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A decade of the *Missouri Hunger Atlas:* Information for action

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Abstract

For over a decade, researchers at the University of Missouri Interdisciplinary Center for Food Security (ICFS) have produced five editions of the *Missouri Hunger Atlas*. Through a series of indicator maps and tables, the *Atlas* engages readers visually to help them understand the extent of local food insecurity across the state. The *Atlas* also assesses the performance of public and private programs that help people struggling to obtain sufficient healthy food. In this reflective essay, we discuss the process of creating the *Atlas*, the choice of indicators and data acquisition, the evolution of the *Atlas* over time, and how various groups use the *Atlas*

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for policy and action. The *Atlas* has become a go-to resource for a wide range of users, including policymakers, academics, food bank staff, Extension specialists, and advocates for low-income families. The first ten years of the *Atlas* have demonstrated that measurement is a dynamic process, requiring ongoing adjustments by researchers through discourse with data providers, stakeholder groups, and communities. Given the popularity of the *Atlas* and the availability of comparable secondary data for other state and county geographies, replication of this model by other states is feasible.

Keywords
Hunger, Food Insecurity, Indicator, Need, GIS, Mapping, Performance, Comparison, Food Affordability, Decision Support

Introduction

For more than a decade, researchers at the University of Missouri Interdisciplinary Center for Food Security (ICFS) have produced five editions of the *Missouri Hunger Atlas*, which visually engages readers to better understand hunger and food insecurity in the state. Through a series of indicator maps and tables, the *Atlas* details the extent of food insecurity in the 114 Missouri counties and the City of St. Louis. The *Atlas* also assesses the performance of a host of public and private programs that aim to help people struggling to obtain sufficient healthy food (Bass et al., 2019).

With the *Atlas*, the ICFS seeks to raise awareness among Missourians about hunger and food insecurity in their communities and state, as well as provide information on the public and private programs addressing the issue. The *Atlas* is also designed to help public and private decision-makers assess trends of need, as well as help them assess program performance. In this reflective essay, we discuss the process of creating such an atlas, the choice of indicators and data acquisition, the evolution of the *Atlas* over time, and how various groups across the state use the *Atlas* for policy and action.

Why the *Atlas* is Important

The mission of ICFS is to better understand and address the causes and consequences of hunger and food insecurity. The ICFS aims to build more food secure communities through research, teaching, and engagement (University of Missouri, 2022). Research has demonstrated the devastating social and economic impacts of hunger, which are more intensively absorbed by marginalized groups and vulnerable populations (Fang et al., 2021). COVID-19 has also revealed how adverse global events are linked to food insecurity, and present the need for greater food system readiness, response, and resiliency (Béné, 2020).

The *Missouri Hunger Atlas* was introduced in 2008 as a tool for anti-hunger advocates and policymakers to address an alarming upward trend in food insecurity (Coleman-Jensen et al., 2014). It also filled critical gaps in local, county-level data on hunger need and performance of programs that address the need. At the time, such a compilation of data was difficult to find. The U.S. Department of Agriculture (USDA) Food Environment Atlas and Food Access Research Atlas (formerly known as the Food Desert Locator) were introduced in 2010 and the Feeding America Map the Meal Gap in 2011 (Feeding America, 2022; National Sustainable Agriculture Coalition, 2014; USDA Economic Research Service, 2022a). Despite the introduction of these and other tools, the *Atlas* has remained relevant for Missouri's anti-hunger advocates and policymakers because of its focus on distilling complex, county-level information into an accessible format.

This historical analysis begins by retracing the path of social action that led to the *Missouri Hunger Atlas*. It identifies and discusses several distinct features of the *Atlas* and how it is constructed and has been modified over time, and concludes with the current status of food security in Missouri and lessons learned from the first ten years of the *Atlas*.

History of ICFS and the *Atlas*

In 2000, a team of University of Missouri Rural Sociology faculty and students partnered with local nonprofits on social action research topics identified by the organizations. These partnerships were developed to assist local grassroots organizations that did not otherwise have the staff, capacity, or budget to conduct research. With guidance from Dr. Sandy Rikoon, the group founded the Missouri

Action Research Connection (MARC) to help community organizations address research questions they identified in order to better accomplish their goals and missions. Among the first partners was the Central Missouri Food Bank (CMFB), which needed help finding a new location and learning more about its clients to better meet their nutritional needs. This first project led to additional partnerships, and by 2003 a group of faculty and students from the MU College of Agriculture, Food and Natural Resources (CAFNR) coalesced around this focus on food security issues (University of Missouri, 2022).

In 2004, the group formally organized as the MU Interdisciplinary Center for Food Security, with official approval from CAFNR and the MU Provost's Office. Faculty representing four departments (Dr. Sandy Rikoon, Rural Sociology; Dr. Joan Hermsen, Sociology; Matt Foulkes, Geography; Dr. Nikki Raedeke, Nutritional Sciences) successfully applied for the ICFS's first competitive grant in 2005. The number of faculty and students affiliated with the ICFS has continued to grow and new projects have been initiated.

The first *Missouri Hunger Atlas* was compiled in 2008 in response to rising trends in food insecurity in the state. Data from 2005 showed that Missouri was one of 17 states with rising rates of food insecurity with hunger, and among the top five states in the rate of increase in hunger since 2000 (Foulkes et al., 2008, p. 1). The *Atlas* sought to support the work of policymakers and advocates with reliable state- and county-level data on hunger and food insecurity in a consolidated source. This would provide a snapshot of food insecurity measures of need and program performance across several domains.

Five editions of the *Atlas* have since been published (2008, 2010, 2013, 2016, 2019). Special editions of the *Atlas* for the Kansas City and St. Louis metro areas were released in 2010. A regional report for Missouri's 4th Congressional District was compiled in 2020. The *Atlas* has been printed in spiral-bound hard copies for distribution and made available as a PDF on the ICFS website (University of Missouri, 2022). Individual county data tables are also downloadable for users seeking specific results for their areas.

