

## Determining U.S. Milk Quality Using Bulk-Tank Somatic Cell Counts, 2019

### Summary

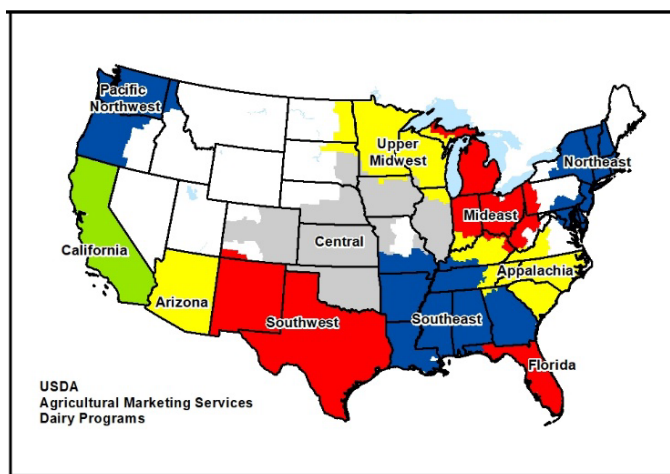
Bulk-tank somatic cell counts (BTSCCs) from monitored Federal Milk Marketing Orders (FMMOs\*) are indicative of the quality of the Nation's milk supply. Milk-weighted BTSCCs account for the amount of milk shipped by a producer, resulting in an overall BTSCC mean of monitored milk. In 2019, the milk-weighted geometric BTSCC mean in the United States was 171,000 cells/mL, essentially unchanged from 172,000 in 2018. The producer BTSCC—which is a geometric, nonmilk-weighted mean of all shipments—was 204,000 cells/mL in 2019, a slight decrease from the 206,000 cells/mL calculated in 2018. Overall, BTSCCs have decreased since 2002.

The BTSCCs for each of the four FMMOs in 2019 were within 5,000 cells/mL of their respective 2018 values. Seven of the 12 States shipping 60 percent or more of their milk through the 4 monitored FMMOs had lower BTSCCs in 2019 than in 2018. Producers that shipped 500,000 lb of milk or more per month had lower BTSCCs than producers that shipped fewer than 500,000 lb per month. BTSCCs peaked in August, while the percentages of fat and protein in milk were lowest in July. Improvements in U.S. dairy management practices are responsible for the decrease in BTSCCs and the corresponding improvement in milk quality since 2002.

### Background

The United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service's Center for Epidemiology and Animal Health, in conjunction with the USDA's Agricultural Marketing Service and the National Mastitis Council's Milk Quality Monitoring Committee, monitor U.S. milk quality using BTSCC data provided by 4 of the Nation's 11 FMMOs: Central, Mideast, Southwest, and Upper Midwest (figure 1). The remaining seven FMMOs do not collect BTSCC data.

**Figure 1. Federal Milk Marketing Orders**



By definition, BTSCCs are the number of white blood cells (primarily macrophages and leukocytes), secretory cells, and squamous cells per milliliter of raw milk.<sup>1</sup> BTSCCs are used as measures of milk quality and as indicators of overall udder health. There is an inverse relationship between BTSCCs and cheese yield and the quality/shelf life of pasteurized fluid milk.<sup>2,3,4</sup> Multiple studies have shown that operations with increased BTSCCs are more likely to have milk that violates antibiotic residue standards.<sup>5,6,7</sup> Milk with antibiotic residues never enters the food supply. The most frequently cited reason for antibiotic residues in milk is inadvertently placing cows treated with antibiotics in the milking string before completing the recommended withdrawal period.<sup>6</sup>

To ensure high-quality dairy products, milk cooperatives and proprietary handlers monitor BTSCCs in milk shipments using standards outlined in the U.S. Pasteurized Milk Ordinance (PMO).<sup>8</sup> In the United States, 750,000 cells/mL is the legal maximum BTSCC for Grade A milk shipments.

\*FMMOs are administrative units consisting of groups of States and were established under the authority of the Agricultural Marketing Agreement Act of 1937, as amended. Their purpose is to stabilize markets by placing requirements on the handling of milk; data are collected to provide accurate information on milk supplies, utilization and sales. Monitored FMMOs are Central, Mideast, Southwest, and Upper Midwest.

If a producer has two out of four shipments that test above the maximum BTSCC (usually tested 30 to 45 days apart), a written notice is issued and an additional sample is tested within 21 days. If three of the last five counts exceed the maximum BTSCC, regulatory action is required, which includes

- 1) Suspending the producer's permit; or
- 2) Foregoing permit suspension, provided that the milk in violation is not sold as Grade A; or
- 3) Imposing a monetary penalty in lieu of permit suspension, provided that the milk in violation is not sold or offered for sale as Grade A.

