Ambulance Deserts

Geographic Disparities in the Provision of Ambulance Services

Maine
Rural Health
Research Center

May 2023

RHRC
Rural Health Research
& Policy Centers
Funded by the Federal Office of Rural Health Policy
www.ruralhealthresearch.org

Ambulance Deserts

Geographic Disparities in the Provision of Ambulance Services

May 2023

Prepared by:

Yvonne Jonk, PhD
Carly Milkowski, MPH
Zachariah Croll, MPH
Karen Pearson, MLIS, MA

of the

Maine Rural Health Research Center
Muskie School of Public Service
University of Southern Maine

Funding Acknowledgement:

This work was supported by the Federal Office of Rural Health Policy (FORHP), Health Resources and Services Administration (HRSA), Grant CA#U1CRH03716, Rural Health Research Center Cooperative Agreement to the Maine Rural Health Research Center. The information, conclusions and opinions expressed are those of the authors and no endorsement by FORHP, HRSA, or HHS is intended or should be inferred.

ACKNOWLEDGEMENTS

Expert Work Group:

We would like to acknowledge the contributions of our expert work group:

Gary Wingrove, FACPE, CP-C

- President and Chief Innovation Officer, The Paramedic Foundation, Duluth, MN

Kevin McGinnis, MPS, EMT-P

- Program Manager, Community Paramedicine - Mobile Integrated Healthcare, NE Mobile Health Services, Scarborough, ME
- Rural Emergency Care, National Association of State EMS Officials (NASEMSO), Falls Church, VA

Nick Nudell, MS, MPhil, NRP, FACPE, PhD Candidate

- Research Manager, UCHealth
- Paramedic Scientist, The Paramedic Foundation, a 501(c)3 non-profit charity
- President, American Paramedic Association
- Treasurer, National EMS Management Association
- Board Member, Colorado Chapter of NAEMSP
- Board Member, EMS Association of Colorado

We would also like to acknowledge the contributions of the late Thomas (Tom) Nehring, former Division Director of the North Dakota Department of Health, Division of EMS and Trauma. Tom's listening sessions held throughout the state of North Dakota in 2014-17 regarding the status of the state's EMS system inspired this work.

Other:

We thank Vinton Valentine, PhD, Director of USM-GIS, for his consultation on the GIS methodology. The authors are grateful to Louisa Munk, MPH, and Brianna Holston, USM Public Health student, for their assistance with formatting.

Contact Information:

For more information, please contact Dr. Yvonne Jonk using the following designated email address: *AmbulanceDeserts@maine.edu*

Recommended Citation

Jonk, Y., Milkowski, C., Croll, Z., & Pearson, K. (2023). *Ambulance Deserts: Geographic Disparities in the Provision of Ambulance Services* [Chartbook]. University of Southern Maine, Muskie School, Maine Rural Health Research Center.

EXECUTIVE SUMMARY

Access to timely ambulance service is an essential part of the emergency medical system. Yet ambulance access varies widely with significant gaps across the country. This research identifies places and people that are more than 25 minutes from an ambulance station, also called an ambulance desert.

We analyzed data for 41 states in 2021-2022 and found that:

- 4.5 million people live in an ambulance desert, 2.3 million (52%) of them in rural counties.
- Four out of five counties (82%) had at least one ambulance desert.
- Rural counties were more likely to have ambulance deserts (84%) than urban counties (77%).
- Areas with the highest share and number of people living in ambulance deserts include the Appalachian region in the South; Western states with difficult mountainous terrain; coastal areas across the U.S.; and the rural mountainous areas of Maine, Vermont, Oregon, and Washington.
- Eight states had fewer than three ambulances covering every 1,000 square miles of land area (the Western states of Nevada, Wyoming, Montana, Utah, New Mexico, and Idaho; and the Midwestern states of North Dakota and South Dakota).

This report presents data on ambulance deserts by state and county. We include maps of ambulance desert locations and health care facility locations for every state with available data. We lacked data on ambulance locations in nine states so the results in this report are likely an undercount of the people and places that are more than 25 minutes from an ambulance station. This study documents coverage gaps in the provision of ambulance services across geographic areas across the United States. In future work we will explore the demographic characteristics of people living in ambulance deserts to better understand where vulnerable populations lack access to ambulance services, particularly in remote rural areas.

CONTENTS

KEY FINDINGS

Overview

- Across the 41 states included in these analyses, 4.5 million people lived in locations that were more than a 25-minute drive from where an ambulance was stationed, and therefore lived in an ambulance desert (AD) in 2021-2022. Of the 4.5 million living in ADs, 2.3 million lived in rural counties.
- Eighty-two percent of all counties (n=2,726) in the 41 states represented in these analyses had at least one AD at the census block level.
- Geographic areas with the most limited access to ambulance services (as reflected by the percent and number of people living in ADs) include the Appalachian region in the South; Western states with difficult mountainous terrain; coastal areas across the U.S.; and the rural mountainous areas of Maine, Vermont, Oregon, and Washington.

Prevalence of Ambulance Deserts in Rural and Urban Counties

- Rural counties were more likely to have ADs (84%) than urban counties (77%). However, because rural counties are less densely populated than urban counties, just over half (51%) of people living in ADs lived in rural counties (n=2.3 million).
- States in the South (e.g., Texas, North Carolina, Alabama, Kentucky, Arkansas, and Tennessee) the Midwest (Missouri) and the West (Montana) had the highest number of rural people living in ADs (over 100,000 people). The Northeastern states of Rhode Island, Connecticut and Massachusetts, and the Southern state of Delaware had the fewest number of people in rural counties living in ADs (fewer than 1,200).
- States with the highest rates (over 94%) of AD populations living in rural counties included New Hampshire, Nebraska, and Ohio, followed by 75% to 87% of AD populations in Wyoming, Iowa, Vermont, Kentucky, Montana, and North and South Dakota.
- States with the lowest rates of AD populations living in rural counties included the Northeastern states of Rhode Island (0%), Massachusetts (7%), and Connecticut (14%) and the Southern states of Delaware (0%), Maryland (10%), and Florida (15%).

Census Region Comparisons

- The South had the highest number of people living in ADs (2.6 million) and accounted for 59% of the people living in ADs across the 41 states.
- In terms of state populations living in ADs in each of the four census regions, Southern states topped the list ranging from 164,000 in Mississippi to well over 300,000 in North Carolina, Alabama, and Texas.
- The Northeastern states of Rhode Island (1,900) and Connecticut (6,000) had the fewest number of people living in ADs statewide, followed by the Midwestern states of Iowa (9,300), Illinois (10,250), and Ohio (12,500).

Number of Ambulance Stations per 100,000 Residents and per 1,000 Square Miles

- The number of ambulance stations per capita ranged from a low of 2 per 100,000 residents in Nevada to a high of 19 per 100,000 residents in North Dakota.
- Although Western and Midwestern states had among the highest number of ambulance stations per capita (12-19 per 100,000 residents), large land areas and low population densities resulted in many of these states experiencing ADs in 75% to 100% of their counties.

- Alternatively, the relatively low number of ambulance stations per capita and high population densities contributed to high numbers of people living in ADs in the South (e.g., North Carolina, Tennessee, and Alabama).
- The Western states of Nevada, Wyoming, Montana, Utah, New Mexico, and Idaho, and the Midwestern states of North and South Dakota had, on average, fewer than three ambulances (range: 0.5 to 2.7) covering every 1,000 square miles of land area.

PROJECT SUMMARY

This chartbook provides an overview of ambulance service provision in the United States, based on ambulance location data acquired for 41 of the 50 U.S. states. The study team collected information on transporting ambulance service locations from state emergency medical service (EMS) agencies and identified ambulance service areas as populated areas within a 25-minute travel radius of a service location, based on consensus within our EMS Expert Work Group. The time that it takes for an ambulance to travel from the service location to residential locations was estimated using road surface and speed limit data. Residential locations were based on 2020 U.S. Census block-level data. Residents living outside of ambulance service areas were categorized as living in an "ambulance desert (AD)." For the national maps, the unit of analysis is the county, and the number and percent of each county's population living in ADs is illustrated and reported by state, the four census regions, and rural-urban county classification using the Rural-Urban Continuum Codes (RUCCs). For the state maps, the unit of analysis is the census block. Anyone living in a census block with a centroid outside of an ambulance service area was considered living in an AD. State, regional, and rural-urban summary statistics based on county-level data are presented first and discussed. State level maps are presented (in alphabetical order) in Appendix A.

INTRODUCTION

Traditionally, ambulance services have been viewed as a transportation service largely organized and funded by community resources and goodwill donations. As such, ambulance services have been governed and regulated by the National Highway Traffic Safety (NHTSA) within the United States Department of Transportation.[1] With the advancement of medical procedures that can be performed outside of the hospital/emergency room setting, the levels of expertise and training required by members of an ambulance crew have increased along with the complexity and costs associated with the medical equipment required to run an ambulance service. The persistent lack of organized infrastructure, formalized recognition, and financial investment in ambulance services as an essential service by both payers and providers has fostered an operating environment characterized by inadequate staffing, scarce resources, and insufficient reimbursement rates. As a result, many areas of the country lack or may be at risk of losing access to ambulance services. While having an ambulance located within a reasonable driving distance does not ensure the service is adequately resourced or staffed, identifying ambulance locations relative to where people live serves as an important first step in understanding the extent to which an ambulance may or may not be able to respond to emergency calls in a reasonable timeframe. To our knowledge, this study is the first to identify areas of the U.S. that do not have a licensed transporting ambulance service within a reasonable driving distance of where people live.

The report begins with a broad overview of ambulance services including common types of organizational structure(s) and workforce and reimbursement issues. The methods section provides our definition of ambulance deserts (ADs) and describes how ADs are illustrated in the national and state maps. The results section begins with an overall description of the prevalence of ADs in rural and urban counties across the 41 states for which data were available, and the variation in the percentage of people living in ADs across the four census regions. States are ranked in terms of the percentage of counties in each state with ADs, the number of ambulance stations per 100,000 residents, the number of ambulance stations per 1,000 square miles, and the number and percent of people living in ADs. National level maps illustrating the number and percent of people living in ADs at the county level are presented overall, as well as by rural and urban counties. State level maps illustrating the location of ambulance stations, health care facilities, and ambulance deserts at the census block level are presented in Appendix A. Finally, the discussion and conclusions section provide a summary of the findings and sets the stage for future analyses of populations most at risk for adverse health outcomes associated with poor access to ambulance services.

Organization and Structure of the Ambulance Industry

In 2020, there were 23,272 ambulance agencies in the U.S. with nearly three-quarters (73%) reporting that they serve rural areas.[2,3] Although air medical transport and non-transporting ambulance services were not the focus of this report, ambulance services are based in a variety of organizational structures: they may be owned privately or by a county or municipality, based in fire departments or hospitals, and include air medical transport, emergency medical dispatch, or non-transporting services.[2]

Ambulances can be staffed by people with a variety of skill levels, spanning paramedics with the highest scope of practice and training, advanced emergency medical technicians (AEMTs+), emergency medical technicians (EMTs), and emergency medical responders (EMRs). EMRs typically do not transport patients. Ambulance staff work either in advanced life support (ALS) or basic life support (BLS) agencies. Paramedics and AEMTs are ALS practitioners, and EMTs are BLS practitioners. The practitioners may be paid or volunteer. Many rural ambulance crews are comprised of volunteer EMTs. Recruitment and retention of EMS personnel is a perennial issue, especially for rural and volunteer EMS agencies, and exacerbated by the aging of the EMS workforce.[4-6]

Funding and reimbursement are significant challenges faced by rural ambulance services.[3,7] Ambulance services are reimbursed by Medicare, Medicaid, and commercial insurers, but only if the patient is transported. Moreover, reimbursement is often not sufficient to cover operating costs, especially in rural areas where call volume is low relative to the high fixed costs of operating an ambulance.

To date, the delivery of ambulance services has not been systematically integrated into the health care system, particularly in rural areas.[3,8] This lack of systems planning, along with the lack of data on ambulance service locations at the national level has led to gaps in the provision of ambulance services, also known as "ambulance deserts." "Deserts" are conceptualized as places that lack infrastructure and services that exacerbate disparities among populations. The first desert highlighted in the literature surrounded the lack of access to nutritional food, thus called "food deserts."[9-12] Health care deserts expand on this literature and are described as places where populations lack adequate access to six important health care services:[13] pharmacies,[14,15] hospitals and hospital beds, trauma centers, low-cost health centers, and primary care providers. Provider shortages contribute to the lack of access to both primary and specialty physicians in rural areas, including behavioral health providers.[16-21] Rural women must contend with contraceptive,[22] maternal,[23] neonatal[24] and perinatal deserts.[25] To date, no studies have documented the extent to which the general U.S. population lacks access to ambulance service(s) within reasonable travel times.

Rural Challenges

Based on the Office of Management and Budget's definition of rural (nonmetropolitan) counties, 46 million U.S. residents lived in rural areas in 2020, comprising 14% of the U.S. population.[26] Rural populations tend to be older, sicker, and poorer than their urban counterparts,[27, 28] and they face numerous challenges in accessing health care.[27-29] Indeed, the rural-urban gap in mortality continues to widen, exacerbated by shortages of rural providers.[28] Most Health Professional Shortage Areas (HPSAs) are in rural areas, and there is a notable discrepancy between the proportion of the U.S. population residing in rural areas (between 14% and 20%) and physicians who live and practice in rural areas (just over 10%).[18]

Long transport distances and difficult terrain contribute to long wait times and delayed access to care for rural residents.[3,7] A recent study comparing on-scene response times for rural, suburban, and urban ambulances found that the average rural ambulance response time was more than double that of urban ambulances (rural areas ranged from 8 to 19 minutes compared with 4 to 10 minutes for urban areas), with nearly 1 in 10 rural patients waiting over 30 minutes for the arrival of EMS personnel.[30] Greater distance to care is associated with poorer patient outcomes, particularly among trauma patients with longer EMS response times.[30-34]

Impact of Hospital Closures on Ambulance Services

Hospital closures in rural areas[35,36] can also impact the ability of ambulance services to reach a facility capable of providing the appropriate level of care in a timely manner.[32,37-40] The lack of a nearby hospital or emergency department expands the service areas of rural ambulance agencies, increases response times, and tasks ambulance services with caring for complex patients for longer periods of time.[38,39, 41-44]

Ambulance services do not fit the definitions of medically underserved areas (MUAs) or HPSAs, largely because these are measures of practitioners that patients travel to see in a physical building. There is no corresponding shortage definition for ambulance practitioners that travel to the location of the patient. This project's effort to define and identify ADs offers one option to begin defining shortage areas for ambulance services, and as such, the analysis is an important first step in understanding and addressing gaps in ambulance service coverage, particularly in rural areas of the U.S.

METHODS

This chartbook employs a systematic methodology within a geographic information system (GIS) framework for identifying ADs to assist state and regional policymakers in formulating strategic plans to address gaps in ambulance services across the U.S.

Study Objectives

The study aim was to identify geographic disparities in accessing ambulance services by achieving the following study objectives:

1. Building a database of ambulance service locations, broken out by transporting/non-transporting services, to facilitate mapping of transport-capable service locations,
2. Identifying and creating maps of ADs within each state, and
3. Quantifying the number and percent of county populations living in ADs and stratifying these statistics by state, census region, and rural-urban county classification.

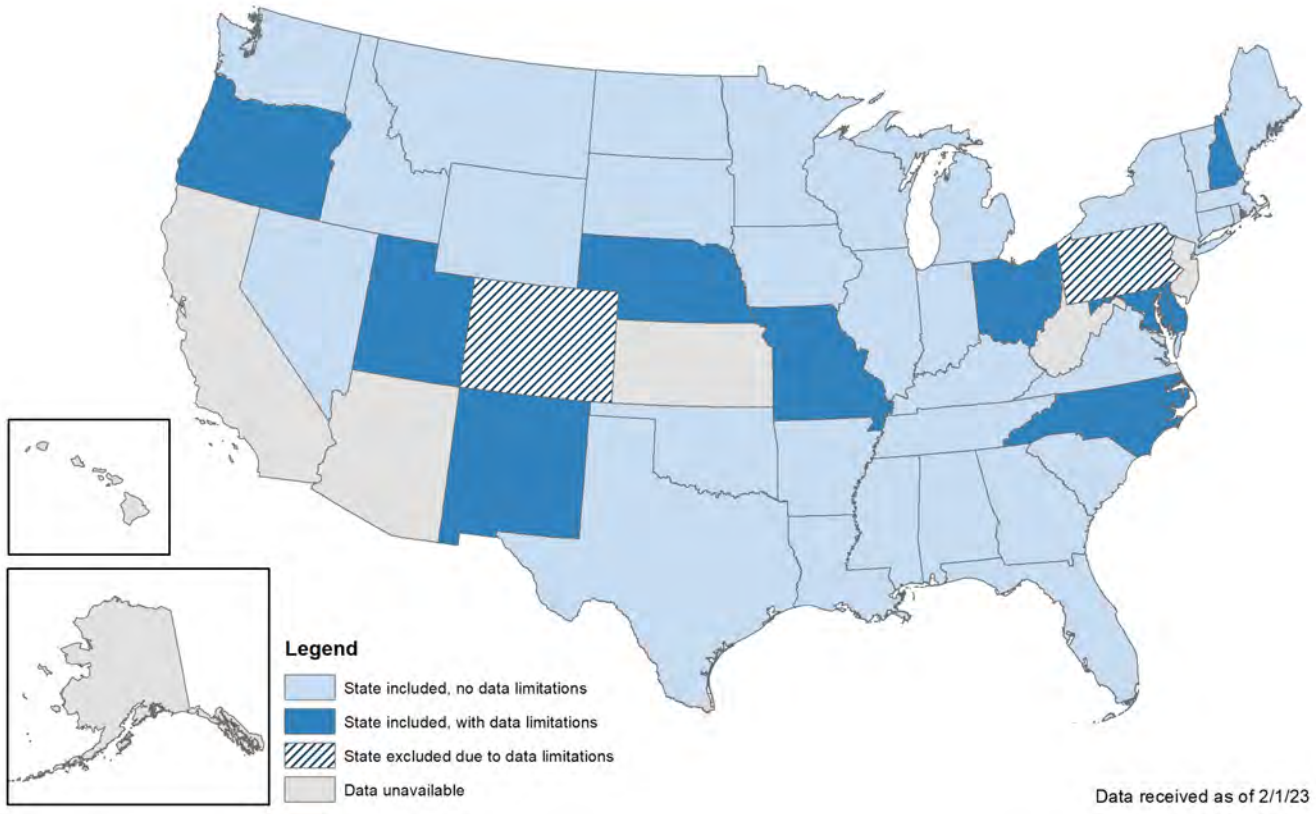
Data Collection

State EMS offices and other applicable EMS organizations in each of the 50 states (including Alaska and Hawaii) were contacted using a standardized email form letter (see Appendix B) to request the most up-to-date ambulance location data available. Prior to contacting state EMS officials, comprehensive web searches for ambulance location data for each state were conducted. This information was used to tailor our initial email outreach, which described both the overall project goals and any progress to date on data collection for the state. The state contacts were asked to verify the accuracy of ambulance location data identified through web searches, and updated information was requested as appropriate. For example, many states were able to provide more current or detailed information by differentiating between transporting and non-transporting services (i.e., services staffed by first responders without a ground transporting ambulance), listing additional satellite stations, or providing physical rather than mailing addresses. Follow-up emails were sent to non-responding states, and phone calls were initiated to state contacts who had not responded by email. Additional information about the study was provided and meetings or phone calls were held as requested by several states. For some states, data request forms or Freedom of Information Act (FOIA) forms and payments were submitted.[i]

As shown in Figure 1, ambulance data were requested from each of the 50 states. Of the states that responded, 31 provided ambulance location data with no limitations and 10 provided data with minor limitations. Two states responded but were excluded due to major data limitations. Data were unavailable from seven states. Major data limitations included not being able to distinguish transporting from non-transporting services (i.e., services that consist of first responders that do not have a ground transporting ambulance); minor limitations included the provision of incomplete information on ambulance station locations. For example, some states were only able to provide agency mailing or headquarters addresses (which may not correspond with station locations), potentially resulting in the overestimation of ambulance deserts. Any data limitations are listed in the footnotes of the state maps (Appendix A).

[i] Four states (LA, MN, MS, and OK) required data request forms and fees, ranging from $4.50 to $120.80, as permitted under the FOIA. Six states (CO, GA, IL, IN, MI, and OR) required data request forms but no fees.

FIGURE 1. Ambulance Data Availability and Limitations by State, 2021-2022



Notes: Data provided by 41 states: 31 states had no data limitations; 10 had minor data limitations.
Of the remaining 9 states: 2 had major data limitations and data were unavailable for 7 states.

Maps for each state were created in ArcGIS Desktop ArcMap version 10.8.1[45] using cartographic boundary files (state and county) from the US Census Bureau,[46] and 2020 Census block population data from Esri's World Geocoding Service[47] and the US Census Bureau.[48] Counties were classified as rural and urban using the 2013 Rural-Urban Continuum Codes (RUCCs).[49]

Ambulance station addresses provided by each state were geocoded using Esri and added to the state maps. Ambulance service provider addresses were obtained from state EMS offices as described above.

Next, 25-minute drive time service areas for ambulance stations were estimated using ArcGIS.[50] The definition of a 25-minute travel radius for ambulance service areas was based on consensus within the Expert Work Group.

The service area analysis identified a geographic area encompassing all roads that can be accessed within a specified distance or time (i.e., 25 minutes) from an origin point (i.e., an ambulance station). To estimate populated areas with more limited access to ambulance services, populated census blocks with a geographic center outside of a 25-minute ambulance service area were defined as ADs.

Definitions

Ambulance station: The physical location of a ground transport-capable ambulance service when parked and awaiting a call.

Ambulance service area: A geographic area encompassing all roads that can be accessed within a 25-minute drive time from an ambulance station.

Ambulance desert: A populated census block with its geographic center outside of a 25- minute ambulance service area.

Census blocks identified as ADs were mapped at the state level in relation to the ambulance stations in each state, as well as in relation to other health care facilities (short-term hospitals and Critical Access Hospitals (CAHs), Federally Qualified Health Centers (FQHCs), and Rural Health Clinics (RHCs)). Health care facility locations were obtained from the Health Resources and Services Administration (HRSA).[51]

For each state, the total population living in an AD was estimated using 2020 Census block-level population data.[52] The percent and number of rural and urban county populations living in an AD was estimated as well as the percent of the total AD population living in a rural county. Finally, national maps illustrating county-level rates of living in an AD were created.

RESULTS

The results section begins with an overall description of the prevalence of ADs in rural and urban counties across the 41 states (Table 1), and the distribution of people living in ADs across rural-urban counties within the four census regions (Table 2). Grouping states within census regions, state-level statistics and rankings are reported in Tables 3-6 and Tables 9-12 as follows:

- Percent of counties with ADs (Table 3),
- Number of ambulance stations per 100,000 residents (Table 4),
- Number of ambulance stations per 1,000 square miles (Table 5),
- Percent of county populations living in ADs (Table 6),
- Overview of the information on AD populations displayed in the state maps (Table 9),
- Distribution of state populations living in ADs (Table 10),
- Distribution of rural county populations living in ADs (Table 11), and
- Percent of AD populations living in rural counties (Table 12).

National level maps illustrating the distribution of county populations living in ADs are presented overall, as well as by rural-urban counties. State level maps illustrating the location of ambulance stations and ADs at the census block level are presented in Appendix A.

Prevalence of Ambulance Deserts in Rural and Urban Counties

Across the 41 states included in these analyses, 4.5 million people lived in locations that were more than a 25-minute drive from where an ambulance was stationed, and therefore lived in an ambulance desert (AD) in 2021-2022 (Table 1). Of the 4.5 million living in ADs, 2.3 million lived in rural counties and 2.2 million lived in urban counties. Note that we used county as our unit of analysis and some counties contain a mix of rural and urban places.[53] Thus, our analysis found that both urban and rural counties contain communities that are ambulance deserts. Eighty-two percent of all counties (n=2,726) in the 41 states represented in these analyses had at least one ambulance desert (AD) at the census block level.

In examining the prevalence of ADs, a substantial majority of both urban and rural counties in the 41 states represented in these analyses had at least one census block classified as an AD within them (Table 1). Rural counties were more likely to have at least one AD than urban counties (84% versus 77%), and a higher proportion of rural county populations were living in ADs. Specifically, of the 1,723 rural counties and 1,003 urban counties represented within the 41 states, rural counties had higher percentages of their populations living in ADs (9.3% on average) compared with urban counties (3.5% on average).

TABLE 1. Prevalence of Ambulance Deserts in Rural and Urban Counties Across 41 States, 2021-2022

	Rural Counties	Urban Counties	All Counties
Number of counties (in 41 states)	1,723	1,003	2,726
Number (%) of counties with at least one AD at the census block level	1,455 (84.4%)	771 (76.9%)	2,226 (81.7%)
Number (%) of counties with no ADs	268 (15.6%)	232 (23.1%)	500 (18.3%)
Percent of population living in ADs:			
Average across all counties	9.3%	3.5%	7.2%
Average across counties with ADs	11.0%	4.6%	8.8%
Total AD populations (n)	2,310,920	2,200,364	4,511,284

Notes: AD = Ambulance Deserts; all counties in these analyses are populated; only populated census blocks were included when identifying ADs.
Population Data Source: United States Census Bureau, American Community Survey

Census Region Comparisons

Across the four census regions and considering both urban and rural counties, the South had the highest number of people living in ADs (2.6 million) and accounted for 59% of the people living in ADs across the 41 states (Table 2). Considering AD populations living in rural counties, the South also had the highest number of AD populations living in rural counties (1.2 million) and accounted for 51% of the AD population living in rural counties across the 41 states. The South also accounts for a greater number of states (15) than the other regions and represented half of all counties and approximately half of the total sample population. The Western and Midwestern states accounted for 24% and 19%, respectively, of AD populations living in rural counties. The Northeastern census region had the lowest number of AD populations living in rural counties (n=132,000) and accounted for 6% of the total number of people living in ADs in rural counties.

TABLE 2. Regional Differences in Ambulance Desert Populations, 2021-2022

Census Region	States	Counties		Total Population		Ambulance Desert (AD) Populations			
						All Counties with ADs		Rural Counties with ADs	
	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Northeast	7	131	4.8	35,090,056	14.2	228,921	5.1	132,004	5.7
Midwest	11	950	34.8	65,835,583	26.6	624,826	13.9	434,642	18.8
South	15	1,368	50.2	123,146,840	49.7	2,661,652	59.0	1,188,733	51.4
West	8	277	10.2	23,816,568	9.6	995,885	22.1	555,541	24.0
Totals	41	2,726	100	247,889,047	100	4,511,284	100	2,310,920	100

Notes: All counties in these analyses are populated; only populated census blocks were included when identifying Ambulance Deserts.
Population Data Source: United States Census Bureau, American Community Survey

Percent of Counties with Ambulance Deserts by State and Census Region

Next, state level analyses and rankings are presented, with states in each of the census regions color coded as displayed in Table 2 above and repeated in subsequent tables. Strikingly, 100% of the counties in the Western states contained ADs, and many states in the South (11 out of 15 states) and Northeast (4 of 7 states) had over 90% of their counties containing ADs at the census block level (Table 3). Four of the 10 Midwestern states had the lowest percentage of counties with ADs: less than half of the counties in Ohio (24%), Iowa (37%), and Illinois (48%) had residents living in ADs, and just over half (52%) of Minnesota's counties had ADs within them.

TABLE 3. Percent of Counties with Ambulance Deserts by State and Census Region, 2021-2022

State	Counties	Counties with Ambulance Deserts		State Rankings	Counties with Ambulance Deserts
	Number	Number	Percent		Percent
Connecticut	8	7	87.5	Arkansas	100
Maine	16	15	93.8	Idaho	100
Massachusetts	14	13	92.9	Montana	100
New Hampshire	10	9	90.0	Nevada	100
New York	62	51	82.3	New Mexico	100
Rhode Island	7	5	71.4	North Dakota	100
Vermont	14	14	100	Oregon	100
Illinois	102	49	48.0	Utah	100
Indiana	92	46	50.0	Vermont	100
Iowa	99	37	37.4	Washington	100
Michigan	83	58	69.9	Wyoming	100
Minnesota	87	45	51.7	Louisiana	98.4
Missouri	115	111	96.5	Tennessee	97.9
Nebraska	93	71	76.3	Mississippi	97.6
North Dakota	53	53	100	Missouri	96.5
Ohio	88	21	23.9	Oklahoma	96.1
South Dakota	66	57	86.4	South Carolina	95.7
Wisconsin	72	55	76.4	Alabama	95.5
Alabama	67	64	95.5	Texas	94.9
Arkansas	75	75	100	North Carolina	94.1
Delaware	4	3	75.0	Maine	93.8
Florida	67	62	92.5	Massachusetts	92.9
Georgia	159	102	64.2	Florida	92.5
Kentucky	120	110	91.7	Kentucky	91.7
Louisiana	64	63	98.4	New Hampshire	90.0
Maryland	24	21	87.5	Connecticut	87.5
Mississippi	82	80	97.6	Maryland	87.5
North Carolina	101	95	94.1	South Dakota	86.4
Oklahoma	77	74	96.1	New York	82.3
South Carolina	46	44	95.7	Virginia	78.9
Tennessee	95	93	97.9	Wisconsin	76.4
Texas	254	241	94.9	Nebraska	76.3
Virginia	133	105	78.9	Delaware	75.0
Idaho	44	44	100	Rhode Island	71.4
Montana	56	56	100	Michigan	69.9
Nevada	17	17	100	Georgia	64.2
New Mexico	33	33	100	Minnesota	51.7
Oregon	36	36	100	Indiana	50.0
Utah	29	29	100	Illinois	48.0
Washington	39	39	100	Iowa	37.4
Wyoming	23	23	100	Ohio	23.9

Census Region Legend	West	Midwest	South	Northeast

Number of Ambulance Stations per 100,000 Residents and per 1,000 Square Miles

The number of ambulance stations per capita ranged from a low of 1.8 per 100,000 residents in Nevada to a high of 18.6 per 100,000 residents in North Dakota (Table 4). However, illustrating how highly dispersed the rural populations are, and how many square miles each ambulance station potentially needs to cover, the Western states of Nevada, Wyoming, Montana, Utah, New Mexico, and Idaho, and the Midwestern states of North and South Dakota, have fewer than three ambulances covering every 1,000 square miles of land area (range: 0.5 to 2.7 ambulances per 1,000 square miles) (Table 5). While these statistics do not account for whether these areas are populated or not, they illustrate why many rural states such as North and South Dakota, where they have a relatively large number of stations per capita (approximately 14 to 19 per 100,000 residents), still face coverage gaps with respect to ambulance services.