Distinct Features of the *Atlas*

Several features of the *Missouri Hunger Atlas* make it distinct from other food insecurity indicator projects. The *Atlas* is designed as a comparative tool rather than an absolute measurement tool. Results are primarily reported as percentages, rather than absolute numbers, which allows for comparison between counties of varying population sizes. While this opportunity for comparison is an important component of the *Atlas*, the authors caution that critical evaluation of the data is still necessary. Direct comparison of counties may disguise important differences between counties that shape these indicators. For example, the "participation rate of 80 [percent] in a highly populated area [like St. Louis] may mean that more people remain nonparticipants than in a county with a lower population and 70 [percent] participation rate" (Foulkes et al., 2008, p. 5).

Results on indicators of hunger need and program performance are also ranked for Missouri's 114 counties and the City of St. Louis. These 115 rankings are grouped into five categories (Very Low, Low, Average, High, and Very High) following a quintile classification method that divides the state into five equal fifths, each including one-fifth of the categories in the state (National Center for Geographic Information and Analysis, n.d.). Categories are then mapped for visualization of results statewide. This allows decision-makers to see how counties or regions are faring relative to other parts of Missouri, and to track the relative position of counties over time.

More recent editions of the *Atlas* also include a novel food affordability measure. This measure operationalizes food affordability as the percentage of household budget spent on food. *Atlas* researchers originally developed this composite variable for the 2013 edition (Cafer et al., 2013). This measure highlights the disparity of food costs for many individuals and households as a result of income, accessibility, and local costs of food. Reporting food affordability results by county helps raise awareness of inequities, as the effects of hunger/food insecurity often fall disproportionately on people who are low-income and live in places that lack access to affordable food (Cafer et al., 2019).

While the *Atlas* is comparable to other data

tools, such as the USDA Food Environment Atlas, it differs in several ways. The Food Environment Atlas includes a variety of indicators related to the retail food environment, food assistance programs, food insecurity, food taxes, local foods, health and physical activity, and socioeconomic characteristics (USDA ERS, 2022a). However, certain indicators in the Food Environment Atlas, such as those for the National School Lunch Program (NSLP), Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation, and Supplemental Nutrition Assistance Program (SNAP) participation, are only available at the state level. While this state-level data can be useful (and it should be noted that the Food Environment Atlas does include other county-level indicators), it may not satisfy the data needs of many decision-makers. For these important federal safety net programs, the *Atlas* provides county-level estimates of program eligibility combined with county-level program participation administrative data requested from state agencies, which also estimates the percentage of the eligible population that participates in the programs. The ICFS deliberately made the choice to use only county-level indicators, and eliminated those not available at the county level, to provide a consistent and localized assessment of hunger need and program performance.

Another difference is the *Atlas*'s focus on comparative data that can clearly articulate both county-level needs on the one hand and how a county performs when addressing those needs through public and private programs. This data is presented in maps and county data tables. The tables are especially useful because they present the need and performance data side by side, making the comparisons easy to understand. *Atlas* readers commonly report that this "need versus performance" feature is one of the most popular and useful pieces of information provided by the *Atlas*.

The *Atlas* also differs from the USDA Food Access Research Atlas, which combines measures of poverty and supermarket location to document census tracts where food access may be an issue. By comparison, and as noted above, the *Atlas* primarily focuses on the presentation of food insecurity measures along with food assistance program eligibility and participation data. While the tools are similar, they highlight different measures and provide unique information for understanding food insecurity.

The *Atlas* is also comparable to Feeding America's Map the Meal Gap (Feeding America, 2022). While these data tools share similarities, they also differ in important ways. Both tools present county-level data related to food insecurity. Significantly, while the 2008 and 2010 editions of the *Atlas* utilized a novel method for estimating county-level food insecurity, more recent editions have used the Feeding America estimates. Both tools present information related to federal safety net programs, although they take different approaches. As noted previously, for SNAP, WIC, and NSLP, the *Atlas* provides an estimate of program eligibility and combines that with administrative data to also estimate the percentage of the eligible population participating in each program. Map the Meal Gap takes a different approach by segmenting estimates of program eligibility among the food insecure population: (1) those who fall below the SNAP threshold (130% of poverty), (2) those who fall between 130% and 185% of poverty, and (3) those who are above the threshold (185% of poverty) for other nutrition programs. Map the Meal Gap does not include information about program participation. Similarly, both tools present data related to food affordability, but do so in unique ways. Features of the *Atlas* include the presentation of county-level demographic, health, and economic data; food bank food distributions per person in poverty; and the composite need, performance, and need vs. performance indicators.

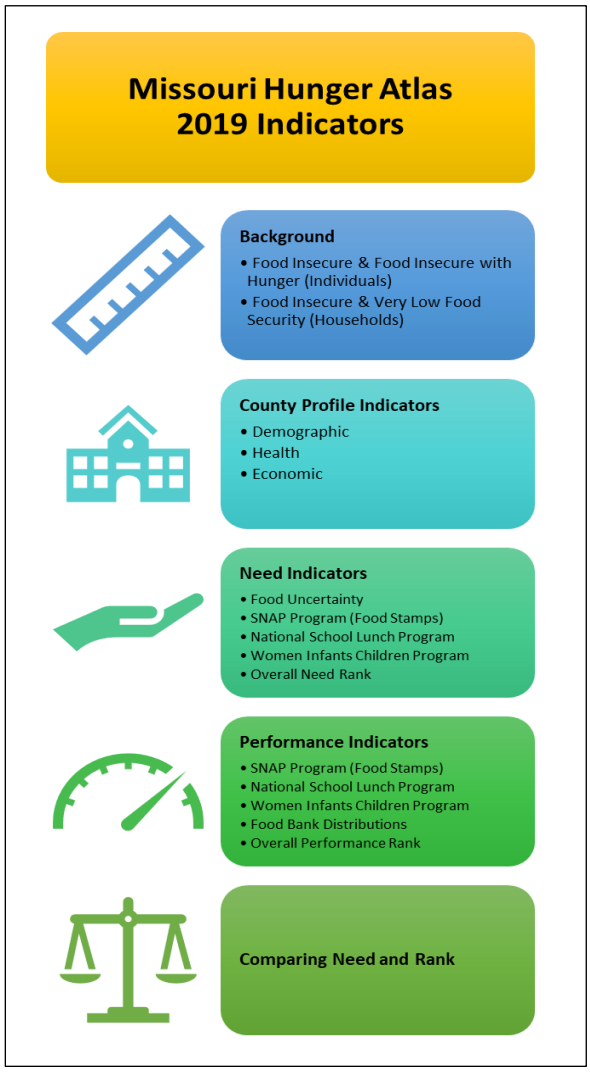
Overall, the *Atlas* is an accessible data tool for data experts and lay audiences alike. It focuses on select measures and presents them in an accessible format and style. Policymakers, state department administrators, educators, and local advocates often remark on its accessibility and appreciate how the data is presented.