The maximum BTSCC level is 400,000 cells/mL in the European Union (EU),<sup>9</sup> Australia,<sup>10</sup> New Zealand,<sup>10</sup> and Canada.<sup>11</sup> The maximum BTSCC level in Brazil is 1,000,000 cells/mL.<sup>12</sup>

Although there has been support in recent years for lowering the U.S. Grade A milk maximum BTSCC to 400,000 cells/mL per shipment, no changes to the PMO have been made. In January 2012, the EU implemented regulations that require milk products, including whey, exported to the EU have a maximum BTSCC of 400,000 cells/mL.<sup>13 14 15</sup>

Four States, however, have reduced the maximum BTSCC limit per shipment for producers in their States: California (600,000 cells/mL), Idaho (400,000 cells/mL), Oregon (500,000 cells/mL), and Washington (400,000 cells/mL).<sup>16</sup>

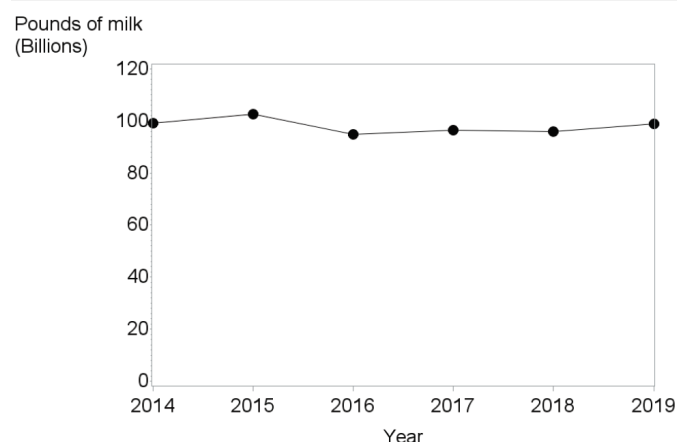
Producers in the United States that have four consecutive rolling 3-month BTSCC geometric means greater than 400,000 cells/mL cannot export milk to the EU, unless a derogation<sup>◊</sup> is requested and approved. If the derogation is not approved, processors must suspend milk pick-ups from that farm, segregate any products made from that milk from products that comply with EU requirements, or make sure that products made from noncompliant milk are not certified.<sup>14</sup>

The EU also regulates bacterial standard plate counts in which a 2-month geometric mean is used based on a minimum of two standard plate counts performed per month. The bacterial limit for the EU is 100,000 bacteria/mL, which is also the limit for Grade A milk in the United States; however, the United States and the EU calculate compliance differently.<sup>8 14</sup>

## Monitored FMMOs

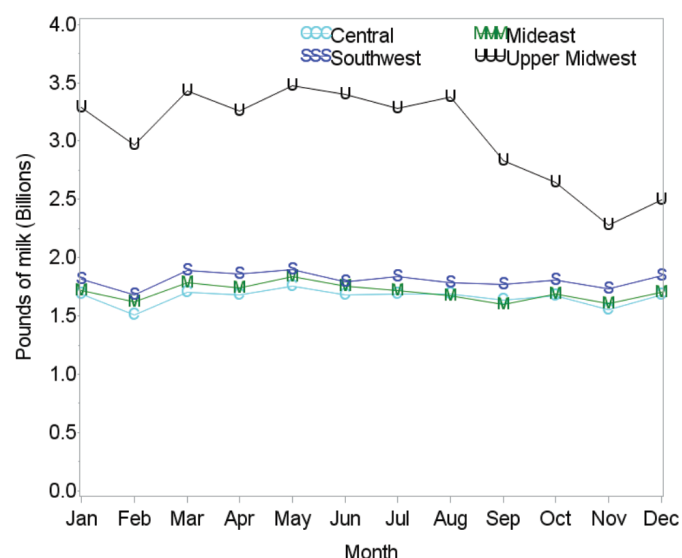
In 2019, monitored milk from the Central, Mideast, Southwest, and Upper Midwest FMMOs originated from 18,792 producers representing 55.0 percent of the Nation's 34,187 licensed dairies.<sup>17</sup> This monitored milk accounted for 98.8 billion pounds (45.2 percent) of the 218.4 billion pounds of milk produced in the United States in 2019.<sup>17</sup> The pounds of milk monitored by the four FMMOs has remained fairly constant since 2016 (figure 2).

**Figure 2. Total pounds of milk shipped through the four monitored FMMOs, by year**



Of the four monitored FMMOs, the Upper Midwest FMMO shipped the most milk in 2019 (from 2.5 to 3.5 billion pounds per month) (figure 3). The Mideast, Southwest, and Central FMMOs shipped from 1.5 to 2.0 billion pounds per month. The Upper Midwest FMMO had the largest fluctuation in pounds of milk shipped per month, with a large decrease observed in September through December. The other three FMMOs were more consistent in the pounds of milk shipped per month during 2019.

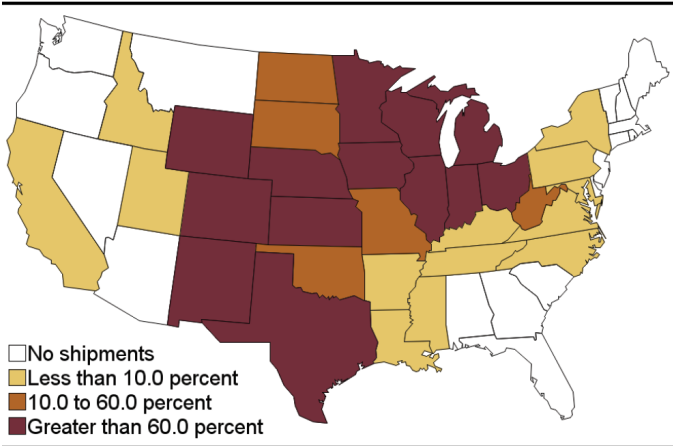
**Figure 3. Total pounds of milk shipped through the four monitored FMMOs in 2019, by FMMO and by month**



<sup>◊</sup>A derogation is a provision in an EU legislative measure that allows for all or part of the legal measure to be applied differently, or not at all, to individuals, groups, or organizations.

