Weather Fatal Crashes IMPACT Special Study

Weather Fatal Crashes (WFCs) vs Weather Non-Fatal Crashes (WNFCs)

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See http://www.safehomealabama.gov/caps-special-studies/ for all CAPS Special Studies.

0.0 Introduction

In this study, the following weather conditions will be considered as potentially resulting in crashes that are negatively affected by weather: Fog. Mist, Rain, Blowing Snow, and Severe Winds. There will be some analyses where these will be elaborated upon and compared, but for the most part these will be considered collectively and references as “Weather” crashes. The major comparison will compare Weather Fatal Crashes (WFCs) with Weather Non-Fatal Crashes (WNFCs). While there are definitely some fatal crashes that occur in Clear and Cloudy weather, these will be ignored in this study so that the negative effects of weather can be evaluated.

Over the five years of data (CY2018-2022) used in this study, there were 105,495 weather related motor vehicle crashes. These resulted in the following crash severities for each of the weather-involved conditions as defined for this study:

Severity of Weather-Involved Crashes

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2018-2022 Alabama Integrated eCrash Crash Data | Weather Items with at least one fatal crash | 1/ 1/201

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	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
Fog	57 10.27%	194 7.80%	459 5.41%	290 3.18%	2868 3.50%	111 3.92%	3979 3.77%
E Mist	93 16.76%	443 17.81%	1341 15.79%	1500 16.43%	13465 16.42%	520 18.36%	17362 16.46%
Rain	402 72.43%	1839 73.91%	6668 78.52%	7317 80.15%	65389 79.74%	2192 77.37%	83807 79.44%
E Blowing Snow	1 0.18%	0 0.00%	1 0.01%	3 0.03%	20 0.02%	3 0.11%	28 0.03%
Severe Winds	2 0.36%	12 0.48%	23 0.27%	19 0.21%	256 0.31%	7 0.25%	319 0.30%
TOTAL	555 0.53%	2488 2.36%	8492 8.05%	9129 8.65%	81998 77.73%	2833 2.69%	105495 100.00%

Of these, 2833 had unknown severities. Thus, the number of Weather related crashes that will be use in the IMPACT comparisons is 105495-2833 = 102,662. We must also deduct the 555 fatal crashes in order to get the total WNFCs in the control subset; this gives 102,662 – 555 = 102,107. The table at the top of the next page compares the various weather involved items as we have defined them. The sample sizes for Blowing Snow and Severe Winds are much too small to draw any conclusions in comparisons to the other items. For those with adequate sample sizes, it seems clear that Fog is the worst weather condition followed by Mist and Rain. It is interesting to note that the similar statistics for Clear Weather, resulted in 2937 fatal crashes in 500,277 total crashes, or a Percent Fatal of 0.59%. This is a higher percent than that of Mist or Rain below, which is indicative of the reduced speed in these conditions.

Severity by Weather Condition

Weather Condition	Fatal Crashes	Total Crashes (Known)	Percent Fatal
Fog	57	3,879 (3,768)	1.47%
Mist	93	17,362 (16,842)	0.54%
Rain	402	83,807 (81,625)	0.48%
Blowing Snow	1	28 (25)	3.57%
Severe Winds	2	319 (312)	0.62%
TOTAL	555	(102,662)	0.54%

We did not include Clear or Cloudy weather conditions in our analysis in order to better focus on those weather conditions that can result in a greater number of crashes and potential fatalities.

In this report the word “Weather” will be used to refer to Weather-Related Crashes. Crashes that occur during clear or cloudy weather were excluded. The purpose of this report is to provide information by which the total number of Weather Fatal Crashes (WFCs) may be reduced, and to reduce the severity of the *potential* WFCs that will occur so that fewer of them result in fatalities. Thus, Weather Fatal Crashes (WFCs) are those that occur during any one of the five conditions given in the table above.

The primary analytical technique employed to generate most of the displays for this purpose (in Sections 4-8) is a component within the Critical Analysis Reporting Environment (CARE) called Information Mining Performance Analysis Control Technique (IMPACT). For a detailed description of the meaning of each element of the IMPACT outputs, please see: http://www.caps.ua.edu/software/care/

Sections 4 through 8 present the results of a number of IMPACT evaluations of Weather Fatal Crashes (WFCs) compared to Weather Non-Fatal Crashes (WNFCs) over a recent five-year period (CY2018-2022). The purpose of these comparisons is to determine the causes of fatal crashes that might distinguish those that involve Weather Fatal Crashes (WFCs) from Weather Non-Fatal Crashes (WNFCs). This is different from many of the other Special Studies that have been performed, which had the goals of reducing all of a particular type of crash regardless of severity, not concentrating on those that were fatal.

IMPACT works by surfacing “over-representations.” An *over-represented* attribute is found in this study when that attribute has a greater share of Weather Fatal Crashes (WFCs) than would be expected if its proportion were the same as that for Weather Non-Fatal Crashes (WNFCs). That is, the WNFC crashes are serving as a *control* to which the WFCs are being compared to determine over-representations, which could typically indicate causes.

As a first example, over the five years of the crash data studied (CY2018-2022), we found that WFCs for the Highway Classification attribute value of “County” had over 50% (57.60%) times higher proportion of crashes than did the Weather Non-Fatal Crashes (WNFCs) on County roads (details in Section 2.3). The Odds Ratio was 1.576*, where the * indicates that the difference in the proportions is statistically significant. The Odds Ratios are calculated from the corresponding proportions, which for this County Road example were 23.60% for WFCs and 14.98% for WNFCs (e.g., 23.60/14.98=1.576). When such differences are statistically significant (as in this case), this is evidence that this attribute should be given additional attention, and in some cases, further analyses are performed to obtain information for *countermeasure* development. For example, additional *selective enforcement* for WFC-related violations (e.g., excessive speed, seatbelts, and Impaired Driving) might concentrate more on County roads than they have in the past. If possible, and not seen as creating hazards, selective enforcement might be performed during inclement weather.

Unless otherwise stated, the items within the tables given above the charts in the IMPACT displays are ordered by *Max Gain*. *Max Gain* is the improvement by WFC reduction that could be obtained if a countermeasure were applied to reduce the proportion of the Weather <u>Fatal</u> Crashes (WFCs) to the proportion of Weather <u>Non-Fatal</u> Crashes (WNFCs) for the particular attribute under consideration. In the Highway Classification example, this would reduce the 23.60% to 14.98%, which would produce the gain of a reduction of 47.875 fatal crashes. (For the complete IMPACT display see Section 2.3). This potential reduction in fatal crashes is called Max Gain because it is generally the maximum gain that could be expected by implementation of the most effective countermeasures. The Max Gain for each attribute value can be seen in the extreme right column of the IMPACT display tables.

This report continues with three sections that provide a high-level summary of the IMPACT results and a more detailed explanation of their specifics. These are called: (1.0) Summary of Findings and Recommendations, (2.0) Filter and IMPACT Set-ups, and (3.0) Weather Fatal Crash Comparison by Year. Section 2.3, as introduced above, is also introductory in that it provides more details of the IMPACT example given above -- a comparison for the Highway Classification attribute that gives us a high-level insight into where the WFCs are occurring.

Section 3 is an IMPACT comparison of the year attribute between fatal and non-fatal Weather crashes (WFCs vs WNFCs). It provides a high level view of how these two factors are increasing/decreasing each year in comparison to one another. After Section 3, the IMPACT comparisons between WFCs and WNFCs are presented, for most relevant attributes, under the following headings, given here with their section numbers:

- 4.0 Geographic and Harmful Event Factors,
- 5.0 Time Factors,
- 6.0 Factors Affecting Severity,
- 7.0 Driver and Vehicle Demographics, and
- 8.0 Driver Behavior.

See the Table of Contents above for a guide to sections of interest.

1.0 Summary of Findings and Recommendations

This section comes immediately after the Introduction in this report for two reasons: (1) for those who do not have time to go through all of the IMPACT analyses, and/or (2) as an introduction to these more detailed IMPACT studies. These summaries are referenced to the more detailed analyses so that any questions regarding their sources can be accessed easily. The following section numbers: (1.1), (1.2), and (1.3), are omitted in this section to maintain consistency of the second digit with the numbering of the analytical sections (Sections 4-8).

Findings and recommendations are organized into the areas of: (1.4) Geographical Factors, (1.5) Time Factors, (1.6) Severity Factors, (1.7) Driver and Vehicle Demographics, and (1.8) Driver Behavior. The ordering of these recommendations, either generally or within their respective categories, is not meant to imply priority. However, the detailed information given should be quite useful in the further prioritization and allocation of traffic safety resources. This process of optimization should consider balancing costs of all of the recommendations, which can be validated against the information presented in the IMPACT Sections 4.0-8.0.

For a special report on traffic safety resource optimization, please see:
http://www.safehomealabama.gov/wp-content/uploads/2019/03/Traffic-Safety-Innov-2017-04.pdf

Terminology: *Expected proportions* (AKA *expectations*) of the WFCs are obtained from the comparison of their proportions with the proportions for their corresponding WNFC control classifications. The IMPACT analyses in this study enables the determination of over-representations in either the WFCs or the WNFCs, which would be an under-representation of the WFCs.

Note: subsection numbers for Sections 1.1, 1.2 and 1.3 have been omitted below in order to keep the subsection numbering system consistent with that of the IMPACT displays that follow. Findings are from the IMPACT analyses in Sections 4-8 that compare WFCs vs WNFCs over the five years of the study (CY2018-2022).

Quick tips to help you survive and save the lives of others:

1. If you do not have a compelling reasons to go out in inclement weather, just stay home and travel when the bad weather clears. This is especially true in the South with regard to fog and snow. Very few drivers have had extensive experience with these conditions. The following items should be observed if delay is impossible.
2. Make sure you and your passengers buckle up; this is your number one defensive action.
3. Do not initiate travel when weather forecasts indicate that the weather will become a problem before you finish your trip.
4. Do not have even one alcohol drink or take any drugs (some of which induce sleep) before driving. These substances have a significant increase on a crash resulting in death.

5. Similarly, do not ride with anyone who has been drinking alcohol or taking drugs. This would be true in all driving situations, but the consequences of these substances are greatly multiplied by the effects of bad weather.
6. In bad weather, stay on well-lit, low speed-limit roads. Avoid remote rural roads.
7. Once you become comfortable in the speed, reduce it another five to ten miles per hour. This can cut your probability of death in half.
8. Reduced speed will also enable you to see pedestrians that could otherwise be invisible in severe weather conditions. See Section 7.6 for advice to pedestrians.
9. Observe and obey all warning signs e.g., sharp curves.
10. Avoid late-night driving since the proportion of impaired drivers increases in the later hours. This is especially true over weekends and before/after holidays.

Recommendations corresponding to each of the findings are given in the bullet list below:

- **1.4 Geographical Factors (4.0)**
  - County (4.1, C001) - Generally, the over-represented fatal crashes in counties are rural with (or near) large population centers. The large population centers increase the traffic and thus the crashes, while being rural generally make a larger proportion of these crashes fatal. Placed in Max Gain order, the six WFC-over-represented counties with the highest Max Gain – potential for fatality reductions – are (with their frequencies): Dekalb 18, Cullman 18, Dallas 12, Talladega 17, Walker 15, St Clair 15, and Macon 8. (Note that the ordering by Max Gain often does not necessarily match the ordering by frequency.) The WNFC-over-represented counties with the highest potential for fatality reduction with their fatal crash frequencies are: Jefferson 70, Madison 21, Mobile 38, Shelby 14, Lee 5, Tuscaloosa 20 and Montgomery 22. It is recommended that these and the over-represented counties be given special attention for both weather-related fatality and crash reduction. Generally, the countermeasures recommended to be applied to specific roadway segments are determined by hotspot analysis. They consist of selective enforcement for Speed, Seatbelts, and Impaired Driving as well as other driver faults that are given in Section 8.
  - City (4.2, C002) -- Comparisons of WFCs to WNFCs view rural areas of counties as separate “virtual cities.” There is little surprise in the number of rural areas in this listing. In Section 4.2, City (and rural virtual city) comparisons are presented in the IMPACT table for all areas that had Max Gains greater than 4.5. The top 6 WFC-over-represented Cities are: Rural Cullman 17, Rural Dekalb 13, Rural Talladega 14, Rural Walker 13, Rural Dallas 11, Rural Jefferson 28, Rural St Clair 12, and Rural Mobile 15. The top five WNFC-over-represented Cities with their expected fatal crash numbers are: Mobile 20, Birmingham 34, Huntsville 17, Tuscaloosa 5, and Montgomery 14. It is recommended that the cities with a high frequencies of fatal crashes be given special guidance, and perhaps additional funding, along with the most over-represented cities. Many such large city areas have a considerable amount of Open Country that tends to increase their fatality

count, as will be discussed in the Locale attribute in Section 4.4. The presence of patrol police alone can bring speeds down to a point that fatalities are reduced accordingly (See Sections 6.2 and 6.3).

- Rural/Urban (4.3, C010) Weather Fatal Crash (WFC) Proportion – WFCs occurred in 62.70% Rural and 37.30% Urban areas. This attribute is determined by the city limits boundaries as opposed to the speed limits or other environmental factors (see Locale immediately below). For WNFCs, these proportions came out to be 28.42% Rural and 71.58% Urban, which demonstrates further that the non-fatal crashes tend to be in the urban areas. Concentration for fatality reduction is recommended in Rural areas where hotspot analyses determines that there are concentrations of fatal crashes. Recommendations to reduce fatalities within any of the Rural areas include:
  - Implement a larger police presence in the more critical areas,
  - Lower the speed limits in frequent crash areas, and
  - Add special speed yellow warning signs in speed-vulnerable areas.

  Anyone wishing analysis of different additional cities, counties, or other areas, please contact CAPS – please email brown@cs.ua.edu.
- Locale (4.4, C033) – Open Country shows a high level of over-representation in the WFCs (374, 67.39%). Those countermeasures recommended for rural areas would be applicable to Open Country areas within city limits, which in most cases have traffic equivalent to rural areas, as illustrated in the next display in Section 4.5. While their proportions were not over-represented, the following had very high WFC frequencies: Shopping or Business 89, and Residential 80.
- Cross-tabulation of Locale (4.5, C033) by Rural/Urban (C010) for WFCs (fatal crashes). The largest number of WFCs were in the Rural, Open Country specifications, with 316 WFCs. This illustrates that the Locale attribute is more definitive in specifying the surrounding areas of crashes than is the Rural/Urban attribute. Recommendations for rural areas apply equally to Open Country Locales.
- Highway Classifications (4.6, C011) – in order of Max Gains, the largest was State 160, followed by County 131, and Federal 95. Interstate 87 was under-represented. These results are closely related to the number of Fatal Crashes per mile on the respective Highway Classifications. Some selective enforcement done on Interstates might be performed on these other roadway systems, especially during periods of inclement weather.
- Most Harmful Event (4.7, C019) – ordered by Max Gain. The following items had the largest number of fatality occurrences (listed in Max Gain order with their fatal crash frequencies):

WEATHER FATAL CRASH (WFC)	FREQUENCY
Collision with Tree	115
Collision with Non-Motorist: Pedestrian	51

Overturn/Rollover	51
Fire/Explosion	11
Collision with Utility Pole	18

Recommendations to reduce the various most harmful events need to be quite broad to cover all of the various route causes for the types of crashes listed. For more information on this, see the Driver Behavior recommendations in Sections 8.1-8.4. See Section 7.5 for recommendations to reduce pedestrian crashes.

- Roadway Curvature and Grade (4.8, C407). The following items were the most significantly over-represented (given with frequencies):

Weather Fatal Crashes (WFCs)	**FREQUENCY**
Curve Right and Down Grade	36**
Curve Left and Level	36**
Curve Left and Downgrade	28*
Curve Right and Level	25
Straight at Hillcrest	9
Straight with Down Grade	61
Curve Left and Upgrade	11

* Highly Over-represented
** Very Highly over-represented

Recommendations include selective enforcement and speed-limit-reduction (e.g., advisory speed and curve warning signs) concentrating on all of the curve types given above. The application of Advisory Speed Limits for Curves might be improved by considering the recent release of GDOT_16-31 (trb.org) entitled: *An Enhanced Network-Level Curve Safety Assessment and Monitoring Using Mobile Devices*; GDOT_16-31 (trb.org). This report appears at:

http://www.safehomealbama.gov/tag/road-improvements

Other engineering recommendations should evaluate crashes at curves based on hotspot analyses, especially those curves with grades.

- **1.5 Time Factors (5.0)**
  - Year (5.1, C003) – Year 2019 was significantly under-represented in WFCs and 2021 was over-represented. This reflects what appears to be an increase in the last two years. The reason for these increased WFC proportions is not definitive, but it is recommended that this consistent increase should be watched to determine a cause in future years, since this might be an early indication that the proportions of Weather Fatal Crashes (WFCs) per year are increasing over time.
  - Month (5.2, C004) – The proportions of WFCs and WNFCs correlated with each other closely in all months (no significant over-representations were found). January and May had the largest positive Odds Ratios, and they may be given special selective enforcement concentration, with specific Weather locations

determined by hotspot analyses. This could also signal an increase in law enforcement presence during inclement weather even if not conducting selective enforcement for safety reasons.

- Day of the Week (2.3, 5.7 C006) – Sunday had the only statistically significant over-representation, although Monday had more WFCs. The over-representations on Saturday and Sunday would give some indication of Impaired Driving (Alcohol and/or Non-Alcohol Drugs) being involved. It will be shown in Sections 5.6 and 5.7 the degree that ID accounts for some of the higher proportions of weekend fatal crashes. This being the case, it is recommended that the countermeasures for ID be emphasized in the times indicated by the Time by Day crosstab, and the locations by hotspot analysis. See Sections 8.3 and 8.4 for specific ID analyses.
- Time of Day (5.5-5.6, C008) – In *Natural Time Order*. In addition to Impaired Driving (ID), some of the late-night crashes are due to drowsiness causing, among other things, a diminished ability to see road edge lines. The ID recommendations apply particularly to these over-represented times. See Sections 5.6- 5.7 next for more on time of day implications.
- Time of Day by Day of the Week (5.6-5.7, C008 x C006) – *For all Weather fatal crashes.* This quantifies the extent of the fatal crash concentrations on Friday nights, Saturday mornings and nights, and Sunday mornings. This is a very useful summary for deploying selective enforcement details, especially during the weekend hours. Recommendations here are to adjust the selective enforcement times to the days of the week and times of day using this cross-tabulation along with hotpot analysis. See further discussion of these findings in Section 5.6.

- **1.6 Factors Affecting Severity (6.0)**
    - Severity for All Highway Classifications (6.1, C025, C011) – This cross-tabulation was performed for *<u>all Weather crash records</u>* so that the various severities on the different Highway Classifications could be seen. Note the high fatal over-representations on Federal, State and County roads. For Weather fatality reduction, the enforcement priority is recommended on the State, Federal and County roads. If drivers have the option, this chart could be helpful in assisting them in choosing the safest routes for their trips, especially if they were expecting bad weather.
    - Speed at Impact (6.2, C224) – Impact speeds below 46 MPH are generally over-represented for WNFCs since WNFCs are generally over-represented at slower impact speeds, and the low sample sizes for the WFCs at these speeds prevent their statistical tests for these speeds. Above 46 MPH, it becomes clear that fatal crash probability is increasing exponentially with speed. Several analyses over the past decades have found the general rule of thumb that for every 10 MPH

increase in impact speeds, the probability of the crash being fatal doubles. Thus, the reduction in just 5-10 MPH impact speed will have a major reduction in fatalities. This was validated in the discussion below of the cross-tabulation of impact speeds by severity (Section 6.4). The recommendation here is to perform selective enforcement along with the various PI&E programs that go with it – in other words, use whatever resources are available to bring about an overall speed reduction, and especially those speeds that are violating speed laws. At the same time, additional enforcement is essential to eliminate the other dangerous driver behaviors, which are discussed in Section 8.

