Targeted Residential Fire Risk Reduction

A Summary of At-Risk Areas in Tennessee

Len Garis, Sarah Hughan, and Charles Jennings

August 2016

UNIVERSITY OF THE FRASER VALLEY
SCHOOL OF CRIMINOLOGY & CRIMINAL JUSTICE

UNIVERSITY OF THE FRASER VALLEY
CENTRE FOR SOCIAL RESEARCH

Background

Reducing fires and saving lives is a mandate for all Fire Services. Globally, many departments have implemented door to door campaigns to educate their citizens on fire reduction and safety (TriData, 2009). However, focusing on an entire community is expensive, time consuming, and overall, an inefficient use of limited resources. A 2007 TriData report on best practices in residential fire safety in England, Scotland, Sweden, and Norway identified that "of all the best practices identified in this study, one stands out. To reduce fire casualties in the home, the British fire service is *visiting large number of high-risk households* [emphasis added] to do fire safety inspections and risk reductions, especially to ensure they have a working smoke detector" (TriData, 2007, p.vi). Similarly, in the publication, the *Reduced Frequency and Severity of Residential Fires Following Delivery of Fire Prevention Education by On-Duty Fire Fighters: Cluster Randomized Controlled Study* Clare, Garis, Plecas, and Jennings (2012) reviewed best practices from other countries on residential fire safety and concluded that "targeted home visits have produced promising results examining a range of outcome measures, from reduction in rates of fires and fire-related casualty through to increased presence of working smoke alarms when residences were audited" (p. 123).

Research has substantiated that certain groups are at an elevated risk of experiencing fires. In particular, children under the age of 6 , older adults over the age of 64 (e.g. Jennings, 1996; LeBlanc et al., 2006; Scholer, Hickson, Mitchel & Ray, 1998; U.S. Fire Administration, 1997, 2004), and those living in socio-economic disadvantage (e.g., Jennings, 1999; Schaenman et al., 1990; Shaw, McCormick, Kustra, Ruddy & Casey, 1988; U.S. Fire Administration, 1997, 2004) are the populations most at-risk for experiencing a residential fire. Residential fires also account for the vast majority of fire fatalities (Chien & Wu, 2008), typically as a result of smoke inhalation or carbon monoxide poisoning (Miller, 2005). Young children and older adults are also at higher risk of dying from a residential fire due to their inability to hear and/or respond to a smoke alarm (Marshall, Runyan, Bangdiwala, Linzer, Sacks, & Butts, 1998). Residents of low socio-economic areas are also at greater risk (Miller, 2005; Duncanson, Woodward, & Reid, 2002), primarily due to their tendency not to have a working smoke alarm in the home.

Aware of these relative risk levels, the Surrey Fire Services engaged in an evidence-based smoke alarm distribution campaign, known as the HomeSafe program, that used the foregoing criteria to target high risk locations in the city identified in an analysis of 20 years of municipal fire incidence data (McCormick, 2009). The program mandate was to have all homes with working smoke alarms in order to reduce the number of residential fires, as well as fire-related injuries and deaths within the community. To achieve this, firefighters conducted door-to-door visits with all addresses in the identified zones where they distributed fire safety education materials, which included information on high-risk groups, and identified the leading causes of residential fires in the city (i.e. cooking and non-smoking related open flame fires, such as candles or matches; McCormick, 2009). They also asked residents about the presence of working smoke alarms, and offered to install smoke alarms free of charge if one was not present in the home (Clare et al., 2012). Educational material was left for those not at home to read and educate themselves on fire safety. Over the course of one week, 18,473 residential dwellings in seven high-risk zones were visited by fire services.

To review the effect of this distribution methodology, Clare and colleagues (2012) conducted an experimental study measuring the outcomes in the high-risk zones receiving the targeted outreach compared to a randomized control sample of equally high-risk areas that had not received the targeted outreach. The specific analysis conducted to identify the high-risk population for the City of Surrey is summarized as follows:

> First, the specific addresses of all relevant types of residential fires that had occurred in the city since late 2006 were mapped, and high-density areas were identified. In addition to this, Census information was used to identify areas of the city that would be expected to have an elevated likelihood of experiencing fires. This use of Census data built on research evidence that

> demonstrates an elevated risk of experiencing fire as a function of individual characteristics. As a result, areas of interest were identified if they had a proportionally high representation of: (a) children under 6 years, (b) adults aged over 64, (c) single parent families, (d) high-residential mobility residents, (e) unemployed residents. (Clare, et al., 2012, p.125)

The authors statistically compared the rate of residential fire incidents occurring two years pre-intervention against the rate of residential fire incidents two years post-intervention occurring in the experimental and control locations. Whereas the control locations experienced a 15% reduction in residential fires over time, the experimental locations experienced a 64% reduction. In addition, the length of time between fires increased by only 4 days in the control locations, versus 193 days in the experimental locations (Clare et al., 2012). In other words, the evidence-based fire education and smoke alarm distribution methodology that targeted high-risk locations both statistically and substantially reduced the rate of residential fires in high-risk jurisdictions and increased the length of time between fires. This study therefore provided definitive evidence for the increased efficiency and effectiveness of using local fire data to guide education and distribution campaigns.

As of April 2016 Surrey Fire Services has made contact with approximately 40,000 residents through the HomeSafe program and have installed over 1,000 smoke alarms in homes. The program has been an overwhelming success. Working smoke alarms have increased from 16% in 2008 to 59% in 2015. Casualty rates (injuries and fatalities combined) saw a 65% reduction and fire rates reduced by 47% between the years 2006 and 2015. This program provides an effective model that can be easily adopted by fire services in other communities to better achieve their mandate of reducing fires and saving lives.

However, many communities may lack the analytical resources required to identify their high-risk locations. As such, the purpose of this report is to chronicle a simple methodology and highlight areas within each county that are at the highest risk for residential fires. The method is based on the risk factors identified by research and adopted by the HomeSafe program in Surrey, B.C. By using this approach, fire services can improve the effectiveness of smoke detector distribution campaigns.

Summary of Tennessee

The Tennessee State Fire Marshal's Office provided information pertaining to residential structure fires, fire-related deaths and injuries for the years 2006-2014. In November 2012, the State Fire Marshal's Office initiated a smoke alarm program for the State of Tennessee entitled "Get Alarmed, TN!". As per the State Fire Marshal's Office website (accessed August 2016) the program has completed the following:

- Over 119, 000 smoke alarms distributed
- 473 participating fire departments
- Averaging 170 homes per week
- 139 documented alerts and saves from "Get Alarmed" smoke alarms.

Figure 1 illustrates the breakdown of smoke alarm installations throughout the State of Tennessee. It is to be noted that the total number of smoke alarm installations that were geocoded was 76,998 resulting in approximately 42,000 smoke alarm installations (or 35%) unrepresented.

Figure 2 illustrates the number of residential structure fires in each county over the period 2006-2014. The most populated counties (Shelby, Davidson, Knox and Hamilton) had the highest number of fires; whereas, three of the least populated counties (Pickett, Moore and Hancock) had the least amount of residential structure fires. As fires are not evenly distributed throughout each county, Figure 3 illustrates the kernel density ("calculates a magnitude-per-unit area from point features using a kernel function to fit a smoothly tapered surface to each point") (Esri, ArcGIS for Desktop, 2016) of residential fires for all of Tennessee. Within Shelby County, Memphis is showing a high level of residential fires especially in the Washington Heights and North Memphis neighbourhoods. The cities of Chattanooga, Nashville and Knoxville are also showing a higher density of residential fires within the State of Tennessee, but less than Memphis.