Producers in 31 States marketed at least 1 milk shipment through 1 of the 4 monitored FMMOs during 2019 (figure 4). States that shipped more than 60.0 percent of the total State milk production were located in each of the four monitored FMMOs. The remaining milk from these States was shipped through a nonmonitored FMMO. Milk production data for East Coast, Southeastern, and West Coast States (including California, which produces the most total pounds of milk of any State),<sup>17</sup> are not well represented in this information sheet.

**Figure 4. Percentage of total State milk production shipped through the four monitored FMMOs during 2019, by State**



Of the 18,792 producers that shipped milk through one of the four FMMOs in 2019, 56.3 percent marketed milk through the Upper Midwest FMMO (table 1), while only 2.8 percent did so through the Southwest FMMO. In total, 180,087 milk shipments were monitored, with 95,779 (53.2 percent) coming from the Upper Midwest. The Upper Midwest FMMO accounted for 37.2 percent of milk monitored by the four FMMOs and 16.8 percent of all milk produced in the United States. The Upper Midwest and Mideast FMMOs had a higher percentage of shipments relative to the amount of monitored milk. Conversely, in the Central and Southwest FMMOs, 15.8 and 3.3 percent of shipments accounted for 20.2 and 22.0 percent of the monitored milk, respectively, indicating that relatively large herds supply milk through these two FMMOs. The Upper Midwest FMMO reported the lowest milk-weighted geometric BTSCC mean in 2019 (158,000 cells/mL), while the Southwest FMMO had the highest at 193,000 cells/mL.

**Table 1. Number and percentage of producers, shipments, milk marketed, and BTSCCs for the four monitored FMMOs during 2019**

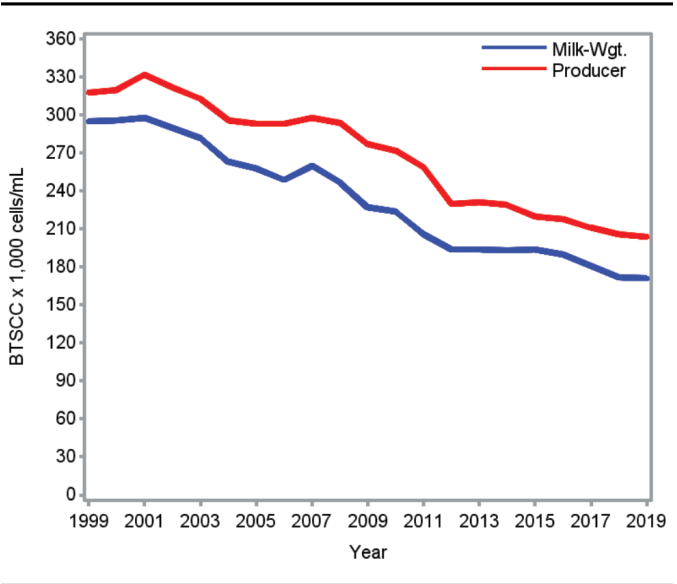
FMMO					
	Central	Mideast	South-west	Upper Midwest	Total
Producers					
Number	2,773	4,913	517	10,589	18,792
Percent	14.8	26.1	2.8	56.3	100.0
Percent of licensed U.S. dairies	8.1	14.4	1.5	31.0	55.0
Shipments					
Number (x1,000)	28.5	50.0	5.9	95.8	180.1
Percent	15.8	27.8	3.3	53.2	100.0
Milk					
Billion pounds	19.9	20.5	21.7	36.7	98.8
Percent monitored	20.2	20.7	22.0	37.2	100.0
Percent of U.S. production	9.1	9.4	9.9	16.8	45.2
BTSCC					
Milk-weighted BTSCC (x1,000 cells/mL)	184	165	193	158	171

\*Certain row totals are shown as 100.0 to aid in interpretation; however, estimates may not always sum to 100.0 due to rounding.

**2019 BTSCC trends**

In 2019, the milk-weighted geometric BTSCC mean in the United States was 171,000 cells/mL, essentially unchanged from 172,000 in 2018. (figure 5). Milk-weighted BTSCCs take into account the amount of milk shipped by a producer, resulting in an overall BTSCC mean of monitored milk. The producer BTSCC—which is a geometric, nonmilk-weighted mean of all shipments—was 204,000 cells/mL, a slight decrease from the 206,000 cells/mL calculated in 2018.

Figure 5. Milk-weighted and producer BTSCCs for the four monitored FMMOs, by year



Evaluating BTSCC levels

In 2019, more than 99.5 percent of monitored milk and shipments met the current PMO limit of 750,000 cells/mL (table 2). During all months monitored, 97.7 percent of milk produced was below 400,000 cells/mL, and 74.3 percent of producers shipped milk below this limit for the entire year. Of 18,792 producers, 97.8 percent shipped milk with BTSCCs below 750,000 cells/mL during all months monitored.

