CARE IMPACT Study of Drowsy Driving (DrD) in Alabama

2014-2018 Data Updated with 2017-2021 Data

David B. Brown, PhD, P.E.
brown@cs.ua.edu

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1.1 Introduction

According to a NCSDR report (NCSDR): "NHTSA [national] data indicate that in recent years there have been about 56,000 crashes reported by police annually that cited driver drowsiness/fatigue [Drowsy Driving, which we are calling DrD]. See listing of all references in Section 1.2. Annual national averages of roughly 40,000 nonfatal injuries and 1,550 fatalities result from these crashes, a ratio of close to one in every 26 crashes. It is widely accepted by traffic safety professionals that these statistics underreport the extent of DrD crashes. These statistics were checked against those obtained in Alabama and accessed by CARE (discussed below), and our conclusion is that all of the articles are still quite applicable, while the AAA Report is the most current and comprehensive.

To bring the above home to Alabama, over the five calendar years of 2017-2021, under the category on the crash report form heading of "Drowsy Driving Asleep-Fatigue" law enforcement crash records reported 168 Fatal Injury crashes; 1,471 Suspected Serious Injury crashes; 3,043 Suspected Minor Injury crashes; 2,083 Possible Injury crashes; and 10,572 Property Damage Only crashes, for a total of 17,792 DrD crashes. The estimate fatal to total crashes for Alabama is one in every 106 crashes, which is considerably smaller than that estimated Nationally. This averages to a total of 3,558 DrD crashes in Alabama per year. The table below indicates the actual number of crashes in each year of the study. This is further discussed in conjunction with attribute C003 (Crashes per Year) below.

Frequency of DrD Crashes by Year

Year	**Number**	**% of Total**	**All Crashes**	**Ratio (1 DrD in X Crashes)**
2017	3649	20.51	157,203	43.08
2018	3747	21.06	160,163	42.74
2019	3686	20.72	159.125	43.17
2020	3160	17.76	134,212	42.47
2021	3550	19.95	151,954	42.80
TOTAL	**15,770**	**100.0%**		

After the references given in the next section, this report will continue by presenting the major findings organized by the following major groupings of the attributes: Geographical, Time and Weather, Driver Related, Severity and Vehicles. The findings from these CARE IMPACT studies are presented in five sections presenting the displays for each IMPACT run. A final section presents an example of the hotspot outputs that can be generated for DrD hotspots over the state. These high crash locations are quite important since it has been determined (reference: SJ: National Article) that characteristics of *the roadway itself can tend to produce an affinity toward drowsiness.*

Most people have had times when they are a bit tired when reading a book or watching TV that they slip into a sleep without knowing it until they wake up. If this has happened to you, you are typical since this is not unusual. The very same thing happens to drivers under similar circumstances. Driving is not reading a book, but there are many psychological aspects of the two activities that are quite similar. This is especially true on long trips where the driver has had a chance to get drowsy. It is particularly applicable in rural area in which the roadway environment is quite uniform and does not change as often as in the case of urban driving. As you go through the various aspects of this report note those circumstance that apply to you and resolve what countermeasures you are going to take when they apply. Just knowing the problem and resolving not to go to sleep is not an effective countermeasure.

1.2 References

Primary National Study Source: AAA Foundation for Traffic Safety
Countermeasures to Reduce Drowsy Driving: Results of a Literature Review and Discussions with Experts - AAA Foundation for Traffic Safety
607 14th Street NW, Suite 201, Washington, DC, 20005

SJ: National Article Reference:
https://www.sleepjunkie.org/falling-asleep-wheel/

WRBL: Local News Referencing the Article Above:
https://www.wrbl.com/news/highway-to-south-texas-rated-worst-for-sleepy-driver-deaths-holiday-travelers-warned/?utm_medium=social&utm_source=facebook_WRBL_News_3

NCSDR: National Center on Sleep Disorders Research (NCSDR) and NHTSA:
Drowsy Driving and Automobile Crashes; NCSDR/NHTSA Expert Panel on Driver Fatigue and Sleepiness;
https://one.nhtsa.gov/people/injury/drowsy_driving1/drowsy.html#EXECUTIVE%20SUMMARY

NHTSA: NHTSA home page for drowsy driving (links to research):
https://one.nhtsa.gov/Driving-Safety/Drowsy-Driving/Research-on-Drowsy-Driving

1.2.1 Recommendations to reduce DrD Crashes

The following were suggested by AAA, although comments have been added to many of them.

- Pay Special attention to getting adequate (normal) sleep the night before a long trip.
- Napping helps if the driver did not get the normal amount of sleep, but it is no substitute for the normal sleep that the driver is used to.
- Consuming higher amounts of caffeine than is normal keeps many people awake and sharp, but it does not work with everyone, especially if that is the norm. Having a very cold coke (or other caffeinated soft drink) handy and taking a big swallow of it at the first signs of dozing might help, but it is not an effective long-term countermeasure.
- Some Advanced Driver Assistance Systems (ADAS) are particularly directed at faults such as DrD. If this has been a problem in the past for given drivers, they should seek out such devices when they purchase a new car.
- Some roadway modifications, such as rumble strips, may serve to wake drivers up when they are approaching a dangerous situation. This may also be implemented by light combinations to get the drivers' attentions.
- Drivers with sleep disorders should avoid driving on long trips. If you can easily fall asleep while someone else is driving, this is a sure sign that special attention must be given to your not taking over the driving task on long or boring trips.

- Drowsy Driving laws only work as a deterrent, and that may be after the fact. Many drivers are in denial when it comes to their possibility of losing control.

The following countermeasures were suggested by the IMPACT analyses. They apply especially to drivers who have had problems with DrD in the past. If possible, an alternative driver should be engaged if the current driver has had any DrD experiences in the past.

Situations to Avoid

- C010. Rural roads, especially those that have become boring to drive due to frequent use by the current driver.
- C011. Interstates, State and County roads on which the driver has had any indication of DrD in the past.
- C028. Mileposted routes that have demonstrated a high frequency of DrD crashes in the past. See also Sections 8 and 9.
- C110. Driving long distances from the driver's residence.
- C004. Longer trips in the months of April through August. Be aware of the increased danger if there have been recent time changes to daylight savings time.
- C006. Weekend travel, in that Saturday and Sunday are over-represented with DrD crashes. These are days to avoid for the following reasons: (1) you could be one DrD to add to its over-representations on weekends, (2) other causes, such as alcohol and non-alcohol drugs make DrD and other types of crashes more frequent and more lethal, and (3) many others on the road over the weekends are involved in the types of travel that are not normal for them, including late-night travel. See next recommendation.
- C008, C031 Time of Day. Ten PM and after, and the later hours, including late early morning until 9 AM are over-represented. DrD happens during the day, but not nearly as much as late night and early morning hours.
- C032. Fog is in a category of its own, and its ability to make drivers doze off is proven. It is best, if at all possible, to avoid driving in fog.
- C015. Driver faults that are most found in combination with DrD include the following: Ran off Road, DUI, Crossed Centerline, Traveling Wrong Way/Wrong Side, Over Speed Limit, and Over Correcting/Over Steering. Avoiding these will reduce DrD.
- C107. If you are, or if you are riding with, a driver aged 19 through 29, they are all over-represented in DrD. Special provisions are required to keep them awake, or relieve them with an alternative driver in no longer than an hour.
- C122-123. The use of any level of alcohol or non-alcohol drugs dramatically increases the DrD chances. Do not use these substances before driving, and do not ride with anyone who does.
- C129. Do not count on the curvature or any other roadway characteristic (or lack thereof) to keep you awake. Over-representations occur at most all of these features.
- C224. Do not exceed the speed limit thinking that you will beat falling asleep in this way. Obviously, many DrD drivers were driving well over their respective speed limits, and it did not prevent them from getting in a DrD crash, many at high severity.
- C101. Pickup drivers should investigate the various possibilities to determine why their vehicle type is over-represented in DrD crashes.

- C208. Drivers of older model year vehicles should realize that their model years tend to be over-represented in DrD crashes.

Situations to Engage

- C027. Urban roadways with sufficient intersections to keep the driver awake.
- A good night's sleep the night before. In this regard it is best to distract your mind from the excitement of the next-days trip. This might be done with a book or an iPhone.
- Have interesting conversations with the driver to assure s/he is not becoming bored.
- Watch the driver and if you see any signs of drowsiness, offer to take the wheel. This should be well received if the driver is ready for a nap.

IMPACT Study Findings

The detailed (IMPACT analyses) for the summaries that are given in this section are contained in the sections that follow, referenced by the crash attribute numbers (Cnnn). The acronym we will use for Drowsy Driving will be DrD, to distinguish it from that commonly used for Distracted Driving (DD). Parts 2.1 and 2.2 have been skipped in the next section in order to keep the findings sections numbered the same as the corresponding IMPACT outputs in the next major section.

2.3 Geographical Findings

- C010 Rural or Urban. Rural areas had over twice their expected proportion with over half (52.24%) of the DrD crashes being in rural areas, while the non-DrD crashes only had about 22.79% in the rural areas. The reason for this is fairly obvious – observations tend to get uninteresting when the roadside scenery is not changing, and rural areas tend to involve longer trips. The recommendation to road maintenance would be to place some type of diversion on those highways that are exhibiting excessive DrD crashes. See C028 in Section 3, below. [Explanation on IMPACT: The red background on an IMPACT item indicates that it has an Odds Ratio of at least 2; in this application, this means that the proportion of the DrD crashes is twice that of the non-DrD crashes, which is extremely significant statistically. Impressing upon drivers of the fact that these roads exhibit more than expected DrD crashes would seem to go a long way to reducing DrD crashes on them.]
- C011 Highway Classification. This reflects the rural/urban finding above. Interstates have been found to be particularly vulnerable to DrD-caused crashes. However, in Alabama, State and County roads are also significantly over-represented. It may be for different reasons. The boring nature of driving on Interstates is obvious; however, they may be much more forgiving than State and County roads when it comes to vehicles veering off the roadway.

- C027 At Intersection. Intersections occur much more often in urban areas, so the rural tendency of DrD crashes is supported by the finding of under-representation at intersections. It might also be reasoned that the intersection itself provides a "wake-up call" for the driver.
- C028 Mileposted Routes. This is one of the most important findings in that it differentiates the particular roadways that exhibit a proclivity toward DrD. The SJ report (referenced below) showed clearly that some roadway types are more prone to create DrD conditions than others. Findings from Alabama confirm this result, showing that some roadways have up to five times the relative proportion of DrD crashes than those of their non-DrD crashes. The IMPACT display for C028 below shows the top 27 DrD Max Gain roadways, where the Max Gain is the number of crashes that would be reduced if the proportion of DrD crashes was reduced to the same as the proportion of non-DrD crashes. The highest of these was I-65, which had a max gain of over 500 crashes (over the five-year period of the study). Recognize that the Max Gain will be affected by the length and volume of traffic on the subject roadway. This sensitivity to ADT and segment length does not affect the Odds Ratio, which compares the proportion of DrD against non-DrD crashes <u>on that same roadway segment or intersection</u>. An example Hotspot analysis for DrD crashes on I-65 is given in Section 8, the final section of this report. This is an excerpt of the analysis that is available to all law enforcement in Alabama via CARE. Recall that the red background for lines in the table indicates that the item's DrD proportion is at least twice that of its non-DrD proportion. See Section 8 for a detailed example.
- C033 Locale. As expected Open Country is the only Locale that is significantly over-represented.
- C110 Driver Residence Distance. While not as large an Odds Ratio as many of the items given above, the Greater than 25 Miles (from home) is over a third higher than what would be expected from the proportion of non-DrD crashes, which is still statistically significant at a high level.

2.4 Time and Weather Findings

- C003 Year. Examining the Subset Frequency column shows a decrease of nearly 99 DrD crashes over the five years. There was an increase primarily up to 2016, and it has dropped off since then. The Odds Ratios being close to 1 indicate that the proportion to DrD crashes has remained stable over the five-year period of the data – it has neither increased nor decreased more than the overall non-DrD crash proportion, which is a good proxy for overall traffic volume.
- C004 Month. It would be expected that the months of the longer trips would be over-represented in DrD crashes. This over-representation starts in April, but the difference is not significant. It becomes significant for May, June, July and August, which are the expected vacation months. These are also months with longer days that could involve people in longer trips. Public PI&E warnings regarding the dangers of drowsy driving should be timed appropriately. However, the average DrDs per month is 1,483 DrD

crashes, and even the lowest months have well over 1,000 DrD crashes, so it is important to keep the recognition of this problem in front of the public all year round.

- C006 Day of the Week. Clearly Saturday and Sunday are the bad days for DrD crashes, which would be expected since the bulk of the traffic during the week is for commuting and delivery. Also, see C122 and C123, (in Section 5) which show the high correlation of DrD with Impaired Driving (ID/DUI).
- C008 Time of Day. Ten PM and after, and the later hours, including late early morning until 9 AM. The chart is totally informative. DrD happens during the day, but not nearly as much as late night and early morning. This also shows the correlation with ID/DUI and also with not getting enough sleep to get drivers through the night.
- C031 Lighting Conditions. It is not just the time, but also the presence or absence of light. Note Dark-Roadway Lighted has only 91 crashes, while the number for Dark, Roadway Not Lighted is 4,665. Roadway Lighted must be qualified by the fact that these conditions exist mainly in the urban rather than the rural areas, so it is the urban driving as well as the lighting. These things all work together, and it is difficult to analyze each of them independently.
- C032 Weather. What is it about rain that keeps us awake? – perhaps the fear that if we doze off the consequences will be obvious. It would be good if we could maintain this fear into clear weather as well. For right now it appears that bad weather is a positive factor in reducing the number of DrD crashes. Fog is in a category of its own and its ability to make drivers doze off is proven by the Odds Ratio of 2.598. It is best, if at all possible, to avoid driving in fog. The combined dozing off and inability to see ahead is a deadly combination.

2.5 Driver Related Findings

- C015 Primary Contributing Circumstances. Once narrowed down, this attribute enables a good perception of what is going on at the same time as DrD, which might be more instrumental than the DrD itself. These include the following: Ran off Road, DUI, Crossed Centerline, Traveling Wrong Way/Wrong Side, Over Speed Limit, Other - No Improper Driving, and Over Correcting/Over Steering.
- C017 First Harmful Event. There is nothing unexpected here. When a person loses consciousness behind the wheel, the results are random. If there happens to be a vehicle in its path, hitting it may be avoided in some cases by evasive action on the part of the other driver – perhaps taking any evasion, even if resulting in a crash – to avoid the perceived worst case scenario. Thus, this attribute generally demonstrates the objects that are the first thing encountered by a vehicle that randomly departs the roadway.
- C023 Manner of Crash. The major finding here is obviously that DrD crashes are dominated by single vehicle crashes, which is consistent with many of the findings above. Even though there are some large numbers on some of the two-vehicle Manner of Crash types, most of them are under-represented, indicated by an Odds Ratio less than 0.5.
- C052 Number of Vehicles. This quantifies the dominance of single-vehicle crashes at 67.84% of all DrD crashes. Those that do involve more than one vehicle are distributed

in a diminishing way over the number of vehicles involved as would be expected for non-DrD crashes.

- C104 Causal Unit (CU) Left Scene. The proportion of DrD crashes where the causal driver left the scene is one of the lowest left-scene proportions found for all crash types. Perhaps this is due to their not being fully cognizant of what went on prior to the crash. Also, the increased severity of DrD crashes would make many of them impossible to drive away from.
- C107 CU Driver Raw Age. The youngest drivers (aged 16-18) are either significantly under-represented (16-17) or as expected (18). After that, from aged 19 through 29, they are all over-represented. This is evidence of a correlation with alcohol and drugs, and it also indicates that the 16-18 year olds are typically not driving on the longer trips in which DrD becomes problematic. We would also expect the very youngest drivers to have a high level of excitement from driving that would make sleep less likely.
- C109 CU Driver Gender. Very clearly, males are significantly over-represented in DrD crashes, with an Odds Ratio (1.402) of about 40% higher than expected. The reason for this is not clear, but it probably is relates to males being the primary drivers on longer trips and those that go late into the night (see time of day C008 in Section 4).
- C115 CU Driver CDL Status and C080 CMV Involved. These two attributes are considered together to give the most accurate possible picture of CMV involvement. CMV operation requires a Commercial Drivers' License (CDL), which is the subject of C115. Adding the Not Applicable with the Unknown gives about 94% that are not CMV, from which CMV involvement can be inferred to be about 6%. This is confirmed from the C080 value of 5.95% the item where CMV Involved is indicated. This does not appear to be a large percentage, but it must be compared to the proportion of their crashes in general (in this case their non-DrD crashes). In both cases we see that the CMV involvement in DrD crashes is significantly higher than that expected. It is slightly above 15% higher proportion as given by the C080 result. C115 indicates that this over-representation is much higher for those whose licenses are not Current/Valid. While we might expect professional drivers to have relatively fewer DrD crashes, we must recognize that they are generally involved in far more longer trips than is true of non-CDL drivers. The conclusion here is that DrD countermeasures need to be emphasized as much with CMV drivers as with anyone else; and perhaps the laws requiring them to rest at certain intervals need to be better observed and enforced.
- C122 CU Officer Opinion Alcohol. The effect of alcohol and drugs on creating drowsy drivers cannot be disputed. Here the proportion of those who were using alcohol is 60.3% higher for DrD crashes than for non-DRD crashes in general.
- C123 CU Officer Opinion Drugs. (Non-alcohol) drugs are more over-represented than is alcohol. The proportion of drivers using drugs being DrD is close to four times higher than those not using drugs (Odds Ratio = 3.536%).
- C129 Vehicle Maneuvers. Falling asleep at the wheel can be described as an unforced error (in tennis terminology). After that, what happens is a random, uncontrolled event. It seems that if the environment is a curve, there is an excellent chance it will result in a crash (Odds Ratio = 2.386). Even worse is if the vehicle departs the roadway (Odds

Ratio 3.026). But the overwhelming proportion of DrD crashes (81.93%) are on straight and level roadways where there is still 1.519 times the probability of getting in a DrD crash, perhaps due to the boring nature of Strait and Level.

2.6 Findings Related to Severity

- C025 Crash Severity. All of the highest injury categories (Fatal, Incapacitation and Non-Incapacitating) are highly over-represented, with two of them over twice the proportion that occurs for non-DrD crashes. Fatal is the smallest of these, but its proportion is still 1.694 (Odds Ratio) times the non DrD crashes. Some possible reasons for these higher severity will be given in the next attributes considered in this section. We also postulate that the consequences of crashes are more severe when drivers do not have awareness to take defensive actions once the inevitable crash event sequences are in process. Very few other crashes have this characteristic. There were 168 fatal DrD crashes during the five years of this study.
- C038 Adjusted EMS Arrival Delay Time. The 0 to 5-minute delay from crash time to ambulance arrival is significantly under-represented, as is the 6-10-minute delay. After that, all of the delay categories are over-represented. Items with less than 20 occurrences are not processed with a statistical test, but it seems likely that all of the delay times above 10 minutes are significantly over-represented. We expect that this is due to the rural nature of the large majority of these crashes. The times being analyzed here are from the crash report to the time that the ambulance arrives. There is no accounting for the delay between the crash itself and when it is reported. This is especially relevant in late night crashes, which characterize DrD crashes. Certainly, rural roads that have relatively few vehicles late at night would be susceptible to this problem. It would be expected in the many single-vehicle DrD crashes that some might run off the road and not be discovered for an extended time. This certainly contributes to the increases in high-severity crashes that was observed in C025.
- C060 Number Injured Including Fatalities. Single injury crashes have the highest over-representation. However, all of the multiple injury classifications are over-represented up to and including 7 injuries. The number of instances drops off exponentially after one injury, and the No Injuries category is significantly under-represented.
- C224 CU Estimated Speed at Impact. This is the largest single factor that determines whether crashes result in fatalities or not. In this case the average speed at impact of the DrD crashes was estimated to be 51.3 MPH, while that of the non-DrD crashes was 32.1 MPH. It has been determined in a large number of former studies within Alabama that, above 40 MPH, each increase in the impact speed of 10 MPH doubles the probability of that crash being fatal. Since this doubling is from its next lower 10 MPH-lower speed estimate, this is an exponential increase. So, for example, if the probability of a crash being fatal at 40 MPH is 1%, the probability at 50 MPH would be 2%, and the probability at 60 MPH would be 4% , and the probability at 70 MPH would be 8%, doubling from its previous value for each increase in 10 MPH (hypothetical numbers for illustration only). This reflects the laws of physics and kinetic energy. Display C025 shows that the probability of a DrD crash being fatal is 0.94%, while that same probability for a non-

DrD crash is only 0.56%. While the doubling effect does not apply to averages, this difference of 38% is quite significant.