FIGURE 1: SMOKE ALARM INSTALLATION COUNTS BY COUNTY

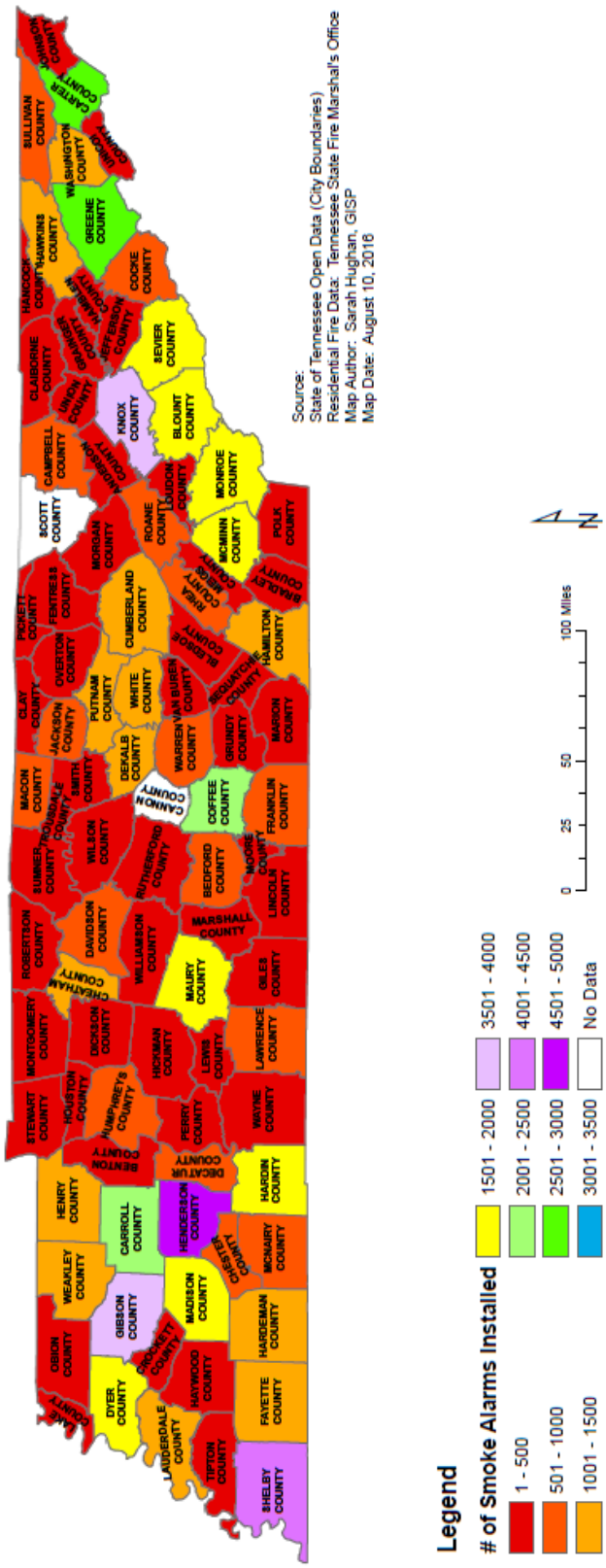


FIGURE 2: NUMBER OF RESIDENTIAL FIRES BY COUNTY (2006-2014)