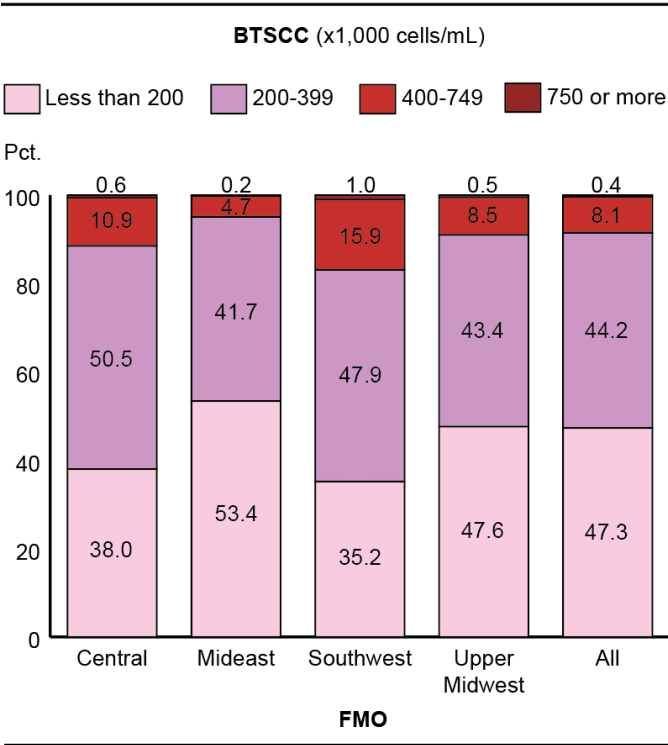
Table 2. Percentage of milk, shipments, and producers for the four monitored FMMOs, by BTSCC level during 2019

Percent			
Milk-weighted BTSCC (x1,000 cells/mL)	Milk (98.8 billion pounds)	Shipments (180,087)	Producers* (18,792)
Less than 100	8.9	8.2	2.2
Less than 200	65.6	47.3	22.9
Less than 400	97.7	91.5	74.3
Less than 650	99.8	99.0	95.6
Less than 750	99.9	99.6	97.8

\*All shipments for the entire year met criteria.

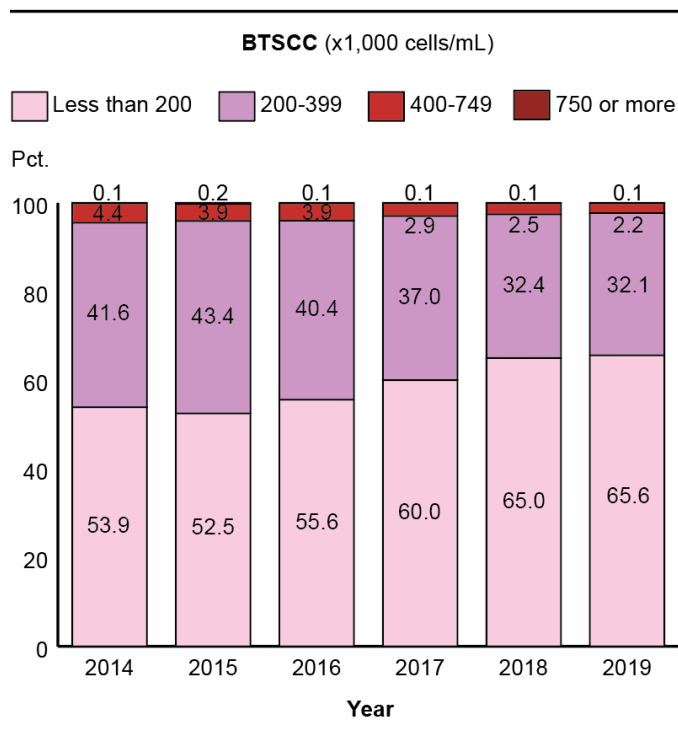
In 2019, about 45 percent of shipments from each monitored FMMO had BTSCCs from 200,000 to 399,000 cells/mL. More than 90 percent of shipments in the Mideast and Upper Midwest FMMOs (95.1 and 91.0 percent, respectively), and more than 80 percent of shipments in the Central and Southwest FMMOs (88.5 and 83.1 percent, respectively) shipped milk with BTSCCs below 400,000 cells/mL (figure 6).

Figure 6. Percentage of shipments by FMMO and by Milk-weighted BTSCC, 2019



From 2014 through 2019, the percentage of total milk shipped with BTSCCs less than 200,000 cells/mL increased from 53.9 to 65.6 percent of milk shipped (figure 7). The percentage of total milk with counts less than 400,000 cells/mL increased from 95.5 to 97.7 percent during the same period.

