



MAPPING THE RURAL KANSAS DENTAL WORKFORCE SEPTEMBER 2011

IMPLICATIONS FOR
POPULATION ORAL
HEALTH

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EXECUTIVE SUMMARY

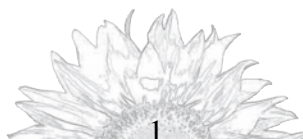
Fewer people living in rural communities, limited access to all types of health care services, an aging dentist workforce and the high costs necessary to run and maintain a viable dental practice combine to produce an oral health care workforce crisis in rural Kansas. This project uses a geographic information systems (GIS) approach to pinpoint locations in Kansas where there are the fewest dental providers serving their communities and oral health care delivery innovation is needed most urgently.

Findings from this research confirm a 2009 KDHE Bureau of Oral Health workforce study that described a shortage of primary care dentists and Extended Care Permit dental hygienists (ECPs) in certain rural areas of Kansas. Setting aside county boundaries typically used to describe federally designated health professional shortage areas (HPSA); this research expands on the concept of workforce shortage areas to look at where people live, how they travel and where providers practice. Taking these factors into account, this research identifies gaps in the dental provider coverage map more precisely than traditional HPSAs designations.

The authors introduce the concept of a “Dental Care Service Desert” to describe the primary GIS result. This methodology is used to define food deserts and other relevant public health shortage areas, but up to this point has not been applied to oral health. The “Dental Care Service Desert” is a new designation that describes geographic areas where there are no dental services and where the closest dental office is at least a half-hour drive from residents’ homes. Findings indicate that at least 57,000 Kansans live in Dental Care Service Deserts, and this number is projected to increase as the current primary care dentist rural workforce retires, and as currently forecast, is not fully replaced.

Key findings from the study include:

1. Access to primary care dentists is not equal for all Kansans.
2. Extended Care Permit dental hygienists have not fully filled in the geographic gaps where primary care dentistry is unavailable.
3. Areas of western Kansas will join the Dental Care Service Desert in the next three years because of retirement of many primary care dentists.
4. The addition of strategically placed dental providers could make a difference in access to oral health care in western Kansas.
5. Dental care workforce innovations or pilot interventions could be tested in Dental Care Service Deserts.





BACKGROUND AND STUDY RATIONALE

Two studies have greatly increased our understanding of the challenges that face rural Kansans who access oral health care services and the professionals who provide that care. This research study, Mapping the Rural Dentist Workforce, utilized both of these studies to create an innovative rural workforce assessment that provides a new concept – the Dental Service Access Desert – with geographic specificity intended to provide the locations where workforce innovations would be ideal in Kansas.

Kansas 2009 Oral Health Workforce Assessment

A comprehensive workforce project was conducted in 2009 for the Bureau of Oral Health by the University of Kansas Center for Community Health Improvement. The project surveyed Kansas’ practicing primary care dentists and community-based dental hygienists (Extended Care Permit dental hygienists or ECPs) about their practices and opinions concerning the oral health care needs of Kansas. The dentist survey sample was drawn to be statistically valid, and was representative of primary care dentists in frontier, small rural, large rural and urban counties. A census sample of ECPs also was included in the study. Along with the dental professional surveys, the 2009 assessment also included regional community focus groups that captured local opinions about dental access. That study was published by the Bureau of Oral Health and is available online at: http://kdheks.gov/ohi/download/2009_Oral_Health_Workforce_Assessment.pdf.

Key findings from that study confirmed many assumptions that Kansans have about rural oral health care. For example, there are fewer dentists serving populations in frontier and rural

communities and the dentists practicing there are older and sponsor few ECPs. In 2009, 54 percent of dentists practicing in frontier counties were planning to retire in next three to five years and among those dentists already seeking to sell their practices, most had no interested buyers. The study raised the issue of how these dentist retirements and the eventual closure of rural and frontier dental offices will contribute to the deterioration of access to office-based oral health care. The study also found that these rural providers accepted Medicaid patients more often than their urban counterparts. Community members in the regional focus groups expressed gratitude for the work of these dedicated providers, but also shared that there is much more demand for oral health care services, especially among the Medicaid, uninsured, and special needs populations, than there are rural providers able (or willing) to serve.

The survey also included a subsample of all dentists working in Kansas safety net clinics (N=38). The findings indicated that Kansas safety net clinic dentists were on average younger, more racially diverse and included more female dentists than the general sample of private practice dentists. These provider characteristics are promising in terms of addressing health disparities, as the evidence for closing gaps in access and care improve as the workforce more closely resembles the population it strives to serve. However, it is important to stress that the majority of Kansas' primary care dentists (1,215 in 2009) work in private practice settings. This is true that nationally as well – 93% of practicing dentists work within a traditional private practice model (American Dental Association, 2009). The novel research presented in this report maps the locations of rural and frontier dental practices in a targeted region of dentally underserved counties in central and western Kansas. These maps include the locations of five active dental safety net clinics (Atwood, Hays, Garden City, Hutchinson and Salina), but the vast majority of the practices mapped are traditional private practice dental offices.

As mentioned above, the 2009 Workforce Assessment project also included a survey of Extended Care Permit (ECP) dental hygienists. In 2003 Kansas created the ECP with the intent of expanding access to preventive oral health services for underserved populations. ECPs are



permitted to practice relatively independently in community settings such as public schools, Head Starts, local health departments, safety net clinics, adult care homes and long-term care facilities. ECP practice is targeted to underserved populations. For example, ECPs are only allowed to treat Medicaid and low income children (not all children) in the school setting. The survey asked ECPs about their practice activities, as well as included a complementary set of questions in the dentist survey regarding dentist utilization and knowledge of the ECP. In 2009, 89 of the over 1500 Kansas registered dental hygienists had Extended Care Permits. In 2011 that number has risen to 124 ECPs. In 2009 ECPs primarily were working in safety net clinics in large(r) rural and urban areas, and 66% said they used their ECP eight or fewer hours a week. Six years after creation, about half (56.4 percent) of practicing dentists were aware of the ECP dental hygiene model.

2010 KUMC and KPEPR Rural Primary Care Patient Survey

The second study that informs the challenge of providing care to rural communities is a survey conducted through the University of Kansas Medical Center, Department of Family Medicine Research Division in collaboration with the Kansas Physicians Engaged in Primary Care Research (KPEPR) network and with funding, in part, by the Sunflower Foundation. (The research is being prepared for publication.) During the summer between the first and second year of medical school, students are provided the opportunity to work side-by-side with primary care physicians across the state. The program is longstanding, and is one strategy used to encourage medical students to commit to the practice of primary care early in their medical training. It also helps cement students' positive view of the lifestyle associated with being a rural or small town physician in the hopes that such exposure influences where they will practice after completing their medical training and residency.

In 19 rural communities during the summer of 2010, medical students collected data during routine primary care office visits from over 350 patients (KUMC IRB #12287). Surveys were



administered in the waiting room and collected at the end of the medical visit. Respondents were asked to share their home address (they represent residents in 100 different towns/cities) and then asked where they traveled for a variety of goods and services including where they receive dental care. For each service, patients also reported how frequently they made these trips, their estimated drive time and estimated distance in miles. Current access patterns were identified and used in this research project as a way to calibrate distances to reach services or purchase goods. The summer medical student survey project provided information that was used to define drive time buffers described later in this report.

Both the patient surveys described above and 2009 regional community focus groups reflected opinions that the rural residents expect travel to access to care and services to be difficult and participants shared that they travel routinely over fairly long distances. What is equally important to point out is that they also expressed a preference that they not have to travel as far and that they know of others in their communities who cannot travel because of transportation difficulties, advanced age, and poor health. Many also stated that some community members are unable to find a provider willing to see them no matter how far the distance.

2011 Oral Health Workforce Assessment Project: Mapping the Rural Dentist Workforce

In 2010 the Bureau of Oral Health received funding to expand research on the oral health workforce. Utilizing the surveys and studies described above as a foundation, the Bureau contracted with University of Kansas Center for Community Health Improvement to provide additional research that would help guide state oral health workforce planning. Based on prior research, people currently not served by the oral health system include three major sub-populations of interest:

- People who cannot easily travel for services (this group includes the elderly and frail population, a group that represents an important sector of many rural communities) and



others with limited mobility or lack of support systems that contribute to their inability to have dependable travel options (e.g., individuals who have to borrow a car or depend on a neighbor or family member to take them) to access services;

- Those without dental insurance and those who cannot afford to pay out-of-pocket for care; and
- Medicaid/HealthWave enrollees who cannot find a dental provider willing to accept patients that have public insurance as their only source of payment.

Regardless of the impression that traveling for care is routine and expected in rural Kansas, most rural residents would agree that receiving oral health care is more challenging in rural and frontier areas, and they would prefer to have access to a primary dental practice located closer to home. This in combination with the workforce data that demonstrates the declining dentist oral health workforce in rural and frontier areas, led the research team to focus their efforts on identifying the parts of western and central Kansas with most severe workforce needs. By providing specific geographical data, the team reasoned that newly developed programs and innovations could be piloted in these targeted areas.

Some possible innovations could include community or hospital-based oral health projects, public and/or charitable financing pilots to expand access, and new workforce models such as the introduction of a mid-level professional. These types of programs could be introduced on a limited basis to test acceptability, effectiveness and impact. It is important to note that the purpose of this study was not to test or advocate for any one workforce or access model. The focus of this research was to clearly demarcate specific locations in Kansas that are experiencing oral health workforce challenges in order to guide oral health program developers and policy makers to allocate resources to locations that would have the greatest impact and the best chance for success.





MATERIALS AND METHODS

Using geographic information systems (GIS) and findings from prior published research, an approach that merged population data and workforce data was taken to inform possible options to meet the oral health care needs of Kansans who currently do not have comparable access. A centerpiece of this methodology is based on the work of the Florida State University (FSU) primary mapping team partner, Mark Horner (Horner and Mascarenhas 2007) and to an extent, earlier research on which he was a consultant (Susi and Mascarenhas 2002). Both of these previously published efforts were built around the idea of using a geocoded spatial database of dental provider locations mapped in GIS to pinpoint where access points for dental care exist. The approach is to assign geographic coordinate information to dentists' office addresses such that their locations appear on a computer-based map. Once the dentist information is captured in this digital form, subsequent analysis is possible in the GIS to develop measures of service areas.