Organization of the *Atlas*

The *Missouri Hunger Atlas* is organized into several sections (Figure 1). Each edition provides a background of state-level trends in food insecurity, recommendations for how to read and interpret the *Atlas*, and a complete breakdown for how each

indicator was operationalized and obtained. Need Indicator and Performance Indicator sections feature measures of publicly funded programs, including the Supplemental Nutrition Assistance Program (SNAP), Special Supplemental Nutrition Program for Women Infants and Children Program (WIC), and the National School Lunch Program (NSLP), as well as private assistance in the form of emergency food relief provided through regional food banks. A combination of need and performance indicators are utilized to create single overall need and performance rankings for each county. The overall need and performance measures are finally utilized to identify how performance relates to need. This comparison classifies county results in high/low quadrants for both need and performance (see detailed explanation below).

Figure 1. *Missouri Hunger Atlas* Sections



The *Atlas* also provides visual representations of the data. Maps are provided for several indicators, allowing readers, policy makers, and advocates to observe at-a-glance how issues are impacting different parts of the state. Each map provides county-level results, grouped and color-coded using a quintile classification method (National Center for Geographic Information and Analysis, n.d.) (Figure 2).

County data tables are a central feature of the *Atlas*. County tables make up the largest and final section of the data book, providing a printable one-page summary of each county's results, ranks, and state comparisons (Figure 3).

As stated above, the overall need versus overall performance comparison is a unique and highly valued section of the *Atlas*. County results on overall need and overall performance are reduced from five categories (Very Low, Low, Average, High, Very High) to three categories (Low, Average, High). Need and performance results are linked together to compare counties. This enables counties to be placed in one of four quadrants: High Need/High Performance, High Need/Low Performance, Low Need/High Performance, and Low Need/Low Performance counties (Figure 4). Counties with either Average Need or Average Performance are excluded to better highlight cases at either end of the spectrum. Each quadrant provides a lens for further analysis. For example, High Need/Low Performance counties may call for further attention and assessment of challenges and barriers, while High Need/High Performance counties may provide cases to explore effective strategies and best practices. The limitations of such comparisons should be noted, however; social, economic, and cultural contexts can differ widely between counties.

Stages in Constructing the *Atlas*

Construction of the *Atlas* involves at least nine steps (Figure 5). The process begins with the design of a primary data table, which includes all variables to be utilized in calculations, conversions, and presentation of results. Data acquisition, for-

matting, and cleaning are done for each indicator included in the *Atlas*. Standardized results for each indicator are added to the primary data table and utilized for all calculations. Research team members cross-check the accuracy of calculations and conversions and analyze the results. This procedure provides the basis for developing descriptive summaries, graphs, maps, and tables to present results in each section. The process moves on to final stages of proofreading, editing, layout and design of the data book, followed by signoffs and approvals for printing and dissemination. From the start of the process to the finished publication, construction of the *Atlas* is completed in less than 12 months.

Indicator Selection

Estimating hunger is a complex and multidimensional endeavor (Carlson et al., 1999). Through a review of relevant literature on hunger and food security indicators, the ICFS research team arrives at a set of indicators for inclusion in the *Atlas*. They choose a cross-section of contextual (demographic), outcome-based (program), and proxy (unobservable but highly related) variables to provide a more complete picture of hunger need and program performance in each county of the state.

Demographic measures of the unemployment rate and percentage of single-parent households, and health-related measures of hypertension, obesity, and diabetes are included due to their well-established linkages with hunger and food insecurity. Proxy indicators are also selected based on research affirming their linkages to hunger and food insecurity (Bartfeld & Dunifon, 2005). Overall, four criteria guide the rationale behind the selection of indicators for the *Atlas* (Table 1).

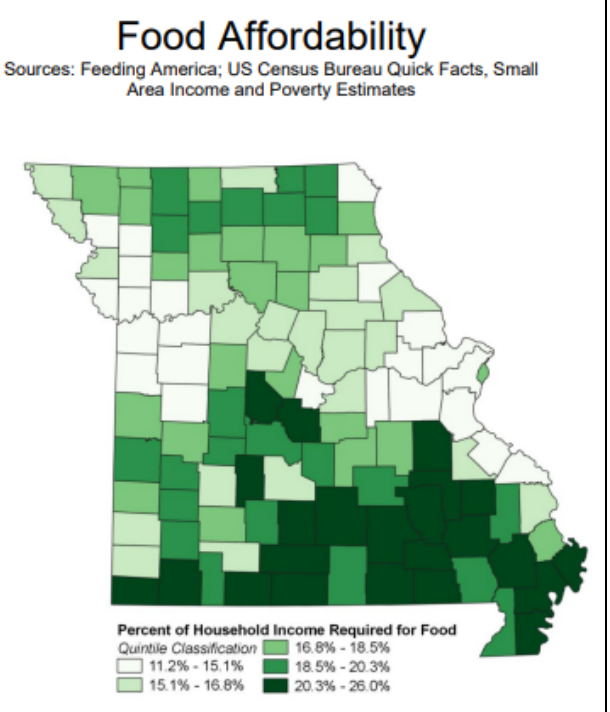
Data Acquisition

The inclusion of measures is contingent on access to reliable data. ICFS researchers obtain data from the U.S. Census and the American Community