TABLE 4. Ambulance Stations per 100,000 Residents by State and Census Region, 2021-2022

State	Ambulance Stations	2020 Total Population	Ambulance Stations	State Rankings	Ambulance Stations
	Number	Number	N per 100,000		N per 100,000
Connecticut	156	3,566,158	4.4	Nevada	1.8
Maine	215	1,362,359	15.8	Utah	2.6
Massachusetts	535	6,965,025	7.7	North Carolina	3.0
New Hampshire	161	1,358,239	11.9	Tennessee	3.1
New York	980	20,122,971	4.9	Alabama	3.4
Rhode Island	64	1,077,212	5.9	Missouri	3.5
Vermont	70	638,092	11.0	Kentucky	4.0
Illinois	849	12,789,384	6.6	Indiana	4.3
Indiana	292	6,766,656	4.3	Connecticut	4.4
Iowa	483	3,186,652	15.2	Mississippi	4.7
Michigan	615	10,014,556	6.1	New York	4.9
Minnesota	493	5,697,701	8.7	Virginia	5.2
Missouri	218	6,146,776	3.5	Louisiana	5.5
Nebraska	358	1,958,934	18.3	Arkansas	5.9
North Dakota	144	774,432	18.6	Rhode Island	5.9
Ohio	879	11,750,316	7.5	Michigan	6.1
South Dakota	124	881,791	14.1	Oklahoma	6.4
Wisconsin	790	5,868,385	13.5	Texas	6.4
Alabama	172	5,001,226	3.4	Illinois	6.6
Arkansas	178	3,001,516	5.9	Maryland	7.0
Delaware	69	972,247	7.1	Delaware	7.1
Florida	1,826	21,371,629	8.5	Oregon	7.2
Georgia	875	10,692,357	8.2	Ohio	7.5
Kentucky	178	4,494,711	4.0	Massachusetts	7.7
Louisiana	256	4,648,716	5.5	Georgia	8.2
Maryland	425	6,092,700	7.0	Florida	8.5
Mississippi	139	2,943,984	4.7	Minnesota	8.7
North Carolina	314	10,351,973	3.0	South Carolina	9.1
Oklahoma	252	3,954,302	6.4	Vermont	11.0
South Carolina	461	5,093,301	9.1	New Mexico	11.6
Tennessee	210	6,877,860	3.1	New Hampshire	11.9
Texas	1,868	29,111,097	6.4	Idaho	12.1
Virginia	444	8,539,221	5.2	Wyoming	12.9
Idaho	221	1,833,529	12.1	Montana	13.1
Montana	142	1,084,225	13.1	Wisconsin	13.5
Nevada	55	3,102,157	1.8	South Dakota	14.1
New Mexico	246	2,112,893	11.6	Iowa	15.2
Oregon	305	4,228,135	7.2	Washington	15.7
Utah	84	3,269,338	2.6	Maine	15.8
Washington	1,194	7,610,342	15.7	Nebraska	18.3
Wyoming	74	574,698	12.9	North Dakota	18.6

Census Region Legend	West	Midwest	South	Northeast

TABLE 5. Ambulance Stations per 1,000 Square Miles by State and Census Region, 2021-2022

State	Ambulance Stations	2010 Land Area	Ambulance Stations	State Rankings	Ambulance Stations
	Number	Square Miles	N per 1,000 Sq Miles		N per 1,000 Sq Miles
Connecticut	156	4,842	32.2	Nevada	0.5
Maine	215	30,843	7.0	Wyoming	0.8
Massachusetts	535	7,800	68.6	Montana	1.0
New Hampshire	161	8,953	18.0	Utah	1.0
New York	980	47,126	20.8	South Dakota	1.6
Rhode Island	64	1,034	61.9	New Mexico	2.0
Vermont	70	9,217	7.6	North Dakota	2.1
Illinois	849	55,519	15.3	Idaho	2.7
Indiana	292	35,826	8.2	Mississippi	3.0
Iowa	483	55,857	8.6	Missouri	3.2
Michigan	615	56,539	10.9	Oregon	3.2
Minnesota	493	79,627	6.2	Alabama	3.4
Missouri	218	68,742	3.2	Arkansas	3.4
Nebraska	358	76,824	4.7	Oklahoma	3.7
North Dakota	144	69,001	2.1	Kentucky	4.5
Ohio	879	40,861	21.5	Nebraska	4.7
South Dakota	124	75,811	1.6	Tennessee	5.1
Wisconsin	790	54,158	14.6	Louisiana	5.9
Alabama	172	50,645	3.4	Minnesota	6.2
Arkansas	178	52,035	3.4	North Carolina	6.5
Delaware	69	1,949	35.4	Maine	7.0
Florida	1,826	53,625	34.1	Texas	7.2
Georgia	875	57,513	15.2	Vermont	7.6
Kentucky	178	39,486	4.5	Indiana	8.2
Louisiana	256	43,204	5.9	Iowa	8.6
Maryland	425	9,707	43.8	Michigan	10.9
Mississippi	139	46,923	3.0	Virginia	11.2
North Carolina	314	48,618	6.5	Wisconsin	14.6
Oklahoma	252	68,595	3.7	Georgia	15.2
South Carolina	461	30,061	15.3	Illinois	15.3
Tennessee	210	41,235	5.1	South Carolina	15.3
Texas	1,868	261,232	7.2	Washington	18.0
Virginia	444	39,490	11.2	New Hampshire	18.0
Idaho	221	82,643	2.7	New York	20.8
Montana	142	145,546	1.0	Ohio	21.5
Nevada	55	109,781	0.5	Connecticut	32.2
New Mexico	246	121,298	2.0	Florida	34.1
Oregon	305	95,988	3.2	Delaware	35.4
Utah	84	82,170	1.0	Maryland	43.8
Washington	1,194	66,456	18.0	Rhode Island	61.9
Wyoming	74	97,093	0.8	Massachusetts	68.6

Census Region Legend	West	Midwest	South	Northeast

Percent of County Populations Living in Ambulance Deserts by Census Region and State

Treating the county as the unit of analysis, the percent of county populations living in ADs are presented as statewide averages across all counties within each state as well as across counties with ADs (Table 6). State rankings focused on all counties within each state are also presented.

Within Census Regions:

Each of the four major census regions showed considerable variation in the percent of their county populations living in ADs. For example, in the Northeast: Connecticut, Massachusetts, and Rhode Island had less than 1% of their county populations living in ADs while the more rural states of Maine and Vermont had 10% and 13% of their populations living in ADs, respectively. The other regions showed similar variation in the percent of people living in ADs with less than 1% to over 15% in the Midwest, less than 1% to 12% in the South, and approximately 10% to 28% in the West.

State Rankings:

Focusing on those counties with ADs, the Western states of Montana (28%), New Mexico (20%) and Utah (19%) had the highest average percentage of their county populations living in ADs, followed by the Midwestern state of South Dakota (15%). The Western states of Nevada (15%), Idaho (13%) and Wyoming (13%) had among the highest percentages of their county populations living in ADs. The Northeastern states of Connecticut (0.3%), Rhode Island (0.4%), and Massachusetts (0.8%) had the lowest county averages of all the states with less than 1% of their county populations living in ADs.

TABLE 6. Percent of County Populations Living in Ambulance Deserts by State and Census Region, 2021-2022

State	Average Across All Counties	Average Across Counties with Ambulance Deserts	State Rankings	Average Across All Counties
	Percent	Percent		Percent
Connecticut	0.2	0.3	Montana	27.8
Maine	9.7	10.3	New Mexico	19.6
Massachusetts	0.7	0.8	Utah	19.1
New Hampshire	2.8	3.1	South Dakota	15.2
New York	2.1	2.5	Nevada	14.9
Rhode Island	0.3	0.4	Idaho	13.3
Vermont	12.9	12.9	Wyoming	13.0
Illinois	0.8	1.8	Vermont	12.9
Indiana	3.7	7.4	Arkansas	12.2
Iowa	0.8	2.2	Oregon	11.3
Michigan	3.4	4.9	North Dakota	10.5
Minnesota	2.3	4.4	Nebraska	10.5
Missouri	10.4	10.8	Missouri	10.4
Nebraska	10.5	13.7	Washington	10.3
North Dakota	10.5	10.5	Texas	9.7
Ohio	0.5	2.3	Alabama	9.7
South Dakota	15.2	17.6	Maine	9.7
Wisconsin	1.5	2.0	North Carolina	9.2
Alabama	9.7	10.1	Louisiana	7.8
Arkansas	12.2	12.2	Tennessee	7.6
Delaware	0.7	1.0	Kentucky	6.9
Florida	2.5	2.7	Virginia	6.5
Georgia	1.9	2.9	Mississippi	6.4
Kentucky	6.9	7.5	Oklahoma	4.8
Louisiana	7.8	8.0	Indiana	3.7
Maryland	3.5	4.0	Maryland	3.5
Mississippi	6.4	6.5	Michigan	3.4
North Carolina	9.2	9.8	New Hampshire	2.8
Oklahoma	4.8	5.0	Florida	2.5
South Carolina	2.5	2.6	South Carolina	2.5
Tennessee	7.6	7.8	Minnesota	2.3
Texas	9.7	10.2	New York	2.1
Virginia	6.5	8.3	Georgia	1.9
Idaho	13.3	13.3	Wisconsin	1.5
Montana	27.8	27.8	Illinois	0.8
Nevada	14.9	14.9	Iowa	0.8
New Mexico	19.6	19.6	Delaware	0.7
Oregon	11.3	11.3	Massachusetts	0.7
Utah	19.1	19.1	Ohio	0.5
Washington	10.3	10.3	Rhode Island	0.3
Wyoming	13.0	13.0	Connecticut	0.2

Census Region Legend	West	Midwest	South	Northeast

NATIONAL MAPS

PERCENT OF COUNTY POPULATIONS LIVING IN AMBULANCE DESERTS

Figures 2 and 3 display the percentage of rural and urban county populations living in ADs using the five categories listed in Table 7. Figure 2 provides a national view whereas Figure 3 highlights differences in rural and urban counties within the 41 states. As shown in Table 7, rural counties were more likely to have higher percentages of their county populations living in ADs than urban counties. Over 80% of urban counties had less than 5% of their populations living in ADs compared with 56% of rural counties.

TABLE 7. Percent of County Populations Living in Ambulance Deserts, 2021-2022

Categories		Rural Counties		Urban Counties		All Counties	
		Number	Percent	Number	Percent	Number	Percent
1	0-1%	542	31.5	541	53.9	1,083	39.7
2	2-5%	422	24.5	273	27.2	695	25.5
3	6-15%	441	25.6	135	13.5	576	21.1
4	16-50%	259	15.0	47	4.7	306	11.2
5	51-100%	59	3.4	7	0.7	66	2.4
Totals		1,723		1,003		2,726	

Note: Categories were chosen based on population tiers

Figures 2 and 3 illustrate the concentration of ADs within the Appalachian region as well as other areas characterized by difficult terrain such as the Rocky Mountains and more mountainous regions of Maine and Vermont. Notably, Texas, the Dakotas, and Nebraska each contain several rural counties with particularly high concentrations of people living in ADs.

Finally, several counties located in coastal areas represent potential areas of concern with extended ambulance drive times likely reflecting the winding roads needed to traverse the jagged terrain.

FIGURE 2. Percent of County Populations Living in Ambulance Deserts, 2021-2022

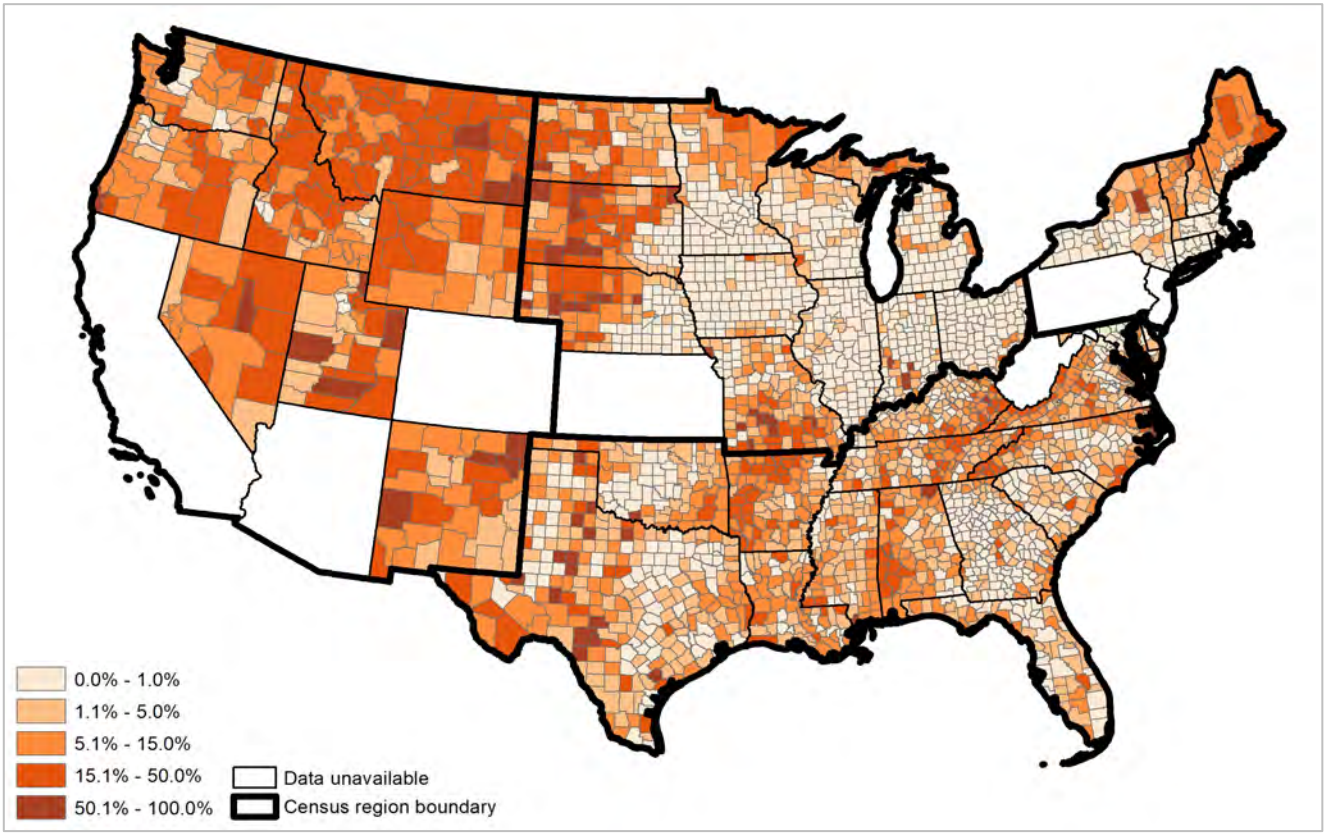
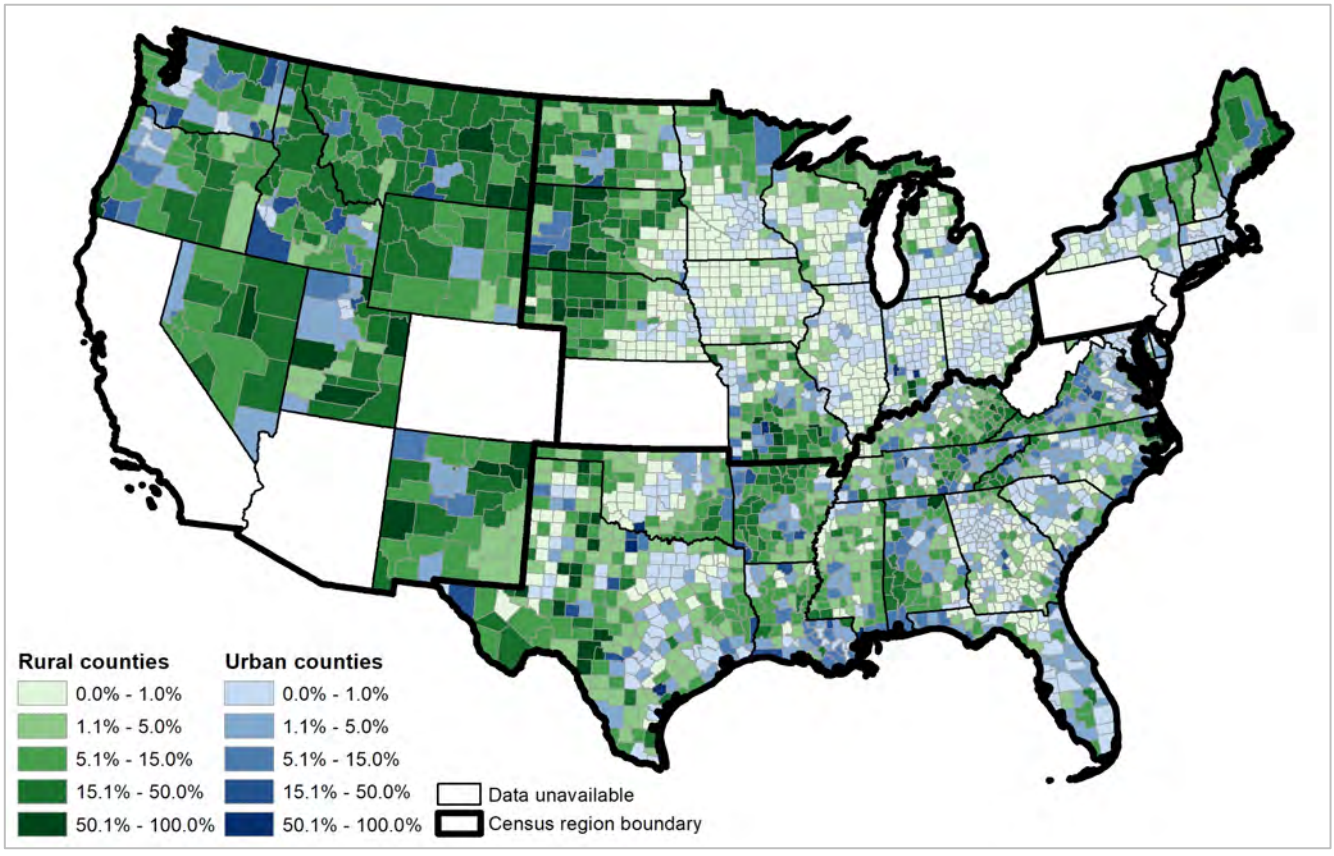


FIGURE 3. Percent of Rural and Urban County Populations Living in Ambulance Deserts, 2021-2022



NUMBER OF PEOPLE LIVING IN AMBULANCE DESERTS BY COUNTY

Turning to the maps illustrating the variation in the average number of people living in counties with ADs: as expected, rural counties with ADs tend to be less densely populated than urban counties (Table 8, Figures 4 and 5). While Iowa, Illinois, Ohio, and Wisconsin, for example, appear to have relatively few people living in ADs, the rest of the nation appears to be facing considerable challenges ensuring timely access to ambulance services (Figures 4 and 5).

TABLE 8. Number of People Living in Ambulance Deserts by County, 2021-2022

Categories		Rural Counties		Urban Counties		All Counties	
		Number	Percent	Number	Percent	Number	Percent
1	0-250	679	39.4	389	38.8	1,068	39.2
2	250-1,000	442	25.7	183	18.3	625	22.9
3	1,000-2,500	331	19.2	192	19.1	523	19.2
4	2,500-10,000	252	14.6	194	19.3	446	16.4
5	10,000-60,000	19	1.1	45	4.5	64	2.3
Totals		1,723		1,003		2,726	

FIGURE 4. Number of People Living in Ambulance Deserts by County, 2021-2022

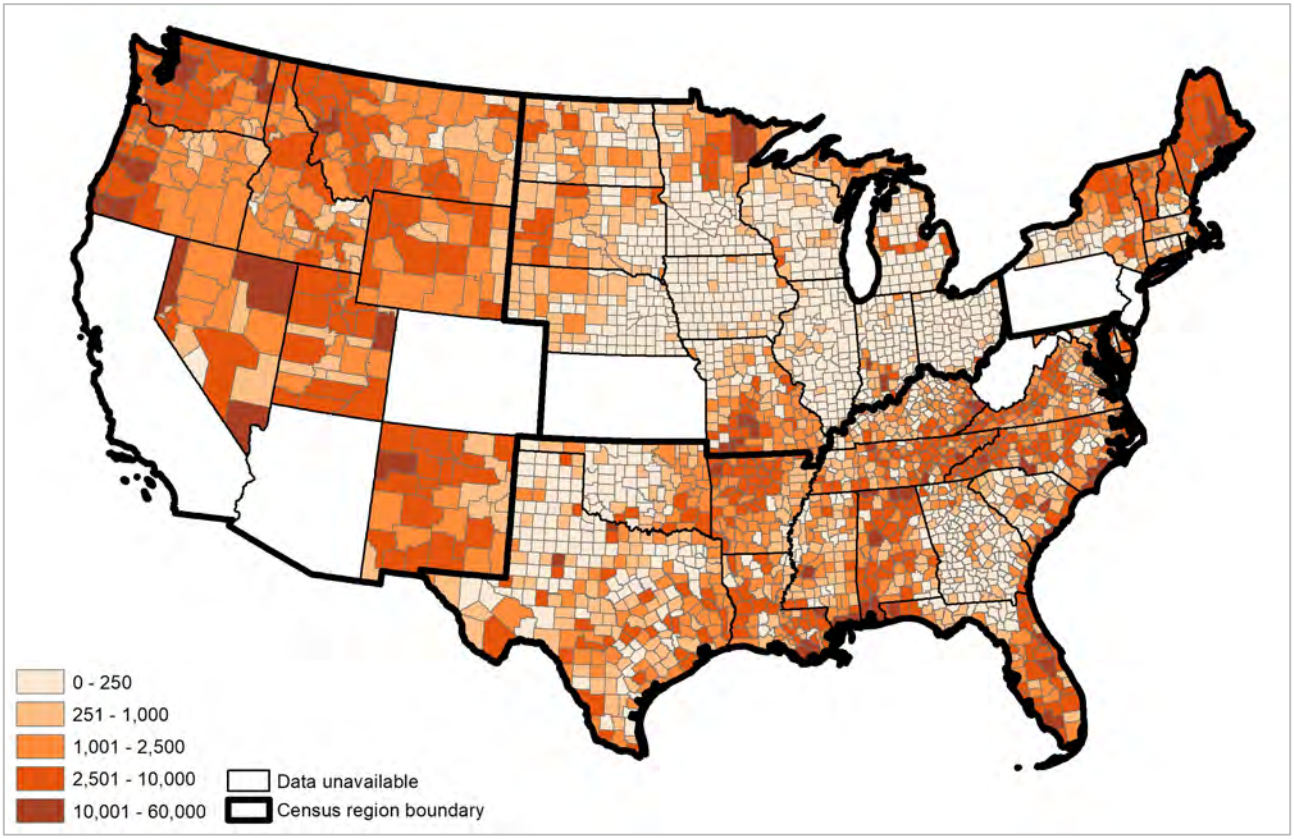
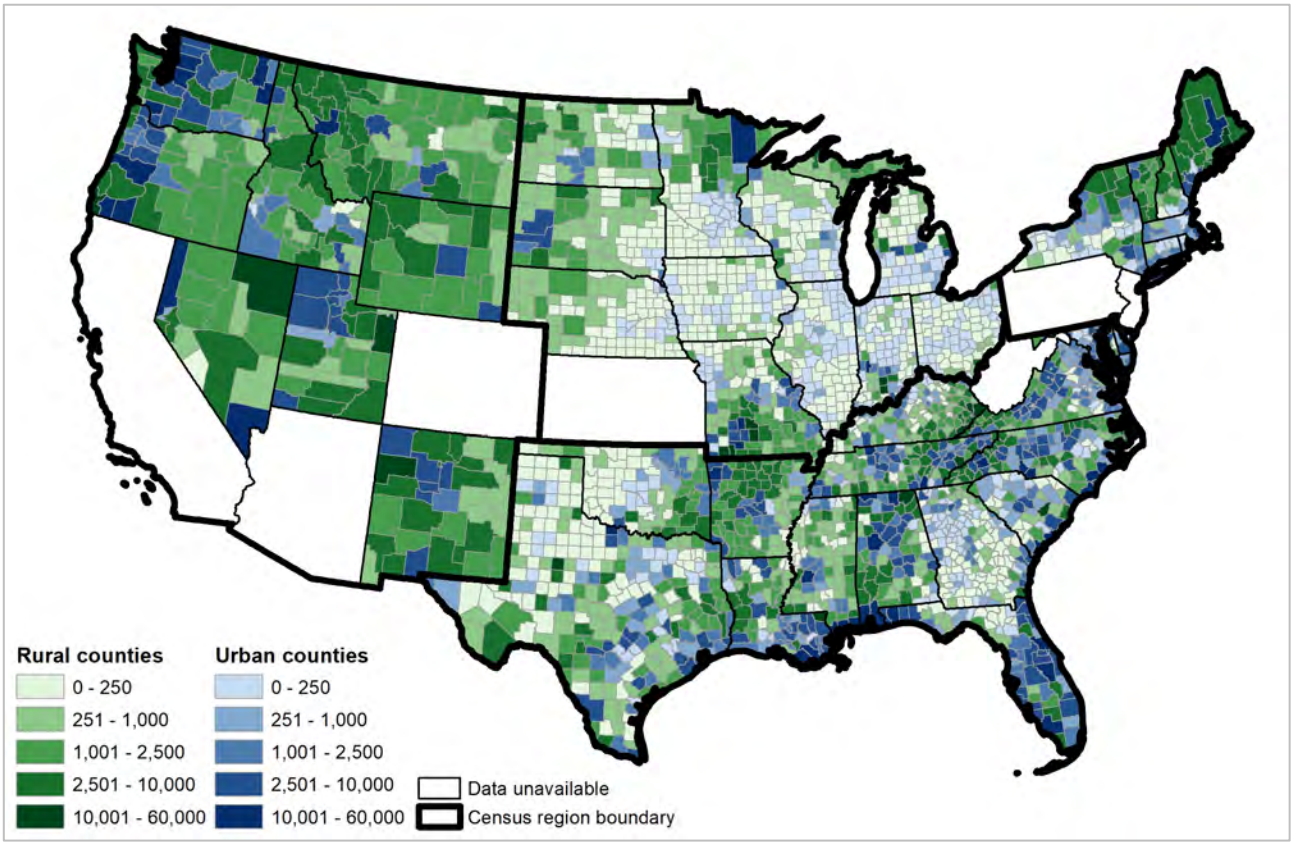


FIGURE 5. Number of People Living in Ambulance Deserts by County Rurality, 2021-2022



SUMMARY OF STATE-LEVEL INFORMATION FOUND IN APPENDIX A. STATE MAPS

Table 9 provides a summary snapshot of the state-level information found in the state maps presented in Appendix A. Tables 10-12 provide a ranked summary of the percent of state and rural populations living in ADs, and the percent of AD populations living in rural counties, respectively.

In terms of the state populations living in ADs, the states in the South were predominantly at the top of the list, ranging from 164,000 in Mississippi to well over 300,000 in North Carolina, Alabama, and Texas (Table 10). Most states in the West had between 100,000 and 200,000 people living in ADs. The Northeastern states of Rhode Island (1,900) and Connecticut (6,000) had the fewest residents living in ADs, followed by the Midwestern states of Iowa (9,300), Illinois (10,250), and Ohio (12,500).

In terms of the rural populations living in ADs: States in the South (e.g., Texas, North Carolina, Alabama, Kentucky, Arkansas, and Tennessee), the Midwest (Missouri), and the West (Montana) had the highest number of rural residents living in ADs (over 100,000 people). The Northeastern states of Rhode Island, Connecticut and Massachusetts, and the Southern state of Delaware had the fewest number of people in rural counties living in ADs (fewer than 1,200) ((Table 11).

Finally, in terms of the percent of the AD population living in rural counties: In 23 of the 41 states, more than half of state populations living in ADs were in rural counties (Table 12). States with the highest rates (over 94%) of AD populations living in rural counties included New Hampshire, Nebraska, and Ohio, followed by 75% to 87% of AD populations in Wyoming, Iowa, Vermont, Kentucky, Montana, and North and South Dakota.

States with the lowest rates of AD populations living in rural counties included the Northeastern states of Rhode Island (0%), Massachusetts (7%), and Connecticut (14%) and the Southern states of Delaware (0%), Maryland (10%) and Florida (15%).

TABLE 9. Number of Ambulance Stations and Characteristics of Ambulance Desert Populations by State and Census Region, 2021-2022

State	Ambulance Stations	Ambulance Deserts (AD)		Rural County Ambulance Deserts (AD)		
		State Populations Living in ADs		Rural County Populations Living in ADs		AD Populations in Rural Counties
	Number	Number	Percent	Number	Percent	Percent
Connecticut	156	6,049	0.2	840	0.5	13.9
Maine	215	82,346	6.0	54,278	9.9	65.9
Massachusetts	535	17,370	0.2	1,170	1.1	6.7
New Hampshire	161	16,335	1.2	15,754	3.1	96.4
New York	980	64,069	0.3	27,046	2.0	42.2
Rhode Island	64	1,913	0.2	0	N/A	N/A
Vermont	70	40,839	6.4	32,916	8.0	80.6
Illinois	849	10,257	0.1	7,169	0.5	69.9
Indiana	292	93,807	1.4	56,974	3.9	60.7
Iowa	483	9,289	0.3	7,952	0.6	85.6
Michigan	615	65,709	0.7	38,857	2.2	59.1
Minnesota	493	46,702	0.8	33,226	2.7	71.1
Missouri	218	249,232	4.1	171,696	11.4	68.9
Nebraska	358	21,746	1.1	20,874	3.2	96.0
North Dakota	144	31,333	4.0	24,980	6.5	79.7
Ohio	879	12,565	0.1	11,887	0.5	94.6
South Dakota	124	58,688	6.7	43,944	9.9	74.9
Wisconsin	790	25,498	0.4	17,083	1.1	67.0
Alabama	172	314,841	6.3	144,260	12.6	45.8
Arkansas	178	195,159	6.5	128,370	11.7	65.8
Delaware	69	7,218	0.7	0	N/A	N/A
Florida	1,826	199,176	0.9	29,031	4.2	14.6
Georgia	875	80,599	0.8	28,005	1.6	34.7
Kentucky	178	177,914	4.0	143,137	7.8	80.5
Louisiana	256	178,747	3.8	65,571	9.0	36.7
Maryland	425	62,912	1.0	6,493	4.6	10.3
Mississippi	139	164,259	5.6	64,881	4.2	39.5
North Carolina	314	366,147	3.5	146,971	7.0	40.1
Oklahoma	252	62,786	1.6	45,733	3.5	72.8
South Carolina	461	83,587	1.6	24,569	3.4	29.4
Tennessee	210	265,949	3.9	109,891	7.2	41.3
Texas	1,868	313,248	1.1	174,909	5.8	55.8
Virginia	444	189,110	2.2	76,912	7.6	40.7
Idaho	221	84,254	4.6	57,428	9.6	68.2
Montana	142	140,365	12.9	112,824	16.0	80.4
Nevada	55	110,933	3.6	36,640	12.7	33.0
New Mexico	246	119,854	5.7	81,399	11.6	67.9
Oregon	305	159,690	3.8	74,988	11.0	47.0
Utah	84	117,299	3.6	69,283	20.8	59.1
Washington	1,194	209,285	2.8	75,942	10.5	36.3
Wyoming	74	54,205	9.4	47,037	11.9	86.8

Census Region Legend	West	Midwest	South	Northeast

Notes: N/A = not applicable. Delaware and Rhode Island do not have any rural counties.

TABLE 10. State Rankings: State Populations Living in Ambulance Deserts, 2021-2022

State	State Populations Living in Ambulance Deserts		State Rankings	State Populations Living in Ambulance Deserts	
	Number	Percent		Number	Percent
Connecticut	6,049	0.2	North Carolina	366,147	3.5
Maine	82,346	6.0	Alabama	314,841	6.3
Massachusetts	17,370	0.2	Texas	313,248	1.1
New Hampshire	16,335	1.2	Tennessee	265,949	3.9
New York	64,069	0.3	Missouri	249,232	4.1
Rhode Island	1,913	0.2	Washington	209,285	2.8
Vermont	40,839	6.4	Florida	199,176	0.9
Illinois	10,257	0.1	Arkansas	195,159	6.5
Indiana	93,807	1.4	Virginia	189,110	2.2
Iowa	9,289	0.3	Louisiana	178,747	3.8
Michigan	65,709	0.7	Kentucky	177,914	4.0
Minnesota	46,702	0.8	Mississippi	164,259	5.6
Missouri	249,232	4.1	Oregon	159,690	3.8
Nebraska	21,746	1.1	Montana	140,365	12.9
North Dakota	31,333	4.0	New Mexico	119,854	5.7
Ohio	12,565	0.1	Utah	117,299	3.6
South Dakota	58,688	6.7	Nevada	110,933	3.6
Wisconsin	25,498	0.4	Indiana	93,807	1.4
Alabama	314,841	6.3	Idaho	84,254	4.6
Arkansas	195,159	6.5	South Carolina	83,587	1.6
Delaware	7,218	0.7	Maine	82,346	6.0
Florida	199,176	0.9	Georgia	80,599	0.8
Georgia	80,599	0.8	Michigan	65,709	0.7
Kentucky	177,914	4.0	New York	64,069	0.3
Louisiana	178,747	3.8	Maryland	62,912	1.0
Maryland	62,912	1.0	Oklahoma	62,786	1.6
Mississippi	164,259	5.6	South Dakota	58,688	6.7
North Carolina	366,147	3.5	Wyoming	54,205	9.4
Oklahoma	62,786	1.6	Minnesota	46,702	0.8
South Carolina	83,587	1.6	Vermont	40,839	6.4
Tennessee	265,949	3.9	North Dakota	31,333	4.0
Texas	313,248	1.1	Wisconsin	25,498	0.4
Virginia	189,110	2.2	Nebraska	21,746	1.1
Idaho	84,254	4.6	Massachusetts	17,370	0.2
Montana	140,365	12.9	New Hampshire	16,335	1.2
Nevada	110,933	3.6	Ohio	12,565	0.1
New Mexico	119,854	5.7	Illinois	10,257	0.1
Oregon	159,690	3.8	Iowa	9,289	0.3
Utah	117,299	3.6	Delaware	7,218	0.7
Washington	209,285	2.8	Connecticut	6,049	0.2
Wyoming	54,205	9.4	Rhode Island	1,913	0.2

Census Region Legend	West	Midwest	South	Northeast

TABLE 11. State Rankings: Rural County Populations Living in Ambulance Deserts, 2021-2022

State	Rural County Populations Living in Ambulance Deserts		State Rankings	Rural County Populations Living in Ambulance Deserts	
	Number	Percent		Number	Percent
Connecticut	840	0.5	Texas	174,909	5.8
Maine	54,278	9.9	Missouri	171,696	11.4
Massachusetts	1,170	1.1	North Carolina	146,971	7.0
New Hampshire	15,754	3.1	Alabama	144,260	12.6
New York	27,046	2.0	Kentucky	143,137	7.8
Rhode Island	0	N/A	Arkansas	128,370	11.7
Vermont	32,916	8.0	Montana	112,824	16.0
Illinois	7,169	0.5	Tennessee	109,891	7.2
Indiana	56,974	3.9	New Mexico	81,399	11.6
Iowa	7,952	0.6	Virginia	76,912	7.6
Michigan	38,857	2.2	Washington	75,942	10.5
Minnesota	33,226	2.7	Oregon	74,988	11.0
Missouri	171,696	11.4	Utah	69,283	20.8
Nebraska	20,874	3.2	Louisiana	65,571	9.0
North Dakota	24,980	6.5	Mississippi	64,881	4.2
Ohio	11,887	0.5	Idaho	57,428	9.6
South Dakota	43,944	9.9	Indiana	56,974	3.9
Wisconsin	17,083	1.1	Maine	54,278	9.9
Alabama	144,260	12.6	Wyoming	47,037	11.9
Arkansas	128,370	11.7	Oklahoma	45,733	3.5
Delaware	0	N/A	South Dakota	43,944	9.9
Florida	29,031	4.2	Michigan	38,857	2.2
Georgia	28,005	1.6	Nevada	36,640	12.7
Kentucky	143,137	7.8	Minnesota	33,226	2.7
Louisiana	65,571	9.0	Vermont	32,916	8.0
Maryland	6,493	4.6	Florida	29,031	4.2
Mississippi	64,881	4.2	Georgia	28,005	1.6
North Carolina	146,971	7.0	New York	27,046	2.0
Oklahoma	45,733	3.5	North Dakota	24,980	6.5
South Carolina	24,569	3.4	South Carolina	24,569	3.4
Tennessee	109,891	7.2	Nebraska	20,874	3.2
Texas	174,909	5.8	Wisconsin	17,083	1.1
Virginia	76,912	7.6	New Hampshire	15,754	3.1
Idaho	57,428	9.6	Ohio	11,887	0.5
Montana	112,824	16.0	Iowa	7,952	0.6
Nevada	36,640	12.7	Illinois	7,169	0.5
New Mexico	81,399	11.6	Maryland	6,493	4.6
Oregon	74,988	11.0	Massachusetts	1,170	1.1
Utah	69,283	20.8	Connecticut	840	0.5
Washington	75,942	10.5	Delaware	0	N/A
Wyoming	47,037	11.9	Rhode Island	0	N/A

Census Region Legend	West	Midwest	South	Northeast

Notes: N/A = not applicable. Delaware and Rhode Island do not have any rural counties.

