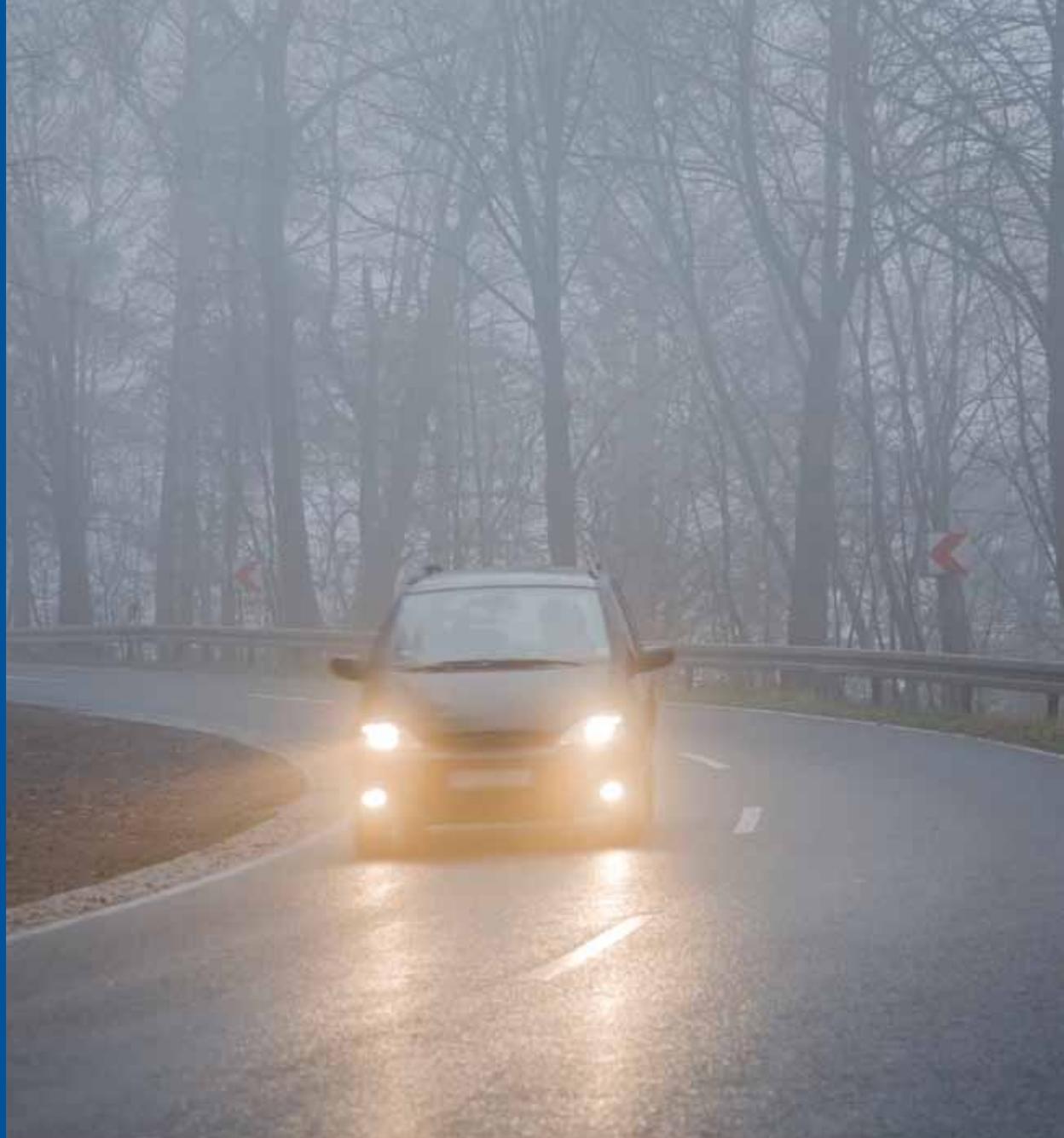


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Hidden Highways: Fog and Traffic Crashes on America's Roads

November 2014



Title

Hidden Highways: Fog and Traffic Crashes on America's Roads (*November 2014*)

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About the Sponsor

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Abstract

Although fog and smoke are understood to create challenging driving conditions for motorists, surprisingly little research has been conducted on the characteristics of fog- and smoke-related crashes, and on the prevalence of such crashes in overall national highway safety statistics. This report illustrates the scope of the problem by presenting 23 years of national data on fatal crashes involving fog and smoke, and 19 years of police-reported crash data pertaining to these conditions. These data point to issues of particular concern with regards to fog and smoke, including the elevated prevalence of such crashes among young drivers, during winter months, and along undivided rural highways. Perhaps most alarmingly, fog and smoke appear to play a major role in fatal multi-vehicle pileups, and are coded as a factor in nearly one-in-five such crashes involving 10 or more vehicles. By examining national and regional data, as well as existing research into driver behavior and perception changes due to fog, this paper offers recommendations that highway officials, safety advocates, parents, automakers, driving instructors, and road users of all kinds can act on in order to promote safe highway operations in foggy or smoky conditions.

Introduction

For three pre-dawn hours of January 29, 2012, the Florida Highway Patrol closed and monitored a stretch of Interstate 75 near Gainesville, Florida, due to thick smoke and fog that had contributed to a non-fatal three-car crash.¹ As visibility improved, the roadway was reopened, despite at least one Trooper's insistence that conditions could change rapidly and smoke and fog could return without warning.² Less than an hour later, 11 people were killed and 18 were injured in a 19-vehicle pileup attributed to a sudden drop in visibility when smoke and fog again covered the freeway.¹

Fog presents numerous challenges to motorists.¹ By definition, it reduces visibility to less than 5/8-mile,³ and, as fog obscures details of the driving environment and reduces contrast, drivers have difficulty accurately perceiving certain things that are crucial for safe driving, such as depth and speed.⁴ Moreover, because high beams reflect off of the suspended water droplets that fog comprises and actually make it harder to see, drivers are deprived of a tool that is useful in other low-visibility situations. And, as was seen in the Florida crash, fog can blanket a roadway with little warning and create sudden and dramatic changes in driving conditions.

Despite these dangers, research addressing the issue of fog and its impact on highway safety is relatively sparse, though some illuminating studies do exist. In examining driver behavior in fog, Broughton et al. determined that fog divides motorists into two camps, which they called "laggers" and "non-laggers."⁵ Non-laggers (the predominant group) – perhaps feeling uncomfortable with the loss of visual reference points in the fog – try to stay within eyeshot of the vehicles in front of them, even though doing so often requires following at an unsafe distance.⁵ To make matters worse, motorists might not be aware of how dangerous their chosen following distance is: Cavallo et al. found that their study participants perceived a lead car to be 60 percent farther away in foggy conditions than in clear conditions.⁶ The potential for crashes when drivers simultaneously try to maintain visual contact with lead vehicles and fail to realize how close they have to come to do so is evident.