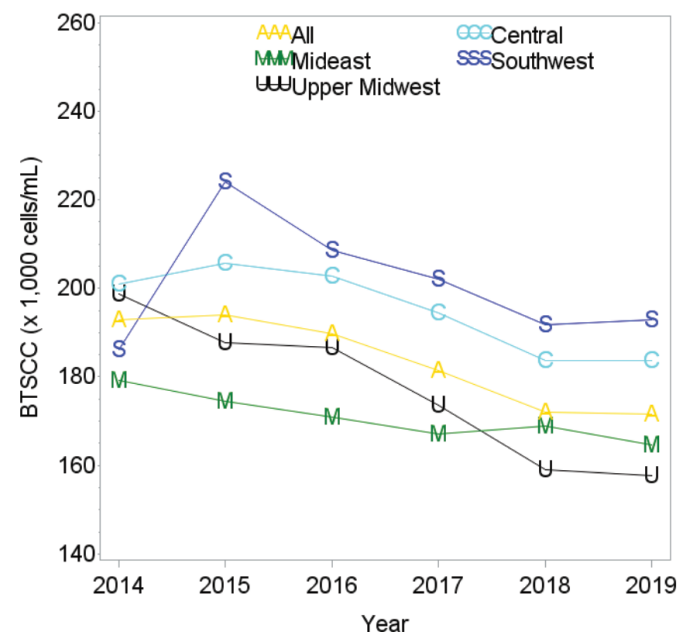
**Figure 7. Percentage of total milk shipped through the four monitored FMMOs, by milk-weighted BTSCC and by year**



## FMMO and State BTSCC trends

Since 2015, milk-weighted BTSCCs have decreased for all four FMMOs (figure 8). In 2019, the BTSCCs for all FMMOs were relatively unchanged from 2018, with the Upper Midwest having the lowest counts at 158,000 cells/mL.

**Figure 8. Milk-weighted BTSCCs, by FMMO, by year**



In total, 13 States marketed 60.0 percent or more of the milk produced in their States through the four monitored FMMOs and accounted for 95.5 percent of the monitored milk (table 3). Wisconsin, Texas, Michigan, New Mexico, and Minnesota accounted for 72.3 percent of all FMMO-monitored milk. Compared with 2018, 7 of the 13 States had decreased BTSCCs in 2019, 5 States had an increased count, and Wisconsin was unchanged.

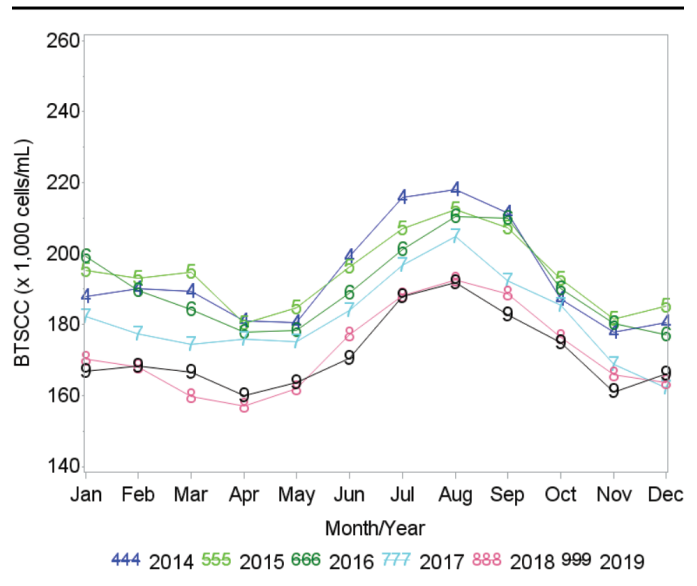
**Table 3. Milk-weighted BTSCCs for States shipping 60 percent or more of their total milk production through the four monitored FMMOs, by State and by year**

BTSCC (x 1,000 cells/mL) by Year							
State	Percent total monitored milk - 2019	2014	2015	2016	2017	2018	2019
CO	4.8	193	189	185	169	157	162↑
IL	1.5	209	205	209	200	193	185↓
IN	2.9	201	200	192	179	185	173↓
IA	5.0	214	204	199	197	187	183↓
KS	2.7	199	212	196	195	188	214↑
MI	11.1	160	156	157	157	159	156↓
MN	7.9	207	196	198	194	164	163↓
NE	1.3	171	171	177	161	175	180↑
NM	9.7	170	209	199	193	187	192↑
OH	4.9	195	187	182	177	180	174↓
TX	16.2	196	235	214	206	193	189↓
WI	27.4	196	185	185	169	156	156
WY	0.1	147	128	125	161	170	186↑
13 States	95.5	191	192	188	180	171	169↓

## Seasonal BTSCC trends

Monthly monitoring continues to show that milk-weighted BTSCCs peak during from July through September when higher temperatures and humidity increase stress on cows and conditions are more favorable for bacterial growth (figure 9). In 2019, monthly milk-weighted BTSCCs were highest during August (192,000 cells/mL) and lowest in April (160,000 cells/mL).