Besides geocoding the primary care dentist provider database, the research team incorporated a series of other spatial and non-spatial databases to further address the access issue in Kansas. These included results from the survey of primary care patients conducted in 2010 by KUMC medical students, US Census population data and road databases for Kansas.

The geographic area of interest was demarcated in a north/south direction to avoid relatively large cities in central Kansas. The geographic area was defined as "western Kansas" and includes all counties west of a line drawn from the western county border of Washington County south to Morton County and then in a slight zigzag fashion to avoid the inclusion of Harvey, Sedgwick and Sumner counties to the southern Kansas/Oklahoma border.



Primary Care Dentist Licensure Data Acquisition, Preparation, and Mapping

The research team received the Kansas State Dental Licensure Database that contained 1,179 records with the assistance from the Kansas Dental Board and the KDHE Bureau of Oral Health. Eight records lacked verifiable address information, and the team was made aware that there may be new dentists who were just awarded their degrees and practicing in the counties of interest, but had not yet appeared in the licensure database. Given these few exceptions, the records were considered largely complete for the geocoding process.

The FSU mapping team found the dentist records in overall good order with a large majority having complete street address information (i.e., street number, street name, city, ZIP code). Preliminary scans revealed some problematic dentist addresses. The file was entered into the Florida State University GIS and geocoded to the street level based on a recent database of continental U.S. streets. The geocoding procedure was run using a “normal” level of strictness for matching criteria. It was also run in “interactive” mode, meaning that the GIS would ask for user input to clarify uncertain addresses before assigning them final coordinate locations. In this way, the analysts were able to fine-tune the exact location of the geocoded dentists. After the first run of geocoding, 1,126 dentist address records were matched (approximately 96 percent of the original total). Fifty-three records were not matched and therefore could not be located immediately in the spatial database.

FSU forwarded the KUMC team the list of 53 unmatched records. In collaboration with the KDHE Bureau of Oral Health, KUMC identified 15 listings that should be deleted (e.g., dentists who had left the state; dentists that primarily serve the state prison population), and FSU removed these from the database. The FSU team continued working with the remaining 38 records. With modest data cleanup and other minor corrections of these records, the FSU team



was able to get 16 of the 38 to geocode with the previously described GIS geocoding procedure. With the remaining 22 records, using additional tools such as publically available maps served by Google and Yahoo and by making phone calls to selected provider locations, the FSU team was able to obtain coordinate locations for 19 of the 22 records and enter them manually into the GIS database. The remaining three unmatched records were forwarded to the KUMC team and Bureau of Oral Health director who determined that they represented possibly licensed but not practicing dentists. Thus, these three records were removed from the database. In total, 1,161 of the original 1,179 dentist address records were geocoded and available for analysis. Put another way, 100 percent of the dentists whose records indicated that they could be geocoded, were geocoded. Finally, two successfully geocoded practice locations fell outside of Kansas, well into Missouri, and were therefore excluded from further analysis.

Using the geocoded dentist office data, the team was able to generate mapping products in GIS (see “Results and Maps” section of report). One key difference in the Kansas study compared to the prior related work is the nature of the geocoded dentist data created. In a previous project involving Ohio dentists, dentists were geocoded to the ZIP code level (Horner and Mascarenhas 2007). This means that their locations were only known to the precision of the ZIP code areas, and that the exact locations of dentists within the ZIP codes were not known. Moreover, because ZIP code areas are known to be hierarchically incompatible with commonly-used census geographies such as tracts and block groups (Grubestic and Matisziw 2006), the Ohio dentist data were limited in terms of how they could be combined with other spatial datasets. By contrast, because the Kansas dentists are geocoded as points based on individual addresses, there is little ambiguity with respect to their exact locations, and more importantly, the Kansas dentist data can be aggregated to any scale desired (e.g. the census tract, block group, ZIP code, etc.). This flexibility provides a huge advantage for analyzing the Kansas data.



Extended Care Permit Dental Hygienist Data Acquisition, Preparation, and Mapping

The relatively recent addition of a new category of oral health care provider, Extended Care Permit dental hygienists (ECPs), was included in the mapping project because they also provide essential oral health care services to Kansas. As required for licensure, ECPs must be experienced dental hygienists who work under the supervision of a dentist to deliver screening, oral prophylaxis, and educational outreach in a variety of non-office based settings. These settings include nursing homes, public health departments and schools, among others. As a provider type, ECP licensure was in part, an attempt to add another option to help mitigate the dental care workforce shortage for Kansans. Although they practice under dentist supervision, these professionals have the ability to take oral health care, referral and education to locations not otherwise served and where patients don't have the ability to travel to a "brick and mortar" dental office. They can be mobile, responsive to community need, and promote oral disease prevention and oral health care in many communities.

The FSU mapping team was provided with a list of 110 ECP dental hygienists with street level address information. Unlike the dentists' addresses that corresponded to their dental office locations, the address information for ECPs reflects the ECPs address of record for their licensure – an address that may reflect their personal mailing address rather than their practice address. For this reason, the maps that result from the ECP data probably do not accurately reflect the locations where these professionals provide services. 2009 survey data included ECPs who said they provided services in five counties that had no primary care dentist (Wallace, Trego, Lane, Haskell and Barber counties), but again, these same respondents reported that they used their ECP for eight hours or fewer on average per week. This underscores that while these locations may understate the areas where ECP services are available, it is not unreasonable to assume that the addresses are at least somewhat near to where they typically work and provide the bulk of their professional care.



Application of the address match procedure as described for dentists resulted in matching 102 of 110 of the ECPs. With additional corrections made to the remaining unmatched records and/or verifying location data, the remaining records also were geocoded to the street level.

Distance to Services Survey Data Acquisition, Preparation and Mapping

Self-reported distance to services data collected from primary care patients was analyzed and univariate statistics were computed. The project goal was to use these data as a way to inform various GIS modeling efforts that would assist in realistically defining service areas or catchment areas. The goal was not to use the self-reported access data to develop micro-local catchment data at the county or practice level. In fact, understanding where specific communities and Kansans travel for access to dental care might better be accomplished by examining ZIP code level data from individual dentist's practices themselves. Rather, the effort was to review whether or not rural Kansans commonly travel comparable distances for services such that generalizations about access could be made broadly. Also of interest was whether their assessment of the time it took to travel those distances were realistic using GIS methods and finally, whether the frequency of travel also was generalizable. For example, respondents to the survey reported visiting their dentist 2.5 times per year, on average, and this statistic varied very little among sites or among respondents (by age or by gender). (The complete survey data set currently is being analyzed and will be available as a separate publication.) The overall purpose for using the survey data in this project was to assist in specifically locating gaps or areas that fall outside of "routine" travel patterns to pinpoint workforce shortage areas.

The Florida State University mapping team received the complete survey data set from the KUMC team, and they used the information along with roadway data and U.S. Census population data to establish the maps presented in the Results and Maps section of this report.





RESULTS AND MAPS

Distribution of Primary Care Dentists

In collaboration with the KUMC team, the Florida State University team developed a series of maps to establish the locations of primary care dentists in the state. Map 1 displays a few important features relevant to the overall objective of this project. First, county borders are retained, and each county is color coded using the USDA rural-urban codes (N=9). The maps display county boundaries for both orientation and to correspond to other reports and research. The map also includes major highways that allow us to link the location of each dentist and calculate the distances among them. The small white box with a number represents the number of primary care dentists (not necessarily all dentists) in the county, according to the licensure data the team used for this and all subsequent analyses. The black dots are the actual geographic locations based on the licensure data used throughout the study. Table 1 displays the information used in part to create Map 1. Table 1 also includes the dentist to population ratios that are lowest in urban counties (1 to 2,084; code 1) and highest in frontier counties (1 to 3,460; code 9). Note that the county density code designation is from 2003 while ratios are calculated using population estimates from 2009. There may be a case where a county changed density code between 2003 and 2009 and is therefore miscategorized; the direction, however is that rural counties are largely becoming less populated (e.g., essentially “more” rural) while urban counties continue to grow in population.

Map 1. Distribution of Primary Care Dentists by County Using USDA Rural-Urban Codes