- Crash Severity (C025) by Impact Speed (6.3, C224). *<u>for all Weather crashes.</u>* This cross-tabulation gives an idea of the risks involved with increased speed on all highway classifications. The red backgrounds in the first column (Fatal Injury) indicates those speeds that had a significantly higher number of fatal crashes.
- Discussion of severity by Impact Speed (6.4. C025, C244). The speed to death relationship was further validated in the discussion of this cross-tabulation. This topic is given elaboration in Section 6.4, which is a discussion of the Probability of Being Killed crossed by Speed at Impact. The recommendation here is that the information of Section 6.4 be an essential part of the training in all traffic safety educational programs, and especially those involving younger drivers. Emphasize: to save lives, slow down to the speed limit and have all passengers fasten their seat belts. The rule of thumb is that each additional 10 MPH of speed doubles the probability of the crash being a fatality.
- Restraint Use by Drivers in Weather Fatal Collisions (6.5, C323) – Restraint use programs have been quite successful in Alabama. It is recommended that the financial support to these programs be increased to assure that their effectiveness will continue. In particular, special concentration needs to be given to convince all drivers of their additional vulnerability, and how severity might be abated by seatbelts when crashes occur. Generally, the probability of a crash causing death is 1 in 8.6 crashes when restraints are not used – it is 1 in 68.8 crashes when using restraints. So the chances of death are 8 times greater when not restrained. See Section 6.6 for more information on the effectiveness of restraints. In weather related crashes, the probability for none used is (226+2875)/226 = one in 13.7 result in fatalities. The probability when using appropriate restraints is (211+83022)/211 = one in 394.5. So the increase in the probability of the crash resulting in death is increased by a factor of 28.8 if seatbelts are not worn.
- Cross-tabulation: Crash Severity (6.6, C025) by Restraint Use (C323) for All Injury Crashes. A comparison in crashes in general of the probability of a fatal crash indicates that a fatality in an injury crash is 8.0 times more likely if the involved occupants are not using proper restraints (see text under the cross-tabulation in Section 6.6). This multiplier would increase as speeds of impact

increase. Because current restraint-use programs are quite effective, consideration should be given to increase their funding to make them even more universally effective. Restraint effectiveness information should be part of all traffic safety educational programs, and consideration should be given to increasing the fines of having unrestrained passengers.

- Number of Vehicles Involved (6.7, C052) – the number of vehicles involved ranged from two to 10, but the large majority were either one- or two-vehicle crashes. The Odds Ratios indicate that generally, the more vehicles involved, the greater the probability that the crash is a fatality. However, single-vehicle crashes had the both the highest proportion and frequency of fatal crashes. We know of no way for drivers to control how many vehicles will be involved, and so no recommendations are being made for this attribute. Avoiding all crashes also avoids all the higher number of vehicles being involved.
- Police Arrival Delay (6.8, C036) – Police response times to WFCs were less than 20 minutes in 38.93% of the WFC police runs. There can be little doubt that the longer delay times has to do with the proportion of these crashes that were located in rural areas (see C033) and at night. The shorter police responses would generally be expected in those responses to crashes in the urban areas. Recommended is that PI&E programs stress the need to call first responders without delay.
- EMS Arrival Delay (6.9, C038) – Probably because of (1) the severity of the crashes (all being fatal for the test cases), (2) the swiftness/urgency in getting called, and (3) the urgency in getting to the scene, much shorter delay times were recorded than that for the police delays. Generally, we can conclude that very few of the fatalities were caused by excessive EMS delays, since the WFC frequencies drop off rapidly after 45 minutes. It is recognized that first responders are currently doing an excellent job in getting to the scene of the crash as quickly as possible without jeopardizing safety. Delays, if any, are usually caused by a failure to report the crash immediately. Recommendation: PI&E programs should promote quicker notification to EMS and law enforcement.

- **1.7 Driver and Vehicle Demographics (7.0)**
    - Driver Age Range 2 (7.1, C106) – This comparison of WFC causal driver age with those of the WNFCs looks at ages in five year increments. WFC significant under-representations were at the younger driver ranges (16-20 and 21-25 years). WFC significant over-representations were in the middle ages (41-45 and 51-55 years). Typically, the older ages had the higher proportions of WFCs.
    - Crash Driver Gender (7.2, C109) – the breakdown in WFC causal drivers is 65.41% male and 22.34% female. For WNFC cashes, the percentage is 52.78% male and 37.44% female. These gender differences certainly indicate that males

are a greater cause of the fatalities in Weather Crashes (as they are in most crash types), and the recommendation is that, if there are countermeasures specifically for fatal crashes that can be directed toward males, this would be much more cost-effective than those directed equally toward all drivers.

- Cross-tabulation of Driver Gender (7.2, C109) by Speed at Impact (7.3, C224) for *All Weather Fatal Crashes*. To get better insight into the reason for male drivers causing more fatal crashes, this analysis shows that males had impact speeds in excess of the 60 MPH in 119 of their Weather Fatal crashes, while the female number for comparable speeds was 30. Thus, all of the recommendations for speed reduction apply much more to males than to females.
- Causal Unit (Vehicle) Type (7.4, C101) – This result was based on a comparison of WFC Causal Unit Type against the same for WNFCs. The highest over-representations for WFCs was Pedestrian with 42 WFCs, a subset frequency of 7.57% and a huge Odds Ratio of 64.933. Following in Max Gain order were Motorcycles 13, 4-WheelOff Road ATVs 3, and Pick-Ups 99. The proportion of Sport Utility Vehicles (16.58%, 92) and Passenger Cars (45.59%, 253) resulted in their placement at the bottom of the list, indicating that they were under-represented in WFCs despite their high frequency numbers since their WNFC proportions were even greater. It is recommended that countermeasure programs that are currently in effect be continued and augmented to emphasize the special issues that the vehicle types noted above have in Weather-involved crashes.
- Number of Pedestrians (7.5, C057) – Single pedestrian WFC pedestrian crashes occur at a proportion 12.07%. which is 40.282 times greater than their Weather Non-Fatal proportion. See the reference at the end of this blurb for a study that concentrated on pedestrians. Both ID (Impaired Driving) and Impaired Walking, contribute to pedestrian collisions, as well as pedestrians not taking the maximum means for being seen at all times, but especially at night. Wearing reflective clothing, and keeping a flashlight lit at night to be seen of vehicle drivers are two of the most important recommendations since lack of visibility was cited for several pedestrian fatal crashes. Both day and night visibility needs to be emphasized in the lower school grades and continued through the young adult years. Pedestrian training needs to be increased to include the advantages of walking against traffic, wearing of reflective clothing at night, and all the other rules for pedestrian safety, including a strong prohibition of walking while intoxicated with either alcohol or other drugs. Additional pedestrian recommendations are in: http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf
- Driver License Status (7.6, C114) – WFC drivers were under-represented in their causal drivers having Current/Valid drivers' licenses. Suspended and Revoked were both highly significantly over-represented for WFCs with Odds Ratios of 2.245 and 4.120. While not statistically significant, Expired and Unlicensed were

also over-represented. All of this would lead us to believe that those responsible for weather fatal crashes were often not operating within the law.

- Driver Employment Status (7.7, C120) – This analysis indicated that the employment rate for the WFCs was about 31.53%, while that for WNFCs was 49.38%. Lower-than-average employment rates are not surprising because of the underlying drug/alcohol root cause of many fatal crashes (see Sections 8.3-8.4). The correlation between not having a job (or being in school) and being involved in a fatal crash should be watched carefully going forward in that it could affect the type and location of countermeasures.

- **1.8 Driver Behavior (8.0)**
  - Primary Contributing Circumstances – PCC (8.1 and 8.2, C015) Driver behaviors that are concurrent with Weather Fatal Crashes might provide the basis for countermeasure development. Those behaviors that were most highly over-represented in WFCs are given below with their WFC and WNFC percentages:

WFCs PCC Overrepresented/Freq	WFC%	WNFC%
Over Speed Limit 40	9.03%**	2.12%
DUI 42	9.48%	4.55%
Improper Crossing Pedestrian 22	4.97%**	0.16%
Crossed Centerline 29	6.55%**	2.30%
Traveling Wrong Way/Side 17	3.84%	0.64%
Aggressive Operation 24	5.42%**	2.44%
Not Visible (often pedestrian) 10	2.26%	0.08%

** Highly significant difference (> 10%)

It is recommended that special consideration in training and enforcement be given to the issues above. Information for DUI is given next in Sections 8.3 and 8.4.

  - CU Officer's Opinion Impaired Driving – CU Officer's Opinion Impaired Driving – Alcohol (8.3-8.4, C122-C123). We saw ample evidence for fatal crashes being caused by Impaired Driving (ID) in the time of day and day of the week attributes. The two ID attributes (alcohol, C122 and non-alcohol drugs C123) indicate the degree that ID was involved in fatal crashes. For alcohol, the proportion of ID fatal crashes was 4.749 times as many for WFCs as for WNFCs. For drugs this number was 10.081 times as many in crashes that were fatal (WFCs).

    It is quite clear that both ID types dramatically increase the probability of the crash resulting in a fatality. For alcohol, the ID multiplier is 17.77 times the probability that the crash will result in a fatality. For non-alcohol drugs, the multiplier is even worse, at 23.31 times as many. One potential reason for this is the survivability might not be as good with non-alcohol drugs as it is with alcohol. The traffic safety community has long since described the problem as being a combination of inexperieced drivers and inexperienced drinkers, to which we can now add inexperienced drug users.

Recommended countermeasures to reduce both ID types are:

- Perform additional ID enforcement at locations determined by Weather hotspot analysis as well as general ID hotspot analysis.
- Mandate breath-alcohol ignition interlock devices for all convicted of ID.
- Perform an in-depth study to determine if problems exist within the current programs, e.g., how the use of interlock devices can be expanded to be made more generally effective.
- Since the presence of drugs/alcohol often do not reach the reporting threshold, especially in cases involving prescription drugs, continue officer training to produce more accurate reporting, especially for non-alcohol drugs.
- Drug/Alcohol Diversion Programs should continue (or new programs adopted) that concentrate on keeping the age 25 through 35 (typically *social users*) from becoming habitual to the point where they become part of the 36-55-year-old over-representation of predominantly *problem users* (see 7.1 for driver ages).
- Combinations of recreational or medical drugs and alcohol can be particularly lethal, and medical practitioners should warn against such problems and discourage all alcohol and additional drug use for their patients who have indicated either of these combinations, or who are taking other prescription drugs.
- Provide additional publicity on the fact that legalized recreational drugs are not a good alternative to alcohol use. The advertising as such should be outlawed. PI&E programs should take the opposite approach to warn drivers that legalization does not relax their responsibilities.
- Recognize the additional hazards of alcohol or drug use in inclement weather. Do not allow friends or relatives to drive under bad weather circumstances.

2.0 Filter and IMPACT Set-ups

Generally, the analyses performed in this study used IMPACT (See Section 2.1) to compare attributes of Weather Fatal Crashes (WFCs) against the same attributes of Weather Non-Fatal Crashes (WNFCs) over a 5-year time period (FY2018-2022). The objective was to determine all significant differences between attributes within these two subsets of data in order to get an improved understanding as to the fatality crash causes (i.e., who, what, where, when, how, causal driver demographics, etc.). This is accomplished by pinpointing common factors that could be used to address any major inconsistencies between these two subsets of crash data. The findings that are presented should be taken into consideration when optimizing the large variety of countermeasures that exist to reduce both crash frequency and severity for WFCs.

Sections 2 and 3 of this report contain information that will be useful in obtaining a high level orientation toward the IMPACT results that follow (in Sections 4 through 8). This introduction will consist of: (2.1) Introduction to IMPACT, (2.2) Definitions of Filters Used, (2.3) Example IMPACT: Day of the Week, and (3.0) Annual Fatal Crashes by Severity. Section 3 presents another IMPACT example for purposes of further orientation.

2.1 Introduction to IMPACT

The findings of Sections 4.0-8.0 are in displays of comparisons for the various attributes that might have an influence on crash, and especially fatal crash, countermeasure development. The CARE analytical technique employed to generate these comparisons is called Information Mining Performance Analysis Control Technique (IMPACT). Unless otherwise indicated in the IMPACT "Order" box, the outputs will be listed in the order of highest *Max Gain* first. (Time attributes are often in their Natural Order.) *Max Gain* is the number of crashes that would be reduced if the respective attribute proportion was not over-represented (i.e., had an Odds Ratio of 1.000). An *over-represented* value of an attribute is a situation found where that attribute has a greater share (proportion) of crashes in WFCs than would be expected from that given in the WNFCs. Similarly, an *under-represented* value of an attribute is a situation found where that attribute has a smaller share of crashes than what would be expected. Please notice that *expectations* involve a comparison of proportions, not frequencies.

IMPACT will display comparisons of WFCs against their WNFC counterparts. In summary, the WNFC Crashes are serving as a control to which the WFCs are being compared. In this way any inconsistencies related to the WFCs surfaces, and this can be subjected to further analyses. For a detailed description of the meaning of each element of the IMPACT outputs, see:

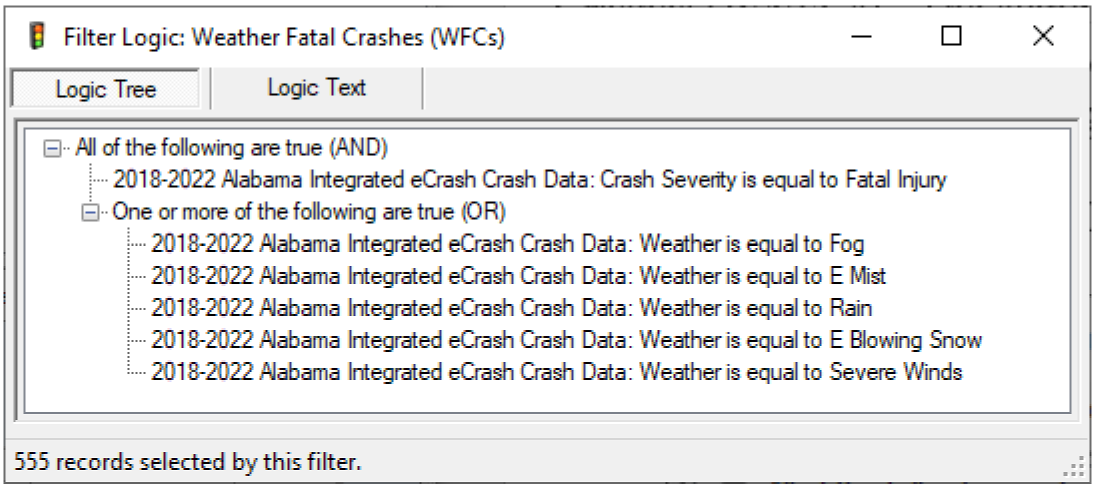
http://www.caps.ua.edu/software/care/

The IMPACT analses are grouped as follow in each of their Sections: 4. Geographical and Harmful Events, 5. Time, 6. Severity, 7. Demographics, and 8. Driver Behavior.

2.2 Filter Definitions for the WFC IMPACT Analyses

The IMPACT analyses will compare Weather Fatal Crashes (WFCs) vs Weather Non-Fatal Crashes (WNFCs). The standard filter for all fatal crashes based on C025 Crash Severity was applied, and separate filters for the WFCs and WNFCs were obtained, where the formal definitions for these two filters are given below.

Formal Definition of Weather Fatal Crashes (WFCs)

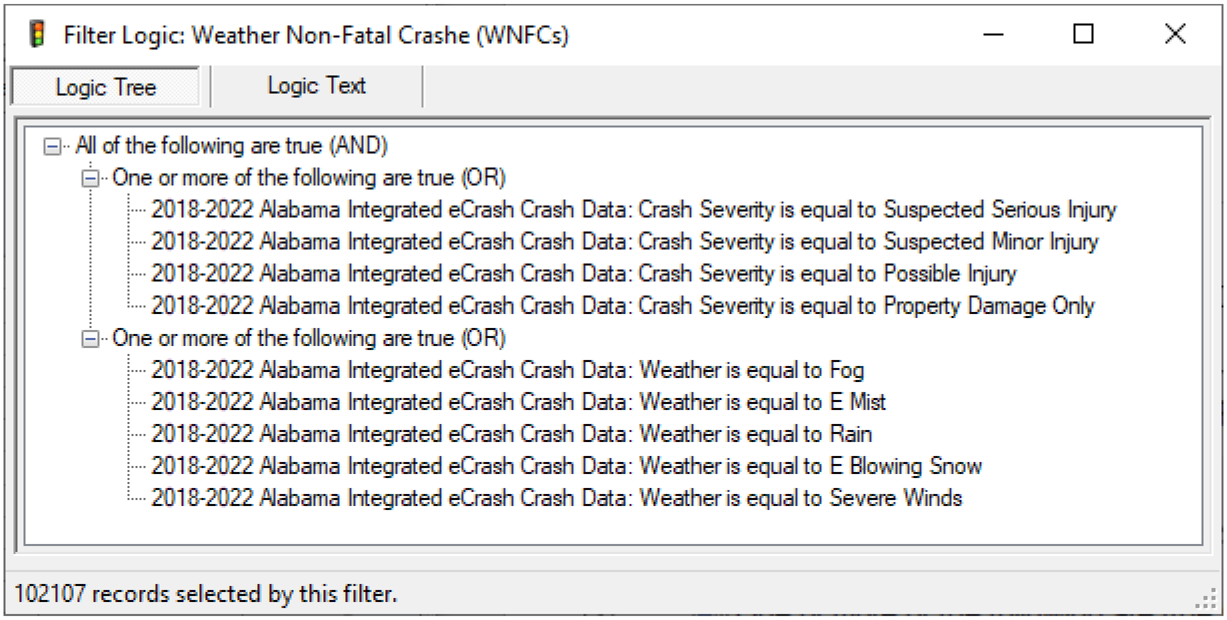


In plain English, the above indicates that all of the *test* crashes (WFCs) to be compared by IMPACT have the following characteristics:

1. They must all be fatal crashes; and
2. They must all have a possible weather causal factor.

555 Crashes Qualified as WFCs for FY2018-2022

Formal Definition of Weather Non-Fatal Crashes (WNFCs)



In plain English, the above indicates that all of the *control* (Other) crashes to be compared by IMPACT have the following characteristics:

1. They must all be non-fatal *injury* or Property Damage Only (PDO) crashes; and
2. They must all have a potential weather relationship cause.

102,107 Crashes Qualified as WNFCs in FY2018-2022.

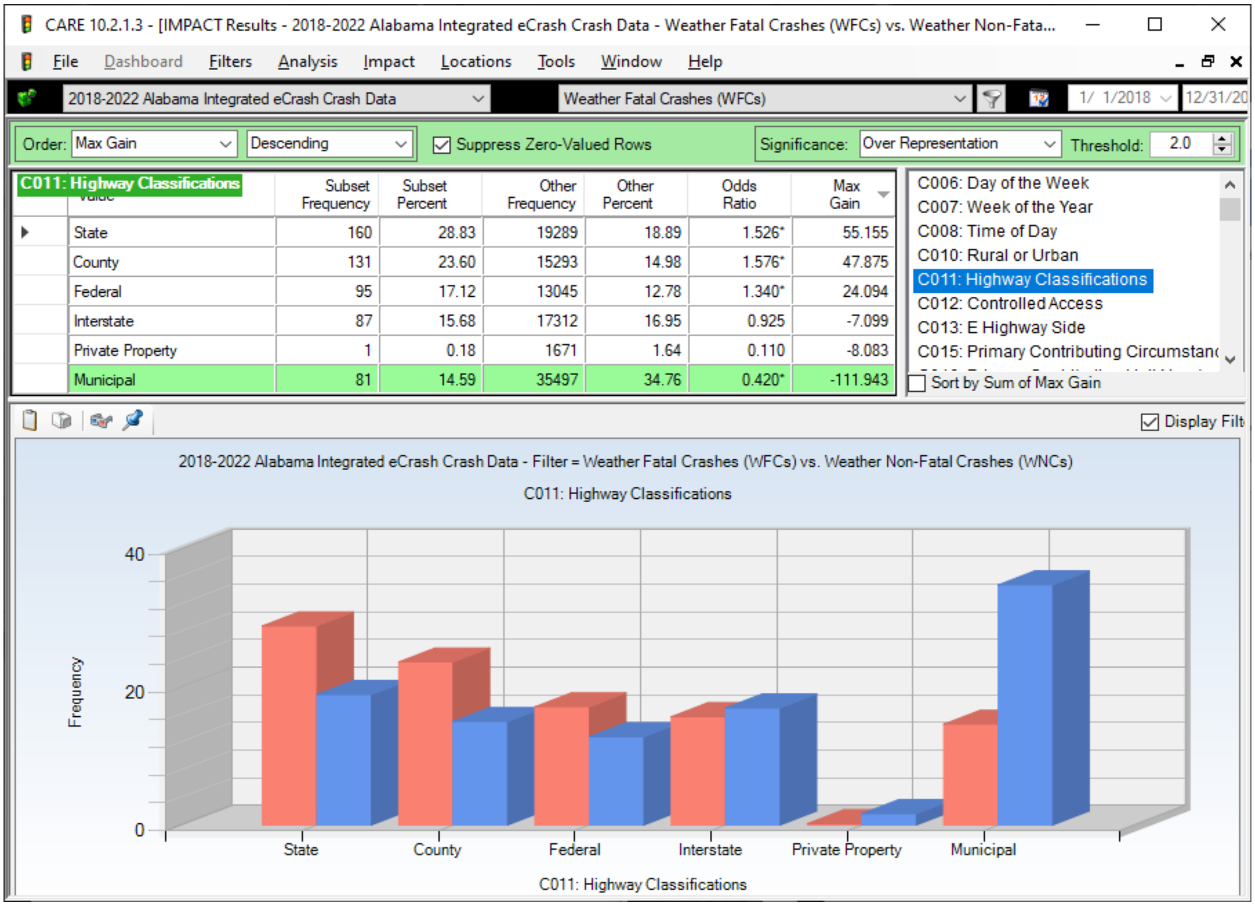
The IMPACT analyses in Section 4 through 8 below will compare the 555 WFCs with the corresponding attributes of the 102,107 WNFCs in order to pinpoint the attributes that are most likely to be causing death in Weather-related Crashes.

