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Agricultural Land Conversion in the Twin Cities: Part II, the National Resources Inventory

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Abstract

We divided the thirteen-county Twin Cities Metropolitan Statistical Area into a “core” and a “fringe” of seven and six counties, respectively. The National Resources Inventory estimates that 170 thousand acres of the Core were converted from agriculture to other uses between 1982 and 1987, while only about 46 thousand acres of the Fringe were so converted. The conversion rate was much greater in the Core than on the Fringe according to the NRI—but not according to the Census of Agriculture. The number of acres of agricultural land converted for each new resident ranged from 0.15 in Sherburne County to 2.49 in Pierce County. Viewed another way, the increase in urban land to house new residents ranged from 0.28 in Ramsey County to 1.23 acres per person in Isanti County.

After much delay, brought about by a year-long withdrawal (<http://www.nhq.nrcs.usda.gov/NRI/1997/>) of the initial release of the USDA’s Natural Resources Inventory (NRI), we can finally deliver the update of Twin Cities agricultural land conversion that we promised two years ago (Wegner and Taff). The data is getting pretty old by now, but it remains the best available source for consistent cross-state land cover information (USDA). Two other useful estimates of Twin Cities land use change over comparable time spans are Pijanowski *et al.*, based on computer-interpreted satellite images, and Twin Cities Metropolitan Council, based on air photo interpretation.

The NRI has been conducted every five years since the late 1970s. It examines, among other elements, actual land cover and land use, soil erosion rates, prime farmland extent, wetland extent, and other natural resource characteristics on all non-federal public land (including tribal lands) and on all private lands. To compile the inventory, air photo and other remote sensing data were collected at some 24,000 pre-selected sample data points throughout the state. Because these same areas are assessed in each inventory, analysts can use any observed land-coverage changes to measure conversion rates across inventories (Fuller; Nusser *et al.*).

Especially in suburban settings, the NRI may lack enough sample points to properly estimate every type of cover/use. In these instances, “imputed sampling” is used (Fuller). In addition, some categories like water, rural roads, and Conservation Reserve Program are not directly measured; rather, they are culled from other sources such as the Census or USDA files. All this can lead to substantial estimation error, especially for smaller land cover/use categories in smaller/rural areas.

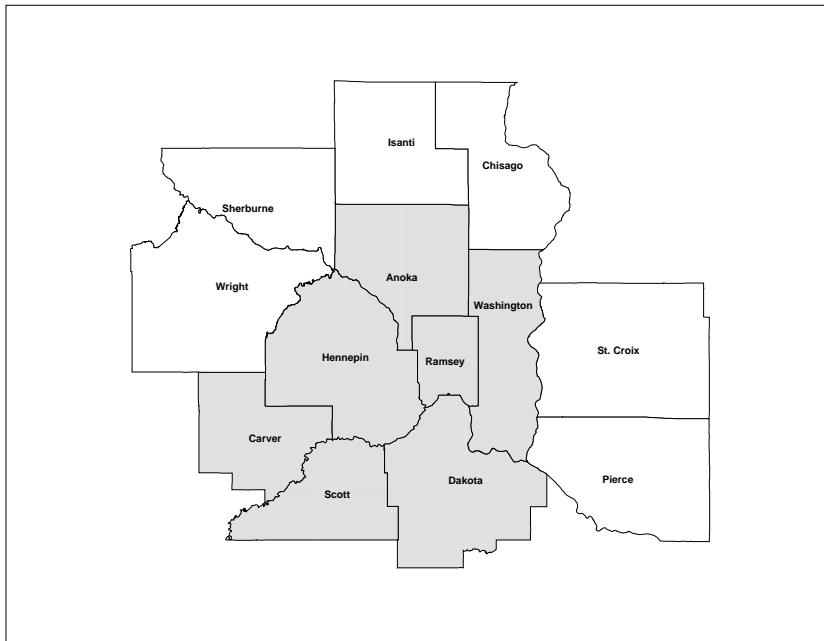
The NRI definitions of cropland and pasture are similar to, but not identical to, those used in the Census of Agriculture (the Census). Cropland “includes areas used for the production of adapted crops for harvest.” Pasture is “managed primarily for the production of introduced or native forage plants for livestock

grazing...regardless of whether or not it is being grazed by livestock.”

