHELS

GRAIN SORGHUM: 420,000 BUSHELS

WHEAT: 2,747,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

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LIVESTOCK:
CORN: 15,427,000 BUSHELS • GRAIN SORGHUM: 827,000 BUSHELS

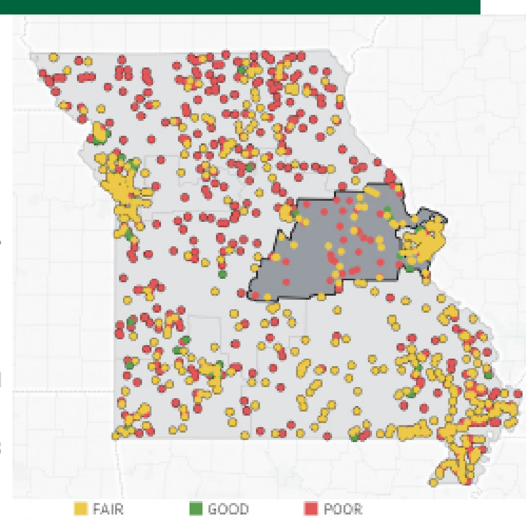
STORAGE *(ON & OFF-FARM)*:
CORN: 3,883,000 BUSHELS • SOYBEANS: 1,398,000 BUSHELS • WHEAT: 1,484,000 BUSHELS
GRAIN SORGHUM: 47,000 BUSHELS

EXPORTS:
CORN: 11,131,000 BUSHELS • SOYBEANS: 3,838,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: -

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 3, there are 6 bridges in good condition, 34 in fair condition, and 33 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 4

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Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 101,148,000 BUSHELS

SOYBEANS: 54,345,000 BUSHELS

GRAIN SORGHUM: 763,000 BUSHELS

WHEAT: 12,421,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

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LIVESTOCK:
CORN: 50,201,000 BUSHELS • GRAIN SORGHUM: 1,646,000 BUSHELS

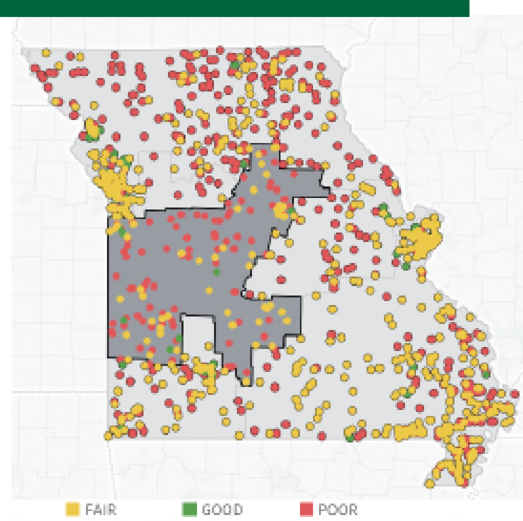
STORAGE *(ON & OFF-FARM)*:
CORN: 10,865,000 BUSHELS • SOYBEANS: 3,675,000 BUSHELS • WHEAT: 6,709,000 BUSHELS
GRAIN SORGHUM: 69,000 BUSHELS

EXPORTS:
CORN: 2,000,000 BUSHELS • SOYBEANS: 6,167,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: 40,620,000 BUSHELS

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 4, there are 8 bridges in good condition, 57 in fair condition, and 85 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 5

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PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 58,565,000 BUSHELS

SOYBEANS: 20,718,000 BUSHELS

GRAIN SORGHUM: 25,000 BUSHELS

WHEAT: 1,216,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

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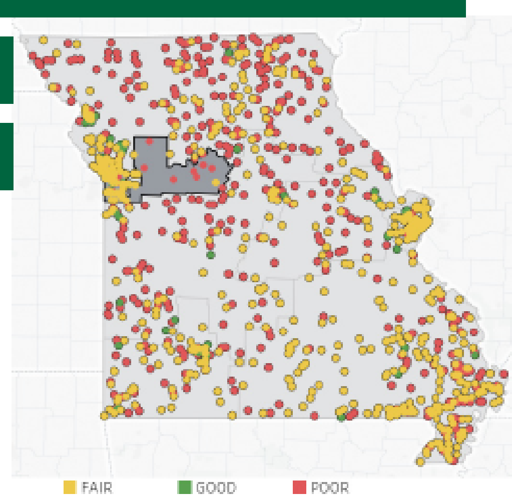
LIVESTOCK:
CORN: 4,186,000 BUSHELS • GRAIN SORGHUM: 85,000 BUSHELS