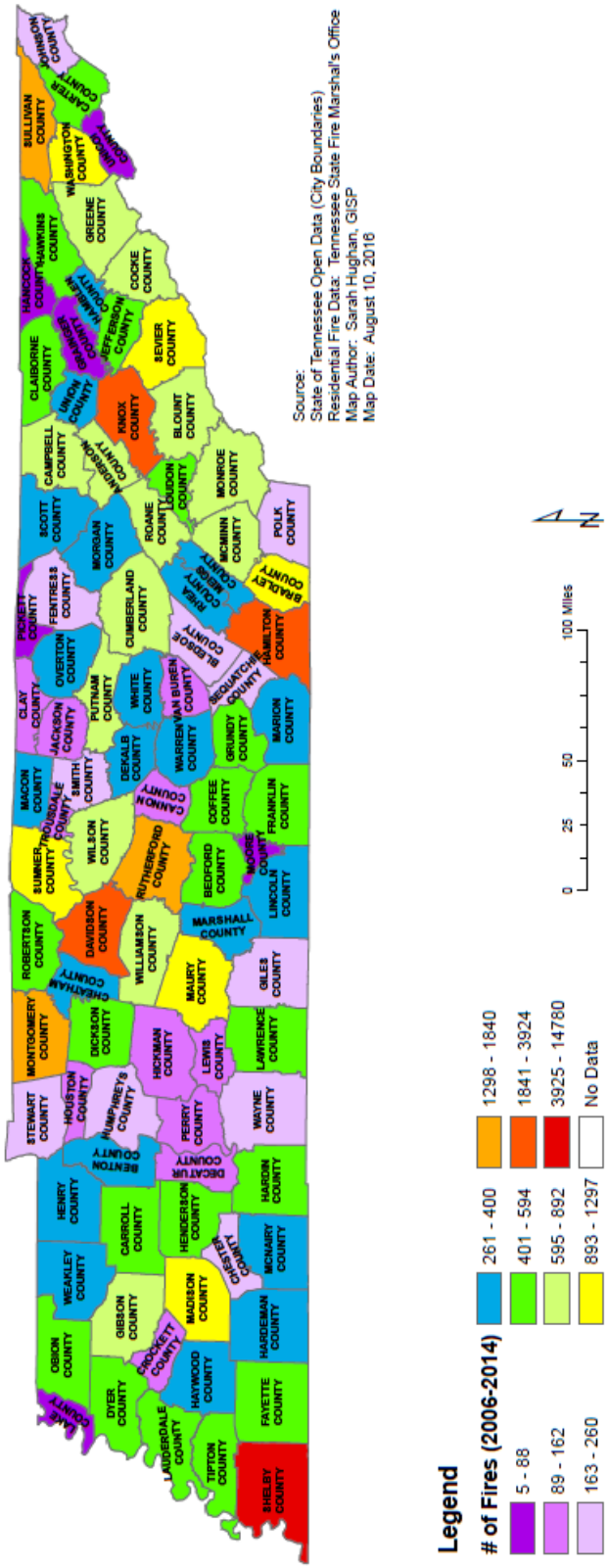
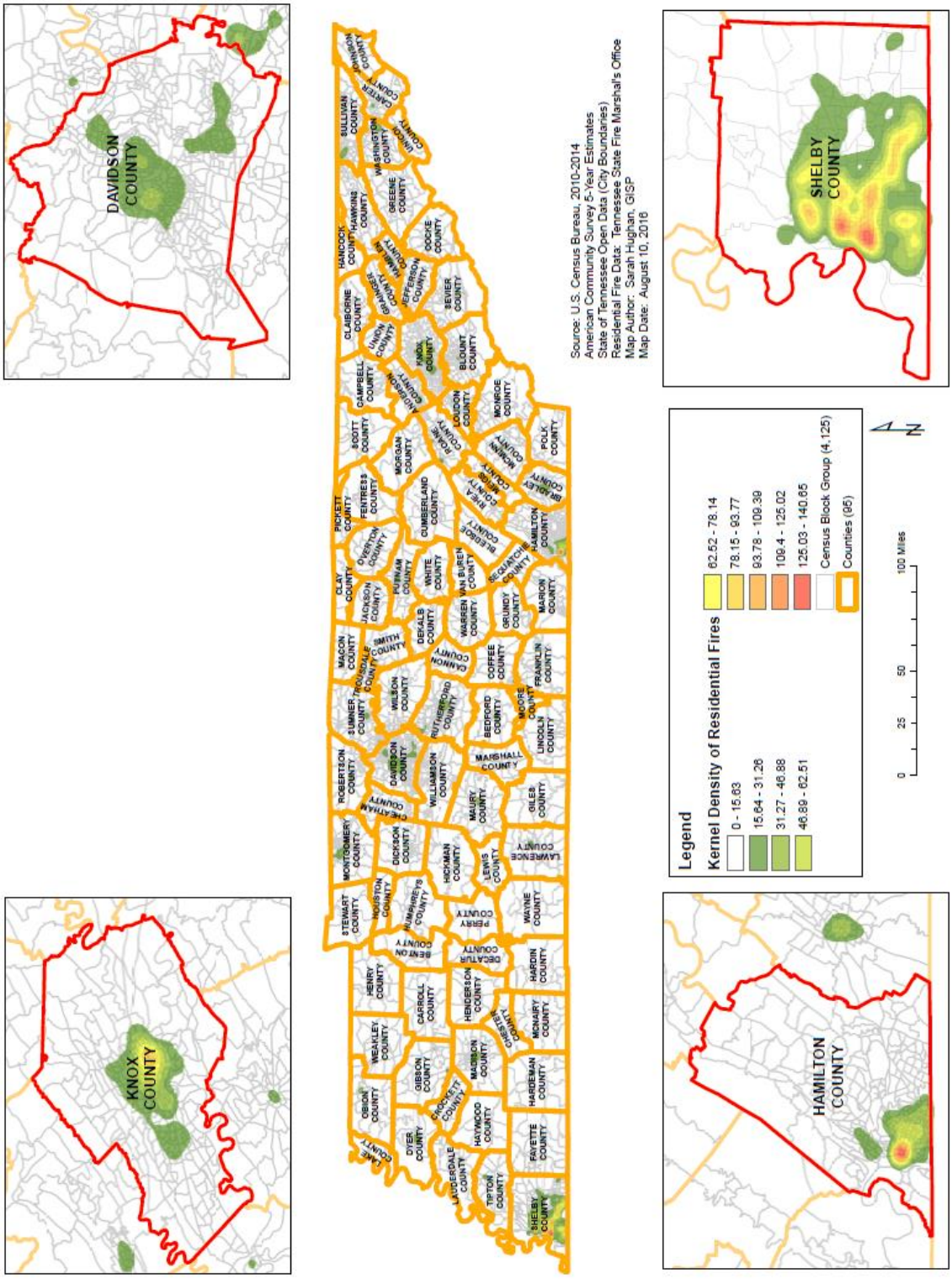
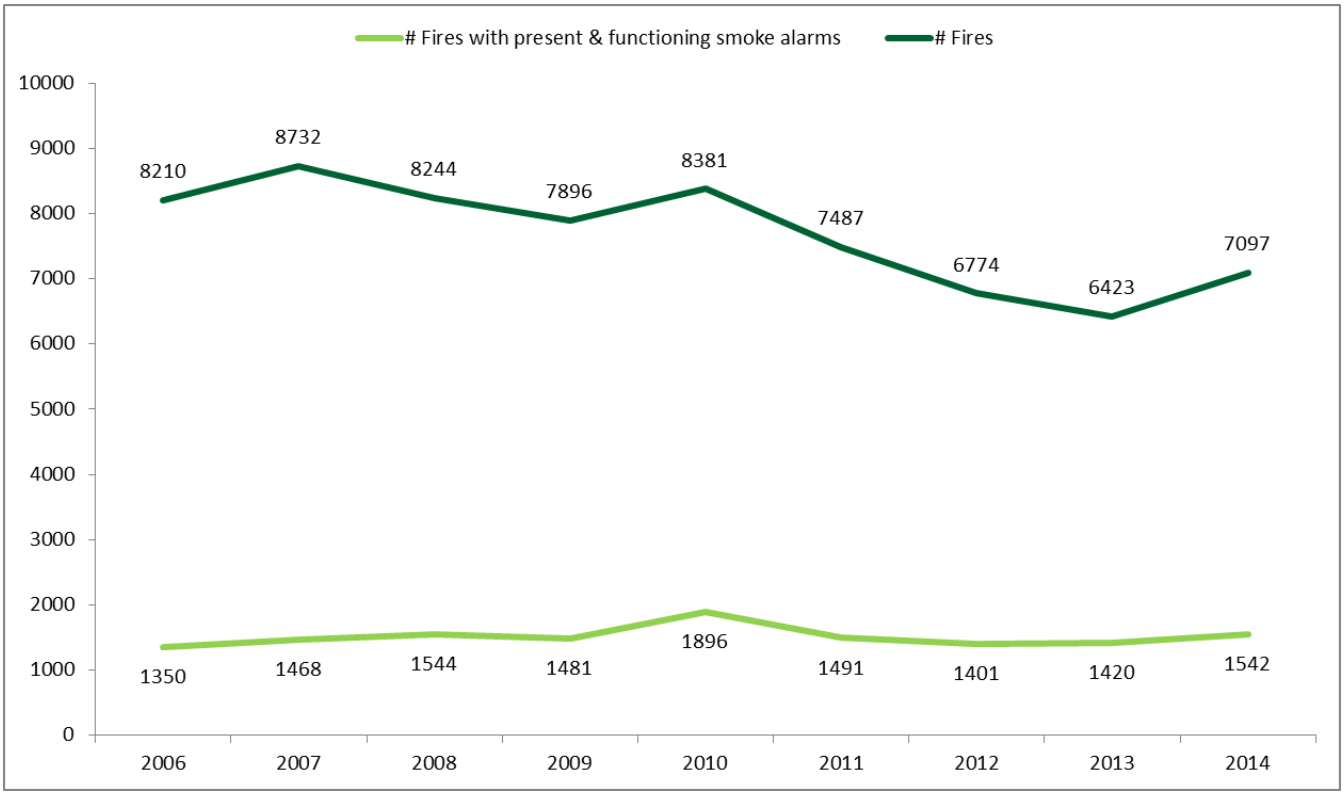


FIGURE 3: NUMBER OF RESIDENTIAL FIRES BY COUNTY (2006-2014)



This section analyzes residential structure fires between 2006 and 2014 for the State of Tennessee. There were 69,244 fires reported over this period, and Figure 4 shows a 16% reduction in the total number of residential structure fires reported in 2014 relative to 2006 and a 14% increase in the number of residential fires where the smoke detector alerted the occupants.

FIGURE 4: RESIDENTIAL STRUCTURE FIRES (TOTAL AND NUMBER WITH PRESENT, FUNCTIONING SMOKE ALARM), TN, 2006-2014



Over this 9 year period the population of Tennessee increased by 8%. This means there was an overall decrease of 19.5% in the rate of residential structure fires in Tennessee per 100,000 people between 2006 and 2014 (Figure 5). Furthermore, the amount of residential structure fires that had detectors that alerted occupants increased by 5.3 percentage points from 16.4% in 2006 to 21.7% in 2014. **Fires will occur, the goal is to maximize residential fire occurrences having working smoke alarms.**

FIGURE 5: RATE OF RESIDENTIAL STRUCTURE FIRES (PER 100,000 PEOPLE)[1], AND PERCENTAGE OF FIRES WITH PRESENT, FUNCTIONING SMOKE ALARMS, IN TN, 2011-2014