For this research note, we combined cultivated cropland, idle cropland, pasture, and Conservation Reserve Program lands into a single *NRI Agricultural Land* category. This corresponds closely with the *Census Agricultural Land* category constructed for an earlier summary of the two data sources (Wegner *et al.*).

To capture some of the dynamics of Twin Cities growth, we divide the thirteen-county Metropolitan Statistical Area into a “core” and a “fringe,” as shown in Figure 1. The NRI estimates that 170 thousand acres of the Core were converted from agriculture since 1982, while only about 46 thousand acres of the Fringe were so converted (Figures 3 and 4). Half the land in the thirteen-county TCMSA was still devoted to agriculture in 1997 (Figure 2). The rate of agricultural land conversion was much greater in the Core than on the Fringe, according to the NRI—but not according to the Census (Figure 5). Some of the difference between the two data sources can be accounted for (but not exactly explained by) different estimates for agricultural land in St. Croix County (Wisconsin). The Census shows a much greater reduction in this category than does the NRI. But the reverse is the case for Dakota County: the NRI shows a much greater reduction than does the Census. Most other counties are consistent across the two data sources. We’re currently looking into these anomalies.

Figure 1: Twin Cities Metropolitan Statistical Area
(“Core” counties in darker shade; “fringe” counties in lighter shade)



**Figure 2: 1997 NRI Land Cover/Use, Twin Cities Metropolitan Statistical Area
(4.07 million acres total)**

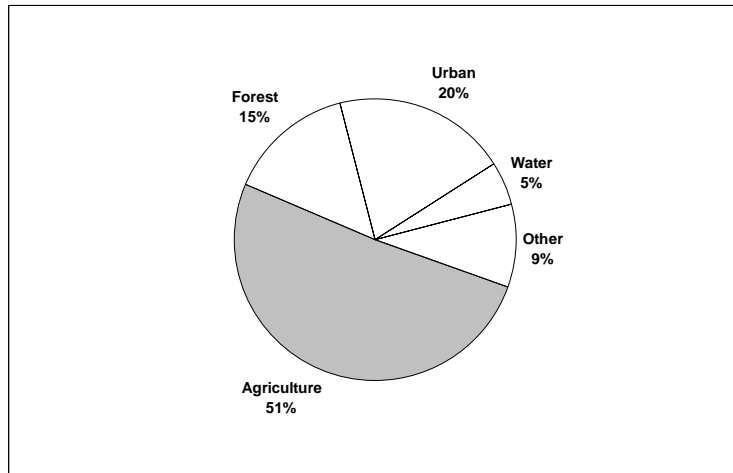


Figure 3: NRI Agricultural Land (thousand acres)

	1982	1987	1992	1997
Anoka	76.9	70.8	68.9	56.7
Carver	188.3	181.0	175.7	167.1
Dakota	257.7	247.6	231.8	210.3
Hennepin	103.0	92.4	81.2	73.0
Ramsey	8.1	5.8	4.7	1.7
Scott	152.8	149.2	143.8	136.8
Washington	151.8	139.1	135.7	123.0
TCMSA Core	938.6	885.9	841.8	768.6
Chisago	150.7	151.0	150.6	143.2
Isanti	153.8	157.3	157.6	151.6
Pierce	261.2	259.4	256.7	253.6
St. Croix	376.4	375.4	372.0	367.7
Sherburne	115.8	114.9	115.5	111.8
Wright	293.9	287.5	287.9	277.7
TCMSA Fringe	1,351.8	1,345.5	1,340.3	1,305.6
Total TCMSA	2,290.4	2,231.4	2,182.1	2,074.2