Figure 2. Food Affordability Map ("Need" Section)

Food Affordability (MAP)
An estimate of the percent of income required each week by households in 2017 to meet average expenditures on food for that county. This indicator was calculated using the average weekly median household income and the average cost of meals as calculated by Feeding America.
Sources: Small Area Income and Poverty Estimates (SAIPE), U.S. Census Quick Facts, Feeding America, 2019 Map the Meal Gap

In order to better understand the context of rising food insecurity in Missouri a new economic indicator, food affordability, was introduced in the 2013 edition of the Missouri Hunger Atlas. The percent of income needed to meet basic household food needs is an important determining factor in the quantity, quality, and types of food families purchase because low-income households often have to make tough choices about how to spend their money, which may ultimately lead to smaller amounts of household funds available for food expenditures. Higher food costs significantly limit household food choices. The food affordability indicator is a county-level estimate of the percent of income required for food each week. It was calculated using the median household income divided by the average household size and then divided by 52 to obtain the average weekly median household income. The average costs of meals, obtained from Feeding America, were multiplied by 21 meals each week, assuming three meals each day. This number was then divided by the average weekly median household income and multiplied by 100 to obtain a percent of weekly income used to purchase food.



Survey as well as state and national agencies, and hunger relief organizations. Data acquisition is done through phone calls, email, web-based data request submissions, and data downloads from the following sources:

- **Feeding America**, Map the Meal Gap
- **Missouri Department of Elementary and Secondary Education**, Food and Nutrition Services
- **Missouri Department of Health and Senior Services**, Missouri Public Health Information Management System (MOPHIMS), Community Data Profiles, CountyLevel Study
- **Missouri Department of Social Services**, Research and Data Analysis Unit
- **Missouri Feeding America—affiliated regional food banks**, Food Distribution Reports
- **Operation Food Search**, Food Distribution Reports
- **U.S. Census**, American Community Survey 5-Year Estimates, Population and Housing Unit Estimates, Small Area Income and Poverty Estimates
- **U.S. Department of Agriculture**, **Economic Research Service**, State Fact Sheets, Household Food Insecurity in the United States

Figure 3. County Data Table

NEED INDICATORS	COUNTY	STATE	RANK
Food Uncertainty 2017			
% Individuals Food Uncertain	17.5	14.2	Very High
% Individuals < 18 Food Uncertain	18.3	17.5	Low
% Individuals Food Uncertain w/ Hunger	6.6	5.3	Very High
Supplemental Nutrition Assistance Program (SNAP/Food Stamps) 2018			
% Total Population Income Eligible	31.4	19.4	Very High
% < 18 Years Income Eligible	24.9	26.1	Low
Free and Reduced-Price Lunch (National School Lunch Program) 2018			
% Students Enrolled	51.1	49.5	Average
Women, Infants, and Children Program (WIC) 2017			
% < 5 Years Income Eligible	57.7	43.3	High

PERFORMANCE INDICATORS	COUNTY	STATE	RANK
Supplemental Nutrition Assistance Program (SNAP/Food Stamps) 2018			
Number of Monthly Participants	2,522	720,543	-
% Total Population Participating	9.9	11.8	Low
% Income Eligible and Participating	35.4	63.2	Very Low
Number of Monthly Participants < 18 Years	1,053	325,938	-
% < 18 Years Participating	22.5	23.6	Average
Free and Reduced-Price Lunch (National School Lunch Program) 2018			
% Students Enrolled and Participating	79.9	74.7	Very High
Women, Infants, and Children Program (WIC) 2017			
Number < 5 Years Participating, Monthly	482	89,338	-
% < 5 Years Eligible and Participating	71.1	55.9	High
Food Bank Distributions 2018			
Total Pounds Distributed in County	779,920	140,373,817	-
Lbs Per Capita Below 100% Poverty Level	131	163	Low

ADAIR COUNTY

OVERALL RANK*	
NEED	PERFORMANCE
Very High	Average

***Overall Rank: Need** is from a composite score including % food uncertain, % SNAP eligible, % NSLP enrolled, and % < 5 WIC eligible.
Performance is from a composite score including % eligible and participating in SNAP, NSLP,WIC, and pounds of food distributed per capita < 100% poverty.

COUNTY PROFILE	COUNTY	STATE		COUNTY	STATE
Demographic Indicators 2017			Economic Indicators 2017		
Total Population	25,377	6,113,532	Population Below Poverty Level	5,943	861,679
Population < 18 Years	4,689	1,382,971	% < 18 Below Poverty	20.7	20.0
Population > 64 Years	3,678	1,007,033	% > 64 Below Poverty	9.8	8.8
Health Indicators 2016			Median Household Income ($, Annual)	38,750	51,542
Obesity Prevalence (%)	27.9	31.2	Unemployment Rate (%)	4.4	3.8
Diabetes Prevalence (%)	8.0	11.1	Single-Parent Households (%)	10.5	16.2
Hypertension Prevalence (%)	29.1	33.7	Food Affordability (%)	18.7	16.0

Missouri Hunger Atlas 2019, Page 30

- **U.S. Department of Labor, Bureau of Labor Statistics**, Local Area Unemployment Statistics

Team members acknowledge the support of many individuals within public and private agencies who assist with retrieval and sharing of data. The *Atlas* is a cooperative endeavor that is possible only through ongoing partnerships with these data providers (Bass et al., 2019).