TABLE 12. State Rankings: Percent of Ambulance Desert Populations in Rural Counties, 2021-2022

State	Ambulance Desert Populations in Rural Counties		State Rankings	Ambulance Desert Populations in Rural Counties	
	Number	Percent		Number	Percent
Connecticut	840	13.9	New Hampshire	15,754	96.4
Maine	54,278	65.9	Nebraska	20,874	96.0
Massachusetts	1,170	6.7	Ohio	11,887	94.6
New Hampshire	15,754	96.4	Wyoming	47,037	86.8
New York	27,046	42.2	Iowa	7,952	85.6
Rhode Island	0	N/A	Vermont	32,916	80.6
Vermont	32,916	80.6	Kentucky	143,137	80.5
Illinois	7,169	69.9	Montana	112,824	80.4
Indiana	56,974	60.7	North Dakota	24,980	79.7
Iowa	7,952	85.6	South Dakota	43,944	74.9
Michigan	38,857	59.1	Oklahoma	45,733	72.8
Minnesota	33,226	71.1	Minnesota	33,226	71.1
Missouri	171,696	68.9	Illinois	7,169	69.9
Nebraska	20,874	96.0	Missouri	171,696	68.9
North Dakota	24,980	79.7	Idaho	57,428	68.2
Ohio	11,887	94.6	New Mexico	81,399	67.9
South Dakota	43,944	74.9	Wisconsin	17,083	67.0
Wisconsin	17,083	67.0	Maine	54,278	65.9
Alabama	144,260	45.8	Arkansas	128,370	65.8
Arkansas	128,370	65.8	Indiana	56,974	60.7
Delaware	0	N/A	Michigan	38,857	59.1
Florida	29,031	14.6	Utah	69,283	59.1
Georgia	28,005	34.7	Texas	174,909	55.8
Kentucky	143,137	80.5	Oregon	74,988	47.0
Louisiana	65,571	36.7	Alabama	144,260	45.8
Maryland	6,493	10.3	New York	27,046	42.2
Mississippi	64,881	39.5	Tennessee	109,891	41.3
North Carolina	146,971	40.1	Virginia	76,912	40.7
Oklahoma	45,733	72.8	North Carolina	146,971	40.1
South Carolina	24,569	29.4	Mississippi	64,881	39.5
Tennessee	109,891	41.3	Louisiana	65,571	36.7
Texas	174,909	55.8	Washington	75,942	36.3
Virginia	76,912	40.7	Georgia	28,005	34.7
Idaho	57,428	68.2	Nevada	36,640	33.0
Montana	112,824	80.4	South Carolina	24,569	29.4
Nevada	36,640	33.0	Florida	29,031	14.6
New Mexico	81,399	67.9	Connecticut	840	13.9
Oregon	74,988	47.0	Maryland	6,493	10.3
Utah	69,283	59.1	Massachusetts	1,170	6.7
Washington	75,942	36.3	Delaware	0	N/A
Wyoming	47,037	86.8	Rhode Island	0	N/A

Census Region Legend	West	Midwest	South	Northeast

Notes: N/A = not applicable. Delaware and Rhode Island do not have any rural counties.

DISCUSSION AND CONCLUSIONS

A substantial majority of counties in the 41 states represented in these analyses contained ADs at the census block level (84% in rural; 77% in urban), demonstrating the gravity of the issue of ensuring access to ambulance services. Rural counties were more likely to have ADs, and in 23 of the 41 states, over half (range 56% to 96%) of state populations living in ADs were living in rural counties.

Given the various metrics presented in the results section, Table 13 summarizes how states compare in terms of their population densities, ambulance stations per square miles, ambulance stations per capita, the prevalence of ADs, and the number of people living in ADs in each state. In the Western and Midwestern states, the prevalence of ADs appears related to sparsely populated rural areas, making it challenging to provide adequate ambulance service coverage. The relatively high percentage of counties with at least one census block that is an AD (e.g., 100% of counties in the Western states contain ADs) stands in stark contrast to the relatively high number of ambulance stations per capita. Because the counties in these states are large (in terms of square miles) and their populations are spread out (i.e., population densities are low), ambulances are likely traveling long distances, contributing to high rates of their county populations living in ADs.

Alternatively, the relatively low number of ambulance stations per capita and high population densities are factors contributing to high numbers of people living in ADs in the South (e.g., North Carolina, Alabama, Texas, and Tennessee). Although the Southern states tend to have relatively low percentages of their AD populations living in rural counties, the exceptions include Kentucky (81%), Oklahoma (73%), Arkansas (66%), and Texas (56%) (Table 12).

Finally, the national maps highlighted the following geographic areas of concern: Southern states (particularly within the Appalachian region); Western states with difficult mountainous terrain; the jagged coastal areas; and the rural mountainous areas of Maine, Vermont, Oregon, and Washington. These areas either had high percentages and/or high numbers of people living in ADs.

TABLE 13. Summary of State Rankings

2020 Population Density		Geographic Density of Ambulance Stations		Population Density of Ambulance Stations		Counties with Ambulance Deserts		State Populations Living in Ambulance Deserts	
State	N per sq mile	State	N per 1,000 sq miles	State	N per 100,000	State	Percent	State	Number
Wyoming	5.9	Nevada	0.5	Nevada	1.8	Arkansas	100	North Carolina	366,147
Montana	7.4	Wyoming	0.8	Utah	2.6	Idaho	100	Alabama	314,841
North Dakota	11.2	Montana	1.0	North Carolina	3.0	Montana	100	Texas	313,248
South Dakota	11.6	Utah	1.0	Tennessee	3.1	Nevada	100	Tennessee	265,949
New Mexico	17.4	South Dakota	1.6	Alabama	3.4	New Mexico	100	Missouri	249,232
Idaho	22.2	New Mexico	2.0	Missouri	3.5	North Dakota	100	Washington	209,285
Nebraska	25.5	North Dakota	2.1	Kentucky	4.0	Oregon	100	Florida	199,176
Nevada	28.3	Idaho	2.7	Indiana	4.3	Utah	100	Arkansas	195,159
Utah	39.8	Mississippi	3.0	Connecticut	4.4	Vermont	100	Virginia	189,110
Oregon	44.0	Missouri	3.2	Mississippi	4.7	Washington	100	Louisiana	178,747
Maine	44.2	Oregon	3.2	New York	4.9	Wyoming	100	Kentucky	177,914
Iowa	57.1	Alabama	3.4	Virginia	5.2	Louisiana	98.4	Mississippi	164,259
Oklahoma	57.6	Arkansas	3.4	Louisiana	5.5	Tennessee	97.9	Oregon	159,690
Arkansas	57.7	Oklahoma	3.7	Arkansas	5.9	Mississippi	97.6	Montana	140,365
Mississippi	62.7	Kentucky	4.5	Rhode Island	5.9	Missouri	96.5	New Mexico	119,854
Vermont	69.2	Nebraska	4.7	Michigan	6.1	Oklahoma	96.1	Utah	117,299
Minnesota	71.6	Tennessee	5.1	Oklahoma	6.4	South Carolina	95.7	Nevada	110,933
Missouri	89.4	Louisiana	5.9	Texas	6.4	Alabama	95.5	Indiana	93,807
Alabama	98.8	Minnesota	6.2	Illinois	6.6	Texas	94.9	Idaho	84,254
Louisiana	107.6	North Carolina	6.5	Maryland	7.0	North Carolina	94.1	South Carolina	83,587
Wisconsin	108.4	Maine	7.0	Delaware	7.1	Maine	93.8	Maine	82,346
Texas	111.4	Texas	7.2	Oregon	7.2	Massachusetts	92.9	Georgia	80,599
Kentucky	113.8	Vermont	7.6	Ohio	7.5	Florida	92.5	Michigan	65,709
Washington	114.5	Indiana	8.2	Massachusetts	7.7	Kentucky	91.7	New York	64,069
New Hampshire	151.7	Iowa	8.6	Georgia	8.2	New Hampshire	90.0	Maryland	62,912
Tennessee	166.8	Michigan	10.9	Florida	8.5	Connecticut	87.5	Oklahoma	62,786
South Carolina	169.4	Virginia	11.2	Minnesota	8.7	Maryland	87.5	South Dakota	58,688
Michigan	177.1	Wisconsin	14.6	South Carolina	9.1	South Dakota	86.4	Wyoming	54,205
Georgia	185.9	Georgia	15.2	Vermont	11.0	New York	82.3	Minnesota	46,702
Indiana	188.9	Illinois	15.3	New Mexico	11.6	Virginia	78.9	Vermont	40,839
North Carolina	212.9	South Carolina	15.3	New Hampshire	11.9	Wisconsin	76.4	North Dakota	31,333
Virginia	216.2	Washington	18.0	Idaho	12.1	Nebraska	76.3	Wisconsin	25,498
Illinois	230.4	New Hampshire	18.0	Wyoming	12.9	Delaware	75.0	Nebraska	21,746
Ohio	287.6	New York	20.8	Montana	13.1	Rhode Island	71.4	Massachusetts	17,370
Florida	398.5	Ohio	21.5	Wisconsin	13.5	Michigan	69.9	New Hampshire	16,335
New York	427.0	Connecticut	32.2	South Dakota	14.1	Georgia	64.2	Ohio	12,565
Delaware	498.8	Florida	34.1	Iowa	15.2	Minnesota	51.7	Illinois	10,257
Maryland	627.7	Delaware	35.4	Washington	15.7	Indiana	50.0	Iowa	9,289
Connecticut	736.5	Maryland	43.8	Maine	15.8	Illinois	48.0	Delaware	7,218
Massachusetts	893.0	Rhode Island	61.9	Nebraska	18.3	Iowa	37.4	Connecticut	6,049
Rhode Island	1,041.8	Massachusetts	68.6	North Dakota	18.6	Ohio	23.9	Rhode Island	1,913

Census Region Legend	West	Midwest	South	Northeast

Study Limitations

Providing a national perspective on the prevalence of ADs called for using geographic entities, namely counties, which facilitated enough granularity to see the variation in rural-urban portions of the states. Thus, this study relied on the RUCCs to identify rural-urban counties and quantify rural-urban populations living in ADs at the county level. Some states (e.g. Maine and Montana) have relatively few counties that cover large land areas. This can result in categorizing people who live in rural census tracts as living in urban counties, particularly if the county contains large urban centers.[53] Thus, this study may underrepresent rural populations living in ADs for states with few counties covering large areas of their states.

Although the research team attempted to ensure the data provided by State EMS agencies accurately represented all transporting ambulance services in the state, as indicated in Figure 1 above, some states were not able to provide this level of granularity: 10 had minor data limitations but were included, 3 had major data limitations and were thus excluded, and 8 states were not able to provide any data on ambulance locations. Among the 10 states with minor data limitations, a small number of addresses that do not actually represent ambulance station locations may have been included or the full set of ambulance stations may not be represented. For example, some states were only able to provide agency mailing addresses (which may or may not correspond with actual station locations) or agency headquarters addresses, potentially resulting in the overestimation of ambulance deserts. Any data limitations are listed in the footnotes of the state maps (Appendix A).

Additionally, this study does not account for the entire EMS system such as air ambulances, nor have the following issues been addressed: the location(s) of first responders, the infrastructure needed to support successful emergency telecommunications via 9-1-1 calls placed on cell phones, broadband or satellite communications, or remote patient care technology (e.g., telemedicine).

This study also does not take into consideration transportation patterns, i.e., commuter or travel routes to vacation venues such as state parks or lake cabins, but rather focuses on permanent residential locations as recorded by the U.S. Census Bureau. Officials may wish to consider whether certain unpopulated areas would benefit from improved ambulance coverage as well, particularly remote areas near natural attractions and other popular travel destinations.

Census blocks on state borders showing deserts may be covered by ambulance services in neighboring states. Given the variation in state policies regulating whether ambulance services can provide coverage across state borders, these issues were considered beyond the scope of this study.

Finally, maps showing ambulance stations within ambulance deserts are the result of the underlying road networks and the criteria that any resident located within a census block whose center is outside of a 25-minute drive time from where the ambulance is located – including the census block that the ambulance is located within – is considered living in an ambulance desert. This is likely to happen in mountainous or difficult terrain where winding roads may make it challenging to travel in a timely manner. Geographically large and sparsely populated census blocks whose centroid may not align with the population distribution of the census block may also result in categorizing these areas as ADs.

Policy Implications

This study is the first known to document coverage gaps in the provision of ambulance services across geographic areas in the U.S. Given the current funding and reimbursement challenges associated with the provision of ambulance services, policymakers may need to consider the appropriate availability of ambulance services within the existing fabric of the health care system. This study illustrates the higher prevalence of ambulance deserts in rural areas. In addition, the persistent threat of rural hospital closures is placing the conversation regarding the development of funding and reimbursement strategies capable of sustaining rural ambulance services and ensuring access to emergent health services in rural areas at the forefront of state and federal policymakers' efforts to reform our health care system.

Future Work

Building on the Maine Rural Health Research Center's existing ambulance and ambulance desert location data, the next phase of this research will use the U.S. Census data to describe the demographic characteristics of populations living in ADs. These analyses will identify areas of the country where vulnerable populations lack access to ambulance services, particularly in remote rural areas.

These analyses will also address the next phase of the patient's journey: traveling from the patient's home to the nearest health care facility capable of serving emergent health care needs (e.g. emergency rooms, hospitals, or clinics). The impact of hospital closures on both the provision of ambulance services and on travel time to the point of care will also be assessed.

REFERENCES

1. Cordi HP, Goldstein S. EMS federal regulations [updated 2021 Aug 11]. *Statpearls [internet]*. StatPearls Publishing; 2022.
2. National Association of State EMS Officials. *2020 national emergency medical services assessment*. NASEMSO;2020 May. Accessed June 9, 2022. https://nasemso.org/wp- content/uploads/2020-National-EMS-Assessment_Reduced-File-Size.pdf
3. RUPRI Health Panel, MacKinney AC. *Characteristics and challenges of rural ambulance agencies: A brief review and policy considerations*. RUPRI;2021 January. Accessed June 7, 2022. https://rupri.org/wp-content/uploads/Characteristics-and-Challenges-of-Rural-Ambulance- Agencies-January-2021.pdf
4. Bolton A. *Rural ambulance services are in jeopardy as volunteers age and expenses mount*. Kaiser Health News;2021 July 6. Accessed January 14, 2022. https://khn.org/news/article/rural- ambulance-services-are-in-jeopardy-as-volunteers-age-and-expenses-mount/
5. Dean J. *Costs, volunteer demands strain rural ambulance services*. Cornell University. 2022. Updated April 25. Accessed June 15, 222. https://news.cornell.edu/stories/2022/04/costs- volunteer-demands-strain-rural-ambulance-services
6. Gau D, Busch F. *Rural EMS 'at a critical point': Southwest Minn. Agencies struggling to find enough EMTs to cover shifts*. Marshall Independent Online News. 2022. Updated April 30, 2022. Accessed May 6, 2022. https://www.marshallindependent.com/news/local- news/2022/04/rural-ems-at-a-critical-point/
7. Woodard C. *Maine's emergency medical response system is teetering on the brink of collapse*. Portland Press Herald. 2019. Updated December 8. Accessed January 14, 2022. https://www.pressherald.com/2019/12/08/were-in-crisis/
8. Federal Interagency Committee on Emergency Medical Services. *2011 national EMS assessment*. U.S. Department of Transportation, National Highway Traffic Safety Administration;2012. DOT HS 811 723. Accessed January 26, 2021. https://www.ems.gov/pdf/811723-National-EMS- Assessment-2011.pdf
9. Annie E. Casey Foundation. *Food deserts in the United States*. Blog. Annie E. Casey Foundation,. 2021, February 13. Accessed June 14, 2022. https://www.aecf.org/blog/exploring-americas- food-deserts
10. Jiao J, Moudon AV, Ulmer J, Hurvitz PM, Drewnowski A. How to identify food deserts: Measuring physical and economic access to supermarkets in King County, Washington. *Am J Public Health*. Oct 2012;102(10):e32-9. doi: 10.2105/ajph.2012.300675
11. Sharkey JR, Horel S. Neighborhood socioeconomic deprivation and minority composition are associated with better potential spatial access to the ground-truthed food environment in a large rural area. *J Nutr*. Mar 2008;138(3):620-7. doi: 10.1093/jn/138.3.620
12. Sharkey JR, Horel S, Dean WR. Neighborhood deprivation, vehicle ownership, and potential spatial access to a variety of fruits and vegetables in a large rural area in Texas. *Int J Health Geogr*. May 25 2010;9:26. doi: 10.1186/1476-072x-9-26
13. Nguyen A, van Meijgaard J, Kim S, Marsh T. *Mapping healthcare deserts: 80% of the country lacks adequate access to healthcare*. The GoodRx Research Team;2021 September. Accessed June 9, 2022. https://assets.ctfassets.net/4f3rgqwzdznj/1XSl43l40KXMQiJUtl0ilq/ad0070ad4534f9b5776bc2c41091c321/GoodRx_Healthcare_Deserts_White_Paper.pdf
14. Graves JM, Abshire DA, Undeberg M, Forman L, Amiri S. Rural-urban disparities in access to Medicaid-contracted pharmacies in Washington state, 2017. *Prev Chronic Dis*. Aug 20 2020;17:E92. doi: 10.5888/pcd17.200066
15. Pednekar P, Peterson A. Mapping pharmacy deserts and determining accessibility to community pharmacy services for elderly enrolled in a state pharmaceutical assistance program. *PLoS One*. 2018;13(6):e0198173. doi: 10.1371/journal.pone.0198173
16. Andrilla CHA, Garberson LA, Patterson DG, Quigley TF, Larson EH. Comparing the health workforce provider mix and the distance travelled for mental health services by rural and urban Medicare beneficiaries. *J Rural Health*. 2021;37(4):692-699. doi: 10.1111/jrh.12504

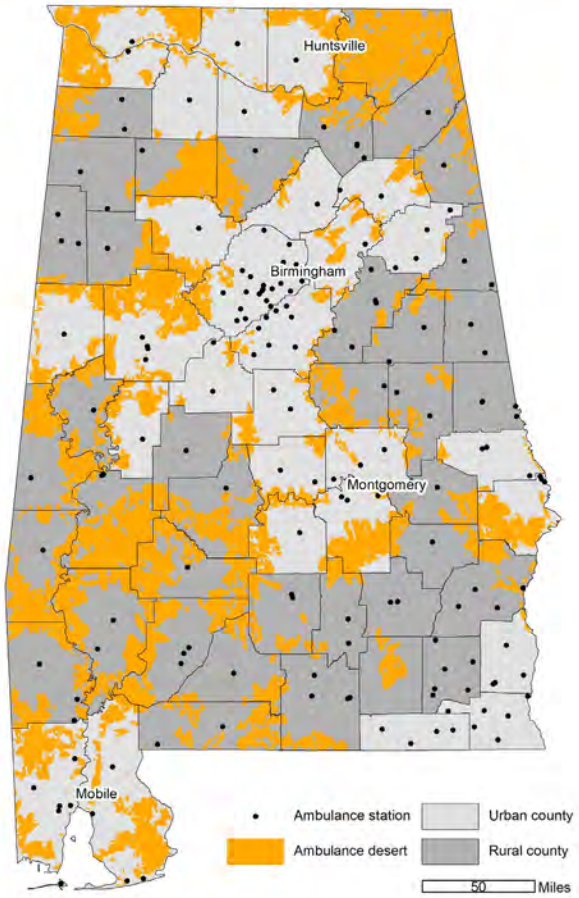
17. Andrilla CHA, Patterson DG, Garberson LA, Coulthard C, Larson EH. Geographic variation in the supply of selected behavioral health providers. *Am J Prev Med*. Jun 2018;54(6 Suppl 3):S199- s207. doi: 10.1016/j.amepre.2018.01.004
18. Barreto T, Jetty A, Eden AR, Petterson S, Bazemore A, Peterson LE. Distribution of physician specialties by rurality. *J Rural Health*. 2021;37(4):714-722. doi: https://doi.org/10.1111/jrh.12548
19. Gemelas JC. Post-aca trends in the US primary care physician shortage with index of relative rurality. *The Journal of Rural Health*. 2021;37(4):700-704. doi: 10.1111/jrh.12506
20. Gong G, Phillips SG, Hudson C, Curti D, Philips BU. Higher US rural mortality rates linked to socioeconomic status, physician shortages, and lack of health insurance. *Health Aff (Millwood)*. Dec 2019;38(12):2003-2010. doi: 10.1377/hlthaff.2019.00722
21. Machado SR, Jayawardana S, Mossialos E, Vaduganathan M. Physician density by specialty type in urban and rural counties in the US, 2010 to 2017. *JAMA Network Open*. 2021;4(1):e2033994. doi: 10.1001/jamanetworkopen.2020.33994
22. Kreitzer RJ, Smith CW, Kane KA, Saunders TM. Affordable but inaccessible? Contraception deserts in the US states. *J Health Polit Policy Law*. Apr 1 2021;46(2):277-304. doi: 10.1215/03616878-8802186
23. Gjesfjeld CD, Jung JK. How far?: Using geographical information systems (gis) to examine maternity care access for expectant mothers in a rural state. *Soc Work Health Care*. 2011;50(9):682-93. doi: 10.1080/00981389.2011.575537
24. Brown SA, Richards ME, Elwell EC, Rayburn WF. Geographical information systems for mapping maternal ground transport to level iii care neonatal centers. *Am J Perinatol*. Apr 2014;31(4): doi: 10.1055/s-0033-1348029
25. Rayburn WF, Richards ME, Elwell EC. Drive times to hospitals with perinatal care in the United States. *Obstet Gynecol*. Mar 2012;119(3):611-6. doi: 10.1097/AOG.0b013e318242b4cb
26. Dobis EA, Krumel Jr TP, Cromartie J, Conley KL, Sanders A, Ortiz R. *Rural America at a glance: 2021 edition*. USDA, Economic Research Service;2021. Accessed June 14, 2022. https://www.ers.usda.gov/webdocs/publications/102576/eib-230.pdf?v=7940.5
27. Shortell SM, Fulton BD, Comfort LN. *Improving the health of rural Americans*. Health Affairs Blog. DOI: 10.1377/hblog20211007.974893. 2021, October 13. Accessed June 14, 2022. https://www.healthaffairs.org/do/10.1377/forefront.20211007.974893/full/
28. Ziller EC. Access to medical care in rural America. In: Warren JC, Smiley KB, eds. *Rural public health: Best practices and preventive models*. Springer Publishing Company; 2014:11-28:chap 2.
29. Ziller EC, Burgess AR, Thayer D. *Health care use and access among rural and urban nonelderly adult Medicare beneficiaries*.2020 January. PB-74. Accessed June 9, 2022. https://digitalcommons.usm.maine.edu/insurance/79/
30. Mell HK, Mumma SN, Hiestand B, Carr BG, Holland T, Stopyra J. Emergency medical services response times in rural, suburban, and urban areas. *JAMA Surgery*. 2017;152(10):983. doi: 10.1001/jamasurg.2017.2230
31. Gonzalez RP, Cummings GR, Mulekar MS, Harlan SM, Rodning CB. Improving rural emergency medical service response time with global positioning system navigation. *J Trauma*. Nov 2009;67(5):899-902. doi: 10.1097/TA.0b013e3181bc781d
32. Newgard CD, Fu R, Bulger E, Hedges JR, Mann NC, Wright DA, et al. Evaluation of rural vs urban trauma patients served by 9-1-1 emergency medical services. *JAMA Surg*. Jan 1 2017;152(1):11-18. doi: 10.1001/jamasurg.2016.3329
33. Nicholl J, West J, Goodacre S, Turner J. The relationship between distance to hospital and patient mortality in emergencies: An observational study. *Emerg Med J*. Sep 2007;24(9):665-8. doi: 10.1136/emj.2007.047654
34. Uribe-Leitz T, Jarman MP, Sturgeon DJ, Harlow AF, Lipsitz SR, Cooper Z, et al. National study of triage and access to trauma centers for older adults. *Ann Emerg Med*. Feb 2020;75(2):125-135. doi: 10.1016/j.annemergmed.2019.06.018
35. Nikpay S, Tschautscher C, Scott NL, Puskarich M. Association of hospital closures with changes in Medicare-covered ambulance trips among rural emergency medical services agencies. *Acad Emerg Med*. Sep 2021;28(9):1070-1072. doi: 10.1111/acem.14273

36. North Carolina Rural Health Research Program, Cecil G. Sheps Center for Health Services Research, The University of North Carolina at Chapel Hill. *183 rural hospital closures: January 2005 – present (140 since 2010)*. 2022. Accessed July 27, 2022. https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/
37. Miller A. *Rural communities left hurting without a hospital, ambulance or doctors nearby*. Kaiser Health News. 2021. Updated December 23. Accessed January 14, 2022. https://khn.org/news/article/rural-communities-left-hurting-without-a-hospital-ambulance-or- doctors-nearby/
38. Miller KEM, James HJ, Holmes GM, Van Houtven CH. The effect of rural hospital closures on emergency medical service response and transport times. *Health Serv Res*. Apr 2020;55(2):288-300. doi: 10.1111/1475-6773.13254
39. Troske S, Davis A. *Do hospital closures affect patient time in an ambulance?* ;2019 February 20. Accessed June 7, 2022. https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1007&context=ruhrc_reports
40. Yurkanin A. *'Nobody's going to come': Greene County ambulance woes highlight problems in rural Alabama*. AL.com. 2022. Updated June 1. Accessed June 7, 2022. https://www.al.com/news/2022/06/nobodys-going-to-come-greene-county-ambulance-woes- highlight-problems-in-rural-alabama.html
41. Balasubramanian SS, Jones EC. Hospital closures and the current healthcare climate: The future of rural hospitals in the USA. *Rural Remote Health*. Jul-Aug 2016;16(3):3935.
42. Kaufman BG, Thomas SR, Randolph RK, Perry JR, Thompson KW, Holmes GM, et al. The rising rate of rural hospital closures. *J Rural Health*. Winter 2016;32(1):35-43. doi: 10.1111/jrh.12128
43. Scotti S. Tracking rural hospital closures. *NCSL LegisBrief*. Jun 2017;25(21):1-2.
44. Wishner J, Solleveld P, Rudowitz R, Paradise J, Antonisse L. *A look at rural hospital closures and implications for access to care: Three case studies*. Henry J Kaiser Family Foundation;2016 July. Accessed April 11, 2022. http://files.kff.org/attachment/issue-brief-a-look-at-rural-hospital- closures-and-implications-for-access-to-care
45. *ArcGIS desktop*. Environmental Systems Research Institute (ESRI). 2016. Accessed May 25, 2022. https://www.esri.com/en-us/arcgis/products/arcgis-desktop/overview
46. United States Census Bureau. *Cartographic boundary files--shapefile*. 2021. Updated October 8. Accessed May 31, 2022. https://www.census.gov/geographies/mapping-files/time- series/geo/carto-boundary-file.html
47. Esri. *World geocoding service*. 2020. Updated August 20. Accessed May 25, 2022. https://www.arcgis.com/home/item.html?id=305f2e55e67f4389bef269669fc2e284
48. Esri. *USA census 2020 redistricting blocks*. 2022. Updated January 25. Accessed May 31, 2022. https://www.arcgis.com/home/item.html?id=b3642e91b49548f5af772394b0537681
49. U.S. Department of Agriculture ERS. *2013 rural-urban continuum codes*. 2020. Updated December 10. Accessed May 25, 2022. https://www.ers.usda.gov/data-products/rural-urban- continuum-codes.aspx
50. Esri. *ArcGIS generate service areas (ready to use)*. 2022. Accessed December 7, 2021. https://pro.arcgis.com/en/pro-app/latest/tool-reference/ready-to-use/itemdesc-generate- service-areas.htm
51. Health Resources and Services Administration. *HRSA data explorer*. 2022. Accessed May 31, 2022. https://data.hrsa.gov/tools/data-explorer
52. United States Census Bureau. *American community survey (ACS)*. 2022. Updated April 21. Accessed June 22, 2022. https://www.census.gov/programs-surveys/acs
53. Bennett KJ, Borders TF, Holmes GM, Kozhimannil KB, Ziller E. What is rural? Challenges and implications of definitions that inadequately encompass rural people and places. *Health Aff (Millwood)*. 2019;38(12):1985-1992. doi: 10.1377/hlthaff.2019.00910

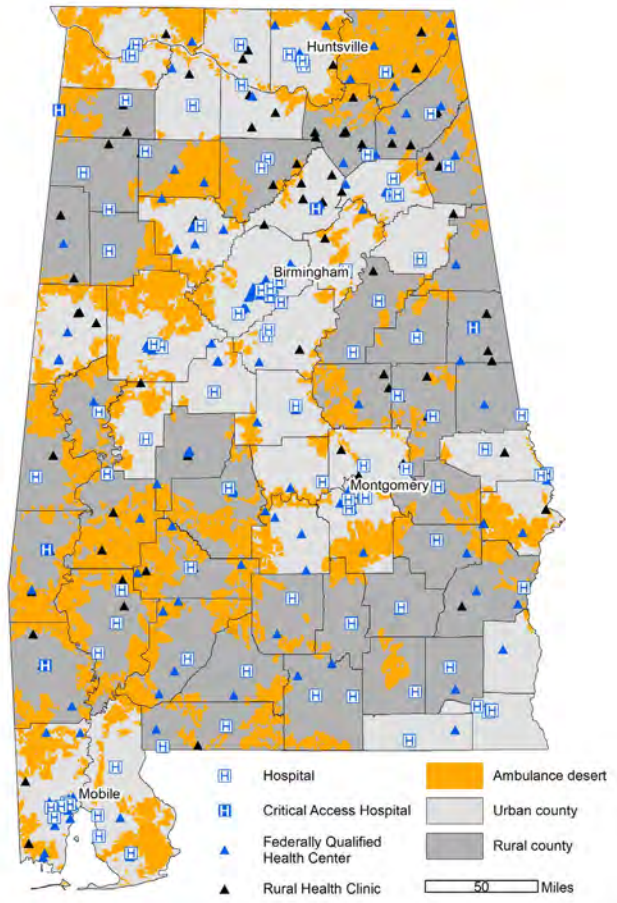
APPENDIX A: STATE MAPS

ALABAMA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

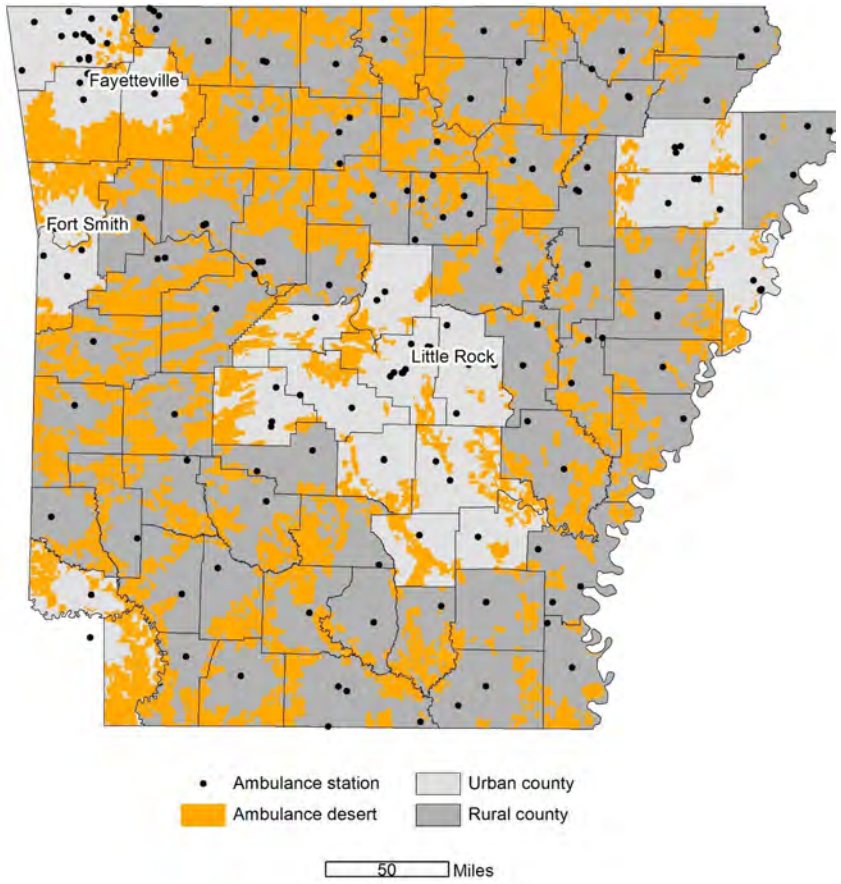


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
172	314,841	6.3%	144,260	12.6%	45.8%