Safe following distances are, of course, related to travel speeds, and here too the existing research highlights some issues. Brooks et al., for example, found that drivers do not tend to reduce speed in fog until their ability to stay in their travel lane is compromised.⁷ Because lane markings (which are close to the vehicle and often retroreflective) may remain detectable even in certain limited-visibility conditions, Brooks et al. cautioned that drivers can become overconfident in fog, and also found that when motorists do finally slow down, the speed reduction is often not sufficient to avoid unexpected hazards.⁷ Furthermore, Mueller et al. looked at this issue through the lens of driver experience, and found that young novice drivers were the slowest to react to hazards, and reduced their speed the least in response to foggy conditions.⁸

While these and other studies provide insight into driver behavior and perception of speed and distance in fog, they do not address crash outcomes or trends related to foggy conditions. Here the research is even sparser. Abdel-Aty et al., in an effort to fill this void, took a detailed look at fog and smoke-related crashes in Florida, using crash data from

2003-2007.⁹ Among their findings were that fog- and smoke-related crashes were most likely to occur during the winter months (December – February), in the early morning hours, and in rural areas.⁹ They also found that crashes in smoke and fog tended to involve more vehicles and more serious injuries than did crashes in clear visibility conditions.⁹

This study paints a more complete picture of fog- and smoke-related fatal crashes (FSFC) and fog- and smoke-related police-reported crashes (FSPC) by examining national trends. It offers a descriptive analysis of 23 years of crash data (1990-2012) from the National Highway Traffic Safety Administration’s Fatality Analysis Reporting System (FARS), and 19 years of data (1990-2008) from the National Automotive Sampling System General Estimates System (NASS GES). Such an analysis will help fill some of the knowledge gaps regarding fog- and smoke-related crashes, and be of benefit to overall highway safety efforts given the elevated potential for severe and multi-vehicle crashes in foggy conditions.

Methods

The data for this report come from two sources, both overseen by the National Highway Traffic Safety Administration (NHTSA):

- 1) The Fatality Analysis Reporting System (FARS) is a national database that documents every traffic crash on a public roadway in the United States involving at least one fatality (within 30 days of the crash).
- 2) The National Automotive Sampling System General Estimates System (NASS GES) provides national data from a representative sample of all types of police-reported crashes, including fatal, property damage only, injury, etc.

Twenty-three years of FARS data (1990-2012) and 19 years of GES data (1990-2008) were collected and analyzed for this report. Data were tabulated to track fog-related crashes as a percentage of all fatal crashes (Table 1), and were weighted to reflect fog-related crashes as a percentage of all police-reported crashes nationwide (Table 1b). Also of interest were the characteristics of fatal crashes involving fog, including time of day, month, number of vehicles involved, roadway alignment, etc. These are presented in Table 2. Additionally, due to regional variations in fog prevalence, data were broken down by state and NHTSA region (Table 3). Graphs were created from subsets of the data to highlight especially noteworthy trends, and are presented throughout.

Complete data are presented in each of the tables; however, it is important to note that in 2007, the coding of the FARS “weather” variable changed. Through 2006, “fog” was a separate and distinct category of the weather variable; beginning in 2007, “fog,” “smoke,” and “smog” were all combined. As such, it is not possible to distinguish between these three atmospheric events in the 2007-2012 data. For consistency, this report refers to “fog- or smoke-related” crashes throughout, given that the effects that these conditions have on visibility are largely similar. The data does distinguish between crashes involving the coding of fog alone, and fog together with other types of precipitation, such as rain or snow.

Results

General Trends Over Time

Over the past two decades, the United States has experienced a general decreasing trend in the number of fatal crashes involving fog (Table 1; Figure 1), and the number of police-reported crashes involving fog (Table 1b; Figure 2).

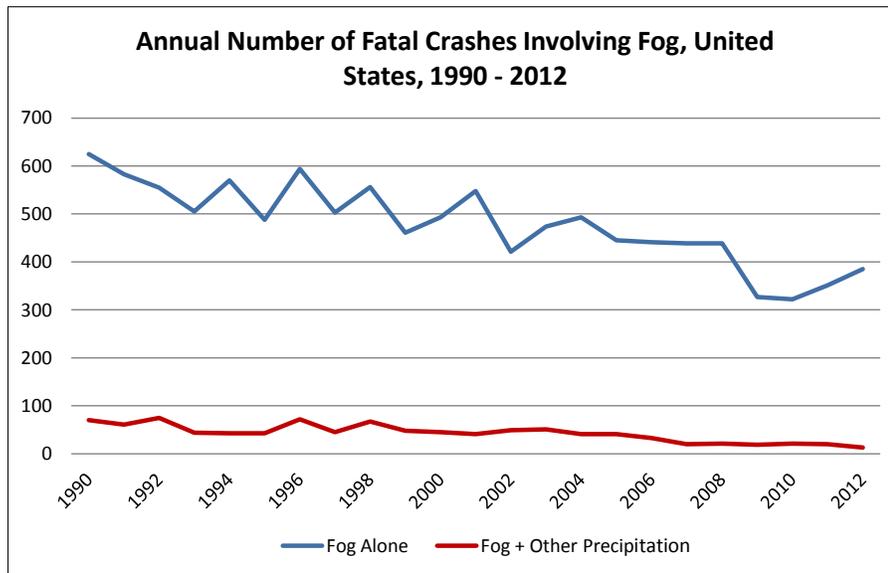


Figure 1. Graph compiled from FARS data (1990-2012 Final Files)

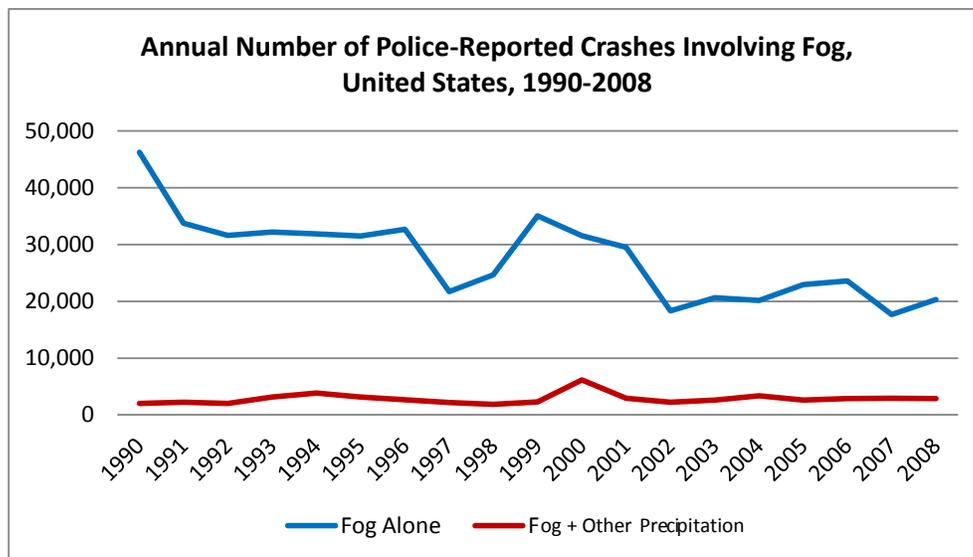


Figure 2. Graph compiled from NASS GES data (1990-2008). Data weighted to reflect all police-reported crashes nationwide

These trends are consistent with an overall reduction in both fatal and police-reported crashes nationwide during this time. However, the good news is that there has also been a decline in the percentage of overall crashes accounted for by fog- and smoke-related incidents. This trend is shown below for fatal crashes (Table 1; Figure 3) and for all police-reported crashes (Table 1b; Figure 4).