In 2021, a codebook for *Missouri Hunger Atlas 2019* was developed to serve as a technical guide for the production of future atlases. The codebook incorporates lessons learned over the first ten years, breaking down the methodology and providing step-by-step instructions for generating results for each indicator, from data collection and conversions to calculations and reporting.

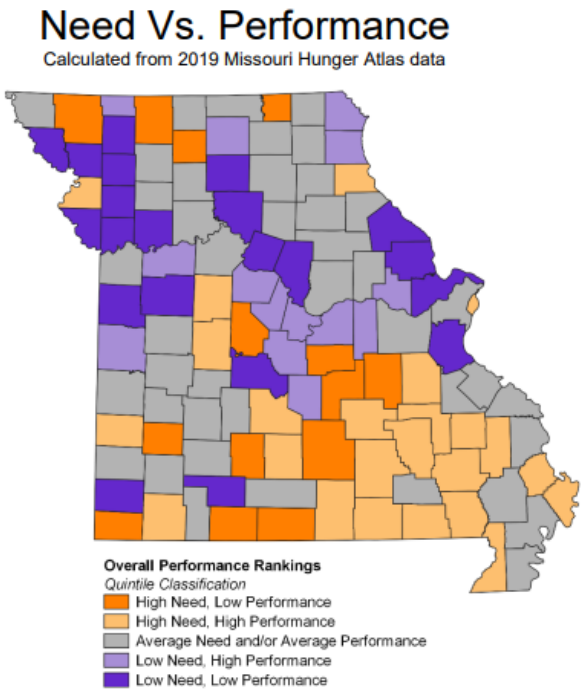
Evolution of the *Atlas*

To better understand the history of the *Atlas*, and to support current efforts to modernize the *Atlas* and transition it to an online web application, an inventory of *Atlas* indicators, data sources, and methods was created dating back to 2008. Beginning with the primary data table for the 2019 edition, *Atlas* indicators, sources, timespans, and calculation methods were documented in a historical data table or "harmony" spreadsheet. This initial data table was reviewed by ICFS and MU Center for Health Policy colleagues for feedback and input. Data from the remaining atlases (2016, 2013, 2010, and 2008) was then added, annotating changes to indicators, labels, descriptions, and sources from publication to publication.

The inventory yielded an analysis of how the *Missouri Hunger Atlas* has evolved over time. The evolution can be characterized by (1) constants

Figure 4. Need vs. Performance Comparison

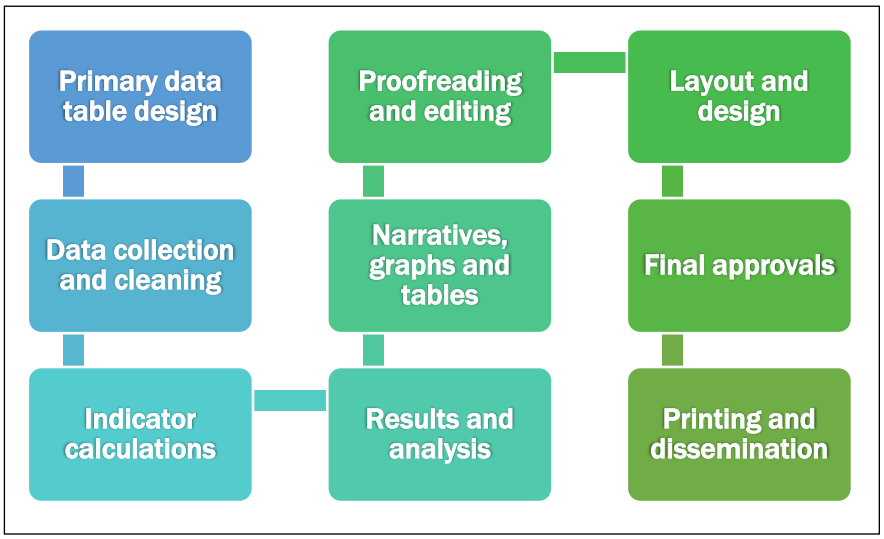
High Need/High Performance		High Need/Low Performance	
Barry	Marion	Crawford	Nodaway
Barton	Mississippi	Dade	Ozark
Benton	Oregon	Grundy	Phelps
Bollinger	Pettis	Harrison	Schuyler
Buchanan	Reynolds	McDonald	Taney
Butler	Ripley	Maries	Texas
Dent	St. Louis City	Morgan	Webster
Dunklin	Scott		
Howell	Shannon		
Iron	Washington		
Laclede	Wayne		
Madison	Wright		
Low Need/High Performance		**Low Need/Low Performance**	
Bates	Miller	Andrew	Howard
Clark	Moniteau	Boone	Jefferson
Cole	Osage	Camden	Johnson
Cooper	Pulaski	Cass	Lincoln
Gasconade	Sullivan	Chariton	Linn
Lafayette	Warren	Christian	Newton
Lewis	Worth	Clay	Pike
		Clinton	Platte
		DeKalb	Ray
		Gentry	St. Charles
		Holt	



At the other end of the spectrum are twenty-one counties that have comparatively low percentages of populations with hunger needs but are also doing comparatively worse in meeting the requirements of these populations. Many of these

Missouri Hunger Atlas 2019, Page 24

Figure 5. Stages in Constructing the *Missouri Hunger Atlas*



(attributes which have remained unchanged throughout), (2) changes in indicators, and (3) changes in co-authors. The following sections provide a summary of this evolution, a discussion of how the *Atlas* has been used by various stakeholder groups, the ten-year progress of food security in the state, and a conclusion, with lessons to apply for the future.