2.7 Findings Related to Vehicles and Vehicle Ages

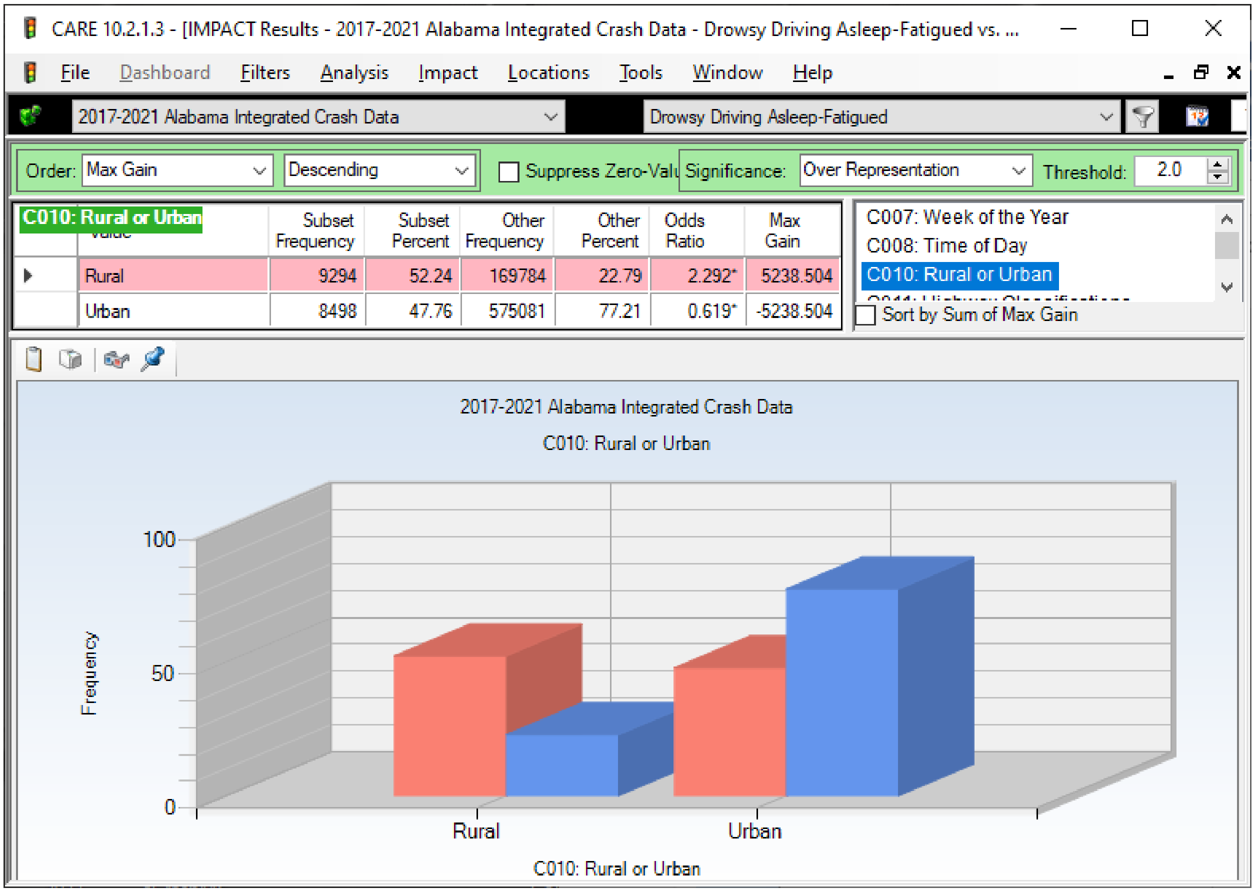
- C101 Causal Unit (CU) Type. Other than light pick-ups and passenger cars, there does not seem to be a correlation between the vehicle type that is causing or necessarily avoiding DrD crashes. Of course, it is the drivers that are prone to use these vehicles that might be over- or under-represented, as opposed to the vehicles themselves. Passenger cars with an Odds Ratio of 1.049 are close to the other over-represented vehicle types. However, there might be an inference that drivers of pick-up trucks are more inclined to DrD. Perhaps this has to do with the driver sitting higher off the roadway than is true in many of the other vehicle types. This needs more investigation because the over-representation of pick-ups is clearly demonstrated.
- C208 CU Model Year. Vehicle years that are significantly over-represented start at 2001 and go through 2005, with 2004 being the last of these that are statistically significant. Model years in 2013 and 2015 are significantly under-represented. It might be reasoned that some of the vehicles from 2007 and after have additional safety features that could prevent DrD crashes. In general, it is the older vehicles that have the higher chances of being involved in a DrD crash.

2.8 Hotspot Analysis

Hotspot analyses can be performed using a DrD filter for any type of roadway in Alabama. This filter will only allow DrD crashes to be considered in the analysis. Since Interstates and other mileposted routes tend to have more DrD crashes, hotspot analyses on these roadway types is considered to be most fruitful. However, certain segments within all road types could be over-represented in DrD crashes. This is where hotspot analysis is most important since there is no other way to identify such segments. Examples are given in the last section of this report, the first of which is the first hotspot segment found on I-65 (starting with milepost 0.0 near Mobile). The crash frequency criterion for this analysis was all hotspots that had more than 50 DrD crashes in a ten-mile segment. It is interesting that the first such hotspot could not be found on I-65 in less than 40 miles from Mobile. This is not saying that no DrD crashes occurred; they just were not of such a concentration to qualify according to the hotspot criterion given above. Perhaps it takes 40 miles for most drivers to become drowsy, and taking a break at least every 50 miles (or hour of driving) would be an excellent recommendation.

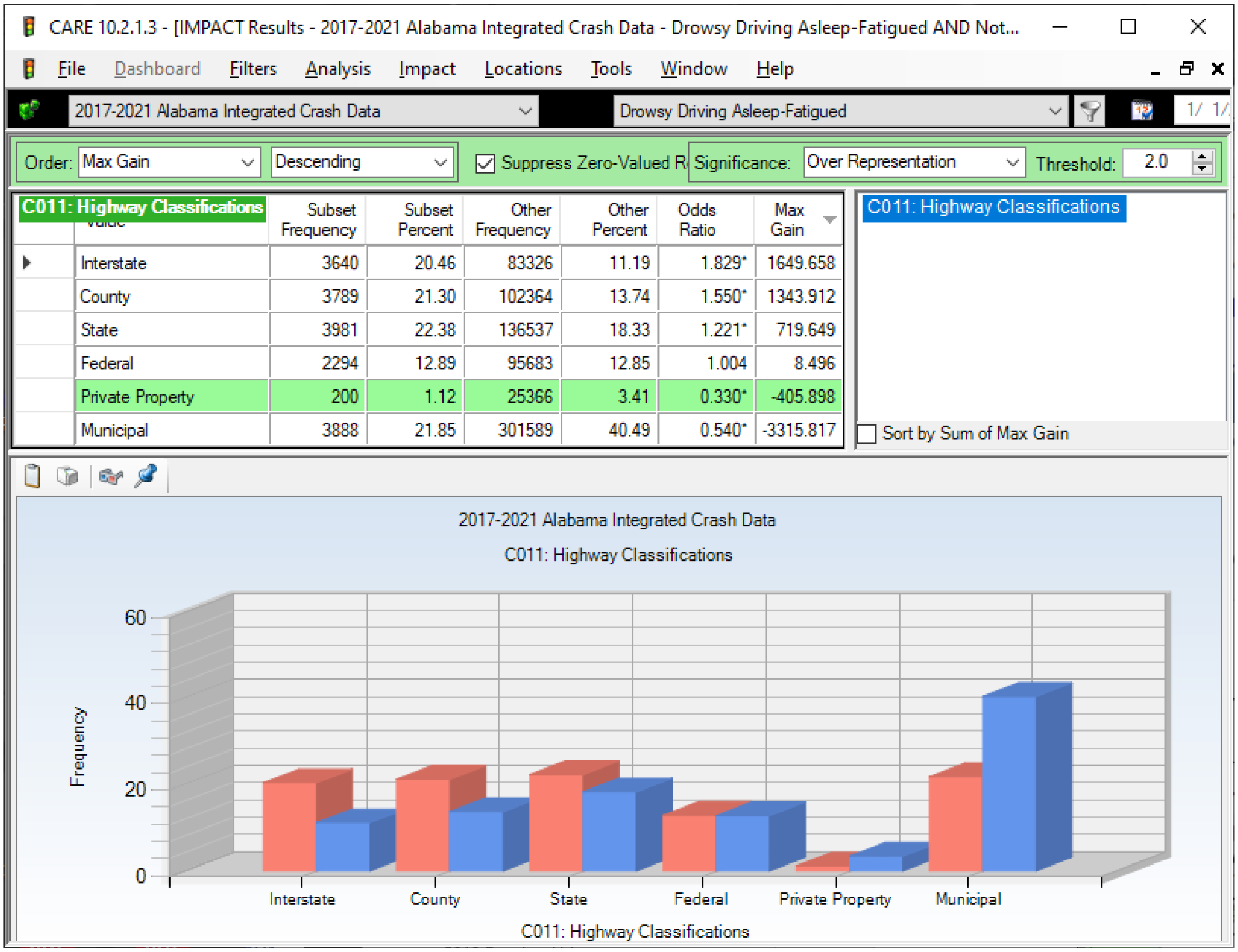
3. IMPACT Displays – Geographical/Roadway 10, 11, 13, 27, 28, 33, 110

C010 Rural or Urban



Rural roads are over-represented by over twice (Odds Ratio 2.292) of urban roadways. This is likely due to the increased traffic and other environmental features tend to keep drivers awake. There is also the fact that rural trips tend to be longer than urban, giving drivers a longer chance to get bored and doze off.

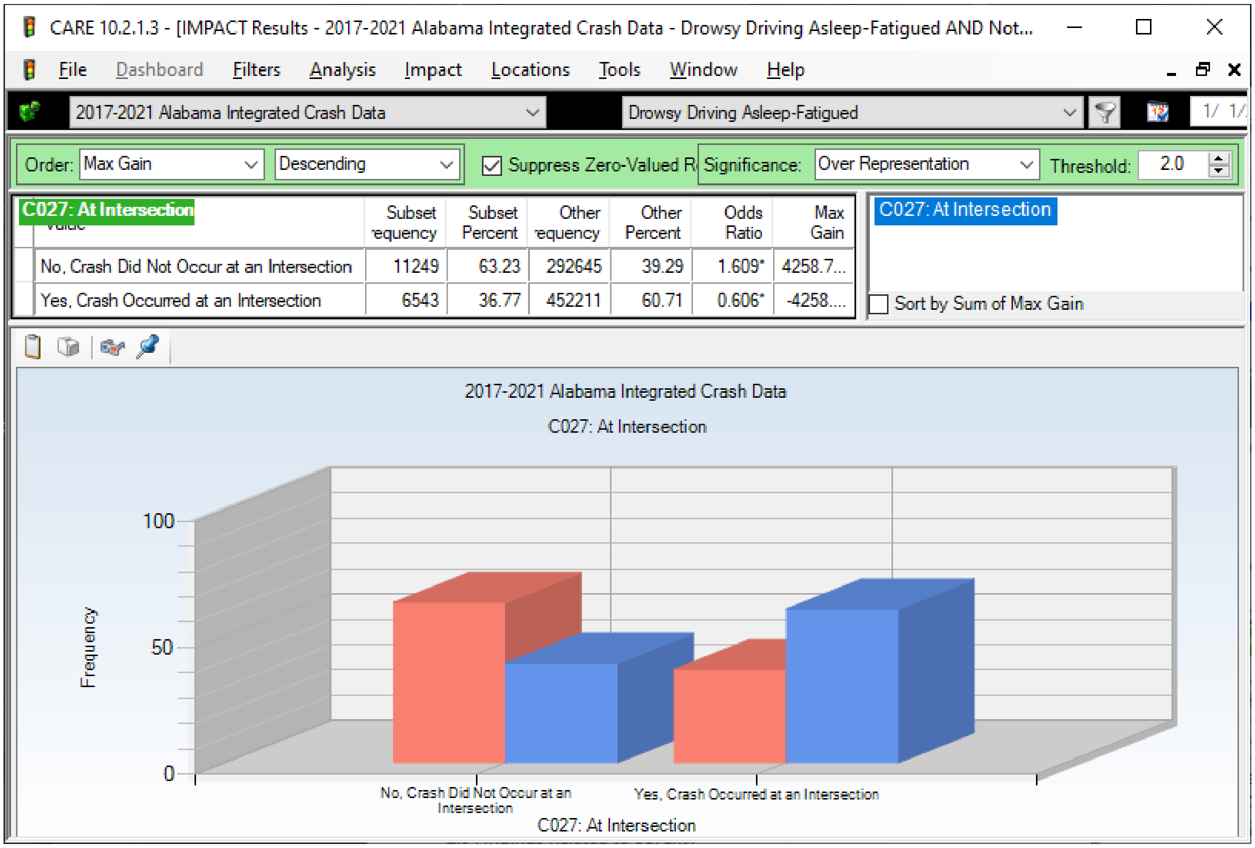
C011 Highway Classification



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Interstate	3640	20.46	83326	11.19	1.829*	1649.658
County	3789	21.30	102364	13.74	1.550*	1343.912
State	3981	22.38	136537	18.33	1.221*	719.649
Federal	2294	12.89	95683	12.85	1.004	8.496
Private Property	200	1.12	25366	3.41	0.330*	-405.898
Municipal	3888	21.85	301589	40.49	0.540*	-3315.817

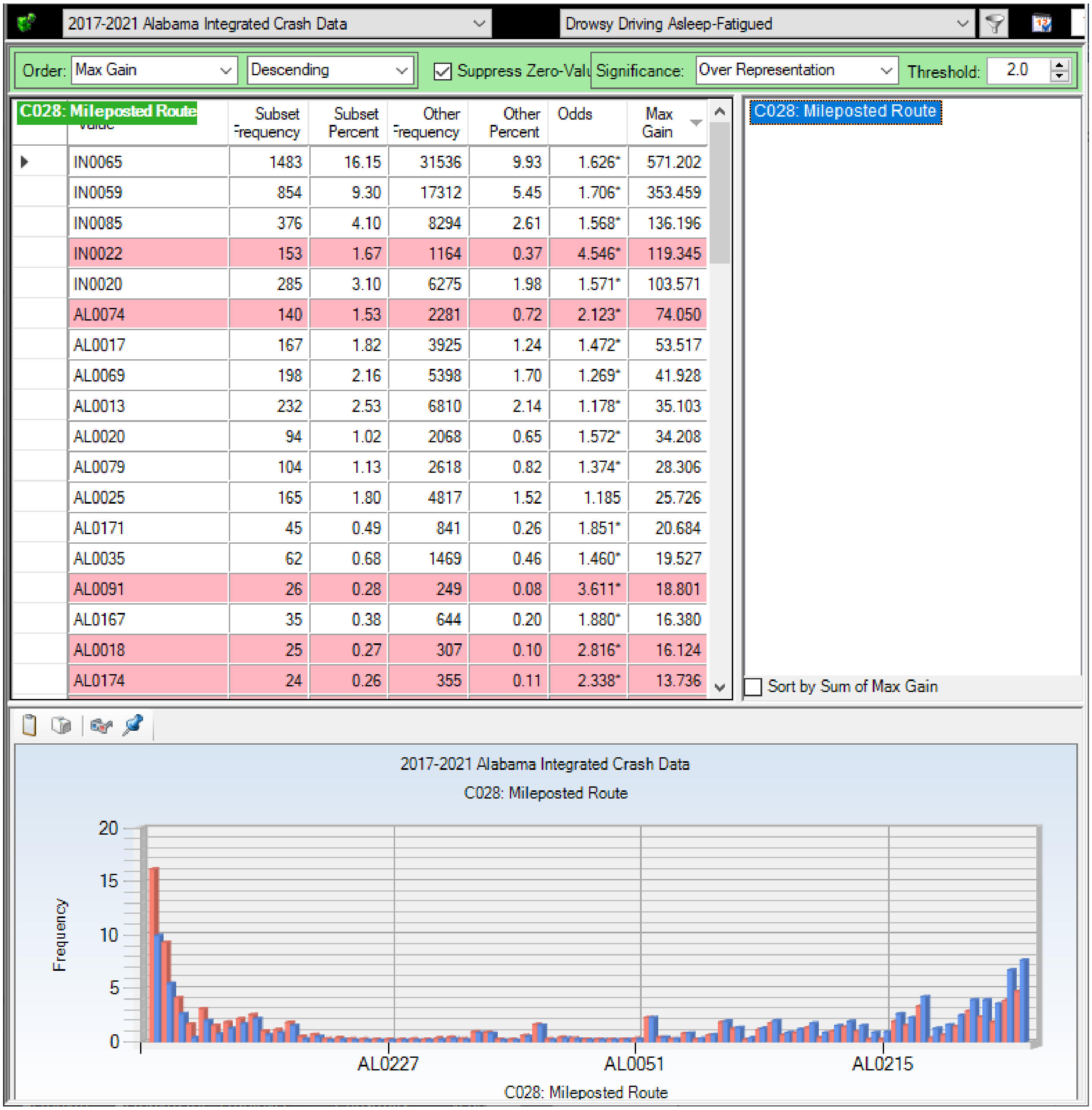
As would be expected, those predominantly rural highways that have little ongoing challenges and environmental distractions have the higher odds ratios. Intestates had the highest, but surprisingly, County Roads came in a close second. This demonstrates that DrD can be a problem even when the roadways are challenging to drive.

C027 At Intersection



It is reasonable to see that Intersections, in and of themselves, would not cause DrD crashes. Generally, the drivers would have to be DrD as they entered the intersection. This occurred in close to 40% (36.77%) of the DrD crashes, which resulted in 6,543 DrD crashes in the five-year period.

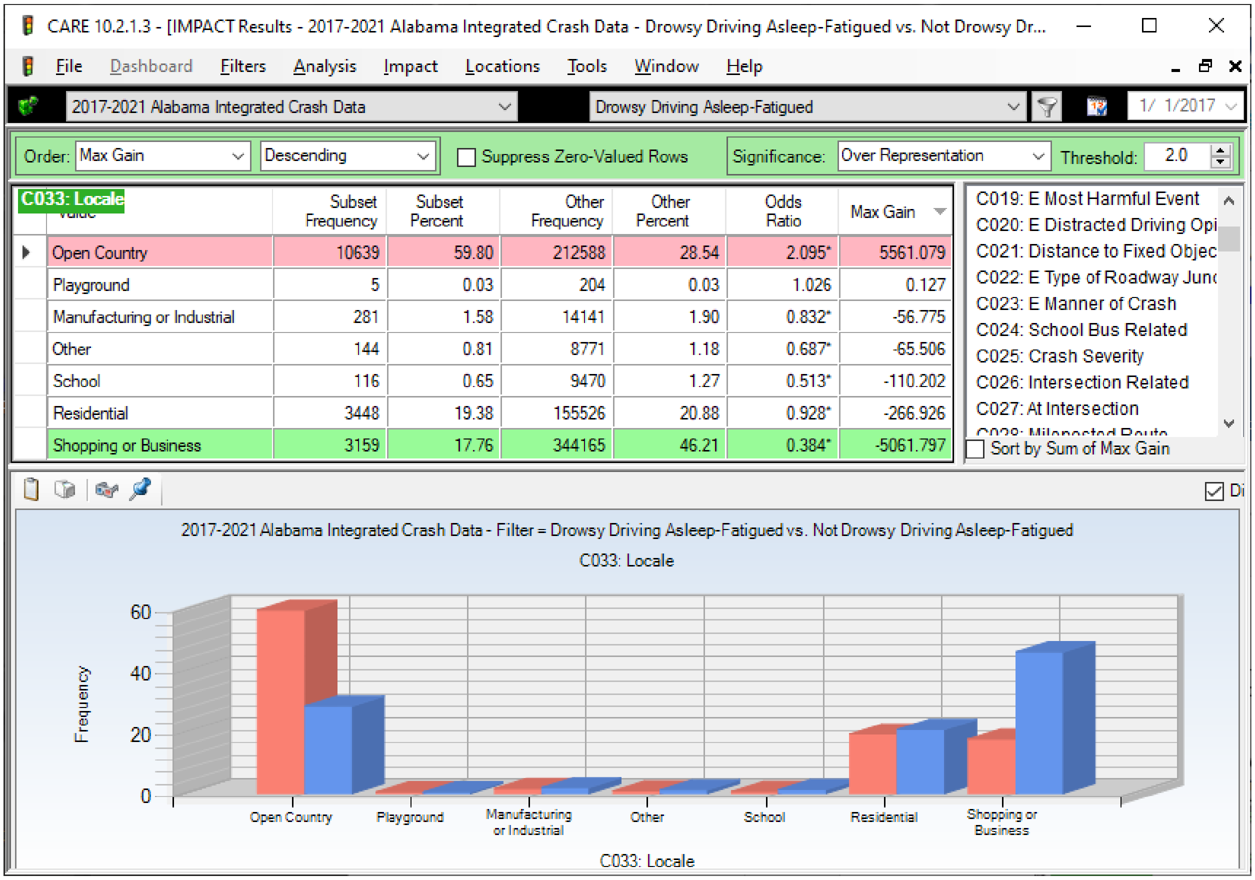
C028 Mileposted Routes



C028: Mileposted Route Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
IN0065	1483	16.15	31536	9.93	1.626*	571.202
IN0059	854	9.30	17312	5.45	1.706*	353.459
IN0085	376	4.10	8294	2.61	1.568*	136.196
IN0022	153	1.67	1164	0.37	4.546*	119.345
IN0020	285	3.10	6275	1.98	1.571*	103.571
AL0074	140	1.53	2281	0.72	2.123*	74.050
AL0017	167	1.82	3925	1.24	1.472*	53.517
AL0069	198	2.16	5398	1.70	1.269*	41.928
AL0013	232	2.53	6810	2.14	1.178*	35.103
AL0020	94	1.02	2068	0.65	1.572*	34.208
AL0079	104	1.13	2618	0.82	1.374*	28.306
AL0025	165	1.80	4817	1.52	1.185	25.726
AL0171	45	0.49	841	0.26	1.851*	20.684
AL0035	62	0.68	1469	0.46	1.460*	19.527
AL0091	26	0.28	249	0.08	3.611*	18.801
AL0167	35	0.38	644	0.20	1.880*	16.380
AL0018	25	0.27	307	0.10	2.816*	16.124
AL0174	24	0.26	355	0.11	2.338*	13.736

Roadways with zero or very few DrD crashes were removed from this analysis. Roadways with the highest total volumes (I-65, I-59 and I-85) had the highest percentages of DrD crashes. This would seem to be because they are significantly longer routes, and thus many of their drivers would have a greater opportunity to become DrD. See Section 8 for more details of location analyses.