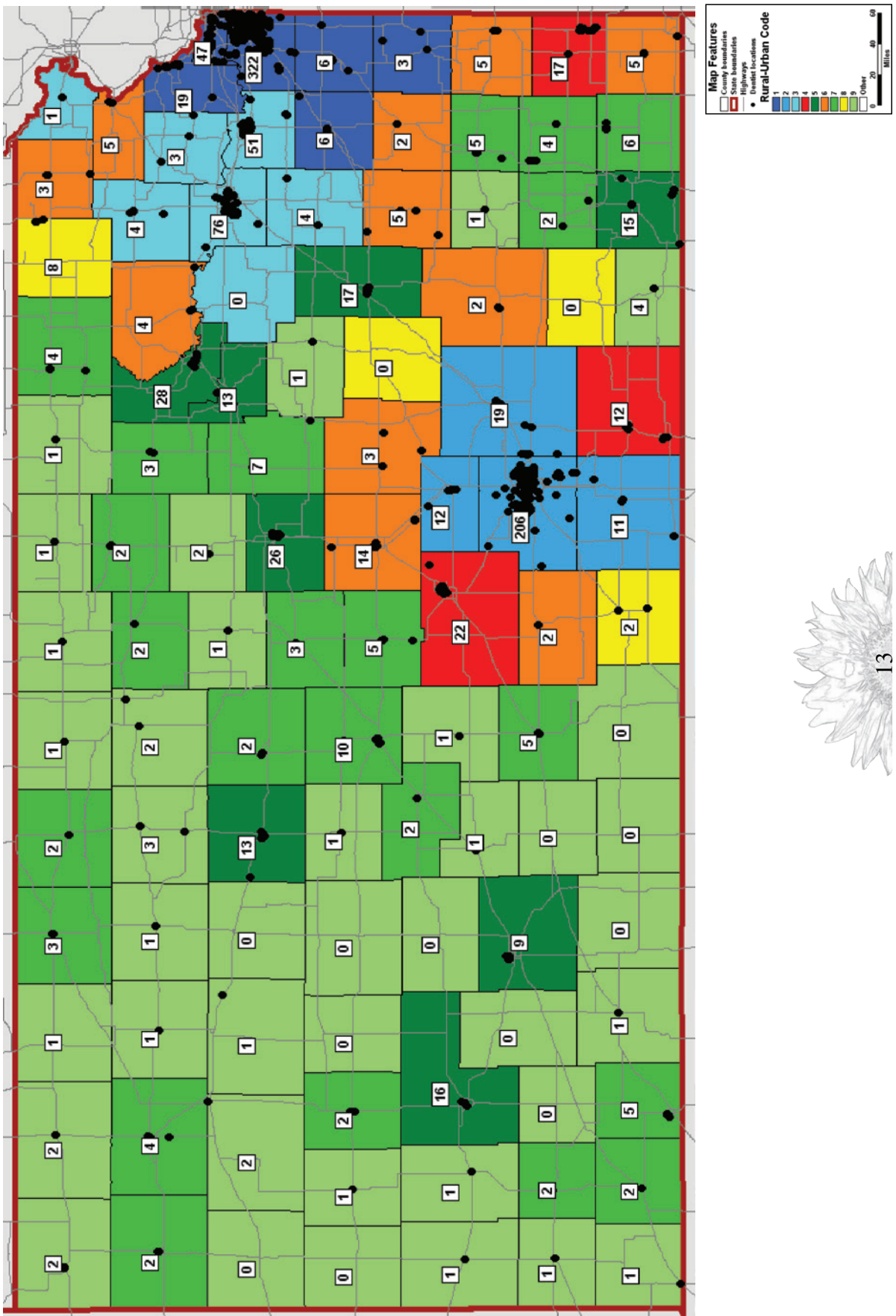


Table 1. Distribution of Primary Care Dentists by County Using USDA Rural-Urban Codes

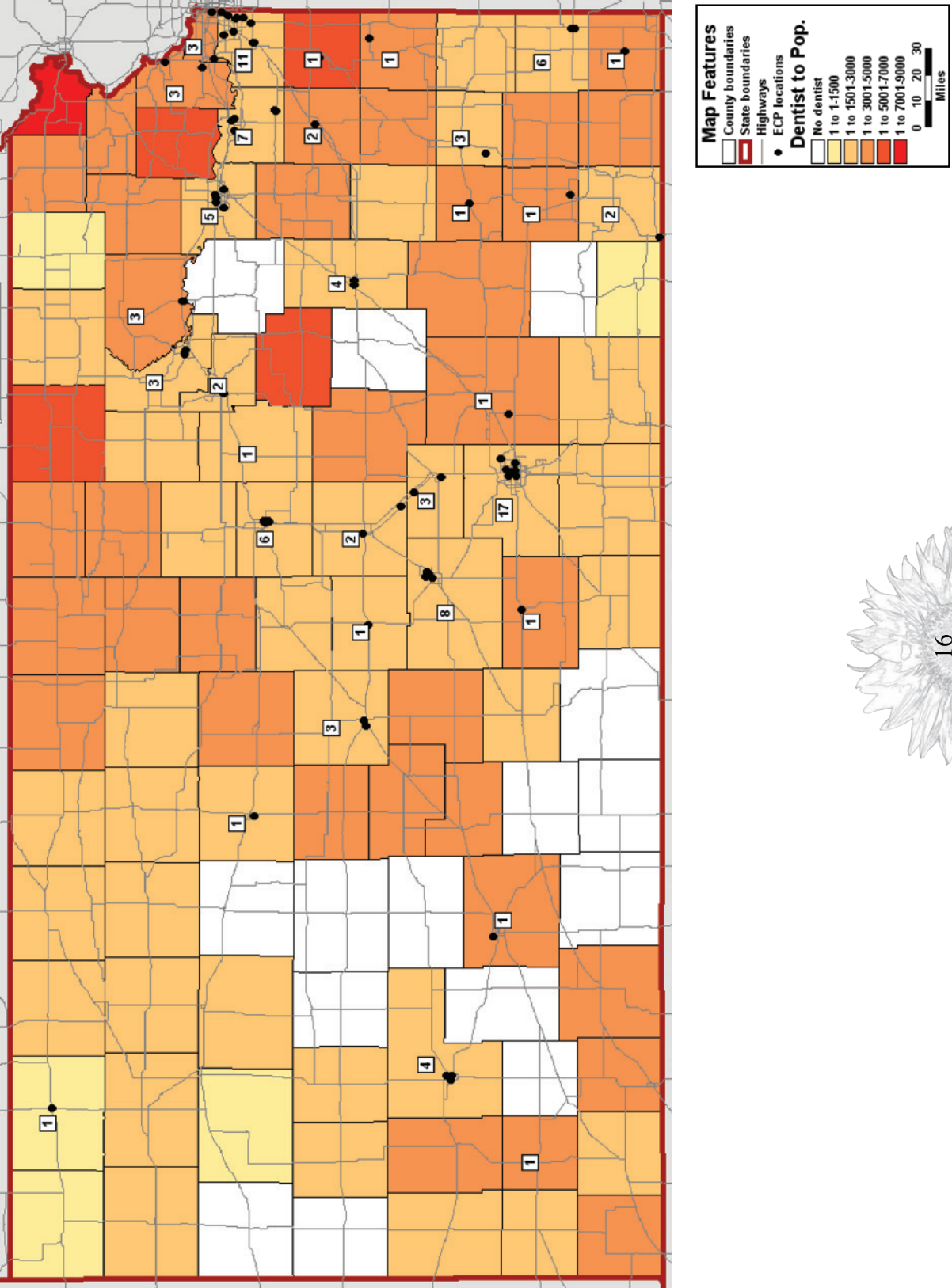
2003 Rural-Urban Continuum Code	Description for 2003 Codes	Number of Counties	Total Population Estimate (2000)	Total Population Estimate (2009)	Number of Dentists	Population per Dentist (2009)	Number of Zero Dentist Counties
1	County in metro area with 1 million population or more	6	740,364	839,794	403	2,083.86	0
2	County in metro area of 250,000 to 1 million population	4	571,166	612,683	248	2,470.50	0
3	County in metro area of fewer than 250,000 population	7	332,762	354,831	139	2,552.74	1
4	Non-metro county with urban population of 20,000 or more, adjacent to a metro area	3	139,323	135,860	51	2,663.92	0
5	Non-metro county with urban population of 20,000 or more, not adjacent to a metro area	8	317,062	328,816	137	2,400.12	0
6	Non-metro county with urban population of 2,500-19,999, adjacent to a metro area	11	159,927	153,673	50	3,073.46	0
7	Non-metro county with urban population of 2,500-19,999, not adjacent to a metro area	23	258,517	243,636	84	2,900.43	0
8	Non-metro county completely rural or less than 2,5000 urban population, adj. to a metro area	4	23,544	21,434	10	2,143.40	2
9	Non-metro county completely rural or less than 2,5000 urban population, not adj. to a metro area	39	145,753	128,020	37	3,460.00	12
Total		105	2,688,418	2,818,747	1,159	-	15

Distribution of Extended Care Permit Dental Hygienists

In addition to mapping the distribution of primary care dentists, the team also mapped the location of Extended Care Permit dental hygienists (ECPs). Because these oral health professionals must be sponsored by a dentist who also provides some oversight, it was not unexpected that ECPs would geocode in a pattern similar to that of primary care dentists. Map 2 shows the distribution of ECPs by county density designation. Again, the white boxes indicate the number of ECPs that gave that county as their primary address to the Kansas Dental Board. Most ECPs practice in counties located farther east than the area of interest for this study. Less than 30 ECPs geocoded to counties in the western two-thirds of the state.

There are a few differences between the distribution of ECPs and that of primary care dentists. For example, comparing Map 1 and 2, there are many counties in western Kansas that have a dentist but don't have an ECP. There are no geocoded ECPs in any of the white-shaded counties that have no primary care dentists. As ECPs often work with mobile equipment in community sites, it is possible that ECPs may travel into those counties to provide services, but the Kansas Dental Board does not collect publically available information about ECP community practice sites so it was not possible to map this impact. It could be assumed that ECPs work within a reasonable distance of their primary address, so it is worth noting that few ECPs are located near or adjacent to counties without dentists and those with the highest dentist-to-population ratios.

Map 2. Locations of ECPs Relative to Dentist to Population Ratios



ZIP Code Analysis

The analytic plan included adding more granularity to the analysis by focusing in on smaller units of geography. In part based on Horner's previous research in Ohio, the team explored using ZIP codes in Kansas. ZIP codes are not entirely defined or determined by census or population numbers. Even though their designation can be idiosyncratic, they are a strategic way to use mapping to illustrate the influence of distribution (in this case, dentists and ECPs) to demographic (population) factors.