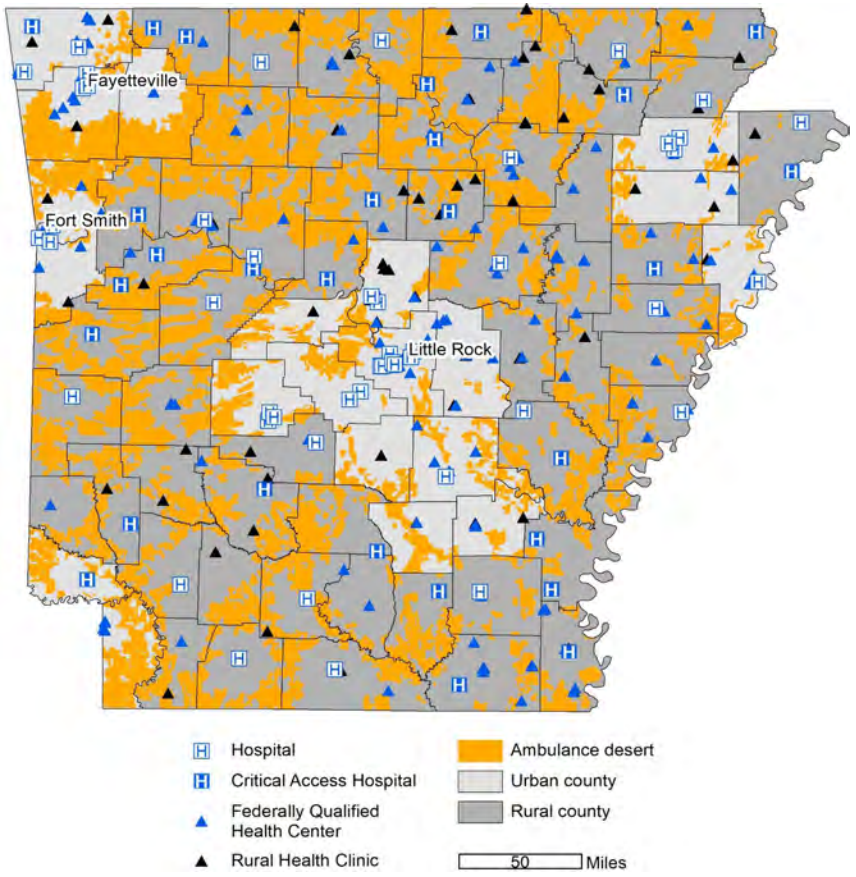
Data sources: Alabama Public Health, Office of EMS; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

ARKANSAS

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

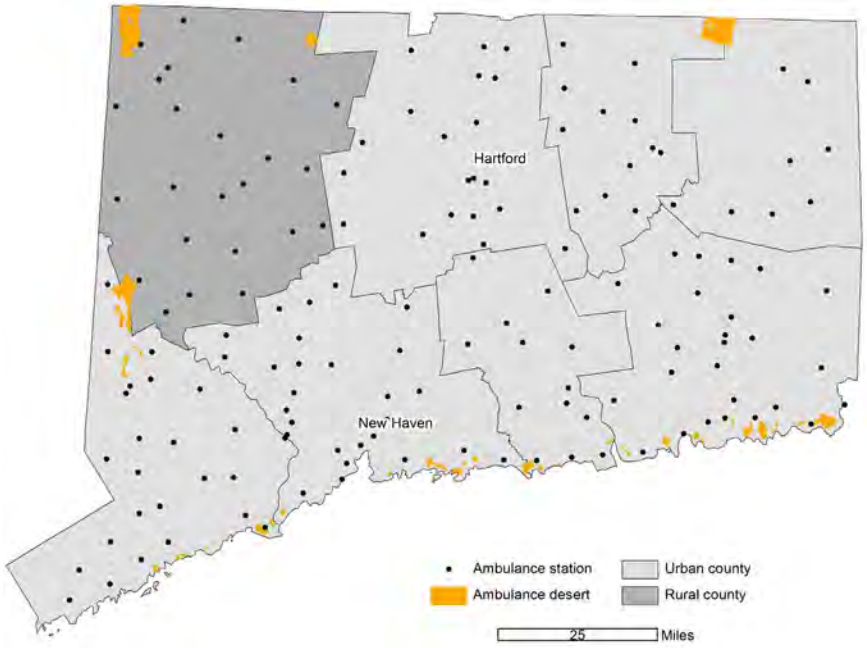


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
178	195,159	6.5%	128,370	11.7%	65.8%

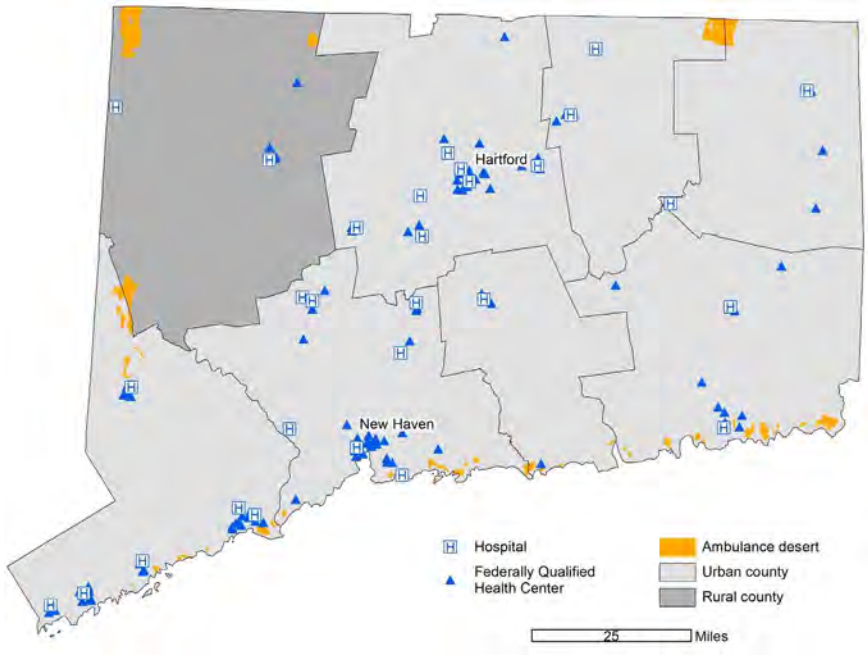
Data sources: Arkansas Department of Health, Office of EMS; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

CONNECTICUT

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

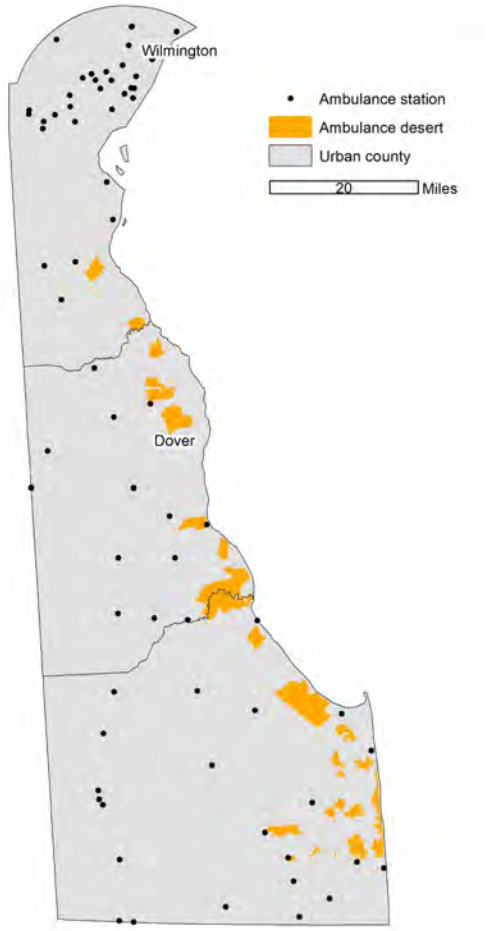


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
156	6,049	0.2%	840	0.5%	13.9%

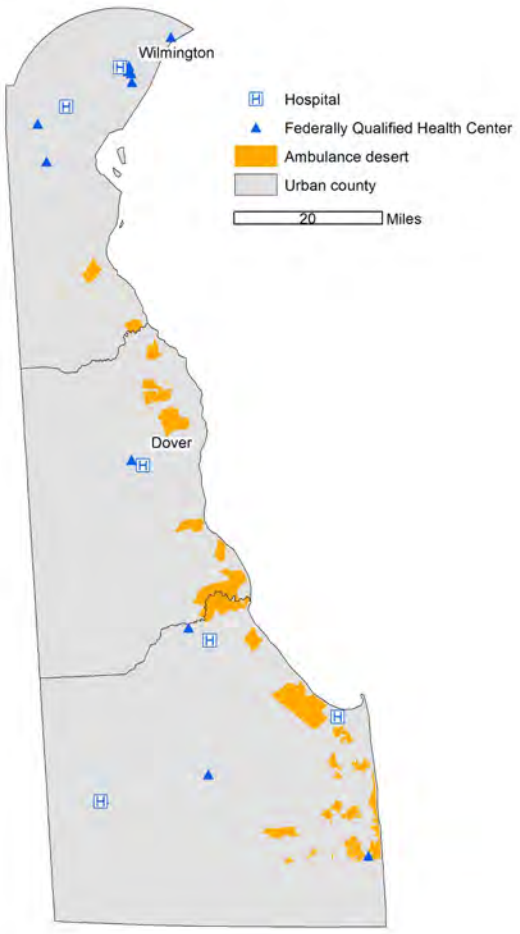
Data sources: Connecticut Department of Public Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

DELAWARE

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

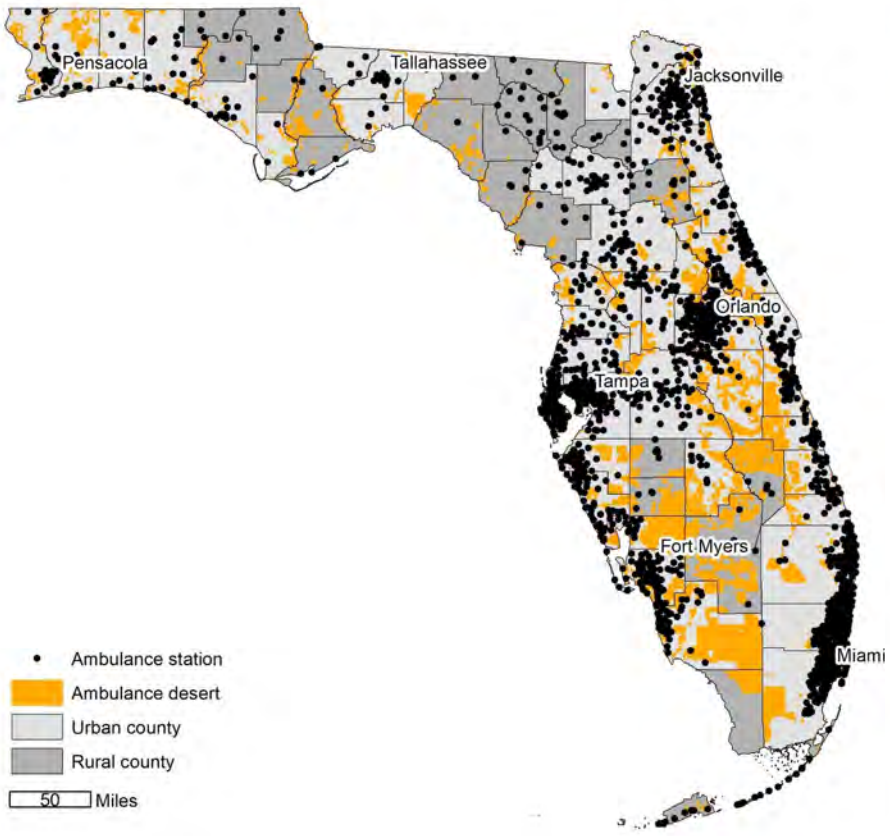


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
69	7,218	0.7%	n/a	n/a	n/a

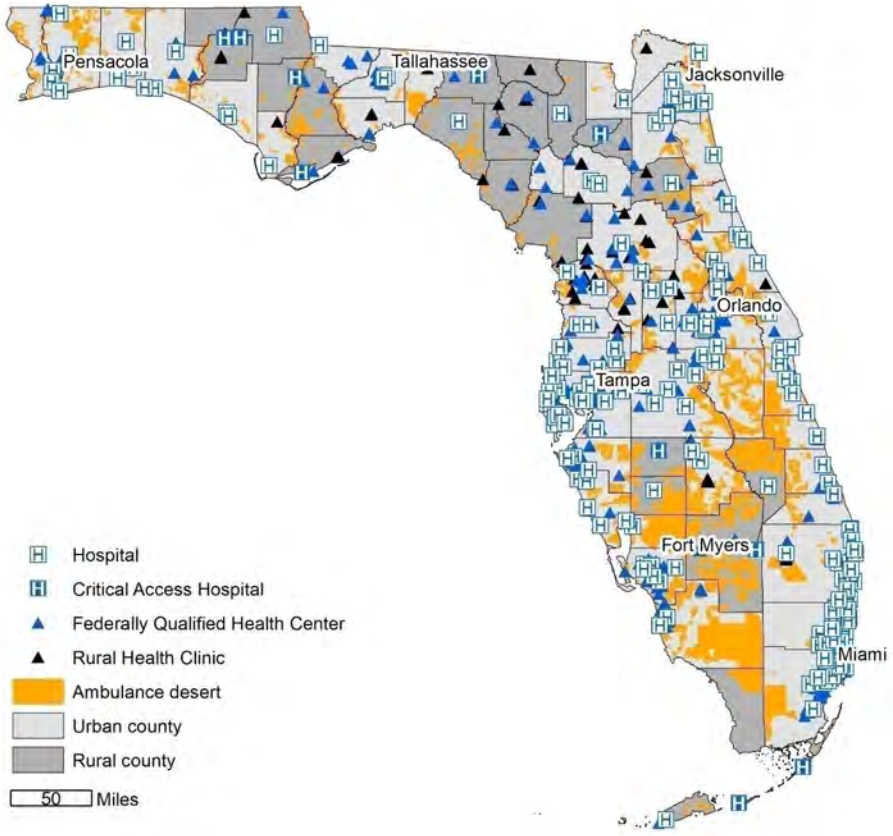
Data sources: Delaware State Fire Prevention Commission; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.
Data limitations: State only able to provide mailing addresses for stations. Ambulance service areas and ambulance deserts may differ from shown.

FLORIDA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

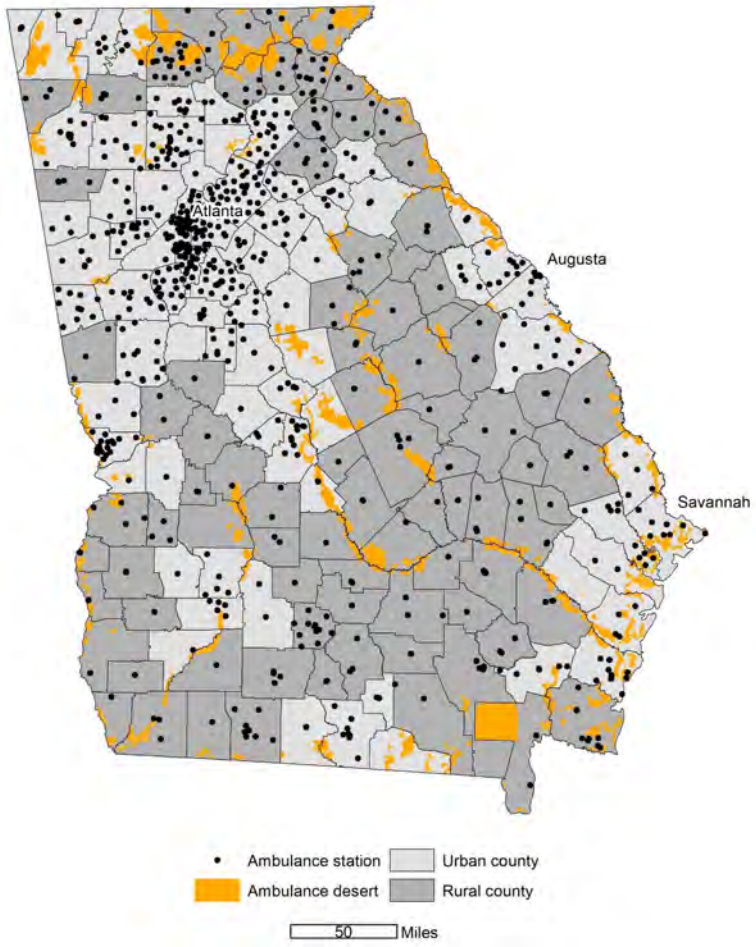


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
1,826	199,176	0.9%	29,031	4.2%	14.6%

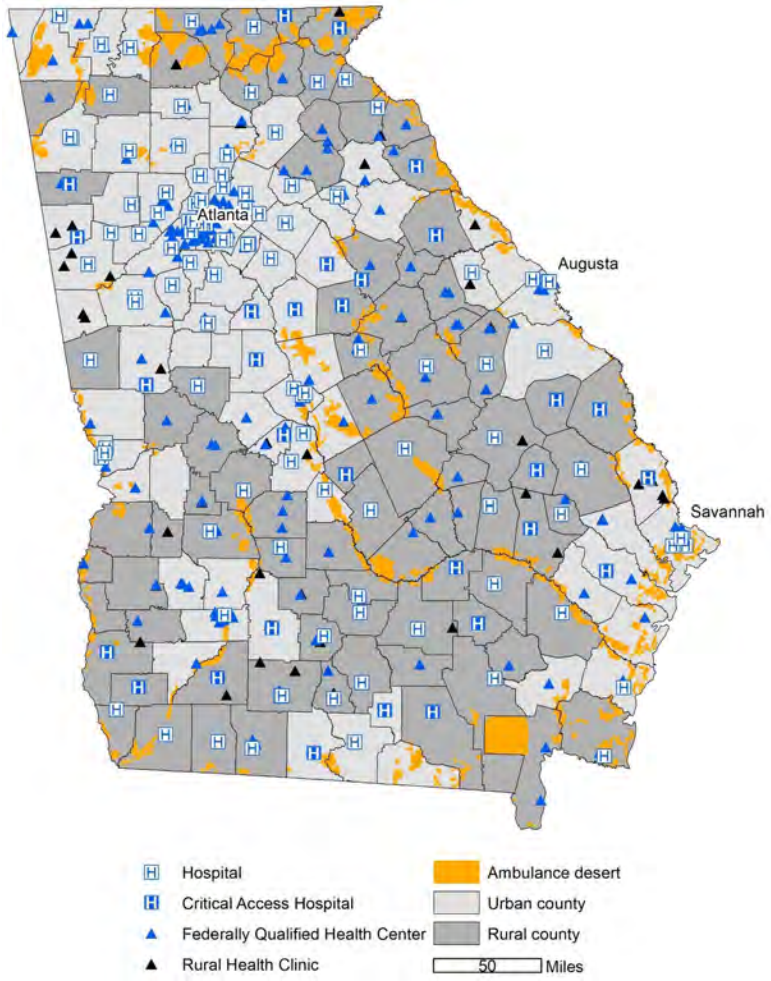
Data sources: Florida Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

GEORGIA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

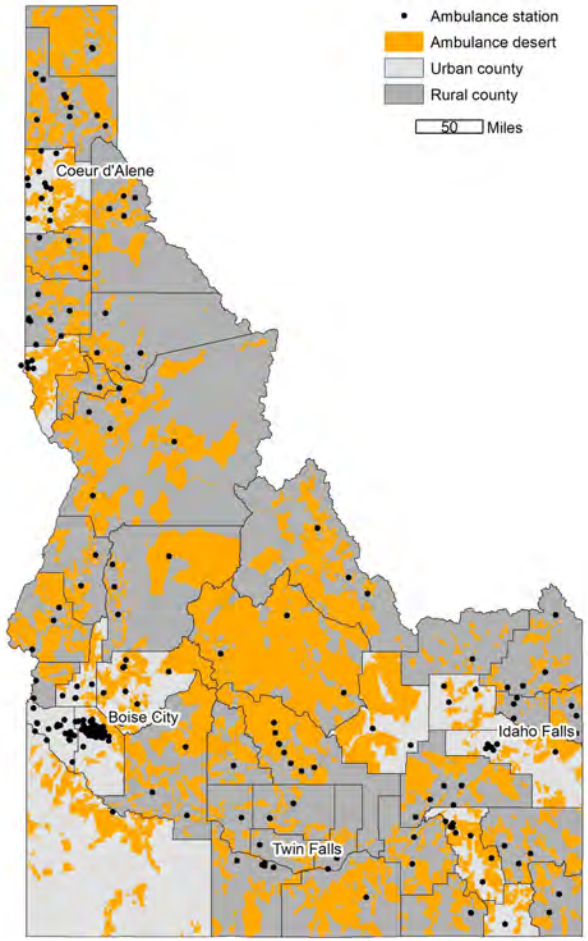


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
875	80,599	0.8%	28,005	1.6%	34.7%

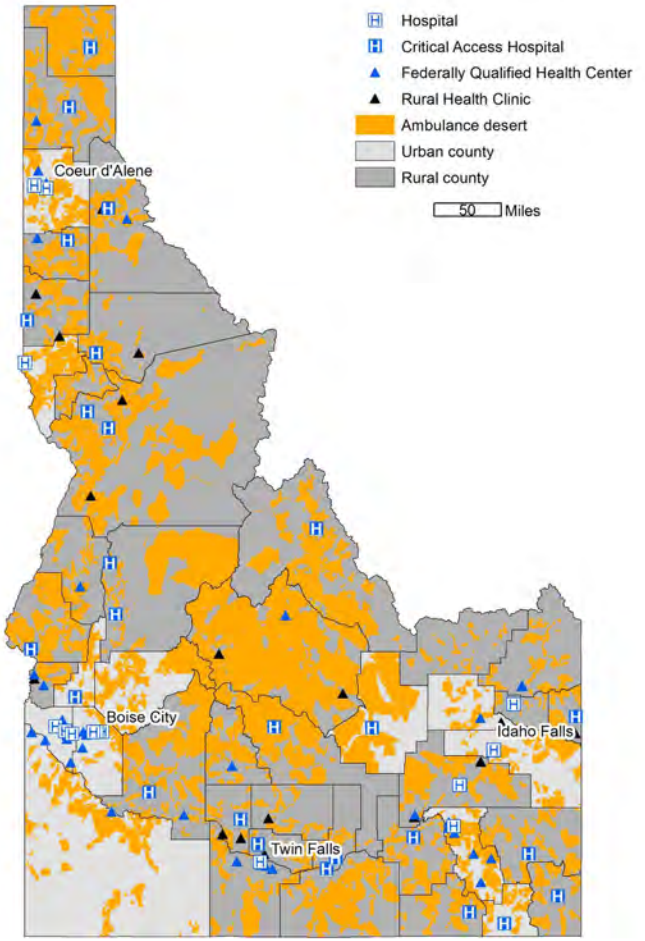
Data sources: Georgia Department of Public Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

IDAHO

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

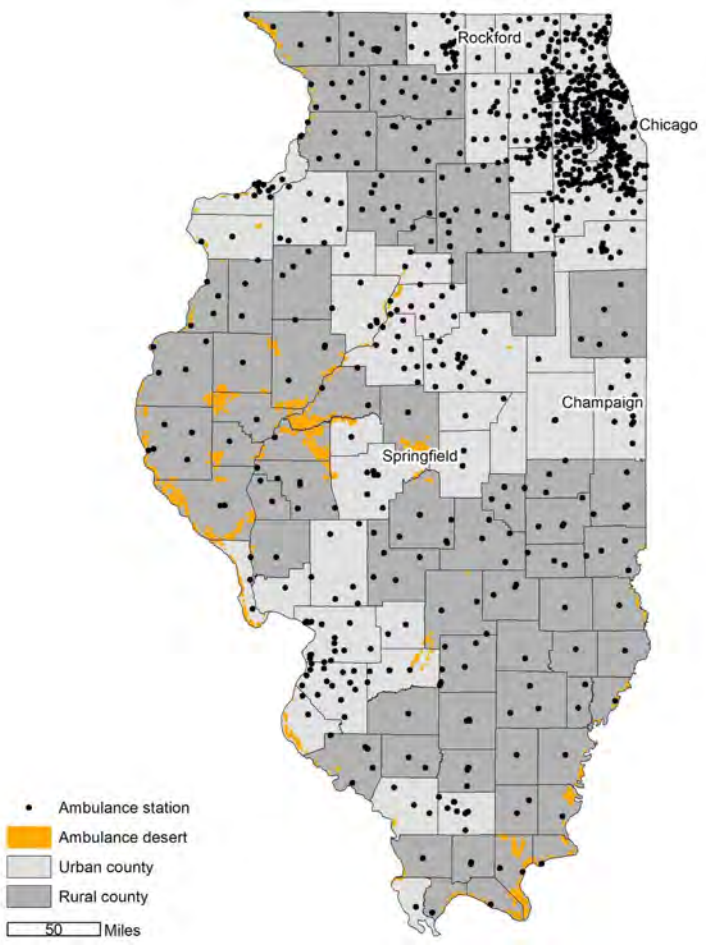


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
221	84,254	4.6%	57,428	9.6%	68.2%

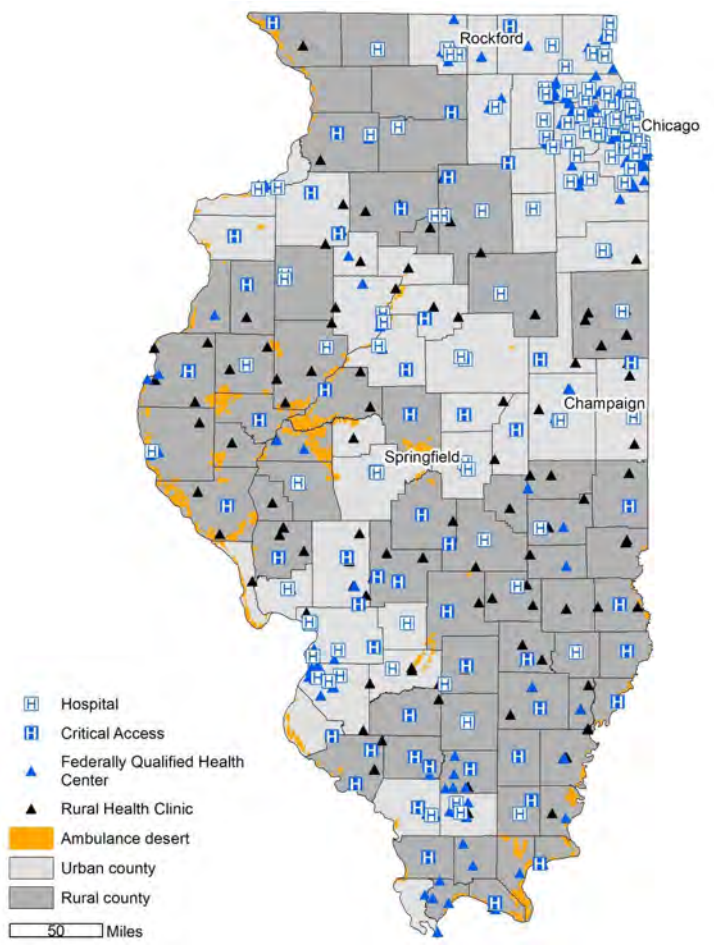
Data sources: Idaho Department of Health & Welfare, Bureau of Emergency Medical Services and Preparedness; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

ILLINOIS

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

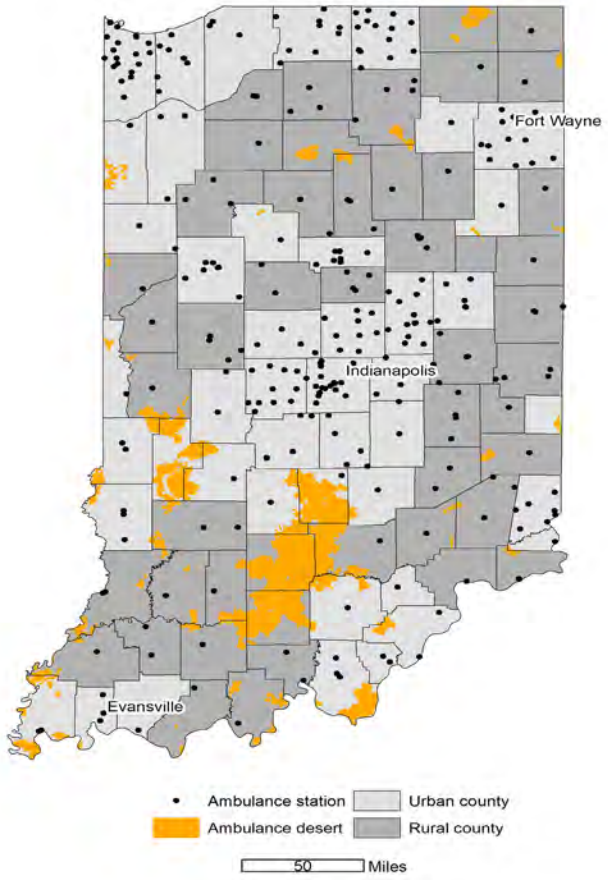


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
849	10,257	0.1%	7,169	0.5%	69.9%

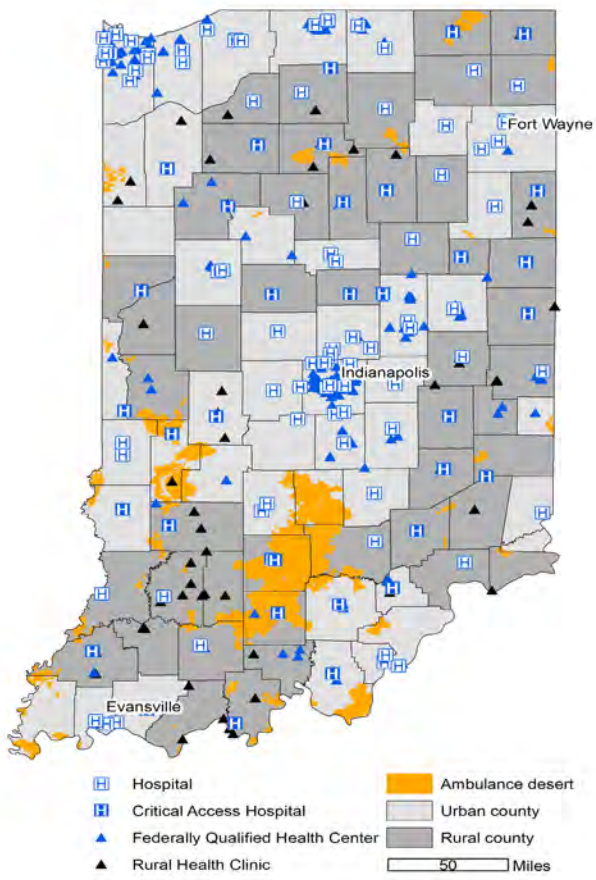
Data sources: Illinois Department of Public Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