The following provide reasons for selecting WFCs as the *test subset* and WNFCs as the *control subset* (called "Other" in the IMPACTs):

- To determine what causes fatal crashes, the fatal crashes have to be compared against similar non-fatal crashes.
- The test subset was all Weather Fatal Crashes (WFCs).
- The control subset was all Weather involved Non-Fatal Crashes (WNFCs).

Note the filter of the IMPACT analyses two *subset* columns in Sections 4 through 8 are WFCs, and the comparative "Other Subsets" (also called the *control* subsets) are WNFCs. These comparisons are different from many IMPACT analyses CAPS has done in the past, because here both the Subset crashes and the "Other" crashes consist of Weather crashes. Thus, they are quite comparable to each other.

2.3 Highway Classification (4.6, C011); Comparison of WFCs and WNFCs



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
State	160	28.83	19289	18.89	1.526*	55.155
County	131	23.60	15293	14.98	1.576*	47.875
Federal	95	17.12	13045	12.78	1.340*	24.094
Interstate	87	15.68	17312	16.95	0.925	-7.099
Private Property	1	0.18	1671	1.64	0.110	-8.083
Municipal	81	14.59	35497	34.76	0.420*	-111.943

Reminder: Weather Fatal Crashes (WFCs) = **Red bars**;

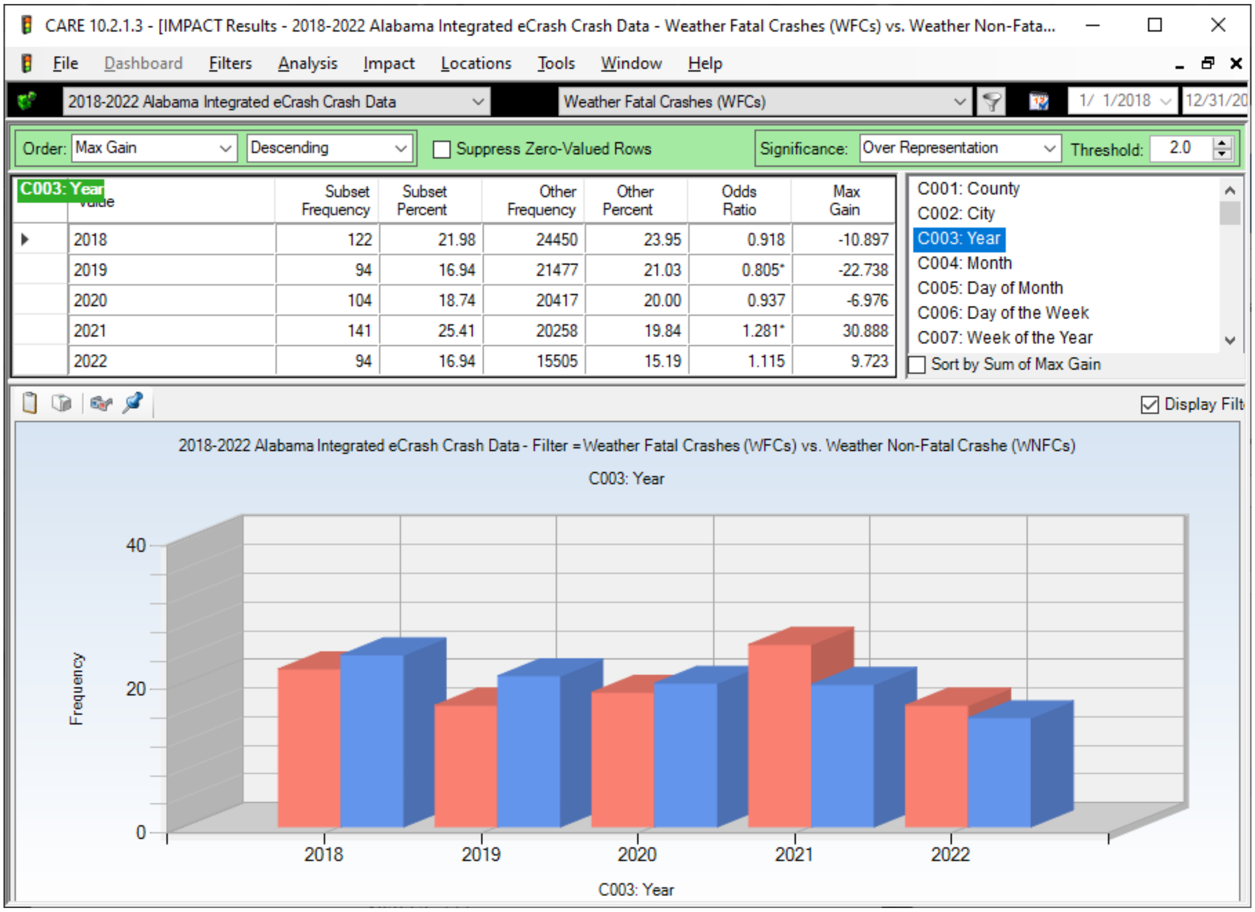
Weather Non-Fatal Crashes (WNFCs) = **Blue bars**.

In this IMPACT display, as well of those in Sections 4 through 8, the Subset (given by the red bars) is the Weather Fatal Crashes (WFCs). The "Other" crashes are those that are Weather Non-Fatal Crashes (WNFCs). This IMPACT (and those below) will use both of the filters defined above to compare the WFCs directly with the WNFCs. The above shows that State, County and Federal highway classifications are significantly over-represented in WFCs, as shown by the asterisk (*) on their Odds Ratios. Interstate highways are under-represented, while Municipal roads are highly significantly under-represented, as indicated not only by the asterisk but also by the green background. If any of the roadway classifications were highly significantly over-represented, they would have red backgrounds.

These IMPACT results will be given additional discussion in Section 4.6.

3.0 Fatal to Non-Fatal Weather Crash Comparison by Year

WFCs vs WNFCs by Year



C003: Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2018	122	21.98	24450	23.95	0.918	-10.897
2019	94	16.94	21477	21.03	0.805*	-22.738
2020	104	18.74	20417	20.00	0.937	-6.976
2021	141	25.41	20258	19.84	1.281*	30.888
2022	94	16.94	15505	15.19	1.115	9.723

Reminder: WFCs= Weather Fatal=**Red bars**; WNFCs=Weather Non-Fatal=**Blue bars**.

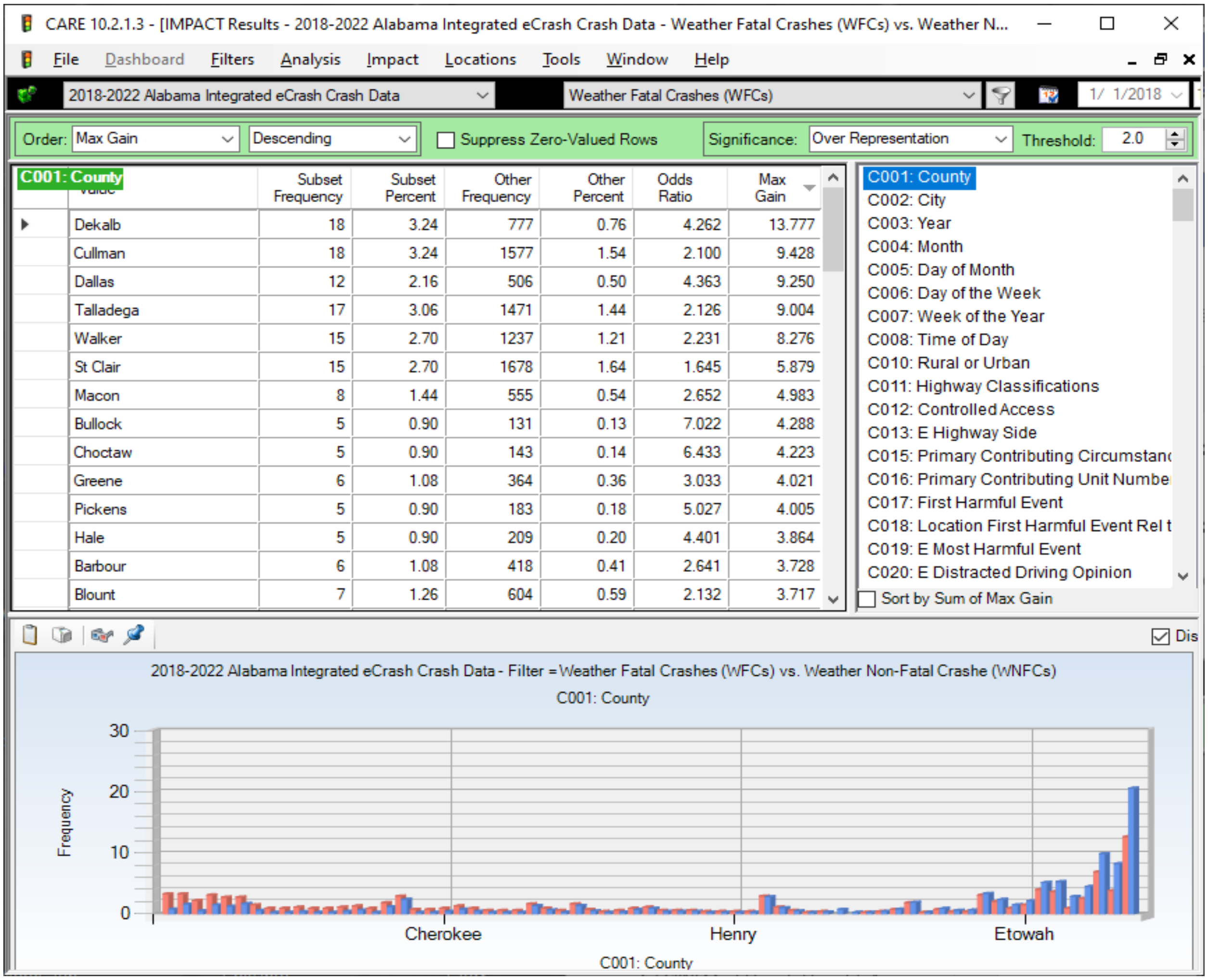
This is an example to further demonstrate the IMPACT displays. None of the years were over-represented in WFCs except 2021, which had a significant over-representation (Odds Ratio 1.281*). The year 2019 was significantly under-represented in fatal crashes, meaning the proportion of WFCs was lower than the proportion of WNFCs. The differences in the other three years, 2018, 2020 and 2022 were not statistically significantly.

See Section 5.1 for additional comments on changes by year.

The remaining parts of this report will present the displays and comments on the large number of IMPACT comparisons that were performed.

4.0 Geographic and Harmful Event Factors

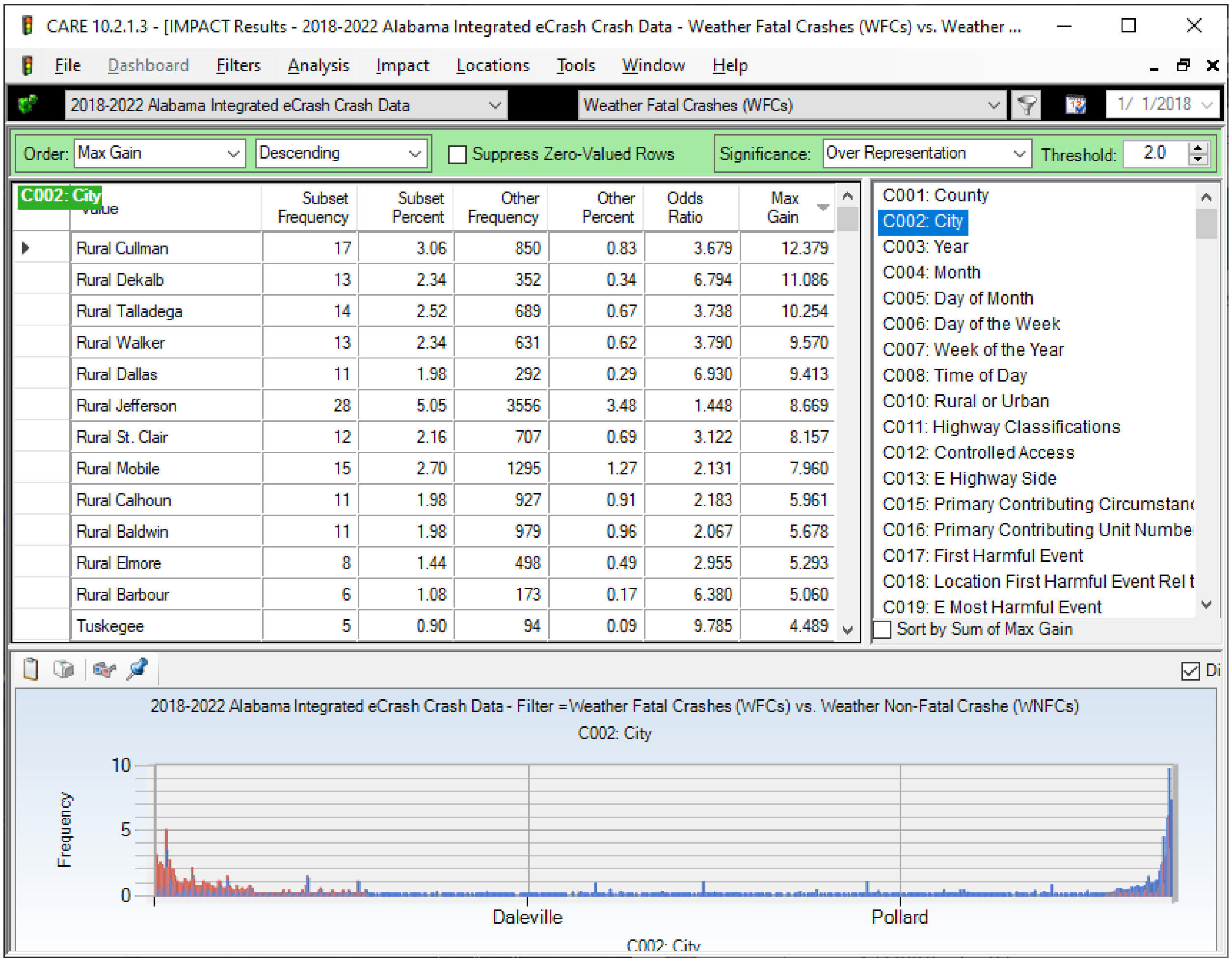
4.1 C001 County WFCs vs WNFCs (top 14 counties) ordered by Max Gain



C001: County	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Dekalb	18	3.24	777	0.76	4.262	13.777
Cullman	18	3.24	1577	1.54	2.100	9.428
Dallas	12	2.16	506	0.50	4.363	9.250
Talladega	17	3.06	1471	1.44	2.126	9.004
Walker	15	2.70	1237	1.21	2.231	8.276
St Clair	15	2.70	1678	1.64	1.645	5.879
Macon	8	1.44	555	0.54	2.652	4.983
Bullock	5	0.90	131	0.13	7.022	4.288
Choctaw	5	0.90	143	0.14	6.433	4.223
Greene	6	1.08	364	0.36	3.033	4.021
Pickens	5	0.90	183	0.18	5.027	4.005
Hale	5	0.90	209	0.20	4.401	3.864
Barbour	6	1.08	418	0.41	2.641	3.728
Blount	7	1.26	604	0.59	2.132	3.717

Each line of table above gives both WFC and WNFC crashes. So, Cullman County, second to the top. had 18 Weather Fatal Crashes (WFCs) and 1,577 Weather Non-Fatal Crashes (WNFCs). Their proportions (3.24% and 1.54%) are used to obtain the Odds Ratio of 2.100. Statistical significance is not calculated if either of the frequencies are less than 20. Proportions are calculated from the attribute frequency divided by the total number of crashes in each column. The Max Gain (9.428) is the number of Weather Fatal Crashes (WFCs) that would be reduced if the 3.24% was reduced to 1.54%. The above display has been arranged in Max Gain order to indicate the counties that have the highest potential for gain in reducing their WFC proportions to their WNFC proportions. The display above contains all of the counties with Max Gains greater than 3.712.

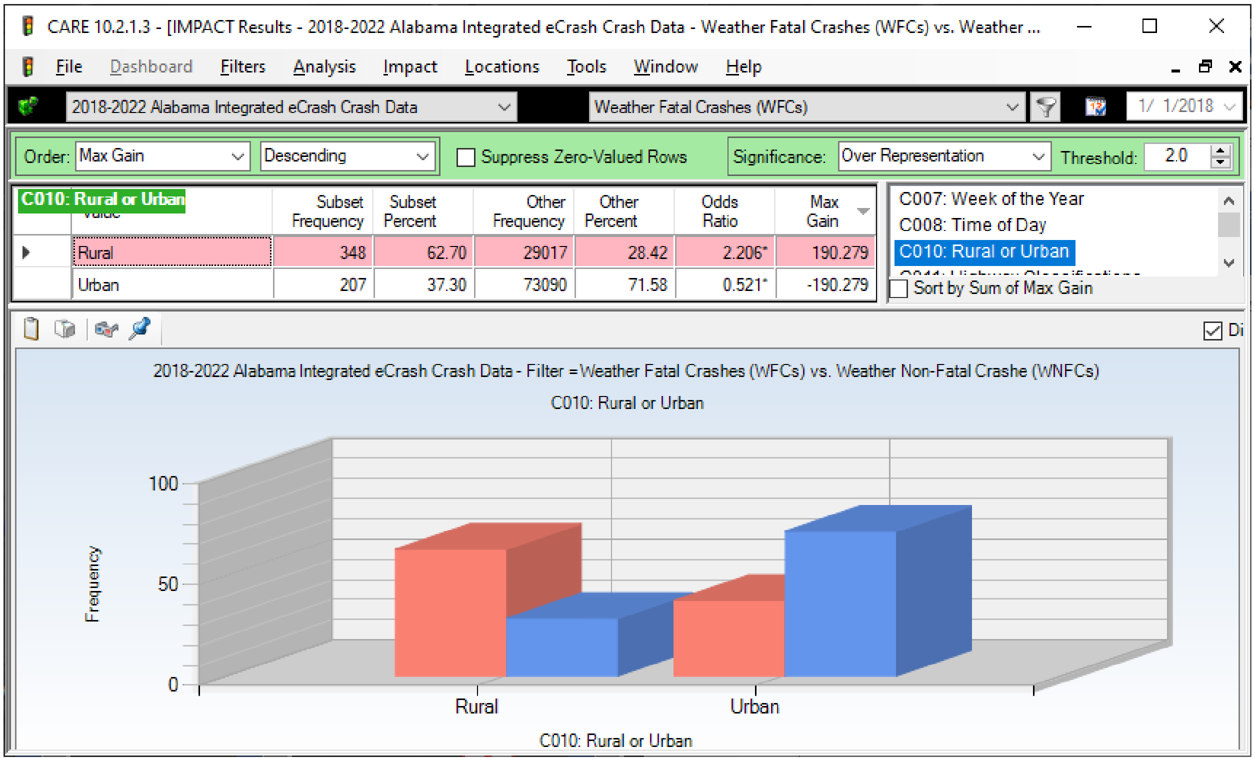
4.2 C002 Cities (top 13) with Highest Max Gains (Rural Areas = Virtual Cities)



C002: City Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Rural Cullman	17	3.06	850	0.83	3.679	12.379
Rural Dekalb	13	2.34	352	0.34	6.794	11.086
Rural Talladega	14	2.52	689	0.67	3.738	10.254
Rural Walker	13	2.34	631	0.62	3.790	9.570
Rural Dallas	11	1.98	292	0.29	6.930	9.413
Rural Jefferson	28	5.05	3556	3.48	1.448	8.669
Rural St. Clair	12	2.16	707	0.69	3.122	8.157
Rural Mobile	15	2.70	1295	1.27	2.131	7.960
Rural Calhoun	11	1.98	927	0.91	2.183	5.961
Rural Baldwin	11	1.98	979	0.96	2.067	5.678
Rural Elmore	8	1.44	498	0.49	2.955	5.293
Rural Barbour	6	1.08	173	0.17	6.380	5.060
Tuskegee	5	0.90	94	0.09	9.785	4.489

For comparison purposes, the rural areas of counties are considered to be "virtual cities," and crashes that occur there are listed as "Rural [County Name]" but they are viewed as cities so that their crashes can be effectively accounted for and compared. The high crash rural areas are generally adjacent to (or partially contain) significant urban areas that have a high traffic density. The display for this is in Max Gain ordering to put those (possibly virtual) cities that have the highest potential for Weather Fatal Crash (WFC) reduction at the top. The display is for all Max Gains > 4.500. It is no surprise that the rural areas have relatively more fatal crashes than their urban city counterparts, as will be shown in the next attribute below. The six highest (virtual) cities according to their Max Gains are: Rural Cullman 17, Rural Dekalb 13, Rural Talladega 14, Rural Walker 13, Rural Dallas 11, and Rural Jefferson 28. Mobile 20, Birmingham 34 and Huntsville 17 had high frequencies, but their proportions were less than the WNFCs in these cities, so in a sense, these high frequencies were expected.