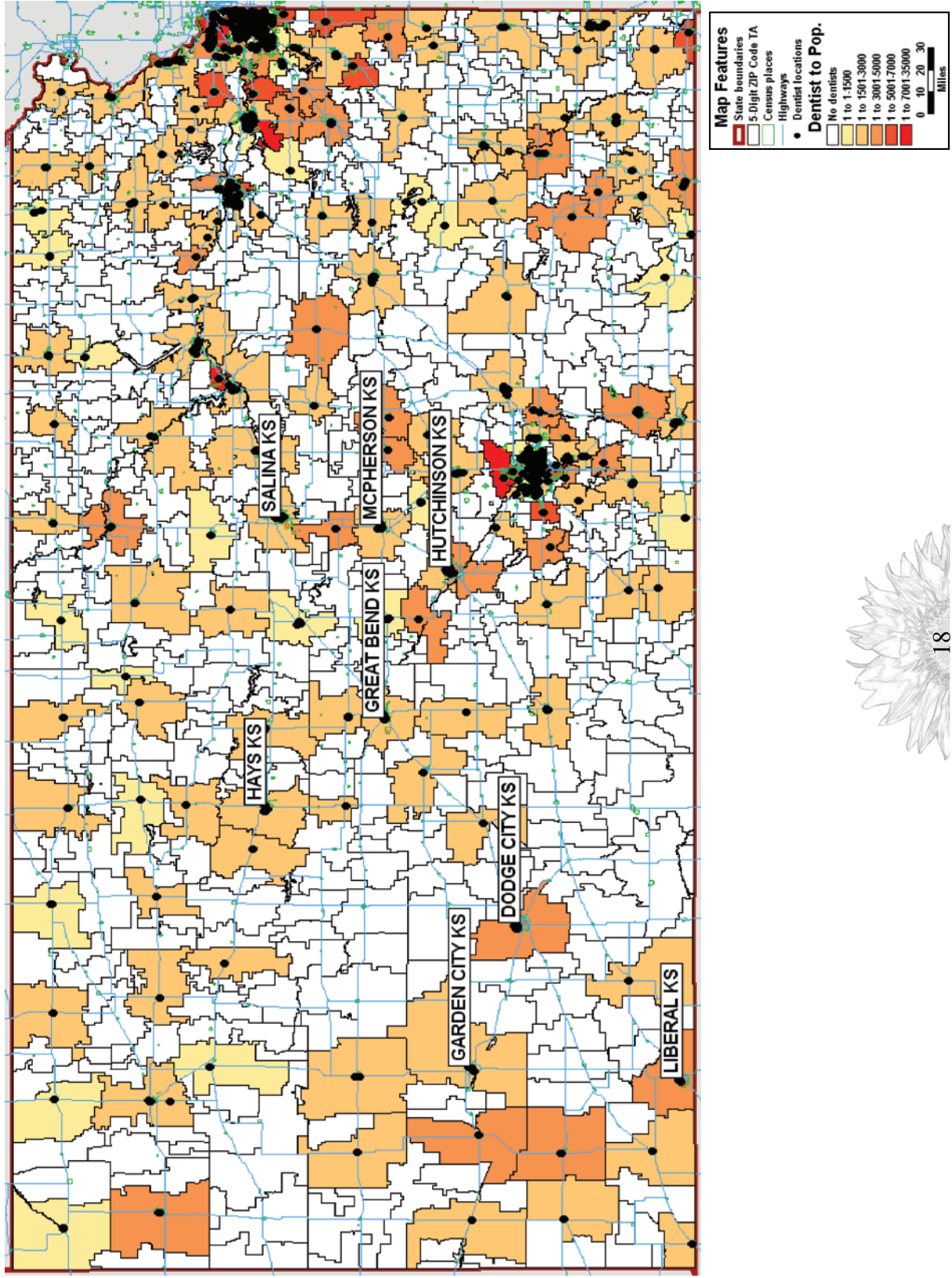
Map 3 displays the primary care dentist to population ratios where the demarcations are the boundaries between ZIP codes. Eight cities in western and central Kansas that contain practicing primary care dentists were targeted for closer analysis (see section "Drive Time Analysis of Coverage"), and they are highlighted on the map. Of the 703 ZIP codes designated in Kansas by the database, 483 of these have no dentist located within them (68.7 percent). For some perspective on this number, this compares to about 40.97 percent of ZIP codes in Ohio having no dentists as reported in a past study (Horner and Mascarenhas 2007).

The ZIP codes are categorized and shaded on Map 3 using the same methodology as Maps 1 and 2 (e.g., US Census data within each ZIP code was aggregated for classificatory purposes). This display of the primary care workforce reflects a comparable but enhanced distributional pattern shown in Maps 1 and 2. Geographic gaps in service take on a more population-specific contour, and areas of service considered at the ZIP code level give a better visual representation of the primary care dentists' service areas, as well as the large areas in white where there are no dental practices.

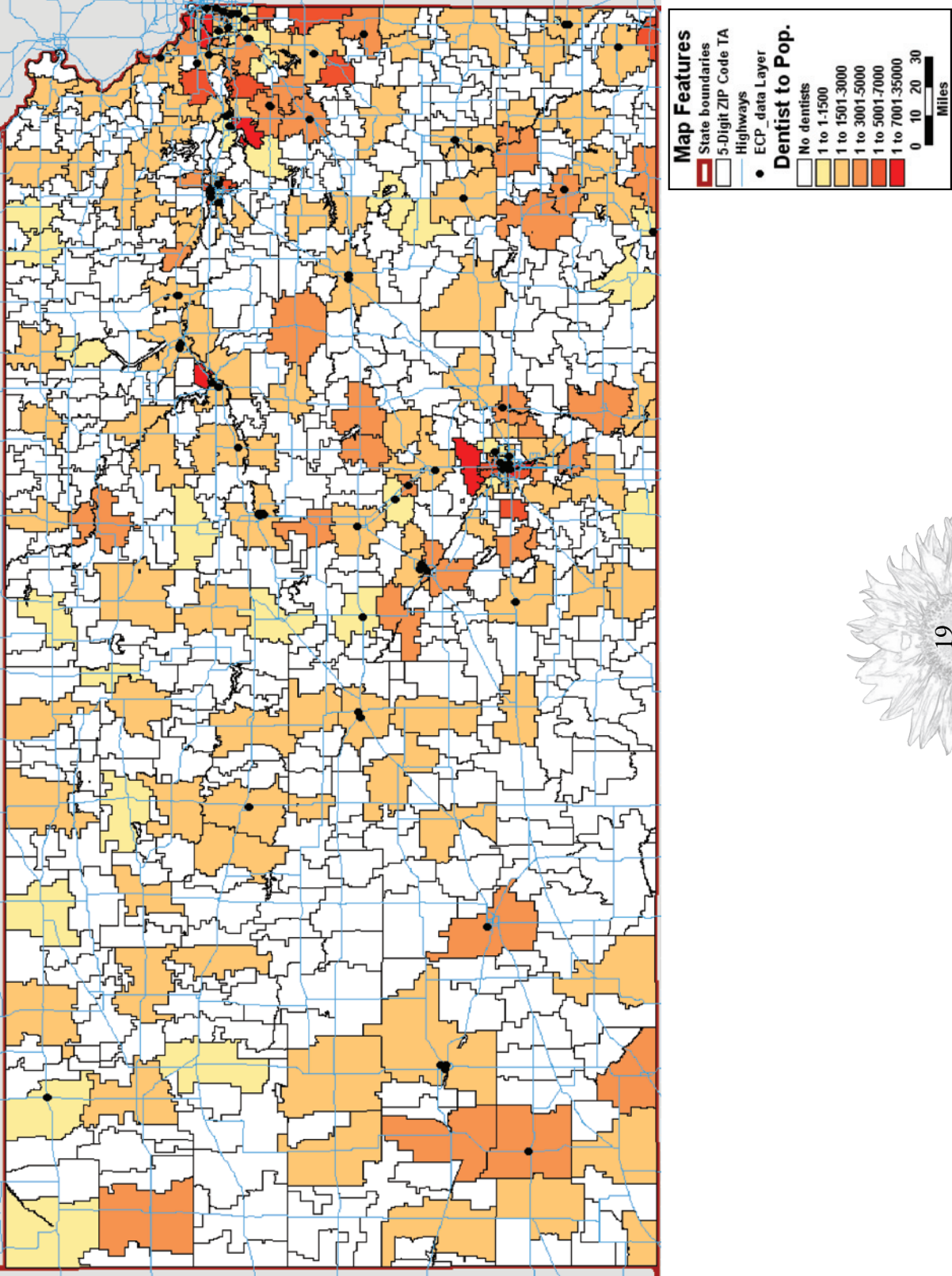
Map 4 uses the same approach as Map 3, but in this case, the map displays the distribution for ECPs. Again, the patterns mirror those provided in Map 2 in that ECPs repeat the distributional pattern of primary care dentists. Note that there are no ECPs located in the ZIP codes that are white (ZIP codes without a dentist) nor are there ECPs in many of the 1-1500 or 1301-3000 (low service) coded ZIP codes of western Kansas.



Map 3. Locations of Dentists Relative to Dentist to Population Ratios by ZIP code



Map 4. Locations of ECPs Relative to Dentist to Population Ratios by ZIP code



Drive Time Analysis of Coverage and Preliminary Display of Dental Care Service Deserts

As western Kansas is geographically large and primarily rural, it is critical to consider the role of transportation routes and distances between services sites when looking at access to oral health workforce. This research combines population and survey data with available road network data to provide yet another facet to this discussion. To this end, the FSU team obtained a detailed road network for the state of Kansas from ESRI (2006).

To explore the idea of dental coverage incorporating road networks, the FSU mapping team created drive time buffers (also referred to in the literature as travel time contours, network bands, and other similar terms) around the geocoded dental practice locations. A drive time buffer takes a specific point on the road network (in this case the nearest dental practice), and outlines a polygon to show how far someone could drive from that point (in all possible directions), in a specific amount of time utilizing the road networks that are in place. Drive time buffers based on interstate highways are larger polygons than those constructed around neighborhood streets because interstates allow the driver to travel farther per unit of time because of their higher speed limits. Similarly, building drive time buffers in areas with more densely developed road networks tends to result in larger polygons, holding other effects constant. Drive time buffers can be set using various criteria including the times reported by patients.