STORAGE *(ON & OFF-FARM)*:
CORN: 6,291,000 BUSHELS • SOYBEANS: 1,401,000 BUSHELS • WHEAT: 657,000 BUSHELS
GRAIN SORGHUM: 1,000 BUSHELS

EXPORTS:
CORN: 10,000,000 BUSHELS • SOYBEANS: 2,720,000 BUSHELS

FURTHER PROCESSING:
CORN: 14,286,000 BUSHELS • SOYBEANS: 73,767,000 BUSHELS



For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 5, there are 12 bridges in good condition, 69 in fair condition, and 14 in poor condition.

MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 6

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Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 280,460,000 BUSHELS

SOYBEANS: 125,909,000 BUSHELS

GRAIN SORGHUM: 1,038,000 BUSHELS

WHEAT: 5,393,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

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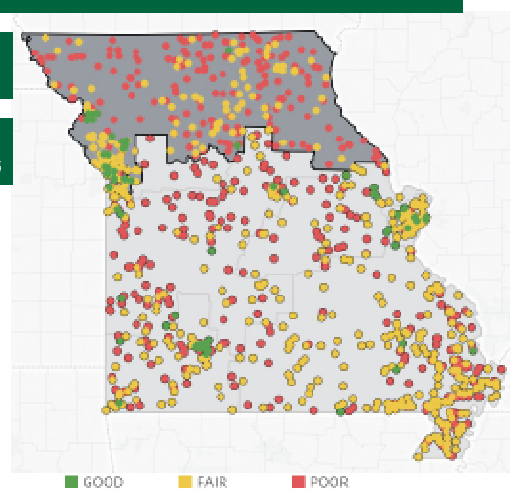
LIVESTOCK:
CORN: 35,721,000 BUSHELS • GRAIN SORGHUM: 678,000 BUSHELS

STORAGE *(ON & OFF-FARM)*:
CORN: 30,127,000 BUSHELS • SOYBEANS: 8,514,000 BUSHELS • WHEAT: 2,913,000 BUSHELS
GRAIN SORGHUM: 133,000 BUSHELS

EXPORTS:
CORN: 92,516,000 BUSHELS • SOYBEANS: 18,827,000 BUSHELS

FURTHER PROCESSING:
CORN: 84,643,000 BUSHELS • SOYBEANS: 76,573,000 BUSHELS



For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 6, there are 26 bridges in good condition, 147 in fair condition, and 177 in poor condition.

MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 7

Missouri Soybeans · MissouriCorn · MASBDA · Decision Innovation Solutions

Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 8,870,000 BUSHELS

SOYBEANS: 4,484,000 BUSHELS

GRAIN SORGHUM: 25,000 BUSHELS

WHEAT: 2,717,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills. Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

LIVESTOCK:
CORN: 47,495,000 BUSHELS • GRAIN SORGHUM: 1,488,000 BUSHELS

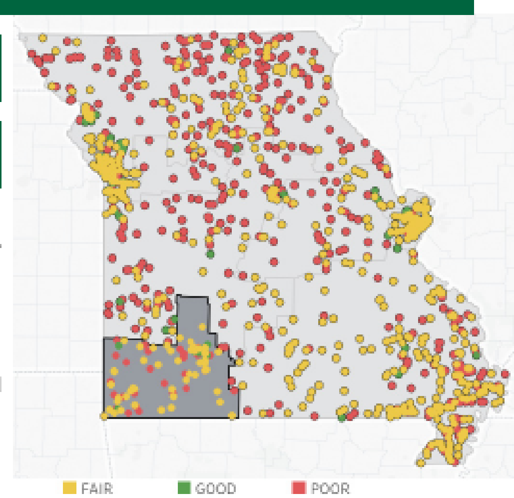
STORAGE *(ON & OFF-FARM)*:
CORN: 953,000 BUSHELS • SOYBEANS: 303,000 BUSHELS • WHEAT: 1,468,000 BUSHELS
GRAIN SORGHUM: 10,000 BUSHELS

EXPORTS:
CORN: - • SOYBEANS: 2,541,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: -

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 7, there are 17 bridges in good condition, 51 in fair condition, and 28 in poor condition.