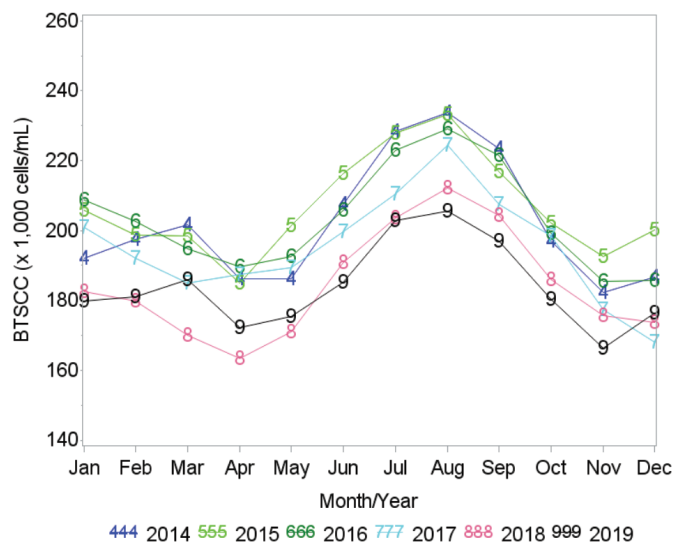
**Figure 9. Milk-weighted BTSCCs for the four monitored FMMOs, by month and by year**



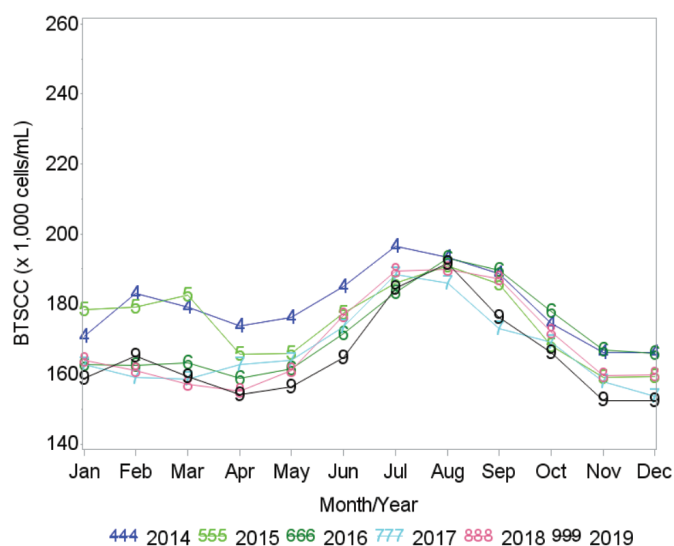


Figures 10 to 13 represent seasonal fluctuations in milk-weighted geometric BTSCC means for each monitored FMMO by month and year. For the Central and Upper Midwest FMMOs in 2019, monthly BTSCCs were generally lower compared with counts in 2014 through 2017. Counts in the Mideast FMMO were the most consistent and lowest in terms of BTSCCs during the last 6 years compared with the other three monitored FMMOs. The Southwest FMMO has been the most volatile in terms of seasonal fluctuations.

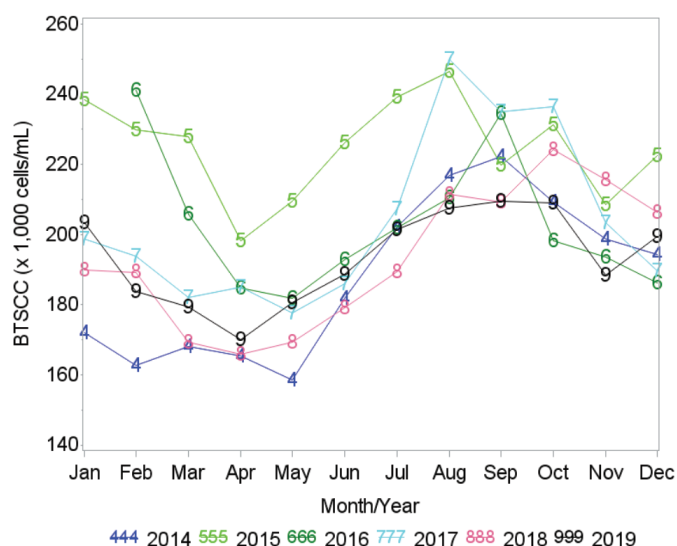
**Figure 10. Central FMMO milk-weighted BTSCCs, by month and by year**



**Figure 11. Mideast FMMO milk-weighted BTSCCs, by month and by year**

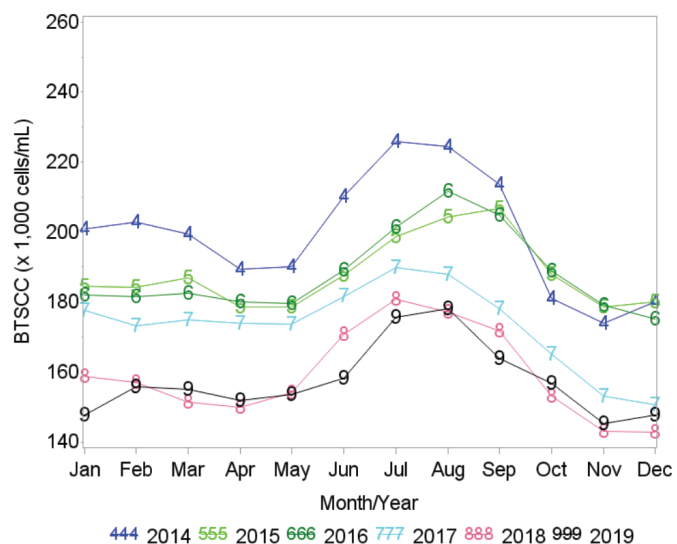


**Figure 12. Southwest FMMO milk-weighted BTSCCs, by month and by year\***



\*In January 2016, BTSCCs in the Southwest FMMO were 315,000 cells/mL.