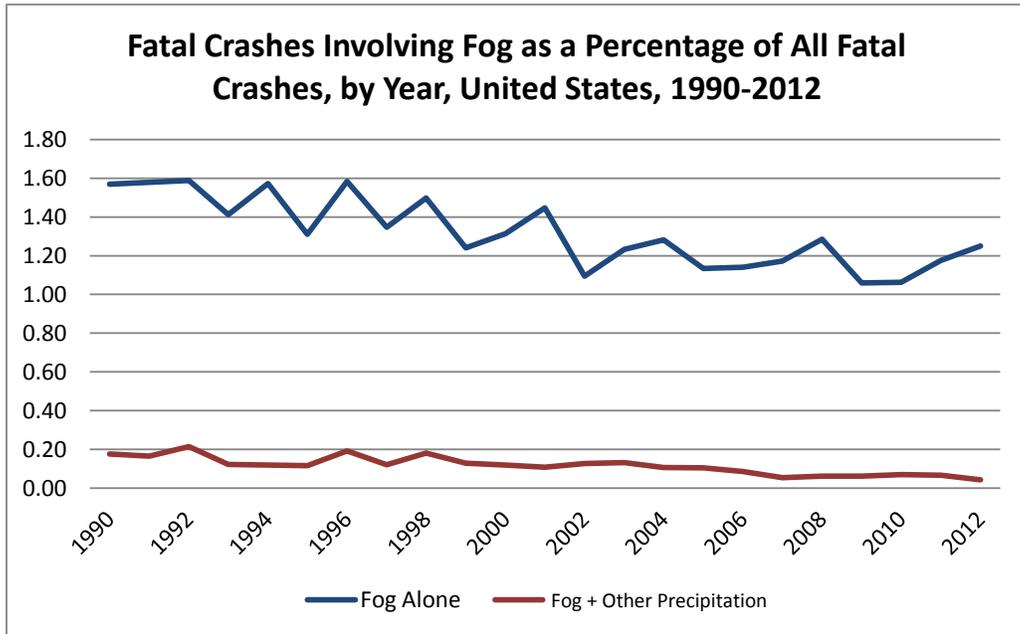


Figure 3. Graph compiled from FARS data (1990-2012 Final Files)

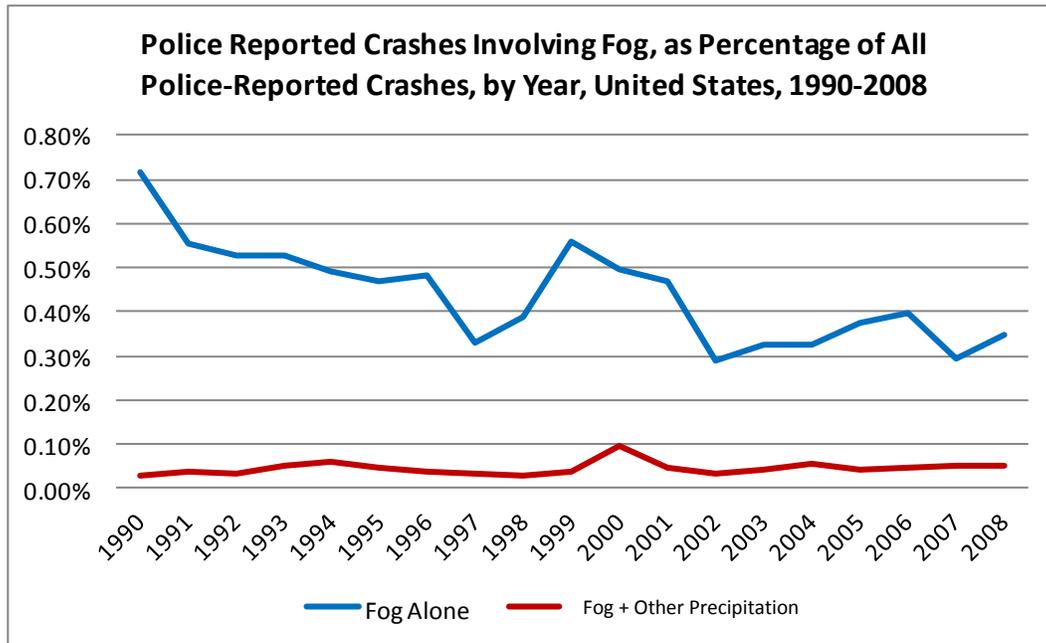


Figure 4. Graph compiled from NASS GES data (1990-2008). Data weighted to reflect all police-reported crashes nationwide

Regional Variations

Not all parts of the country are equally susceptible to fog formation. Consequently, the degree to which fog- and smoke-related crashes factor into overall crash numbers differs by region and by state. Table 3 presents an overall state-by-state breakdown of fatal crashes involving fog for the 23 years of data covered in this study. Figures 5 and 6 group and present these data according to the 10 NHTSA regions to highlight broad variations across the country.

Looking at numbers alone, Region 4 in the Southeast (AL, FL, GA, SC, TN), Region 5 in the Midwest (IL, IN, MI, MN, OH, WI), and Region 6 in the South/Gulf Coast (LA, MS, NM, OK, TX) experience the most fog- and smoke-related fatal crashes (Figure 5). The picture changes, however, when looking at the *proportion* of fatal crashes in each region that involve fog (Figure 6). Here the highest percentages are in Region 1 in New England (CT, MA, ME, NH, RI, VT), Region 7 in the central U.S. (AR, IA, KS, MO, NE), and Region 10, which includes the Pacific Northwest (AK, ID, MT, OR, WA).

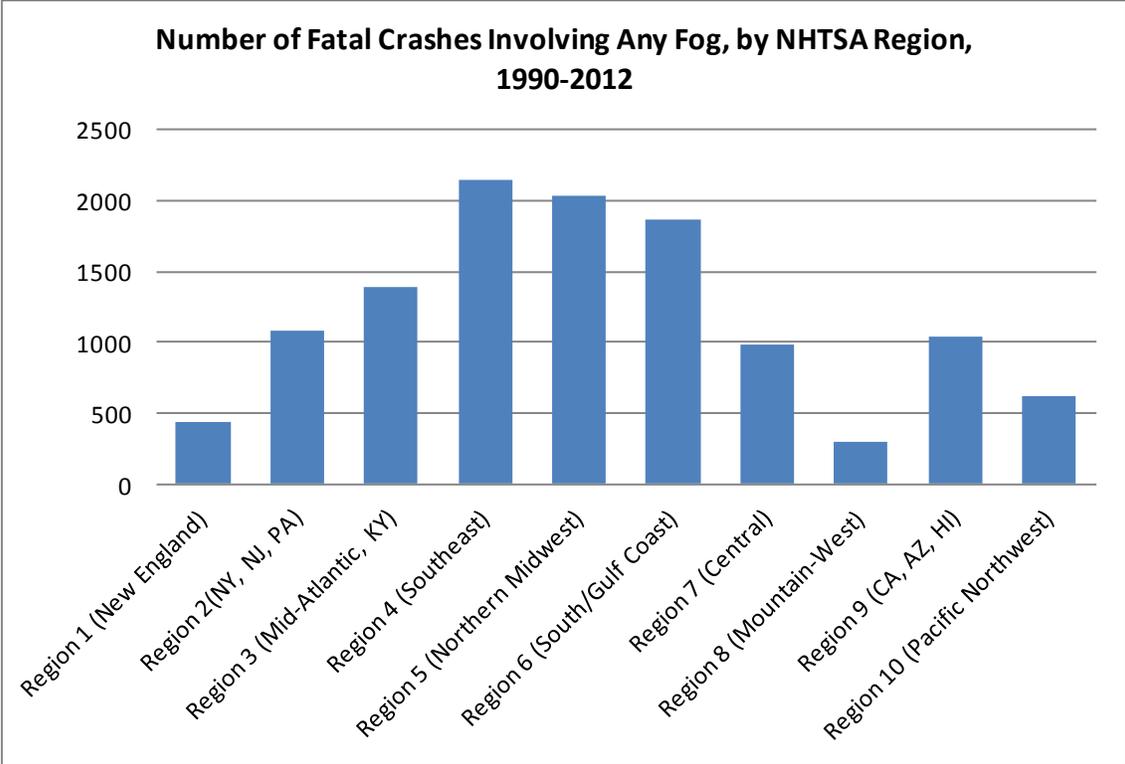


Figure 5. Graph compiled from FARS data (1990-2012 Final Files)