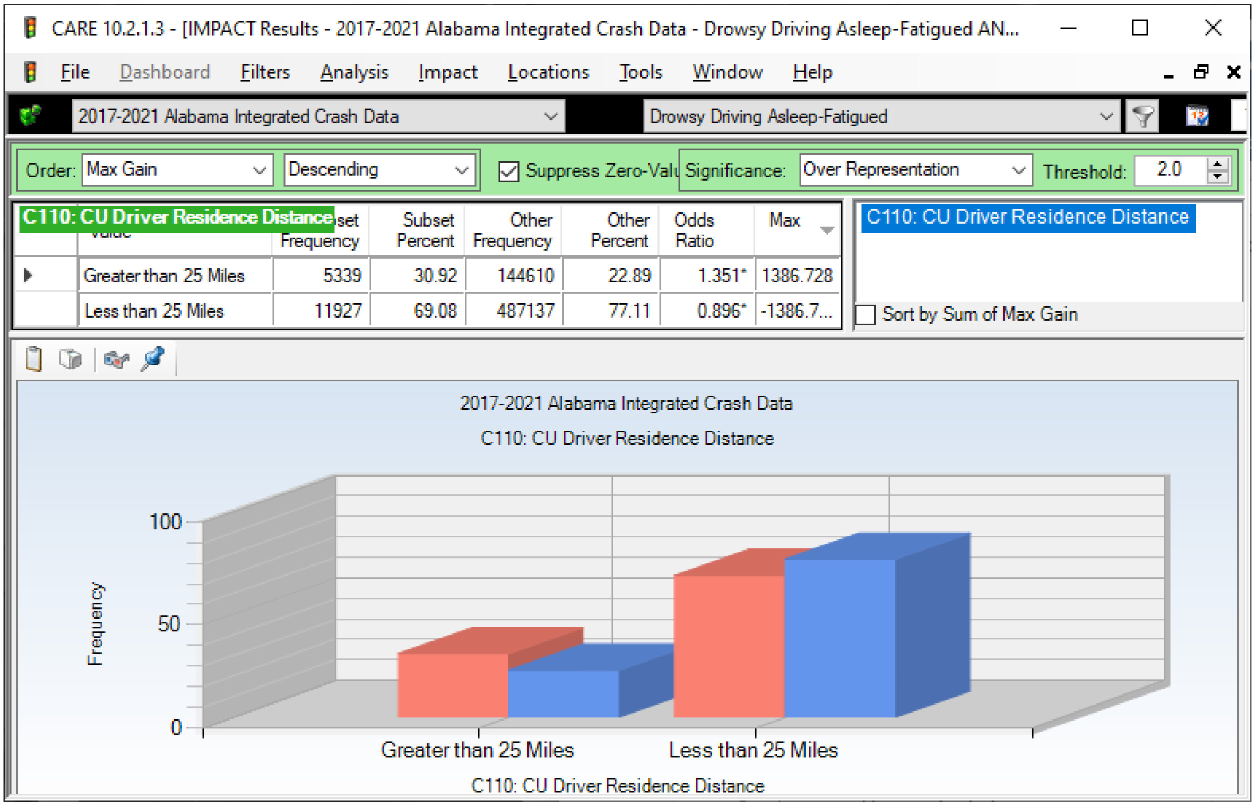
C033 Locale



C033: Locale Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Open Country	10639	59.80	212588	28.54	2.095*	5561.079
Playground	5	0.03	204	0.03	1.026	0.127
Manufacturing or Industrial	281	1.58	14141	1.90	0.832*	-56.775
Other	144	0.81	8771	1.18	0.687*	-65.506
School	116	0.65	9470	1.27	0.513*	-110.202
Residential	3448	19.38	155526	20.88	0.928*	-266.926
Shopping or Business	3159	17.76	344165	46.21	0.384*	-5061.797

This result is consistent with the Rural/Urban, Highway Classification and other general environmental factors.

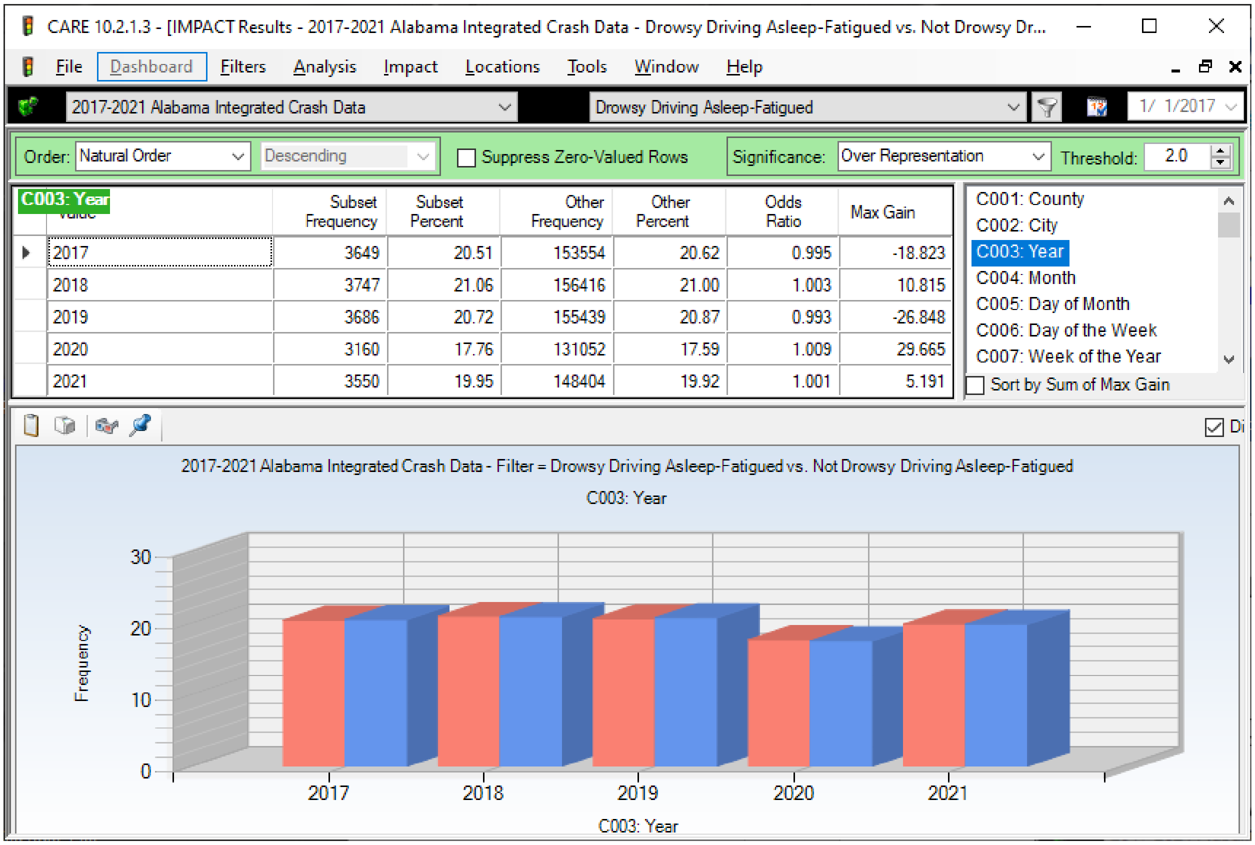
C110 CU Driver Residence Distance



While not as dramatic as many of the other comparable factors, it is reasonable to see that the longer trips (greater than 25 miles) are over-represented in DrD crashes.

4 IMPACT Displays – Times, Weather and Lighting 3, 4, 6, 8, 31-32

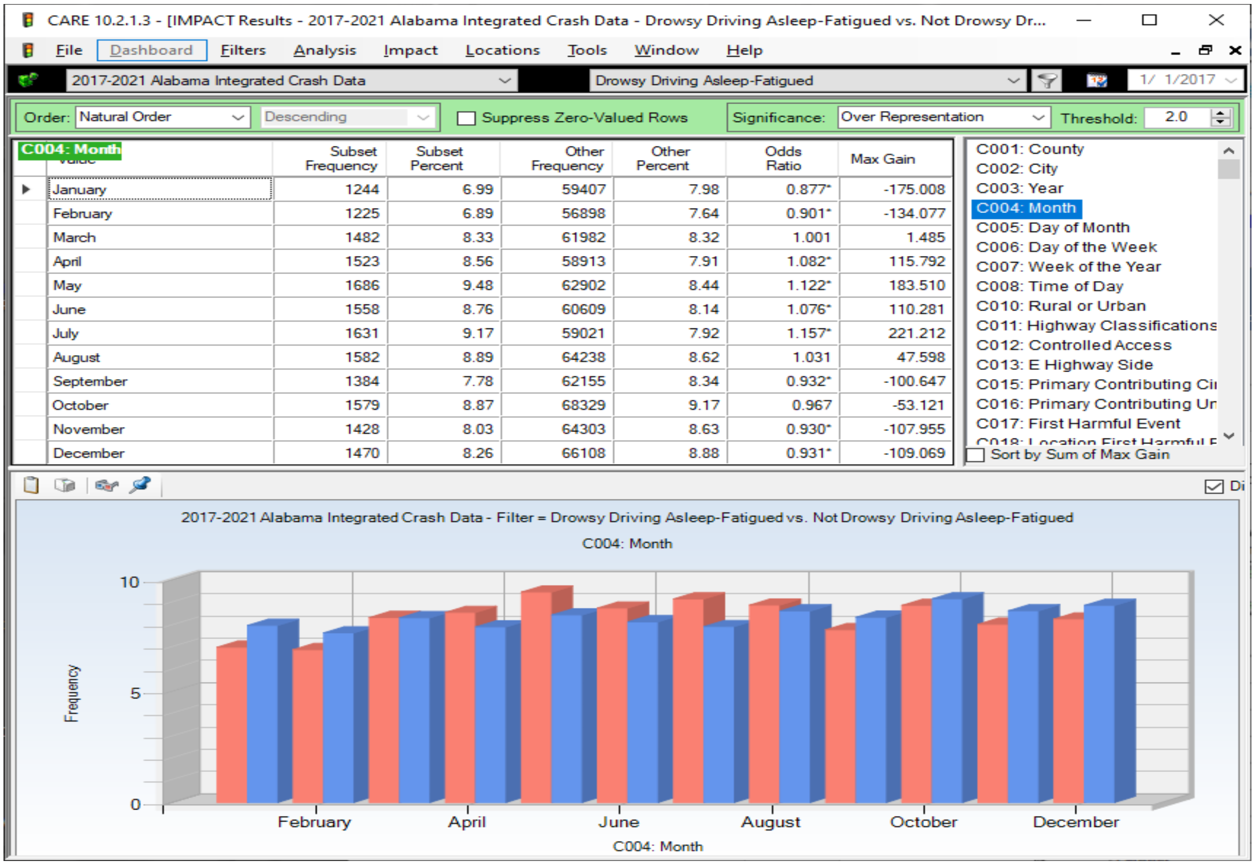
C003 Year



C003: Year	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2017	3649	20.51	153554	20.62	0.995	-18.823
2018	3747	21.06	156416	21.00	1.003	10.815
2019	3686	20.72	155439	20.87	0.993	-26.848
2020	3160	17.76	131052	17.59	1.009	29.665
2021	3550	19.95	148404	19.92	1.001	5.191

While the number of DrD crashes would seem to be coming down over the years, this decrease is about the same as the overall decrease in crashes over the 2017-2021 five-year period.

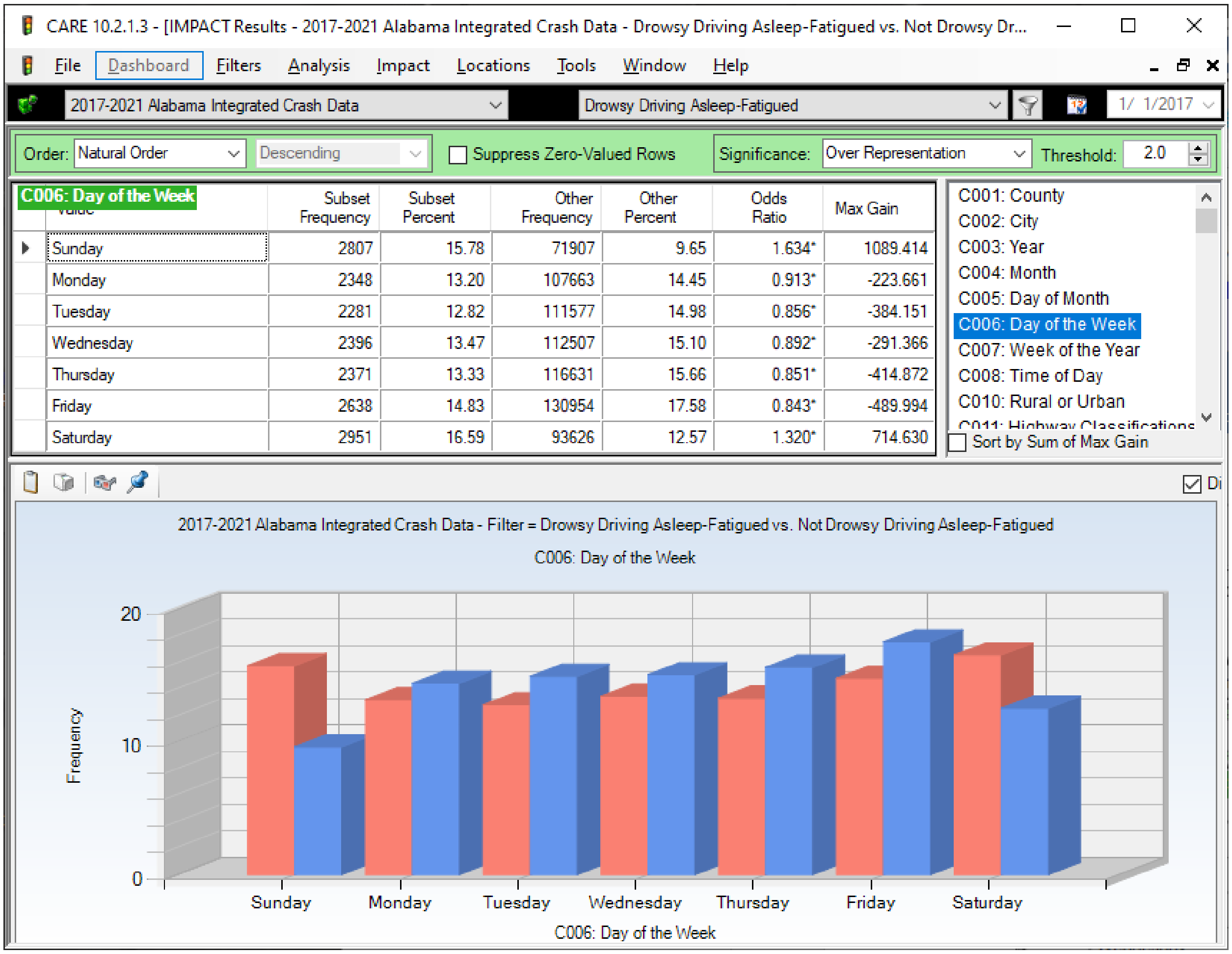
C004 Month



C004: Month	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
January	1244	6.99	59407	7.98	0.877*	-175.008
February	1225	6.89	56898	7.64	0.901*	-134.077
March	1482	8.33	61982	8.32	1.001	1.485
April	1523	8.56	58913	7.91	1.082*	115.792
May	1686	9.48	62902	8.44	1.122*	183.510
June	1558	8.76	60609	8.14	1.076*	110.281
July	1631	9.17	59021	7.92	1.157*	221.212
August	1582	8.89	64238	8.62	1.031	47.598
September	1384	7.78	62155	8.34	0.932*	-100.647
October	1579	8.87	68329	9.17	0.967	-53.121
November	1428	8.03	64303	8.63	0.930*	-107.955
December	1470	8.26	66108	8.88	0.931*	-109.069

April through July (springtime month) are over-represented. This could have to do with the additional hours of light due to the time change in these months.

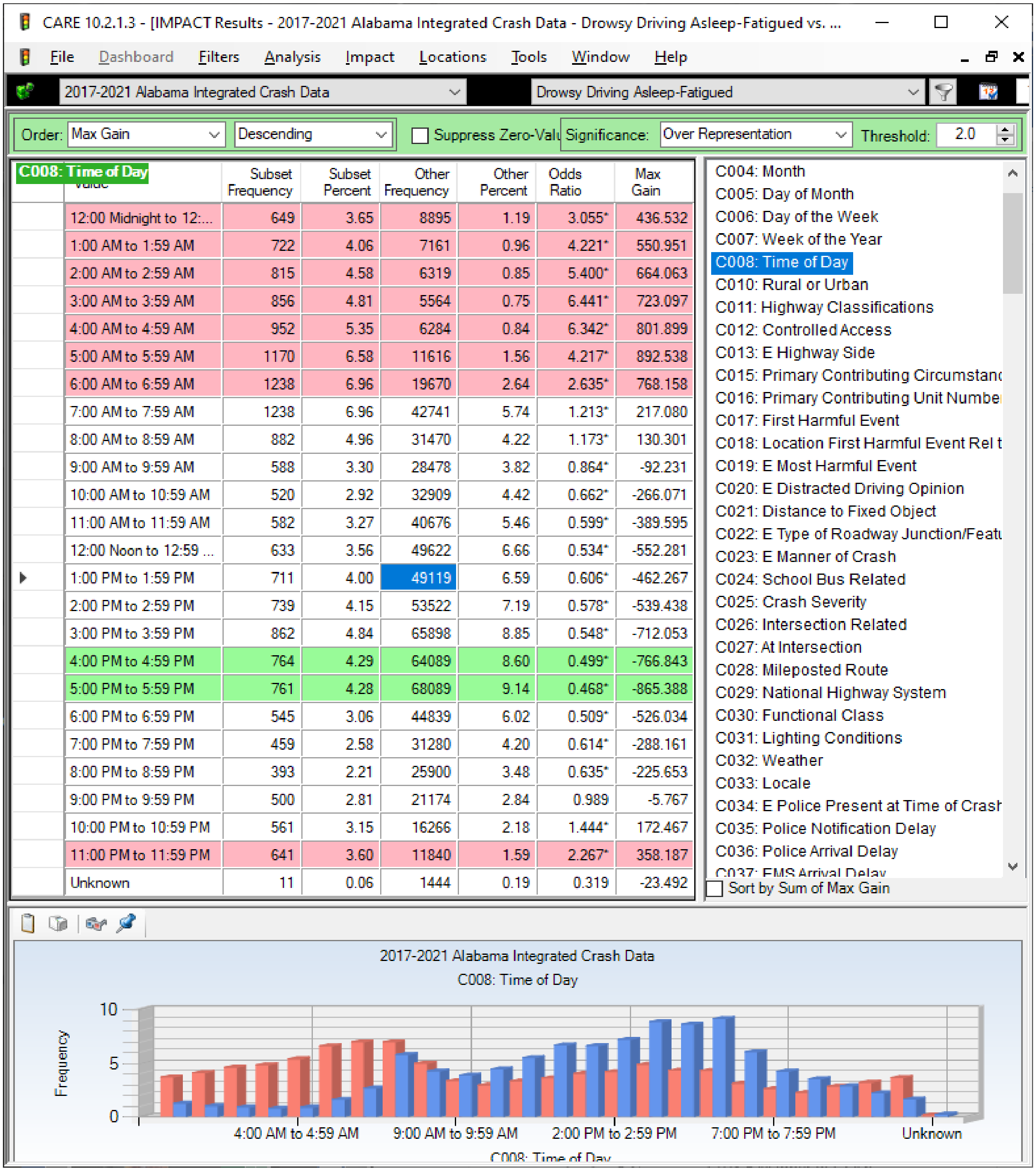
C006 Day of the Week



C006: Day of the Week	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Sunday	2807	15.78	71907	9.65	1.634*	1089.414
Monday	2348	13.20	107663	14.45	0.913*	-223.661
Tuesday	2281	12.82	111577	14.98	0.856*	-384.151
Wednesday	2396	13.47	112507	15.10	0.892*	-291.366
Thursday	2371	13.33	116631	15.66	0.851*	-414.872
Friday	2638	14.83	130954	17.58	0.843*	-489.994
Saturday	2951	16.59	93626	12.57	1.320*	714.630

Saturday and Sunday are the only days that are over-represented, both significantly so. We will see in the Time of Day analysis below the tendency for DrD crashes to occur at night (after dark). This result indicates that there is significantly more after-dark travel on weekends than on week days, which is reasonable.