MISSOURI

COMMODITY FLOW & INFRASTRUCTURE STUDY

CONGRESSIONAL DISTRICT 8

Missouri Soybeans · Missouri Corn · MASBDA · Decision Innovation Solutions

Like many other Midwestern states reliant upon infrastructure to move agricultural commodities to markets, Missouri's transportation system needs to be upgraded and modernized. The interstate highway system is more than fifty years old, many of the locks and dams on key river systems date back over seventy years, and the rail network system was originally built in the late 1800s. Agricultural commodities are often transported multi-modally and in many cases over a long distance. The goal of this study is to identify commodity markets and understand how these commodities (soybeans, corn, grain sorghum and wheat) flow from producers to markets to end users. This was done by analyzing the patterns, methods, and flow of commodities with-in and outside of Missouri.

PRODUCTION OF COMMODITIES BY CONGRESSIONAL DISTRICT

CORN: 67,039,000 BUSHELS

SOYBEANS: 66,016,000 BUSHELS

GRAIN SORGHUM: 191,000 BUSHELS

WHEAT: 12,162,000 BUSHELS

*Note: Production values have been pro-rated where congressional districts do not follow county boundaries.

Commodities flow from farms though various channels to local elevators, directly to processors, to terminal elevators, to export facilities and to distant feed mills. Movement of commodities can be within a county, across counties, across many counties and can move from Missouri to other states and from other states into Missouri.

LIVESTOCK:
CORN: 14,657,000 BUSHELS • GRAIN SORGHUM: 59,000 BUSHELS

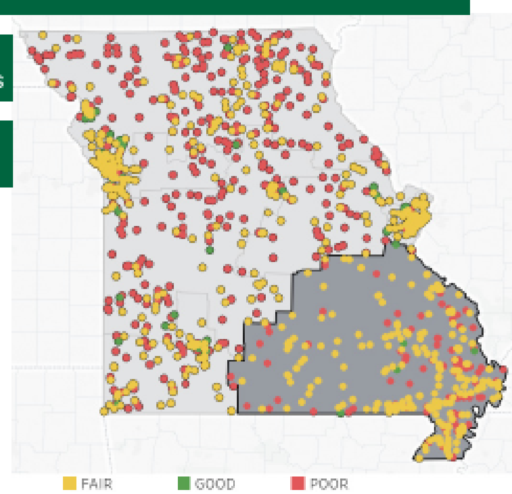
STORAGE *(ON & OFF-FARM)*:
CORN: 7,201,000 BUSHELS • SOYBEANS: 4,464,000 BUSHELS • WHEAT: 6,568,000 BUSHELS
GRAIN SORGHUM: 25,000 BUSHELS

EXPORTS:
CORN: 25,537,000 BUSHELS • SOYBEANS: 44,210,000 BUSHELS

FURTHER PROCESSING:
CORN: - • SOYBEANS: -

For an industry to first achieve and then maintain competitiveness relative to other competing locations, transportation infrastructure must be continually addressed. As infrastructure deteriorates, moving products to market becomes less efficient, both in terms of time and cost.

In Missouri, truck transportation accounted for 43% of total ton-miles for outbound agricultural commodity shipments in 2016, 52% for inbound shipments of agricultural commodities, and 89% of agricultural commodity shipments within the State, making quality roads and bridges a crucial piece in the supply chain. According to the Missouri Department of Transportation, in Congressional District 8, there are 4 bridges in good condition, 209 in fair condition, and 95 in poor condition.



Research Implications/Suggestions for Further Research

Transportation Infrastructure Issues

An emerging issue for many farmers and local businesses is the deteriorating condition of transportation infrastructure (particularly bridges) in rural areas. Figure 114 shows all the bridges in Missouri that have weight restrictions of 40 tons or less and are also in poor condition.

The majority of these bridges are located in rural areas. Many do not affect primary commerce and may not even impede automobile movement in rural areas, but they can be significant impediments for farmer access to fields and for moving commodities by semi-trucks from fields to farm bins and/or to markets. While the impacts of such impediments are relatively small and may only affect a small locale or a few producers, when all of these impediments are aggregated, it adds up to significant impediments for a significant number of producers and detracts from productivity in rural Missouri.