Figure 4: NRI Agricultural Land in TCMSA Core and Fringe

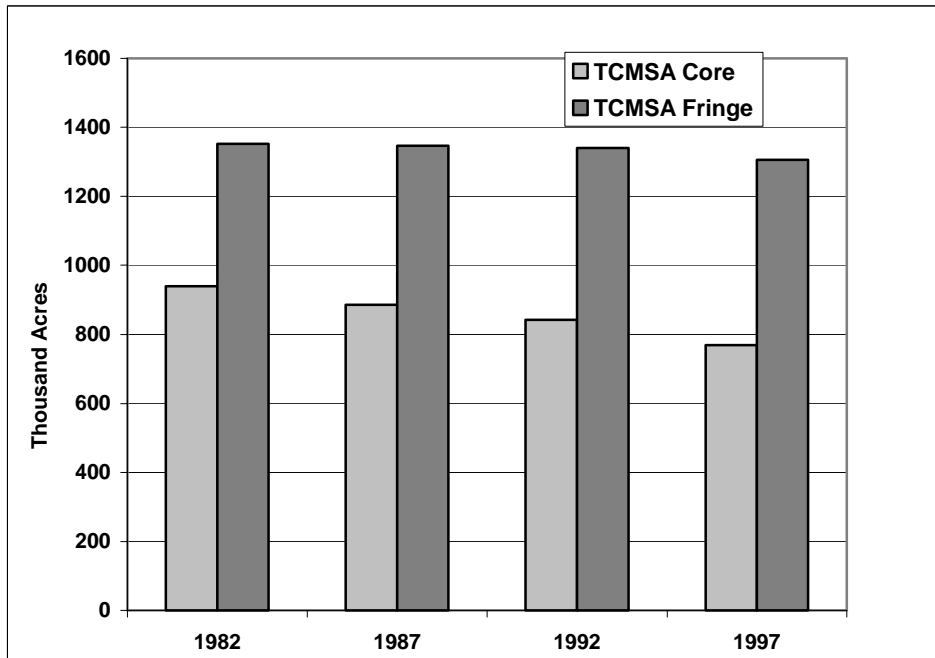
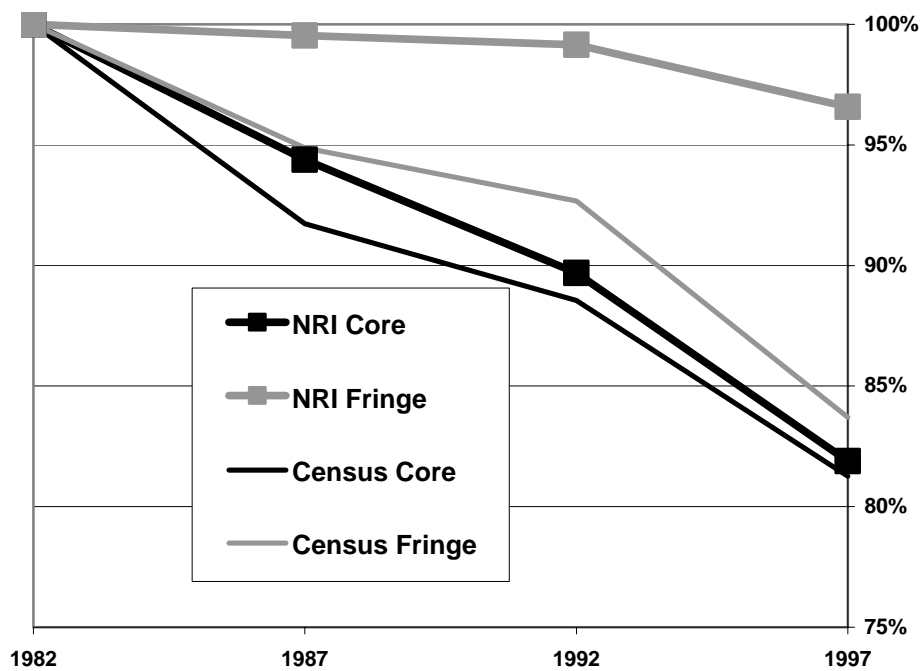