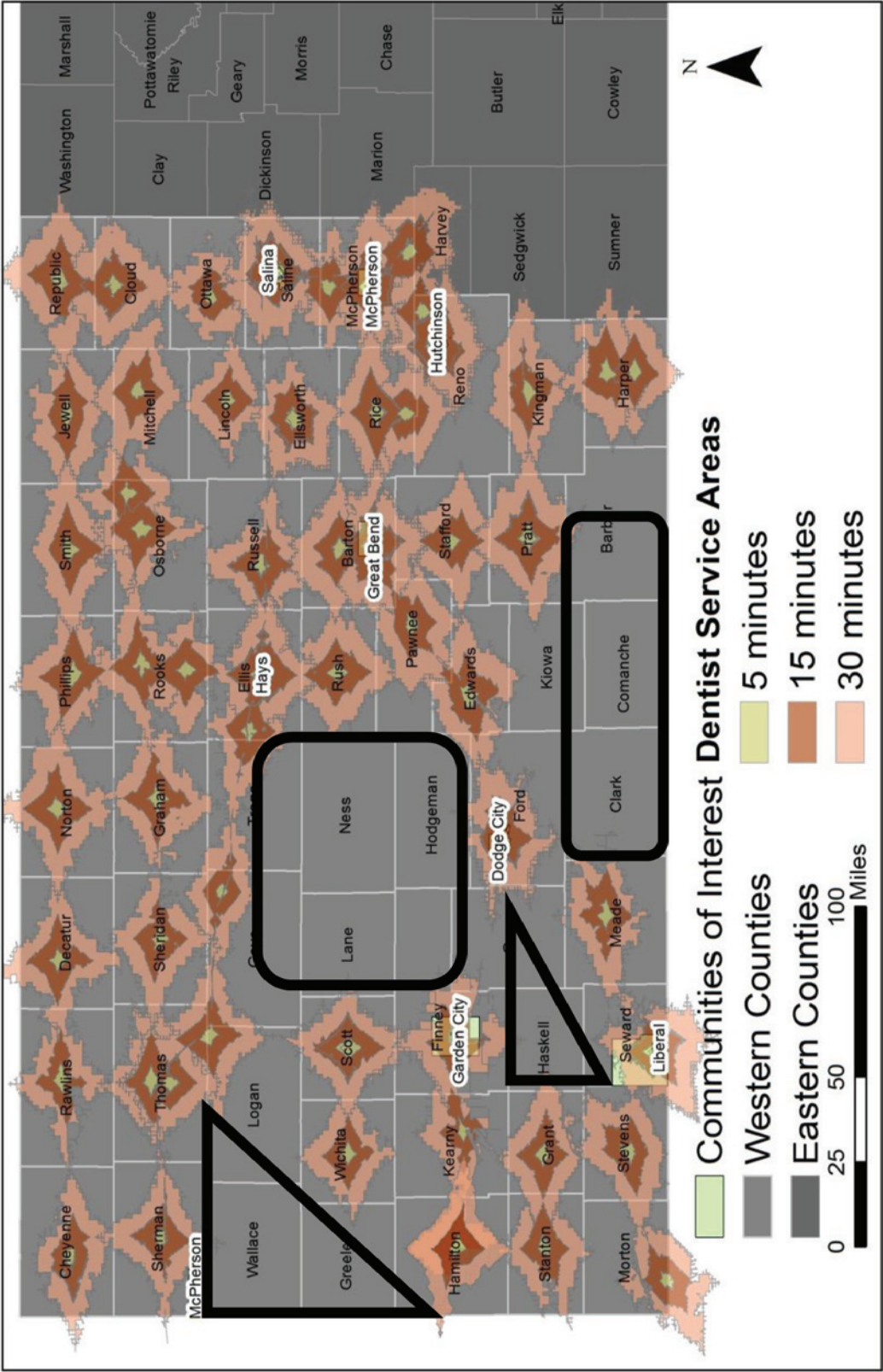
The research team used available primary data from the patient survey to determine travel time budgets. As up to 30 minutes was the time reported for 75 percent of the Primary Care Patient Survey respondents, FSU decided to use that as the upper bound for coverage. They then chose two shorter cutoffs for comparison purposes at 15 minutes (half of 30) and 5 minutes. Map 6 shows the polygon-shaped drive time buffers for the three selected travel time budgets around primary care dentists in western Kansas. The irregular shape of the polygons is a function of



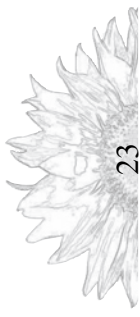
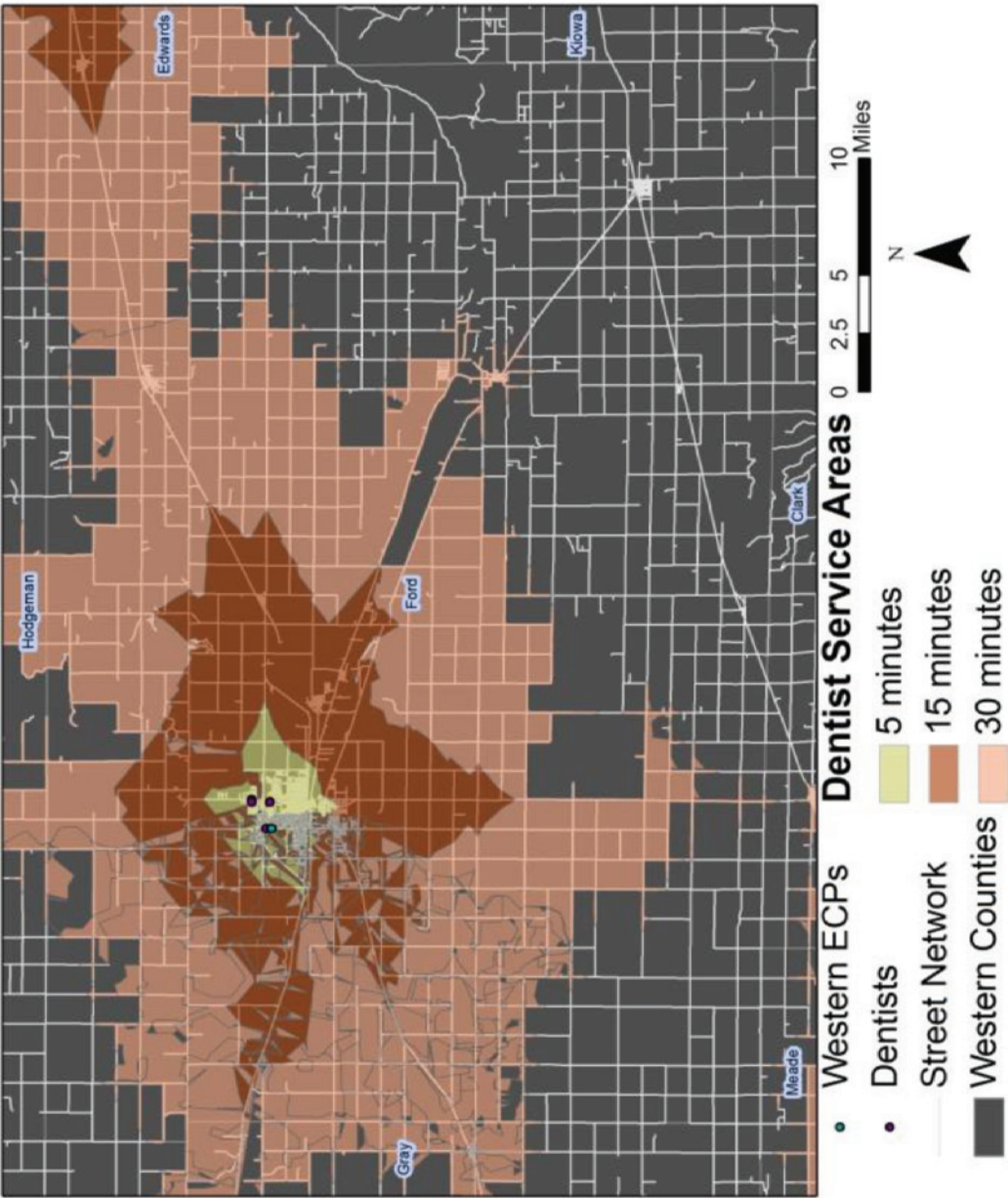
the geometry of the road network (not shown in this figure). With this approach, it is clear that several areas do not have access to a primary care dentist within a drive time of 30 minutes. At least four distinct areas in western Kansas are outlined in thick black shapes on Map 5. These are the regions that this report identifies as “Dental Care Service Deserts.”

To better observe the detail in the drive time buffers and network polygons, we examined eight target communities. In Map 6, we show the zoomed in image of the five, 15 and 30 minute dentist drive times areas for one of the communities of interest, Dodge City. This close-up view provides information about how network geometry influences buffer polygon shapes, as well as the buffer extents around the dentist access points. Notice that the one primary care dentist in Edwards County has a 30 minute drive time buffer that “touches” the 30 minute drive time buffer of the service areas of the dentists in Ford County in the upper right quadrant of the map. What this indicates is that for people who live generally along US Highway 50 between these two counties, they have the potential to access care from two different catchment areas. This does not address access per se, but it does inform the fluid way in which a patient could potentially choose from among providers depending on the distance from the person’s home. Most importantly, our analysis of this community and others in western Kansas supports our approach that access is not adequately described using only a county level perspective alone. Instead, we argue that a more detailed and regional view of access points provides more useful and precise information to pinpoint areas with critical oral health access deficiencies.

Map 5. Drive Time Buffers around Primary Care Dentists Office with Four Dental Care Service Deserts



Map 6. Drive Time Buffers around the Primary Care Dentists' Offices in Dodge City, KS



The goal of examining the polygons constructed around the primary care dentists is that, with GIS, we can combine the drive time buffers with the most up-to-date, available population block group data to look at dental provider coverage for Kansas populations on a sub-county, county, regional and statewide scale. The FSU mapping team determined the geographic centroid point of each census block group of interest in western Kansas, and if the centroid fell within a given buffer, then the block group's population was considered to have access. The team recognizes that this may not reflect actual dental access (see Limitations section) but it does indicate that there is a licensed dental professional with a dental practice that has the potential infrastructure to provide oral health services. This further underscores that addressing workforce issues is best served when population data are used. This encourages addressing the oral health care needs of Kansans on a much more practical level based on the nearest locations they can go to receive oral health care services.

Table 2 presents the results of the dental practice coverage analysis, which considered the three different travel time buffer intervals (30, 15, 5 minutes) for dentists and ECPs, using three years of population estimates (2006, 2008, 2010) to look at trends over time. Analysis focused on the 519 U.S. Census-defined block groups in western Kansas used throughout this report. According to the 2010 population estimates, there were approximately 514,376 people in this area. Looking at the 30 minute interval, about 57,811 people (11 percent) did not live within 30 minutes of either a dentist or ECP. Dentists cover a much larger portion of the population (450,640 individuals) than do ECPs (286,361 individuals) at the 30 minute drive time buffer interval, which is not surprising given their respective number and spatial distribution in western Kansas. Naturally, decreasing the interval of drive time (with all else held constant) will result in the dentists and ECPs covering less of the population. Both the results of the 15 minute interval and the 5 minute interval illustrate this fact; fewer people are covered when the distance is shortened between the dental office and a person's home.