Many attributes of the Missouri Hunger *Atlas* have been consistent over the first decade. The overall layout, section headings and organization of the data book, how to read and interpret *Atlas* results, emphasis on comparisons, county-level results, printable one-page county tables, maps for data visualization, and use of quintile classifications of counties have all remained unchanged. For overall need and performance comparisons, the methodologies, composite variables, and weights assigned to variables have remained durable as well.

The evolution of indicators from 2008–2019 is visually highlighted in Appendix 1. Indicators remaining consistent over the five editions include county profile demographic variables and certain measures for the Supplemental Nutrition Assistance Program (SNAP), Special Supplemental Nutrition Program for Women, Infants, and Children Program (WIC), and National School Lunch Program (NSLP). Several indicators included in the 2008 and 2010 editions were not retained in later versions, largely due to lack of data for all counties, and the narrowing of the *Atlas* to focus on the most essential measures. For example, Summer Food Service Program and Child & Adult Care Program performance measures appeared only in early editions. While these program results were originally included for informational purposes, not all counties participate in those programs, making comparisons between counties impossible. Availability of county-level data for all counties became an important determining point for which indicators were included in the *Atlas*.

Table 1. *Missouri Hunger Atlas* Indicator Selection Criteria

1. **Proxy power:** The indicator says something of central importance about hunger, and gets to the heart of matter.
2. **Communication power:** Researchers and collaborators have mutual agreement on what the indicator measures.
3. **Data power:** Quality data is accessible to compare counties, available and calculatable on an annual basis, gathered and administered consistently over time, and affordable and cost-effective to use.
4. **Policy power:** The data can be watched and tracked over time to see if interventions matter.

Source: Friedman, 2015.

In some instances, the source of data from the same agencies changed over time. For example, data for county demographic health variables for obesity, diabetes, and hypertension originated from the Missouri Department of Health and Senior Services. In 2008, results came from the 2003 Health and Preventative Status Report. Results for the 2010 data book came from the 2007 Missouri County-Level Study Questionnaire. Working with key personnel from each data provider was crucial to navigating changes that had occurred between *Atlas* time intervals.

Within the Need section, food insecurity measures changed most frequently since the first *Atlas*. Food uncertain and food uncertain with hunger labels replaced food insecure and food insecure with hunger in 2010. These changes in terms were due to a revised modeling methodology that was comparable but not identical to that used by the data providers. The new terms were also found by partners to be more meaningful and revealing. (Team members also acknowledge that the meaning of the term food security is more broadly understood now than ten years ago, when it tended to carry connotations of food safety as well as food scarcity.) Household estimates of food insecurity were replaced by estimates of individuals beginning in 2016, providing a more relatable and compelling image of the extent of hunger in Missouri. The 2016 edition also marked the inclusion of the results of Feeding America's Map the Meal Gap report, replacing prior ICFS modeling using data from U.S. Census, American Community Survey, Bureau of Labor Statistics, and U.S. Department of Agriculture sources.

Other shifts included updates to variables measuring similar phenomena, such as a shift in 2016 from female-headed households to single-parent households, a measure encompassing more family structures. Rates of food insecurity in 2019 were significantly higher than the national average for households with children headed by a single caregiver, although female-headed households were still 75% more likely to be food insecure than male-headed households (Coleman-Jensen et al., 2020). Beginning with the 2010 *Atlas*, inclusion of the poundage of food distributed by regional food banks added an important variable on the extent of direct food provision to needy families in each county.

Changes in some data sources and methods were a combination of internal decisions that the team made and external changes due to factors beyond the team's control. To estimate SNAP eligibility, the 2019 *Atlas* team elected to use 125% of Federal Poverty Level as the guideline for income eligibility in place of the 130% of Federal Poverty Level used by SNAP. Lowering the threshold from 130% to 125% compensated for a small number of people who meet the SNAP income threshold but are not eligible for benefits due to other disqualifying criteria (personal assets, immigrant status, employment status). This adjustment aimed to provide an estimate of SNAP eligibility more in line with reality. The *Atlas* team continues to investigate models for predicting SNAP eligibility that provide a more specific estimate.

Atlas indicators are constantly a work in progress and are updated every three years with the latest information and more validated measures. The stated goals for the *Atlas* include use by diverse groups and dialogue among individuals that may lead to evolving ideas about indicators. Users are welcomed to add comments or make suggestions about the indicators and the presentation of findings (Bass et al., 2019). *Atlas* authors indicate that changes have been prompted by user feedback, narrowing down to more meaningful measures and adjusting to county-level data limitations.

Regarding changes in team members, an evolving group of co-authors produced five editions of the *Missouri Hunger Atlas*, as well as two special additions for St. Louis and Kansas City. Teams ranged in size from as few as four to as many as ten faculty, staff, and graduate students as co-authors and contributors. As Rural Sociology faculty and co-founder of ICFS, Dr. Sandy Rikoon provided author continuity for the *Atlas* through the 2008–2019 period. The ICFS has remained committed to faculty and students working collaboratively on the applied research, gathering and analyzing data and compiling the *Atlas*. Teams worked closely with data experts and analysts from the Office of Social and Economic Data Analysis and the Missouri Census Data Center, as well as

with state agency contacts and food bank representatives. The team timeline for compiling the *Missouri Hunger Atlas* from start to finish was typically less than one calendar year.

Uses of the *Atlas* for Policy and Action

The *Missouri Hunger Atlas* is used primarily for purposes of advocacy, research, extension education, and policy decision-making support. Researchers draw from the *Atlas* as a resource for case studies and other analyses in education and the social sciences. Extension specialists in community and economic development and in food and nutrition education utilize the *Atlas* for conducting needs assessments, writing local and regional grant proposals, and making presentations to community groups. They also indicate that the *Atlas* can be a tool to start conversations with municipal and county leaders on issues of hunger and food security, with data that allows for comparisons to neighboring areas.