INDIANA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

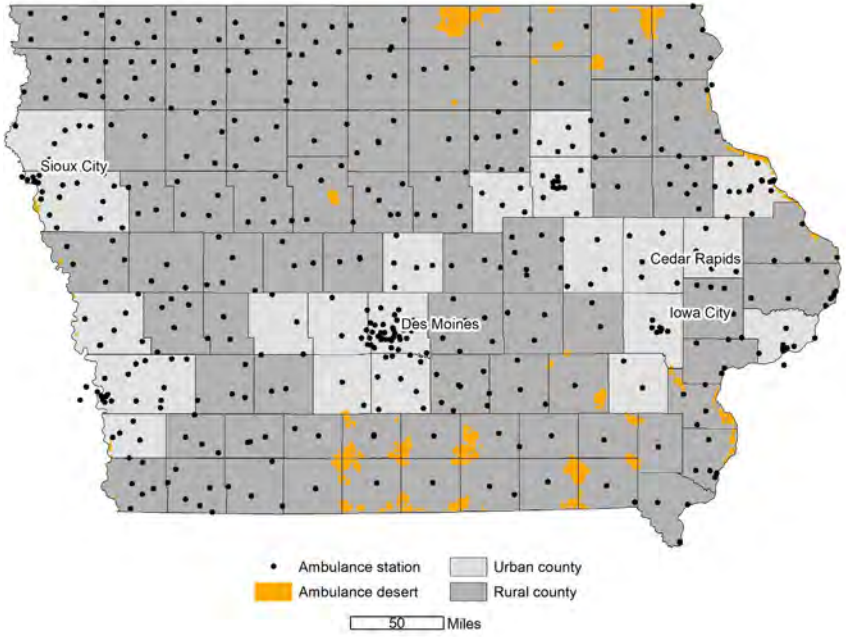


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
292	93,807	1.4%	56,974	3.9%	60.7%

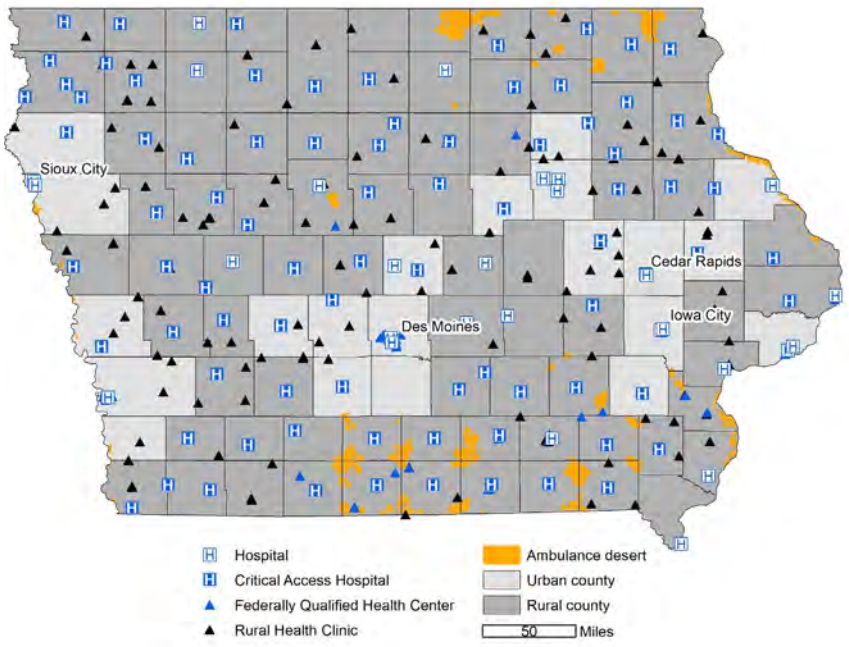
Data sources: Indiana Department of Homeland Security; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

IOWA

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

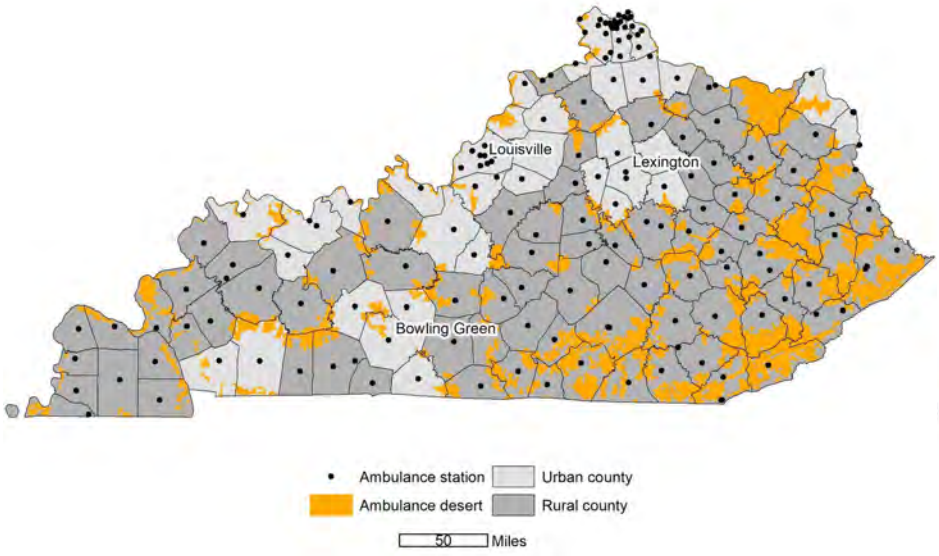


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
483	9,289	0.3%	7,952	0.6%	85.6%

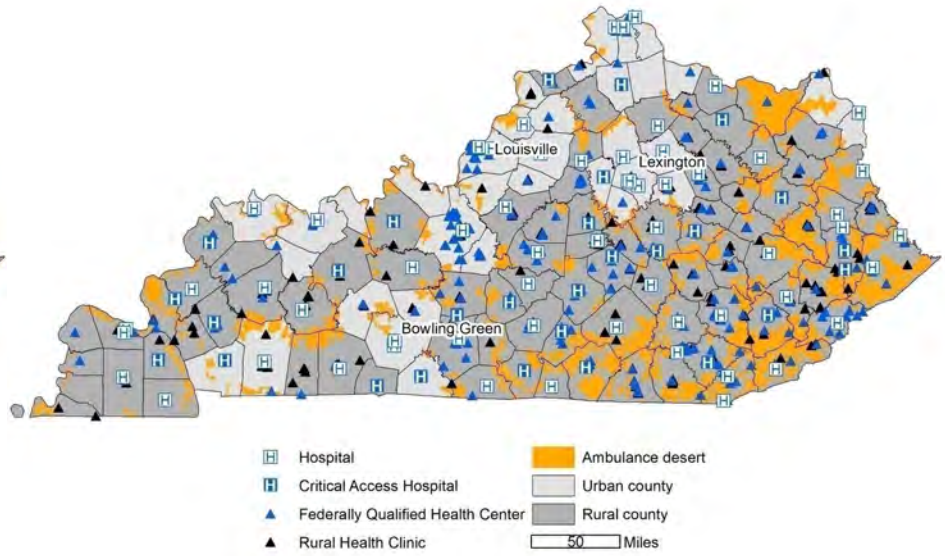
Data sources: Iowa Bureau of Emergency and Trauma Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

KENTUCKY

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

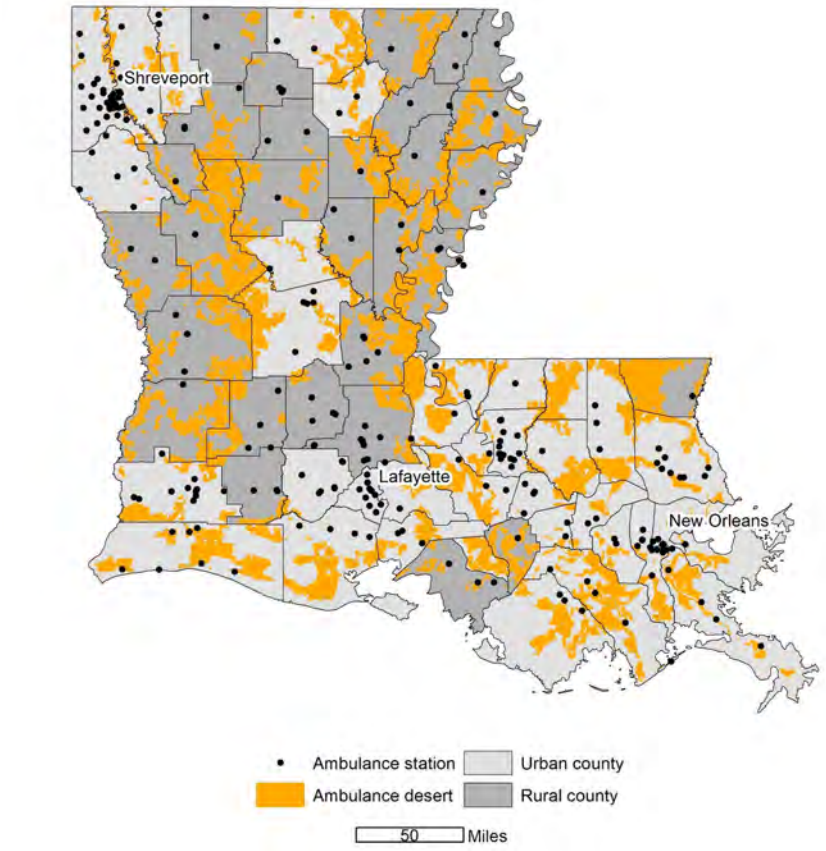


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
178	177,914	4.0%	143,137	7.8%	80.5%

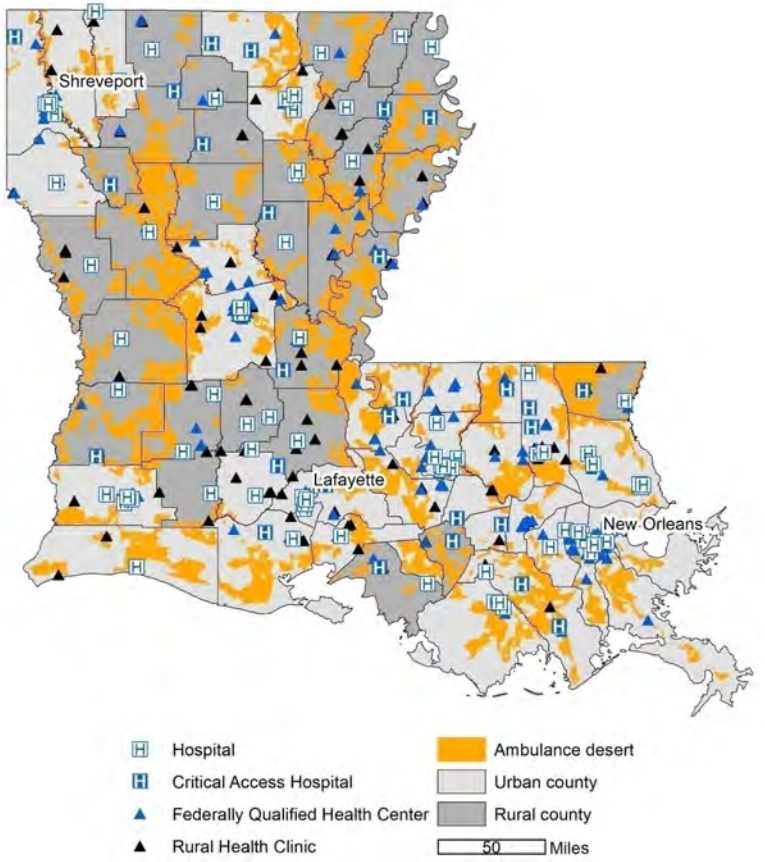
Data sources: Kentucky Board of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

LOUISIANA

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

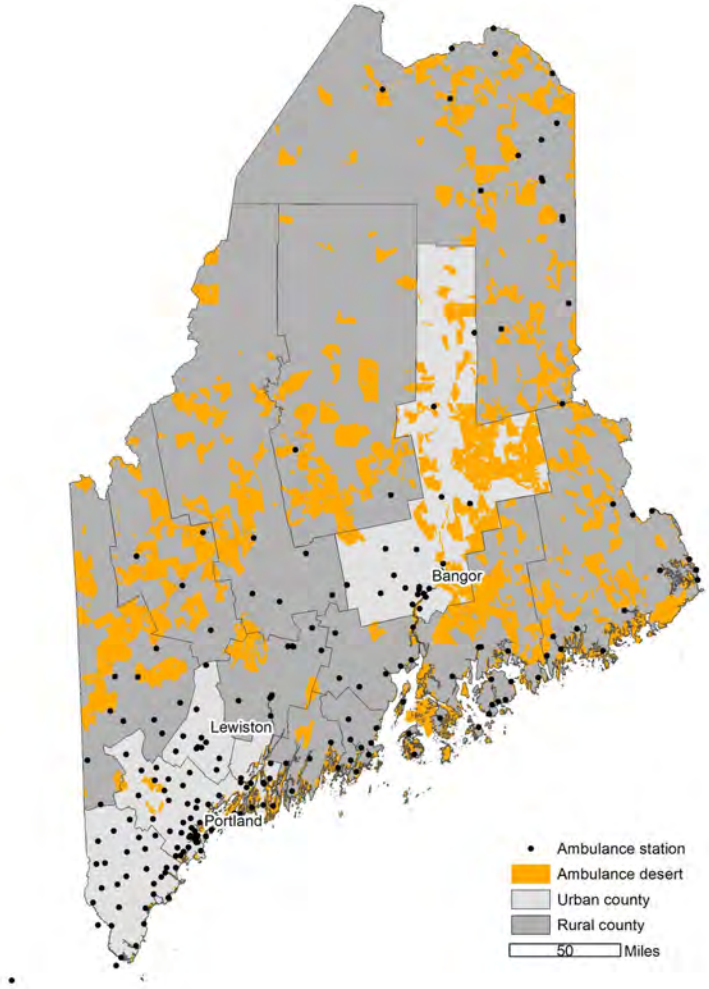


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
256	178,747	3.8%	65,571	9.0%	36.7%

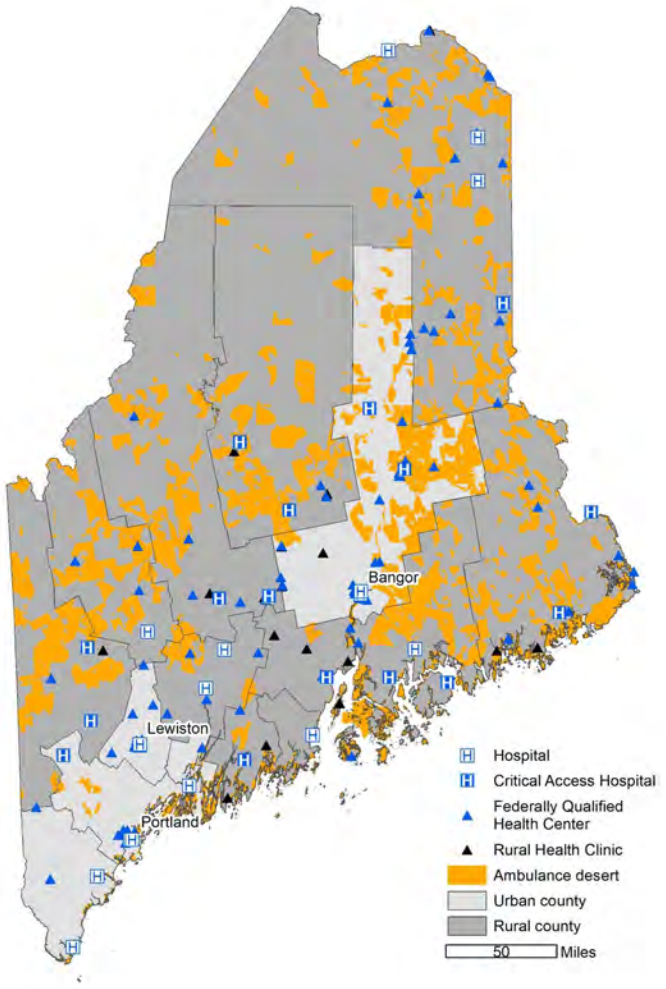
Data sources: Louisiana Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

MAINE

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

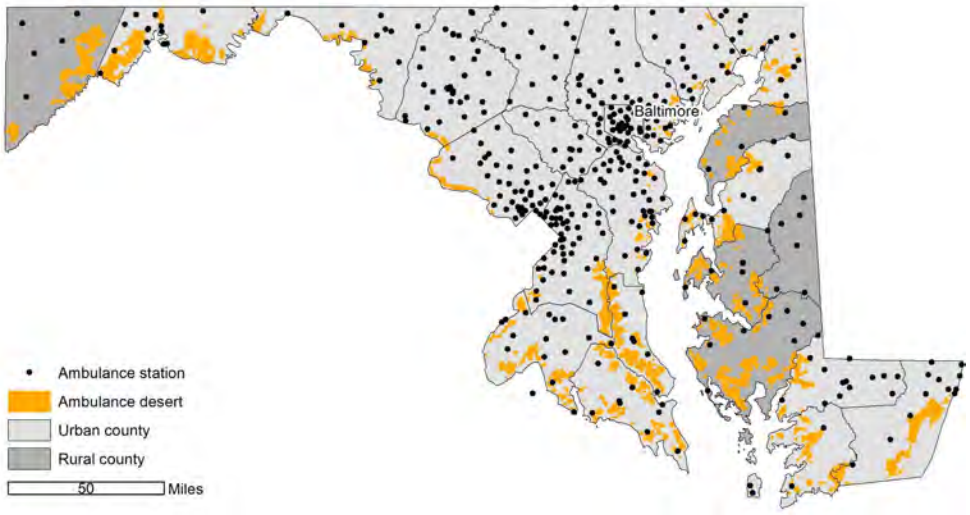


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
215	82,346	6.0%	54,278	9.9%	65.9%

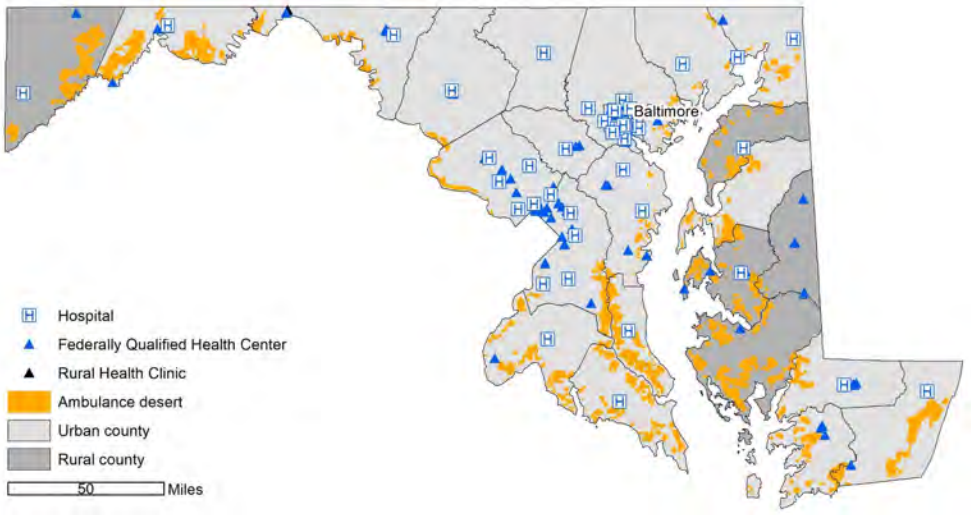
Data sources: Maine EMS; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

MARYLAND

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities



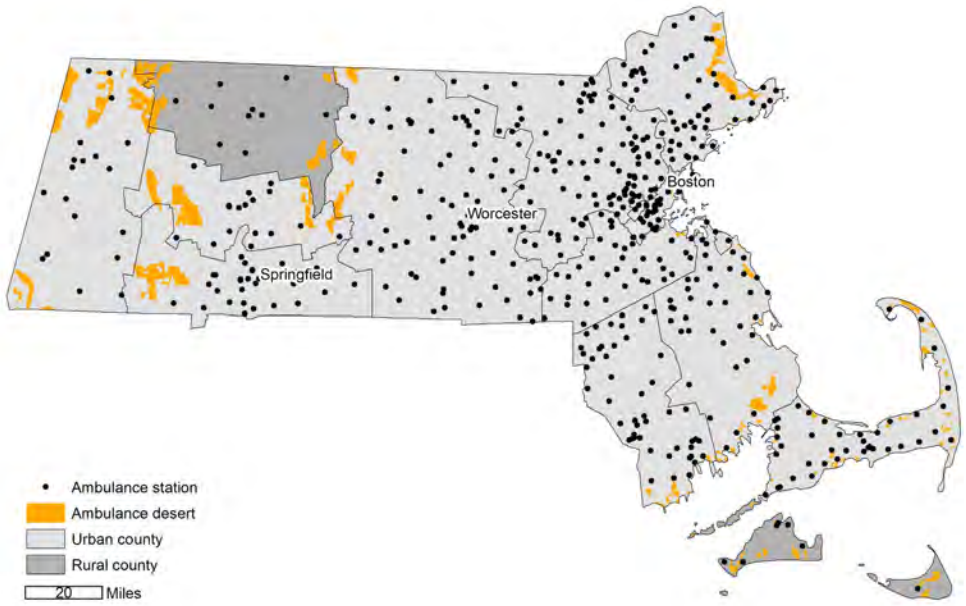
Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
425	62,912	1.0%	6,493	4.6%	10.3%

Data sources: Maryland county EMS offices; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

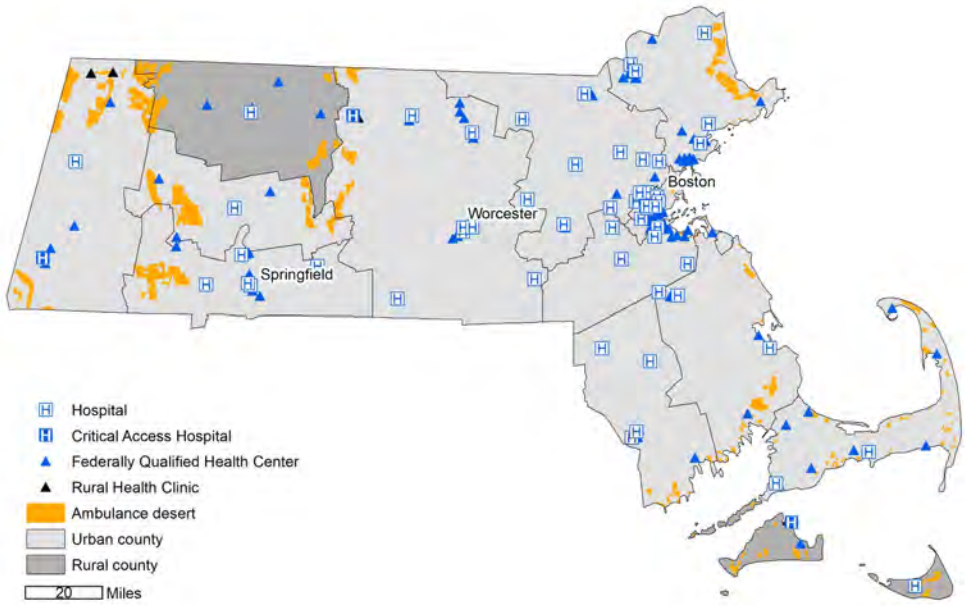
Data limitations: Maryland does not have a centralized EMS database. Ambulance station addresses were obtained from county EMS offices and compiled by the research team. There may have been differences between counties in how they defined and provided address data.

MASSACHUSETTS

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

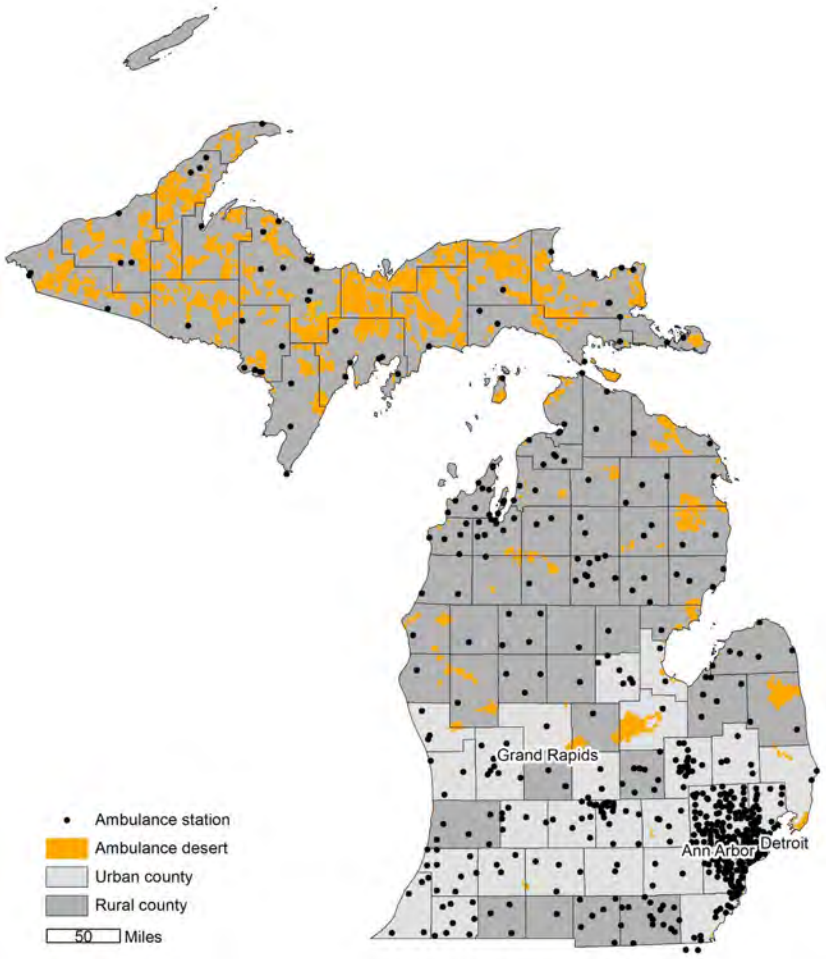


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
535	17,370	0.2%	1,170	1.1%	6.7%

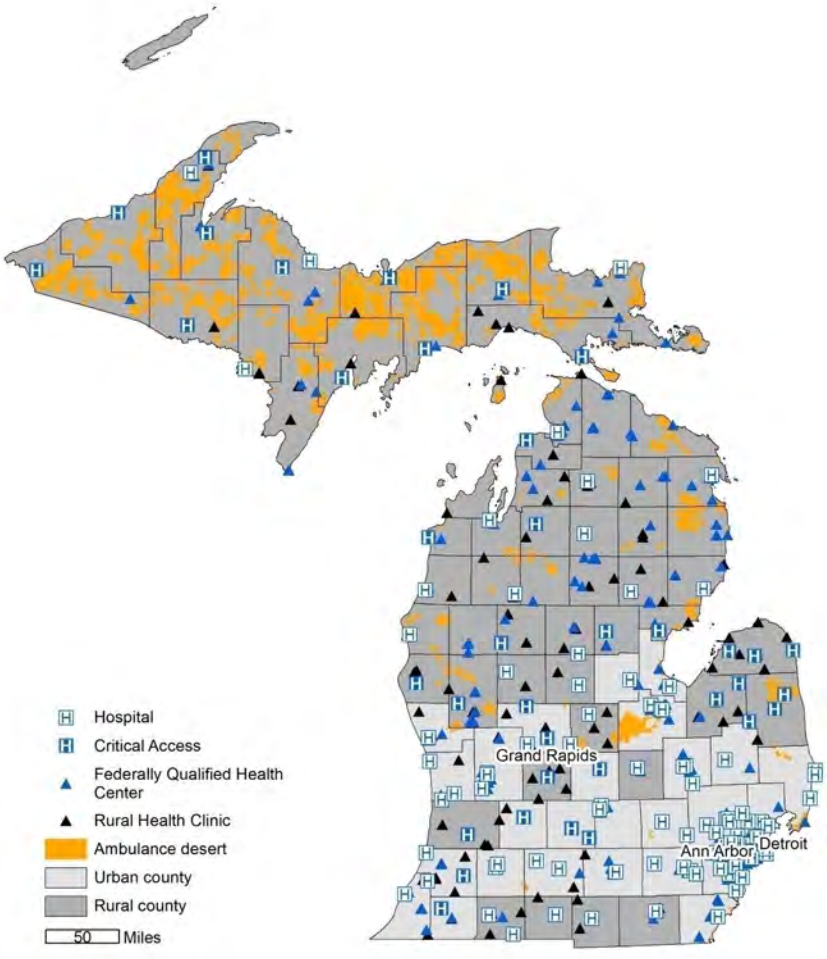
Data sources: Massachusetts Office of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

MICHIGAN

Ambulance Locations and Deserts



Ambulance Deserts and Health Care Facilities

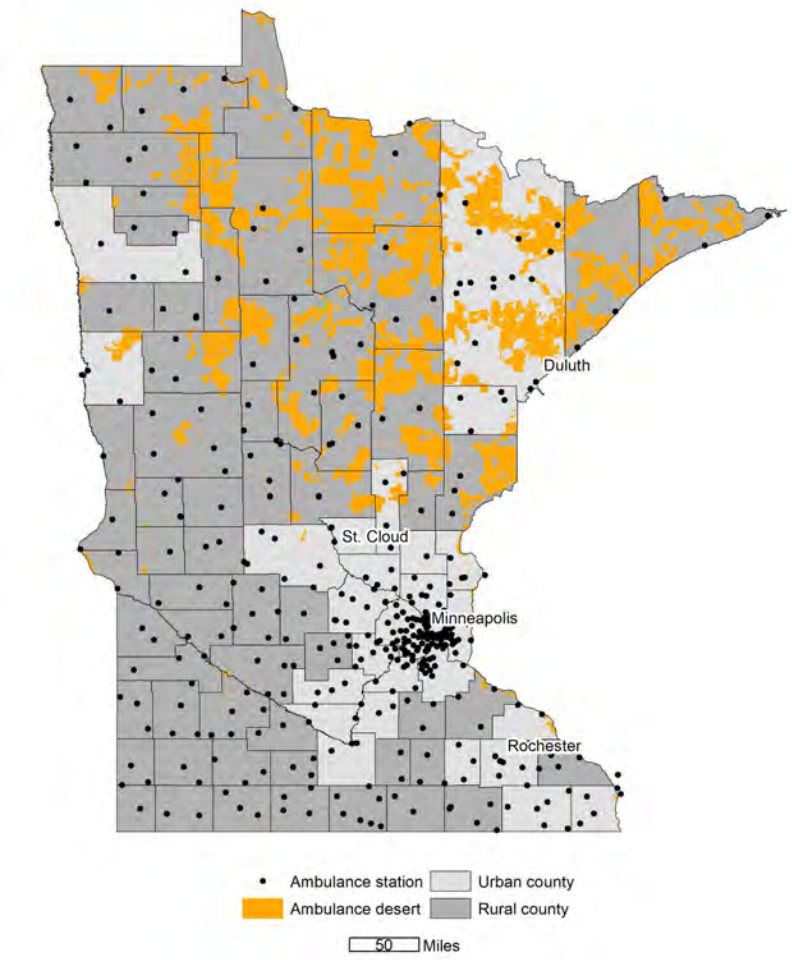


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
615	65,709	0.7%	38,857	2.2%	59.1%

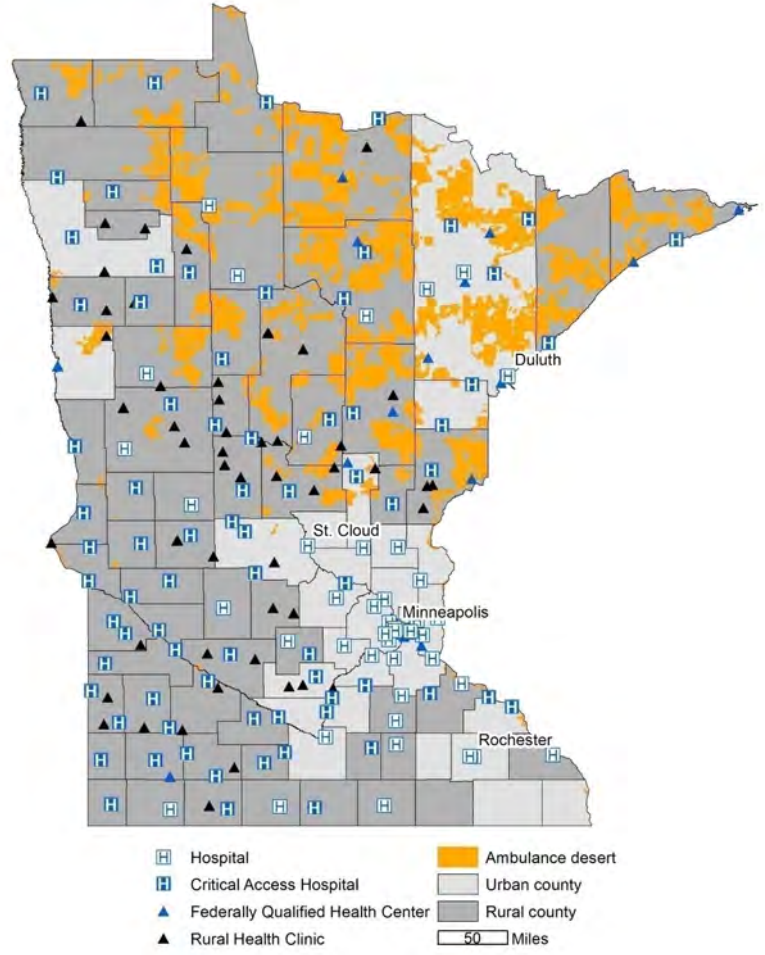
Data sources: Michigan Department of Health and Human Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