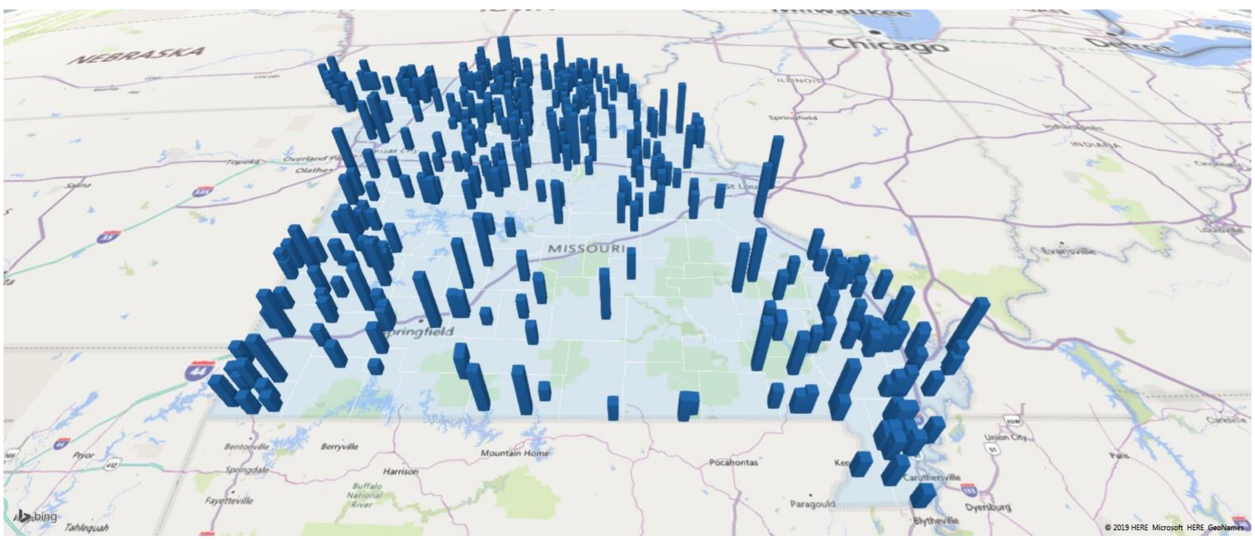


Figure 114 Missouri Bridges in Poor Condition with 40 ton or less weight restrictions

As one might notice in the graphic, there are many varying heights to the bars. Since the tallest bars represent bridges that have 40 ton weight limits, any bar less than the tallest ones represents a bridge that cannot handle a loaded semi-truck load of grain, nor can it handle the weight of much of modern ag equipment. These bridges can result in very inefficient movement of grain at the farm level if smaller truck loads or smaller wagons need to be used to move grain at harvest.

In addition, these bridges can be quite restrictive with regards to moving feed to modern livestock facilities. In past decades, much livestock feed was handled by single axle feed trucks that weighed no more than 13 tons. That is not the case today. Many feed delivery trucks have dual axles and weigh up to 24 tons or are configured as semi-trucks and are 40 tons loaded. Having to work around weight limiting bridges on these secondary roads creates significant inefficiency for grain, feed and livestock movements. In addition, the presence of such weight-limited bridges can result in location of new livestock facilities in locations that avoid these supplemental routes.

A second issue, not directly related to the condition of the bridges on these secondary roads, but involving the roads themselves is the condition of the secondary road surface and the potential for such roads to be weight listed on a seasonal basis. Such weight-limited listing can affect the ability of farmers to move grain from farm storage to local elevators, processors, terminal elevators and export markets when weight restrictions are in force. In addition, season weight restrictions on these roads can severely affect the timely and cost-effective delivery of feed to livestock facilities and affect the timely movement of livestock to and from the production facilities. Removal of these obstacles would make operation of the transportation system much more efficient for farmers and livestock producers.

Ongoing Analysis

In the course of producing this analysis there were many challenges in data availability that were in most cases resolved. Other data sources can be identified or enhanced. In addition, tools and models were developed that will facilitate timely updates in production, movement, processing and utilization of the commodities included in the analysis. Therefore, it would be prudent to consider establishing an update frequency that recognizes the dynamic nature of the industry.