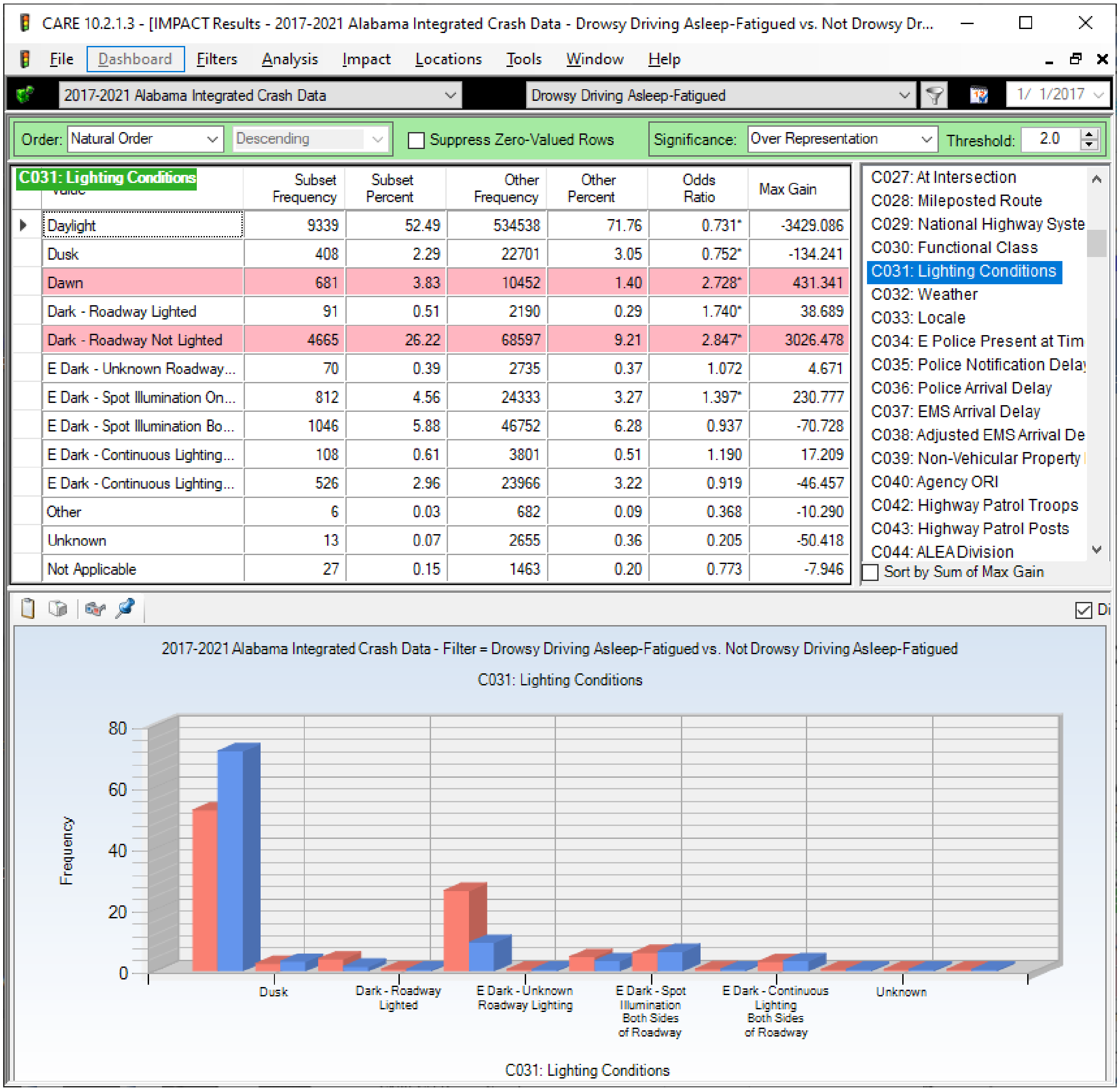
C008 Time of Day



C008: Time of Day Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
12:00 Midnight to 12:...	649	3.65	8895	1.19	3.055*	436.532
1:00 AM to 1:59 AM	722	4.06	7161	0.96	4.221*	550.951
2:00 AM to 2:59 AM	815	4.58	6319	0.85	5.400*	664.063
3:00 AM to 3:59 AM	856	4.81	5564	0.75	6.441*	723.097
4:00 AM to 4:59 AM	952	5.35	6284	0.84	6.342*	801.899
5:00 AM to 5:59 AM	1170	6.58	11616	1.56	4.217*	892.538
6:00 AM to 6:59 AM	1238	6.96	19670	2.64	2.635*	768.158
7:00 AM to 7:59 AM	1238	6.96	42741	5.74	1.213*	217.080
8:00 AM to 8:59 AM	882	4.96	31470	4.22	1.173*	130.301
9:00 AM to 9:59 AM	588	3.30	28478	3.82	0.864*	-92.231
10:00 AM to 10:59 AM	520	2.92	32909	4.42	0.662*	-266.071
11:00 AM to 11:59 AM	582	3.27	40676	5.46	0.599*	-389.595
12:00 Noon to 12:59 ...	633	3.56	49622	6.66	0.534*	-552.281
1:00 PM to 1:59 PM	711	4.00	49119	6.59	0.606*	-462.267
2:00 PM to 2:59 PM	739	4.15	53522	7.19	0.578*	-539.438
3:00 PM to 3:59 PM	862	4.84	65898	8.85	0.548*	-712.053
4:00 PM to 4:59 PM	764	4.29	64089	8.60	0.499*	-766.843
5:00 PM to 5:59 PM	761	4.28	68089	9.14	0.468*	-865.388
6:00 PM to 6:59 PM	545	3.06	44839	6.02	0.509*	-526.034
7:00 PM to 7:59 PM	459	2.58	31280	4.20	0.614*	-288.161
8:00 PM to 8:59 PM	393	2.21	25900	3.48	0.635*	-225.653
9:00 PM to 9:59 PM	500	2.81	21174	2.84	0.989	-5.767
10:00 PM to 10:59 PM	561	3.15	16266	2.18	1.444*	172.467
11:00 PM to 11:59 PM	641	3.60	11840	1.59	2.267*	358.187
Unknown	11	0.06	1444	0.19	0.319	-23.492

As noted above, the hours of no or little sunshine tend to have consistently more DrD crahes.

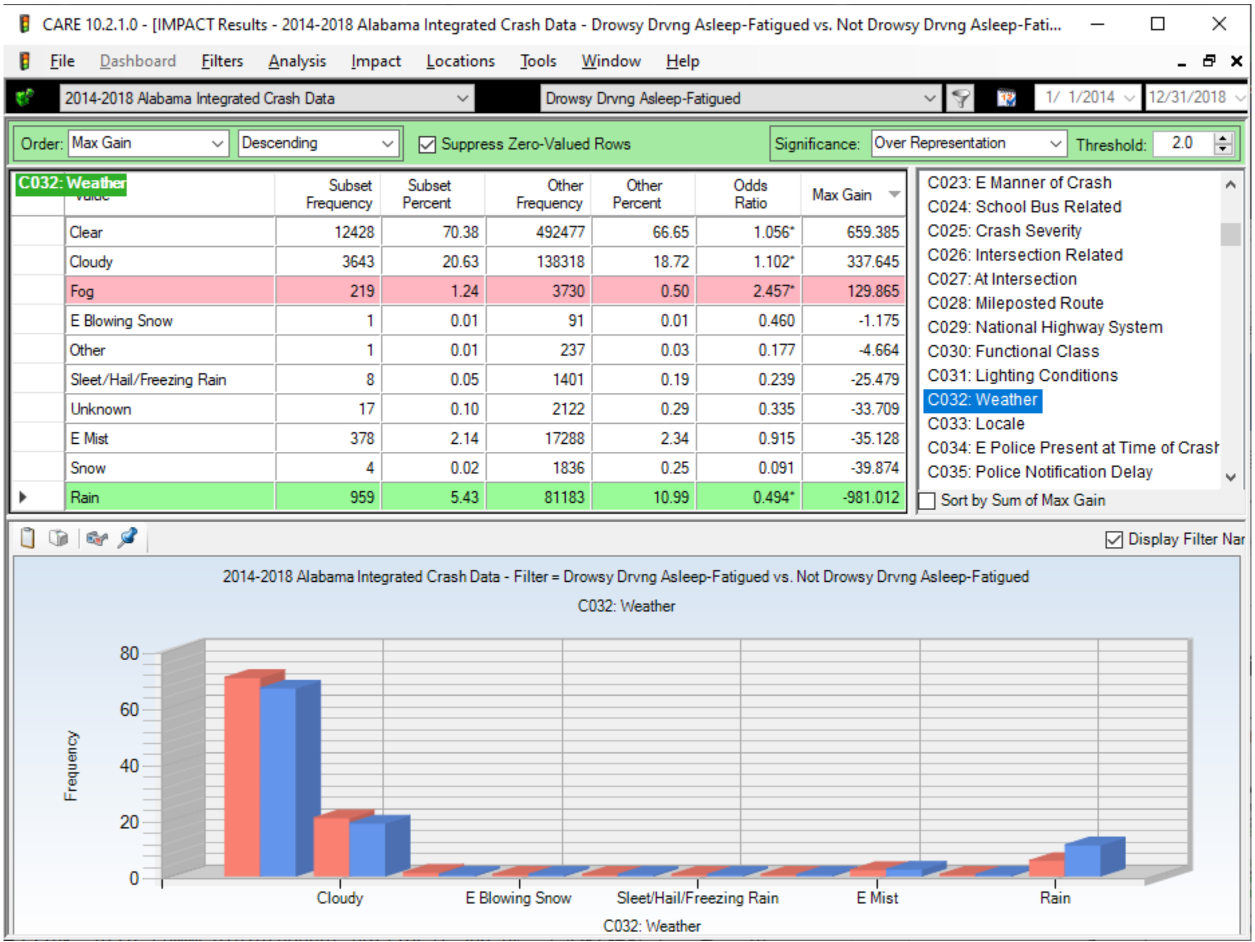
C031 Lighting Conditions



C031: Lighting Conditions Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Daylight	9339	52.49	534538	71.76	0.731*	-3429.086
Dusk	408	2.29	22701	3.05	0.752*	-134.241
Dawn	681	3.83	10452	1.40	2.728*	431.341
Dark - Roadway Lighted	91	0.51	2190	0.29	1.740*	38.689
Dark - Roadway Not Lighted	4665	26.22	68597	9.21	2.847*	3026.478
E Dark - Unknown Roadway...	70	0.39	2735	0.37	1.072	4.671
E Dark - Spot Illumination On...	812	4.56	24333	3.27	1.397*	230.777
E Dark - Spot Illumination Bo...	1046	5.88	46752	6.28	0.937	-70.728
E Dark - Continuous Lighting...	108	0.61	3801	0.51	1.190	17.209
E Dark - Continuous Lighting...	526	2.96	23966	3.22	0.919	-46.457
Other	6	0.03	682	0.09	0.368	-10.290
Unknown	13	0.07	2655	0.36	0.205	-50.418
Not Applicable	27	0.15	1463	0.20	0.773	-7.946

Dark was expected to be over-represented. Dawn was not, at least to the extent found. It seems reasonable that most who were still driving at dawn were probably driving a good part of the night.

C032 Weather



C032: Weather Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Clear	12428	70.38	492477	66.65	1.056*	659.385
Cloudy	3643	20.63	138318	18.72	1.102*	337.645
Fog	219	1.24	3730	0.50	2.457*	129.865
E Blowing Snow	1	0.01	91	0.01	0.460	-1.175
Other	1	0.01	237	0.03	0.177	-4.664
Sleet/Hail/Freezing Rain	8	0.05	1401	0.19	0.239	-25.479
Unknown	17	0.10	2122	0.29	0.335	-33.709
E Mist	378	2.14	17288	2.34	0.915	-35.128
Snow	4	0.02	1836	0.25	0.091	-39.874
Rain	959	5.43	81183	10.99	0.494*	-981.012

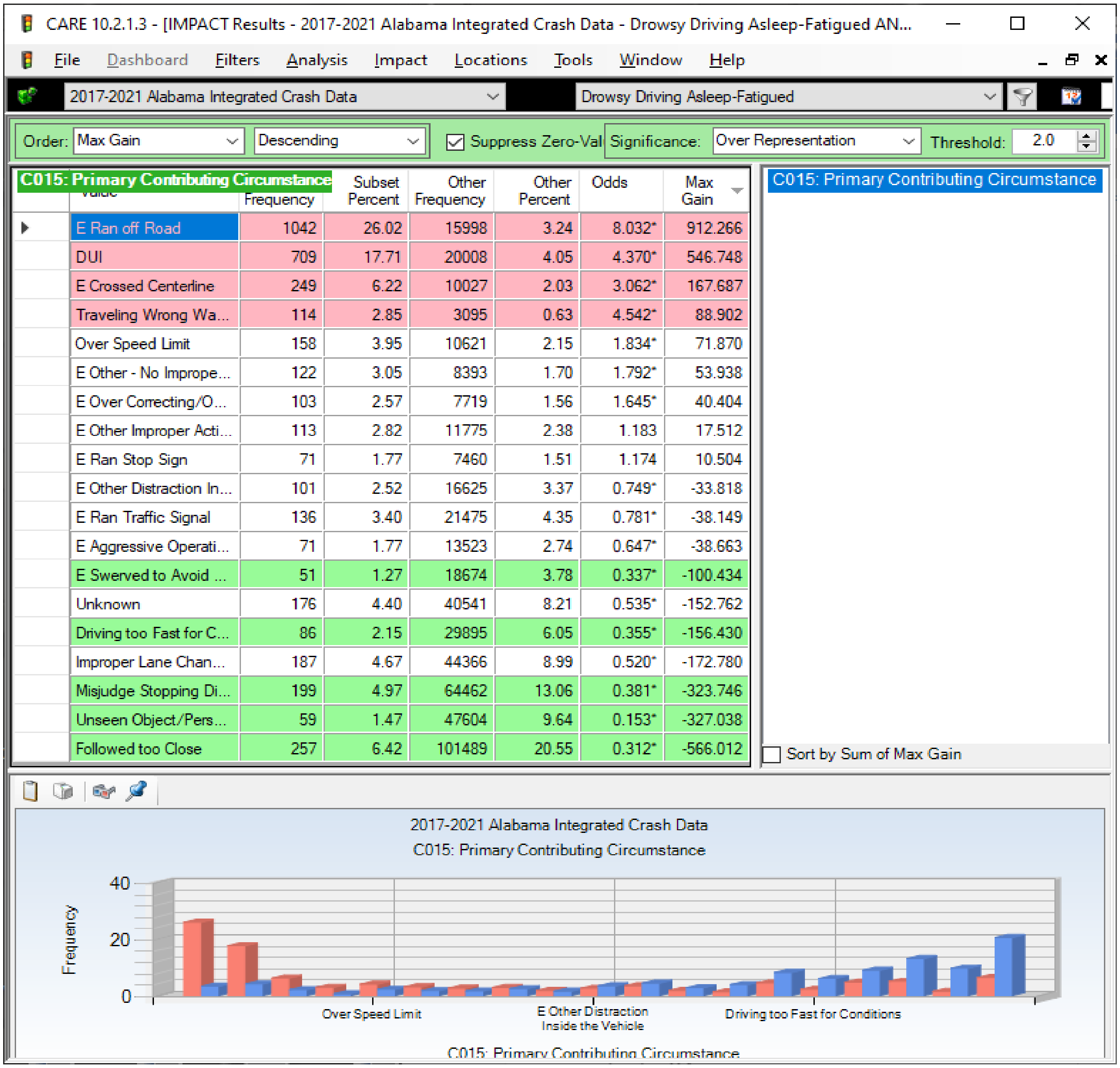
Fog is a particular problem. Possibly, in the fog, drivers have a diminished ability to sense when they are getting dangerously drowsy. Rain, on the other hand, probably leads to a heightened sense of danger in general, and it appears that rain is the most favorable weather for avoiding DrD.

5. IMPACT Displays – Driver Issues

15, 17, 23, 52, 104, 107, 109, 115, 122-123, 204

C015 Primary Contributing Circumstances –

Removed E Fatigued/Asleep and all items with less than 50 occurrences.

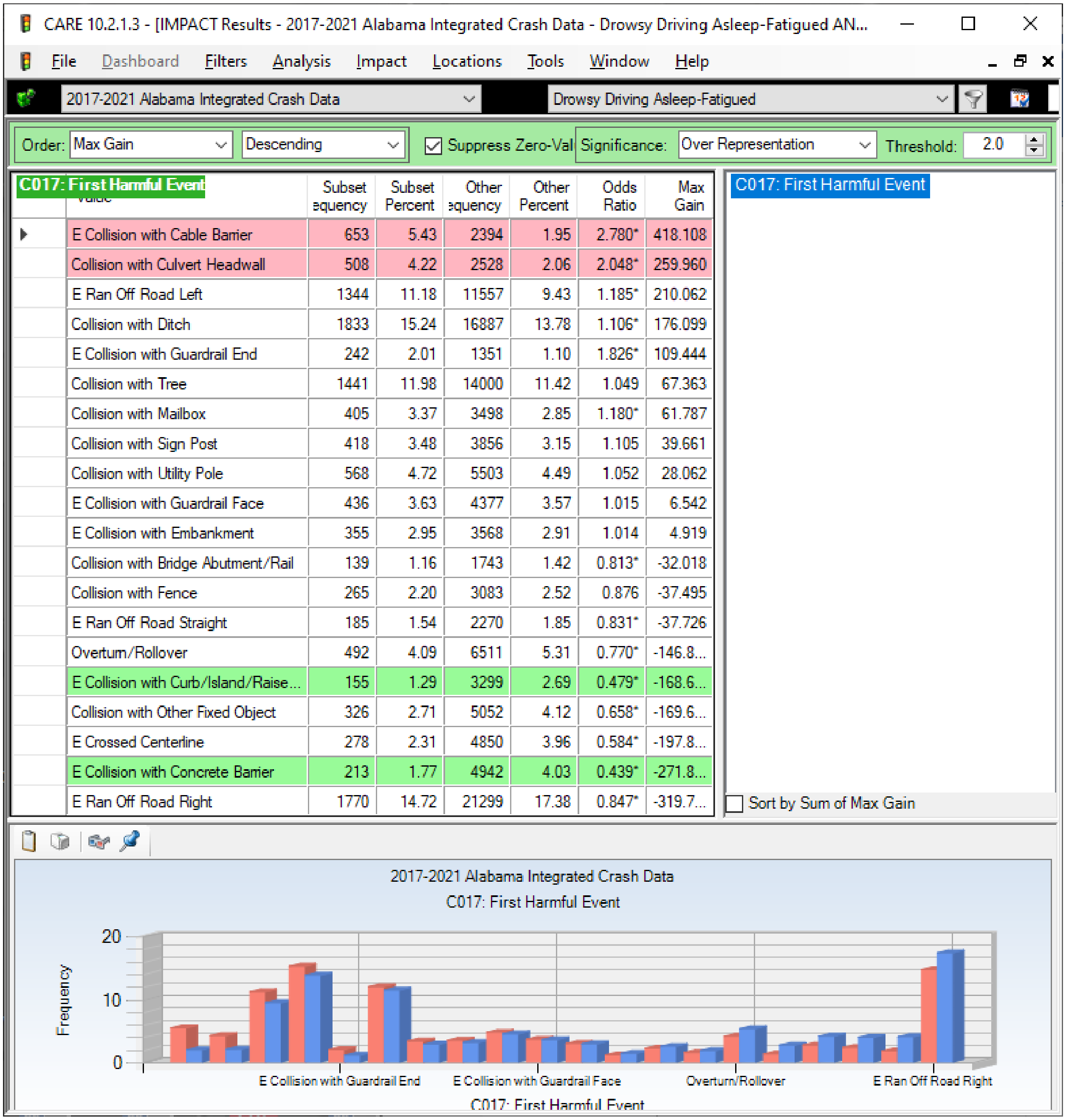


C015: Primary Contributing Circumstance Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
E Ran off Road	1042	26.02	15998	3.24	8.032*	912.266
DUI	709	17.71	20008	4.05	4.370*	546.748
E Crossed Centerline	249	6.22	10027	2.03	3.062*	167.687
Traveling Wrong Wa...	114	2.85	3095	0.63	4.542*	88.902
Over Speed Limit	158	3.95	10621	2.15	1.834*	71.870
E Other - No Imprope...	122	3.05	8393	1.70	1.792*	53.938
E Over Correcting/O...	103	2.57	7719	1.56	1.645*	40.404
E Other Improper Acti...	113	2.82	11775	2.38	1.183	17.512
E Ran Stop Sign	71	1.77	7460	1.51	1.174	10.504
E Other Distraction In...	101	2.52	16625	3.37	0.749*	-33.818
E Ran Traffic Signal	136	3.40	21475	4.35	0.781*	-38.149
E Aggressive Operati...	71	1.77	13523	2.74	0.647*	-38.663
E Swerved to Avoid ...	51	1.27	18674	3.78	0.337*	-100.434
Unknown	176	4.40	40541	8.21	0.535*	-152.762
Driving too Fast for C...	86	2.15	29895	6.05	0.355*	-156.430
Improper Lane Chan...	187	4.67	44366	8.99	0.520*	-172.780
Misjudge Stopping Di...	199	4.97	64462	13.06	0.381*	-323.746
Unseen Object/Pers...	59	1.47	47604	9.64	0.153*	-327.038
Followed too Close	257	6.42	101489	20.55	0.312*	-566.012

The Primary Contributing Circumstance of Fatigued/Asleep had 12,890 occurrences and made the other items unusable. With Fatigued/Asleep removed, the main use of this attribute is to see what PCCs accompanied the DrD. The ones in red at the top give a good idea in this regard.