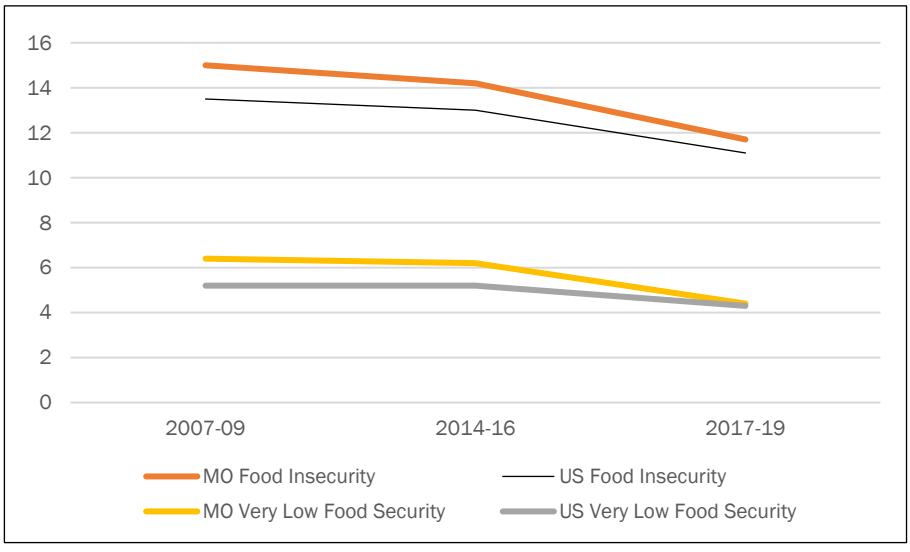
Anti-hunger advocates use the findings to inform their audiences and raise public awareness of the extent of food insecurity, as well as the degree to which publicly funded programs are addressing hunger. The *Missouri Hunger Atlas* is prominently featured on the Feeding Missouri website under *Missouri Hunger Facts* (Feeding Missouri, 2022). Empower Missouri, a statewide advocacy organization working on issues of food, shelter, and justice, highlighted *Atlas* findings during its 2020 annual conference to prepare attendees with a toolkit for action on hunger issues during COVID-19 (Kerrigan, 2020). The Missouri Community Action Network, widely recognized for developing the Community Action Poverty Simulation as an experiential learning tool, featured *Atlas* results in the 2020 *Missouri Poverty Report*, co-authored with Missourians to End Poverty (Missouri Community Action Network, 2022). The Boone Indicators Dashboard, which informs diverse organizational partners on community performance in four priority issues areas, includes the *Missouri Hunger Atlas* on its resource page (Boone Impact Group, n.d.).

Policymakers and program managers find the *Atlas* to be an informative tool that deepens their understanding of the geography of food insecurity in the state, and how counties have fared on rankings and trends over time. For example, legislators are often interested to learn how counties in their districts compare to other regions of the state across indicators. The *Atlas* is also consulted by agency program managers for data points to monitor the comparative effectiveness of hunger-fighting programs they administer.

Progress on Food Security

The extent to which the *Missouri Hunger Atlas* has contributed to impacts on hunger and food insecurity in Missouri is beyond the scope of this paper, but it is noteworthy that the state has made progress on this issue over the same period the *Atlas* has been published (Figure 6). Since 2007, the average percentage of food-insecure households in Missouri has decreased from 15% to 11.7%, and the average percentage of very-low-food-secure households dropped from 6.4% to 4.4% (USDA Economic Research Service, 2022b). In comparison to national averages, food-insecure

Figure 6. Missouri and U.S. Food Insecurity, 2007–2019



households in the U.S. dropped 13.5% to 11.1%, and very-low-food-secure households decreased 5.2 to 4.3% over the same period. The trend over the ten-year-plus period shows that Missouri is closing the gap on food insecurity, bringing levels closer to national averages. While this is good news and a positive trend for Missouri, much is still to be done to address food insecurity in the state.

Lessons Learned

Hunger is a complex and multi-faceted issue affecting the lives of many Missourians. Measurement of the true extent of hunger is imprecise, and at best an estimation or approximation. The *Missouri Hunger Atlas* offers a set of collective clues, piecing together a picture of how food insecurity impacts counties and the state. The first ten years of the *Missouri Hunger Atlas* have demonstrated that measurement is a dynamic process, requiring ongoing adjustments by researchers through discourse with data providers, stakeholder groups, and communities.

The *Missouri Hunger Atlas* has become a go-to resource for a wide range of intended users, including policymakers, academics, food bank staff, Extension specialists, and advocates for low-income families. The stated goals of the *Atlas* include providing measures to assess trends in need and program performance, raising awareness of the extent and depth of food insecurity and hunger at the local level, increasing knowledge of how public programs and food banks are reaching food-insecure people, and helping decision-makers assess performance to improve delivery of resources and assistance. Anecdotal evidence gathered through stakeholder meetings and general feedback suggests that these goals are at least in part being met.

Readers have also noted the novel features of the *Atlas* which they find useful in making comparisons and exploring relationships between counties and regions. Indicators of food affordability and comparisons of need vs. performance are quite distinct among hunger and food insecurity resources. Use of the *Missouri Hunger Atlas* to initiate conversations with community leaders about food insecurity and hunger is an additional outcome that has been emphasized by educators and advocates. Use of the *Atlas* as a tool for community action and social change deserves further investigation. Going forward, researchers can consider how the selection of *Atlas* indicators can raise consciousness about emerging issues, such as how food security relates to concerns of diversity, equity, and inclusion.

Conclusion

Over the first ten years, the *Missouri Hunger Atlas* has received a positive response from numerous stakeholder groups who have used the data books in multi-faceted ways to inform strategies and support their decisions in the fight against hunger. Users indicate the *Atlas* makes state and county-level food insecurity and hunger data from public sources more accessible by combining them into one resource for Missouri. Methodologies converting data to ranks, indices of hunger need and performance, and need vs. performance comparisons provide the foundation for new insights by decision-makers.