MINNESOTA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

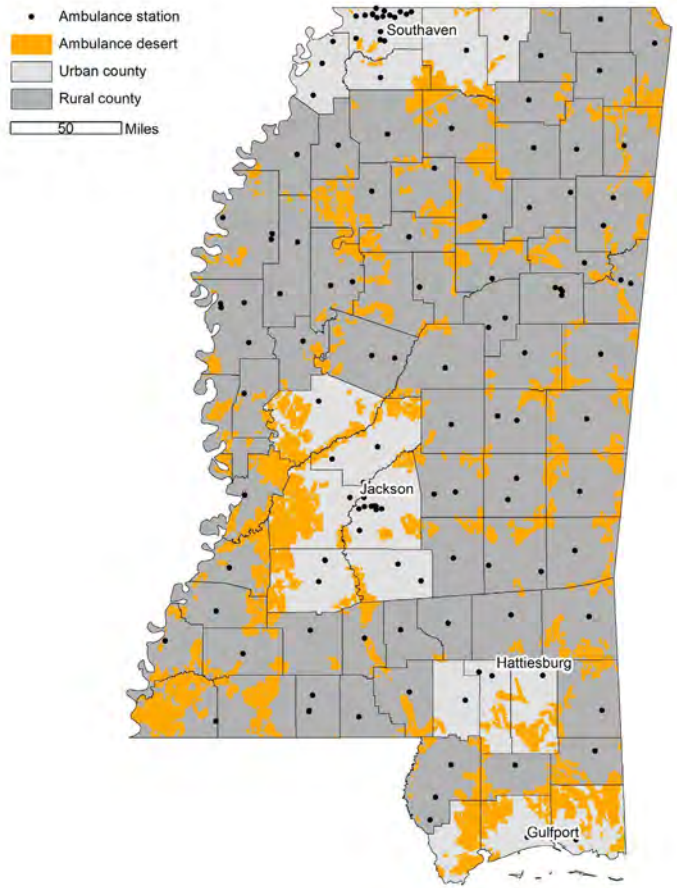


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
493	46,702	0.8%	33,226	2.7%	71.1%

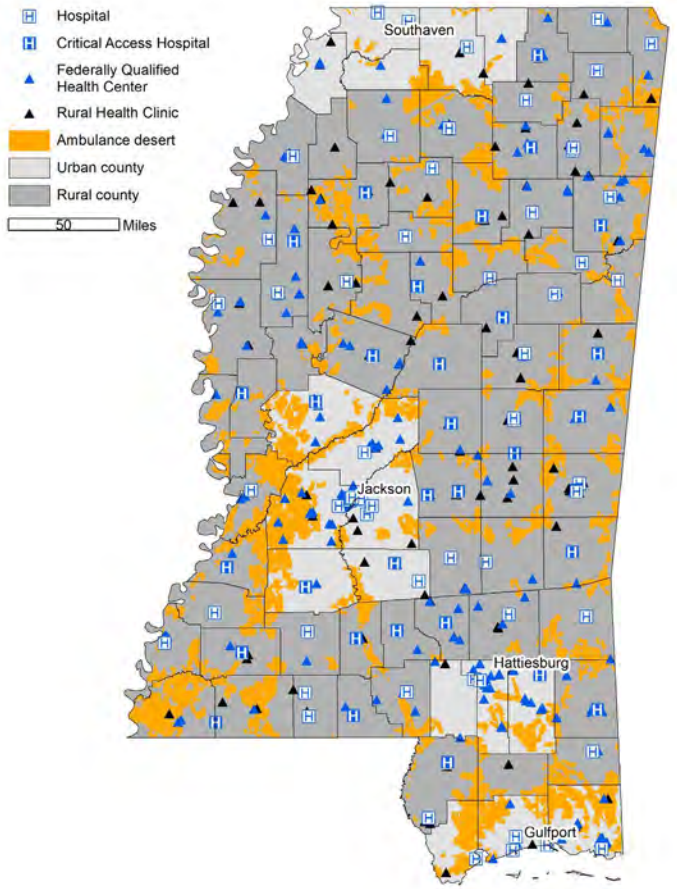
Data sources: Minnesota Emergency Medical Services Regulatory Board; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research

MISSISSIPPI

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

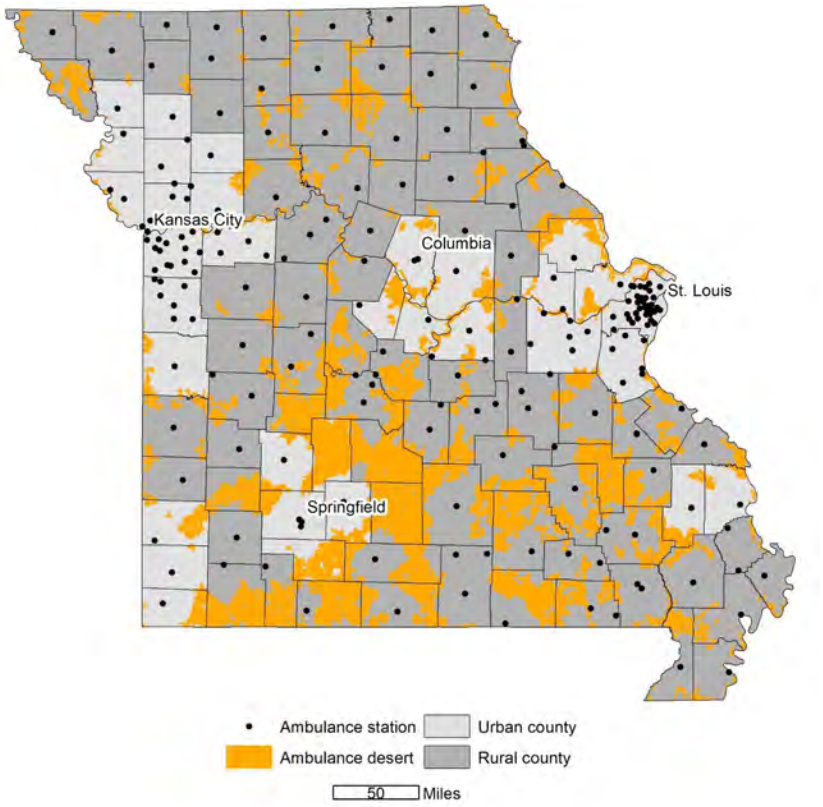


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	N	% of rural county pop.	% of total desert pop.
139	164,259	5.6%	64,881	4.2%	39.5%

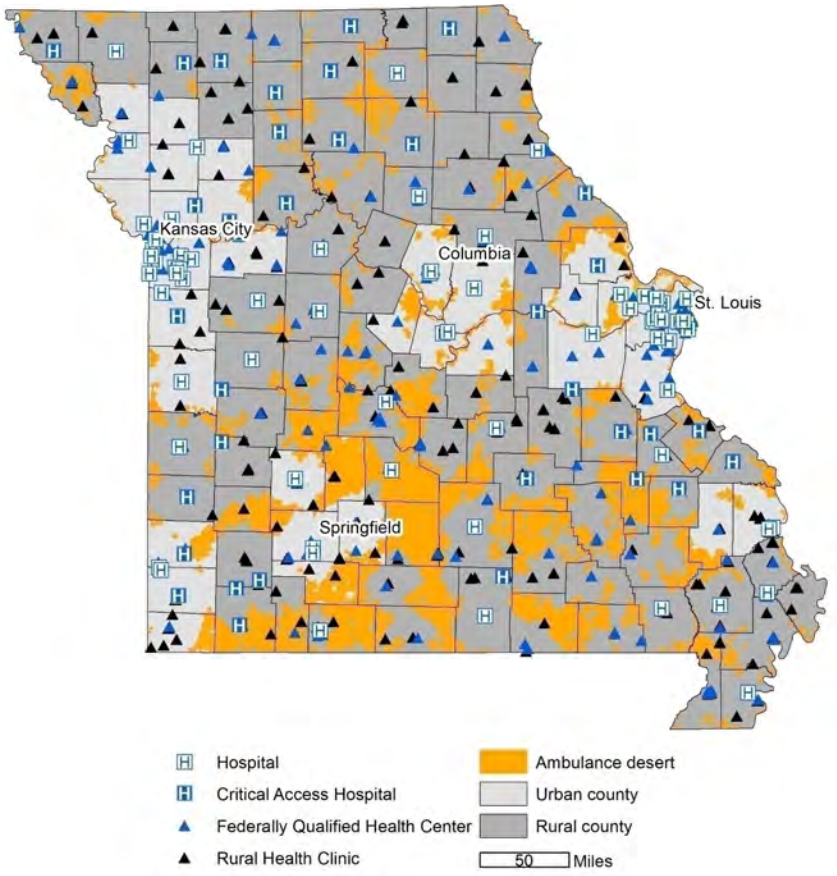
Data sources: Mississippi State Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

MISSOURI

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts



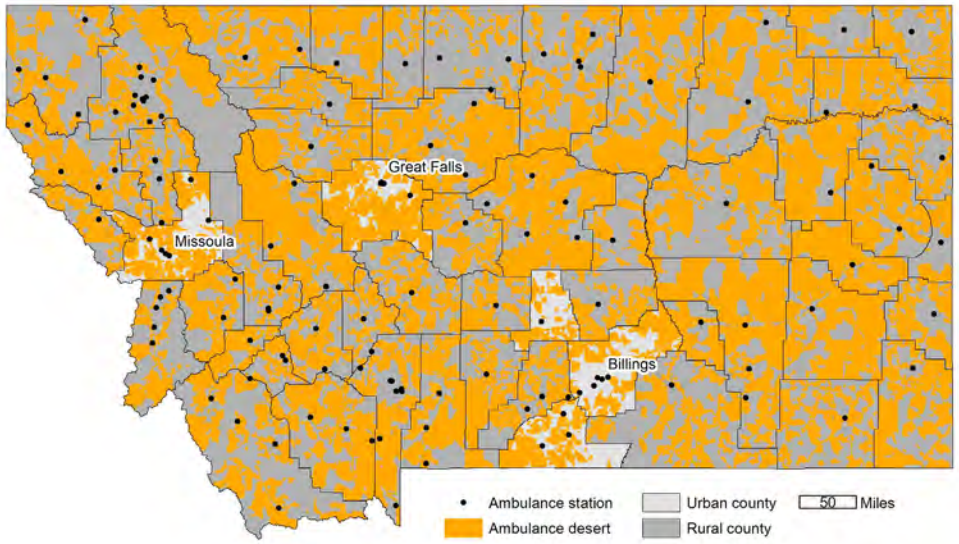
Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
218	249,232	4.1%	171,696	11.4%	68.9%

Data sources: Missouri Department of Health and Senior Services, Bureau of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

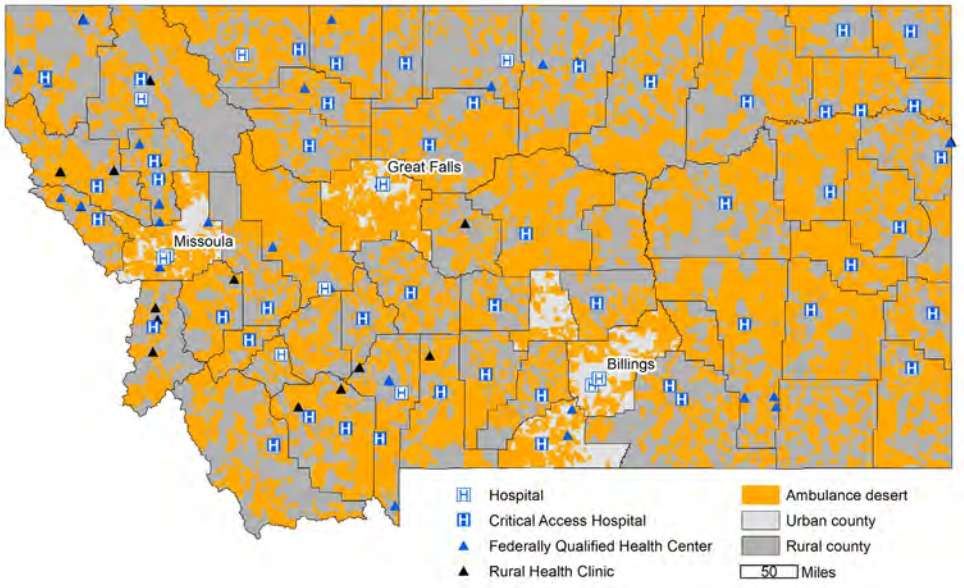
Data limitations: State unable to provide all ambulance station locations (only able to provide locations of agency headquarters). This may result in an overestimation of ambulance deserts.

MONTANA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

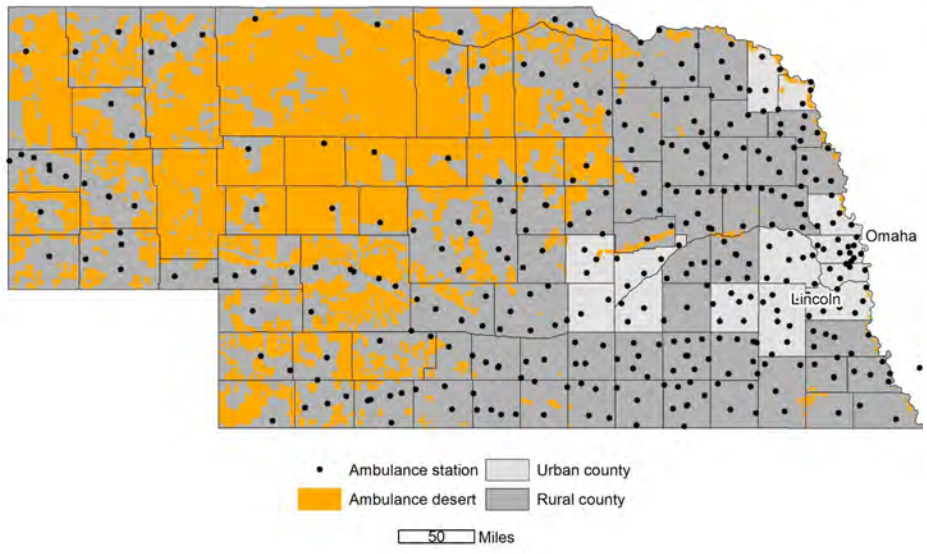


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
142	140,365	12.9%	112,824	16.0%	80.4%

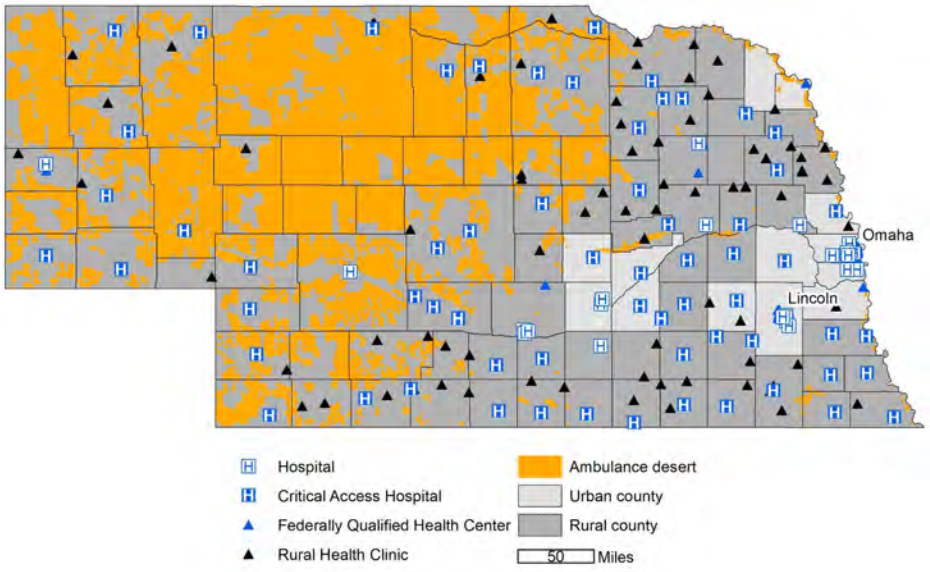
Data sources: Montana Bureau of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

NEBRASKA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts



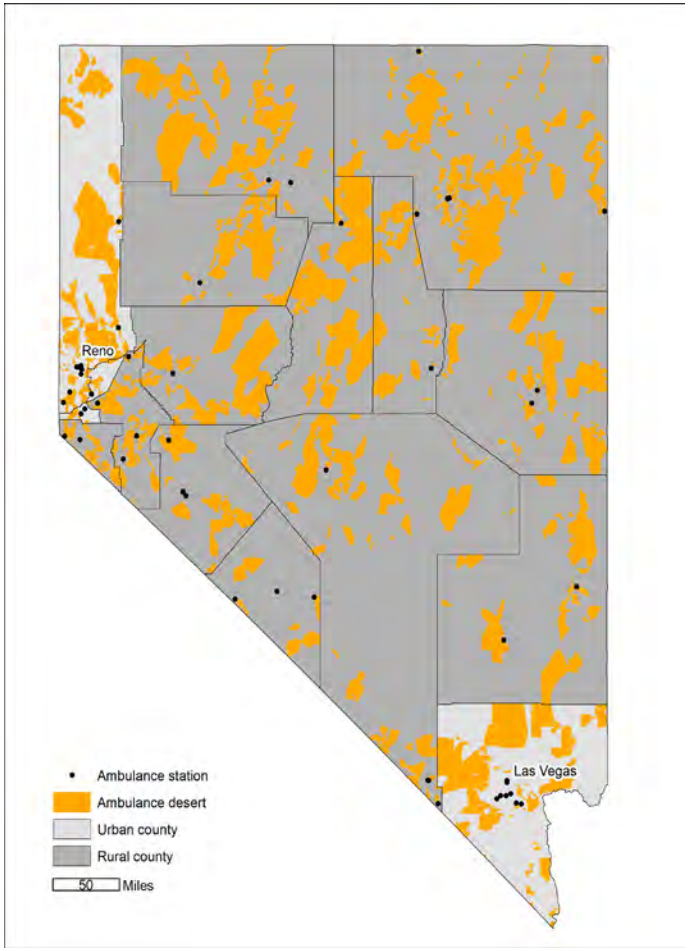
Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
358	21,746	1.1%	20,874	3.2%	96.0%

Data sources: Nebraska Department of Health and Human Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

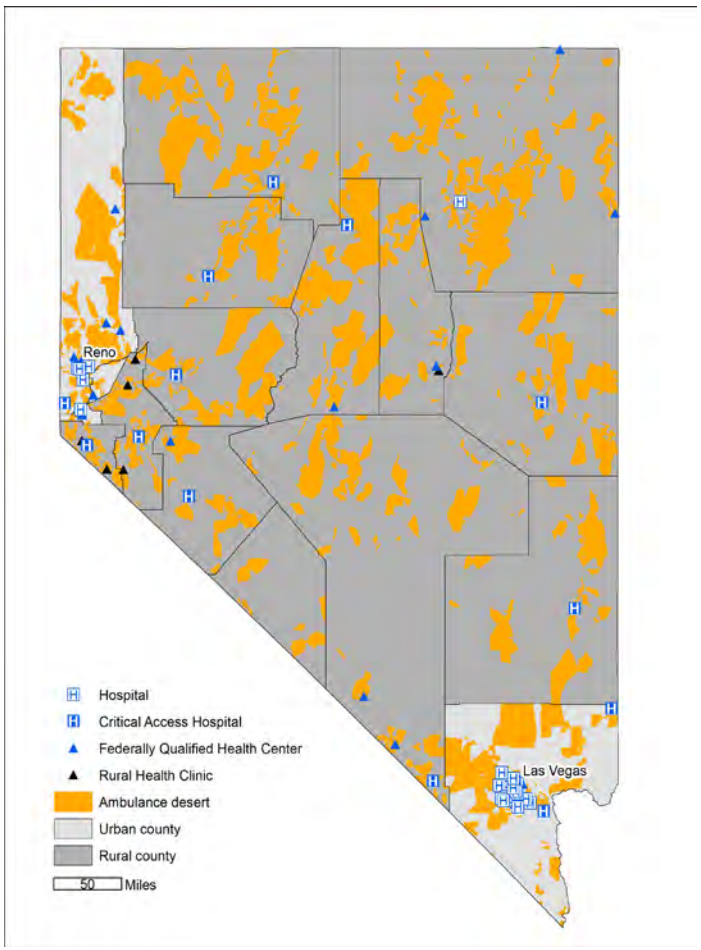
Data limitations: State unable to provide all ambulance station locations (only able to provide mailing addresses or locations of agency headquarters). This may result in an overestimation of ambulance deserts.

NEVADA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

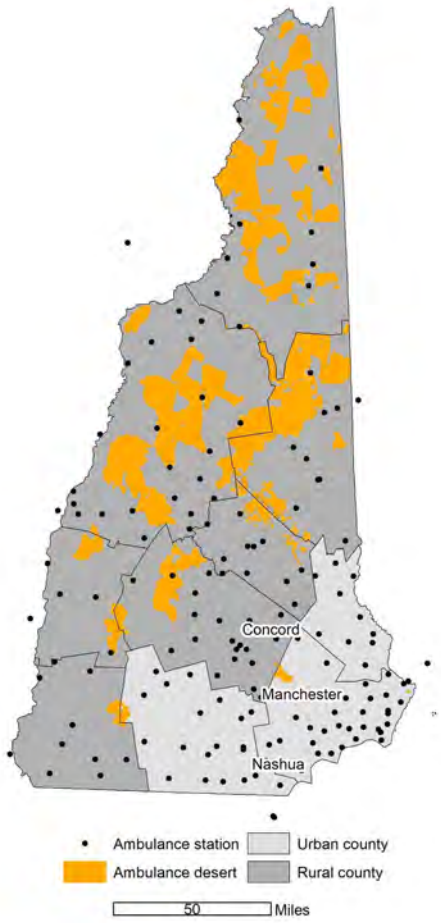


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
55	110,933	3.6%	36,640	12.7%	33.0%

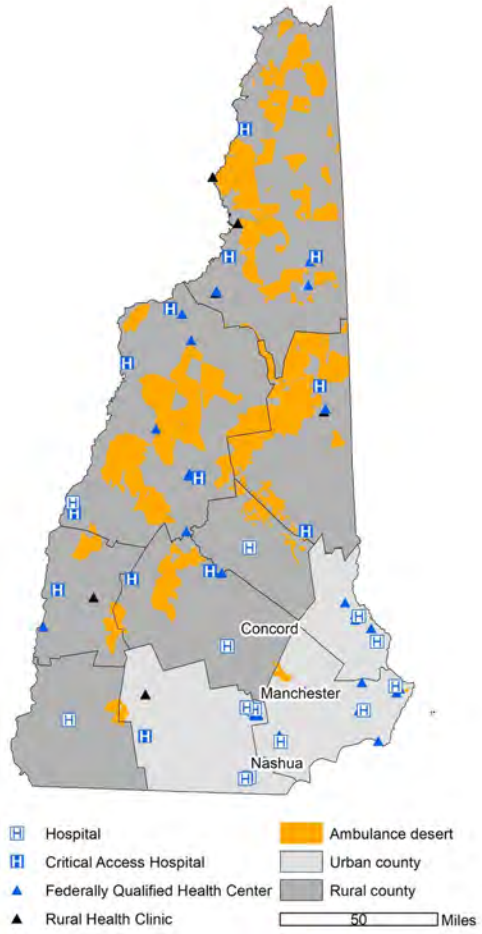
Data sources: Nevada Health Workforce Research Center; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

NEW HAMPSHIRE

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

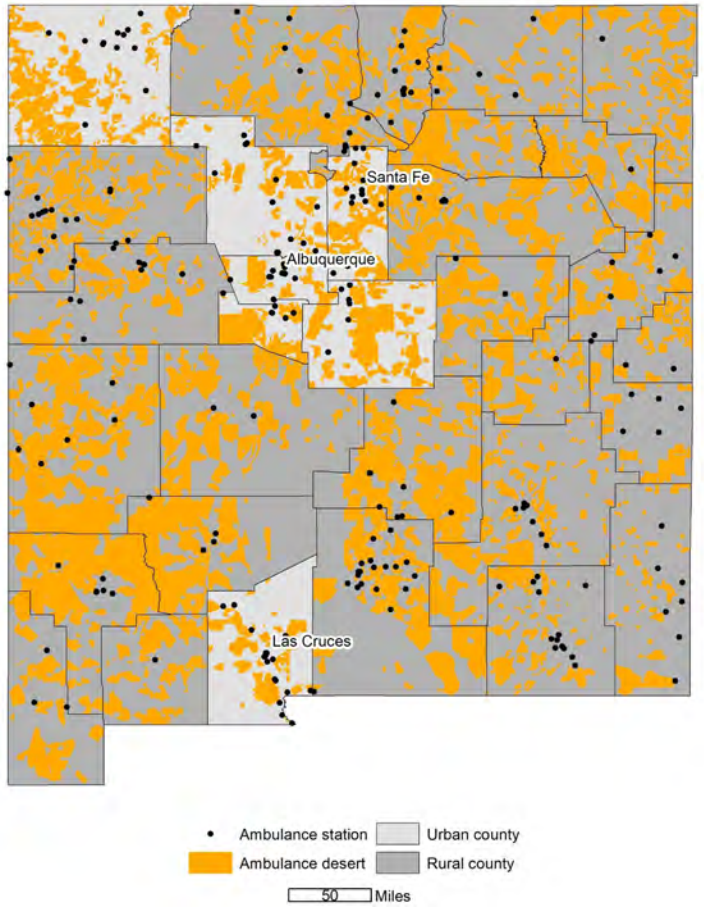


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
161	16,335	1.2%	15,754	3.1%	96.4%

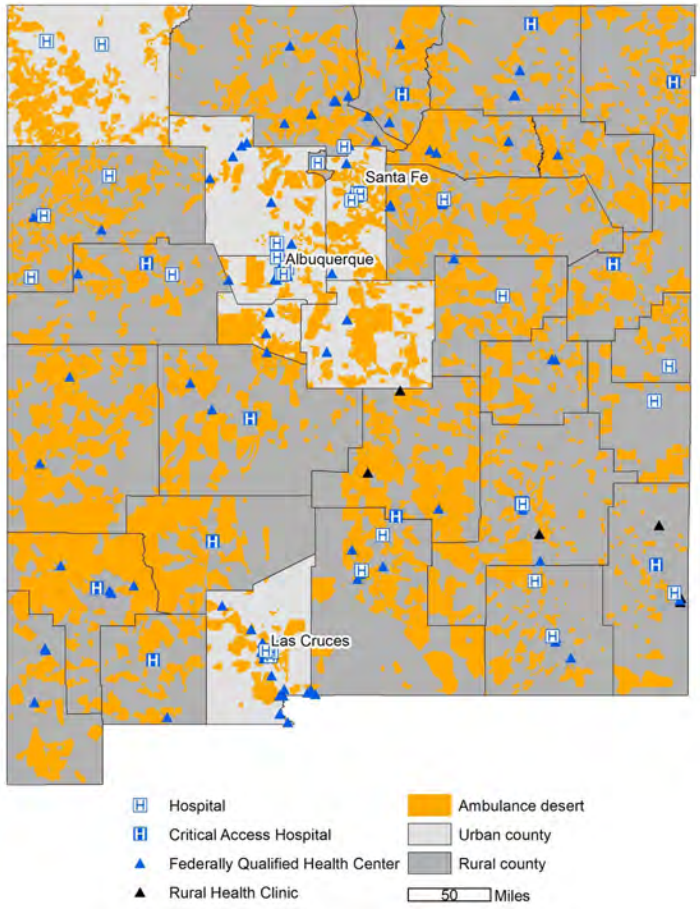
Data sources: New Hampshire Department of Safety, Bureau of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service. **Data limitations:** State unable to provide all ambulance station locations (only able to provide locations of agency headquarters). This may result in an overestimation of ambulance deserts.

NEW MEXICO

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

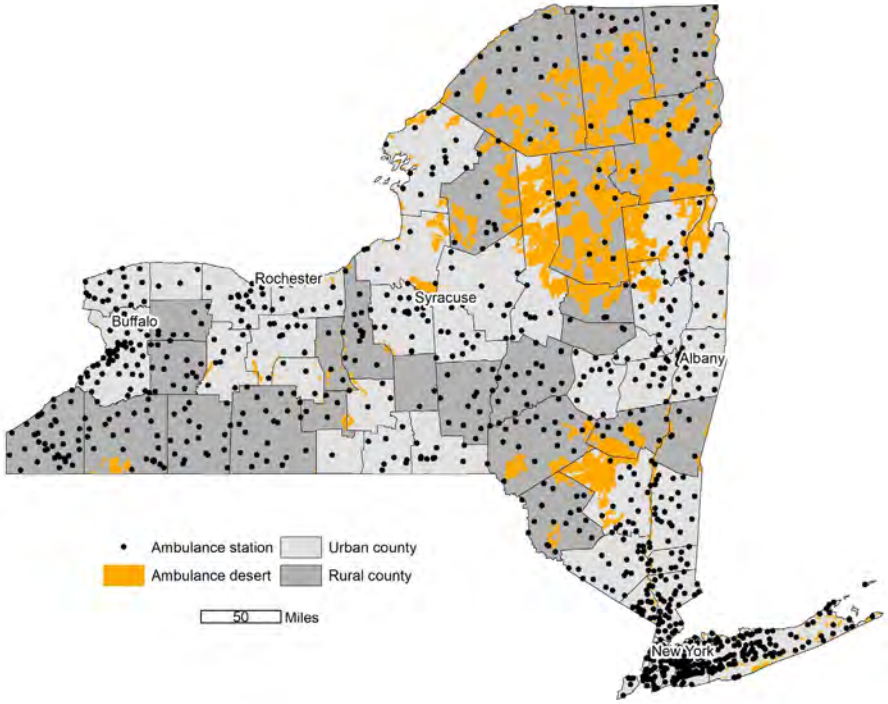


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	**n**	**% of state pop.**	**n**	**% of rural county pop.**	**% of total desert pop.**
246	119,854	5.7%	81,399	11.6%	67.9%

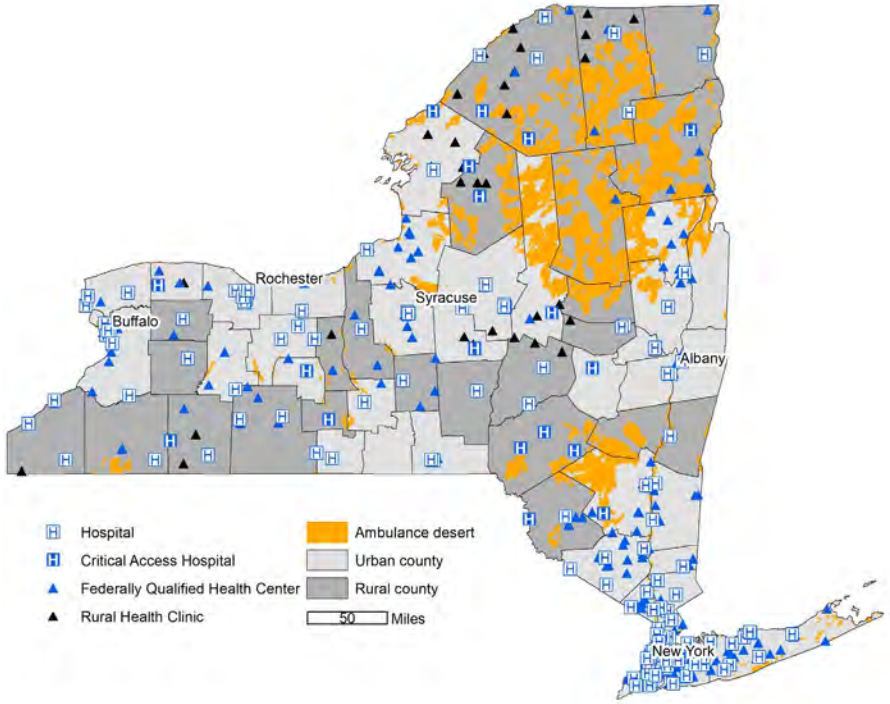
Data sources: New Mexico Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.
Data limitations: Station location addresses were imputed for some stations.