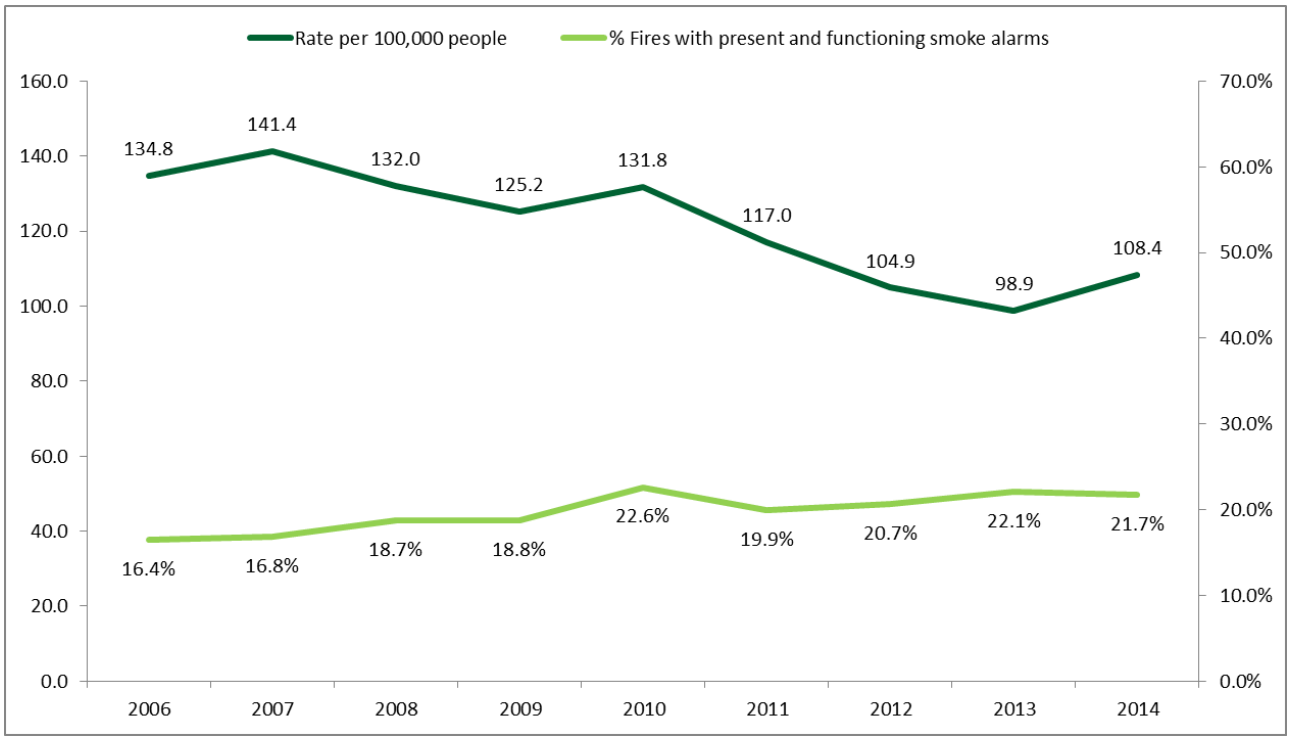


Figure 6 illustrates the injury and fatality rate per 1,000 fires in Tennessee between 2006 and 2014. Over this 9 year period there was a 2% increase in the number of injuries (36.2 per 1,000 fires in 2006 increased to 36.9 in 2014). Over the same period of time there was a 10% reduction in the death rate over the 9-year period (12.2 per 1,000 fires in 2006 to 11 per 1,000 fire in 2014).

[1] Population estimates taken from: http://www.census.gov

FIGURE 6: RATE OF RESIDENTIAL STRUCTURE FIRE CASUALTIES (INJURIES AND DEATHS PER 1,000 FIRES), IN TN, 2011-2014

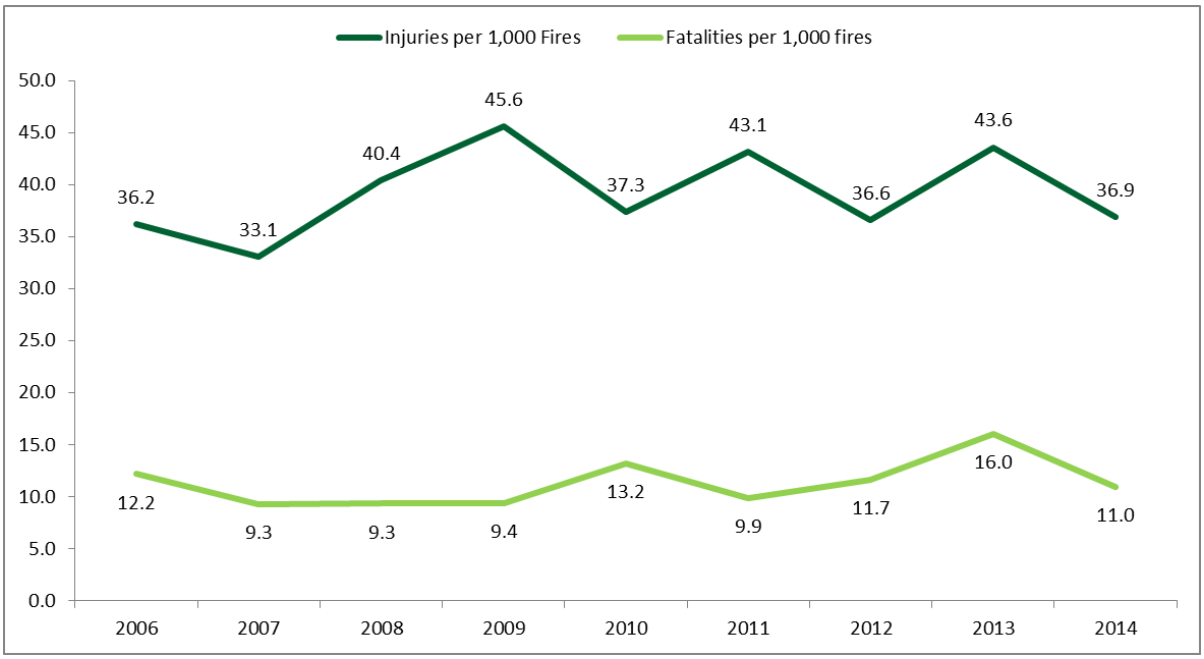
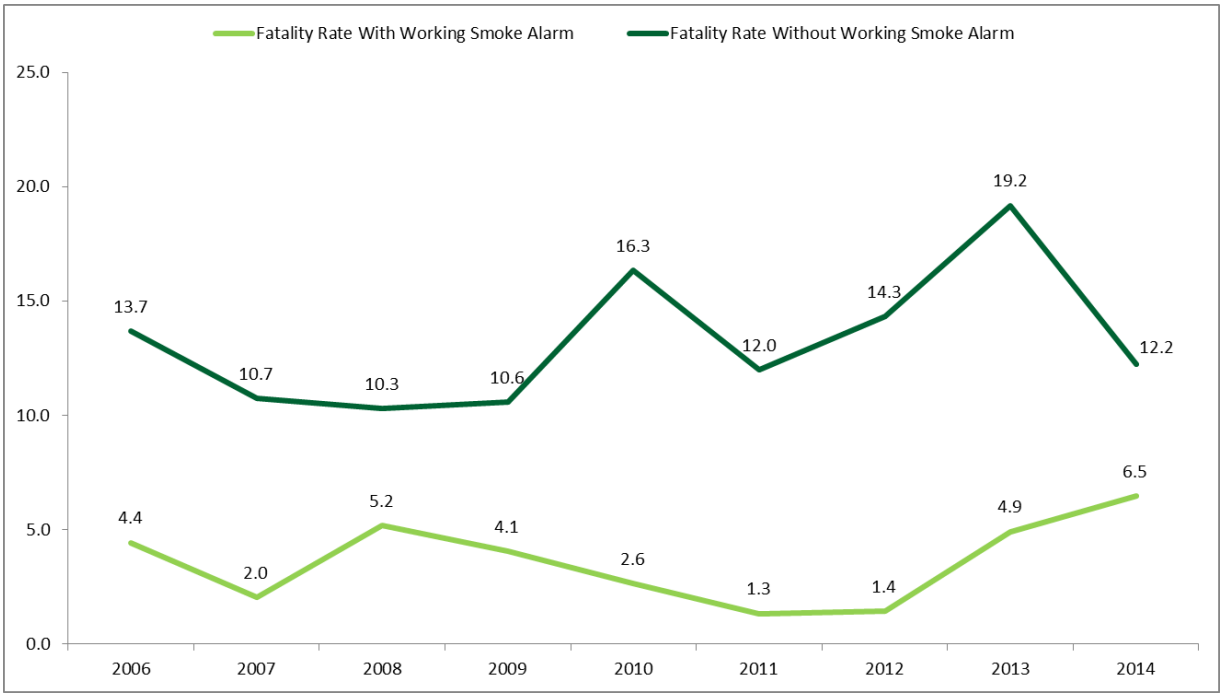