Seasonal and Time-of-Day Patterns

Consistent with Abdel-Aty et al.’s findings in Florida, fatal crashes nationwide involving fog are most prevalent during the winter months (December – February), when they account for 2.44 percent of all fatal crashes, and are least prevalent in the summer (June – August), when they account for less than 1 percent of all fatal crashes (Figure 7). Additionally, the prevalence of smoke- and fog-related fatal crashes is highest in the overnight (midnight – 5:59 AM) and

morning (6:00 – 11:59 AM) hours (Figure 8). This is not surprising, as the overnight and early morning hours – when the temperature is generally the coolest and water vapors can condense into droplets – are when fog formation is most likely to occur.¹⁰ Additionally, these are times when visibility is generally already compromised due to poor lighting. Adding smoke or fog to the mix further degrades already-challenging driving conditions.⁵

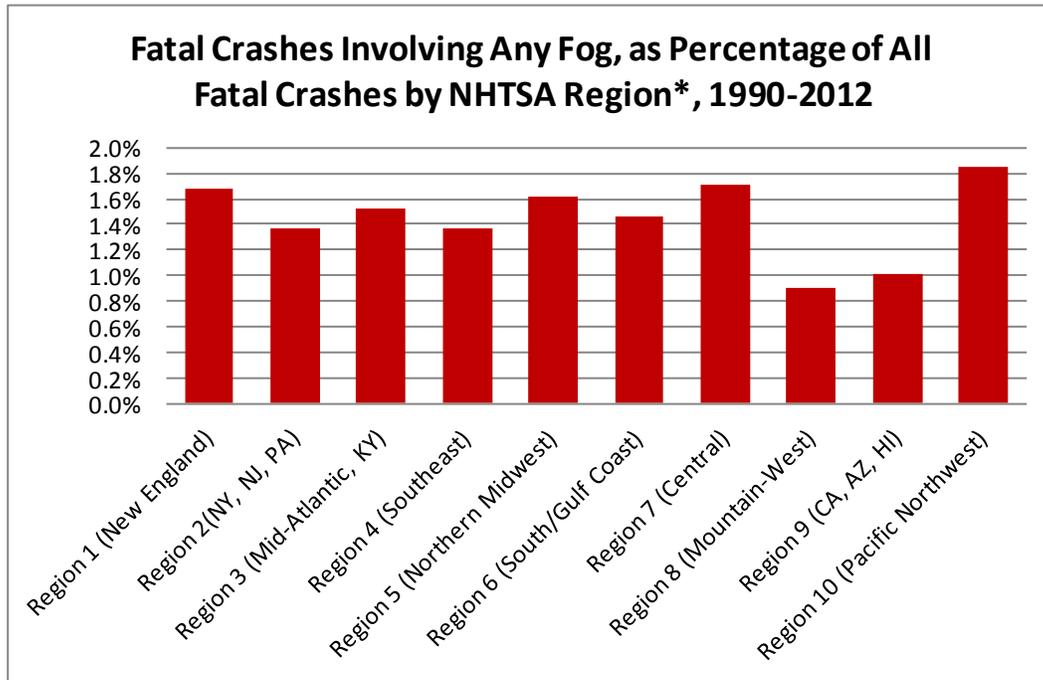


Figure 6. Graph compiled from FARS data (1990-2012 Final Files)
 *See Table 3 for state listing by NHTSA region.

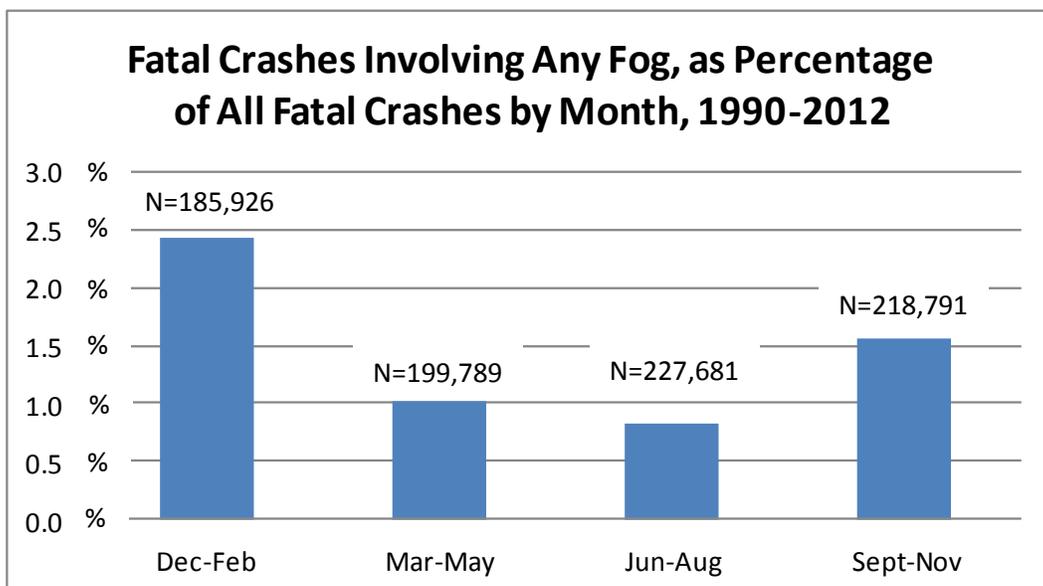


Figure 7. Graph compiled from FARS data (1990-2012 Final Files)

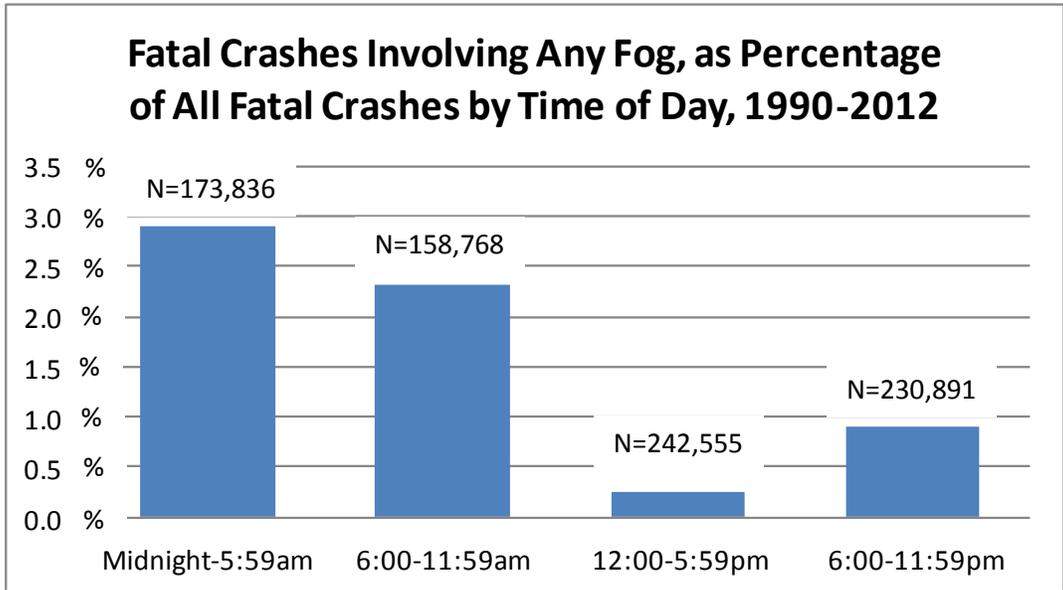


Figure 8. Graph compiled from FARS data (1990-2012 Final Files)