NEW YORK

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

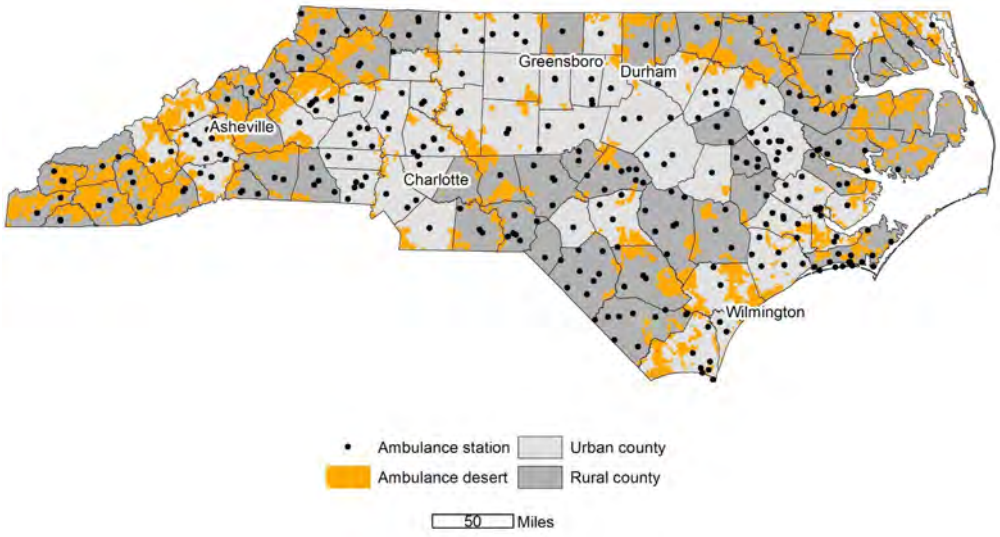


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
980	64,069	0.3%	27,046	2.0%	42.2%

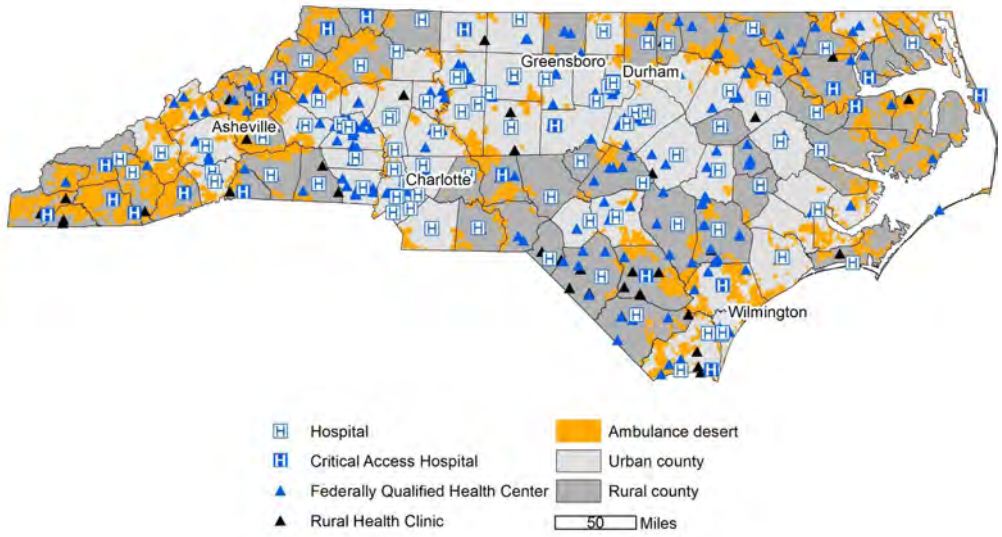
Data sources: New York Department of Health, Bureau of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

NORTH CAROLINA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts



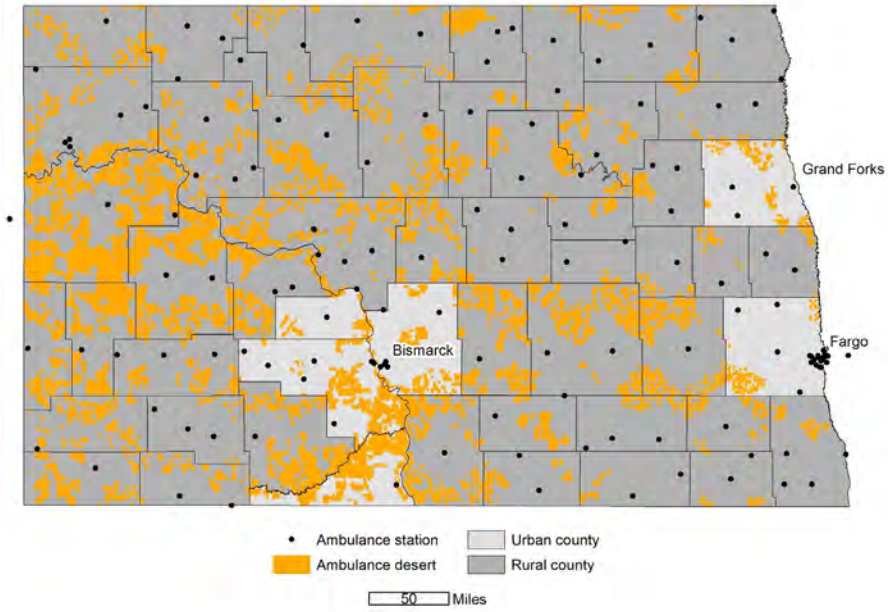
Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
314	366,147	3.5%	146,971	7.0%	40.1%

Data sources: North Carolina Department of Health and Human Services, Office of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

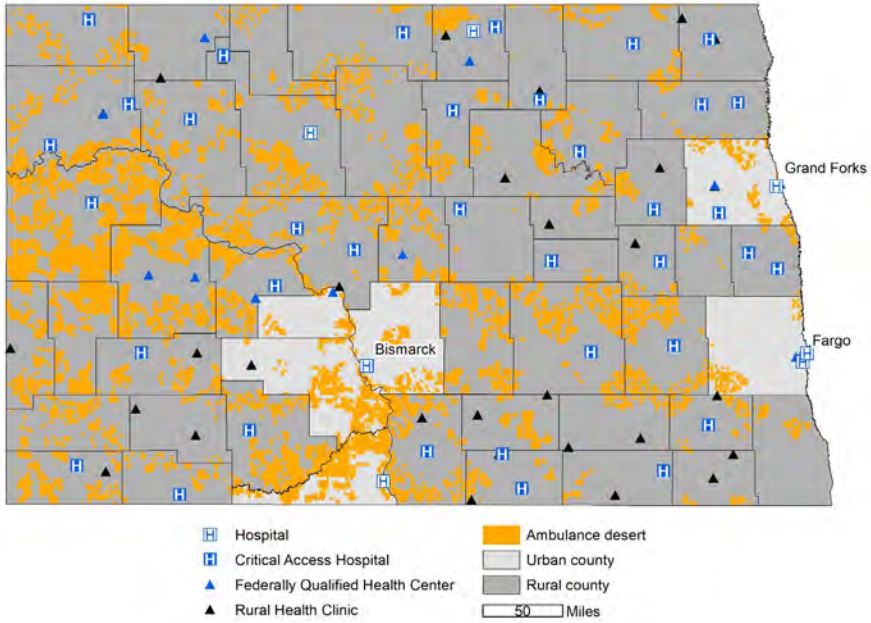
Data limitations: State unable to provide all ambulance station locations (only able to provide locations of agency headquarters). This may result in an overestimation of ambulance deserts.

NORTH DAKOTA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

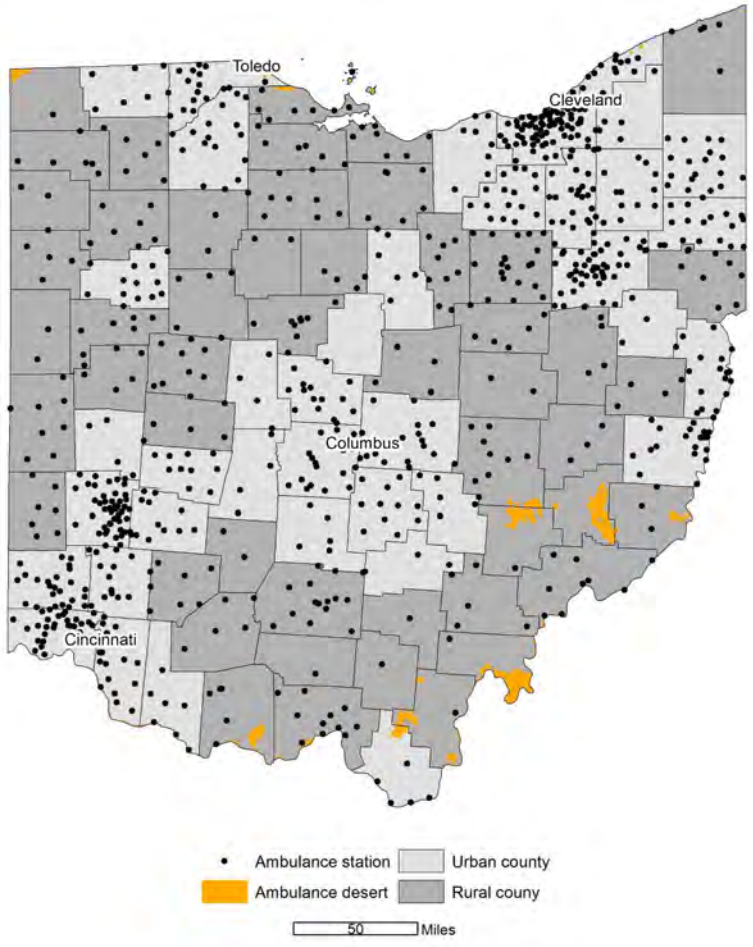


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	**n**	**% of state pop.**	**n**	**% of rural county pop.**	**% of total desert pop.**
144	31,333	4.0%	24,980	6.5%	79.7%

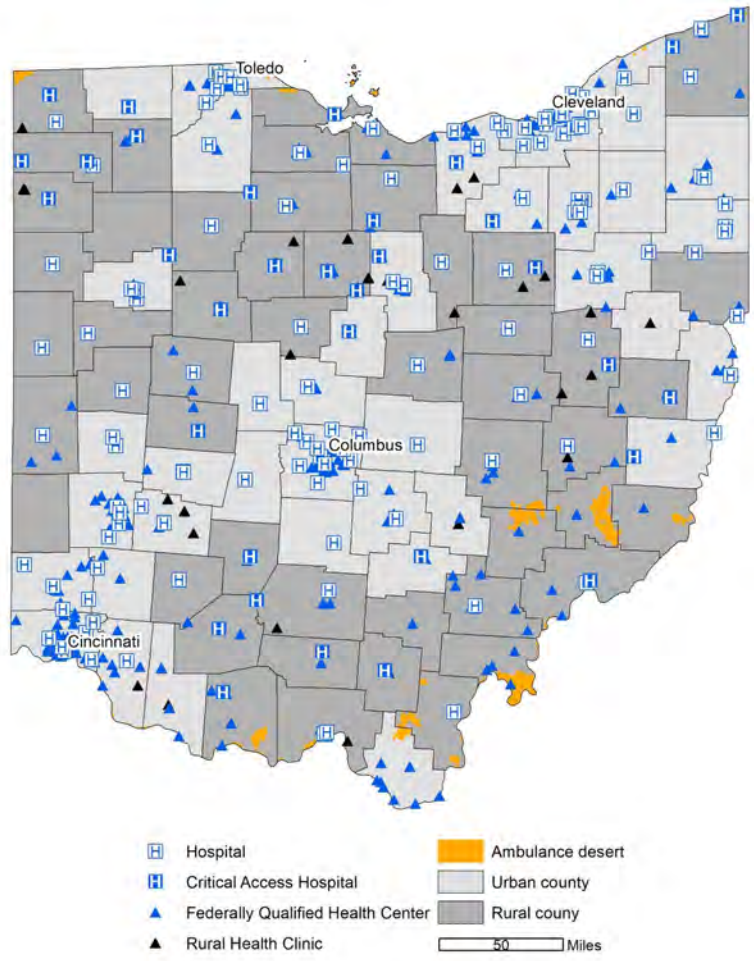
Data sources: North Dakota Division of Emergency Medical Systems; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

OHIO

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

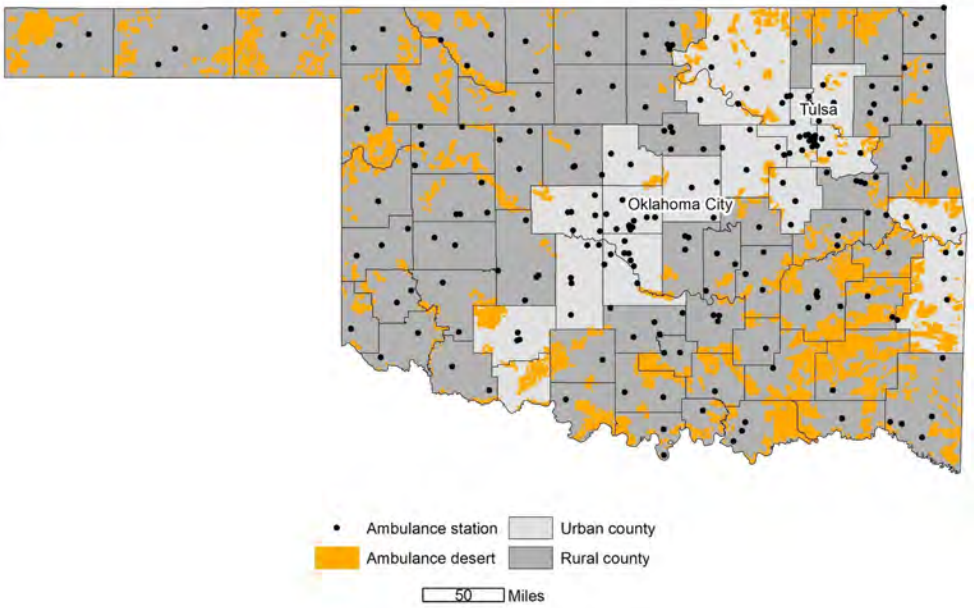


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
879	12,565	0.1%	11,887	0.5%	94.6%

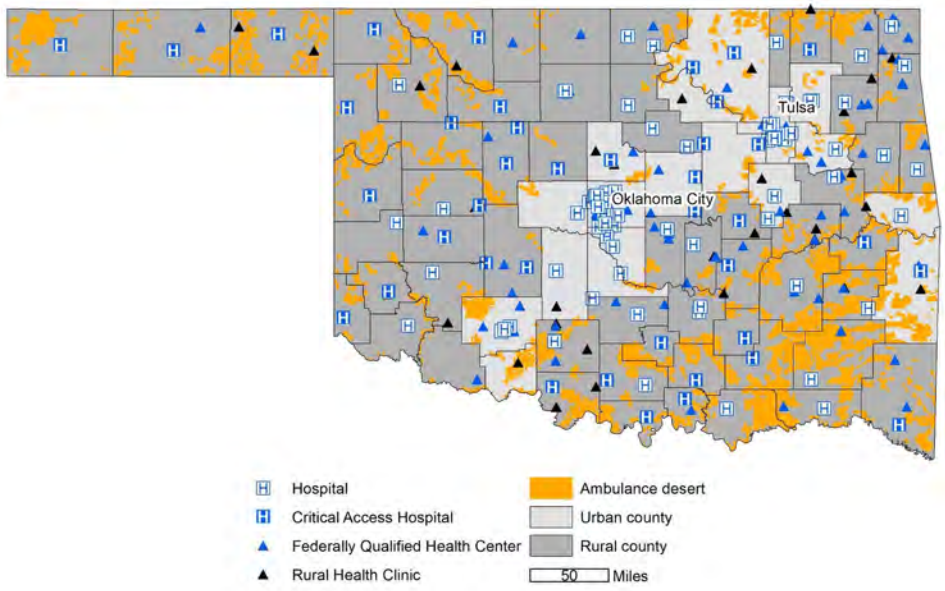
Data sources: Ohio Department of Public Safety; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

OKLAHOMA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

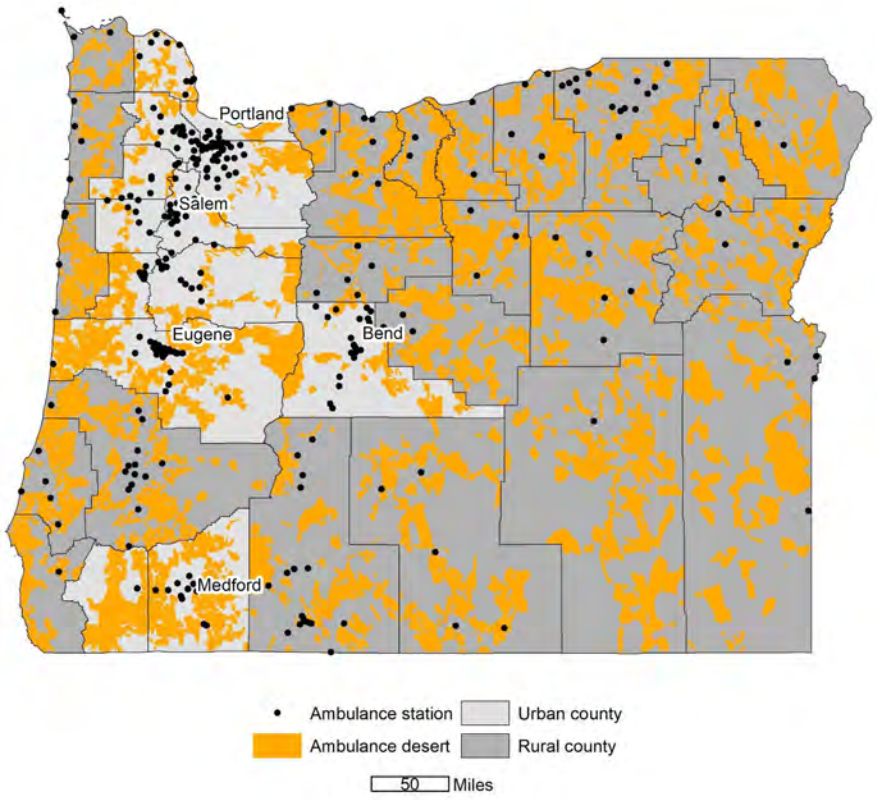


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
252	62,786	1.6%	45,733	3.5%	72.8%

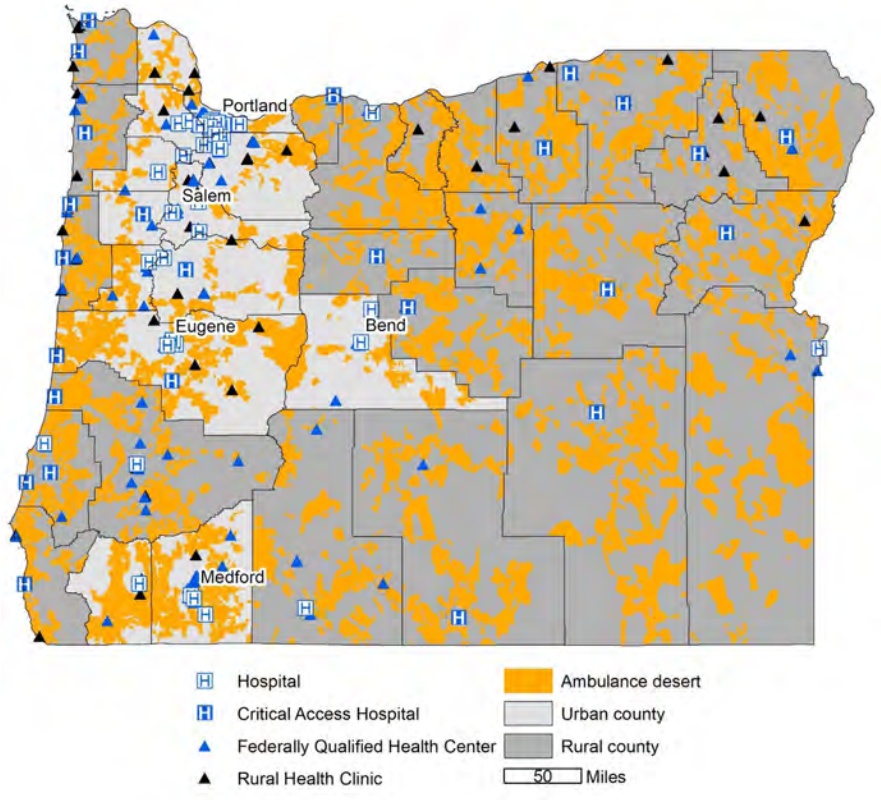
Data Sources: Oklahoma State Department of Health, EMS Division; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

OREGON

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

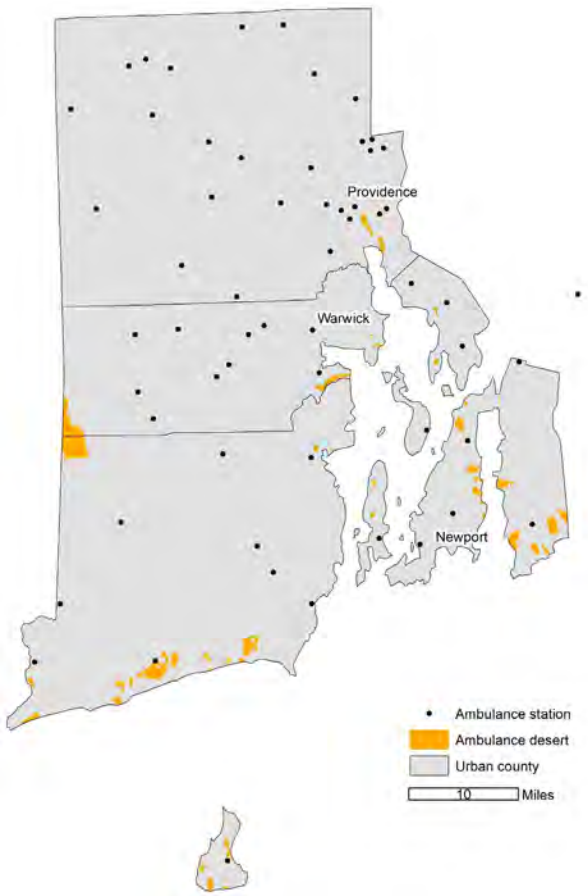


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
305	159,690	3.8%	74,988	11.0%	47.0%

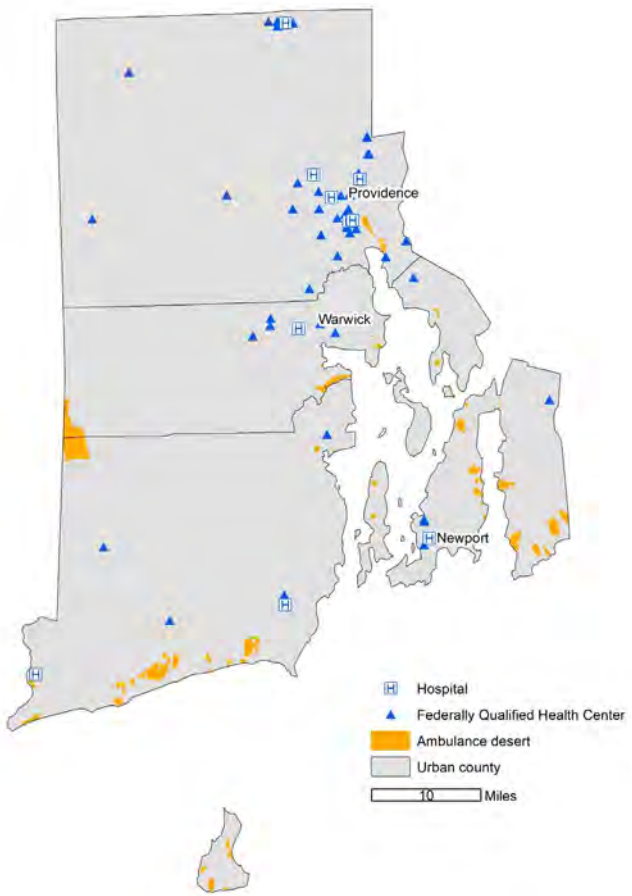
Data sources: Oregon EMS & Trauma Systems, Public Health Division; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

RHODE ISLAND

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

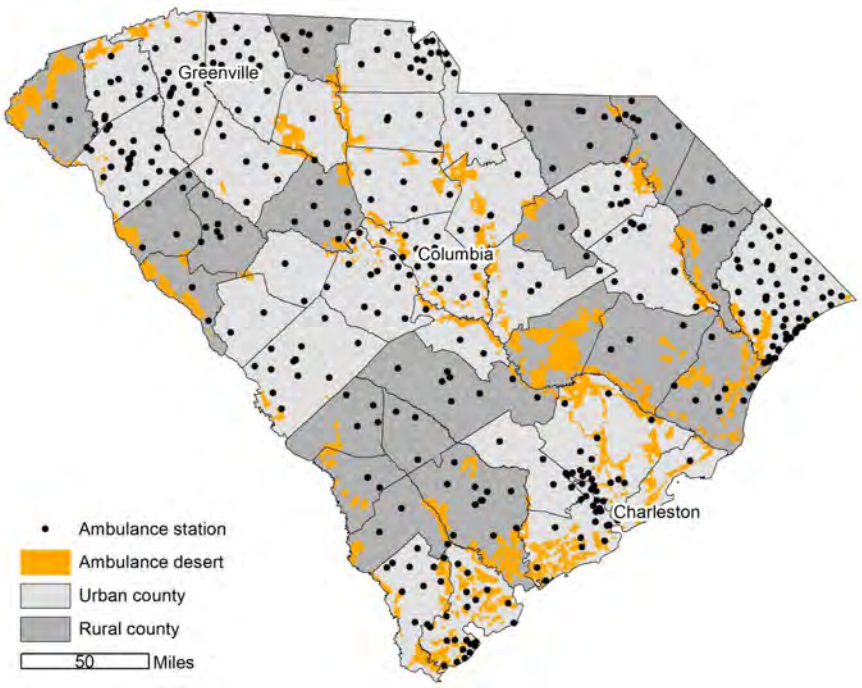


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
64	1,913	0.2%	n/a	n/a	n/a

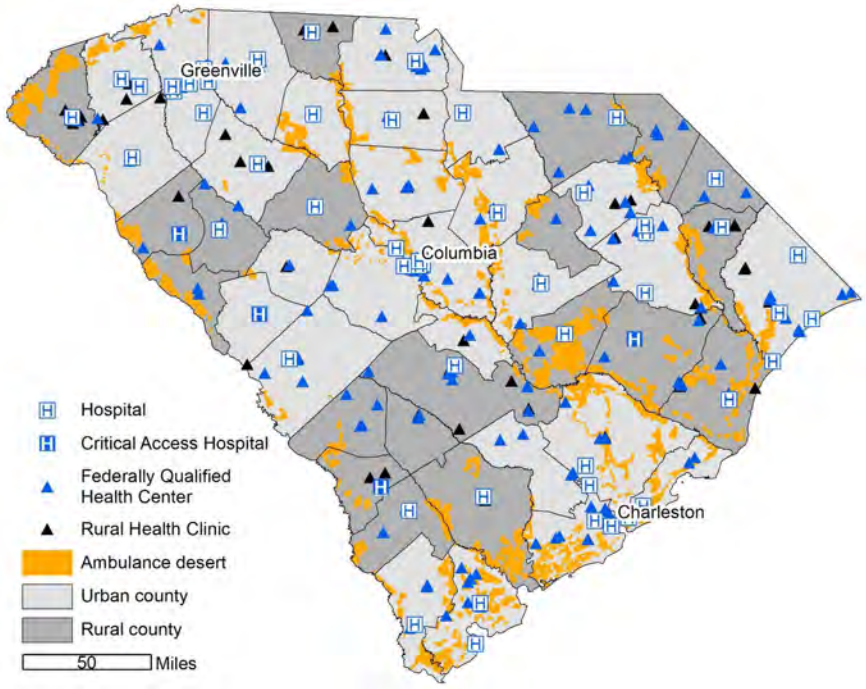
Data sources: Rhode Island Department of Health, Center for Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

SOUTH CAROLINA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

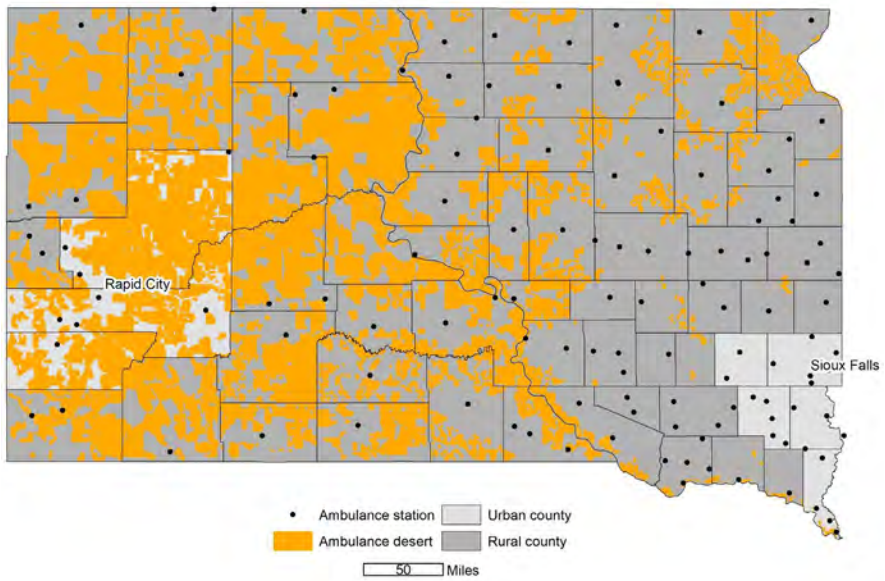


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
461	83,587	1.6%	24,569	3.4%	29.4%

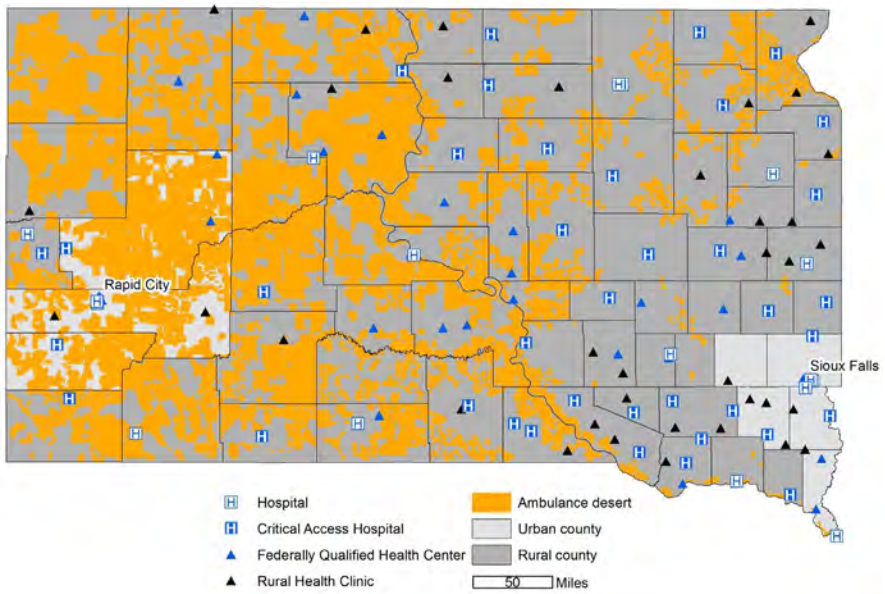
Data sources: South Carolina Department of Health and Environmental Control; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

SOUTH DAKOTA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

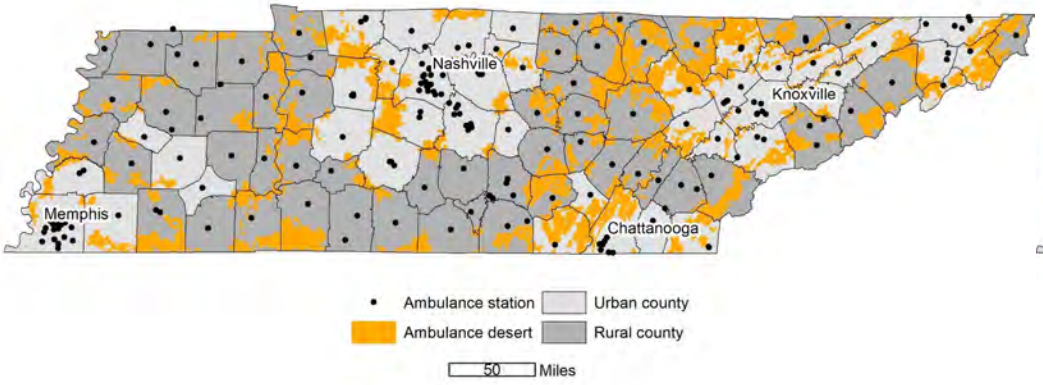


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
124	58,688	6.7%	43,944	9.9%	74.9%

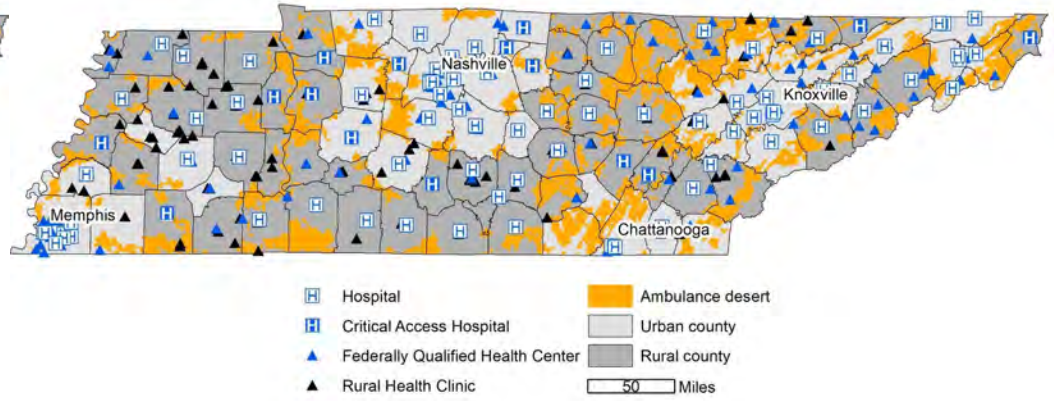
Data sources: South Dakota Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