C017 First Harmful Event

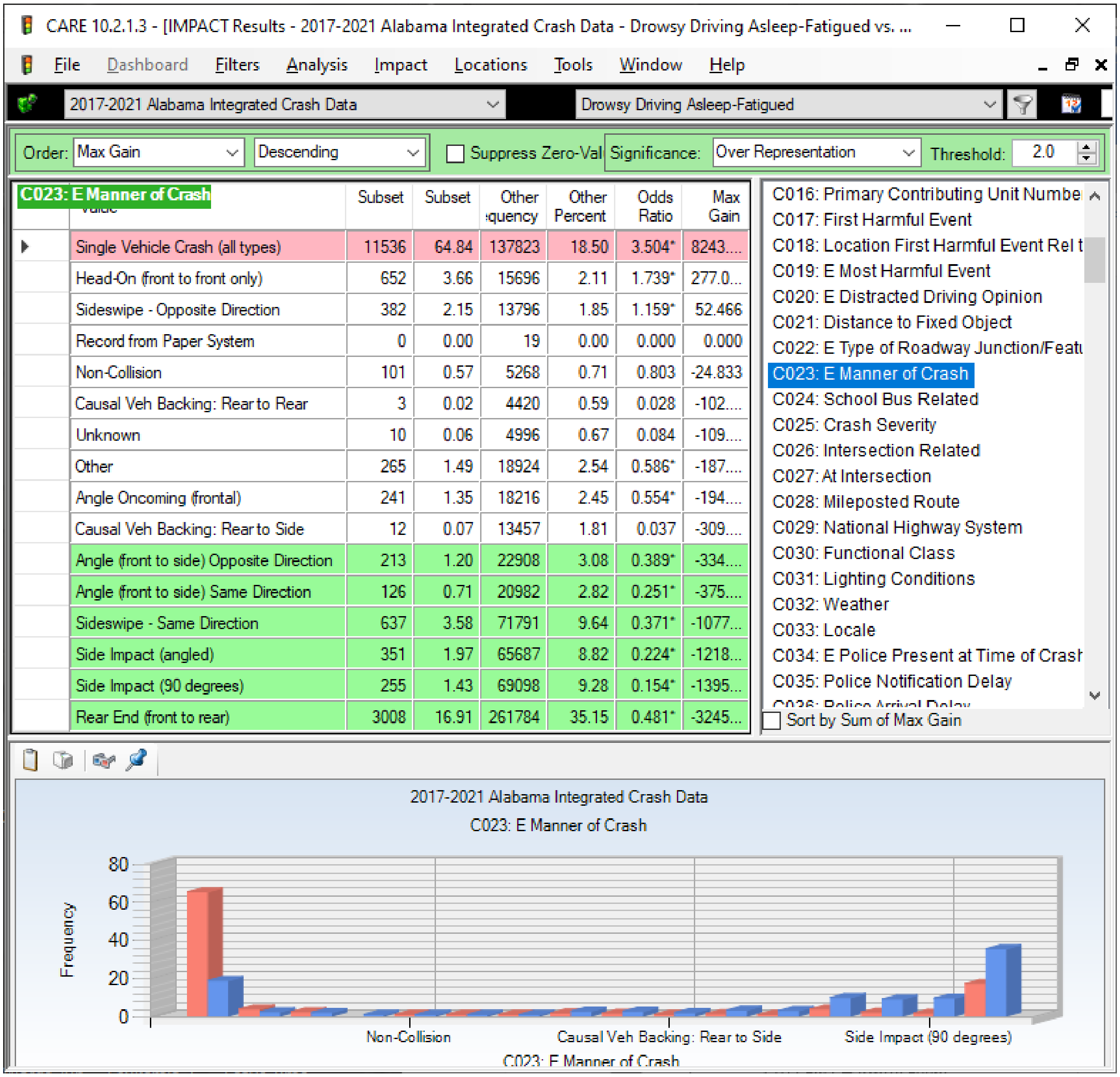
Removed: all items with less than 100 crashes in subset;
also removed Motor Vehicle in Traffic and Parked Motor Vehicle.



C017: First Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Collision with Cable Barrier	653	5.43	2394	1.95	2.780*	418.108
Collision with Culvert Headwall	508	4.22	2528	2.06	2.048*	259.960
E Ran Off Road Left	1344	11.18	11557	9.43	1.185*	210.062
Collision with Ditch	1833	15.24	16887	13.78	1.106*	176.099
E Collision with Guardrail End	242	2.01	1351	1.10	1.826*	109.444
Collision with Tree	1441	11.98	14000	11.42	1.049	67.363
Collision with Mailbox	405	3.37	3498	2.85	1.180*	61.787
Collision with Sign Post	418	3.48	3856	3.15	1.105	39.661
Collision with Utility Pole	568	4.72	5503	4.49	1.052	28.062
E Collision with Guardrail Face	436	3.63	4377	3.57	1.015	6.542
E Collision with Embankment	355	2.95	3568	2.91	1.014	4.919
Collision with Bridge Abutment/Rail	139	1.16	1743	1.42	0.813*	-32.018
Collision with Fence	265	2.20	3083	2.52	0.876	-37.495
E Ran Off Road Straight	185	1.54	2270	1.85	0.831*	-37.726
Overturn/Rollover	492	4.09	6511	5.31	0.770*	-146.8...
E Collision with Curb/Island/Raise...	155	1.29	3299	2.69	0.479*	-168.6...
Collision with Other Fixed Object	326	2.71	5052	4.12	0.658*	-169.6...
E Crossed Centerline	278	2.31	4850	3.96	0.584*	-197.8...
E Collision with Concrete Barrier	213	1.77	4942	4.03	0.439*	-271.8...
E Ran Off Road Right	1770	14.72	21299	17.38	0.847*	-319.7...

There is no pattern to the First Harmful Event due the DrD driver not recognizing items to avoid.

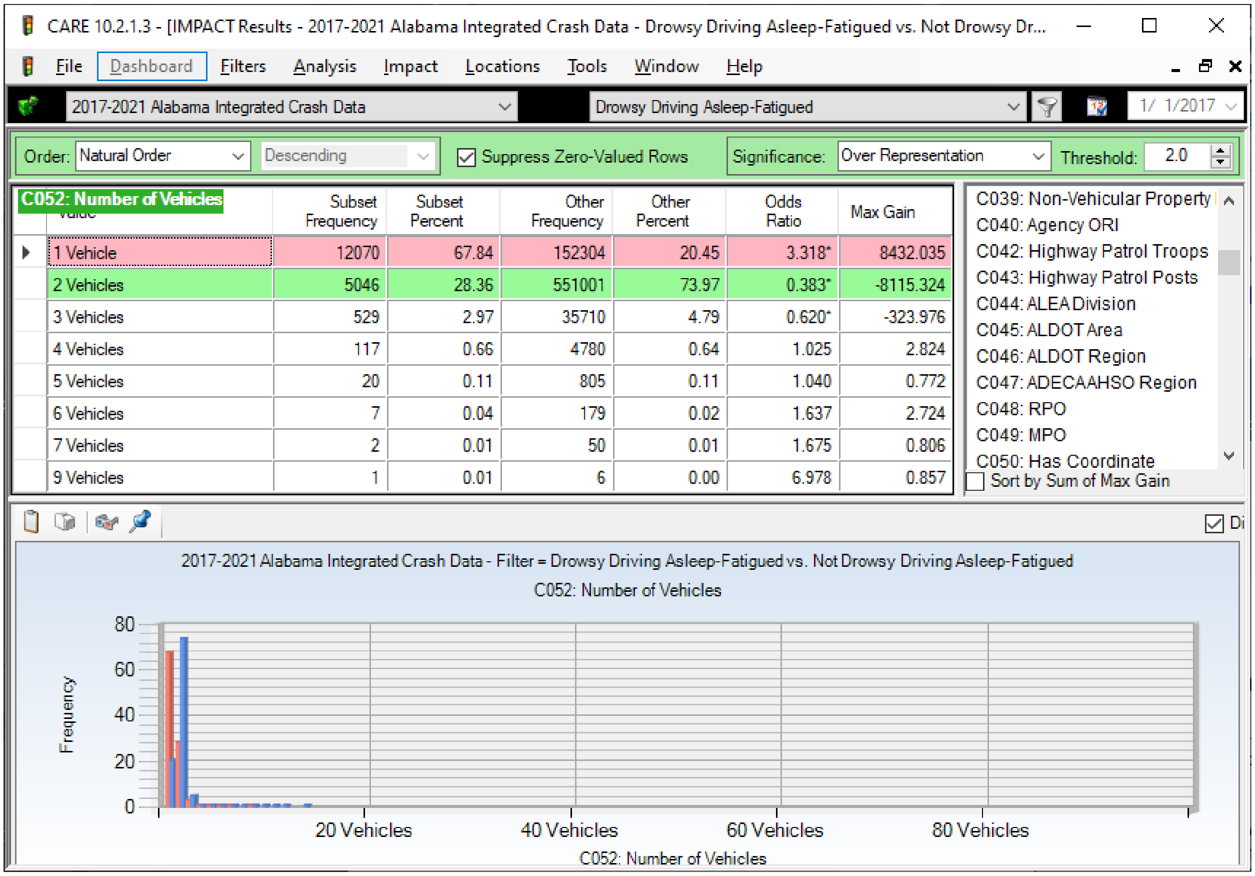
C023 E Manner of Crash



C023: E Manner of Crash Value	Subset	Subset	Other Frequency	Other Percent	Odds Ratio	Max Gain
Single Vehicle Crash (all types)	11536	64.84	137823	18.50	3.504*	8243....
Head-On (front to front only)	652	3.66	15696	2.11	1.739*	277.0...
Sideswipe - Opposite Direction	382	2.15	13796	1.85	1.159*	52.466
Record from Paper System	0	0.00	19	0.00	0.000	0.000
Non-Collision	101	0.57	5268	0.71	0.803	-24.833
Causal Veh Backing: Rear to Rear	3	0.02	4420	0.59	0.028	-102....
Unknown	10	0.06	4996	0.67	0.084	-109....
Other	265	1.49	18924	2.54	0.586*	-187....
Angle Oncoming (frontal)	241	1.35	18216	2.45	0.554*	-194....
Causal Veh Backing: Rear to Side	12	0.07	13457	1.81	0.037	-309....
Angle (front to side) Opposite Direction	213	1.20	22908	3.08	0.389*	-334....
Angle (front to side) Same Direction	126	0.71	20982	2.82	0.251*	-375....
Sideswipe - Same Direction	637	3.58	71791	9.64	0.371*	-1077....
Side Impact (angled)	351	1.97	65687	8.82	0.224*	-1218....
Side Impact (90 degrees)	255	1.43	69098	9.28	0.154*	-1395....
Rear End (front to rear)	3008	16.91	261784	35.15	0.481*	-3245....

As would be expected, the vast majority of DrD crashes involve only the one vehicle. However, when two vehicles are involved, the results can be devastating. Example: there were 652 Head On (front to front only) crashes, any and all of which could have been fatalities. A crosstab revealed that 32 of these crashes were fatal.

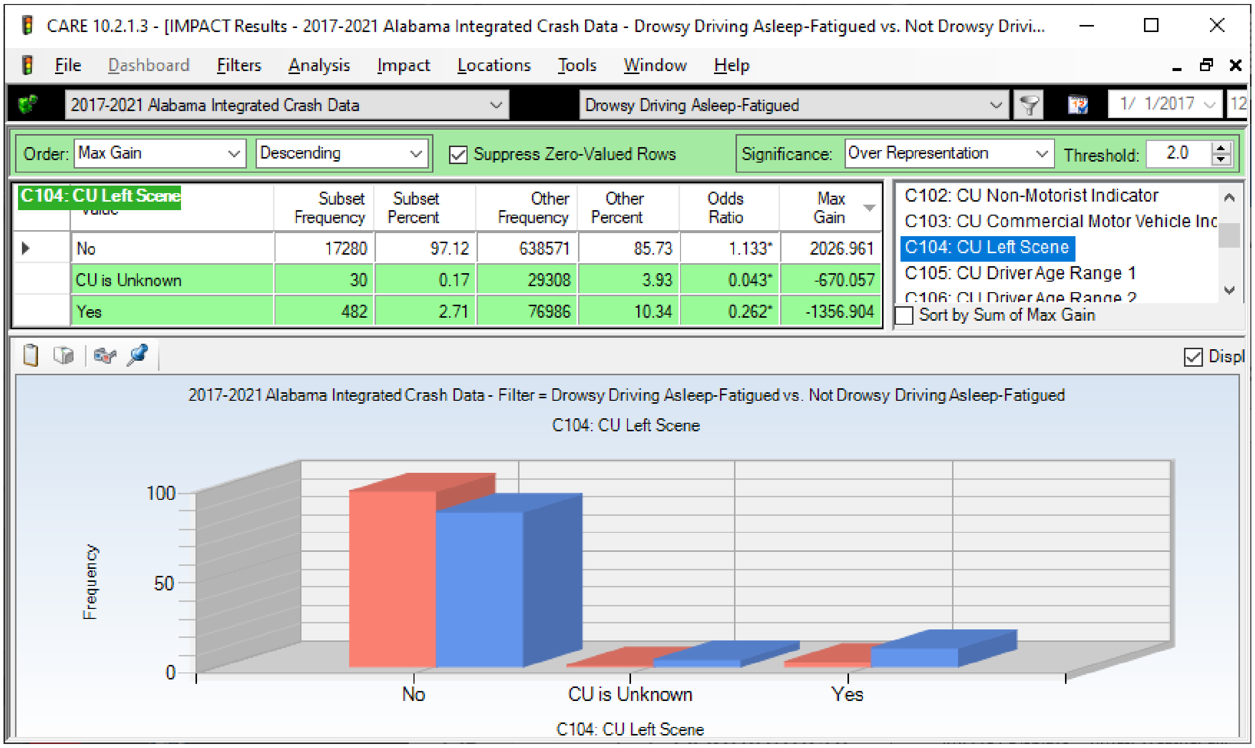
C052 Number of Vehicles



C052: Number of Vehicles	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	12070	67.84	152304	20.45	3.318*	8432.035
2 Vehicles	5046	28.36	551001	73.97	0.383*	-8115.324
3 Vehicles	529	2.97	35710	4.79	0.620*	-323.976
4 Vehicles	117	0.66	4780	0.64	1.025	2.824
5 Vehicles	20	0.11	805	0.11	1.040	0.772
6 Vehicles	7	0.04	179	0.02	1.637	2.724
7 Vehicles	2	0.01	50	0.01	1.675	0.806
9 Vehicles	1	0.01	6	0.00	6.978	0.857

It is reasonable that most (67.84%) of DrD crashes are single vehicle. When a driver loses consciousness, there is no reason that a second vehicle need be involved. Of course they are, since in many cases, other vehicles are the first items that can be hit by the out of control DrD vehicle.

C104 CU Left Scene



Leaving the scene of a crash requires a fairly clear head to evaluate the consequences. Often DrD drivers are surprised by the crash and not in any condition to think of leaving the scene.

C107 CU Driver Raw Age

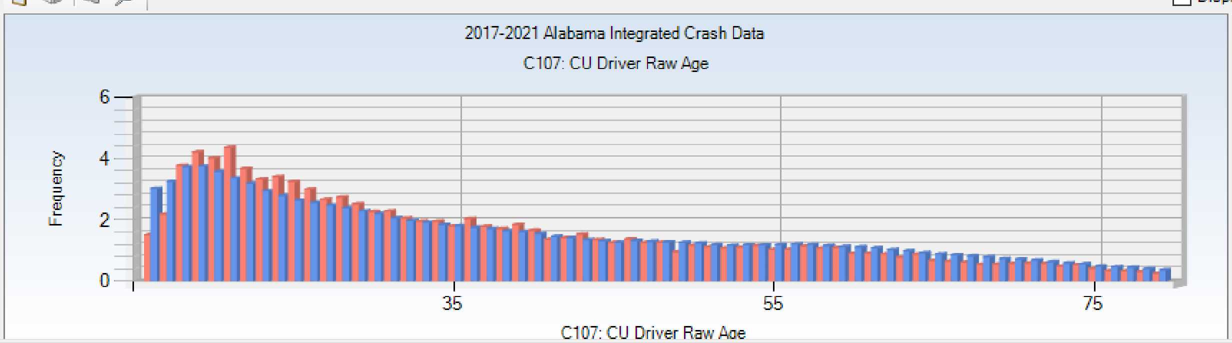
2017-2021 Alabama Integrated Crash Data | Drowsy Driving Asleep-Fatigued | 1/ 1/2017

Order: Max Gain | Descending | Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C107: CU Driver Raw Age Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
16	261	1.50	19117	3.02	0.496*	-265.662
17	379	2.18	20518	3.25	0.670*	-186.259
18	657	3.77	23592	3.73	1.011	7.054
19	734	4.21	23706	3.75	1.124*	80.913
20	699	4.01	22587	3.57	1.123*	76.741
21	760	4.36	21231	3.36	1.299*	175.098
22	639	3.67	20136	3.19	1.152*	84.265
23	580	3.33	18561	2.94	1.134*	68.655
24	593	3.40	17640	2.79	1.220*	107.028
25	565	3.24	16666	2.64	1.231*	105.861
26	522	3.00	16172	2.56	1.172*	76.471
27	464	2.66	15620	2.47	1.078	33.678
28	477	2.74	15088	2.39	1.148*	61.334
29	437	2.51	14419	2.28	1.100	39.765
30	394	2.26	13856	2.19	1.032	12.275
31	397	2.28	12967	2.05	1.111	39.767
32	357	2.05	12432	1.97	1.042	14.506
33	339	1.95	12066	1.91	1.020	6.589
34	339	1.95	11597	1.83	1.061	19.509
35	311	1.79	11365	1.80	0.993	-2.099
36	354	2.03	11039	1.75	1.164*	49.882
37	310	1.78	10807	1.71	1.041	12.273
38	297	1.71	10308	1.63	1.046	13.021
39	319	1.83	10152	1.61	1.141*	39.318
40	288	1.65	9698	1.53	1.078	20.826

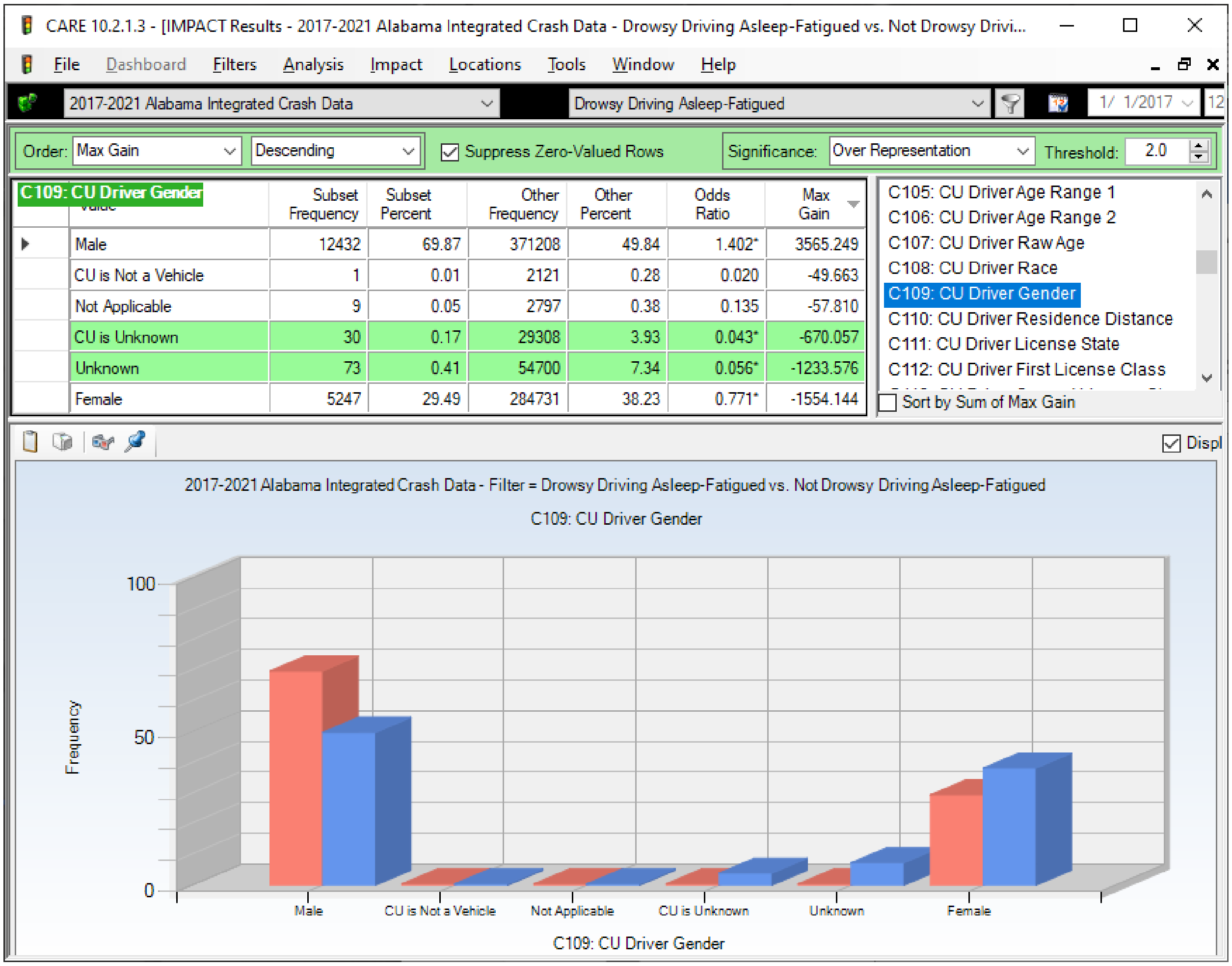
C107: CU Driver Raw Age

Sort by Sum of Max Gain



Over-representations 19 and above are significant up to and including age 26, while 16 and 17 are significantly under-represented. This would lead to the speculation that alcohol/drugs were involved, which we will confirm shortly in C122 and C123. Alcohol especially is not typically a problem of our youngest drivers.