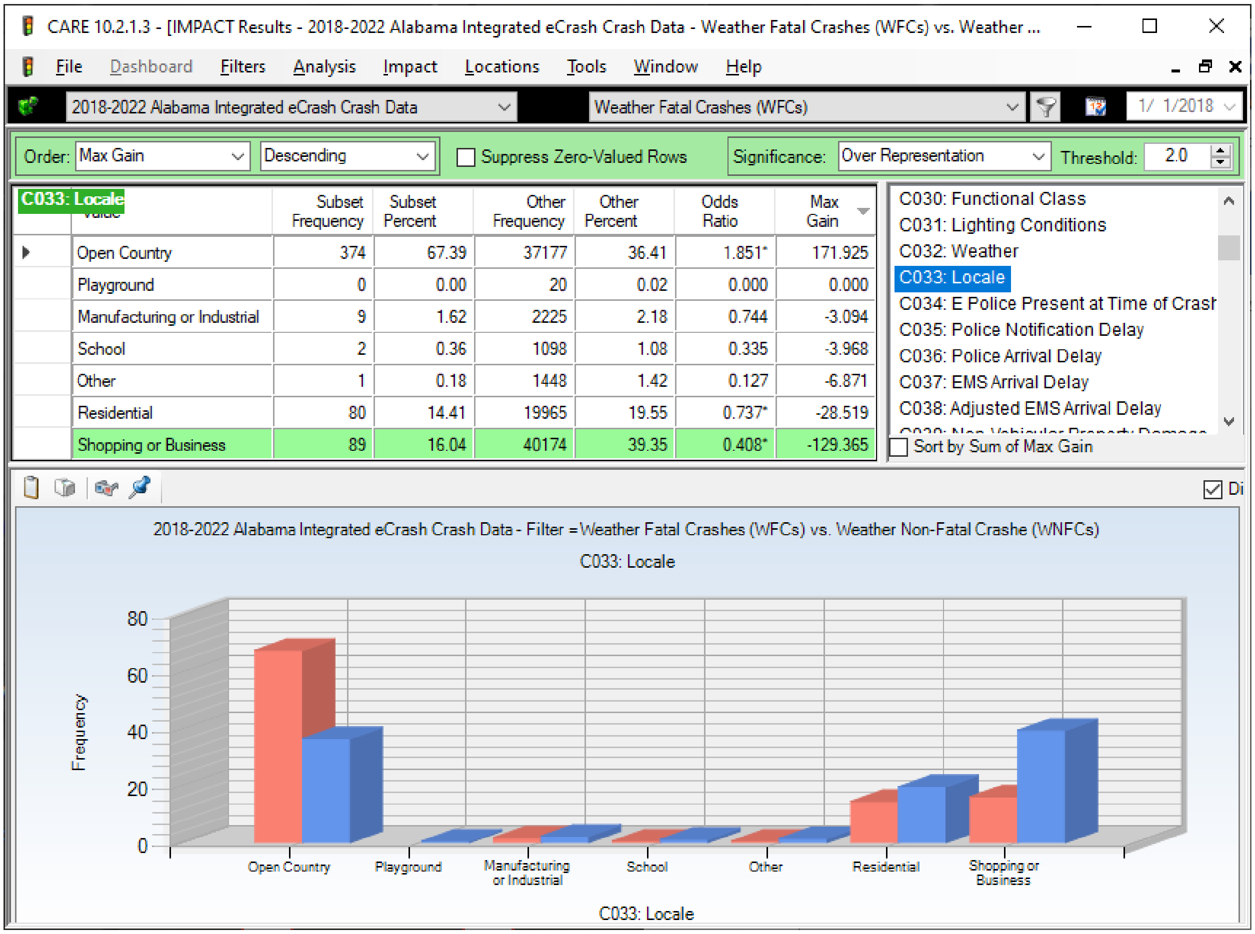
4.3 C010 Rural or Urban



The Weather Fatal Crashes (WFCs) had 62.70% of their fatal crashes in Rural areas, as compared to only 28.42% in the Urban areas. The WNFCs were highly urban, with 71.58% of their crashes in the urban areas. Both results were highly significant, and they illustrate how lethal Rural crashes generally are, as compared to Urban roadways. This is attributed to the comparative speed at impact on the Rural roads. Speed will be considered again in Section 6.2, C224, Speed at Impact. Speed not only can cause a crash, but it can also dramatically increase its severity.

Some Open Country areas are within city limits (see Sections 4.4 and 4.5 below).

4.4 C033 Locale



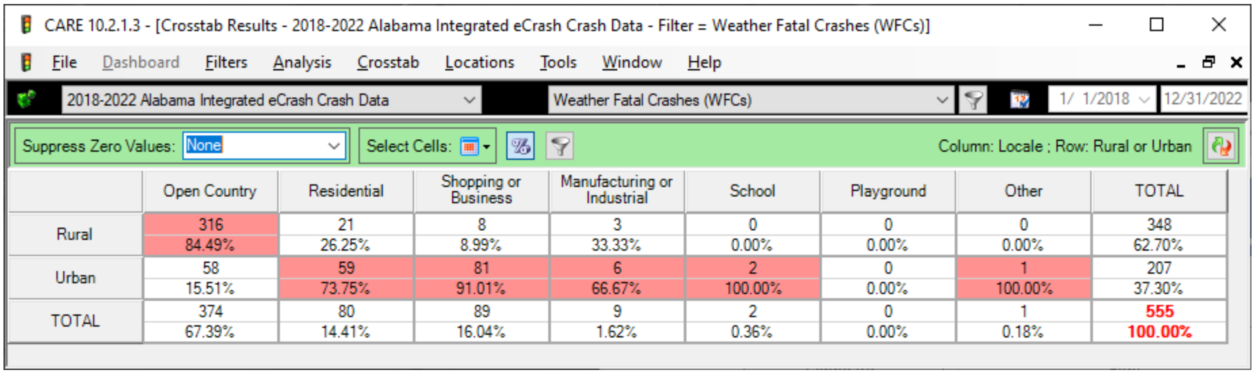
Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Open Country	374	67.39	37177	36.41	1.851*	171.925
Playground	0	0.00	20	0.02	0.000	0.000
Manufacturing or Industrial	9	1.62	2225	2.18	0.744	-3.094
School	2	0.36	1098	1.08	0.335	-3.968
Other	1	0.18	1448	1.42	0.127	-6.871
Residential	80	14.41	19965	19.55	0.737*	-28.519
Shopping or Business	89	16.04	40174	39.35	0.408*	-129.365

Open Country, with 374 WFCs showed significant differences between WFCs and WNFCs. The WFC proportion for Open Country was 67.39%, and its Odds Ratio was 1.851. Shopping or Business, and Residential were both significantly under-represented in fatal crashes, although both had fairly high frequencies (89 for Shopping or Business and 80 for Residential). But the proportions for these were considerably lower than those of their corresponding WNFCs. This demonstrates a significantly larger proportion of Open Country in the urban roadway system. The two factors that contribute to the Open Country results are its being proximal to urban areas, which increase the traffic flow, and the greater speeds on the Open Country roads, which increase the number of fatalities.

See Section 4.5 below for a breakdown of Open Country by Rural/Urban.

4.5 C033 Locale by C010 Rural-Urban for WFCs

It is obvious in the above outputs that WFCs are greatly over-represented in the Rural and Open Country areas. It is interesting to perform a cross-tabulation for Locale over the Rural and Urban areas to further define this relationship. The following, *which is only for WFCs*, gives one such analysis.


CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Weather Fatal Crashes (WFCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Weather Fatal Crashes (WFCs) | 1/ 1/2018 | 12/31/2022

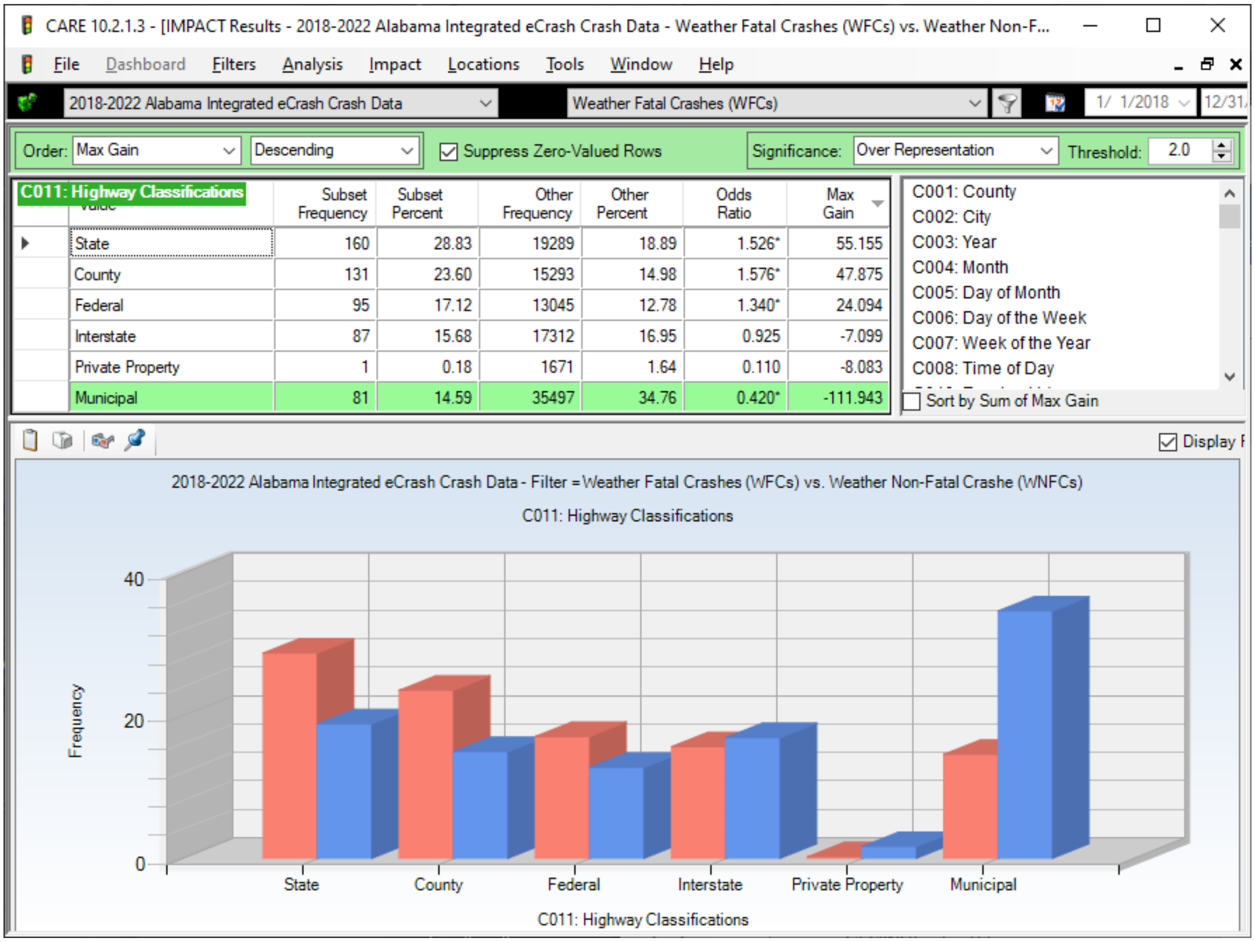
Suppress Zero Values: None | Select Cells: | Column: Locale ; Row: Rural or Urban

	Open Country	Residential	Shopping or Business	Manufacturing or Industrial	School	Playground	Other	TOTAL
Rural	316 84.49%	21 26.25%	8 8.99%	3 33.33%	0 0.00%	0 0.00%	0 0.00%	348 62.70%
Urban	58 15.51%	59 73.75%	81 91.01%	6 66.67%	2 100.00%	0 0.00%	1 100.00%	207 37.30%
TOTAL	374 67.39%	80 14.41%	89 16.04%	9 1.62%	2 0.36%	0 0.00%	1 0.18%	555 100.00%

The red-backed cells in CARE cross-tabulations indicate a cell over-representation by more than 10%. Those that are over-represented, but by less than 10% would have a yellow background (none qualify here). The white background indicates that the cell is under-represented. For example, while 37.30% of all WFCs were Urban, only 73.75% (58) occurred at the Residential Locale. Since this is greater than a 10% difference, it has a red background.

This shows that the Rural/Urban attribute may not be as definitive as is Locale in categorizing crash locations by their general environmental factors. The speed limit within some city limits would cause this in Open Country areas.

4.6 C011 Highway Classifications



This display was introduced in Section 2.3, but little was said of its countermeasure ramifications. Clearly State (160 frequency) routes have the largest number and proportion (26.83%) of Weather Fatal Crashes (WFCs). The other major roadway systems that are also significantly over-represented fall in the following max gain order (given with the frequencies): County (131), and Federal (95). Interstate was under-represented, having a higher proportion of WNFCs than WFCs. While significantly under-represented (0.370*) from its proportion point of view (13.25%), Municipal still had a substantial number of fatal crashes (81), which was about the same as Interstate (87).

4.7 C019 Most Harmful Event (>1 in MaxGain order)

CARE 10.2.1.3 - [IMPACT Results - 2018-2022 Alabama Integrated eCrash Crash Data - Weather Fatal Crashes (WFCs) AND Not E Most Har...

File Dashboard Filters Analysis Impact Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Weather Fatal Crashes (WFCs) | 1/ 1/2018 | 12/31/20

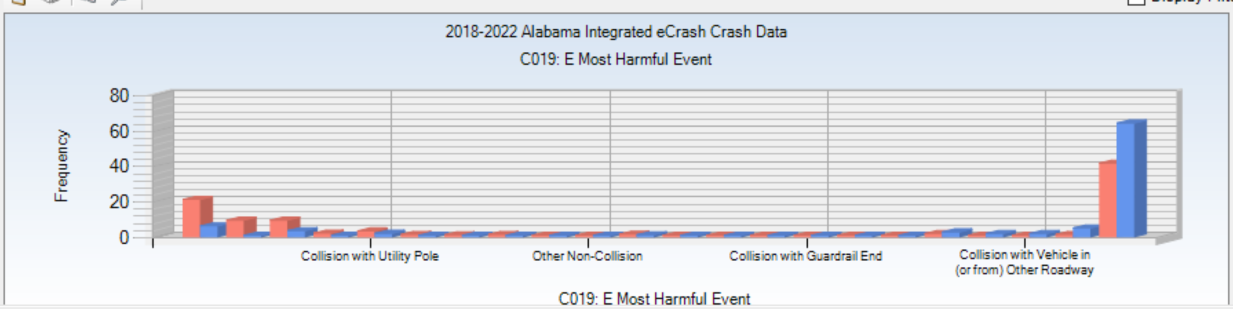
Order: Max Gain | Descending | Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C019: E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Collision with Tree	115	21.02	5916	6.10	3.444*	81.609
Collision with Non-Motorist: Pedestrian	51	9.32	280	0.29	32.271*	49.420
Overturn/Rollover	51	9.32	3301	3.41	2.737*	32.369
Fire/Explosion	11	2.01	155	0.16	12.574	10.125
Collision with Utility Pole	18	3.29	1849	1.91	1.725	7.564
Collision with Light Pole (Non-Breakaway)	7	1.28	227	0.23	5.464	5.719
Collision with Culvert Headwall	6	1.10	546	0.56	1.947	2.918
Collision with Other Non-Fixed Object	7	1.28	742	0.77	1.671	2.812
Collision with Overhead Object/Bridge/Tree	3	0.55	128	0.13	4.153	2.278
Other Non-Collision	3	0.55	138	0.14	3.852	2.221
Collision with Other Fixed Object	8	1.46	1085	1.12	1.306	1.876
Fell/Jumped from Motor Vehicle	2	0.37	29	0.03	12.219	1.836
Collision with Railway Vehicle/Train	2	0.37	32	0.03	11.073	1.819
Immersion	2	0.37	84	0.09	4.218	1.526
Collision with Guardrail End	4	0.73	452	0.47	1.568	1.449
Ran Off Road Straight	2	0.37	189	0.20	1.875	0.933
Collision with Embankment	3	0.55	839	0.87	0.634	-1.735
Collision with Parked Motor Vehicle	10	1.83	2595	2.68	0.683	-4.646
Ran Off Road Right	5	0.91	1744	1.80	0.508	-4.843
Collision with Vehicle in (or from) Other Roadway	3	0.55	1781	1.84	0.298	-7.052
Collision with Ditch	7	1.28	4775	4.93	0.260	-19.951
Collision with Vehicle in Traffic	227	41.50	62110	64.09	0.648*	-123.556

C019: E Most Harmful Event

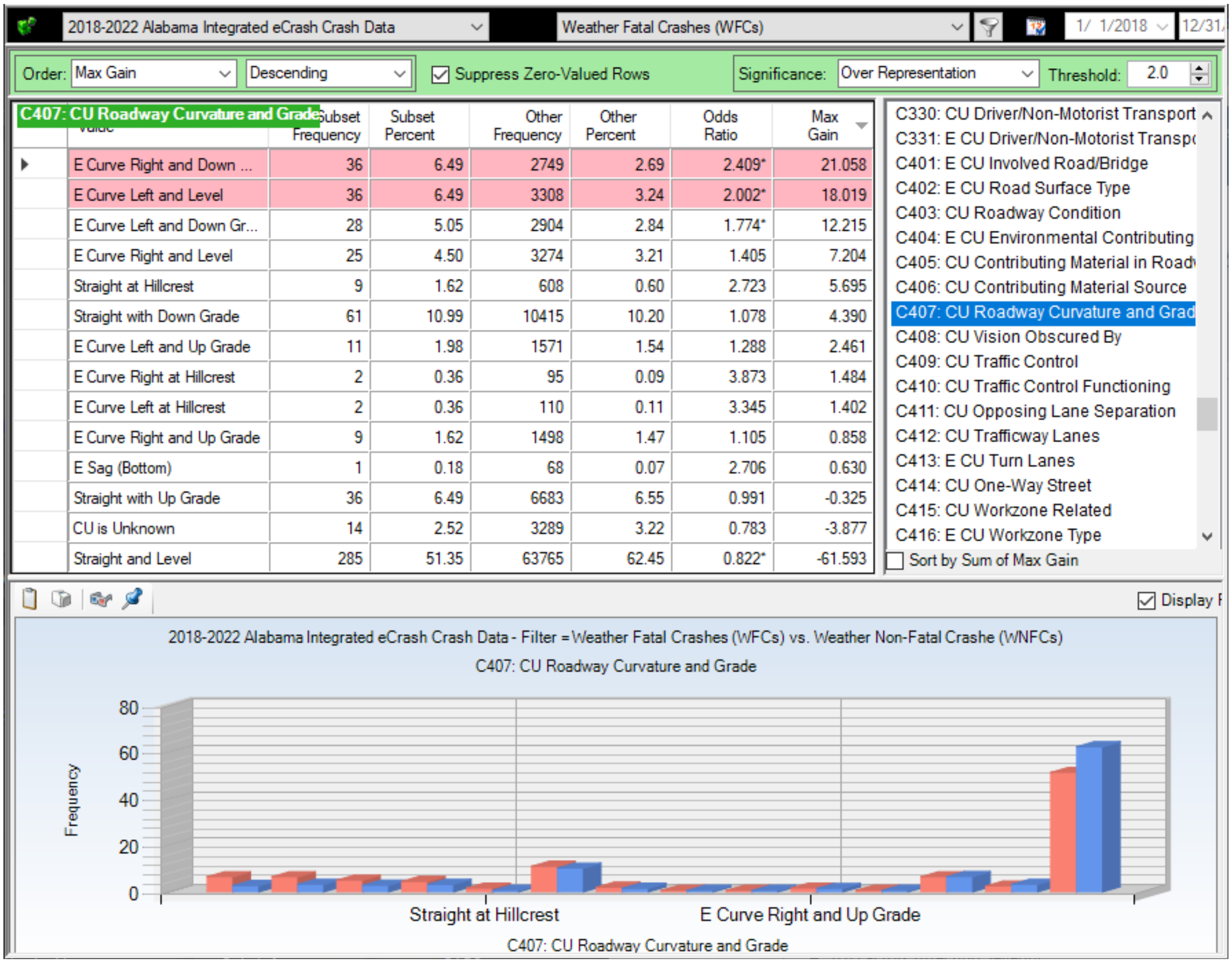
Sort by Sum of Max Gain

Display Filte



The display above is intended to show safety engineers factors that are involved with fatal weather collisions. The top five over-represented crash types (with frequencies) are: Collision with Tree 115, Collision with Non-Motorist: Pedestrian 51, Overturn/Rollover 51, Fire/Explosion 11 and Collision with Utility Pole 18. Collision with Vehicle in Traffic had the highest frequency (227), but its proportion (41.50%) was considerably less than that of WNFCs (64.09%)