Land Use and Roadway Type

Variations in the prevalence of fog- and smoke-related fatal crashes are also seen when looking at land use and roadway type. Prevalence is greater in rural areas – where such crashes account for nearly two percent of fatal crashes – than in urban ones, where less than one percent of fatal crashes are accounted for by fog (Figure 9). Additionally, undivided, two-way roadways see a greater share of fog- and smoke-related crashes than do divided or one-way roads (Figure 10). This national finding is consistent with what Abdel-Aty et al. saw in the Florida data.⁹

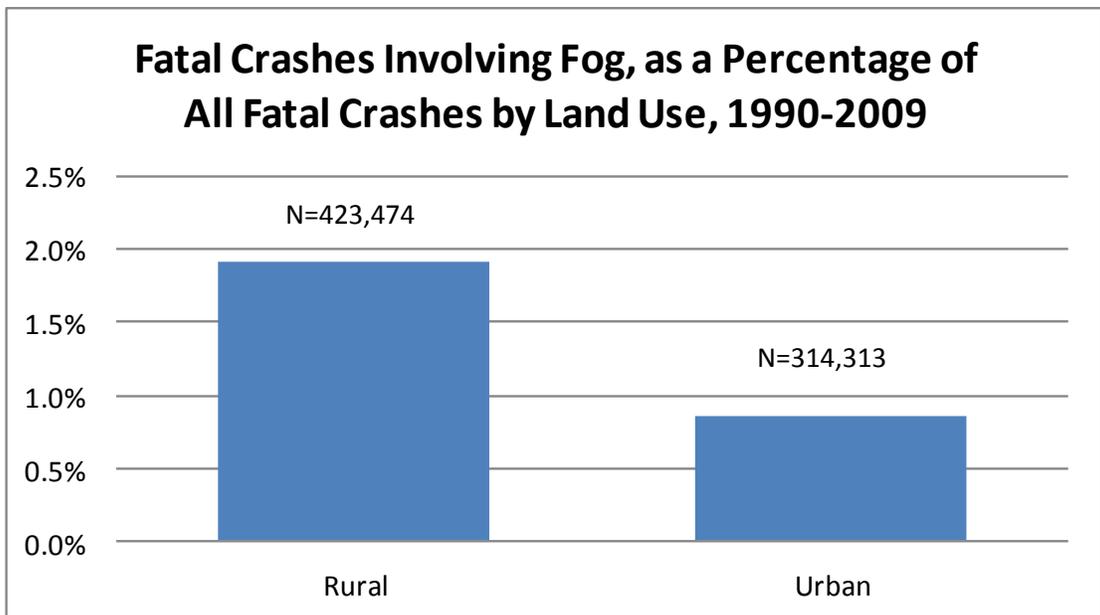


Figure 9. Graph compiled from FARS data (1990-2008 Final Files; 2009 Annual File)

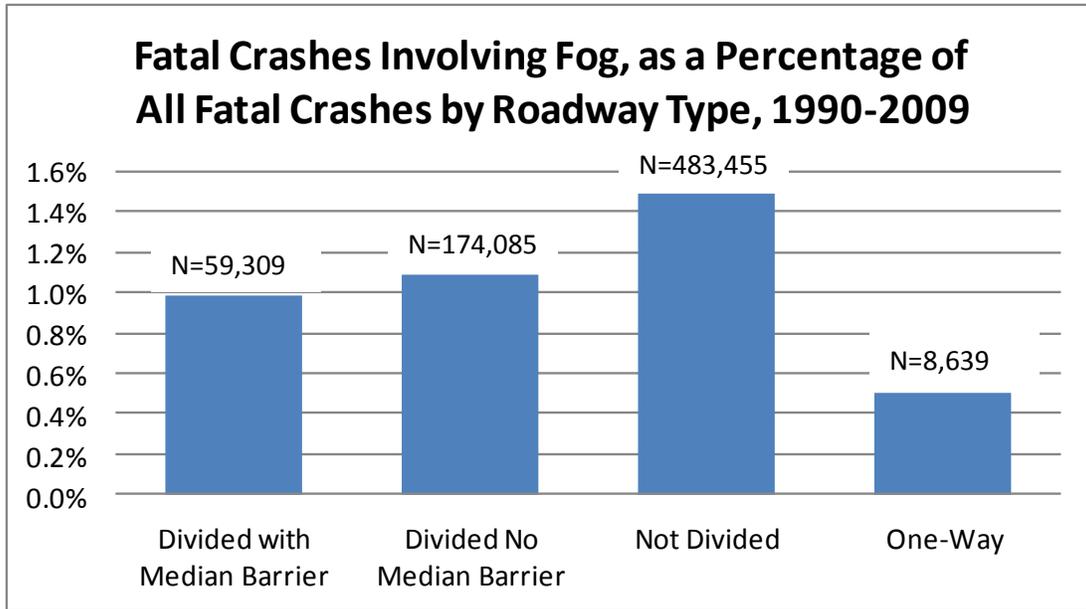


Figure 10. Graph compiled from FARS data (1990-2008 Final Files; 2009 Annual File)

Driver Age and Number of Vehicles Involved

The national data show that, in general, for drivers of older ages, fog- and smoke-related fatal crashes account for a smaller share of fatal crash involvements. The proportion is highest for drivers aged 20-29, for whom fog is coded in 1.54 percent of their fatal crashes, and lowest for drivers aged 70 and older, for whom fog is coded in just 0.65 percent of fatal crashes (Figure 11). Teens, at 1.46 percent, see the second highest proportion.

Another pattern seen in the national data with regard to fog- and smoke-related crashes pertains to the number of vehicles involved. For single-vehicle fatal crashes, as well as fatal crashes involving 2-5 vehicles, the prevalence of fog as a factor is relatively low and fairly consistent, ranging from 1.40 percent to 1.47 percent. For crashes involving six to nine vehicles, however, the prevalence more than triples, to 4.37 percent. And for pileups involving 10 or more vehicles – such as the 19-vehicle disaster in Florida in January 2012 that claimed 11 lives – fog is coded in nearly one-in-five occurrences (Figure 12). While such crashes are indeed rare (215 occurred over the 20-year study period, compared with more than 482,000 fatal single-vehicle crashes), the alarming spike in prevalence suggests that fog and smoke are indeed risk factors for this horrific and lethal crash type.

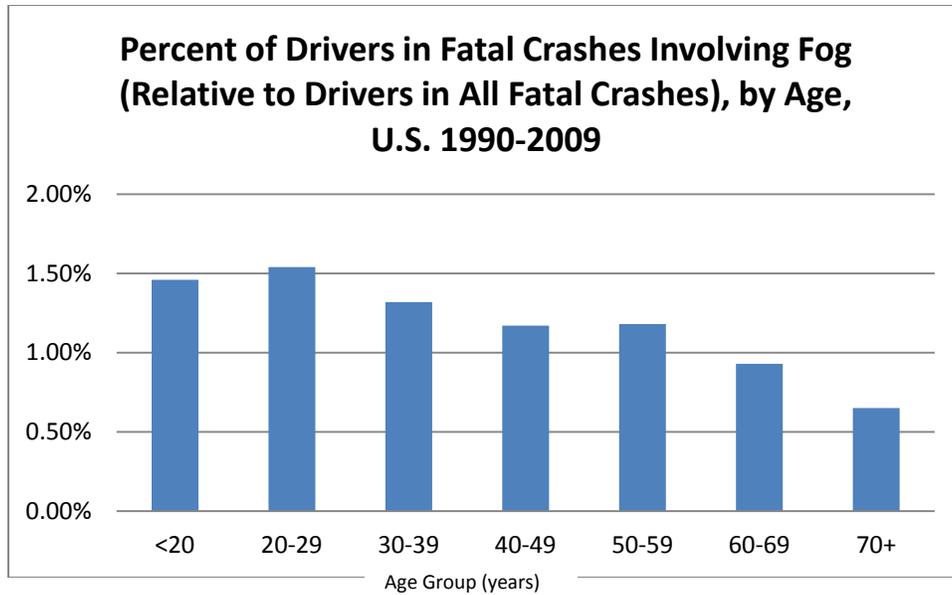


Figure 11. Graph compiled from FARS data (1990-2008 Final Files; 2009 Annual File)