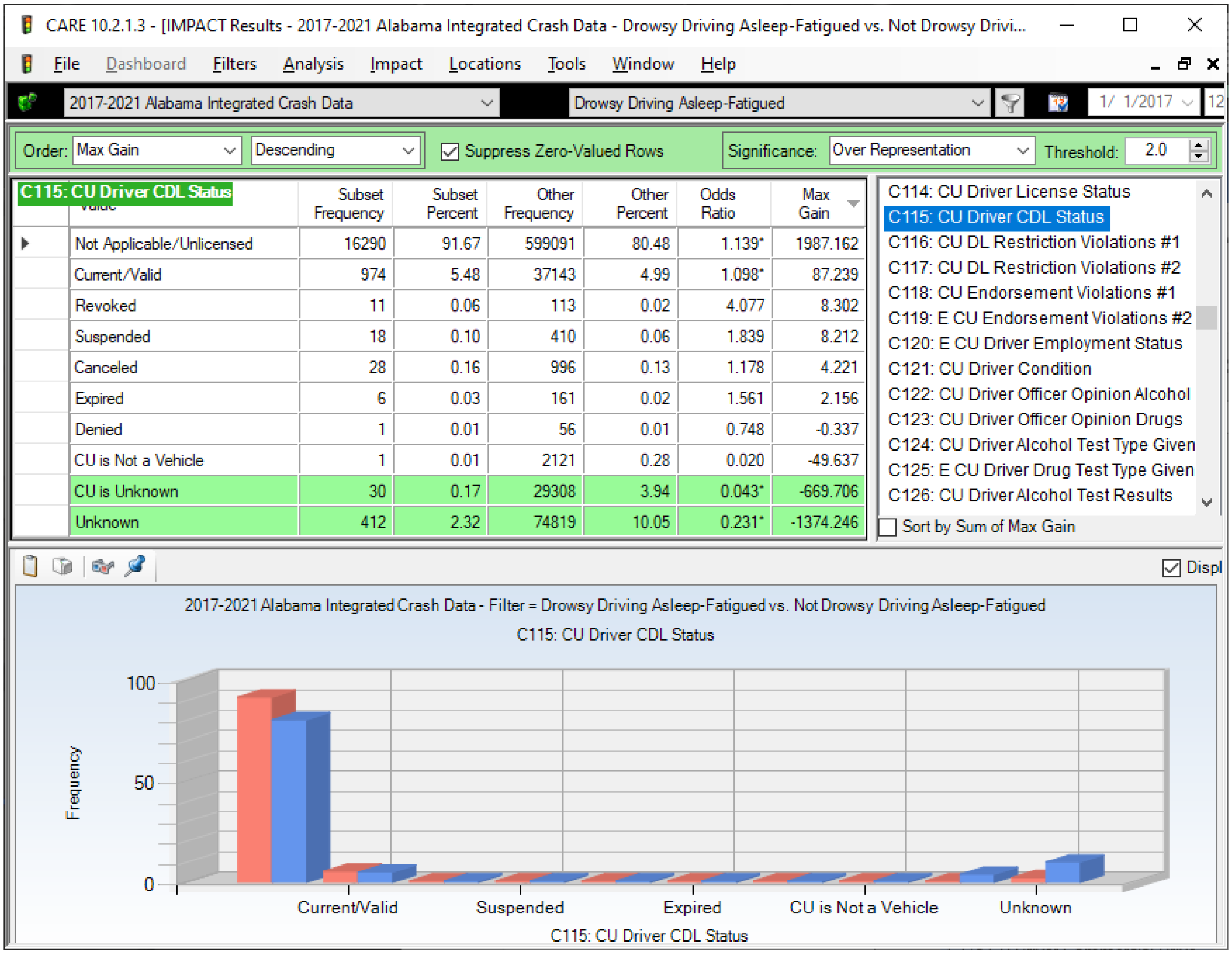
C109 CU Driver Gender



C109: CU Driver Gender	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Male	12432	69.87	371208	49.84	1.402*	3565.249
CU is Not a Vehicle	1	0.01	2121	0.28	0.020	-49.663
Not Applicable	9	0.05	2797	0.38	0.135	-57.810
CU is Unknown	30	0.17	29308	3.93	0.043*	-670.057
Unknown	73	0.41	54700	7.34	0.056*	-1233.576
Female	5247	29.49	284731	38.23	0.771*	-1554.144

Male drivers are guilty of DrD at a rate (69.87%) or over double that of females (25.49%). Reasons for this relate to all of the DrD over-representations: i,e., time of driving, duration of trip, rural/urban, and use of alcohol and other drugs, etc.

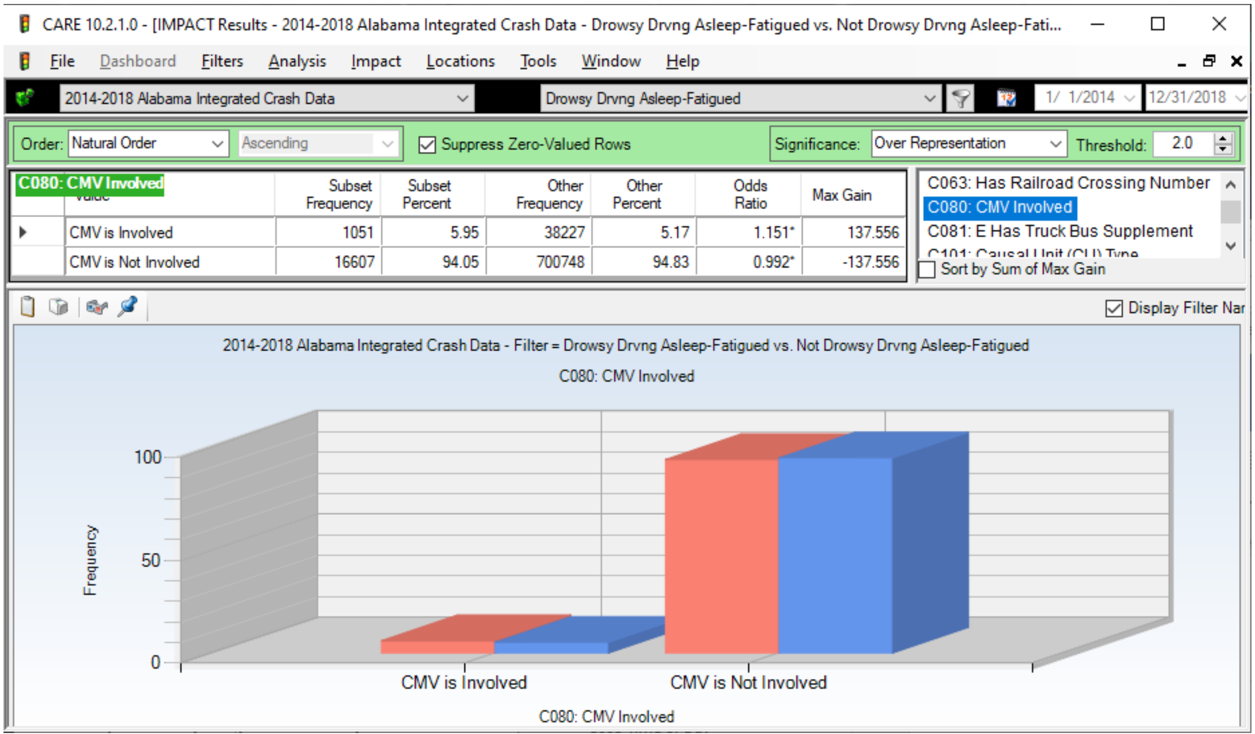
C115 CU Driver Commercial Driver License (CDL) Status



C115: CU Driver CDL Status	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Not Applicable/Unlicensed	16290	91.67	599091	80.48	1.139*	1987.162
Current/Valid	974	5.48	37143	4.99	1.098*	87.239
Revoked	11	0.06	113	0.02	4.077	8.302
Suspended	18	0.10	410	0.06	1.839	8.212
Canceled	28	0.16	996	0.13	1.178	4.221
Expired	6	0.03	161	0.02	1.561	2.156
Denied	1	0.01	56	0.01	0.748	-0.337
CU is Not a Vehicle	1	0.01	2121	0.28	0.020	-49.637
CU is Unknown	30	0.17	29308	3.94	0.043*	-669.706
Unknown	412	2.32	74819	10.05	0.231*	-1374.246

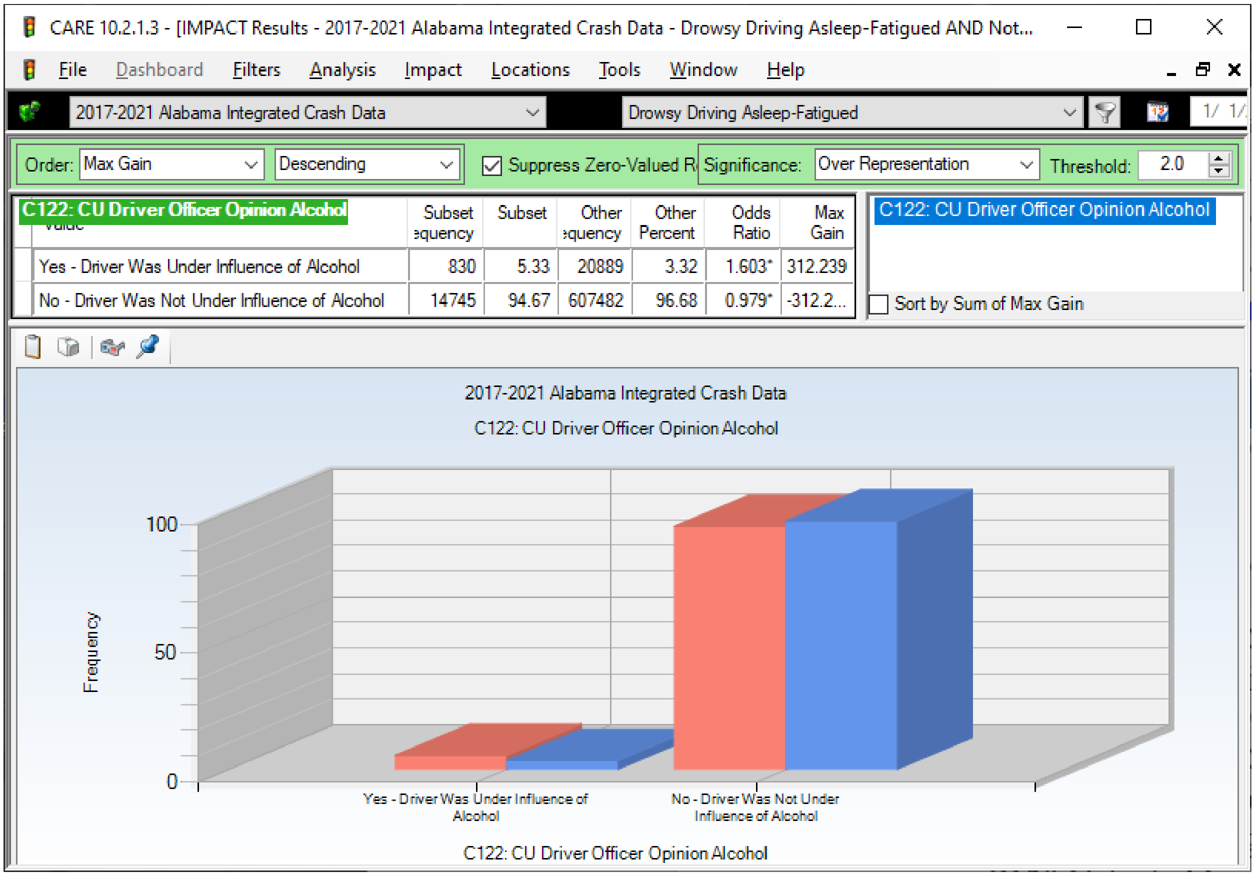
Drivers with CDL licenses are trained to avoid DrD. However, their length of time behind the wheel and other factors essentially sets them up for DrD. Their rate (5.48%) is well under the non-CDL licensed drivers (91.67%). Rates here are the percentage of all DrD crashes that are attributed to these drivers.

C080 CMV Involved



Results here are similar to those for C115. However, a CMV might be involved in a DrD crash without it being the CMV driver's fault.

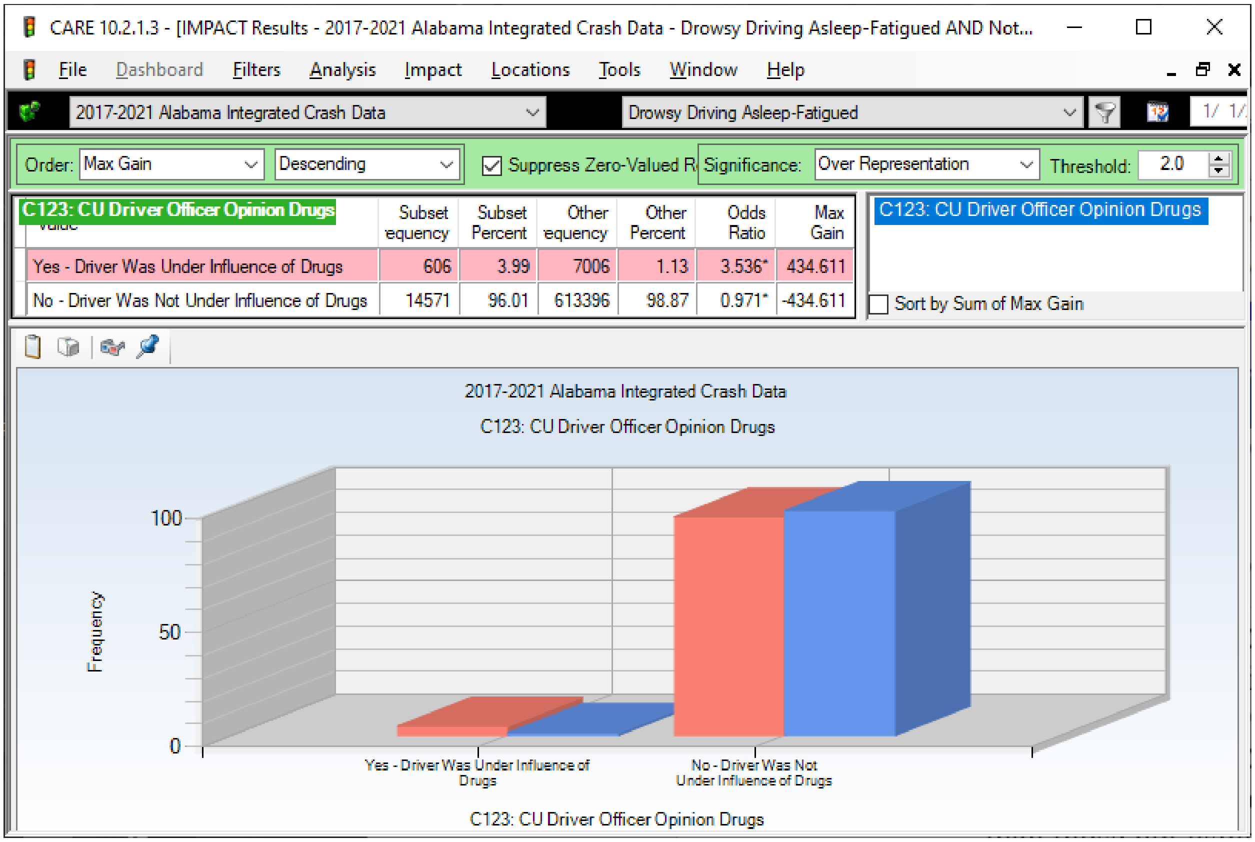
C122 CU Driver Officer Opinion Alcohol



C122: CU Driver Officer Opinion Alcohol	Subset Frequency	Subset	Other Frequency	Other Percent	Odds Ratio	Max Gain
Yes - Driver Was Under Influence of Alcohol	830	5.33	20889	3.32	1.603*	312.239
No - Driver Was Not Under Influence of Alcohol	14745	94.67	607482	96.68	0.979*	-312.2...

This indicates that while non-DrD drivers in general were 3.32% under the influence of alcohol, DrD drivers were DUI alcohol (5.33%), a difference that is statistically significant. The Odds Ratio that compares these two findings is 1.603, i.e., 60.3% times higher for DrD than for non-DrD.

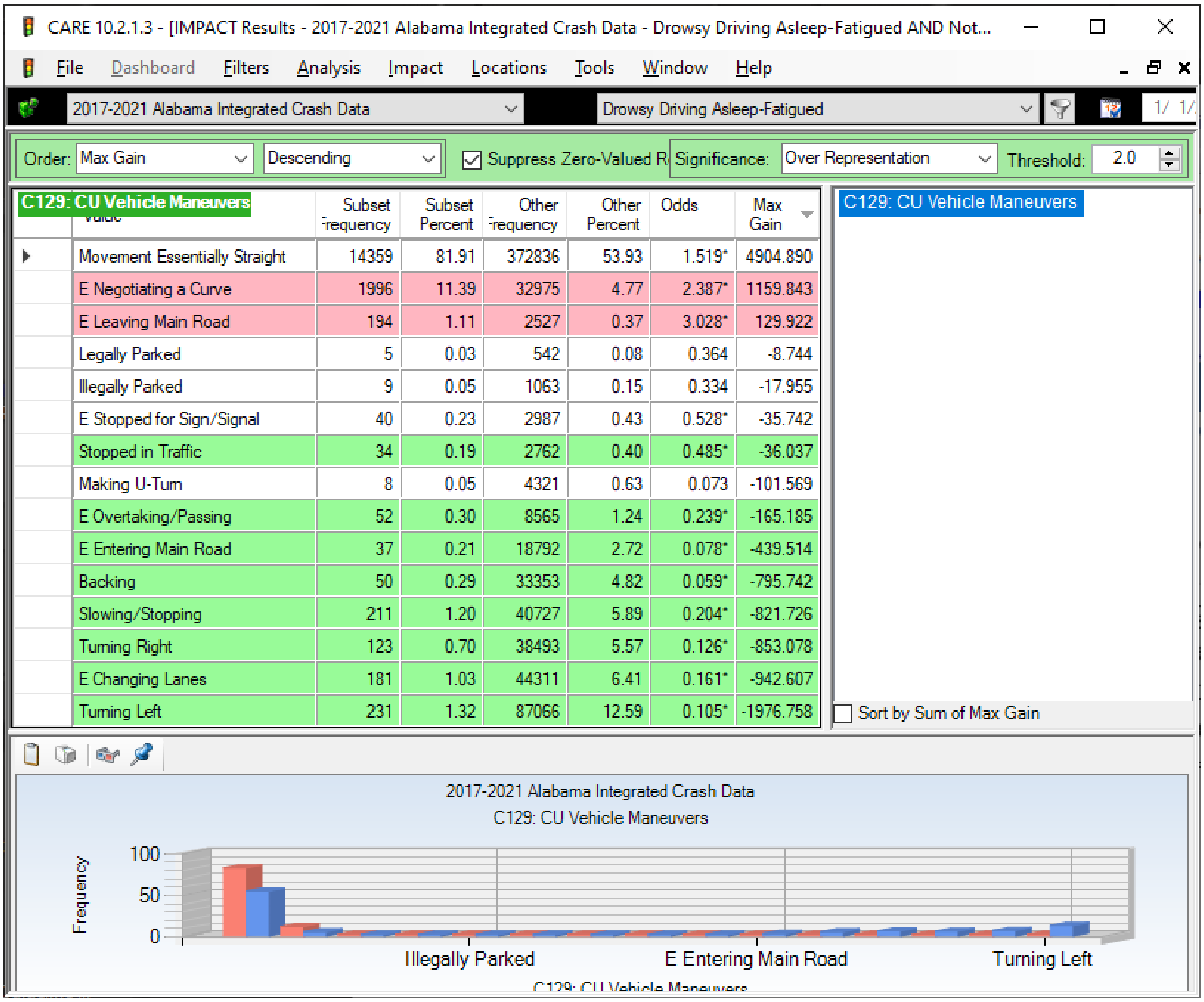
C123 CU Officer Opinion Drugs



This is similar to the alcohol analysis given above, with one main difference. Note that the Odds Ratio here is 3.536, while for alcohol it was only 1.603. This indicates a larger proportion for DrD drug cases than that for alcohol, non-alcohol drugs causing the driver to be DrD a proportion that is 3.536 times that of the non-DrD drivers. This might also show that on a per-individual basis, non-alcohol drugs can be more inclined to cause DrD crashes than is true for alcohol alone. Of course, both of these agents are deadly in causing traffic crashes in general.

C129 CU Vehicle Maneuvers

The following was reduced by removing all cases in which there were zero crashes.