4.8 C407 CU Roadway Curvature and Grade



WFCs are over-represented in all curve types except Straight with Up Grade and Straight and Level. Over-represented WFCs with the highest frequencies (in Max Gain order):

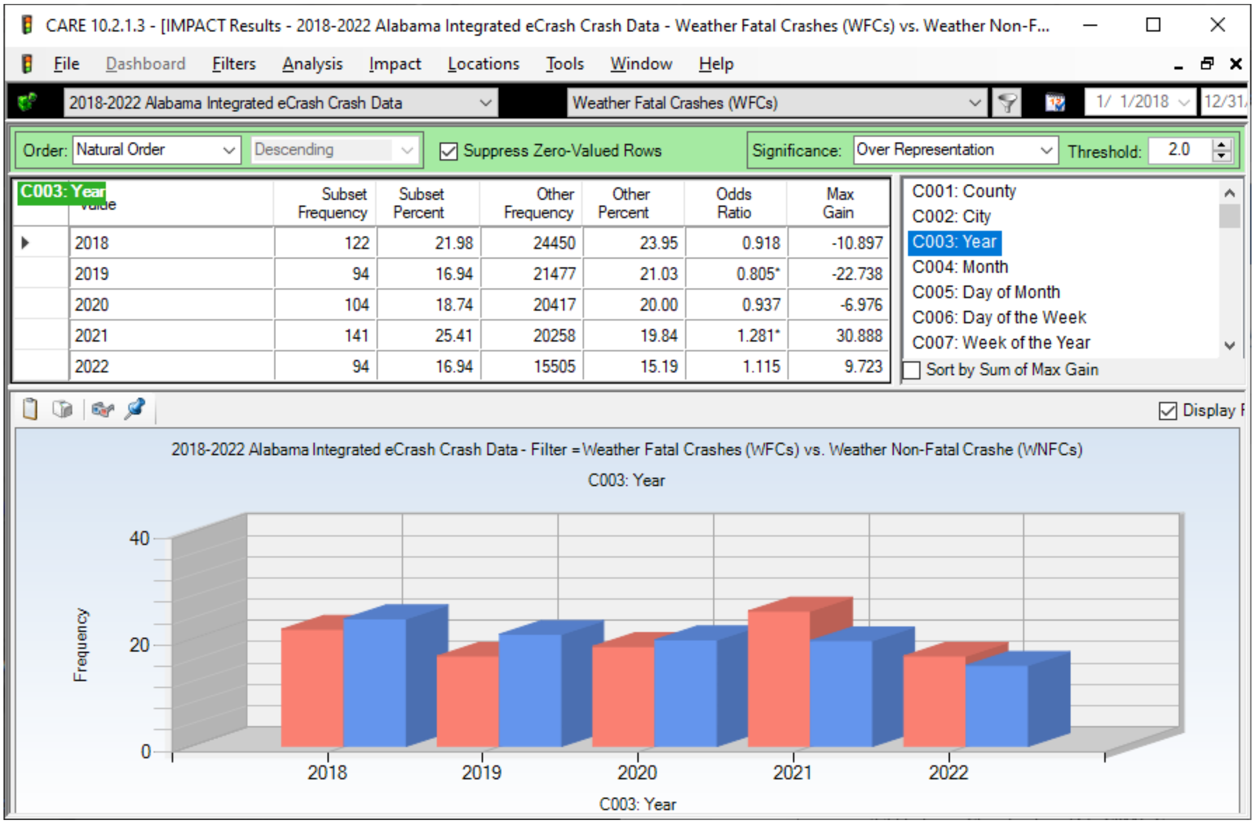
Curve Right and Down Grade	36
Curve Left and Level	36
Curve Left and Down Grade	28
Curve Right and Level	25
Straight at Hillcrest	9
Straight with Down Grade	61
Curve Left and Up Grade	11

The only curvatures that were under-represented in WFCs were Straight with Upgrade 285, and Straight with Up Grade 36. Clearly these had the most combined WFCs but their fatality proportions were lower than their WNFC proportions.

5.0 Time Factors

5.1 C003 Year – IMPACT duplicated from Section 3.0 for ease of reference

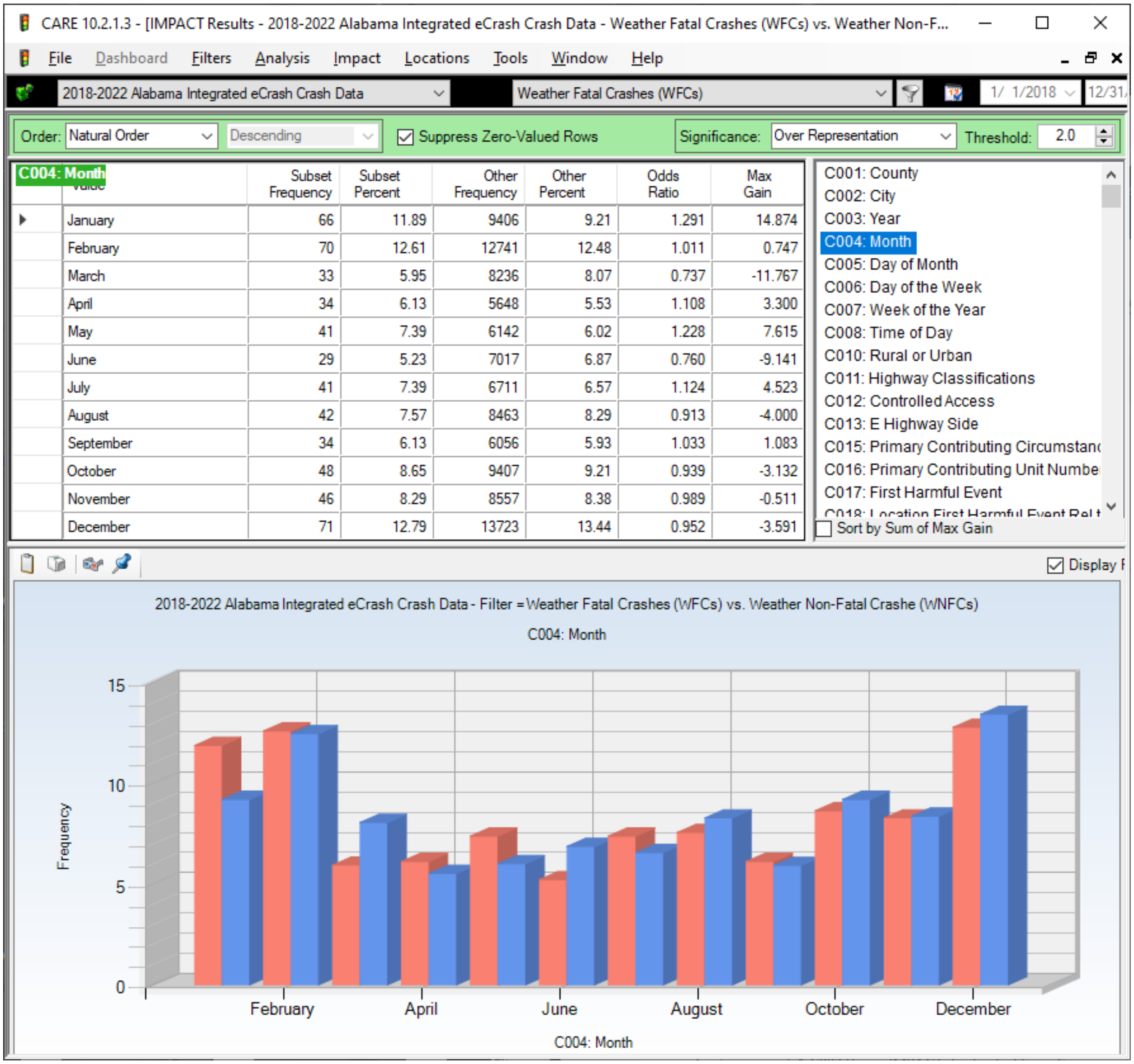
Year: Weather Fatal Crashes (WFCs) vs Weather Non-Fatal Crashes (WNFCs)



C003: Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2018	122	21.98	24450	23.95	0.918	-10.897
2019	94	16.94	21477	21.03	0.805*	-22.738
2020	104	18.74	20417	20.00	0.937	-6.976
2021	141	25.41	20258	19.84	1.281*	30.888
2022	94	16.94	15505	15.19	1.115	9.723

Variations in proportions between the WFCs and the WNFCs were found to be significant in 2019 and 2021 for the opposite of reasons. 2019 was significantly under-represented inWFCs, while 2021 was over-represented. There also seems to be a growth in the WFC proportions in 2021 and 2022. While under-represented in 2018 through 2020, they became over-represented in years 2021-2022. The reason for these increased WFC proportions is not definitive, but this consistent increase should be watched to determine the cause in future years. Year 2021 has the highest over-representation, but this seems to regress to the mean in 2022.

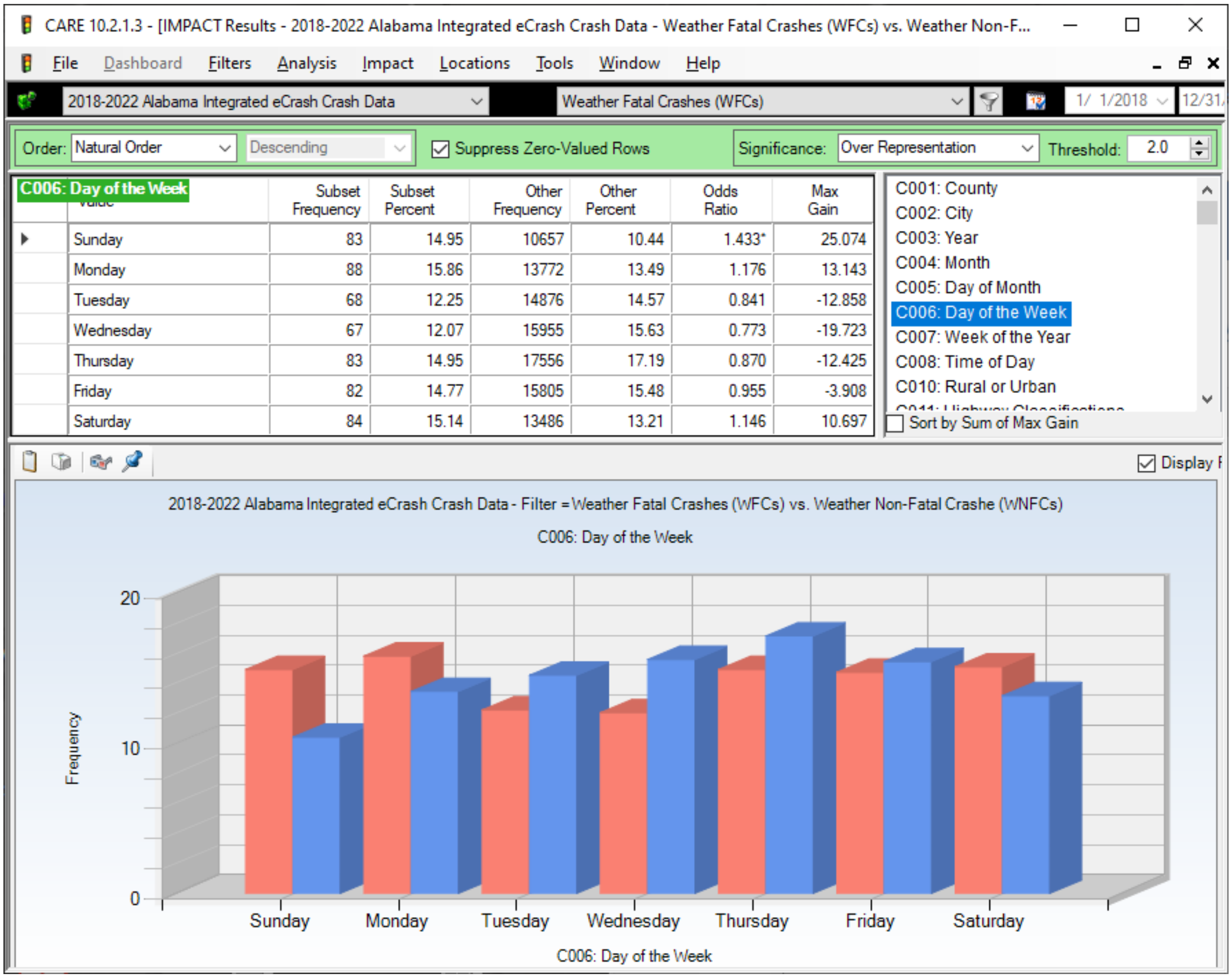
5.2 C004 Month



C004: Month Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
January	66	11.89	9406	9.21	1.291	14.874
February	70	12.61	12741	12.48	1.011	0.747
March	33	5.95	8236	8.07	0.737	-11.767
April	34	6.13	5648	5.53	1.108	3.300
May	41	7.39	6142	6.02	1.228	7.615
June	29	5.23	7017	6.87	0.760	-9.141
July	41	7.39	6711	6.57	1.124	4.523
August	42	7.57	8463	8.29	0.913	-4.000
September	34	6.13	6056	5.93	1.033	1.083
October	48	8.65	9407	9.21	0.939	-3.132
November	46	8.29	8557	8.38	0.989	-0.511
December	71	12.79	13723	13.44	0.952	-3.591

The ordering in the display above is according to the natural ordering of months. None of the months had statistically significant over-representations or under-representations. WFC months generally fell in line with their WNFC counterparts. The largest over-representations were in January and May, which had Odds Ratios of 1.291 and 1.228, which were relatively large, but not large enough to qualify as statistically significant. No sequential collective over-representations were found. This indicates that the times of year do not seem to cause any increases in Weather crashes being fatal. The low WFC sample sizes also work against statistical significance.

5.3 C006 Day of the Week Comparison WFCs and WNFCs



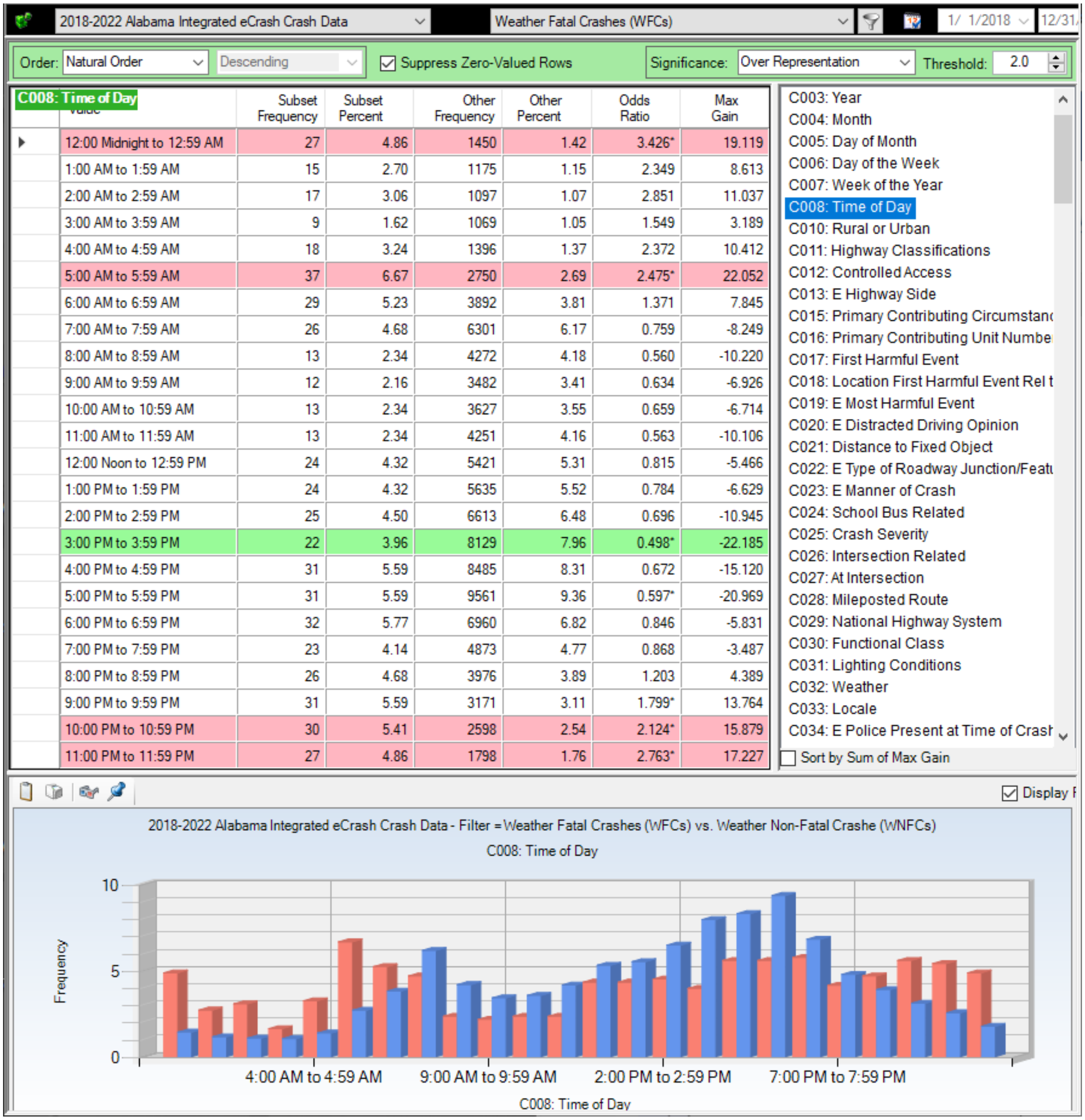
C006: Day of the Week Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Sunday	83	14.95	10657	10.44	1.433*	25.074
Monday	88	15.86	13772	13.49	1.176	13.143
Tuesday	68	12.25	14876	14.57	0.841	-12.858
Wednesday	67	12.07	15955	15.63	0.773	-19.723
Thursday	83	14.95	17556	17.19	0.870	-12.425
Friday	82	14.77	15805	15.48	0.955	-3.908
Saturday	84	15.14	13486	13.21	1.146	10.697

Sunday was the only statistically significantly over-represented day in WFCs as compared to its WNFC counterparts. Monday actually had more WFCs, but its proportion was not high enough to be significant. Because weekends are over-represented in ID (DUI Alcohol or Drugs) this gives us an early indication that WFCs might have an ID causation. This will be validated in Section 8.

5.4 Day of the Week Discussion [covered above.]

Also, relevant Day of the Week information is given in Section 5.6.

5.5 C008 Time of Day



C008: Time of Day	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
12:00 Midnight to 12:59 AM	27	4.86	1450	1.42	3.426*	19.119
1:00 AM to 1:59 AM	15	2.70	1175	1.15	2.349	8.613
2:00 AM to 2:59 AM	17	3.06	1097	1.07	2.851	11.037
3:00 AM to 3:59 AM	9	1.62	1069	1.05	1.549	3.189
4:00 AM to 4:59 AM	18	3.24	1396	1.37	2.372	10.412
5:00 AM to 5:59 AM	37	6.67	2750	2.69	2.475*	22.052
6:00 AM to 6:59 AM	29	5.23	3892	3.81	1.371	7.845
7:00 AM to 7:59 AM	26	4.68	6301	6.17	0.759	-8.249
8:00 AM to 8:59 AM	13	2.34	4272	4.18	0.560	-10.220
9:00 AM to 9:59 AM	12	2.16	3482	3.41	0.634	-6.926
10:00 AM to 10:59 AM	13	2.34	3627	3.55	0.659	-6.714
11:00 AM to 11:59 AM	13	2.34	4251	4.16	0.563	-10.106
12:00 Noon to 12:59 PM	24	4.32	5421	5.31	0.815	-5.466
1:00 PM to 1:59 PM	24	4.32	5635	5.52	0.784	-6.629
2:00 PM to 2:59 PM	25	4.50	6613	6.48	0.696	-10.945
3:00 PM to 3:59 PM	22	3.96	8129	7.96	0.498*	-22.185
4:00 PM to 4:59 PM	31	5.59	8485	8.31	0.672	-15.120
5:00 PM to 5:59 PM	31	5.59	9561	9.36	0.597*	-20.969
6:00 PM to 6:59 PM	32	5.77	6960	6.82	0.846	-5.831
7:00 PM to 7:59 PM	23	4.14	4873	4.77	0.868	-3.487
8:00 PM to 8:59 PM	26	4.68	3976	3.89	1.203	4.389
9:00 PM to 9:59 PM	31	5.59	3171	3.11	1.799*	13.764
10:00 PM to 10:59 PM	30	5.41	2598	2.54	2.124*	15.879
11:00 PM to 11:59 PM	27	4.86	1798	1.76	2.763*	17.227

The time of day distribution pattern is consistent with the hours that are typically associated with Impaired Driving (ID). However, the hazards of weather-related crashes would also be expected to occur during the dark night-time hours. See the further discussion in Section 5.6.