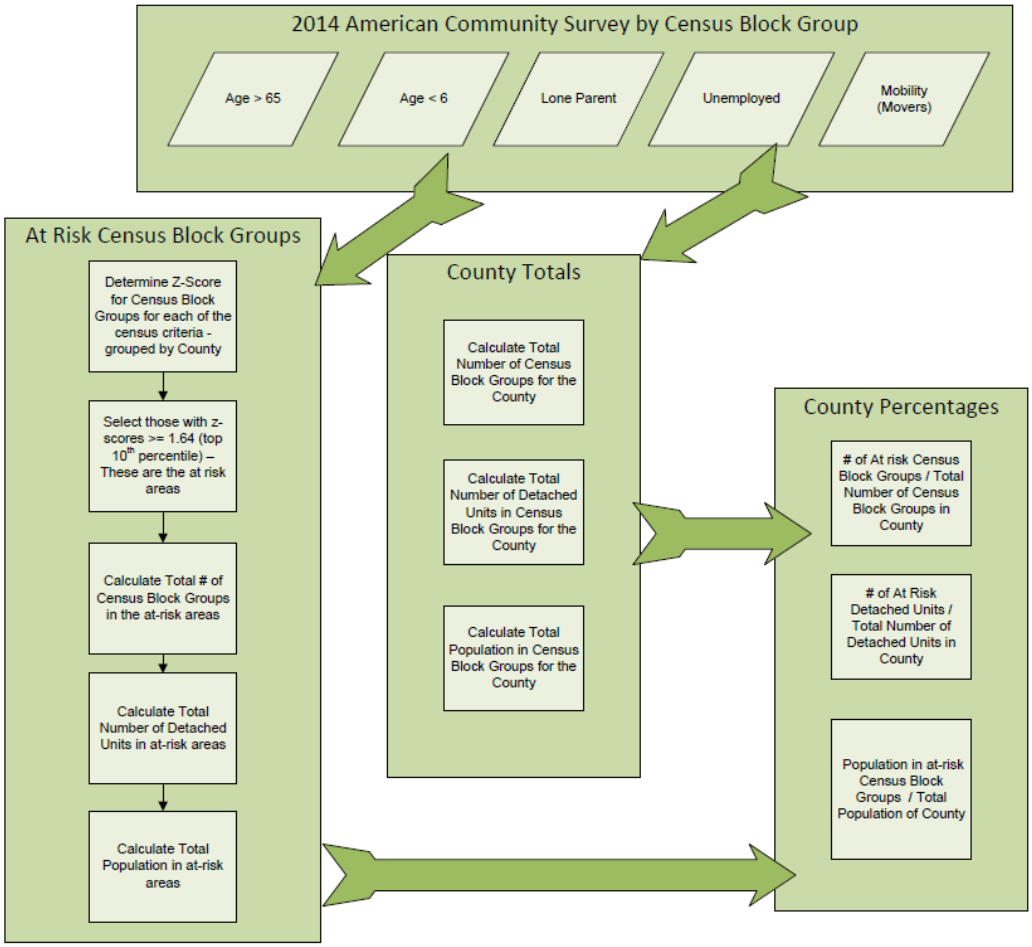
Figure 7 illustrates the fatality rate for residential structure fires with working smoke alarms versus those without working smoke alarms. In 2012, residents were more than 10 times likely to perish in a fire without a working smoke alarm as compared to having a fire with a working smoke alarm. ***SMOKE ALARMS SAVE LIVES***!

FIGURE 7: RATE OF RESIDENTIAL STRUCTURE FIRE FATALITIES IN FIRES WITH WORKING SMOKE ALARMS AND NON-FUNCTIONING SMOKE ALARMS (PER 1,000 FIRES), IN TN, 2006-2014



Using the 2014 American Community Survey 5-Year Estimates, the HomeSafe criteria – residents over age 65 and under age 5, lone parent families, frequent movers, and the unemployed – was evaluated to determine the top 10th percentile of census block groups (within each county) that would be at most risk for fires to occur in their home. The primary focus of the HomeSafe initiative is on single-family detached dwellings. Figure 8 details the process flow to calculate the values (census block group counts and sums for detached units and population) for at risk areas and total values for the State.

FIGURE 8: PROCESS FLOW FOR DATA ANALYSIS & CALCULATIONS



Based on the methodology shown above, the totals for Tennessee are:

- Total number of census block groups is 4,125
- Total number of detached units is 1,951,514
- Total Population is 6,451,365
- Total number of at-risk census block groups is 974
- Total number of at-risk detached units is 585,558
- Total population in at-risk census group blocks is 2,238,363
- The percentage of at-risk census block groups is 23.6%
- The percentage of at-risk detached units is 30.0%
- The percentage of at-risk population is 34.7%

Table 1 provides a State summary of at-risk populations. The Table provides information for three main categories of interest to the fire service. First, the number of at-risk census block groups (which represent populations of between 600-3000 persons) and the total number of census block groups within the county are compared to produce the percent of at-risk census block groups. Second, the total number of detached dwellings within the at-risk areas in the county and the total number of detached dwellings in the county are compared to produce the percent of at-risk detached dwellings in the county. Third, the total population in the at-risk census block groups for the county and the total population for the county are evaluated to produce the percent of population that is at-risk in the county. It is to be noted that the population counts include ALL populations as there is no variable available to determine detached dwelling population counts in the American Community Survey.

TABLE 1: STATE DISTRIBUTION OF THE PERCENTAGE OF CENSUS BLOCK GROUPS, DETACHED DWELLINGS, AND POPULATION AT-RISK FOR RESIDENTIAL FIRES