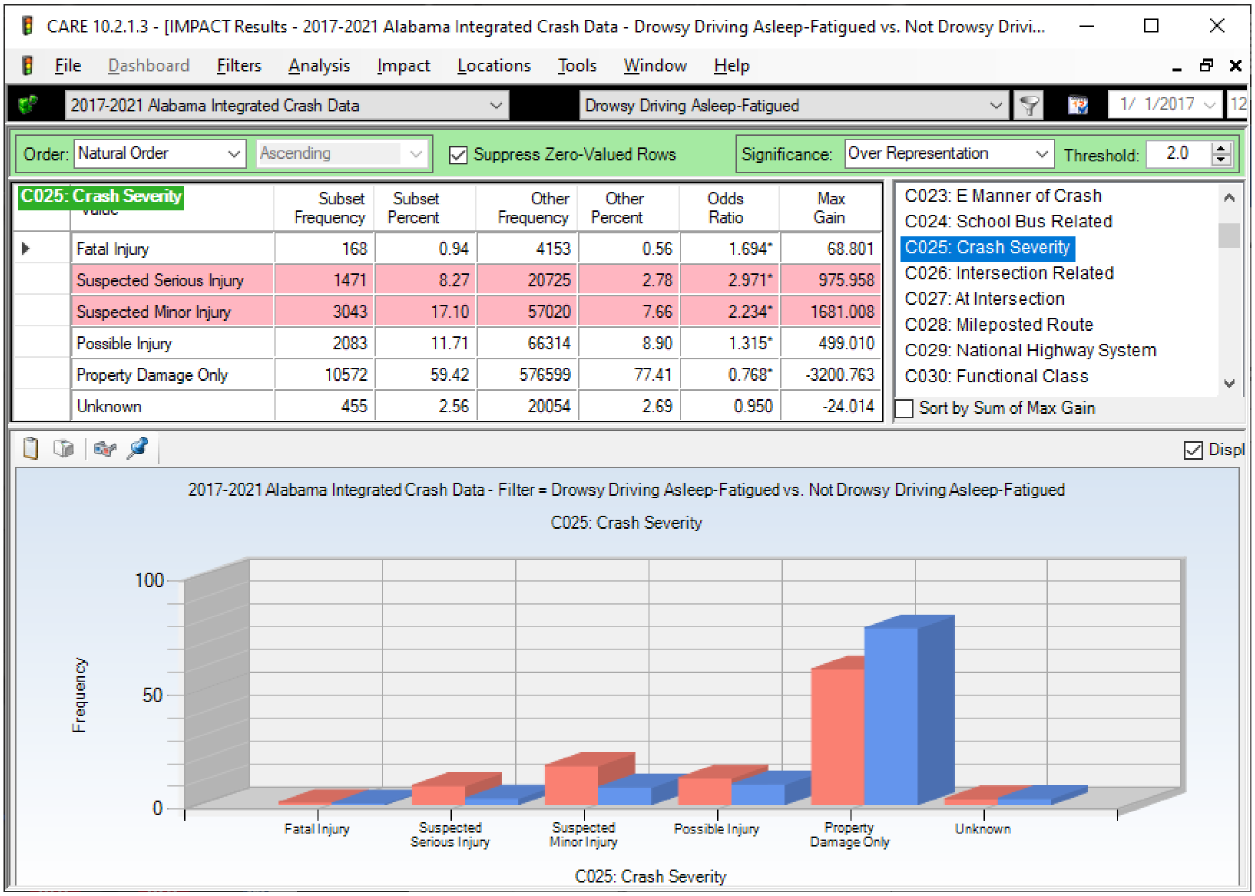


C129: CU Vehicle Maneuvers Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Movement Essentially Straight	14359	81.91	372836	53.93	1.519*	4904.890
E Negotiating a Curve	1996	11.39	32975	4.77	2.387*	1159.843
E Leaving Main Road	194	1.11	2527	0.37	3.028*	129.922
Legally Parked	5	0.03	542	0.08	0.364	-8.744
Illegally Parked	9	0.05	1063	0.15	0.334	-17.955
E Stopped for Sign/Signal	40	0.23	2987	0.43	0.528*	-35.742
Stopped in Traffic	34	0.19	2762	0.40	0.485*	-36.037
Making U-Turn	8	0.05	4321	0.63	0.073	-101.569
E Overtaking/Passing	52	0.30	8565	1.24	0.239*	-165.185
E Entering Main Road	37	0.21	18792	2.72	0.078*	-439.514
Backing	50	0.29	33353	4.82	0.059*	-795.742
Slowing/Stopping	211	1.20	40727	5.89	0.204*	-821.726
Turning Right	123	0.70	38493	5.57	0.126*	-853.078
E Changing Lanes	181	1.03	44311	6.41	0.161*	-942.607
Turning Left	231	1.32	87066	12.59	0.105*	-1976.758

Certain vehicle maneuvers might avoid DrD if employed prior to the DrD. In this case, Movement Essentially Straight is the largest cause, which seems reasonable. Curves, Leaving the Main Road and other items with relatively few DrD crashes might be favorable in keeping the driver awake.

6. IMPACT Displays – Severity 25, 38, 60, 224

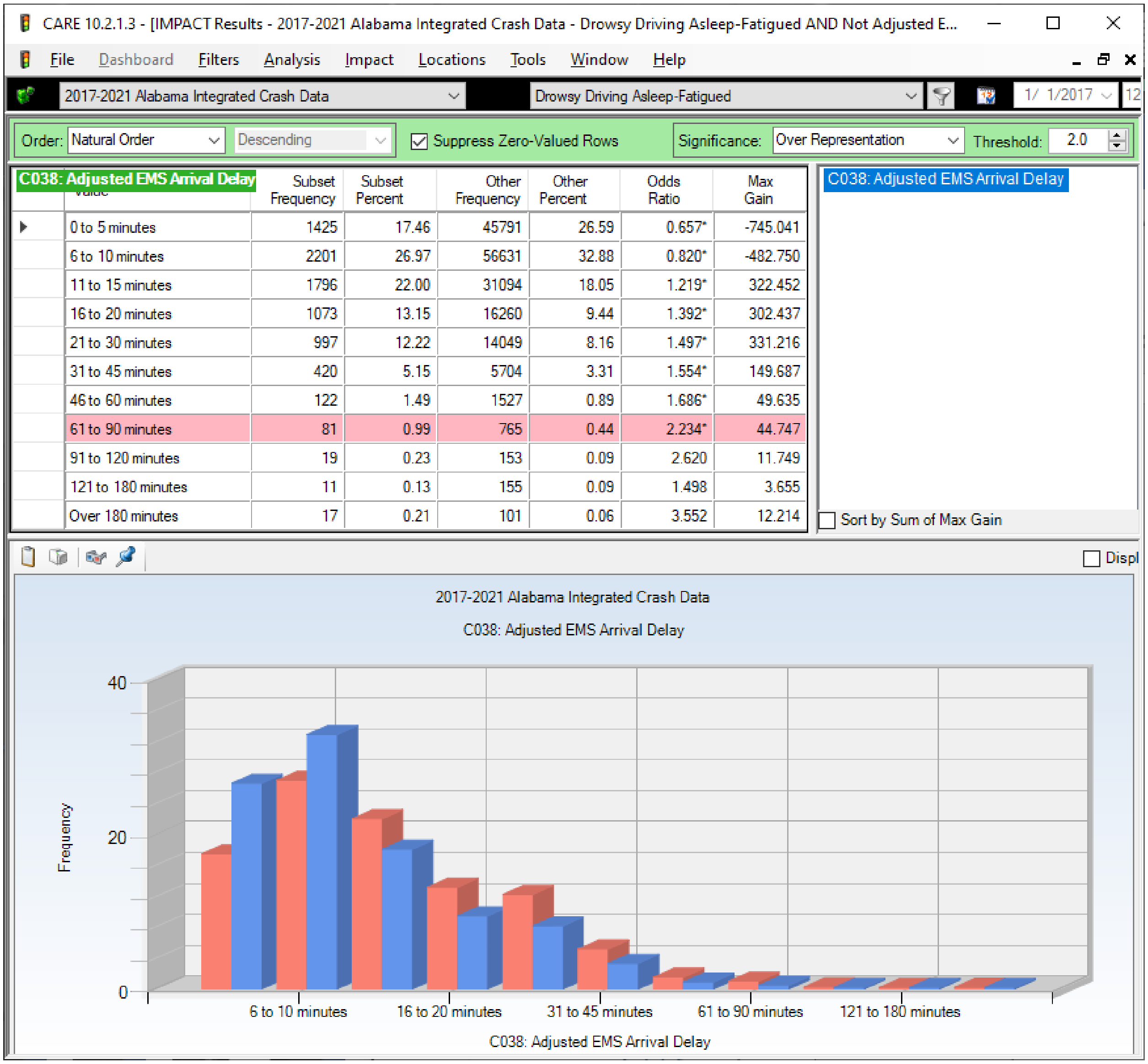
C025 Crash Severity



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	168	0.94	4153	0.56	1.694*	68.801
Suspected Serious Injury	1471	8.27	20725	2.78	2.971*	975.958
Suspected Minor Injury	3043	17.10	57020	7.66	2.234*	1681.008
Possible Injury	2083	11.71	66314	8.90	1.315*	499.010
Property Damage Only	10572	59.42	576599	77.41	0.768*	-3200.763
Unknown	455	2.56	20054	2.69	0.950	-24.014

The general conclusion is that DrD crashes have greater severity that those that are non-DrD. The proportions of all severities, and especially Suspected Serious Injury and Suspected Minor Injury are significantly higher than the corresponding non-DrD severities.

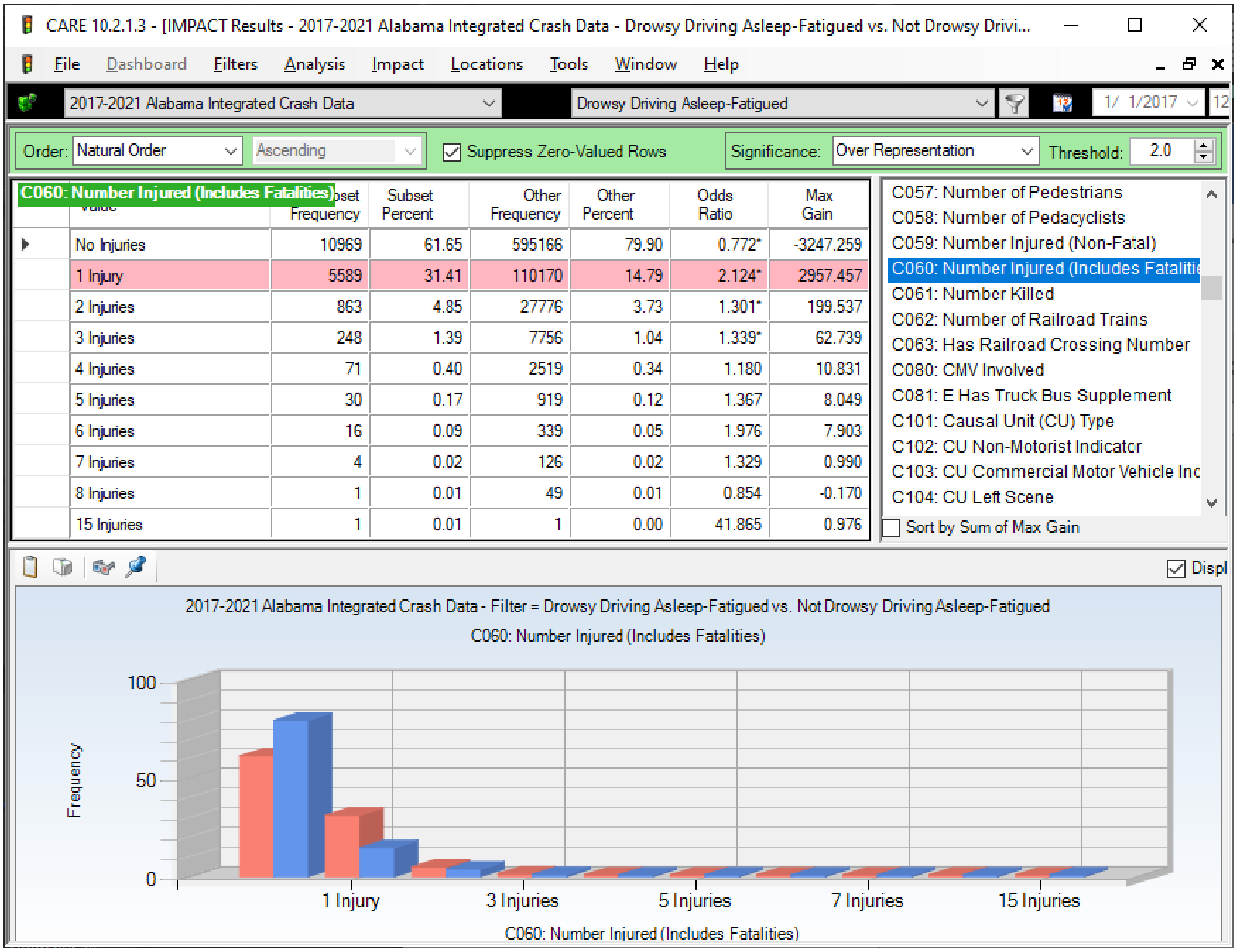
C038 Adjusted EMS Arrival Delay



C038: Adjusted EMS Arrival Delay	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	1425	17.46	45791	26.59	0.657*	-745.041
6 to 10 minutes	2201	26.97	56631	32.88	0.820*	-482.750
11 to 15 minutes	1796	22.00	31094	18.05	1.219*	322.452
16 to 20 minutes	1073	13.15	16260	9.44	1.392*	302.437
21 to 30 minutes	997	12.22	14049	8.16	1.497*	331.216
31 to 45 minutes	420	5.15	5704	3.31	1.554*	149.687
46 to 60 minutes	122	1.49	1527	0.89	1.686*	49.635
61 to 90 minutes	81	0.99	765	0.44	2.234*	44.747
91 to 120 minutes	19	0.23	153	0.09	2.620	11.749
121 to 180 minutes	11	0.13	155	0.09	1.498	3.655
Over 180 minutes	17	0.21	101	0.06	3.552	12.214

Generally, the EMS arrival delay time is longer for DrD crashes than for non-DrD. To some extent this is due to their predominance in rural areas and night times.

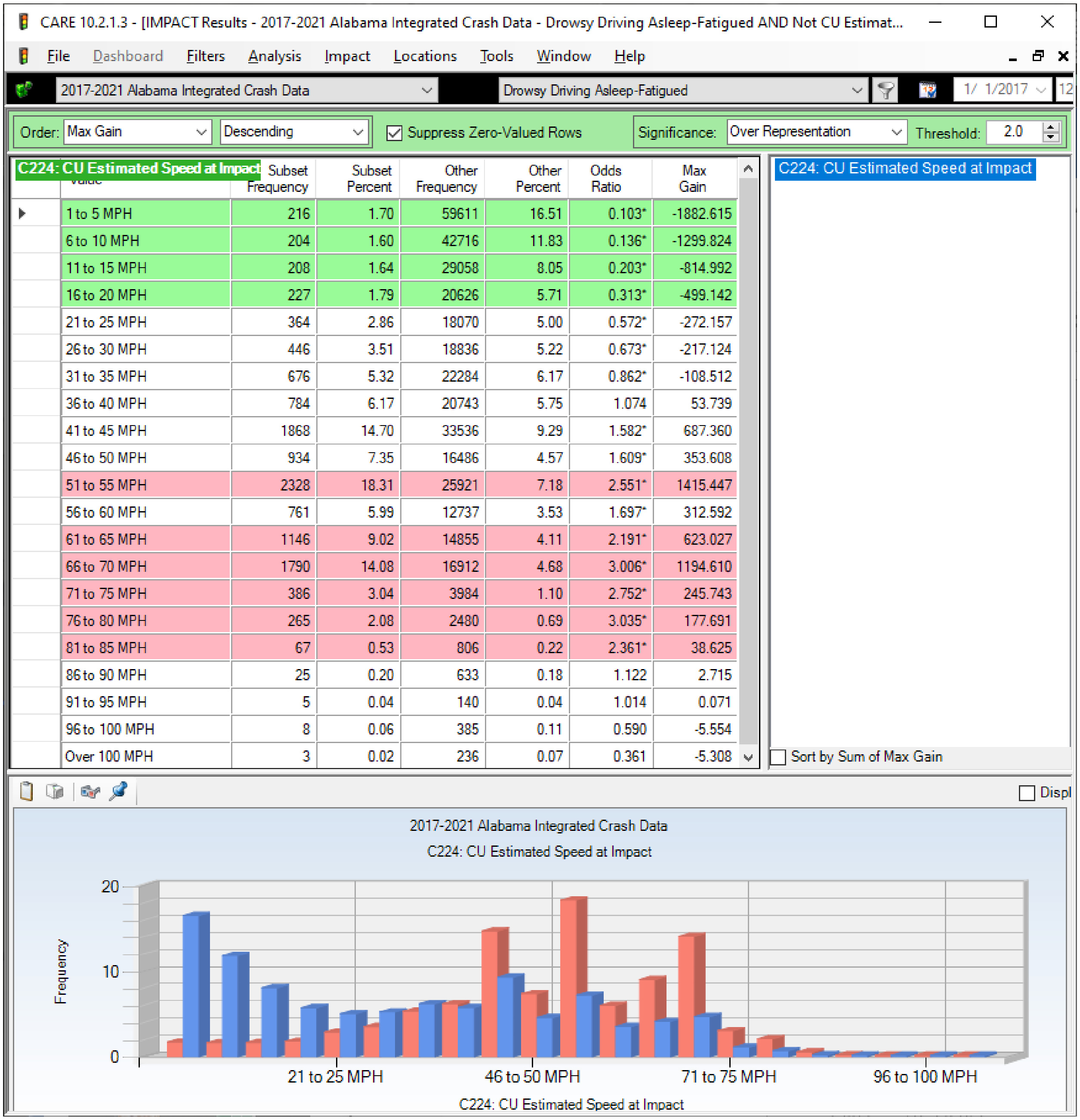
C060 Number Injured (Including Fatalities)



Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
No Injuries	10969	61.65	595166	79.90	0.772*	-3247.259
1 Injury	5589	31.41	110170	14.79	2.124*	2957.457
2 Injuries	863	4.85	27776	3.73	1.301*	199.537
3 Injuries	248	1.39	7756	1.04	1.339*	62.739
4 Injuries	71	0.40	2519	0.34	1.180	10.831
5 Injuries	30	0.17	919	0.12	1.367	8.049
6 Injuries	16	0.09	339	0.05	1.976	7.903
7 Injuries	4	0.02	126	0.02	1.329	0.990
8 Injuries	1	0.01	49	0.01	0.854	-0.170
15 Injuries	1	0.01	1	0.00	41.865	0.976

First notice that the proportion of no-injury DrD crashes is significantly lower (Odds Ratio of 0.772) than the non-DrD crashes. One, two and three injury crashes are significantly higher for DrD than for non-DrD.

C224 CU Estimated Speed at Impact



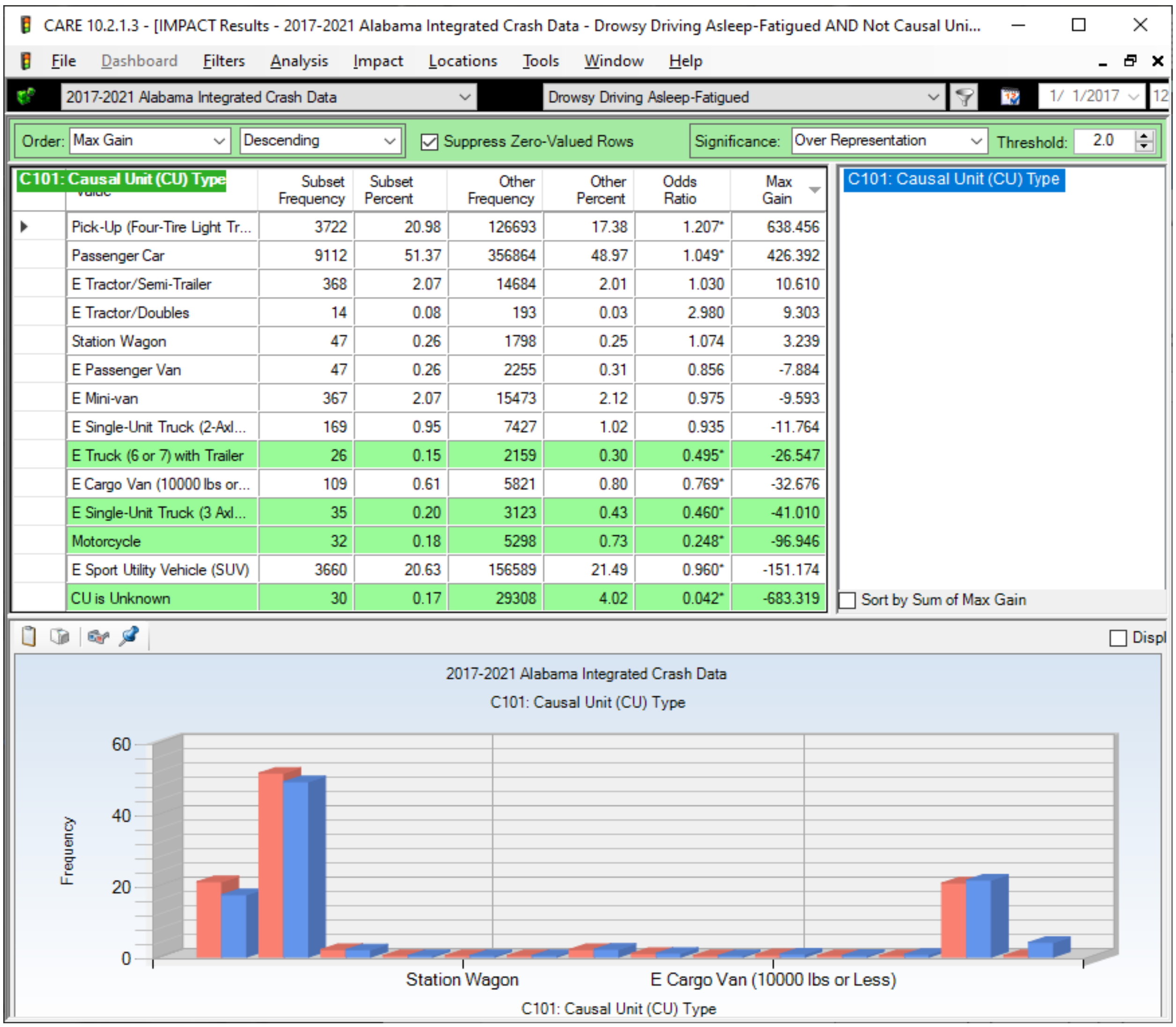
C224: CU Estimated Speed at Impact Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 to 5 MPH	216	1.70	59611	16.51	0.103*	-1882.615
6 to 10 MPH	204	1.60	42716	11.83	0.136*	-1299.824
11 to 15 MPH	208	1.64	29058	8.05	0.203*	-814.992
16 to 20 MPH	227	1.79	20626	5.71	0.313*	-499.142
21 to 25 MPH	364	2.86	18070	5.00	0.572*	-272.157
26 to 30 MPH	446	3.51	18836	5.22	0.673*	-217.124
31 to 35 MPH	676	5.32	22284	6.17	0.862*	-108.512
36 to 40 MPH	784	6.17	20743	5.75	1.074	53.739
41 to 45 MPH	1868	14.70	33536	9.29	1.582*	687.360
46 to 50 MPH	934	7.35	16486	4.57	1.609*	353.608
51 to 55 MPH	2328	18.31	25921	7.18	2.551*	1415.447
56 to 60 MPH	761	5.99	12737	3.53	1.697*	312.592
61 to 65 MPH	1146	9.02	14855	4.11	2.191*	623.027
66 to 70 MPH	1790	14.08	16912	4.68	3.006*	1194.610
71 to 75 MPH	386	3.04	3984	1.10	2.752*	245.743
76 to 80 MPH	265	2.08	2480	0.69	3.035*	177.691
81 to 85 MPH	67	0.53	806	0.22	2.361*	38.625
86 to 90 MPH	25	0.20	633	0.18	1.122	2.715
91 to 95 MPH	5	0.04	140	0.04	1.014	0.071
96 to 100 MPH	8	0.06	385	0.11	0.590	-5.554
Over 100 MPH	3	0.02	236	0.07	0.361	-5.308

The reason for the higher severities is always speed. Here it is clear that speeds in excess of 50 MPH are very significantly over-represented (most in excess of twice the expected in comparison with non-DrD crashes. Over-representations continue up to 95 MPH.