5.6 C008 Discussion on Time of Day by Day of the Week

Refer to the Time of Day (Section 5.5 above) and the Day of the Week by Time of Day cross-tabulation *for all weather fatal crashes* displays (Section 5.7 below). The large Time of Day over-representations on 8:00 PM to 6:59 AM are indicative of ID, fatigue and lack of sleep. The lack of significance indicators could be attributed to the sample sizes being less than 20 for most ot the WFCs.

The *Time of Day by Day of the Week* cross-tabulation (given in the next section *for all fatal crashes* (not subdivided by WFCs and WNFCs) shows the optimal times for Weather enforcement and EMS alerts. Generally, the highest proportion of times in any day are given in red for that day.

Notice that this works well for Friday nights, Saturday mornings, Saturday nights, and Sunday mornings. In addition to ID, these and other over-represented hours are times when drivers might take liberties to drive late at night because they do not have work responsibilities the following day (e.g., on vacations).

The interpretation of the cross-tabulation in Section 5.7 shows both a weather and an ID component. However, the following additional factors might help to explain the concentrations:

- Friday Night/Saturday Morning – 28 WFCs in 10 hours = 2.8 per hour.
- Saturday Night/Sunday Morning – 56 WFCs in 10 hours = 5.6 per hour; these seem to be a combined effect of weather and Impaired Driving.
- Friday morning 33 crashes: weather (hours) = Fog (8), Mist (4); Rain (21) = 33 weather.
- Other times, in addition to weather:
    - Sunday 4:00 PM to 11:59 PM – Fatigue getting home after weekends.
    - Weekdays 10:00 AM to 7:59 PM – Fatigue during long drives during the day.

The expected proportion for all cells in a given row is given at the extreme right in the total row percentage column for each row. If there were absolutely no over-representations across the columns (days), then all of the proportions for those cells would be identical to the one for the total.
Cells that are lower than the average value (given in the TOTAL column) have a neutral (white) background. Those that are higher, but not more than 10% of the proportion are yellow; and those above 10% more than that expected from the TOTAL (right column) are red.

For example, the 4 AM to 4:59 AM row has a total percentage value of 3.24% for the fatal crashes during this hour. The red cells to the left (Sunday and Friday) both have percentages of 4.82% and 4.88%, which are more than 10% greater than 3.06, and thus they have red backgrounds. The yellow cell has a percentage of 3.57%, which is more than 3.24% but less than 10% greater than that average. All the rest of the cells have white background indicating that their percentages are less than 3.24%.

5.7 C008 Time of Day x C005 Day of the Week for WFCs

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Weather Fatal Crashes (WFCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Weather Fatal Crashes (WFCs) | 1/ 1/2018 | 12/31/

Suppress Zero Values: None | Select Cells: | Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	7 8.43%	6 6.82%	1 1.47%	2 2.99%	3 3.61%	5 6.10%	3 3.57%	27 4.86%
1:00 AM to 1:59 AM	5 6.02%	1 1.14%	4 5.88%	0 0.00%	0 0.00%	5 6.10%	0 0.00%	15 2.70%
2:00 AM to 2:59 AM	6 7.23%	2 2.27%	0 0.00%	0 0.00%	1 1.20%	4 4.88%	4 4.76%	17 3.06%
3:00 AM to 3:59 AM	3 3.61%	2 2.27%	1 1.47%	2 2.99%	1 1.20%	0 0.00%	0 0.00%	9 1.62%
4:00 AM to 4:59 AM	4 4.82%	2 2.27%	2 2.94%	1 1.49%	2 2.41%	4 4.88%	3 3.57%	18 3.24%
5:00 AM to 5:59 AM	5 6.02%	5 5.68%	6 8.82%	2 2.99%	7 8.43%	9 10.98%	3 3.57%	37 6.67%
6:00 AM to 6:59 AM	1 1.20%	2 2.27%	5 7.35%	4 5.97%	6 7.23%	6 7.32%	5 5.95%	29 5.23%
7:00 AM to 7:59 AM	7 8.43%	5 5.68%	3 4.41%	1 1.49%	5 6.02%	1 1.22%	4 4.76%	26 4.68%
8:00 AM to 8:59 AM	1 1.20%	2 2.27%	3 4.41%	1 1.49%	2 2.41%	2 2.44%	2 2.38%	13 2.34%
9:00 AM to 9:59 AM	1 1.20%	4 4.55%	2 2.94%	2 2.99%	1 1.20%	1 1.22%	1 1.19%	12 2.16%
10:00 AM to 10:59 AM	1 1.20%	4 4.55%	1 1.47%	2 2.99%	2 2.41%	2 2.44%	1 1.19%	13 2.34%
11:00 AM to 11:59 AM	3 3.61%	4 4.55%	0 0.00%	2 2.99%	2 2.41%	1 1.22%	1 1.19%	13 2.34%
12:00 Noon to 12:59 PM	2 2.41%	9 10.23%	4 5.88%	2 2.99%	2 2.41%	0 0.00%	5 5.95%	24 4.32%
1:00 PM to 1:59 PM	3 3.61%	5 5.68%	5 7.35%	4 5.97%	2 2.41%	4 4.88%	1 1.19%	24 4.32%
2:00 PM to 2:59 PM	1 1.20%	1 1.14%	6 8.82%	1 1.49%	6 7.23%	4 4.88%	6 7.14%	25 4.50%
3:00 PM to 3:59 PM	1 1.20%	8 9.09%	2 2.94%	1 1.49%	6 7.23%	3 3.66%	1 1.19%	22 3.96%
4:00 PM to 4:59 PM	3 3.61%	6 6.82%	2 2.94%	6 8.96%	3 3.61%	6 7.32%	5 5.95%	31 5.59%
5:00 PM to 5:59 PM	3 3.61%	4 4.55%	6 8.82%	6 8.96%	4 4.82%	3 3.66%	5 5.95%	31 5.59%
6:00 PM to 6:59 PM	6 7.23%	4 4.55%	4 5.88%	8 11.94%	3 3.61%	4 4.88%	3 3.57%	32 5.77%
7:00 PM to 7:59 PM	6 7.23%	3 3.41%	2 2.94%	2 2.99%	6 7.23%	2 2.44%	2 2.38%	23 4.14%
8:00 PM to 8:59 PM	4 4.82%	2 2.27%	4 5.88%	6 8.96%	2 2.41%	3 3.66%	5 5.95%	26 4.68%
9:00 PM to 9:59 PM	5 6.02%	4 4.55%	1 1.47%	6 8.96%	4 4.82%	3 3.66%	8 9.52%	31 5.59%
10:00 PM to 10:59 PM	3 3.61%	1 1.14%	2 2.94%	3 4.48%	6 7.23%	8 9.76%	7 8.33%	30 5.41%
11:00 PM to 11:59 PM	2 2.41%	2 2.27%	2 2.94%	3 4.48%	7 8.43%	2 2.44%	9 10.71%	27 4.86%
Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	83 14.95%	88 15.86%	68 12.25%	67 12.07%	83 14.95%	82 14.77%	84 15.14%	555 100.00%

See the discussion in Section 5.6 above.

6.0 Factors Affecting Severity

6.1 C011 Highway Classification by C025 Severity (all Weather crashes)

This is performed to get an initial feeling for the severity of crashes on the different Highway Classifications.

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Weather Items ALL Severities]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

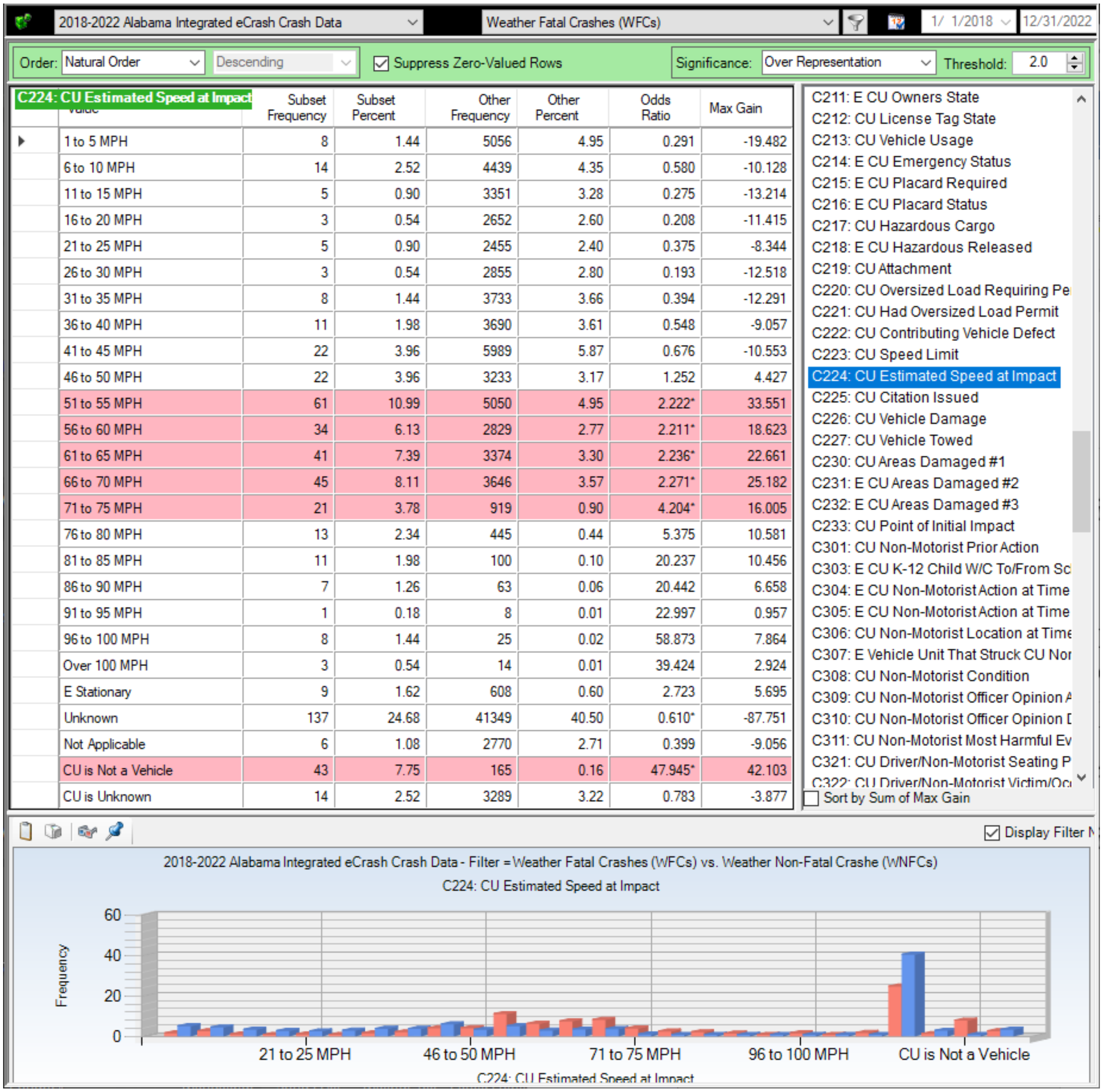
2018-2022 Alabama Integrated eCrash Crash Data | Weather Items ALL Severities | 1/ 1/2018 | 12/31/2022

Suppress Zero Values: None | Select Cells: | Column: Highway Classifications ; Row: Crash Severity

	Interstate	Federal	State	County	Municipal	Private Property	P Other*	TOTAL
Fatal Injury	87 0.49%	95 0.71%	160 0.80%	131 0.81%	81 0.22%	1 0.06%	0 0.00%	555 0.53%
Suspected Serious Injury	329 1.86%	378 2.83%	664 3.32%	616 3.83%	494 1.35%	7 0.40%	0 0.00%	2488 2.36%
Suspected Minor Injury	1274 7.22%	1163 8.71%	1900 9.49%	1711 10.64%	2385 6.51%	59 3.40%	0 0.00%	8492 8.05%
Possible Injury	1304 7.39%	1394 10.44%	1860 9.29%	1081 6.72%	3424 9.34%	66 3.80%	0 0.00%	9129 8.65%
Property Damage Only	14405 81.62%	10110 75.75%	14865 74.27%	11885 73.88%	29194 79.63%	1539 88.70%	0 0.00%	81998 77.73%
Unknown	249 1.41%	207 1.55%	565 2.82%	663 4.12%	1086 2.96%	63 3.63%	0 0.00%	2833 2.69%
TOTAL	17648 16.73%	13347 12.65%	20014 18.97%	16087 15.25%	36664 34.75%	1735 1.64%	0 0.00%	105495 100.00%

Notice that the basis for this cross-tabulation is all 105,495 Weather crashes, for all severities, not just fatal crashes. Fatal Weather Crashes *only* would restrict this output to just the 555 crashes in the top row. This verifies the results presented for fatal Weather crashes in Section 4.6, and it also shows the comparable results for the lesser severities for all of the Highway Classifications. Speed and the failure to wear seatbelts are the primary cause of fatalities caused by all ages. These will be given additional consideration in the attributes described below.

6.2 WFCs vs WNFCs for C224 Speed at Impact



C224: CU Estimated Speed at Impact	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 to 5 MPH	8	1.44	5056	4.95	0.291	-19.482
6 to 10 MPH	14	2.52	4439	4.35	0.580	-10.128
11 to 15 MPH	5	0.90	3351	3.28	0.275	-13.214
16 to 20 MPH	3	0.54	2652	2.60	0.208	-11.415
21 to 25 MPH	5	0.90	2455	2.40	0.375	-8.344
26 to 30 MPH	3	0.54	2855	2.80	0.193	-12.518
31 to 35 MPH	8	1.44	3733	3.66	0.394	-12.291
36 to 40 MPH	11	1.98	3690	3.61	0.548	-9.057
41 to 45 MPH	22	3.96	5989	5.87	0.676	-10.553
46 to 50 MPH	22	3.96	3233	3.17	1.252	4.427
51 to 55 MPH	61	10.99	5050	4.95	2.222*	33.551
56 to 60 MPH	34	6.13	2829	2.77	2.211*	18.623
61 to 65 MPH	41	7.39	3374	3.30	2.236*	22.661
66 to 70 MPH	45	8.11	3646	3.57	2.271*	25.182
71 to 75 MPH	21	3.78	919	0.90	4.204*	16.005
76 to 80 MPH	13	2.34	445	0.44	5.375	10.581
81 to 85 MPH	11	1.98	100	0.10	20.237	10.456
86 to 90 MPH	7	1.26	63	0.06	20.442	6.658
91 to 95 MPH	1	0.18	8	0.01	22.997	0.957
96 to 100 MPH	8	1.44	25	0.02	58.873	7.864
Over 100 MPH	3	0.54	14	0.01	39.424	2.924
E Stationary	9	1.62	608	0.60	2.723	5.695
Unknown	137	24.68	41349	40.50	0.610*	-87.751
Not Applicable	6	1.08	2770	2.71	0.399	-9.056
CU is Not a Vehicle	43	7.75	165	0.16	47.945*	42.103
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877

Generally, the travel speeds at roads that have the most WNFCs have speed limits of 45 MPH or lower, and it is the speeds below 46 MPH that are under-represented for the WFCs (thus, over-represented for WNFCs). Those speeds above 46 MPH are over-represented in fatal crashes (WFCs), and the Odds Ratios generally increase systematically as these speeds increase. Insufficient data exists above 90 MPH. Speed relationship to fatality is discussed below.

6.3 Cross-tab: C025 Severity by C224 Speed at Impact (all Weather crashes)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Weather Items ALL Severities]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Weather Items ALL Severities | 1/ 1/20

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Crash Severity ; Row: CU Estimated Speed at Impact

	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
1 to 5 MPH	8 1.44%	50 2.01%	214 2.52%	347 3.80%	4445 5.42%	74 2.61%	5138 4.87%
6 to 10 MPH	14 2.52%	73 2.93%	313 3.69%	385 4.22%	3668 4.47%	63 2.22%	4516 4.28%
11 to 15 MPH	5 0.90%	63 2.53%	240 2.83%	279 3.06%	2769 3.38%	49 1.73%	3405 3.23%
16 to 20 MPH	3 0.54%	34 1.37%	170 2.00%	238 2.61%	2210 2.70%	33 1.16%	2688 2.55%
21 to 25 MPH	5 0.90%	32 1.29%	172 2.03%	221 2.42%	2030 2.48%	47 1.66%	2507 2.38%
26 to 30 MPH	3 0.54%	31 1.25%	195 2.30%	284 3.11%	2345 2.86%	53 1.87%	2911 2.76%
31 to 35 MPH	8 1.44%	72 2.89%	335 3.94%	332 3.64%	2994 3.65%	68 2.40%	3809 3.61%
36 to 40 MPH	11 1.98%	100 4.02%	356 4.19%	340 3.72%	2894 3.53%	60 2.12%	3761 3.57%
41 to 45 MPH	22 3.96%	226 9.08%	741 8.73%	496 5.43%	4526 5.52%	84 2.97%	6095 5.78%
46 to 50 MPH	22 3.96%	132 5.31%	395 4.65%	278 3.05%	2428 2.96%	48 1.69%	3303 3.13%
51 to 55 MPH	61 10.99%	306 12.30%	749 8.82%	443 4.85%	3552 4.33%	64 2.26%	5175 4.91%
56 to 60 MPH	34 6.13%	150 6.03%	356 4.19%	270 2.96%	2053 2.50%	29 1.02%	2892 2.74%
61 to 65 MPH	41 7.39%	179 7.19%	407 4.79%	263 2.88%	2525 3.08%	28 0.99%	3443 3.26%
66 to 70 MPH	45 8.11%	165 6.63%	373 4.39%	241 2.64%	2867 3.50%	19 0.67%	3710 3.52%
71 to 75 MPH	21 3.78%	45 1.81%	96 1.13%	55 0.60%	723 0.88%	7 0.25%	947 0.90%
76 to 80 MPH	13 2.34%	37 1.49%	62 0.73%	30 0.33%	316 0.39%	3 0.11%	461 0.44%
81 to 85 MPH	11 1.98%	13 0.52%	17 0.20%	8 0.09%	62 0.08%	0 0.00%	111 0.11%
86 to 90 MPH	7 1.26%	14 0.56%	17 0.20%	5 0.05%	27 0.03%	0 0.00%	70 0.07%
91 to 95 MPH	1 0.18%	4 0.16%	1 0.01%	0 0.00%	3 0.00%	0 0.00%	9 0.01%
96 to 100 MPH	8 1.44%	5 0.20%	4 0.05%	2 0.02%	14 0.02%	1 0.04%	34 0.03%
Over 100 MPH	3 0.54%	4 0.16%	3 0.04%	1 0.01%	6 0.01%	1 0.04%	18 0.02%
E Stationary	9 1.62%	22 0.88%	44 0.52%	63 0.69%	479 0.58%	12 0.42%	629 0.60%
Unknown	137 24.68%	602 24.20%	2759 32.49%	4047 44.33%	33941 41.39%	1762 62.20%	43248 41.00%
Not Applicable	6 1.08%	20 0.80%	158 1.86%	178 1.95%	2414 2.94%	180 6.35%	2956 2.80%
CU is Not a Vehicle	43 7.75%	63 2.53%	57 0.67%	26 0.28%	19 0.02%	14 0.49%	222 0.21%
CU is Unknown	14 2.52%	46 1.85%	258 3.04%	297 3.25%	2688 3.28%	134 4.73%	3437 3.26%
TOTAL	555 0.53%	2488 2.36%	8492 8.05%	9129 8.65%	81998 77.73%	2833 2.69%	**105495** **100.00%**

6.4 Dicussion: C025 Probability of being killed x C224 Speed at Impact

The display above presents information on the effect of increased impact speed on the severity of all Weather related crashes. Notice the red in the Fatality and Serious Injury cells as speeds increase. What is more interesting is the probability that an injury crash results in a fatality as a function of impact speed. This is given in the following table using 31-35 MPH as the base speed for the third column, the fatality probability multiplier from this base.