Table 2. Coverage Analysis with Drive Time Buffers and Population Affected

30 MINUTE INTERVAL			
Total Western Block groups	2010 Population	2008 Population	2006 Population
519	514,376	551,523	524,541
Not Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
79	57,811	65,827	61,040
Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
440	456565	485696	463501
Not Covered (Dentist)	2010 Population	2008 Population	2006 Population
81	63736	71696	66856
Covered (Dentist)	2010 Population	2008 Population	2006 Population
438	450640	479827	457685
Not Covered (ECP)	2010 Population	2008 Population	2006 Population
270	228015	254094	237378
Covered (ECP)	2010 Population	2008 Population	2006 Population
249	286361	297429	287163
15 MINUTE INTERVAL			
Total Western Block groups	2010 Population	2008 Population	2006 Population
519	514,376	551,523	524,541
Not Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
170	136,078	153808	142621
Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
349	378298	397715	381920
Not Covered (Dentist)	2010 Population	2008 Population	2006 Population
180	147294	165276	153810
Covered (Dentist)	2010 Population	2008 Population	2006 Population
339	367082	386247	370731
Not Covered (ECP)	2010 Population	2008 Population	2006 Population
325	282668	313722	293570
Covered (ECP)	2010 Population	2008 Population	2006 Population
194	231708	237801	230971
5 MINUTE INTERVAL			
Total Western Block groups	2010 Population	2008 Population	2006 Population
519	514,376	551,523	524,541
Not Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
263	246,665	272884	255604
Covered (Dentist & ECP)	2010 Population	2008 Population	2006 Population
256	267711	278639	268937
Not Covered (Dentist)	2010 Population	2008 Population	2006 Population
284	268810	296755	278310
Covered (Dentist)	2010 Population	2008 Population	2006 Population
235	245566	254768	246231
Not Covered (ECP)	2010 Population	2008 Population	2006 Population
373	353851	387607	364513
Covered (ECP)	2010 Population	2008 Population	2006 Population
146	160525	163916	160028



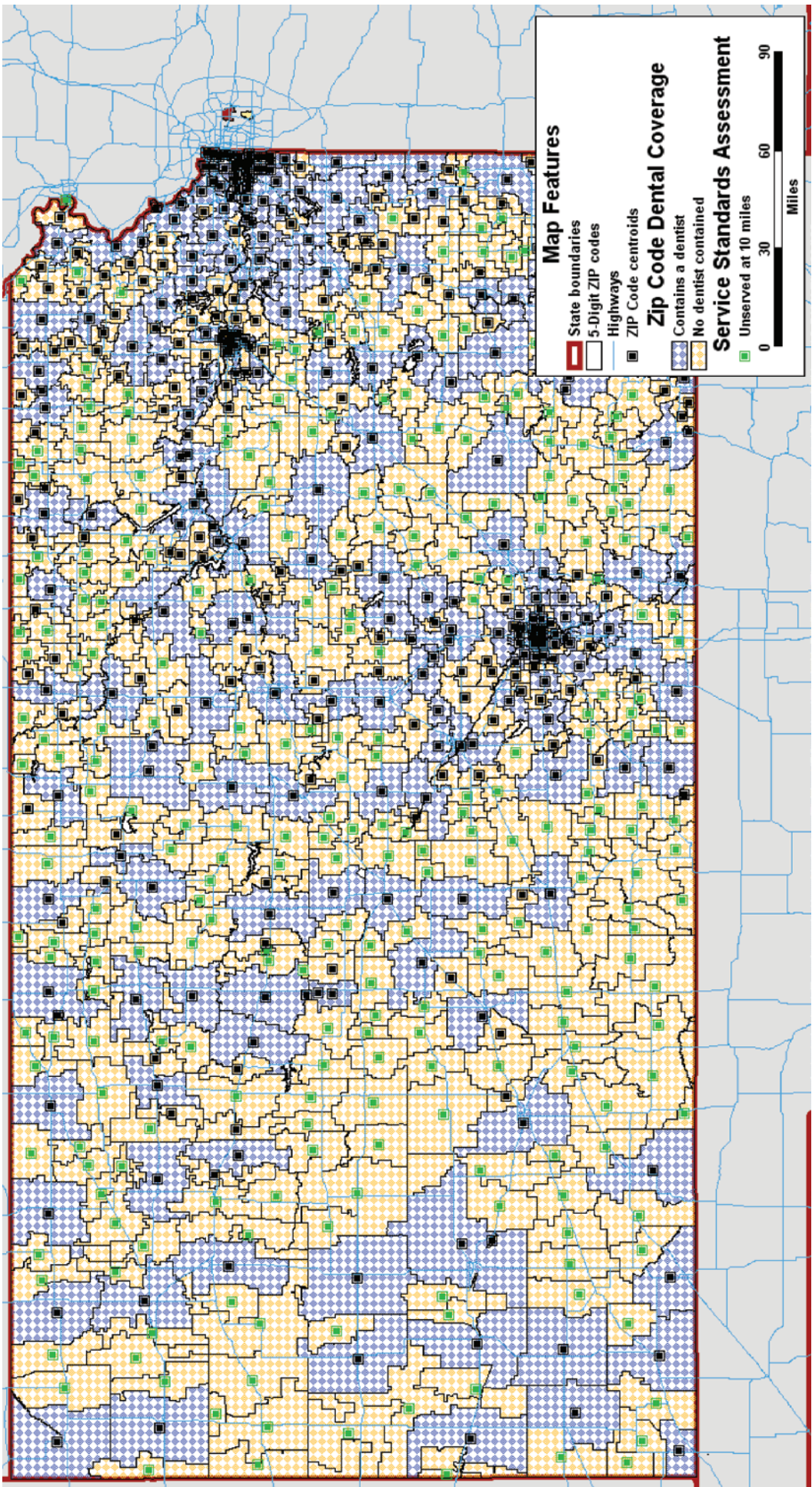
ZIP Code Analysis of Coverage

Analysis of the ZIP code level mapping and the drive time buffer maps suggests that more dentists strategically placed in Kansas could substantially increase geographical availability. This was explored by Horner and Mascarenhas in their Ohio case study (2007) and it is the reason that the Kansas team wanted to collaborate with the Florida State team. Horner and Mascarenhas implemented the notion of ‘service standards’ in their GIS analysis, and they examined whether ZIP codes having no dentist were within a certain distance of another ZIP code that had at least one dentist. The researchers experimented with several distance standards, and for each, the required number of new dentists needed to fill service changed. Larger assumed service standards/distances translated into fewer dentists being needed. In Kansas, we examined the 483 ZIP codes without dentists. There are 304 ZIP codes that were not within 10 miles of another ZIP code with at least one dentist (as measured by centroid-to-centroid distance). If we increase that service standard to 20 miles, then the number of unserved ZIP codes drops to 40.

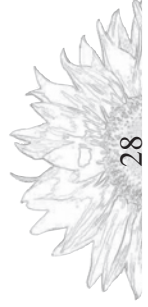
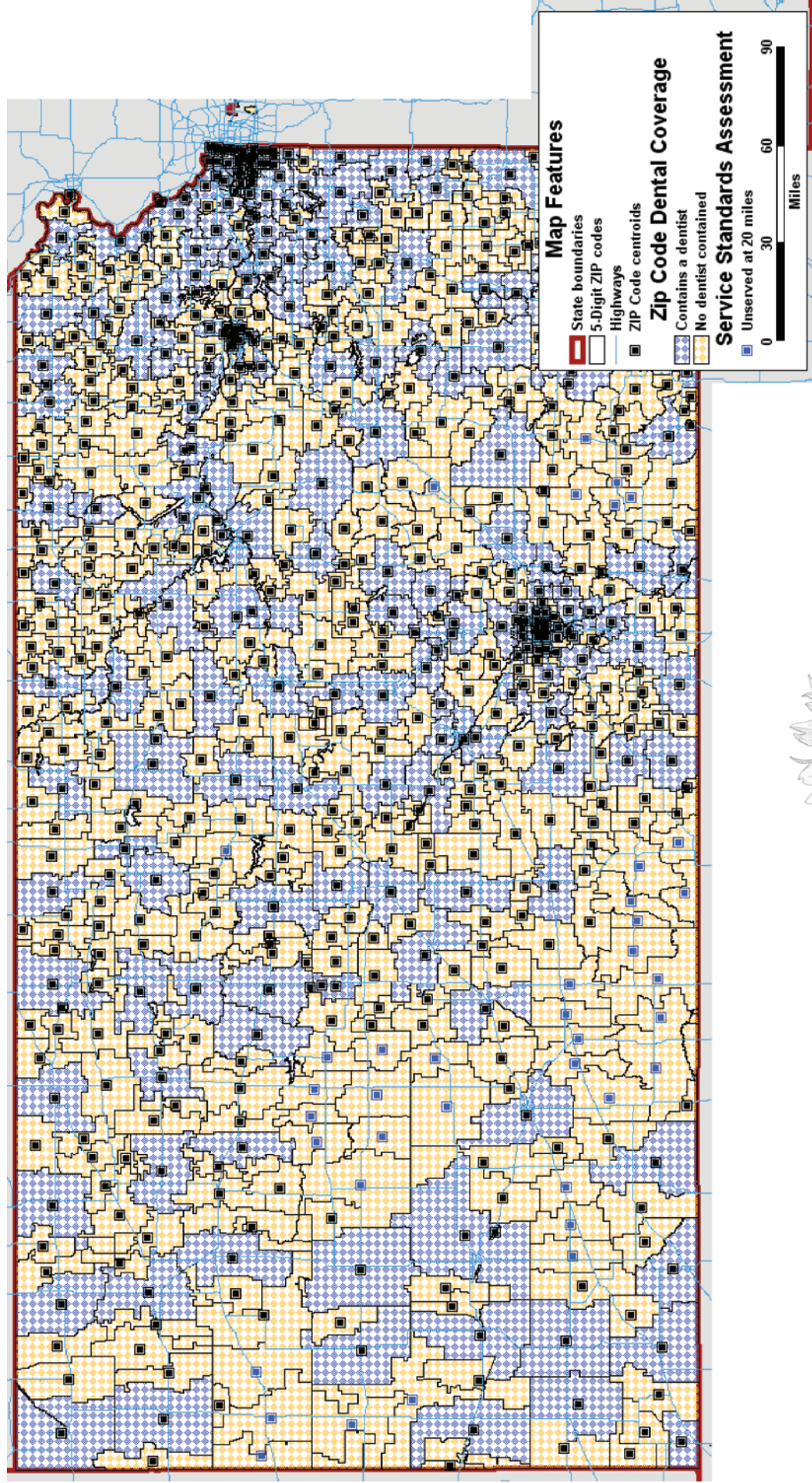
The geography of ZIP codes with and without at least one primary care dentist, the coverage provided to such areas by non-local dentists in adjacent ZIP codes, and areas in need of service are presented in Maps 7 and 8. These figures show the coverage assessment for 10 and 20 miles, respectively. As the 10 mile standard is far more conservative, many more ZIP codes and population centroids (green squares on the map) appear as part of the Dental Care Service Desert.