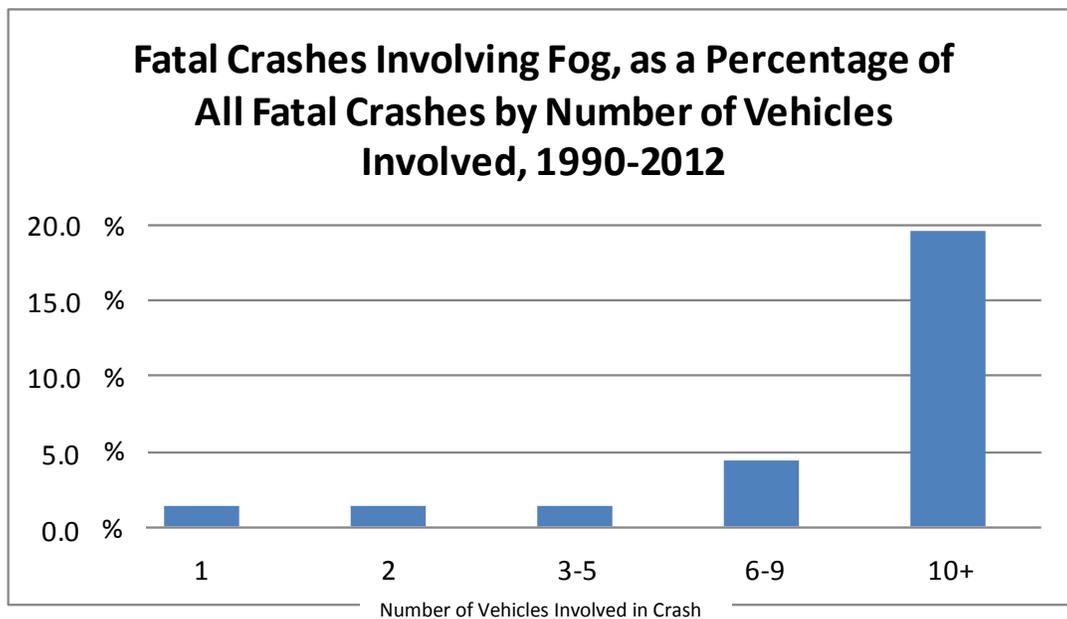


Figure 12. Graph compiled from FARS data (1990-2012 Final Files)

Discussion

While fog- and smoke-related fatal crashes (FSFC) do not generally account for a large percentage of overall fatal crashes (<2%), these numbers only tell part of the story. Whereas crashes related to things like distraction, speeding, or impairment can happen at any time and in any location, FSFC are dependent on the presence of specific atmospheric conditions to occur. With some parts of the country – such as the Southwest – receiving very little fog, and even relatively foggier places seeing little formation during the daylight hours and warmer

months, it is not surprising that the raw crash numbers are somewhat low. What is important is that – given the presence of fog or smoke as opposed to clear conditions – crashes are more likely to occur, to result in serious injuries, and to involve multiple vehicles.⁹ As such, highway safety officials and other stakeholders should not discount the significant threat posed by fog and smoke, and more research on the subject is in order, especially with respect to the effectiveness of countermeasures that may be in use (e.g., fog detection systems).

The roughly two decades of national data presented here help to highlight some of the key issues and concerns posed by FSFC. As shown in Figure 11, FSFC are more prevalent among younger drivers, and are least prevalent among older ones (drivers 75+). This is consistent with the fact that older drivers are among the most responsible on the road, and tend to limit their driving at night and in inclement weather.¹² At the same time, teens are the most inexperienced and crash-prone drivers on the road, and may be unaccustomed to dealing with the particular challenges posed by fog.¹¹ In examining driver behavior changes in fog, as noted earlier, Mueller et al. found that their young novice participants took the longest to react to hazards and reduced their speed the least, and that one-in-four crashed during the study.⁸ However, newly-licensed teens in virtually all states are restricted from driving during the overnight and early morning hours – the times when fog formation and related crashes are most likely to occur – which likely contributes to the slightly lower prevalence of FSFC seen among this age group than among drivers a few years older.

The elevated prevalence of FSFC among younger drivers is yet another reminder of the importance of giving novice drivers ample opportunities to practice their skills under a variety of conditions, and existing AAA Foundation research indicates that there is significant room for improvement in this area. In a naturalistic driving study of teens in the learner stage of North Carolina’s graduated driver licensing (GDL) system, the Foundation found that teens were getting less supervised driving practice than had been previously assumed, and that most of the experience they did get was on bright sunny days and along familiar routes.¹³ In fact, only 16 percent of the video clips showed teens practicing driving in the dark, and just 3 percent were recorded in the rain.¹³ Providing opportunities for teens to practice driving under a variety of conditions – including fog – while under the supervision of parents or guardians is a key component of young driver safety efforts.

The role that fog and smoke appear to play in fatal multi-vehicle pileups (accounting for nearly one-in-five fatal 10+ vehicle crashes) is particularly alarming, and indicative of the myriad ways in which these conditions complicate a driver’s ability to perceive the road environment. With reference points obscured and many motorists looking to lead vehicles to provide some visual context, the potential for crashes rises, particularly since following distances may need to be unsafely short in order to maintain visual contact.⁵ Indeed, Hawkins – in a study from the United Kingdom – observed vehicles clustering in foggy conditions, and the percentage of small gaps in traffic (under 60 meters) increasing by 25 percent.¹⁴ Such clustering has obvious implications for the risk of chain-reaction crashes and multi-vehicle pileups, as drivers may not leave themselves enough time and space to avoid colliding with vehicles around them. This may be particularly true given Cavallo et al.’s findings that drivers perceive vehicles to be farther away in fog than they do under clear conditions, and Broughton et al.’s findings that motorists’ differing approaches for dealing with fog can interrupt the normal flow of traffic and yield discrepancies in speed and vehicle positioning.^{6,5}

Given these challenges, and the deadly risks they pose, greater public awareness of the specific effects that fog and smoke can have on driver perceptions, speed choice, following distance, and other behaviors should be promoted. Such efforts could take the form of modules in driver education courses, seasonal public service announcement (PSA) campaigns during “foggy times” (generally the winter and fall), and more detailed coverage of the effects that fog and smoke have on driving when crashes related to these conditions occur. Specific central themes of such messaging could include references to fog and smoke making objects appear farther away than they are, interfering with driver ability to judge speed, and leading to vehicle clusters on the highway.

While motorists and other road users certainly have a responsibility to take precautions and exercise safe behaviors, highway officials and even vehicle manufacturers also have a role to play in reducing the likelihood and severity of fog- and smoke-related crashes. The breakdown of the national data into NHTSA regions (Figure 6) highlights areas of the country where the implementation of countermeasures for fog- and smoke-related crashes may be of particular benefit.