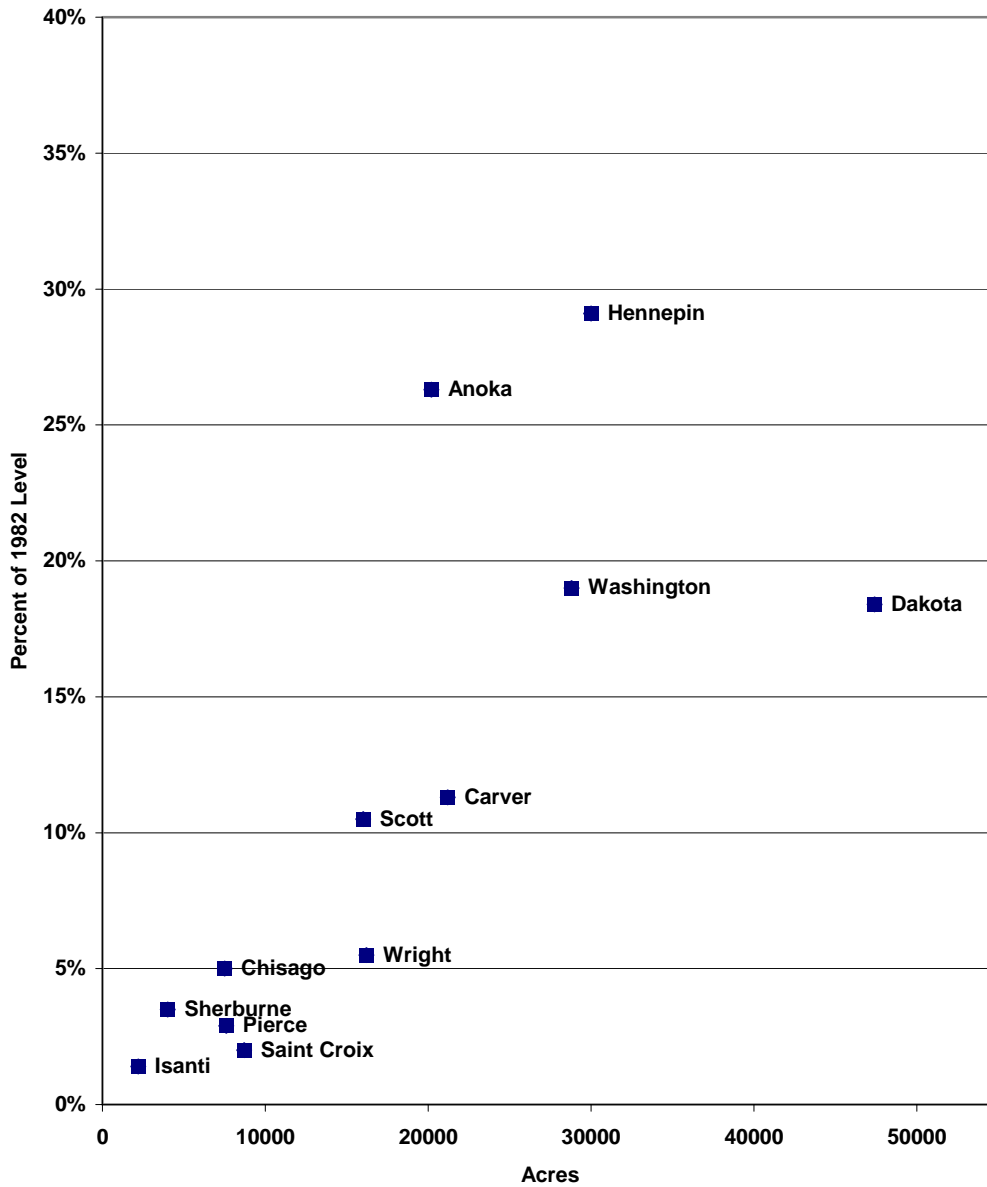
Figure 5: Changes in Agricultural Land compared to 1982 base



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Figure 6 compares the actual and the proportional reduction in NRI Agricultural Land between 1982 and 1987. The relationship is largely linear: higher acreage reductions are associated with higher proportional reductions. Ramsey County is not shown because its acreage reduction combined with its tiny 1982 base leads to a huge (and largely uninformative) proportional reduction.

Figure 6: Decrease in NRI Agricultural Land from 1982, Twin Cities Metropolitan Statistical Area



Because the NRI is a statistical sample and not a complete enumeration, its estimates are made with a known error. We show in Figure 7 the upper and lower bounds of the 95% confidence range for estimates of NRI Agricultural Land for the TCMSA Core. The bounds were constructed by multiplying 1.96 times the standard error of the estimate reported by the USDA for each period. The aggregate standard error of the estimate was calculated by taking the square root of the sum of the squares of each of the county-level standard errors of the estimate. Construction of this confidence interval permits us to make probabilistic claims of this sort: If the USDA had conducted the NRI sampling many, many times, then of all the resulting 95% confidence intervals, only 5% would fail to contain the “true” acreage. Less precisely, we’re “pretty sure” that the true acreage lies somewhere within the calculated interval.