Map 7. Zip Code Level Coverage Assessment at a Service Standard of 10 Miles



Map 8. Zip Code Level Coverage Assessment at a Service Standard of 20 Miles



Closing the Access Gap – Adding Providers in Rural and Frontier Counties

Using methods available in the optimization and spatial modeling literature, it is possible to identify how many additional primary care dentists should be placed in strategic areas to have the most impact on Dental Care Service Deserts (Maps 5 and 8). This geographical dental workforce needs analysis has limitations and it is important to stress that number of providers estimated is based only on the presence or absence of dental practices within a certain geographical area. It is beyond the scope of this research to look at actual unmet dental treatment needs, or the total numbers of dentists that would be required to treat a certain population group's unmet oral health needs.

The first step in estimating the number of providers needed is to assume a distance service standard in the context of this project. Per the prior figures, doing this will determine the ZIP codes that have no dental practice. Once these ZIP codes are identified, then a coverage approach is applied to determine the minimum number of dentists needed to cover an area with workforce shortages. Two assumptions underpin this step. The first is that locating a dentist in a particular ZIP code can provide coverage to other nearby zero-dentist ZIP codes that are within the service standard. Stated another way, another dentist in Kinsley (Edwards County) would have an impact on adjacent populations in Dodge City (Ford County) because of “touching” 30 minute drive time buffers (Map 6). In this way, one need not necessarily add a dentist to every unserved ZIP code, but rather some smaller number of dentists will be needed to cover gaps in access.

Second is the idea of how coverage is provided. For the purposes of this research, coverage is strictly a geographical construct based on distance, so only one dentist in a particular area is needed to provide ‘coverage’. This also means that there are no benefits in the model for greater dentist density in a given ZIP code as coverage is based on whether or not ZIP codes (as represented by their centroids) are served. No direct account is taken of the population living



at each ZIP code in this model form. All of these assumptions are consistent with the Horner and Mascarenhas (2007) approach described in prior studies. In effect, these assumptions are used to generate a series of coverage scenarios that can lead to discussions about addressing geographical access needs.

Several distance standard coverage scenarios were tested (14 trials). Given that 483 ZIP codes have no dentists, service standards ranging from as low as five miles to as high as 30 miles were explored. For example if a five mile service standard is selected, 454 ZIP codes are unserved and it would take placing an additional 432 dentists to meet this definition of geographical need (see Table 3). With a service standard of 20 minutes, 40 ZIP codes are unserved, and it would take 14 dentists to serve those areas. At a 30 minute service standard, only 10 ZIP codes are unserved, and four dentists could close the gap.

Table 3. Results of Coverage Analysis for a Series of Service (Distance) Standards

Trial	Service Standard	Unserved ZIP Codes	Dentist Required to Meet 30 Minute Standard
1	5	454	432
2	6	438	387
3	7	421	335
4	8	387	283
5	9	347	218
6	10	304	180
7	11	267	156
8	12	225	130
9	13	175	99
10	14	141	82
11	15	119	68
12	20	40	14
13	25	19	6
14	30	10	4



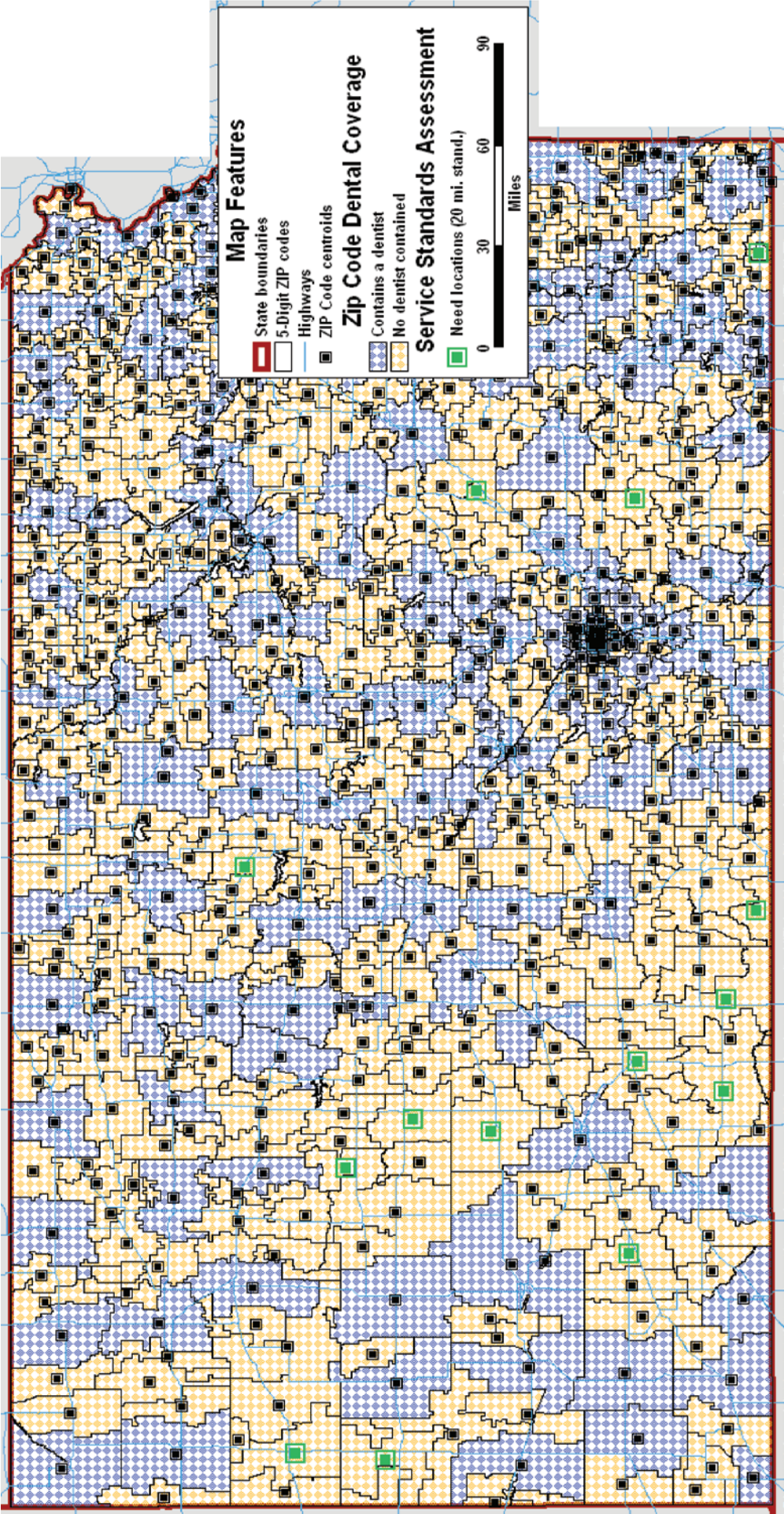
The map developed using a service standard of 20 miles is shown below (Map 9). What is interesting about this figure is that it shows that of the 14 ZIP codes where oral health care services would be most beneficial (green dots/squares) 11 of these are in the study's focus area of western Kansas. Clearly the larger areas without dentists (as identified earlier in this report) constitute an important part of the geographical need.

The mapping team optimized the model to minimize the maximum distance any single no-dentist ZIP code is from its nearest ZIP code that contains at least one dentist. They added the additional constraint that no assigned service distance could be greater than the selected service standard (in this case, a 20 minute drive time buffer).

Map 9 shows the hypothetical "ideal" spatial location for new providers that would meet the oral health care needs of rural Kansans currently without services where the average household would have to drive 20 miles to a dental office (Trial 12 in Table 3). The map takes into account the number of people in need and the usual distance many rural residents currently travel for care. Shortening the drive time would require substantially more providers (see Table 3).



Map 9. GIS Solution for Dental Care service Deserts Using the 20 Mile Distance Standard



Placement of Dental Care and Services to Address Dental Care Access Deserts

Dental Care Access Deserts are empirically defined geographic areas that lack a primary care dental office. Many areas of Kansas have few residents, so it was important to also define deserts taking the number of Kansans that live in these areas into account. Census centroids further define the dental deserts relative to population areas, and this feature improves their usability for addressing where workforce innovations, novel interventions and/or providers should be placed.

Table 4 lists the ten ZIP codes that contain population centroids that are part of these four newly defined Dental Care Access Deserts. Their associated county and primary/largest town or city in each of the ZIP codes also is listed. These 10 ZIP code areas represent the core geographies where placement of four new providers or novel innovations involving the delivery of oral health care services would provide the greatest benefit to citizens who currently have to drive more than 30 minutes to reach a dental office for care.