Speed at Impact	Fatality Odds (1 in …)	Increase Probability above 31-35
31 to 35 MPH	476.13	1
36 to 40 MPH	341.91	1.4
41 to 45 MPH	277.05	1.7
46 to 50 MPH	150.14	3.2
51 to 55 MPH	84.84	5.6
56 to 60 MPH	85.06	5.6
61 to 65 MPH	83.98	5.7
66 to 70 MPH	82.44	5.8
71 to 75 MPH	45.10	10.6
76 to 80 MPH	35.46	13.4
81 to 85 MPH	10.09	47.2
86 to 90 MPH	10.00	47.6
91 to 95 MPH	****	****
96 to 100 MPH	****	****
Over 100 MPH	****	****

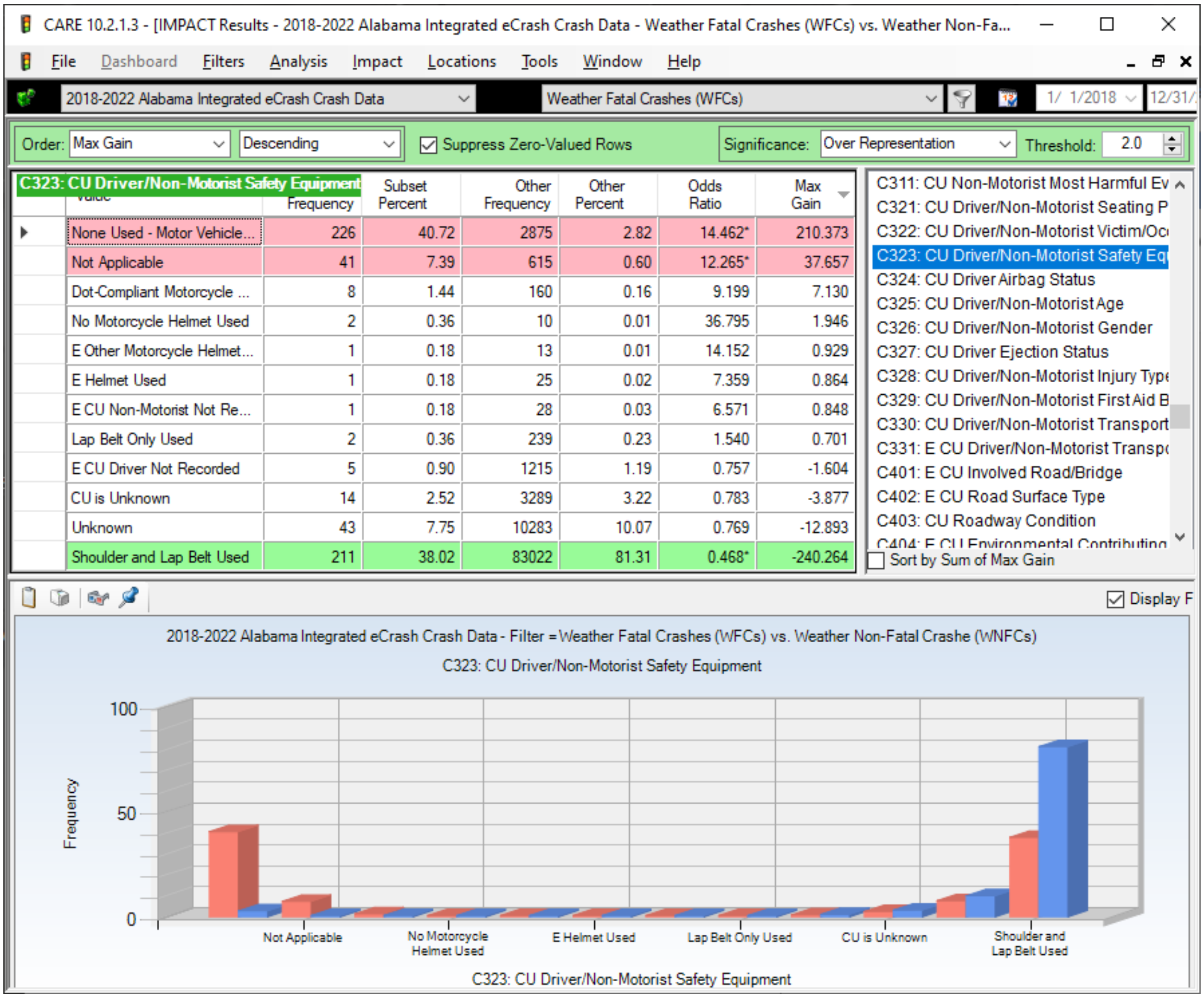
**** Insufficient Data to Calculate

The last column of the above table gives the fatality probability multiplier based on the lowest probability (31-35 MPH), to which the relative value of 1.0 (not a probability) was assigned. The probabilities in the form of "**1 in X**" are given in the middle column. For example, the probability of a Weather crash at 46-50 MPH being fatal is one in 150.14 Weather crashes. This is 3.2 times that probability of the impact speed in the 31 to 35 range. A crash at 86-90 MPH has over 47.6 times the probability of being fatal as does one at 31-35 MPH.

Obviously, speed kills, and a reduction in speed at impact by as little as 5 MPH can have a major effect on whether or not that crash is fatal. On average, the general rule that has been established is that a reduction in impact speeds by 10 MPH cuts the number of fatal crashes in half. This is one reason that selective enforcement is effective – even officer presence generally causes some speed reduction. However, there is another major factor in effect here as well – the failure of WFC and WNFC drivers to be properly restrained, which will be covered in the next separate attribute below (6.5; Restraint Use by Causal Drivers …). This is further multiplied by Impaired Driving because Impaired Drivers have been found to have a much lower restraint use.

6.5 C323 Restraint Use by Drivers in WFCs vs WNFCs

The following display presents a restraint-use comparison of WFCs driver safety belt use compared to that for all drivers in WNFCs, over the same five-year time period.



C323: CU Driver/Non-Motorist Safety Equipment Value	Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
None Used - Motor Vehicle...	226	40.72	2875	2.82	14.462*	210.373
Not Applicable	41	7.39	615	0.60	12.265*	37.657
Dot-Compliant Motorcycle ...	8	1.44	160	0.16	9.199	7.130
No Motorcycle Helmet Used	2	0.36	10	0.01	36.795	1.946
E Other Motorcycle Helmet...	1	0.18	13	0.01	14.152	0.929
E Helmet Used	1	0.18	25	0.02	7.359	0.864
E CU Non-Motorist Not Re...	1	0.18	28	0.03	6.571	0.848
Lap Belt Only Used	2	0.36	239	0.23	1.540	0.701
E CU Driver Not Recorded	5	0.90	1215	1.19	0.757	-1.604
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877
Unknown	43	7.75	10283	10.07	0.769	-12.893
Shoulder and Lap Belt Used	211	38.02	83022	81.31	0.468*	-240.264

The proportion of failure to use proper restraints is 40.72% for Weather Fatal Crashes. The Odds Ratio is a large 14.462, showing that their failure to use restraints causes over 14 times that of the Non-Fatal Weather crashes. Shoulder and Lap Belt Used is over-represented by WNFCs in about double (Odds Ratio 1/0.468 = 2.14 times the expected use in comparison to Fatal Weather Crash (WFC) seatbelt usage. Clearly, being unrestrained contributes heavily to chances of a weather crash resulting in death, as is true of all crash types.

6.6 Crosstabulation: C025 Crash Severity x C323 Restraint Use (all injury)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Injury Crashes (including Fatalities)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

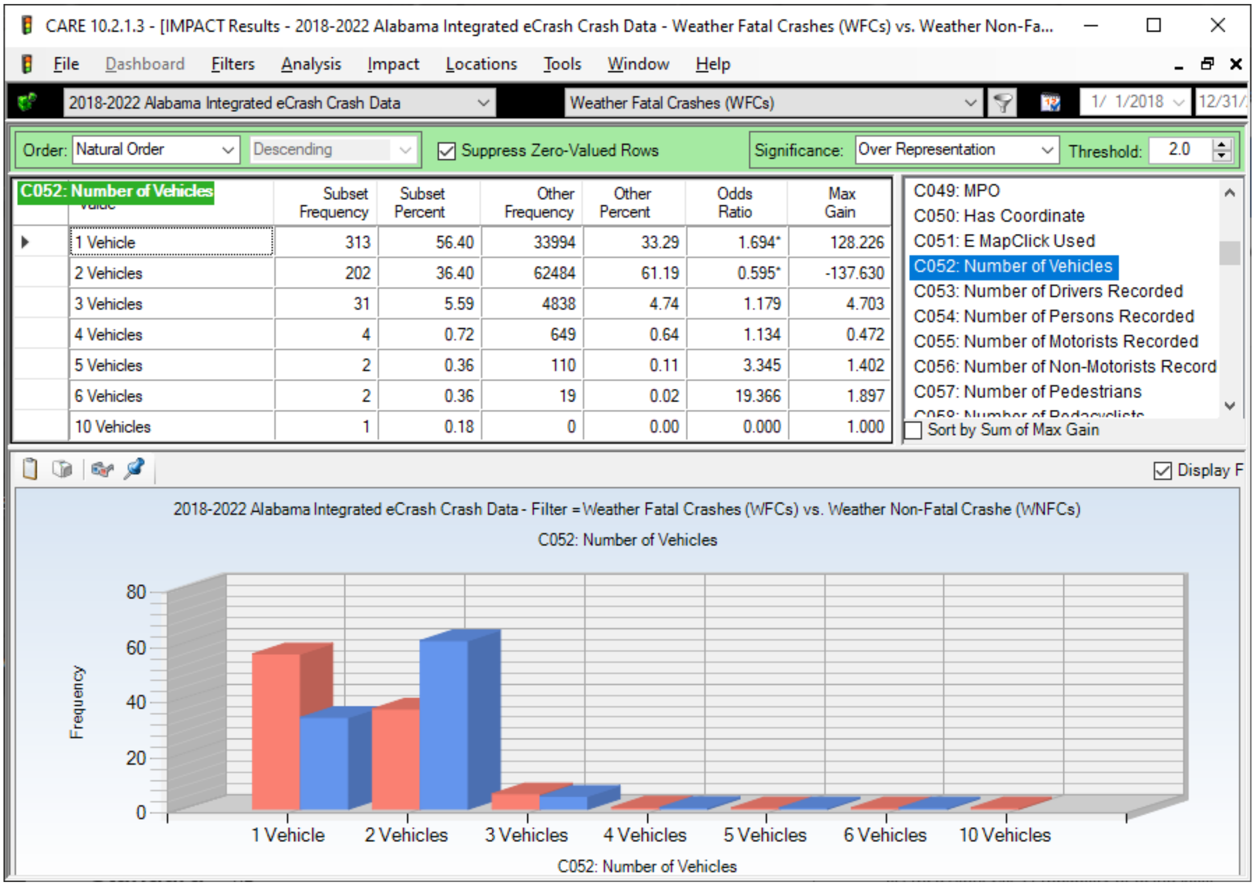
2018-2022 Alabama Integrated eCrash Crash Data | Injury Crashes (including Fatalities) | 1/ 1/2018

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Crash Severity ; Row: CU Driver/Non-Motorist Safety Equipment

	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	TOTAL
None Used - Motor Vehicle Oc	1596 36.51%	4412 21.75%	5240 8.69%	2510 3.91%	13758 9.23%
Shoulder and Lap Belt Used	1581 36.16%	11626 57.32%	44825 74.34%	51783 80.69%	109815 73.64%
Lap Belt Only Used	7 0.16%	42 0.21%	123 0.20%	154 0.24%	326 0.22%
Shoulder Belt Only Used	7 0.16%	32 0.16%	156 0.26%	188 0.29%	383 0.26%
E Forward Facing Child Safety Seat	0 0.00%	1 0.00%	3 0.00%	0 0.00%	4 0.00%
E Rear Facing Child Safety Seat	0 0.00%	0 0.00%	0 0.00%	3 0.00%	3 0.00%
E Rear Facing Child Safety Seat	0 0.00%	0 0.00%	2 0.00%	0 0.00%	2 0.00%
E Child in Arms of Restrained Adult	0 0.00%	0 0.00%	2 0.00%	0 0.00%	2 0.00%
Dot-Compliant Motorcycle Helme	201 4.60%	955 4.71%	1118 1.85%	351 0.55%	2625 1.76%
E Helmet Used	18 0.41%	102 0.50%	177 0.29%	51 0.08%	348 0.23%
E Protective Pads Used (Elbows/Kn	0 0.00%	1 0.00%	0 0.00%	0 0.00%	1 0.00%
Reflective Clothing (Jacket/B	1 0.02%	6 0.03%	7 0.01%	0 0.00%	14 0.01%
E Lighting Used by Non-Motorist	1 0.02%	3 0.01%	3 0.00%	2 0.00%	9 0.01%
E Other Safety Equipment Used	1 0.02%	5 0.02%	10 0.02%	8 0.01%	24 0.02%
E Other Motorcycle Helme	24 0.55%	69 0.34%	62 0.10%	13 0.02%	168 0.11%
No Motorcycle Helmet Used	32 0.73%	111 0.55%	94 0.16%	26 0.04%	263 0.18%
Other	9 0.21%	23 0.11%	56 0.09%	38 0.06%	126 0.08%
Unknown	351 8.03%	1581 7.79%	4982 8.26%	5459 8.51%	12373 8.30%
Not Applicable	385 8.81%	716 3.53%	1066 1.77%	546 0.85%	2713 1.82%
CU is Unknown	116 2.65%	437 2.15%	1948 3.23%	2554 3.98%	5055 3.39%
E CU Driver Not Recorded	32 0.73%	110 0.54%	340 0.56%	414 0.65%	896 0.60%
E CU Non-Motorist Not Reco	10 0.23%	51 0.25%	86 0.14%	72 0.11%	219 0.15%
TOTAL	4372 2.93%	20283 13.60%	60300 40.44%	64172 43.03%	149127 100.00%

Calculations are based on all injury (including fatal) crashes and all ages and weather conditions.
Odds of death not using restraints = 13,758 fatal crashes/1,596 deaths = one in 8.6 injury crashes.
Odds of death using restraints = 109,815 fatal crashes/1,581 deaths = one in 68.8 injury crashes.
Risk of death is increased by an average factor of 8.0 times when not using proper restraints.

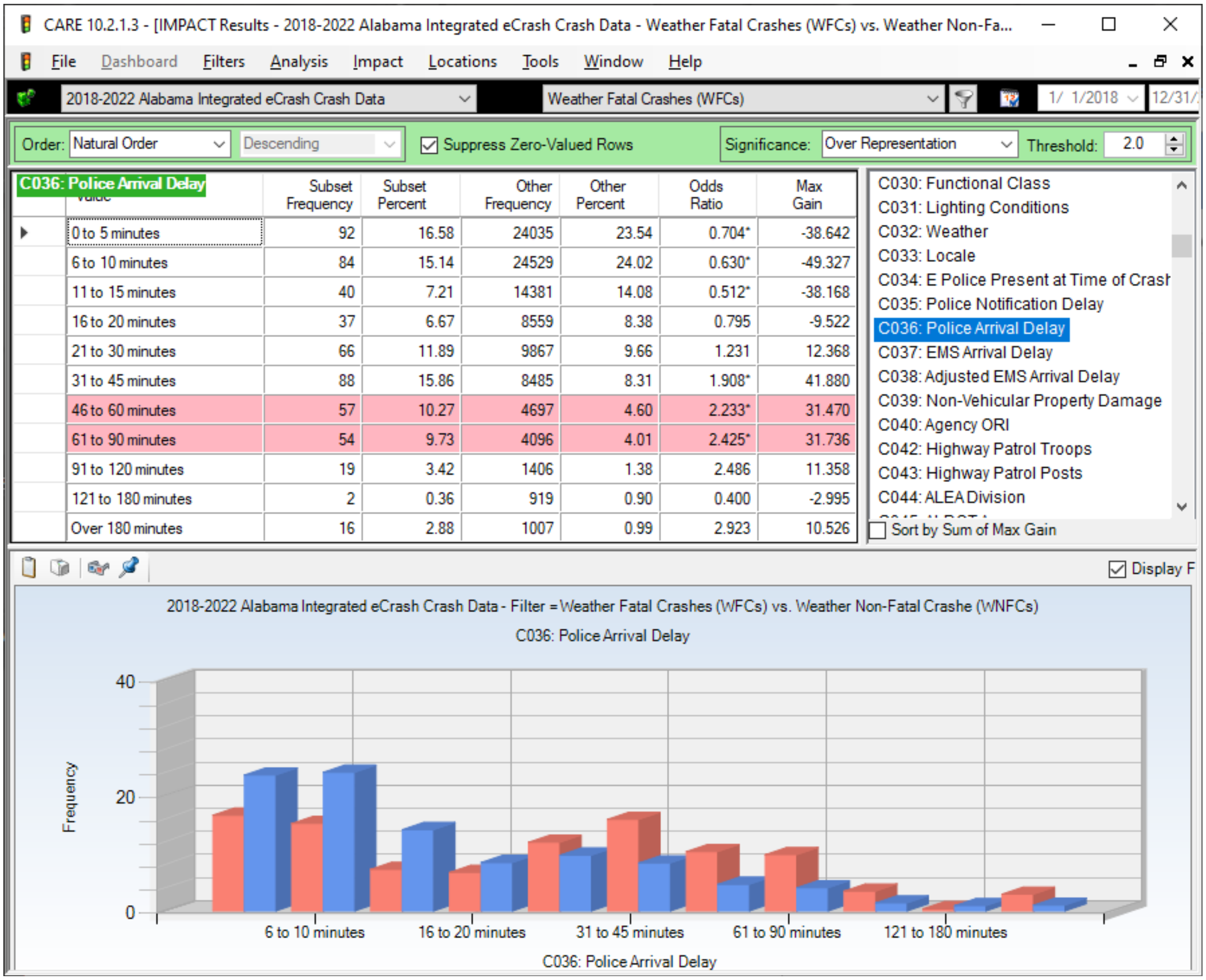
6.7 C052 Number of Vehicles Involved (WFCs vs WNFCs)



C052: Number of Vehicles Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	313	56.40	33994	33.29	1.694*	128.226
2 Vehicles	202	36.40	62484	61.19	0.595*	-137.630
3 Vehicles	31	5.59	4838	4.74	1.179	4.703
4 Vehicles	4	0.72	649	0.64	1.134	0.472
5 Vehicles	2	0.36	110	0.11	3.345	1.402
6 Vehicles	2	0.36	19	0.02	19.366	1.897
10 Vehicles	1	0.18	0	0.00	0.000	1.000

The Numbers of Vehicles in the table above are in their natural order. One and two vehicle crashes both showed significant differences from their non-fatal controls, but for the opposite reason. Two vehicles had fewer WFCs than expected, while single vehicle crashes had more than expected. Statistical differences are not calculated if the sample size is less than 20. However, the Odds Ratio is an indication of the probability of a crash being fatal, and it generally increases with the number of vehicles involved in the crash.