**Figure 13. Upper Midwest FMMO milk-weighted BTSCCs, by month and by year**



Pounds of milk shipped monthly and BTSCC

The amount of milk shipped per month is a proxy for herd size, which has been of interest in terms of milk quality. For the four monitored FMMOs, producers who shipped less than 500,000 pounds of milk per month had higher average milk-weighted BTSCCs during each month of 2019 (figures 14-17). Producers who shipped 5 million or more pounds of milk per month through the Central and Southwest FMMO had the lowest weighted BTSCCs for all months in 2019, compared with producers shipping less than 5 million pounds within these two FMMOs. Producers who shipped from 500,000 to 4,999,999 pounds of milk per month through the Mideast and Upper Midwest FMMOs had BTSCCs similar to producers who shipped 5 million or more pounds of milk per month.

Figure 14. Central FMMO producer average milk-weighted BTSCCs, by month and by pounds of milk shipped per producer, per month

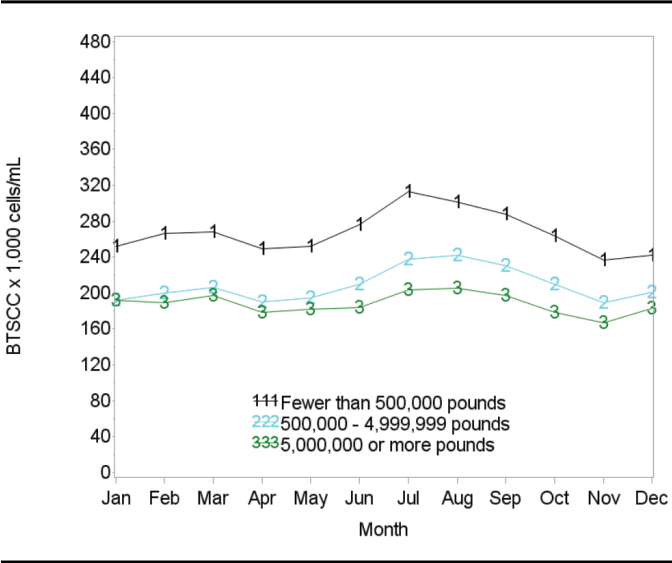


Figure 15. Mideast FMMO producer average milk-weighted BTSCCs, by month and by pounds of milk shipped per producer, per month

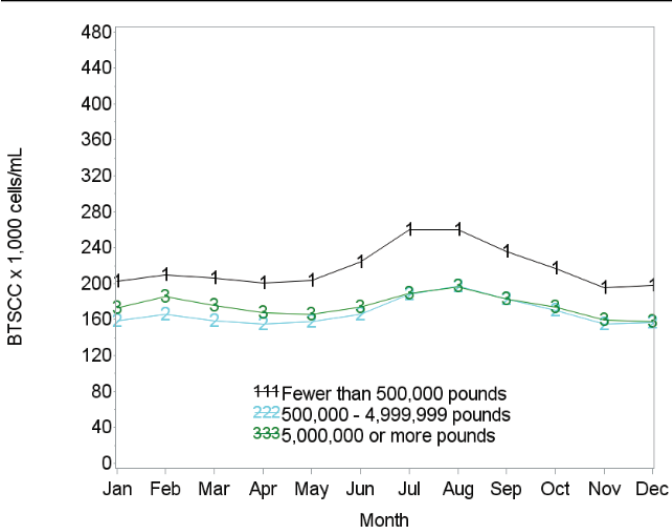
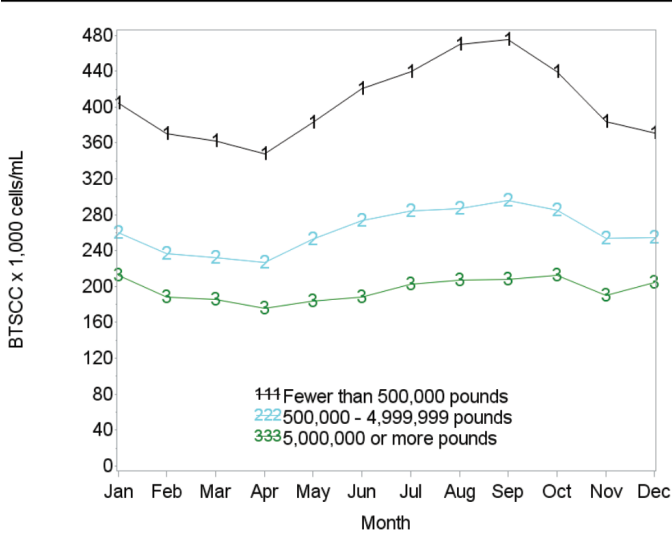
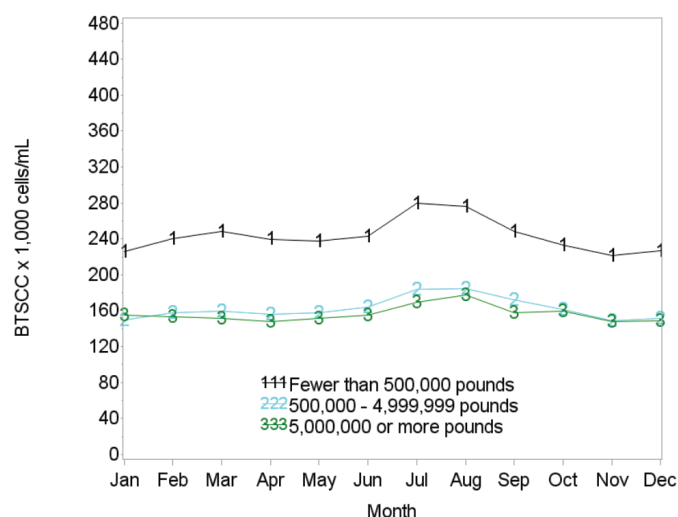