Figure 7: Confidence range (95%) for NRI Agricultural Land estimates (thousand acres): Seven-county TCMSA Core

	Lower bound	Reported estimate	Upper bound
1982	854.5	938.6	1022.7
1987	806.0	885.9	965.8
1992	762.1	841.8	921.5
1997	693.2	768.6	844.0

Error ranges should not be pushed too far. The fact that the upper bound of the 1997 estimate range lies only slightly below the lower bound of the 1982 estimate could lead us to conclude that we’re not really sure that *any* farmland conversion occurred over the period. This would be a silly conclusion, not borne out by even the most casual observation of Twin Cities’ growth.

The NRI permits us to estimate where all the farmland went by tracking individual observation points over the 15 year period. Figures 8 and 9 show the number of acres that were formerly in one use and are now in another (or unchanged). A cell is interpreted as the number of acres that were in the left category in 1982 but changed to the top category in 1997. So, for example, over the entire TCMSA 199 thousand acres that were in agriculture in 1982 had changed to urban use in 1997. Note that not all agriculture conversions were for urban use. For example, 25 thousand acres of 1982 agriculture land were forested by 1997. Nor were agriculture conversions unidirectional: 36 thousand acres that were in forest, urban, water, or other categories in 1982 were converted to agriculture by 1997. Figure 10 illustrates the largely one-way conversion of land to urban uses, although not every “lost” agriculture acre ends up in urban uses.

There is a wide range of land conversion “efficiency” exhibited in the NRI data, although not as wide as in the Census data. The number of acres of agricultural land converted for each new person over the 1982-97 period ranged from 0.15 in Sherburne County to 2.49 in Pierce County (Figure 11). Viewed another way, the increase in *urban* land ranged from 0.28 in Ramsey County to 1.23 acres per person in Isanti County (Figure 12).

Figure 8: Land cover conversion (thousand acres), 1982-1997, Twin Cities Metropolitan Statistical Area

	<i>Agriculture</i>	<i>Forest</i>	<i>Urban</i>	<i>Water</i>	<i>Other</i>	1982 Total
<i>Agriculture</i>	2,037	25	199	4	25	2,290
<i>Forest</i>	12	554	76	3	3	649
<i>Urban</i>	3	3	524			530
<i>Water</i>	5	1		205		211
<i>Other</i>	16	8	17		352	393
1997 Total	2,074	591	816	212	380	4,073

Agriculture combines the NRI categories “cultivated cropland”, “non-cultivated cropland”, “pastureland”, and “Conservation Reserve Program”. *Urban* combines “urban-small and large built-up” plus “rural transportation-roads and railroads.” *Other* includes “minor land cover/uses” and “federal land-cover/use not recorded.” Column and row totals subject to rounding.

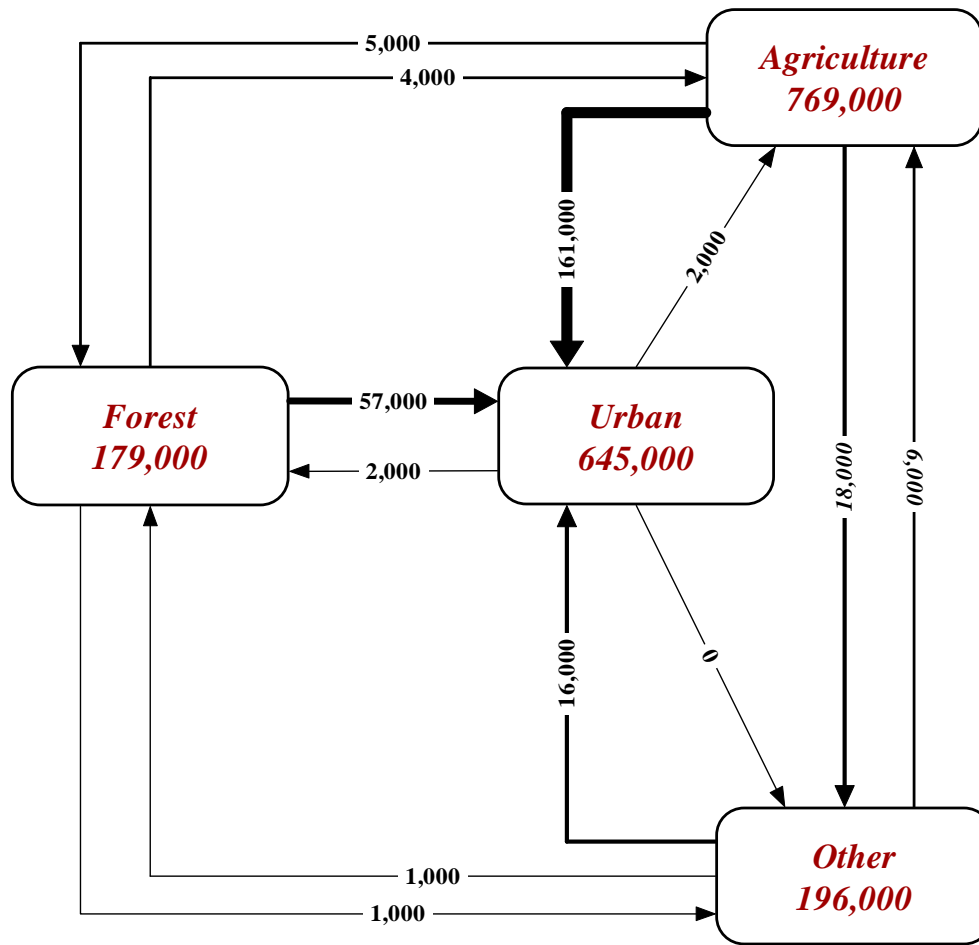
Figure 9: Land cover conversion (thousand acres), 1982-1997, Seven-County TCMSA Core