7. IMPACT Displays – Vehicle 101, 129, 208

C101 Causal Unit (CU) Type

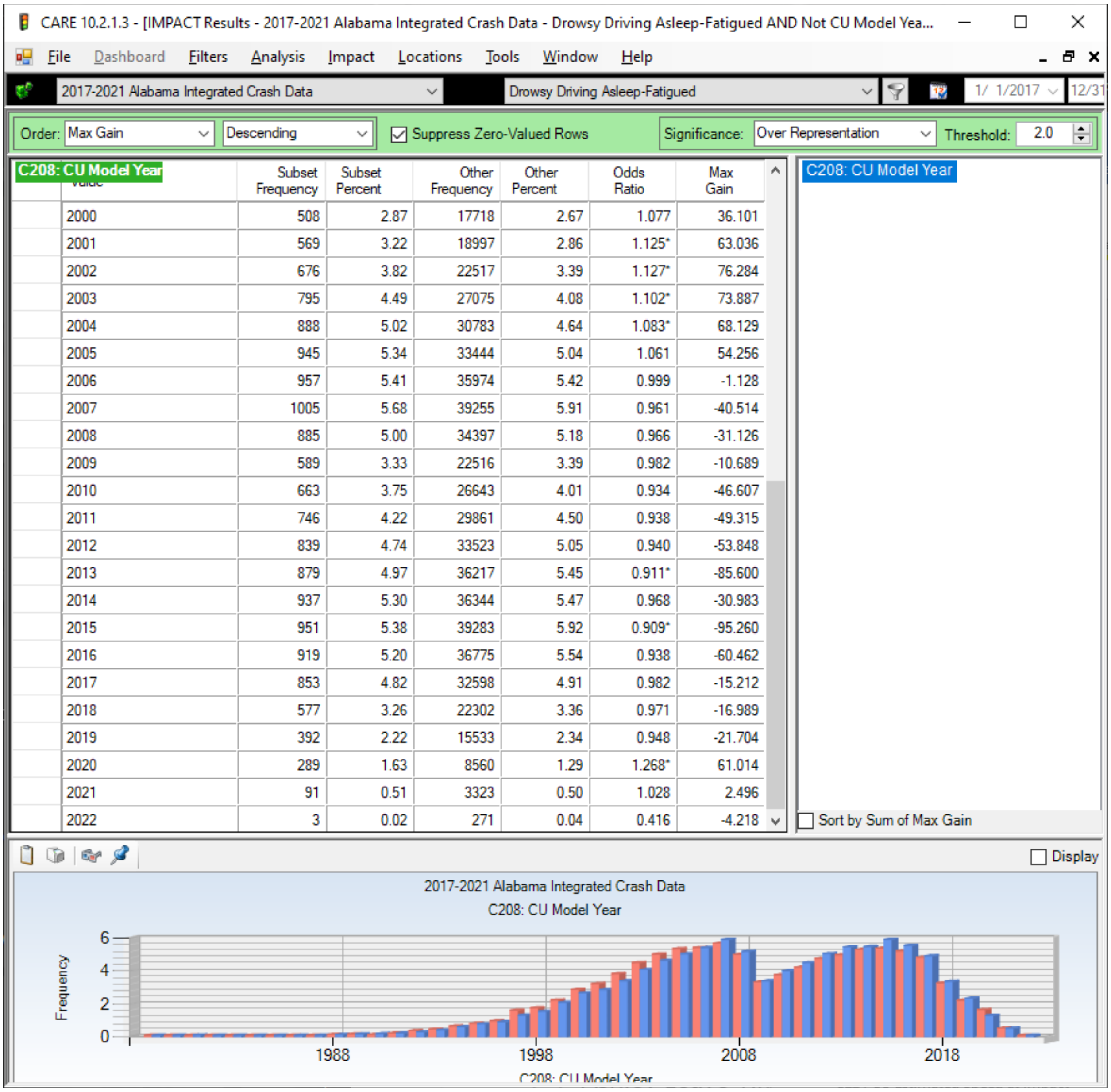
All items with less than 10 crashes in the subset were removed.



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Pick-Up (Four-Tire Light Tr...	3722	20.98	126693	17.38	1.207*	638.456
Passenger Car	9112	51.37	356864	48.97	1.049*	426.392
E Tractor/Semi-Trailer	368	2.07	14684	2.01	1.030	10.610
E Tractor/Doubles	14	0.08	193	0.03	2.980	9.303
Station Wagon	47	0.26	1798	0.25	1.074	3.239
E Passenger Van	47	0.26	2255	0.31	0.856	-7.884
E Mini-van	367	2.07	15473	2.12	0.975	-9.593
E Single-Unit Truck (2-Axl...	169	0.95	7427	1.02	0.935	-11.764
E Truck (6 or 7) with Trailer	26	0.15	2159	0.30	0.495*	-26.547
E Cargo Van (10000 lbs or...	109	0.61	5821	0.80	0.769*	-32.676
E Single-Unit Truck (3 Axl...	35	0.20	3123	0.43	0.460*	-41.010
Motorcycle	32	0.18	5298	0.73	0.248*	-96.946
E Sport Utility Vehicle (SUV)	3660	20.63	156589	21.49	0.960*	-151.174
CU is Unknown	30	0.17	29308	4.02	0.042*	-683.319

Pick-ups have the largest Odds Ratio (1.207), which is significantly higher than Passenger Cars (1.049) despite the fact that it’s frequency (3,722) is only about a third of Passenger Cars (9,112). Frequencies are considerably smaller for the rest of the causal unit types.

C208 CU Model Year

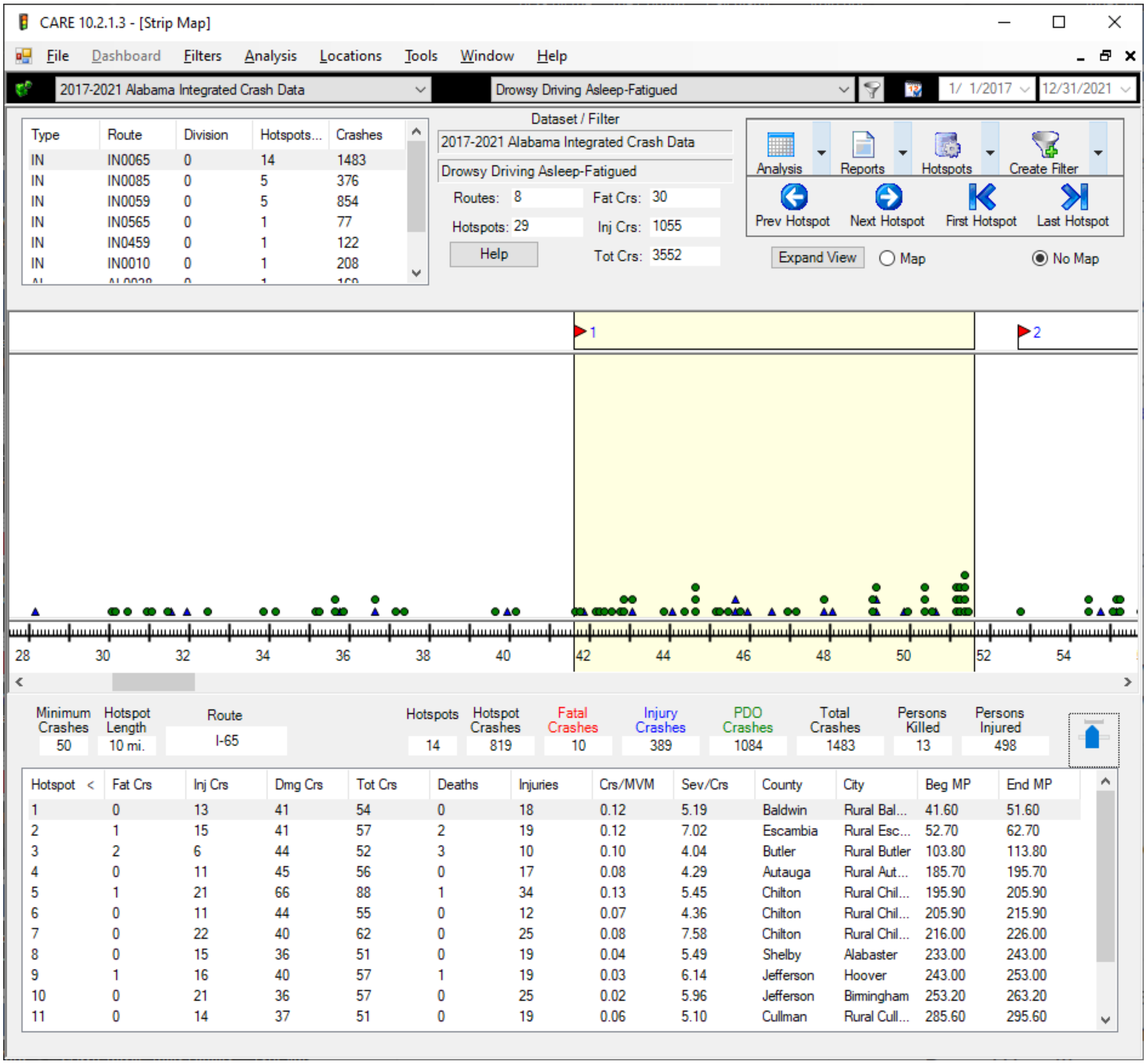


C208: CU Model Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2000	508	2.87	17718	2.67	1.077	36.101
2001	569	3.22	18997	2.86	1.125*	63.036
2002	676	3.82	22517	3.39	1.127*	76.284
2003	795	4.49	27075	4.08	1.102*	73.887
2004	888	5.02	30783	4.64	1.083*	68.129
2005	945	5.34	33444	5.04	1.061	54.256
2006	957	5.41	35974	5.42	0.999	-1.128
2007	1005	5.68	39255	5.91	0.961	-40.514
2008	885	5.00	34397	5.18	0.966	-31.126
2009	589	3.33	22516	3.39	0.982	-10.689
2010	663	3.75	26643	4.01	0.934	-46.607
2011	746	4.22	29861	4.50	0.938	-49.315
2012	839	4.74	33523	5.05	0.940	-53.848
2013	879	4.97	36217	5.45	0.911*	-85.600
2014	937	5.30	36344	5.47	0.968	-30.983
2015	951	5.38	39283	5.92	0.909*	-95.260
2016	919	5.20	36775	5.54	0.938	-60.462
2017	853	4.82	32598	4.91	0.982	-15.212
2018	577	3.26	22302	3.36	0.971	-16.989
2019	392	2.22	15533	2.34	0.948	-21.704
2020	289	1.63	8560	1.29	1.268*	61.014
2021	91	0.51	3323	0.50	1.028	2.496
2022	3	0.02	271	0.04	0.416	-4.218

The recent model years effectively reflect the vehicle ages that are on the road after the recession of 2008. Prior to that the vehicles involved in DrD crashes were over-represented in the current model years. Please note that Years here are vehicle model years and not necessarily the year that the crashes took place.

8. DrD Hotspot Analysis Example Excerpt from I-65

The criteria for this example is 50 DrD crashes in any 10 mile segment. There were 29 such hotspots found on 8 routes, for a total of 3,552 DrD crashes found on the mileposted routes under consideration. Of these 30 were fatal and 1,055 were non-fatal injury crashes.



Interesting that the first hotspot, which is shown on the strip map is not in the dense traffic in Mobile (which would be typical for most hotspot filters for I-65), but is shown beginning at Milepost 41.60, over 40 miles north of that heavier traffic, giving drivers adequate time to become drowsy. This also reflects its occurrence in a rural area.Revisit of C028 Mileposted

Routes. This is one of the most important findings in that differentiates the particular roadways that exhibit a proclivity toward DrD. The SJ report showed clearly that some roadway types are more prone to create the conditions for DrD than others. Findings from Alabama confirm this result, showing that some roadways have up to five times the relative proportion of DrD crashes than those of non-DrD crashes. The IMPACT display C028 in Section 3 shows the top 17 DrD Max Gain roadways, where the Max Gain is the number of crashes that would be reduced if the proportion of DrD crashes was reduced to the same as the proportion of non-DrD crashes. The highest of these was I-65, which had a max gain of 571.202 crashes (over the five-year period of the study). Recognize that the Max Gain will be affected by the length and volume of traffic on the subject roadway segment. However, this sensitivity to ADT and segment length does not affect the Odds Ratio, which compares the proportion of DrD against non-DrD crashes <u>on that same segment's volume and time</u>. An example Hotspot analysis for DrD crashes on I-65 is given above. This is an excerpt of the type of analysis that is available to all law enforcement in Alabama via CARE. Recall that the red background for lines in the table indicates that the item's DrD proportion is at least twice that of its non-DrD proportion.

The hotspot analyses that follow for Interstates used the criterion of at least 60 DrD crashes in ten miles over the past 5 years. The non-mileposted analysis used the criterion of at least 10 DrD crashes at a segment or an intersection.

CARE Route Hotspot Listing

Date: 12/8/2022
Dataset: 2017-2021 Alabama Integrated Crash Data   Filter: Drowsy Driving Asleep-Fatigued
Date Range: 1/1/2017 - 12/31/2021
Overlaps Enabled: No
Number of Hotspots: 14
Minimum Crashes: 60
Segment Length: 10.0 miles

Route: I-65
Number of Hotspots: 8

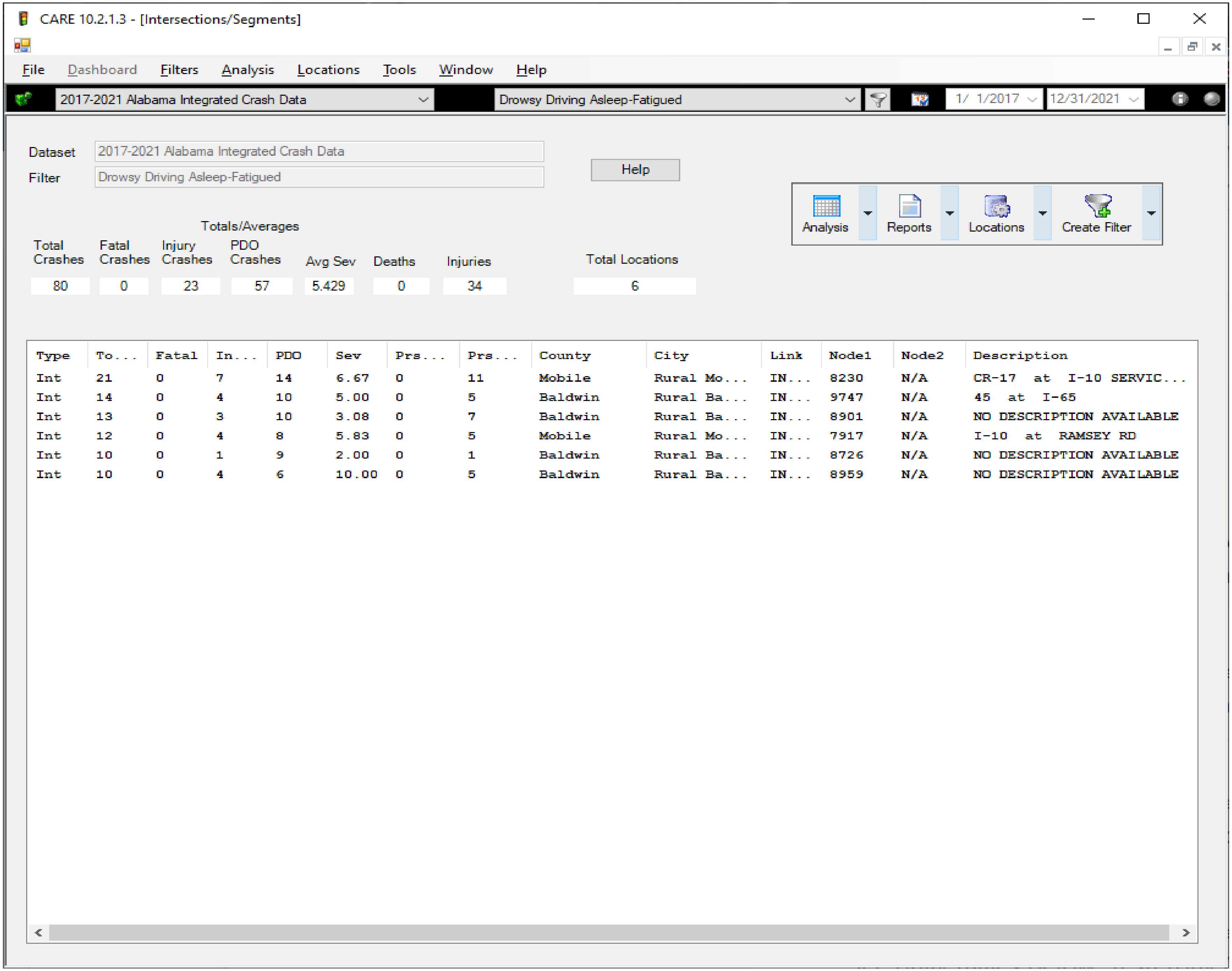
Route	Fatal	Injury	Damage	Total	Killed	Inj	C/MVM	S/CRS	County	City	Beg MP	End MP
I-65	1	17	46	64	2	23	0.13	6.88	Escambia	Rural Escambia	54.40	64.40
I-65	0	12	49	61	0	18	0.09	4.26	Autauga	Rural Autauga	187.00	197.00
I-65	1	19	62	82	1	32	0.12	5.49	Chilton	Rural Chilton	197.00	207.00
I-65	0	19	47	66	0	21	0.08	6.36	Chilton	Rural Chilton	207.90	217.90
I-65	1	18	43	62	1	23	0.04	5.97	Shelby	Pelham	236.90	246.90
I-65	0	21	40	61	0	25	0.03	5.90	Jefferson	Hoover	248.90	258.90
I-65	0	18	45	63	0	23	0.08	4.76	Cullman	Rural Cullman	287.50	297.50
I-65	0	6	62	68	0	6	0.07	1.47	Cullman	Rural Cullman	297.50	307.50

Route: I-59
Number of Hotspots: 4

Route	Fatal	Injury	Damage	Total	Killed	Inj	C/MVM	S/CRS	County	City	Beg MP	End MP
I-59	0	19	41	60	0	21	0.06	6.17	Tuscaloosa	Rural Tuscaloosa	69.50	79.50
I-59	0	27	33	60	0	34	0.06	6.50	Jefferson	Bessemer	100.10	110.10
I-59	0	18	58	76	0	25	0.06	4.08	Jefferson	Rural Jefferson	110.90	120.90
I-59	1	24	43	68	1	32	0.03	7.50	Jefferson	Birmingham	121.30	131.30

Route: I-85
Number of Hotspots: 2

Route	Fatal	Injury	Damage	Total	Killed	Inj	C/MVM	S/CRS	County	City	Beg MP	End MP
I-85	0	16	44	60	0	19	0.08	3.83	Montgomery	Rural Montgomery	11.10	21.10
I-85	1	25	43	69	1	28	0.08	6.67	Lee	Opelika	54.00	64.00


CARE 10.2.1.3 - [Intersections/Segments]
File Dashboard Filters Analysis Locations Tools Window Help
2017-2021 Alabama Integrated Crash Data
Drowsy Driving Asleep-Fatigued
1/ 1/2017
12/31/2021
Dataset 2017-2021 Alabama Integrated Crash Data
Filter Drowsy Driving Asleep-Fatigued
Help
Analysis
Reports
Locations
Create Filter
Totals/Averages
Total Crashes 80
Fatal Crashes 0
Injury Crashes 23
PDO Crashes 57
Avg Sev 5.429
Deaths 0
Injuries 34
Total Locations 6
Type To... Fatal In... PDO Sev Prs... Prs... County City Link Node1 Node2 Description
Int 21 0 7 14 6.67 0 11 Mobile Rural Mo... IN... 8230 N/A CR-17 at I-10 SERVIC...
Int 14 0 4 10 5.00 0 5 Baldwin Rural Ba... IN... 9747 N/A 45 at I-65
Int 13 0 3 10 3.08 0 7 Baldwin Rural Ba... IN... 8901 N/A NO DESCRIPTION AVAILABLE
Int 12 0 4 8 5.83 0 5 Mobile Rural Mo... IN... 7917 N/A I-10 at RAMSEY RD
Int 10 0 1 9 2.00 0 1 Baldwin Rural Ba... IN... 8726 N/A NO DESCRIPTION AVAILABLE
Int 10 0 4 6 10.00 0 5 Baldwin Rural Ba... IN... 8959 N/A NO DESCRIPTION AVAILABLE