County	Number of At Risk Census Block Groups in County	Total Number of Census Block Groups in County	Percent At Risk Census Block Groups	Number of Detached Housing Units in At Risk Census Block Groups	Total Number of Detached Housing Units in County	Percent At-Risk Detached Housing Units in County	Population in At Risk Census Block Groups	Total Population of County	Percent Population in At Risk Census Block Groups in County
Anderson County	12	53	22.6%	6,836	24,614	27.8%	22,301	75,346	29.6%
Bedford County	7	25	28.0%	4,295	13,539	31.7%	15,896	45,660	34.8%
Benton County	2	13	15.4%	982	6,003	16.4%	2,924	16,345	17.9%
Bledsoe County	3	8	37.5%	1,384	3,804	36.4%	6,056	13,240	45.7%
Blount County	21	78	26.9%	12,881	41,089	31.3%	47,538	124,435	38.2%
Bradley County	18	55	32.7%	13,317	29,452	45.2%	45,805	101,004	45.3%
Campbell County	8	32	25.0%	4,709	14,579	32.3%	13,184	40,361	32.7%
Cannon County	2	10	20.0%	1,090	4,370	24.9%	4,144	13,786	30.1%
Carroll County	4	23	17.4%	2,238	9,931	22.5%	6,772	28,511	23.8%
Carter County	4	38	10.5%	3,042	18,932	16.1%	9,819	57,298	17.1%
Cheatham County	4	21	19.0%	2,902	12,189	23.8%	10,492	39,324	26.7%
Chester County	3	9	33.3%	2,347	5,307	44.2%	8,572	17,270	49.6%
Claiborne County	9	22	40.9%	4,665	10,180	45.8%	15,149	31,841	47.6%
Clay County	1	7	14.3%	560	3,085	18.2%	1,647	7,802	21.1%
Cocke County	6	27	22.2%	2,765	11,075	25.0%	11,104	35,453	31.3%
Coffee County	7	34	20.6%	4,033	16,446	24.5%	13,790	53,151	25.9%
Crockett County	2	12	16.7%	1,214	5,096	23.8%	3,735	14,599	25.6%
Cumberland County	10	32	31.3%	7,485	20,863	35.9%	21,500	57,064	37.7%
Davidson County	110	473	23.3%	45,481	153,233	29.7%	256,784	648,048	39.6%
Decatur County	3	10	30.0%	1,714	5,117	33.5%	4,496	11,675	38.5%
DeKalb County	2	13	15.4%	1,328	7,320	18.1%	4,259	18,968	22.5%

County	Number of At Risk Census Block Groups in County	Total Number of Census Block Groups in County	Percent At Risk Census Block Groups	Number of Detached Housing Units in At Risk Census Block Groups	Total Number of Detached Housing Units in County	Percent At-Risk Detached Housing Units in County	Population in At Risk Census Block Groups	Total Population of County	Percent Population in At Risk Census Block Groups in County
Dickson County	9	30	30.0%	5,400	15,440	35.0%	20,167	50,115	40.2%
Dyer County	9	26	34.6%	5,457	12,852	42.5%	16,721	38,156	43.8%
Fayette County	7	33	21.2%	3,781	12,731	29.7%	11,901	38,664	30.8%
Fentress County	3	12	25.0%	1,676	6,522	25.7%	5,232	17,922	29.2%
Franklin County	6	27	22.2%	4,299	14,750	29.1%	13,069	41,069	31.8%
Gibson County	8	40	20.0%	5,011	17,234	29.1%	15,494	49,632	31.2%
Giles County	6	19	31.6%	3,392	9,767	34.7%	10,542	29,064	36.3%
Grainger County	4	16	25.0%	2,087	7,000	29.8%	7,203	22,724	31.7%
Greene County	12	48	25.0%	6,374	21,532	29.6%	20,863	68,596	30.4%
Grundy County	1	11	9.1%	472	4,471	10.6%	1,449	13,574	10.7%
Hamblen County	13	42	31.0%	6,555	19,377	33.8%	21,867	62,863	34.8%
Hamilton County	62	247	25.1%	32,423	105,660	30.7%	123,464	344,772	35.8%
Hancock County		5	0.0%		2,585	0.0%		6,706	0.0%
Hardeman County	4	18	22.2%	1,815	7,757	23.4%	9,301	26,560	35.0%
Hardin County	6	19	31.6%	3,400	10,972	31.0%	10,215	25,969	39.3%
Hawkins County	7	36	19.4%	4,059	18,311	22.2%	13,958	56,741	24.6%
Haywood County	4	15	26.7%	2,340	6,160	38.0%	7,298	18,389	39.7%
Henderson County	2	19	10.5%	1,513	8,928	16.9%	5,303	27,963	19.0%
Henry County	8	28	28.6%	3,059	11,474	26.7%	9,655	32,279	29.9%
Hickman County	5	14	35.7%	2,889	6,790	42.5%	11,537	24,354	47.4%
Houston County	1	7	14.3%	398	3,013	13.2%	1,454	8,356	17.4%
Humphreys County	5	16	31.3%	2,192	6,517	33.6%	7,414	18,322	40.5%
Jackson	2	9	22.2%	1,285	4,079	31.5%	4,590	11,555	39.7%

County	Number of At Risk Census Block Groups in County	Total Number of Census Block Groups in County	Percent At Risk Census Block Groups	Number of Detached Housing Units in At Risk Census Block Groups	Total Number of Detached Housing Units in County	Percent At-Risk Detached Housing Units in County	Population in At Risk Census Block Groups	Total Population of County	Percent Population in At Risk Census Block Groups in County
County									
Jefferson County	9	32	28.1%	4,835	15,674	30.8%	17,496	52,166	33.5%
Johnson County	4	12	33.3%	2,462	6,429	38.3%	8,799	18,089	48.6%
Knox County	62	242	25.6%	36,381	129,890	28.0%	143,813	440,732	32.6%
Lake County	3	7	42.9%	730	1,814	40.2%	4,859	7,725	62.9%
Lauderdale County	5	24	20.8%	1,747	7,945	22.0%	8,369	27,619	30.3%
Lawrence County	6	30	20.0%	3,766	13,490	27.9%	13,030	42,084	31.0%
Lewis County	2	7	28.6%	1,855	4,004	46.3%	5,082	12,010	42.3%
Lincoln County	5	24	20.8%	3,122	11,415	27.3%	9,415	33,498	28.1%
Loudon County	8	31	25.8%	5,070	16,637	30.5%	16,445	49,749	33.1%
Macon County	2	13	15.4%	1,216	6,982	17.4%	4,209	22,582	18.6%
Madison County	15	70	21.4%	9,200	31,367	29.3%	33,261	98,364	33.8%
Marion County	4	19	21.1%	2,923	9,443	31.0%	8,978	28,261	31.8%
Marshall County	5	19	26.3%	3,680	9,825	37.5%	11,848	30,977	38.2%
Maury County	9	50	18.0%	7,815	25,547	30.6%	28,124	82,729	34.0%
McMinn County	11	34	32.4%	6,099	16,298	37.4%	20,043	52,409	38.2%
McNairy County	6	19	31.6%	3,425	9,203	37.2%	9,744	26,138	37.3%
Meigs County	2	6	33.3%	946	3,354	28.2%	4,168	11,694	35.6%
Monroe County	6	28	21.4%	3,494	14,260	24.5%	14,929	45,002	33.2%
Montgomery County	16	85	18.8%	16,811	52,679	31.9%	63,767	182,015	35.0%
Moore County		4	0.0%		2,276	0.0%		6,348	0.0%
Morgan County	4	15	26.7%	1,112	6,061	18.3%	6,768	21,866	31.0%
Obion County	7	28	25.0%	3,183	10,728	29.7%	10,144	31,378	32.3%