TENNESSEE

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

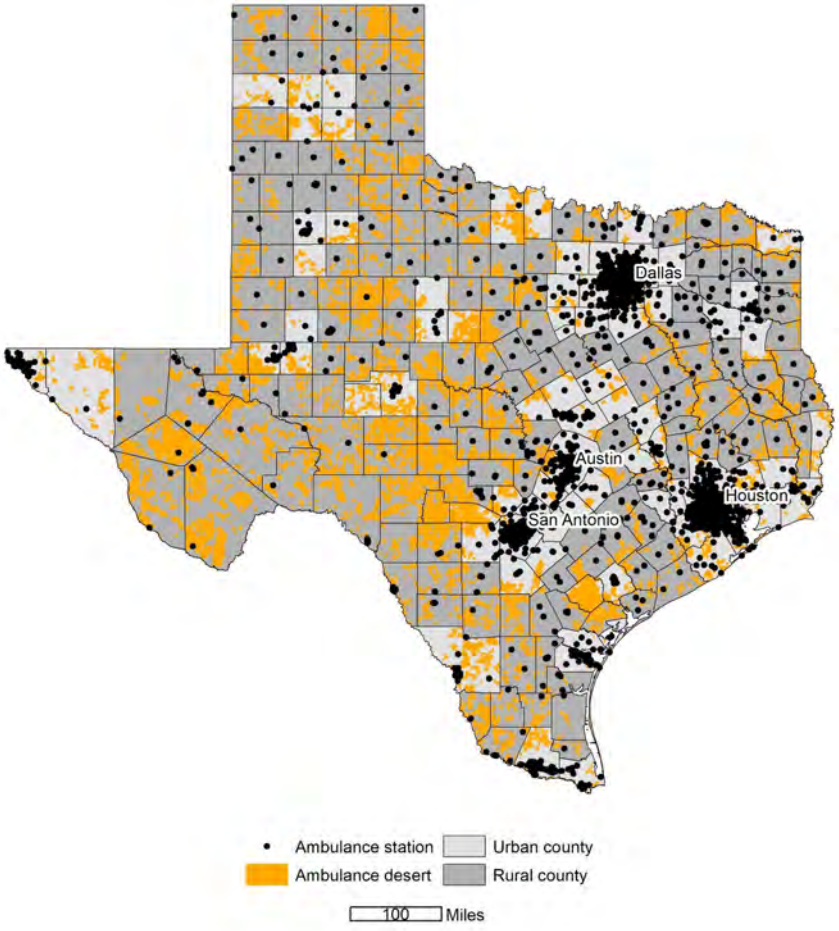


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
210	265,949	3.9%	109,891	7.2%	41.3%

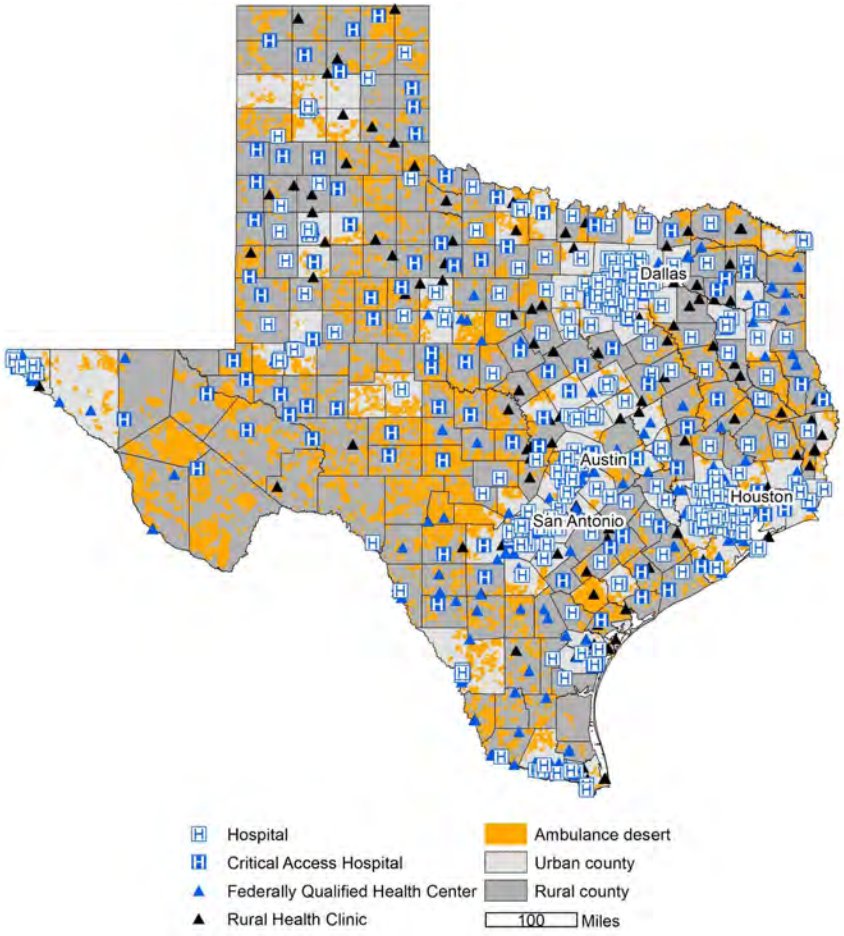
Data sources: Tennessee Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

TEXAS

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

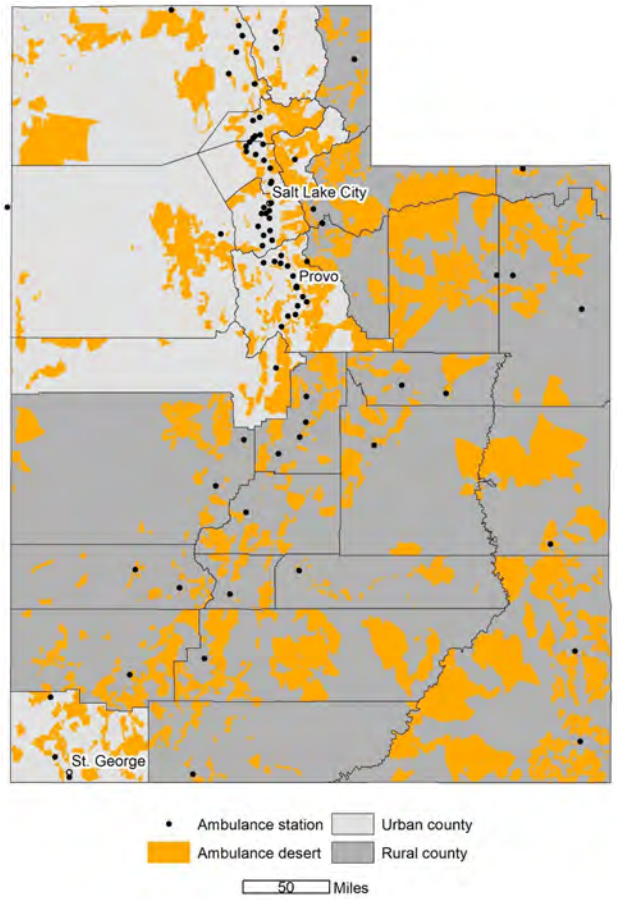


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
1,868	313,248	1.1%	174,909	5.8%	55.8%

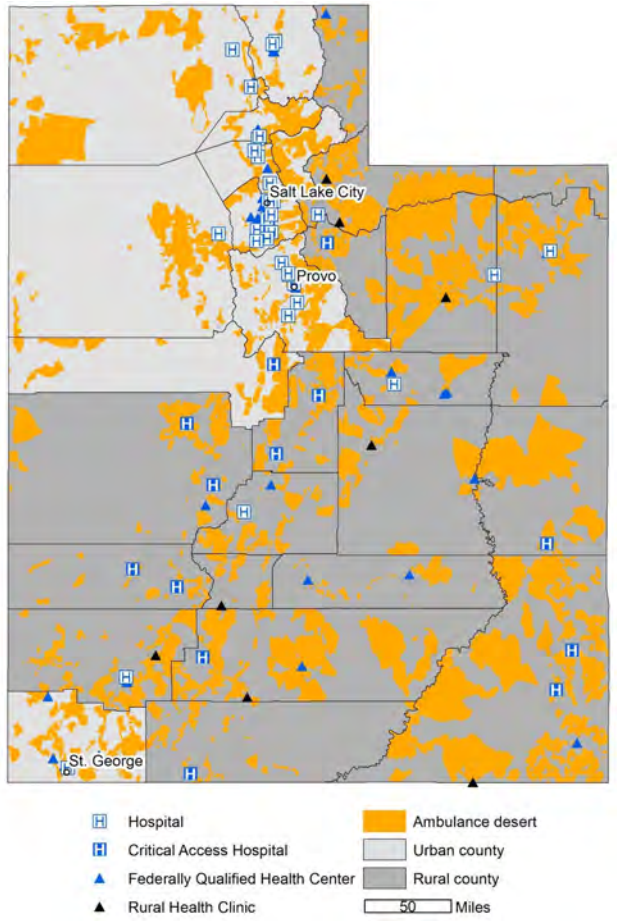
Data sources: Texas Department of State Health Services, EMS/Trauma Systems; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

UTAH

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

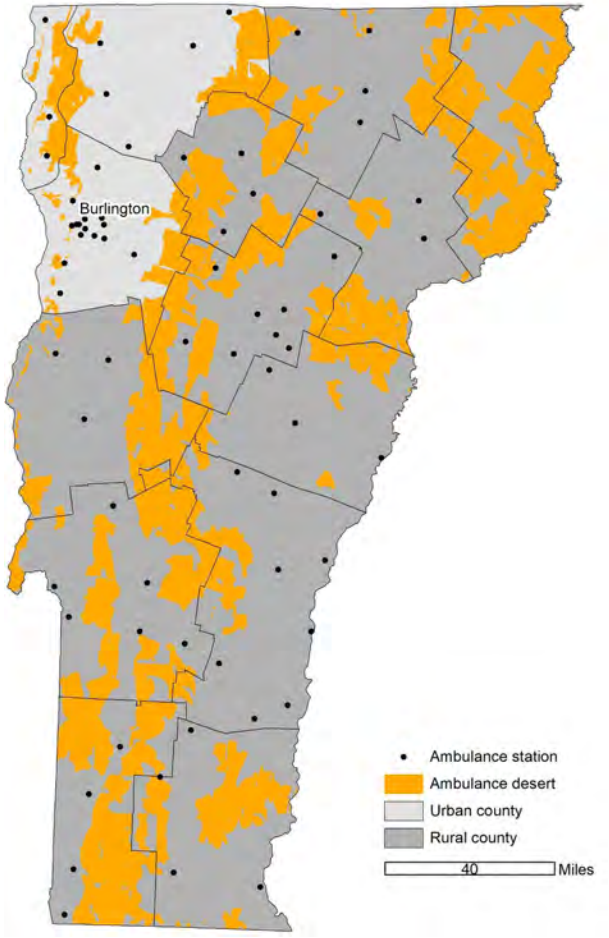


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
84	117,299	3.6%	69,283	20.8%	59.1%

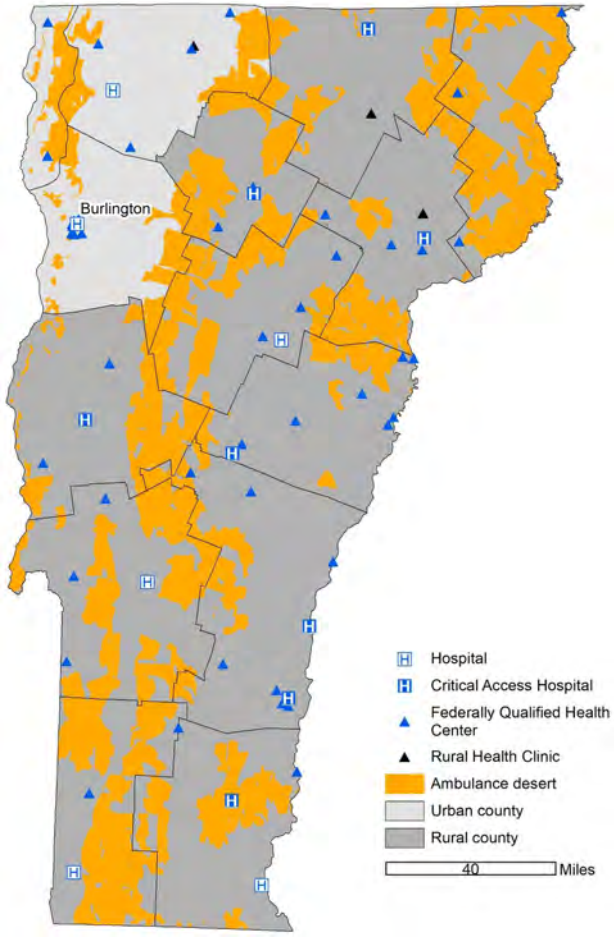
Data sources: Utah Bureau of Emergency Medical Services and Preparedness, Utah Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service. **Data limitations:** State unable to provide all ambulance station locations (only able to provide locations of agency headquarters). This may result in an overestimation of ambulance deserts.

VERMONT

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

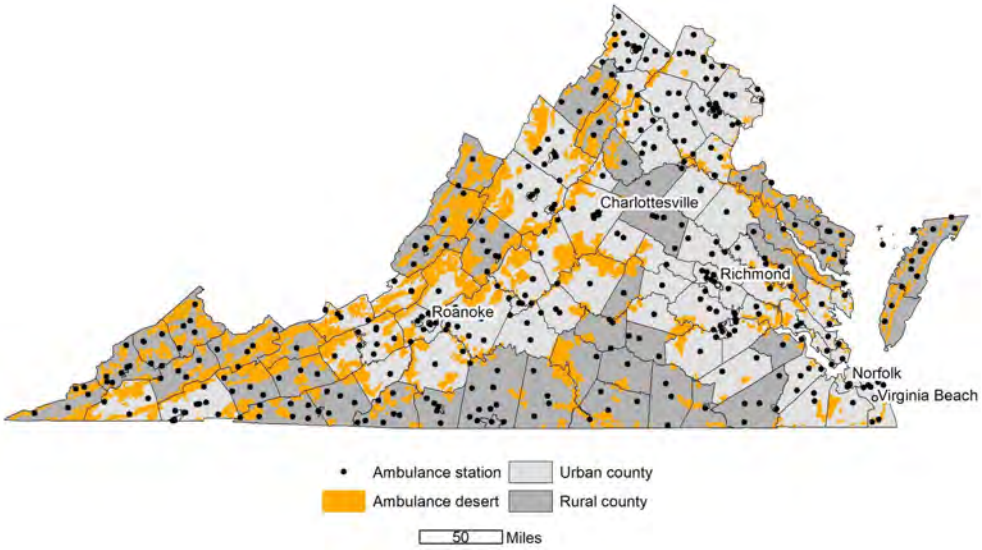


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
70	40,839	6.4%	32,916	8.0%	80.6%

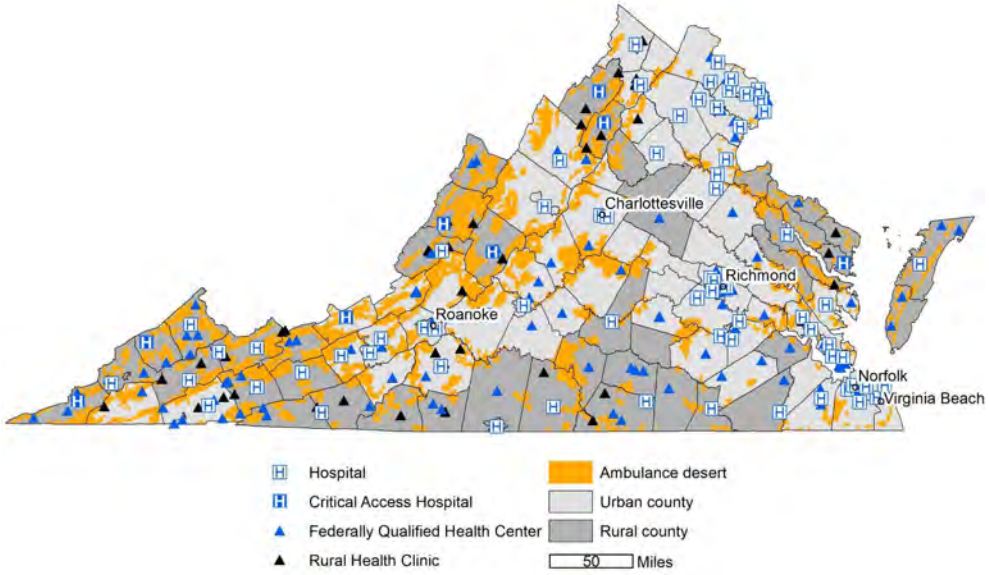
Data sources: Vermont Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

VIRGINIA

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

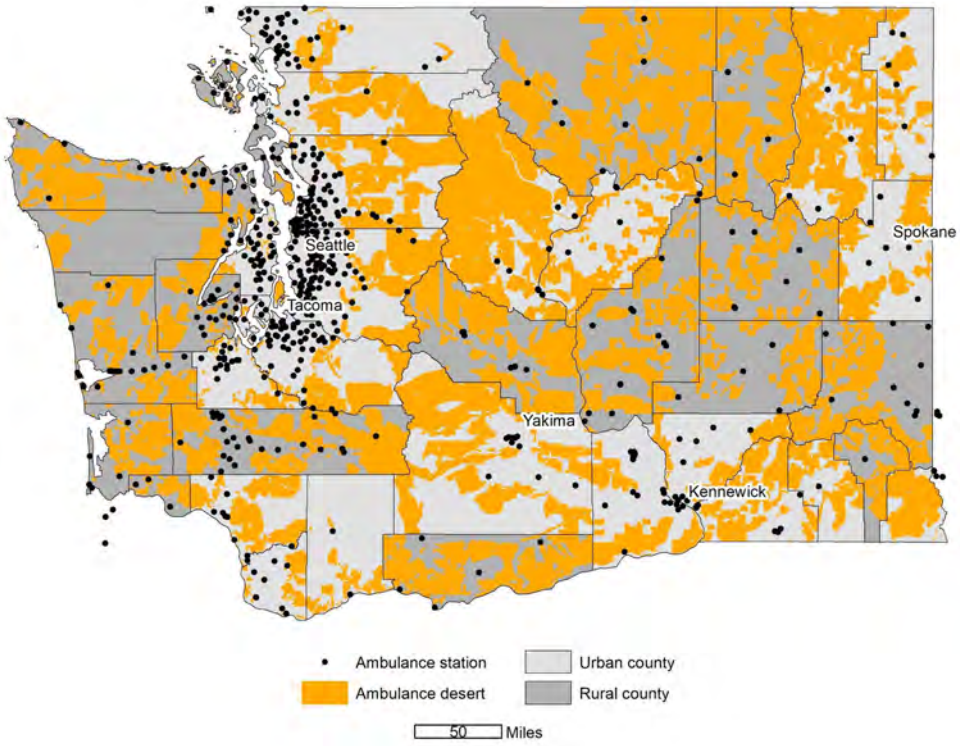


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
444	189,110	2.2%	76,912	7.6%	40.7%

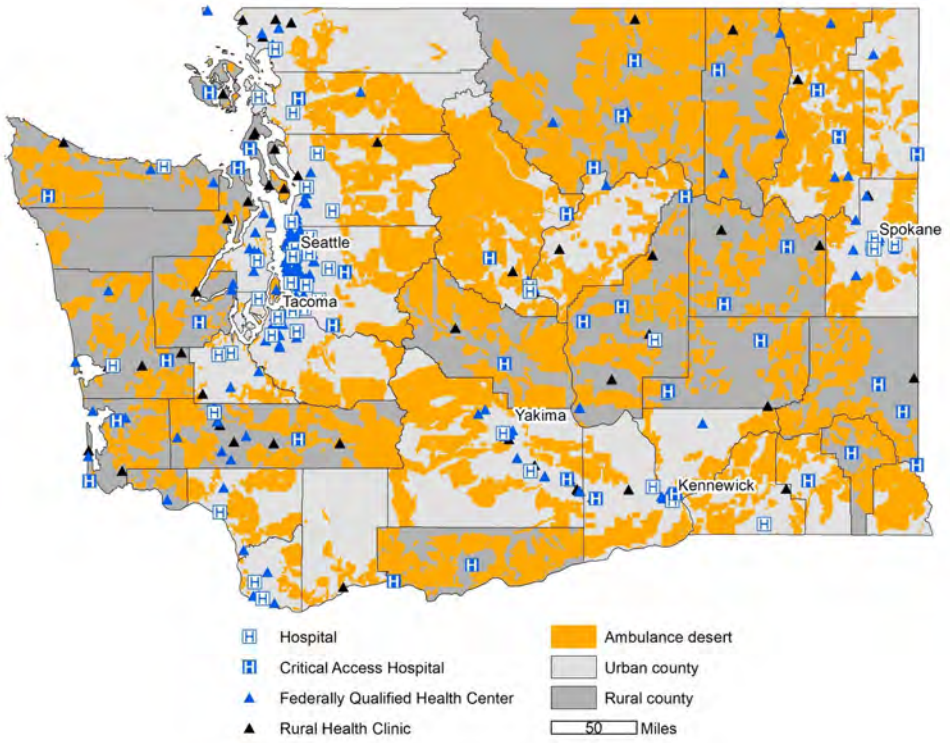
Data sources: Virginia Office of Emergency Medical Services; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

WASHINGTON

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

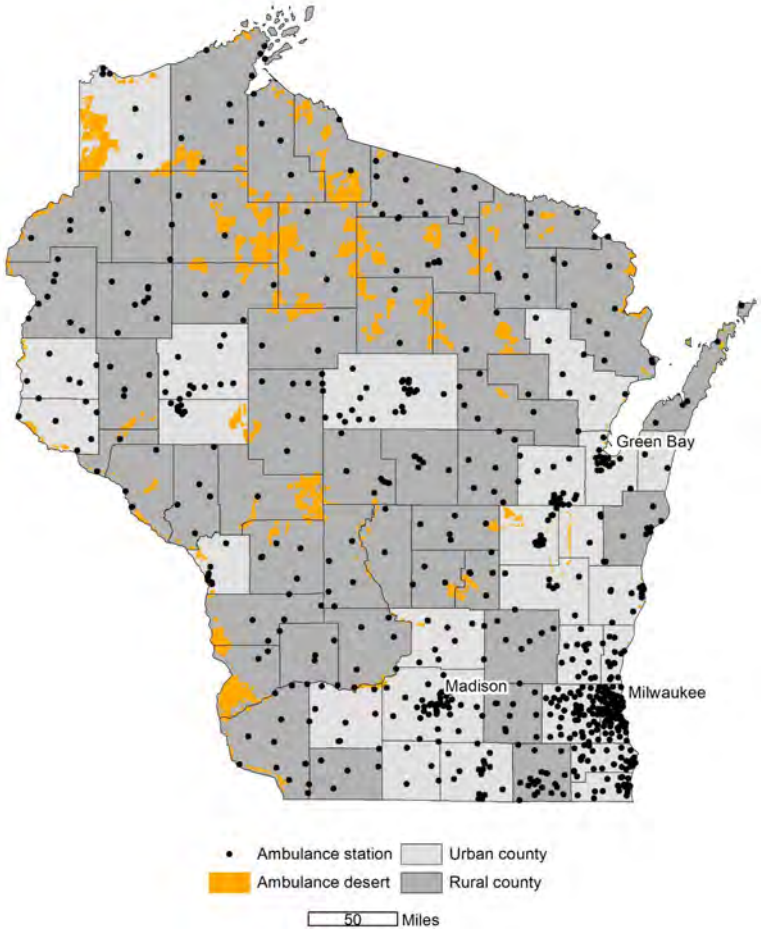


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
1,194	209,285	2.8%	75,942	10.5%	36.3%

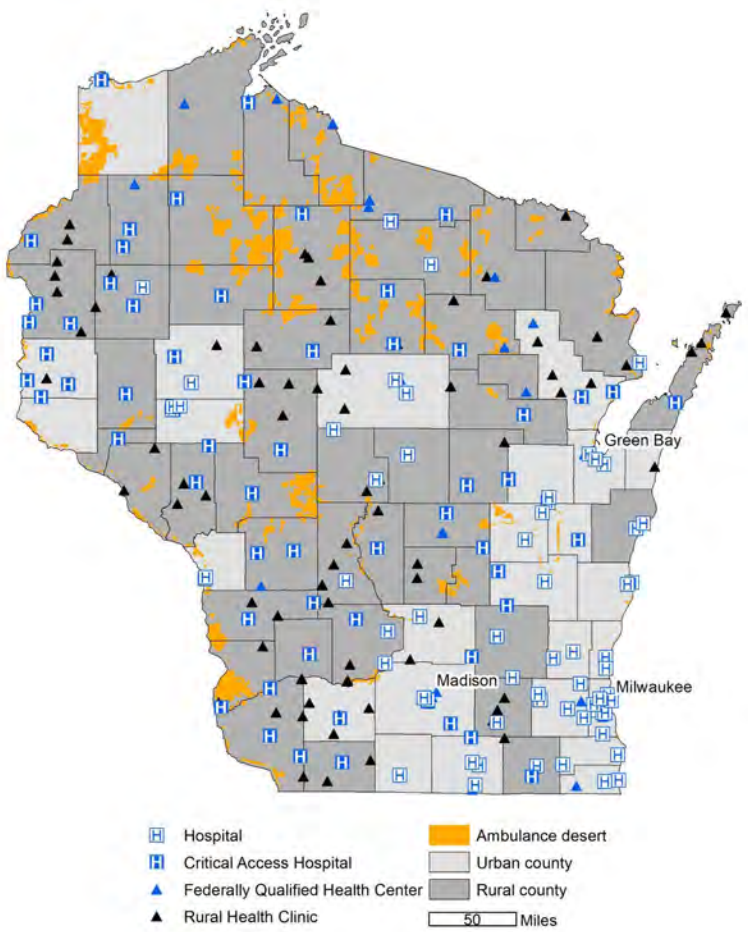
Data sources: Washington State Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

WISCONSIN

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts

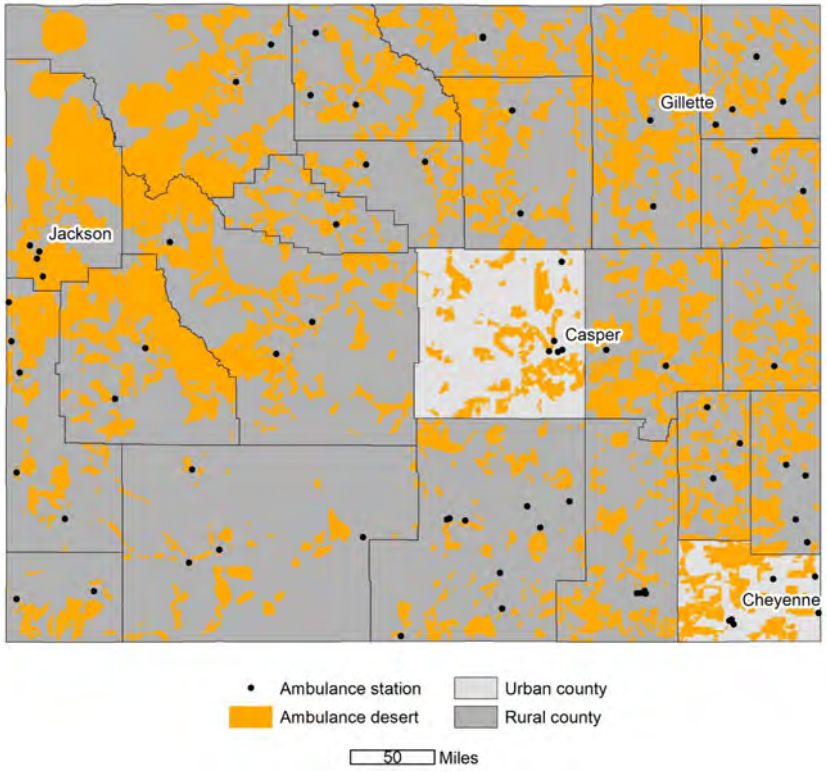


Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
790	25,498	0.4%	17,083	1.1%	67.0%

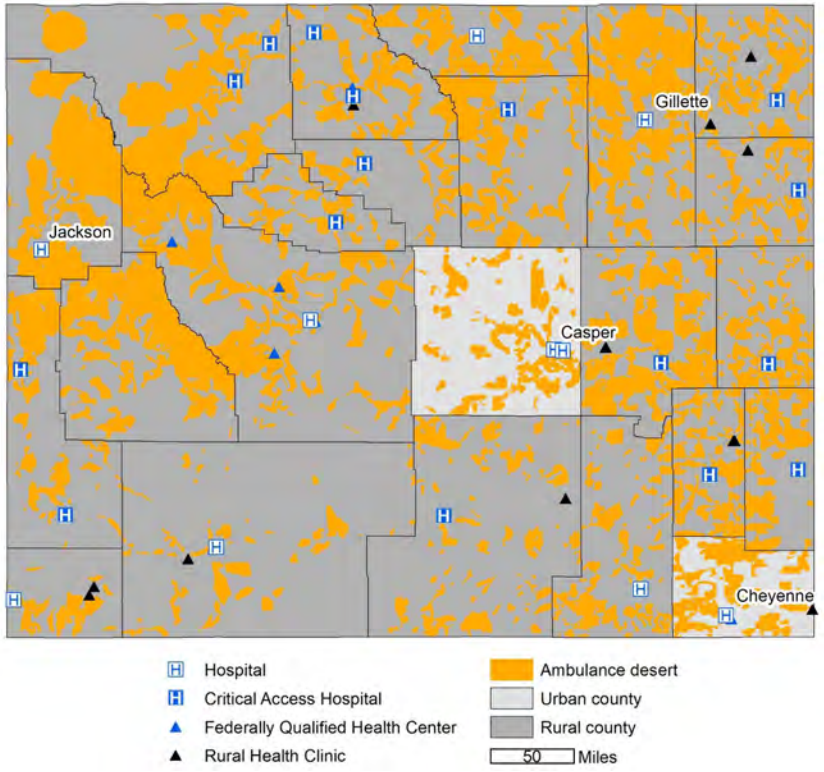
Data sources: Wisconsin Department of Health Services, Office of Preparedness and Emergency Health Care; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

WYOMING

Ambulance Locations and Deserts



Health Care Facilities and Ambulance Deserts



Ambulance stations	Ambulance desert population		Rural county ambulance desert population		
n	n	% of state pop.	n	% of rural county pop.	% of total desert pop.
74	54,205	9.4%	47,037	11.9%	86.8%

Data sources: Wyoming Department of Health; Esri; US Census Bureau; Health Resources & Services Administration; USDA Economic Research Service.

APPENDIX B: DATA REQUEST

Dear Mr./Ms. [State EMS Director],

We are reaching out to you from the Maine Rural Health Research Center regarding some work that we are doing to help state EMS directors visually explain EMS 911-call response capability, particularly in rural areas, around your state. We need your help collecting data to do this.

[INSERT DESCRIPTION OF STATE-SPECIFIC DATA COLLECTION TO DATE]

This work is supported by a grant from the Federal Office of Rural Health Policy (FORHP). FORHP is seeking to make informed policy decisions designed to improve access to EMS services and has tasked us with identifying and mapping ambulance locations in each of the 50 states. The goal is to better understand the extent to which different populations have or lack access to ambulance and EMS services, with access defined for the purposes of this study as areas that have services within a 25- minute travel time.

To do this accurately, we are contacting each state EMS office to request information on:

1) The physical addresses from which ambulances respond to 911 calls (as opposed to the mailing addresses or administrative headquarters). If your list includes non-transporting EMS services, please include a flag distinguishing which services are transporting versus non-transporting. If the actual location data are not available, any address information for ambulance services in the state will be appreciated.
2) If available, we are also requesting the highest level of care that each station or agency is licensed, certified, permitted, or otherwise known to provide.

We know that EMS agencies post or station crews away from quarters based on call patterns and availability changes. We can't account for all such practices, but please explain these practices in your state if you think it helps to understand response times, especially for more rural services.

In order to verify that we have accurately represented the provision of EMS services within your state, we would like to share the results with you, and get your feedback on findings relevant to your state.

In the meantime, if you'd like additional information about this study, please feel free to contact the lead investigator Yvonne Jonk by email. We would be happy to answer any questions you may have. Thank you, in advance, for your time and consideration of this data request.
Kind regards,

Yvonne Jonk, PhD
Associate Research Professor, Deputy Director Maine Rural Health Research Center
Muskie School of Public Service University of Southern Maine
PO Box 9300, Portland, ME 04104