A number of roadway design features, for example, can assist motorists who are struggling with diminished visual references and perception abilities. Rumble strips, for example, provide a physical and audible warning – even when drivers cannot see the center or edge line – that can alert motorists to an imminent roadway departure before it’s too late. Upgraded pavement markings and plastic lane markers may help drivers maintain their position even in thick fog, and widened shoulders can provide safe places for motorists to pull over in the event they feel they can no longer drive safely given the conditions. Additionally, median barriers – such as concrete walls, high-tension cables, or steel guardrails – can prevent vehicles from crossing into oncoming traffic and causing severe head-on wrecks. The national data on FSFC by roadway type (Figure 10) suggests such barriers may be particularly beneficial countermeasures, as the prevalence of such crashes is highest on two-way, undivided roadways. This is further supported in Abdel-Aty et al.’s data from Florida, where they found that, while the likelihood of all crash types examined were higher in foggy conditions than clear ones, the odds ratio was greatest for head-on crashes.⁹ If a barrier is deemed infeasible, centerline rumble strips – which run down the middle of an undivided roadway – can warn drivers that they are about to cross into oncoming traffic.

While highway officials can consider implementing crash countermeasures of the kinds described above, there may be opportunities for reducing fog- and smoke-related crashes through vehicle design and technology, as well. For example, in addition to replicating Cavallo et al.’s findings that vehicles are perceived to be farther away in foggy conditions than in clear ones, Buchner et al. demonstrated that subjects also perceived vehicles with higher-positioned rear lights and rear lights that were closer together as farther away, and suggested that such vehicles may be more likely to be rear-ended in fog.¹⁵ Rear lights that are positioned closer to the ground, and with greater separation, may therefore help trailing motorists better estimate and maintain a safer following distance.

Another issue that merits consideration here is the range of sophisticated crash-avoidance technologies that are increasingly found in new vehicles. Recent research by the AAA Foundation and the Massachusetts Institute of Technology has discovered that while some of these technologies – such as Electronic Stability Control – have a well-documented safety benefit, others still require substantial evaluation before they can be considered “proven.”¹⁷

For example, two of the technologies evaluated – lane departure warnings and forward collision warnings – are intended to help drivers maintain proper vehicle positioning and avoid rear-end crashes (two scenarios that are highly applicable to fog- and smoke-related situations). However, in a consumer-facing rating system developed by the research team (available at www.aaafoundation.org/ratings-vehicle-safety-technology), each of these technologies received 3 out of 5 stars for their theoretical overall safety benefit, and just 1 out of 5 stars for what has been proven in real-world data to-date.¹⁷ And, in addition to this general lack of data, more needs to be learned specifically about how foggy and smoky conditions affect the sensors and/or cameras upon which these systems depend.

While the data presented here do not indicate why FSFC and fog- and smoke-related police reported crashes (FSPC) have generally declined both in number and as percentages of overall crashes over the past two decades, it is likely that several factors are at work. These may include an increase in the number of vehicles with advanced technologies, roadway infrastructure upgrades, and the enactment of state GDL laws restricting high-risk novice drivers from operating motor vehicles during fog-prone overnight hours. It is also possible that larger, climate-level changes have played a role. In examining fog trends across the Southeastern United States (AL, FL, GA, NC, SC, VA) from the mid-20th century through 2003, Forthun et al. found that nearly half of the measurement sites (12 of 26) experienced significant reductions in fog-event days, and only two stations saw an increase.¹⁶ In addition, medium- (3-5 hours) and long-duration (6+ hours) fog-events decreased everywhere that trends were significant, and only five stations showed an increase in short-duration (1-2 hours) periods of fog.¹⁶ Given that the national data show that the Southeast accounts for the greatest number of FSFC (Figure 5), decreases in fog formation and duration in this region may have helped drive down crashes related to these conditions. Forthun et al. note that they believe large-scale and long-term meteorological shifts likely account for the significant decreases in fog-events, but also acknowledge that others have attributed at least some of the decline to urbanization and its associated increase in temperatures and decrease in humidity.¹⁶ While their study looked only at the Southeast, it is certainly possible that the forces of urbanization or broader climate change have impacted fog formation elsewhere, as well.

Conclusion

Despite the relatively low prevalence of fog- and smoke-related fatal and police-reported crashes, and a general decreasing trend in such crashes over the past two decades, fog and smoke remain significant threats to highway safety given the particularly insidious ways in which these conditions appear to impact driver perceptions and behaviors. Given the increased likelihood of crashes in the presence of fog and smoke – and, most troublingly, the increase in severe and multi-vehicle crashes – fog and smoke should be treated as serious safety concerns, and efforts should be made to continue developing and evaluating countermeasures targeting the issue. The national data highlight certain priority concerns with regards to fog – such as young driver crashes, winter driving, multi-vehicle pileups, and undivided rural roadways – and, when considered alongside existing research into driver behavior and perception, offer actionable ideas for highway officials, safety advocates, parents, automakers, driving instructors, and other stakeholders wishing to see reductions in crashes related to fog and smoke.

Tables

Table 1

Fatal Crashes by Police-Reported Fog Status, United States, 1990-2009					
	Fog Alone		Fog + Other Precipitation		All Fatal Crashes
	n (crashes)	% of all fatal crashes	n (crashes)	% of all fatal crashes	N
1990	625	1.57	70	0.18	39,836
1991	583	1.58	61	0.17	36,937
1992	555	1.59	75	0.21	34,942
1993	505	1.41	44	0.12	35,780
1994	570	1.57	43	0.12	36,254
1995	488	1.31	43	0.12	37,241
1996	594	1.58	72	0.19	37,494
1997	503	1.35	45	0.12	37,324
1998	556	1.50	67	0.18	37,107
1999	461	1.24	48	0.13	37,140
2000	493	1.31	45	0.12	37,526
2001	548	1.45	41	0.11	37,862
2002	421	1.09	49	0.13	38,491
2003	474	1.23	51	0.13	38,477
2004	493	1.28	41	0.11	38,444
2005	445	1.13	41	0.10	39,252
2006	441	1.14	33	0.09	38,648
2007	439	1.17	20	0.05	37,435
2008	439	1.28	21	0.06	34,172
2009	327	1.06	19	0.06	30,862
2010	322	1.06	21	0.07	30,296
2011	351	1.18	20	0.07	29,867
2012	385	1.25	13	0.04	30,800

Data: Fatality Analysis Reporting System (FARS), National Highway Traffic Safety Administration, 1990-2012 Final Files.

Note: The coding of FARS variable *WEATHER* was changed in 2007. Until 2006, *fog* was a separate category of *WEATHER*. In 2007, the coding was modified so that the same category included *fog*, *smog*, and *smoke*. Thus, for years 2007-2012, crashes coded above as involving *fog* may have involved *smog* or *smoke* rather than *fog*.

Table 1b**All Police-Reported Crashes by Police-Reported Fog Status, United States, 1990-2008**

	Fog Alone		Fog + Other Precipitation		All Crashes
	n (crashes)	% of all crashes	n (crashes)	% of all crashes	N
1990	46,264	0.72	1,987	0.03	6,462,126
1991	33,762	0.55	2,248	0.04	6,109,931
1992	31,627	0.53	1,986	0.03	5,992,938
1993	32,191	0.53	3,138	0.05	6,094,772
1994	31,884	0.49	3,834	0.06	6,489,122
1995	31,487	0.47	3,134	0.05	6,690,061
1996	32,708	0.48	2,659	0.04	6,761,051
1997	21,727	0.33	2,143	0.03	6,611,906
1998	24,651	0.39	1,840	0.03	6,325,242
1999	35,079	0.56	2,301	0.04	6,271,524
2000	31,577	0.49	6,164	0.10	6,389,310
2001	29,538	0.47	2,924	0.05	6,314,117
2002	18,317	0.29	2,212	0.04	6,304,493
2003	20,621	0.33	2,576	0.04	6,317,752
2004	20,143	0.33	3,375	0.05	6,169,998
2005	22,961	0.37	2,617	0.04	6,146,907
2006	23,583	0.40	2,878	0.05	5,964,194
2007	17,678	0.29	2,947	0.05	6,015,938
2008	20,304	0.35	2,865	0.05	5,801,228

Data: General Estimates System (NASS GES), National Highway Traffic Safety Administration, 1990-2008. Annual Report File. Data are weighted to reflect all police-reported crashes nationwide.