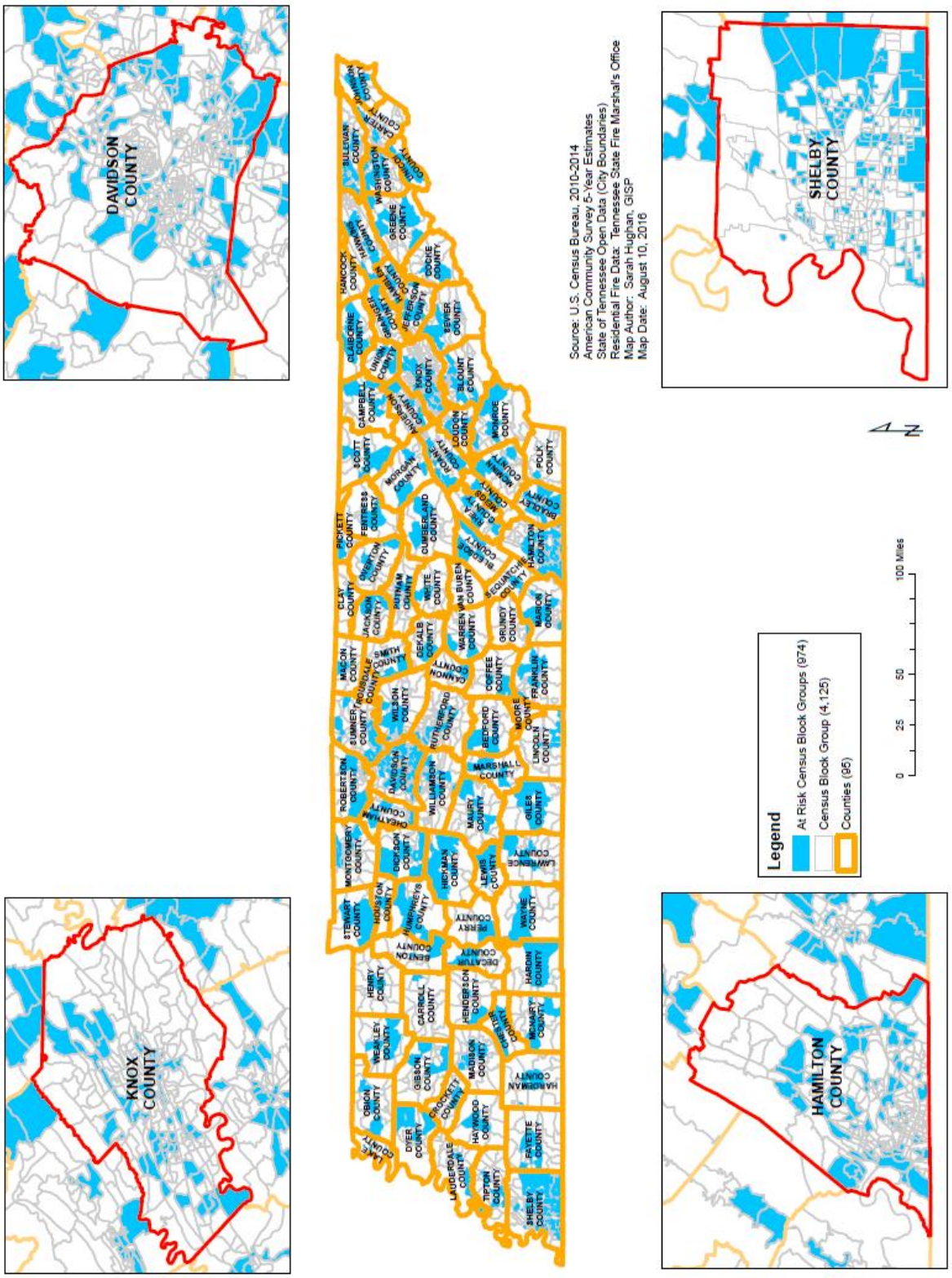
County	Number of At Risk Census Block Groups in County	Total Number of Census Block Groups in County	Percent At Risk Census Block Groups	Number of Detached Housing Units in At Risk Census Block Groups	Total Number of Detached Housing Units in County	Percent At-Risk Detached Housing Units in County	Population in At Risk Census Block Groups	Total Population of County	Percent Population in At Risk Census Block Groups in County
Overton County	4	15	26.7%	1,883	7,176	26.2%	5,892	22,109	26.6%
Perry County	1	7	14.3%	455	2,964	15.4%	1,476	7,851	18.8%
Pickett County	2	5	40.0%	1,045	2,235	46.8%	2,191	5,101	43.0%
Polk County	1	12	8.3%	551	6,038	9.1%	2,205	16,715	13.2%
Putnam County	7	41	17.1%	4,528	21,635	20.9%	19,161	73,237	26.2%
Rhea County	6	19	31.6%	3,956	9,276	42.6%	13,269	32,272	41.1%
Roane County	9	41	22.0%	4,258	17,822	23.9%	14,946	53,413	28.0%
Robertson County	8	34	23.5%	7,446	21,231	35.1%	25,348	67,024	37.8%
Rutherford County	20	123	16.3%	17,856	73,693	24.2%	83,882	275,461	30.5%
Scott County	4	16	25.0%	2,169	6,711	32.3%	7,292	22,104	33.0%
Sequatchie County	2	8	25.0%	1,218	4,510	27.0%	4,425	14,431	30.7%
Sevier County	13	44	29.5%	10,182	37,555	27.1%	36,019	92,561	38.9%
Shelby County	145	628	23.1%	83,546	268,920	31.1%	347,682	936,130	37.1%
Smith County	3	11	27.3%	1,939	6,101	31.8%	7,131	19,092	37.4%
Stewart County	4	11	36.4%	2,655	4,904	54.1%	7,269	13,311	54.6%
Sullivan County	24	111	21.6%	14,974	52,078	28.8%	49,626	156,850	31.6%
Sumner County	24	94	25.5%	15,958	50,200	31.8%	60,437	166,636	36.3%
Tipton County	7	35	20.0%	6,362	18,116	35.1%	21,775	61,433	35.4%
Trousdale County		5	0.0%		2,313	0.0%		7,859	0.0%
Unicoi County	4	14	28.6%	3,039	6,552	46.4%	8,192	18,175	45.1%
Union County	5	14	35.7%	2,639	5,968	44.2%	7,953	19,139	41.6%
Van Buren County		4	0.0%		2,058	0.0%		5,578	0.0%
Warren County	5	27	18.5%	2,686	12,976	20.7%	9,304	39,867	23.3%
Washington County	22	78	28.2%	15,229	36,934	41.2%	54,513	124,798	43.7%

County	Number of At Risk Census Block Groups in County	Total Number of Census Block Groups in County	Percent At Risk Census Block Groups	Number of Detached Housing Units in At Risk Census Block Groups	Total Number of Detached Housing Units in County	Percent At-Risk Detached Housing Units in County	Population in At Risk Census Block Groups	Total Population of County	Percent Population in At Risk Census Block Groups in County
Wayne County	3	13	23.1%	1,207	5,209	23.2%	5,150	16,967	30.4%
Weakley County	6	25	24.0%	2,837	10,949	25.9%	10,942	34,699	31.5%
White County	3	17	17.6%	1,929	8,157	23.6%	5,680	26,086	21.8%
Williamson County	16	81	19.8%	18,984	57,013	33.3%	71,204	193,921	36.7%
Wilson County	13	61	21.3%	11,010	36,753	30.0%	37,444	119,584	31.3%
State Total	974	4,125	23.6%	585,558	1,951,514	30.0%	2,238,363	6,451,365	34.7%

Table 1 indicates that across Tennessee approximately 35% of the residential population is at risk for residential fires. Stewart Country, Pickett County, Unicoi County, Lewis County, Claiborne County and Bradley County have over 45% of their populations at a heightened risk for residential fires. Please note that the population values represent the total population, and not the population within detached housing. All Counties listed above with the exception of Hancock County, Moore County, Trousdale County, and Van Buren County could benefit from the adoption of targeted fire safety public education combined with smoke alarm distribution campaigns as they contain large numbers of residents meeting one or more criteria for elevated residential fire risk.

A more thorough analysis using local planning data (zoning and addressing), municipal distribution of residential structure fires over a five-year period, and identification of the at-risk areas using census data would refine the at-risk properties for each particular jurisdiction.