The goal of this paper is to support the development of an online version of the *Missouri Hunger Atlas*, as an updated decision-support tool for educators, policymakers, and communities. Beginning with the 2019 edition and working back to the 2008 edition, the history and evolution of *Atlas* indicators, data sources, timespans, and methods have been clearly documented. This information will be utilized in harmonizing *Missouri Hunger Atlas* indicators and data requests with other decision-support projects, and in developing a consistent set of indicators across editions. Future plans include moving the *Atlas* to an annual timeline (as Missouri Kids Count does), and documenting processes so as to support the efficient management of the *Atlas* in the future.

Given the receptivity for the *Missouri Hunger Atlas* and the availability of comparable secondary data for other state and county geographies, replication of this model is feasible by other states. An atlas can be a mechanism by which other land-grant universities can raise public awareness of food insecurity, build data partnerships with agencies, provide enhanced decision support to key audiences, and leverage diverse stakeholder engagement around hunger and food security.

In 2021, the ICFS and the MU Center for Health Policy jointly met with *Atlas* users, stakeholder groups, and data contributors to transition the *Atlas* from a data book every three years to an online web application. *Missouri Hunger Atlas* readers can now access previous data books, as well as browse, map, and download data, and print county results online.[1] As we build a modernized online version of the *Atlas* with enhanced data visualization and trend analysis, the opportunity is also ripe for conversations on extending the *Missouri Hunger Atlas* beyond Missouri.

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Appendix 1. *Missouri Hunger Atlas* Indicators, 2008–2019

Interdisciplinary Center for Food Security
University of Missouri

Missouri Hunger Atlas Indicators, 2008-2019

https://foodsecurity.missouri.edu/missouri-hunger-atlas/

Atlas Section	Code	Indicator	2019	2016	2013	2010	2008
BACKGROUND							
	1.1	Individual food insecure & food insecure w/ hunger					
	1.2	Food insecurity rates among Missouri households					
COUNTY PROFILE INDICATORS							
Demographic	2.1.1	Total population					
	2.1.2	Population under 18 years					
	2.1.3	Population over 64 years					
Health	2.2.1	Obesity					
	2.2.2	Diabetes					
	2.2.3	Hypertension					
Economic	2.3.1	Population below poverty					
	2.3.2	Population under 18 years below poverty					
	2.3.3	Population over 64 years below poverty					
	2.3.4	Median household income					
	2.3.5	Unemployment rate					
	2.3.6a	Single parent households					
	2.3.6b	Female headed households					
	2.3.7	Food affordability					
NEED							
Food uncertainty	3.1.1a	% individuals food uncertain					
	3.1.1b	Households food uncertain					
	3.1.1c	% total population food insecure					
	3.1.2a	% children under 18 in food uncertain households					
	3.1.2b	Households with children food uncertain					
	3.1.2c	% < 18 yrs food insecure					
	3.1.3	% > 64 yrs food insecure					
	3.1.4a	% individuals food uncertain with hunger					
	3.1.4b	Households food uncertain with hunger					
	3.1.4c	% food insecure with hunger					
SNAP (Food Stamps)	3.2.1	% total population income eligible					
	3.2.2	% under 18 income eligible					
	3.2.3	Monthly participants					
	3.2.4	% of total population					
	3.2.5	Monthly participants < 18yrs					
	3.2.6	% of < 18 yrs population					
	3.2.7	Monthly benefits					

National School Lunch (NSLP)	3.3	% of K-12 students enrolled in free & reduced-price lunch (MAP)					
Women, Infants, Children (WIC)	3.4.1	% of children under five income eligible					
	3.4.2	Monthly participation					
	3.4.3	Monthly infants & children					
	3.4.4	% of < 5 yrs participating					
Overall Need Rank	3.5.1a	% of population food uncertain (see 3.1.1a)					
	3.5.1b	% of population food insecure					
	3.5.2	% total population income eligible for SNAP/Food Stamps (see 3.2.1)					
	3.5.3	% of K-12 students enrolled in free & reduced-price lunch (see 3.3)					
	3.5.4	% of children under five income eligible (see 3.4.1)					
PERFORMANCE							
SNAP (Food Stamps)	4.1.1	Number of Monthly Participants					
	4.1.2	% total population using SNAP					
	4.1.3	% income eligible and participating					
	4.1.4	Number of Monthly Participants Under 18					
	4.1.5	% of Under 18 Population Participating					
	4.1.6	Avergage Monthly Benefits					
	4.1.7	% of food insecure					
	4.1.8	% of food insecure w/ hunger					
	4.1.9	% of < 18 yrs food insecure					
	4.1.10	% of < 100% poverty					
National School Lunch (NSLP)	4.2	% enrolled and participating (MAP)					
Women, Infants, Children (WIC)	4.3.1	Number of children under 5 participating monthly					
	4.3.2	% of eligible children under 5 participating					
	4.3.3	Number of monthly participants					
Summer Food Service Program	4.4.1	Number of sites					
	4.4.2	Total Reimbursements					
	4.4.3	Reimbursements per student					
Child & Adult Care Program	4.5.1	Total Reimbursements					
	4.5.2	Reimbursements per capita < 5 yrs and < 100% poverty					
Food Bank Distributions	4.6.1	Total pounds in county					
	4.6.2	Pounds of food distributed per capita below poverty level (MAP)					
	4.6.3	Pounds (lbs) per capita food insecure					
Overall Performance Rank	4.7.1	% of income eligible residents who received SNAP/food stamps (see 4.1.3)					
	4.7.2	% of students enrolled and participating in free and reduced-price lunches (see 4.2)					
	4.7.3	% of income eligible infants and children receiving WIC benefits (see 4.3.2)					
	4.7.4	Pounds of food distributed per capita < 100% poverty (see 4.6.2)					
COMPARING NEED AND PERFORMANCE							
	5.1	Comparing need and performance (quintile classification map)					