Table 4. Dental Care Access Desert ZIP Codes, Counties and Nearest Town/City

ZIP Code	County	City/Town
67837	Gray	Copeland
67762	Wallace	Weskan
67758	Wallace	Sharon Springs
67761	Wallace	Wallace
67127	Comanche	Protection
67029	Comanche	Coldwater
67155	Comanche	Wilmore
67057	Barber	Hardtner
67518	Ness	Beeler
67560	Ness	Ness City

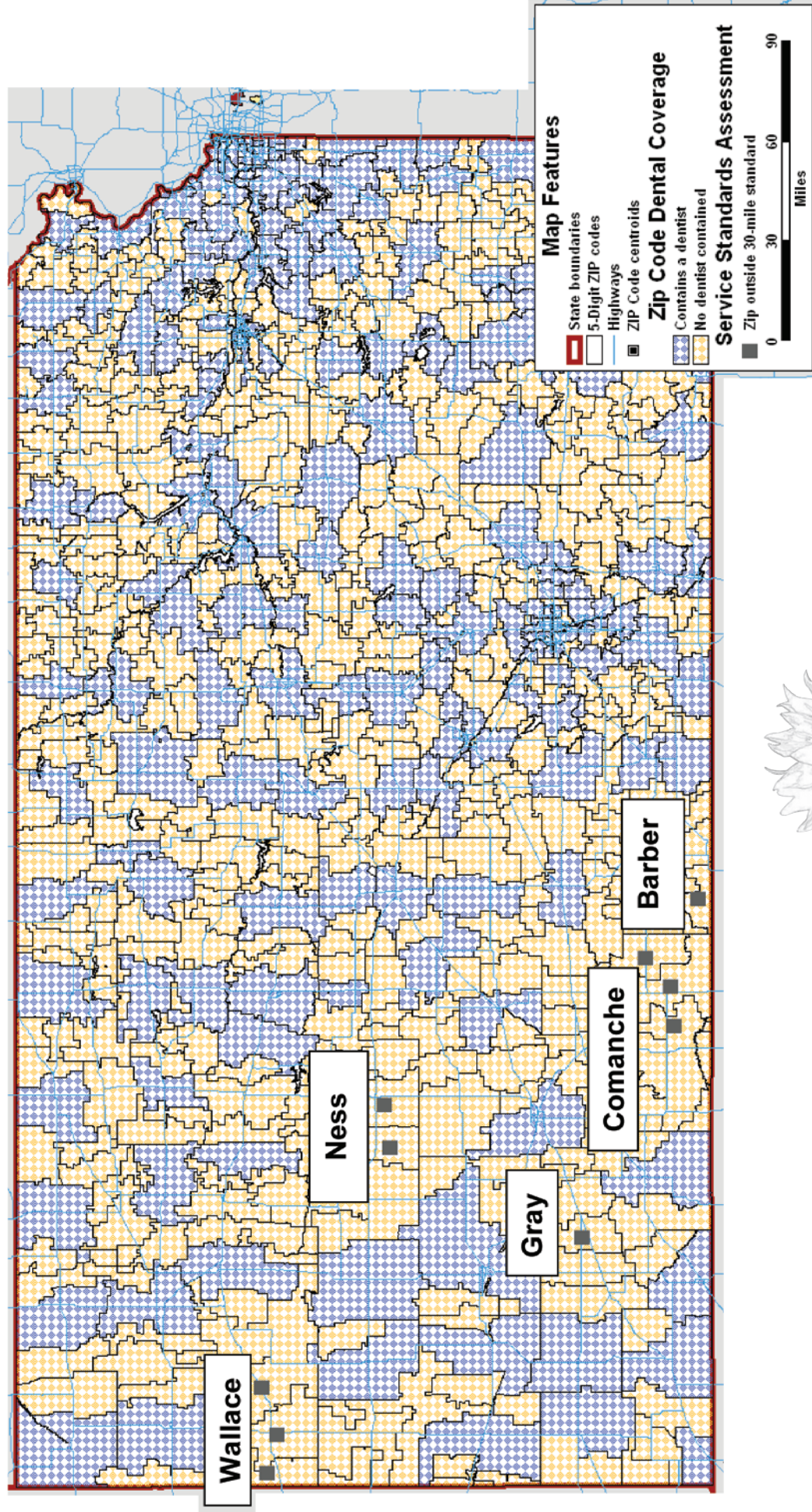
What is important to emphasize is that the research does not suggest that a dentist be placed in each of the towns/cities listed in table 4; rather, the locations listed are the population centroids



where people currently have a 30 minute or more drive time buffer as described earlier in the report. Map 10 displays the 10 ZIP code areas visually. Depending on the placement of a provider or a service site, each area also has the potential to impact adjacent low-service areas for dental care, too. The availability of services will dynamically shift the margins of the desert. Furthermore, if current providers adjacent to a desert close their practices, the desert will expand, and the associated population will join other residents who have limited options to receive health care from oral health professionals.



Map 10. Dental Care Access Desert Population Centroids and Associated County





LIMITATIONS

It is important to identify the limitations of this research to put the key findings in proper context. First, as an exercise using geographic information systems, this research project was designed to display data using maps to inform decision making. While the maps are descriptive in a way that other types of data presentation are not, the parameters used to develop the maps were influenced by a set of decisions made by the researchers, and were subject to a series of choices. The joint team made several choices that affected the results. For example, the distance metrics use for the drive time buffers, the overlaps allowed between service areas, and the dependence on dentist geocoding to licensure data without external verification of those addresses each represent significant choices that could and did affect analyses. While these are limitations, they are not unique to this project. In fact, GIS analysis is by design capable of accommodating a variety of parameters and changing variable definitions that permit the researcher to develop a series of dynamic maps that can describe the multivariate nature of geospatial relationships. It is both the strength and the limitation of the method.

The focus of this report was access to current dental practices in terms of distance, but we know that there are a myriad of other factors that influence whether someone has access to oral health care. Prominent among these factors is cost and insurance – the prior collaborative study between the Bureau of Oral Health and the KUMC Center for Community Health Improvement included traveling to a number of rural communities to discuss workforce issues. Focus group participants clearly identified that the lack of all dental providers was only one dimension of their community's need; the other was having a provider who would accept public insurance or see the uninsured. Access to care is also impacted by linguistic and cultural barriers between those seeking care and those providing it. Dependable transportation is another limitation as is the ability to get to the dental office if individuals are frail, elderly or disabled. Finally, even in areas where there is access to providers, individuals and families need to perceive they have a

need and want oral health care services, including preventive services, otherwise they provide no demand in the economic balance of supply and demand. None of these limitations were factored into the models presented, so communities with high populations of uninsured, Medicaid, elderly, disabled, etc were treated equally with all other communities as we developed the various maps.

It would be ideal to visit areas identified as Dental Care Service Deserts to conduct conversations or focus groups. Some who participated in the first workforce study's focus groups actually do not live in a Dental Care Service Desert, but thought that they did. Talking to others who live in a desert or residents of the areas that would potentially benefit from a local dental service provider also could add much in terms of feasibility assessment or improving our understanding of why their desert exists, especially if they had a history of having a dentist in their community but perhaps lost them to relocation. Hearing from local communities will assist in interpreting this research would inform local innovations or solutions.

Finally, there were data limitations that could have influenced the findings of this research. There may be dentists and ECPs that practice in the high need areas mapped in this study, but without their address information, they were not included in the analysis. This may have resulted in under-counting the available access points to primary care dental services and therefore the maps may overstate the need for additional providers in certain areas. Equally important is that the project focused on mapping the workforce by site and not by service level. The research team did not account for those dentists or ECPs who might practice only part-time which limits their availability to serve local communities, and this type of error would result in overstating the availability of providers in certain areas.

This report focuses on the presence or absence of current dental providers across the rural and frontier areas of Kansas. Clearly this is only one facet of access to oral health care, but it is also one of the most important. A county that has dental providers has the capacity to treat oral disease, whereas a county without providers and dental practices cannot, even if there is demand and their residents have an ability to pay. Having qualified dental professional and appropriate dental facilities is essential but not sufficient to meeting a community's dental care needs.



SUMMARY: INFORMING DENTAL WORKFORCE POLICY

Oral health care services are unevenly distributed throughout the state of Kansas. The research conducted on behalf of the Bureau of Oral Health was designed to address the Director's commitment to seeking workforce solutions best able to meet the oral health care needs of the population. Specific attention was paid to many of the areas in Kansas where prior research had indicated that workforce shortages are of paramount concern.

The following lists the key findings that have an impact on planning and strategies capable of addressing dental care access needs:

1. Access to a primary care dentist is not equal for all Kansans. Not only are some rural communities without a dental provider, the distance needed to travel for some Kansans may prevent them from receiving services. Four geographically and population-defined areas of Western Kansas can be designated as "Dental Service Area Deserts" as they do not have a primary care dental provider within a half hour drive time access for many of their residents.
2. Extended Care Permit dental hygienists have not filled in the geographic gaps where primary care dentistry is unavailable. The Kansas Extended Care Permit was created in 2003 to improve access to preventive services to underserved populations by allowing registered dental hygienists to work in community settings. While some ECPs are delivering needed services and are willing to do more, as of 2009, very few worked in some of the most underserved locations across the state and they provided relatively limited hours of service.

3. Many areas of western Kansas will join a Dental Care Service Desert in the next three years. Many communities in western Kansas have only one dentist, and these dentists are aging and planning retirement. Those seeking retirement cannot sell their practice or find an associate, so it is unlikely that their dental practices will be sustained. Because of this, in the near future, it is probable that more communities will be without a dental provider. This will have the effect of overburdening the remaining dentists and causing Kansans to have to travel even farther to seek care.
4. The addition of strategically placed dental providers or services could make a significant difference in access to oral health care in Kansas. Kansas is a large state geographically and it has large areas with relatively low population. The addition of dental providers in communities within the Dental Care Services Deserts would not only impact that community, but they would also have the potential to impact surrounding areas with limited dental providers.
5. Dental care workforce innovation models and/or new pilot interventions could be tested in the Dental Care Service Deserts. If policymakers want to develop and support oral health care delivery innovation, Kansas Dental Care Service Deserts and more than a dozen statewide areas are now clearly defined and ready for a new approach. Being able to target novel interventions, randomize which communities participate, and create measurable outcomes of success could provide Kansans with better access to oral health care as well as inform national policy makers on effective rural oral health programming.



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