Table 2

Characteristics of Police-Reported Fatal Crashes by Fog Status, United States, 1990-2012			
	Any Fog		All Crashes
	n (crashes)	% of all crashes	N
Month of Crash			
Dec-Feb	4,530	2.44	185,926
Mar-May	2,036	1.02	199,789
Jun-Aug	1,891	0.83	227,681
Sept-Nov	3,396	1.55	218,791
Day of Crash			
Mon-Fri	7,553	1.39	544,387
Sat-Sun	4,334	1.51	287,611
Time of crash			
Midnight-5:59am	5,051	2.91	173,836
6:00-11:59am	3,662	2.31	158,768
12:00-5:59pm	598	0.25	242,555
6:00-11:59pm	2,054	0.89	230,891
Number of Vehicles Involved in Crash			
1	6,753	1.40	482,201
2	4,277	1.44	296,882
3-5	758	1.47	51,586
6-9	57	4.37	1,303
10+	42	19.53	215
Roadway Alignment (1990-2009)			
Straight	6,965	1.27	548,174
Curve	2,883	1.52	189,377
Land Use (1990-2009)			
Rural	7,435	1.76	423,474
Urban	2,411	0.77	314,313
Intersection-Related* (1990-2009)			
Non-Intersection Non-Interchange	6,920	1.38	501,859
Intersection or Intersection-Related	2,028	1.17	173,691
Interchange or Interchange-Related	231	1.13	20,451

Roadway Type (1990-2009)

Divided with Median Barrier	584	0.98	59,309
Divided No Median Barrier	1,898	1.09	174,085
Not Divided	7,190	1.49	483,455
One-Way	43	0.50	8,639

Work Zone

Yes	225	1.35	16,720
No	11,662	1.43	815,414

School zone (1995-2009)

Yes	2	1.16	173
No	7,045	1.26	557,237

Highest Driver BAC in Crash

0	6,880	1.33	517,746
.01-.07	658	1.43	45,896
.08+	4,314	1.62	266,209

Speed-Related Crash (per NHTSA definition; 1990-2009)

Yes	3,463	1.52	228,398
No	6,422	1.25	512,761

Driver Sex (1990-2009)**

Male	4,311	1.35	320,426
Female	1,099	1.17	94,257

Driver Age (1990-2009)**

<20	862	1.46	59,043
20-29	1,887	1.54	122,614
30-39	1,086	1.32	82,026
40-49	736	1.17	62,985
50-59	462	1.18	39,310
60-69	215	0.93	23,235
70+	156	0.65	23,918

Type of vehicle (1990-2009)**

Car / SUV / Pickup / Van	4,846	1.34	360,854
Large Truck / Bus	338	1.53	22,091
Motorcycle	201	0.71	28,355

Data: Fatality Analysis Reporting System (FARS), National Highway Traffic Safety Administration, 1990-2012 Final Files, Except where noted (2009 Annual Report File when 2009 is final year in span).

Note: The coding of FARS variable *WEATHER* was changed in 2007. Until 2006, *fog* was a separate category of *WEATHER*. In 2007, the coding was modified so that the same category included *fog, smog, and smoke*. Thus, for years 2007-2009, crashes coded above as involving *fog* may have involved smog or smoke rather than fog.

* Years 1991 and later only, due to change in coding of variable.

** Includes only drivers involved in single-vehicle crashes and drivers classified as *striking* (vs. *struck*) in multi-vehicle crashes. Multiple-vehicle crashes in which more than one driver was classified as striking were excluded.

Table 3**Proportion of Fatal Crashes Involving Fog, by State/NHTSA Region, United States, 1990-2012**

	Any Fog		All Crashes
	n (crashes)	% of all crashes	N
REGION 1			
Connecticut	104	1.60	6,494
Maine	85	2.22	3,830
Massachusetts	125	1.33	9,426
New Hampshire	41	1.49	2,750
Rhode Island	39	2.34	1,669
Vermont	42	2.38	1,764
TOTAL REGION 1	436	1.68%	25,933
REGION 2 (excluding Virgin Islands, Puerto Rico)			
New Jersey	137	0.89	15,402
New York	340	1.05	32,526
Pennsylvania	606	1.93	31,410
TOTAL REGION 2	1083	1.37%	79,338
REGION 3			
Delaware	39	1.54	2,531
District of Columbia	14	1.38	1,015
Kentucky	337	1.93	17,432
Maryland	116	0.89	12,976
North Carolina	432	1.43	30,250
Virginia	183	0.97	18,826
West Virginia	269	3.33	8,077
TOTAL REGION 3	1390	1.52%	91,107
REGION 4			
Alabama	269	1.24	21,626
Florida	847	1.42	59,624
Georgia	457	1.48	30,931
South Carolina	151	0.76	19,807
Tennessee	419	1.71	24,559
TOTAL REGION 4	2143	1.37%	156,547
REGION 5			
Illinois	443	1.62	27,333
Indiana	296	1.60	18,517
Michigan	376	1.44	26,052
Minnesota	215	1.92	11,196
Ohio	339	1.22	27,705
Wisconsin	370	2.50	14,789
TOTAL REGION 5	2039	1.62%	125,592

REGION 6 (excluding Indian Nations)			
Louisiana	400	2.19	18,295
Mississippi	210	1.28	16,462
New Mexico	36	0.41	8,860
Oklahoma	154	1.07	14,361
Texas	1,062	1.53	69,521
TOTAL REGION 6	1862	1.46%	127,499
REGION 7			
Arkansas	180	1.43	12,564
Iowa	195	2.19	8,890
Kansas	130	1.44	9,057
Missouri	386	1.79	21,534
Nebraska	88	1.69	5,211
TOTAL REGION 7	979	1.71%	57,256
REGION 8			
Colorado	86	0.71	12,064
Nevada	20	0.30	6,732
North Dakota	41	1.89	2,164
South Dakota	80	2.51	3,190
Utah	42	0.70	5,983
Wyoming	33	1.10	3,005
TOTAL REGION 8	302	0.91%	33,138
REGION 9 (excluding Pacific Territories)			
Arizona	25	0.13	19,724
California	1,001	1.25	79,864
Hawaii	7	0.26	2,729
TOTAL REGION 9	1033	1.01%	102,317
REGION 10			
Alaska	22	1.29	1,709
Idaho	53	1.06	5,020
Montana	40	0.87	4,604
Oregon	256	2.71	9,433
Washington	249	1.96	12,694
TOTAL REGION 10	620	1.85%	33,460

Data: Fatality Analysis Reporting System (FARS), National Highway Traffic Safety Administration, 1990-2012 Final Files.

Note: The coding of FARS variable *WEATHER* was changed in 2007. Until 2006, *fog* was a separate category of *WEATHER*. In 2007, the coding was modified so that the same category included *fog*, *smog*, and *smoke*. Thus, for years 2007-2009, crashes coded above as involving *fog* may have involved smog or smoke rather than fog.

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