	<i>Agriculture</i>	<i>Forest</i>	<i>Urban</i>	<i>Water</i>	<i>Other</i>	1982 Total
<i>Agriculture</i>	754	5	161	1	18	939
<i>Forest</i>	4	170	57	2	1	235
<i>Urban</i>	2	2	412	0	0	416
<i>Water</i>	3	1	0	114	0	117
<i>Other</i>	6	1	16	0	177	199
1997 Total	769	179	645	117	196	1,906

Agriculture combines the NRI categories “cultivated cropland”, “non-cultivated cropland”, “pastureland”, and “Conservation Reserve Program”. *Urban* combines “urban-small and large built-up” plus “rural transportation-roads and railroads.” *Other* includes “minor land cover/uses” and “federal land-cover/use not recorded.” Column and row totals subject to rounding.

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Figure 10: Land Conversion, Seven-County TCMSA Core, 1982-97
 (1997 acreages in boxes)



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Figure 11: Reduction in agricultural land for each new resident, Twin Cities Metropolitan Statistical Area Counties, 1982-1997

	Population increase	Reduction in NRI Agricultural Land acres per person	Reduction in Census Agricultural Land acres per person
Anoka	89,273	0.23	0.21
Carver	24,331	0.87	0.85
Dakota	138,378	0.34	0.09
Hennepin	116,496	0.26	0.32
Ramsey	37,639	0.17	0.00
Scott	31,225	0.51	0.66
Washington	73,904	0.39	0.46
TCMSA Core	511,246	0.33	0.28
Chisago	13,220	0.57	2.96
Isanti	6,003	0.37	0.97
St. Croix	12,567	0.69	3.44
Sherburne	26,774	0.15	0.87
Pierce	3,050	2.49	11.34
Wright	23,812	0.68	1.95
TCMSA Fringe	85,426	0.54	2.25
Total TCMSA	596,672	0.36	0.56

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Figure 12: Increase in NRI Urban Land for each new resident, Twin Cities Metropolitan Statistical Area Counties, 1982-1997

	Increase in NRI Urban Land acres	Population increase	Increase in NRI Urban Land acres per person
Anoka	44,200	89,273	0.50
Carver	16,500	24,331	0.68
Dakota	55,700	138,378	0.40
Hennepin	47,600	116,496	0.41
Ramsey	10,600	37,639	0.28
Scott	16,900	31,225	0.54
Washington	38,000	73,904	0.51
TCMSA Core	229,500	511,246	0.45
Chisago	9,500	13,220	0.72
Isanti	7,400	6,003	1.23
Pierce	3,600	3,050	1.18
St. Croix	7,600	12,567	0.61
Sherburne	13,000	26,774	0.49
Wright	15,300	23,812	0.64
TCMSA Fringe	56,400	85,426	0.66
Total TCMSA	285,900	596,672	0.48

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