Figure 16. Southwest FMMO producer average milk-weighted BTSCCs, by month and by pounds of milk shipped per producer, per month





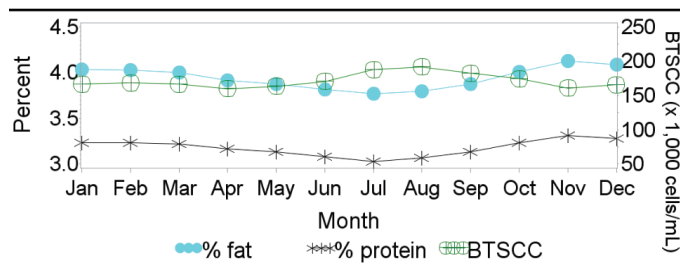
**Figure 17. Upper Midwest FMMO producer average milk-weighted BTSCCs, by month and by pounds of milk shipped per producer, per month**



## Fat and protein

While BTSCCs generally peak during warmer months, the percentages of fat and protein in monitored milk were at their lowest values during this time (figure 18).

**Figure 18. Percentage of fat and percentage of protein in monitored milk, and BTSCCs for the four monitored FMMOs during 2019, by month**



## References

1. Current Concepts in Bovine Mastitis. 5<sup>th</sup> Ed. 2016. National Mastitis Council, New Prague, MN.
2. Barbano DM, Rasmussen RR, Lynch JM. 1991. Influence of milk somatic cell count and milk age on cheese yield. *J Dairy Sci* 74:369–388.
3. Klei L, Yun J, Sapru A, et al. 1998. Effects of milk somatic cell count on cottage cheese yield and quality. *J Dairy Sci* 81:1205–1213.
4. Ma Y, Ryan C, Barbano DM, et al. 2000. Effects of somatic cell count on quality and shelf-life of pasteurized fluid milk. *J Dairy Sci* 83:264–274.
5. Ruegg PL, Tabone TJ. 2000. The relationship between antibiotic residues violations and somatic cell counts in Wisconsin dairy herds. *J Dairy Sci* 83:2805–2809.

6. Ruegg PL. 2005. Relationship between bulk tank milk somatic cell count and antibiotic residues. *Proceedings 44<sup>th</sup> NMC Annual Meeting* p 28–35, Madison, WI.
7. van Schaik G, Lotem M, Schukken YH. 2002. Trends in somatic cell counts, bacterial counts and antibiotic residue violations in New York State during 1999–2000. *J Dairy Sci* 85:782–789.
8. Food and Drug Administration. 2017. Grade A Pasteurized Milk Ordinance, 2017
9. Hillerton JE, Berry EA. 2004. Quality of the milk supply: European regulations versus practice. *Proceedings 43<sup>rd</sup> NMC Annual Meeting* pp 207–214.
10. Smith KL, Hogan JS. 1998. Milk Quality - A Worldwide Perspective. *Proceedings 37<sup>th</sup> National Mastitis Council Annual Meeting* pp 3–9.
11. Dairy Farmers of Ontario – Milk Act Regulation 761: R.R.O. 1990, Milk and Milk Products
12. Rodrigues CO, Cassoli LD, Machado PF. 2005. Milk quality and new regulations in Brazil. *J Dairy Sci* 88:272.
13. Anonymous (2015, April 30). NCIMS keeps national SCC limit at 750,000 with failed vote. *Dairy Herd Management*, online version.
14. USDA Agricultural Marketing Service, European Health Certification Program, online
15. Rowbotham RF, Ruegg PL. 2015. Association of bedding types with management practices and indicators of milk quality on larger Wisconsin dairy farms. *J Dairy Sci* 98:7865–7885.
16. Bechtel, W. (2017, March). Quality Milk, Safe Milk. *Dairy Herd Management*, 54, 28-29.
17. USDA, NASS, Milk Production. February 20, 2020

For more information, contact:

USDA-APHIS-VS-CEAH-NAHMS  
NRRC Building B, M.S. 2E7  
2150 Centre Avenue  
Fort Collins, CO 80526-8117  
970.494.7000  
<http://www.aphis.usda.gov/nahms>

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Mention of companies or commercial products does not imply recommendation or endorsement by the U.S. Department of Agriculture over others not mentioned. USDA neither guarantees nor warrants the standard of any product mentioned. Product names are mentioned solely to report factually on available data and to provide specific information.