Map of Census Block Groups in Top 10th Percentile of HomeSafe Criteria



Conclusion

The Tennessee State Fire Marshal's Office as well as local fire departments have done a remarkable job of distributing over 117, 000 smoke alarms to residents within Tennessee. Because of these smoke alarm installs 139 residents were alerted to a fire within their home, and able to exit the residence. Without these alarm installs, the outcome could have been vastly different. Tennessee has a large population of approximately 6.5 million (estimated 2015 figures), and roughly two million detached units. Supplying one or more smoke alarms to 2 million residences is extremely costly and time consuming. Education is the key component to ensure the residents of Tennessee understand the use and maintenance of smoke detectors, the consequences of a non-functioning smoke alarm, and the placement of smoke alarms within the home.

Using the HomeSafe methodology to target the areas within each county that reflect the highest level of risk will reduce the cost immensely versus supplying smoke alarms to all. The analyses conducted for this report substantiate the importance of examining fire trends at a local level. It is estimated that within Tennessee there are roughly 586,000 detached dwellings, and approximately 2.2 million people that are at the highest risk of having a fire in their home. Having firefighters (or others) go door to door promoting fire risk reduction and safety, as well as smoke alarm testing and installation has been a proven method both in the United Kingdom as well as in Surrey, BC. However, it is essential that fire services examine their local fire trends at community levels before undertaking public education and/or smoke alarm distribution campaigns. The research discussed in this report identified the relative risk levels of communities across Tennessee; however, it is important that fire services not only conduct the HomeSafe analysis at a localized level but also take the added step of overlaying their recent historical residential fire data when considering where to focus their resources in order to maximize returns. Fires will happen, but the overall mandate to reduce residential fires and fire-related casualties will be reached more quickly and efficiently by using localized data-driven approaches.

Fire risk is non-random, and it occurs in these neighbourhoods to those inhabitants. Treating these areas will result in a higher return in reducing fire deaths. The Province of BC has shown a 65% reduction in fire-related fatalities in 4 years.

Acknowledgments

The authors of this paper would like to thank Kidde Canada for publishing this paper as well as their continued support towards the Smoke Alarm movement throughout Canada.

References

Chien, S. & Wu, G. (2008). The strategies of fire prevention on residential fire in Taipei. *Fire Safety Journal, 43*: 71-76.

Clare, J., Garis, L., Plecas, D., & Jennings, C. (2012). Reduced frequency and severity of residential fires following delivery of fire prevention education by on-duty firefighters: Cluster randomized controlled study. *Journal of Safety Research, 43*(2): 123-128. doi:10.1016/j.jsr.2012.03.003.

Duncanson, M., Woodward, A., & Reid, P. (2002). Socioeconomic deprivation and fatal unintentional domestic fire incidents in New Zealand, 1993-1998. *Fire Safety Journal, 37*: 165-179.

Esri, (2016). ArcGIS For Desktop: An Overview of the Density Toolset. *https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/an-overview-of-the-density-tools.htm*

Garis, L., Clare, J. (2012). Smoke Alarms Work, But Not Forever: Posing the Challenge of Adopting Multifaceted, Sustained, Interagency Responses to Ensuring the Presence of a Functioning Smoke Alarm.

Garis, L., Hughan, S., McCormick, A. (2016). *Targeted residential fire risk reduction: A summary of at-risk areas in Canada.* Abbotsford: University of the Fraser Valley.

Jennings, C. (1996). *Urban residential fires: an empirical analysis of building stock and socioeconomic characteristics for Memphis*. Tennessee: Cornell University.

Jennings, C. (1999). Socioeconomic characteristics and their relationship to fire incidence: A review of the literature. *Fire Technology, 35*(1), 7–34.

LeBlanc, J. C., Pless, I. B., King, W. J., Bawden, H., Bernard-Bonnin, A. -C., Klassen, T., et al. (2006). Home safety measures and the risk of unintentional injury among young children: a multicentre case–control study. *Canadian Medical Association Journal, 175*(8), 883–887.

Marshall, S.W., Runyan, C.W., Bangdiwala, S.I., Linzer, M.A., Sacks, J.J., & Butts, J.D. (1998). Fatal residential fires: Who dies and who survives? *JAMA, 279*(2): 1633-1637.

McCormick, A.V. (2009). *Residential Fires in Surrey, B.C.: 1998-2007*. Abbotsford, BC: University of the Fraser Valley.

Miller, I. (2005). *Human Behaviour Contributing to Unintentional Residential Fire Deaths, 1997-2003*. New Zealand Fire Service Commission Research Report Number 47.

Schaenman, P., Stambaugh, H., Rossomando, C., Jennings, C., & Perroni, C. (1990). *Proving Public Fire Education Works*. Arlington, Virginia: TriData Corporation.

Scholer, S. J., Hickson, G. B., Mitchel, E. F., & Ray, W. A. (1998). Predictors of mortality from fires in young children. *Pediatrics, 101*(5), 1–5.

Shaw, K. N., McCormick, M. C., Kustra, S. L., Ruddy, R. M., & Casey, R. D. (1988). Correlates of reported smoke detector usage in an inner-city population: participants in a smoke detector give-away program. *American Journal of Public Health, 78*(6), 650–653.

State of Tennessee. (2016). *TN City boundaries*. State of Tennessee STS GIS Downloadable Data, Tennessee.

Tennessee State Fire Marshal's Office (2016). *Fire Fatalities and Mortality Rate in Tennessee*. https://www.tn.gov/commerce/article/fire-fatalities-and-mortality-rate-in-tn

Tennessee State Fire Marshal's Office (2016). Get Alarmed, TN! *https://www.tn.gov/commerce/article/fire-get-alarmed*

TriData (2007). *Global Concepts in Residential Fire Safety: Part 1 – Best Practices from England, Scotland, Sweden and Norway.* Atlanta, GA: Centers for Disease Control and Prevention, Nation Center for Injury Prevention and Control, Division of Unintentional Injury Prevention.

TriData. (2009). *Global Concepts in Residential Fire Safety: Part 3 – Best Practices from Canada, Puerto Rico, Mexico, and Dominican Republic.* Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Unintentional Injury Prevention.

United States Census Bureau. (2015). *American Community Survey, 2015 estimates*. Washington, DC.

United States Census Bureau. (2016). *Geographical boundary data*. Washington, DC.

U.S. Fire Administration. (1997). Socioeconomic factors and the incidence of fire. Federal Emergency Management Agency, United States Fire Administration, National Fire Data Center.

U.S. Fire Administration. (2004). Fire risk. Emmitsburg, MD: National Fire Data Center.

Vision 20/20. (2008). National strategies for fire loss prevention: Washington DC 2008. Forum Results and Report.

Author Biographical Information

Len Garis is the Fire Chief for the City of Surrey, British Columbia, an Adjunct Professor in the School of Criminology and Criminal Justice & Associate to the Centre for Social Research at the University of the Fraser Valley, a member of the Affiliated Research Faculty at John Jay College of Criminal Justice in New York, and a faculty member of the Institute of Canadian Urban Research Studies at Simon Fraser University. Contact him at LWGaris@surrey.ca.

Sarah Hughan, BES, GISP is an accredited firefighter and is the Computer & GIS Specialist with Surrey Fire Services. Contact her at SHughan@surrey.ca.

Charles Jennings, PhD, FiFireE, CFO, is Associate Professor in the Department of Security, Fire, and Emergency Management and Director of the Christian Regenhard Center for Emergency Response Studies (RaCERS) at John Jay College of Criminal Justice of the City University of New York. He is also a Research Associate at the Centre for Public Safety and Criminal Justice Research at University of the Fraser Valley. Contact him at cjennings@jjay.cuny.edu.

UNIVERSITY OF THE FRASER VALLEY
SCHOOL OF CRIMINOLOGY & CRIMINAL JUSTICE

UNIVERSITY OF THE FRASER VALLEY
CENTRE FOR SOCIAL RESEARCH