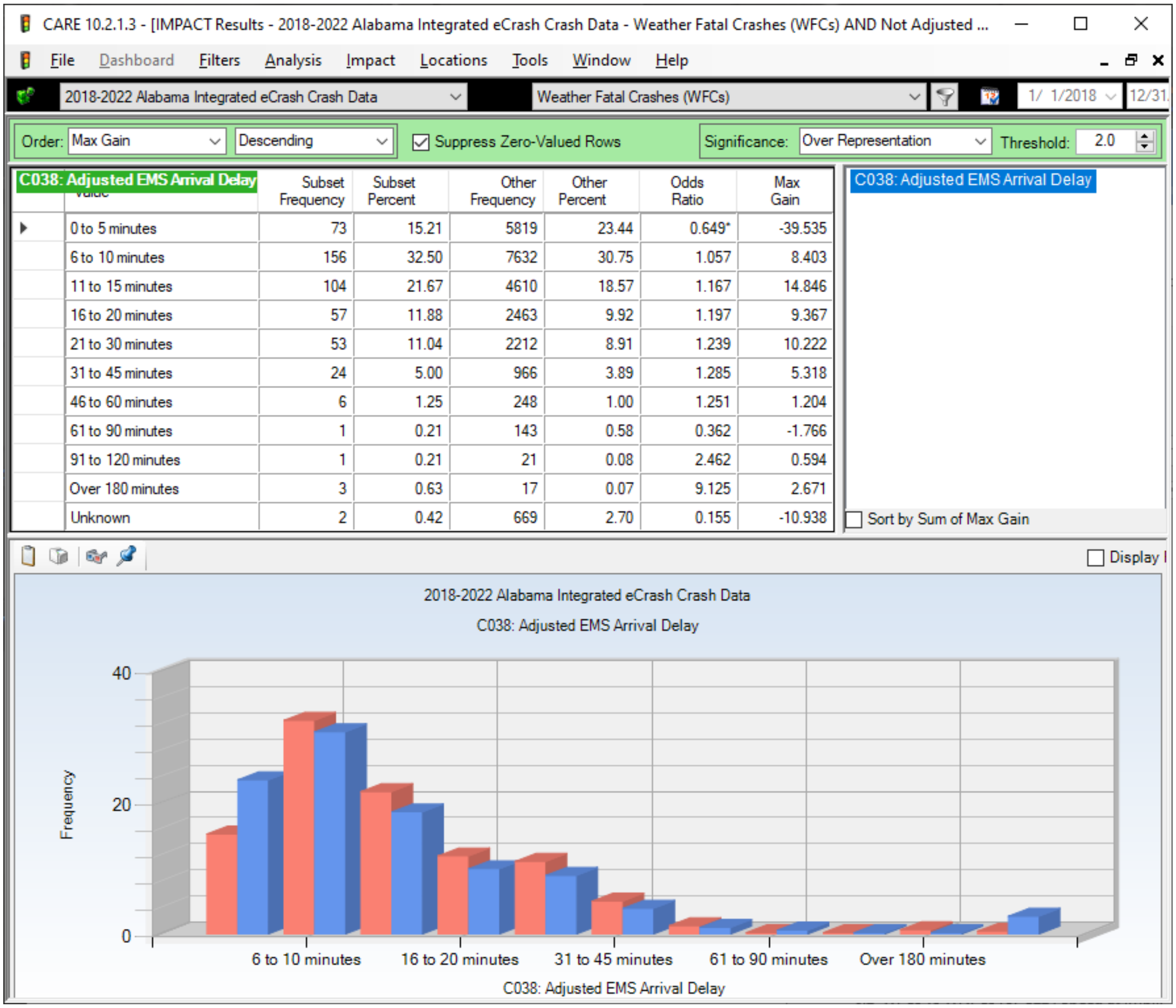
6.8 C036 Police Arrival Delay (WFCs vs WNFCs)



C036: Police Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	92	16.58	24035	23.54	0.704*	-38.642
6 to 10 minutes	84	15.14	24529	24.02	0.630*	-49.327
11 to 15 minutes	40	7.21	14381	14.08	0.512*	-38.168
16 to 20 minutes	37	6.67	8559	8.38	0.795	-9.522
21 to 30 minutes	66	11.89	9867	9.66	1.231	12.368
31 to 45 minutes	88	15.86	8485	8.31	1.908*	41.880
46 to 60 minutes	57	10.27	4697	4.60	2.233*	31.470
61 to 90 minutes	54	9.73	4096	4.01	2.425*	31.736
91 to 120 minutes	19	3.42	1406	1.38	2.486	11.358
121 to 180 minutes	2	0.36	919	0.90	0.400	-2.995
Over 180 minutes	16	2.88	1007	0.99	2.923	10.526

WFC police arrival delays reflect the issues in finding out about the crash and getting to the scene, especially at night and in bad weather. All of the delay times of 21 minutes or more were over-represented for WFCs, most with high Odds Ratios. WFCs are under-represented in all delay times below 21 minutes, of which three of the four were statistically significant. The analysis below shows that this correlates fairly well with EMS arrival times.

6.9 C038 Adjusted EMS Arrival Delay

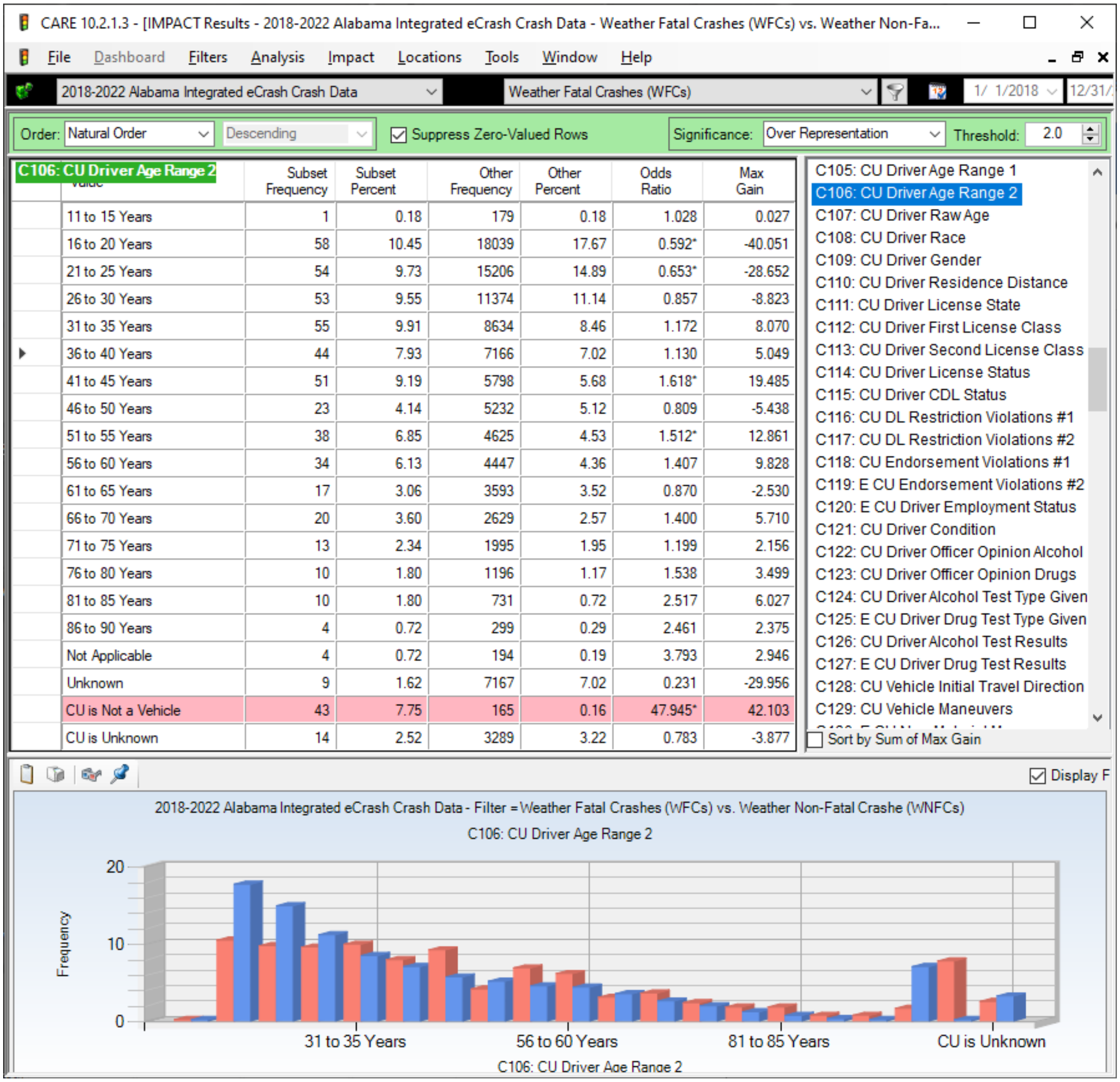


C038: Adjusted EMS Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	73	15.21	5819	23.44	0.649*	-39.535
6 to 10 minutes	156	32.50	7632	30.75	1.057	8.403
11 to 15 minutes	104	21.67	4610	18.57	1.167	14.846
16 to 20 minutes	57	11.88	2463	9.92	1.197	9.367
21 to 30 minutes	53	11.04	2212	8.91	1.239	10.222
31 to 45 minutes	24	5.00	966	3.89	1.285	5.318
46 to 60 minutes	6	1.25	248	1.00	1.251	1.204
61 to 90 minutes	1	0.21	143	0.58	0.362	-1.766
91 to 120 minutes	1	0.21	21	0.08	2.462	0.594
Over 180 minutes	3	0.63	17	0.07	9.125	2.671
Unknown	2	0.42	669	2.70	0.155	-10.938

The vast majority of the ambulance delay times for WFCs are over-represented in having proportions in the 6- to 60-minute range. WNFCs were over-represented in the 0 to 5-minute range, probably attributed to the fact that most of them occurred in urban areas. Those few in the higher delay ranges probably occurred later on into the night, and some might not have been immediately discovered. A cross-tabulation of EMS delay times by roadway lighting conditions showed that 105 of the crashes with delay times over 10 minutes occurred in the Dark with the Roadway Not Lighted.

7.0 Driver and Vehicle Demographics

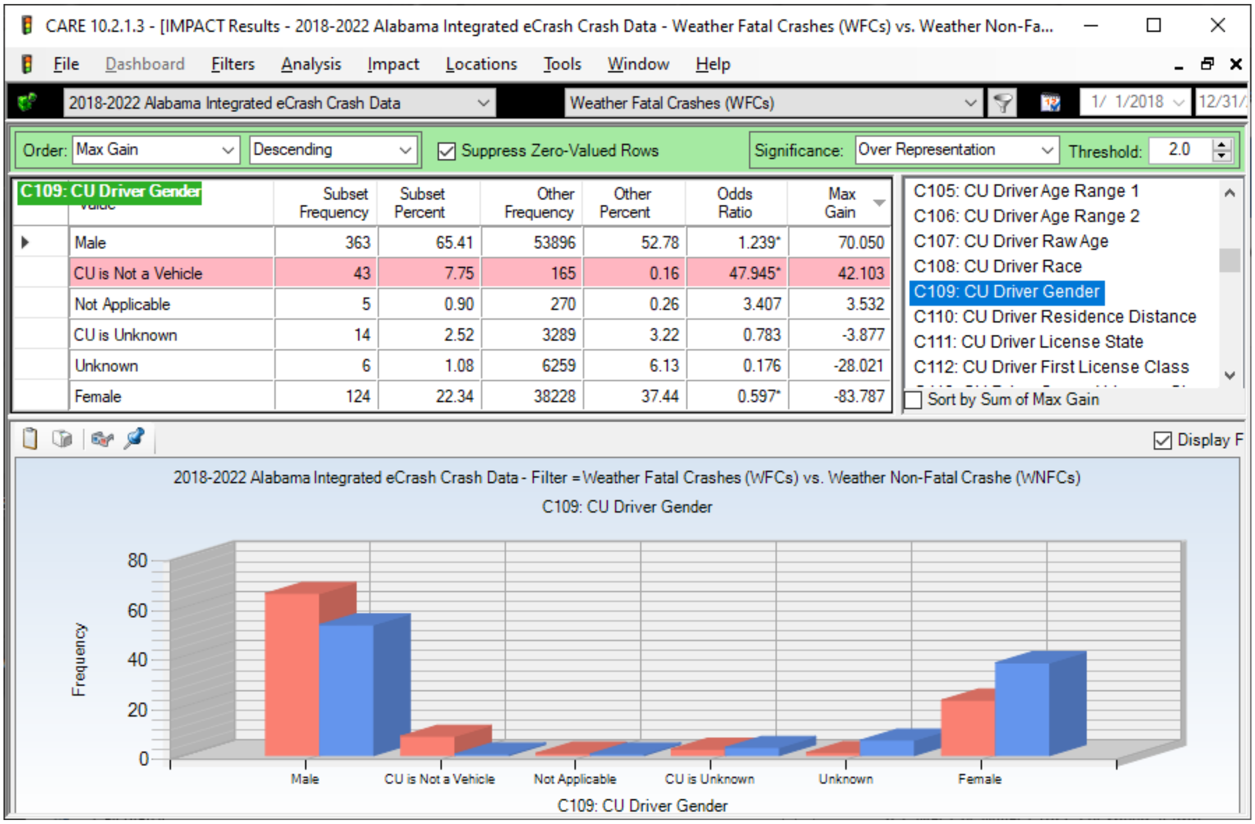
7.1 C106 Driver Age Range 2



C106: CU Driver Age Range 2 Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
11 to 15 Years	1	0.18	179	0.18	1.028	0.027
16 to 20 Years	58	10.45	18039	17.67	0.592*	-40.051
21 to 25 Years	54	9.73	15206	14.89	0.653*	-28.652
26 to 30 Years	53	9.55	11374	11.14	0.857	-8.823
31 to 35 Years	55	9.91	8634	8.46	1.172	8.070
36 to 40 Years	44	7.93	7166	7.02	1.130	5.049
41 to 45 Years	51	9.19	5798	5.68	1.618*	19.485
46 to 50 Years	23	4.14	5232	5.12	0.809	-5.438
51 to 55 Years	38	6.85	4625	4.53	1.512*	12.861
56 to 60 Years	34	6.13	4447	4.36	1.407	9.828
61 to 65 Years	17	3.06	3593	3.52	0.870	-2.530
66 to 70 Years	20	3.60	2629	2.57	1.400	5.710
71 to 75 Years	13	2.34	1995	1.95	1.199	2.156
76 to 80 Years	10	1.80	1196	1.17	1.538	3.499
81 to 85 Years	10	1.80	731	0.72	2.517	6.027
86 to 90 Years	4	0.72	299	0.29	2.461	2.375
Not Applicable	4	0.72	194	0.19	3.793	2.946
Unknown	9	1.62	7167	7.02	0.231	-29.956
CU is Not a Vehicle	43	7.75	165	0.16	47.945*	42.103
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877

The display above presents WFCs compared to WNFCs given in five-year age increments.
WFC significant under-representations = 16-20 and 21-25 years.
WFC significant over-representations = 41-45 and 51-55 years.

7.2 C109 Driver Gender WFCs vs WNFCs



The male and female red and blue bar proportions each individually sum very close to 100%. So the breakdown in WFCs causal drivers is 65.41% male and 22.34% female. For "Other," WNFCs, the percentage is 52.78% male and 37.44% female. These differences in proportions certainly indicate that males are a greater cause of Weather Fatal Crashes (WFCs) than crashes in general, although their proportion of causing crashes in general is also quite high. If there are countermeasures that can be directed toward males, doing so would be much more cost-effective than those directed toward all drivers.

What makes women drivers so much safer in fatal crash comparisons? No doubt it has something to do with speed. See Section 7.3 immediately below.

7.3 Cross-tab C109 Driver Gender x C224 Speed at Impact (all WFCs)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Weather Fatal Crashes (WFCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

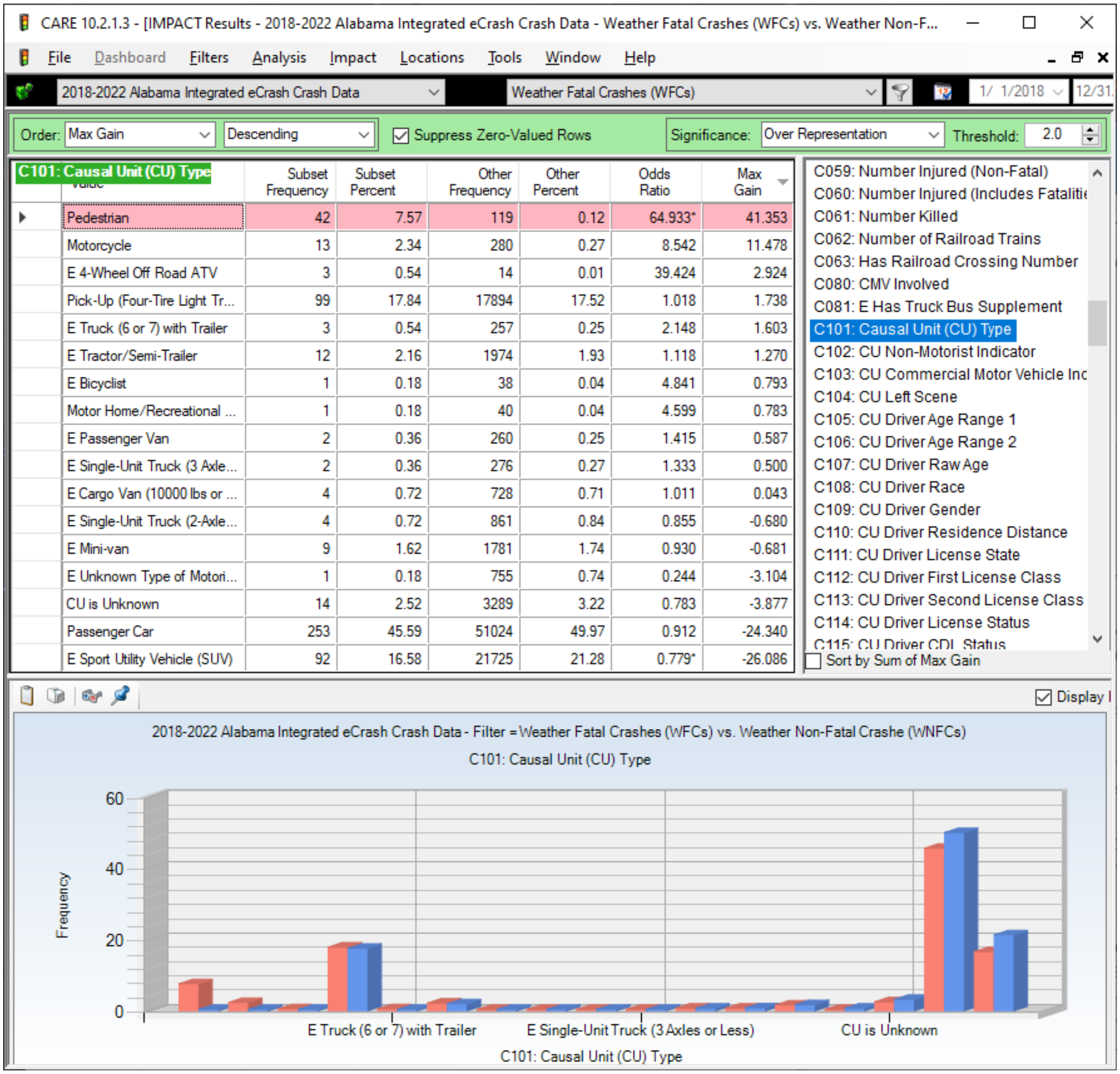
2018-2022 Alabama Integrated eCrash Crash Data | Weather Fatal Crashes (WFCs) | 1/ 1/201

Suppress Zero Values: Rows and Columns | Select Cells: | Column: CU Driver Gender ; Row: CU Estimated Speed at Impact

	Male	Female	Unknown	Not Applicable	CU is Not a Vehicle	CU is Unknown	TOTAL
1 to 5 MPH	5 1.38%	3 2.42%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	8 1.44%
6 to 10 MPH	11 3.03%	3 2.42%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	14 2.52%
11 to 15 MPH	3 0.83%	2 1.61%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	5 0.90%
16 to 20 MPH	2 0.55%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	3 0.54%
21 to 25 MPH	2 0.55%	3 2.42%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	5 0.90%
26 to 30 MPH	2 0.55%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	3 0.54%
31 to 35 MPH	8 2.20%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	8 1.44%
36 to 40 MPH	7 1.93%	4 3.23%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	11 1.98%
41 to 45 MPH	13 3.58%	8 6.45%	1 16.67%	0 0.00%	0 0.00%	0 0.00%	22 3.96%
46 to 50 MPH	18 4.96%	4 3.23%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	22 3.96%
51 to 55 MPH	44 12.12%	17 13.71%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	61 10.99%
56 to 60 MPH	26 7.16%	8 6.45%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	34 6.13%
61 to 65 MPH	33 9.09%	8 6.45%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	41 7.39%
66 to 70 MPH	36 9.92%	9 7.26%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	45 8.11%
71 to 75 MPH	18 4.96%	3 2.42%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	21 3.78%
76 to 80 MPH	11 3.03%	2 1.61%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	13 2.34%
81 to 85 MPH	10 2.75%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	11 1.98%
86 to 90 MPH	6 1.65%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	7 1.26%
91 to 95 MPH	1 0.28%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.18%
96 to 100 MPH	6 1.65%	2 1.61%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	8 1.44%
Over 100 MPH	2 0.55%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	3 0.54%
E Stationary	3 0.83%	2 1.61%	0 0.00%	4 80.00%	0 0.00%	0 0.00%	9 1.62%
Unknown	91 25.07%	40 32.26%	5 83.33%	1 20.00%	0 0.00%	0 0.00%	137 24.68%
Not Applicable	5 1.38%	1 0.81%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	6 1.08%
CU is Not a Vehicle	0 0.00%	0 0.00%	0 0.00%	0 0.00%	43 100.00%	0 0.00%	43 7.75%
CU is Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	14 100.00%	14 2.52%
TOTAL	363 65.41%	124 22.34%	6 1.08%	5 0.90%	43 7.75%	14 2.52%	555 100.00%

Number of males and females involved in WFCs over 60 MPH: 123 Male and 27 Female. The number of male fatal crashes over 60 MPH is 4.56 times than that of the females.

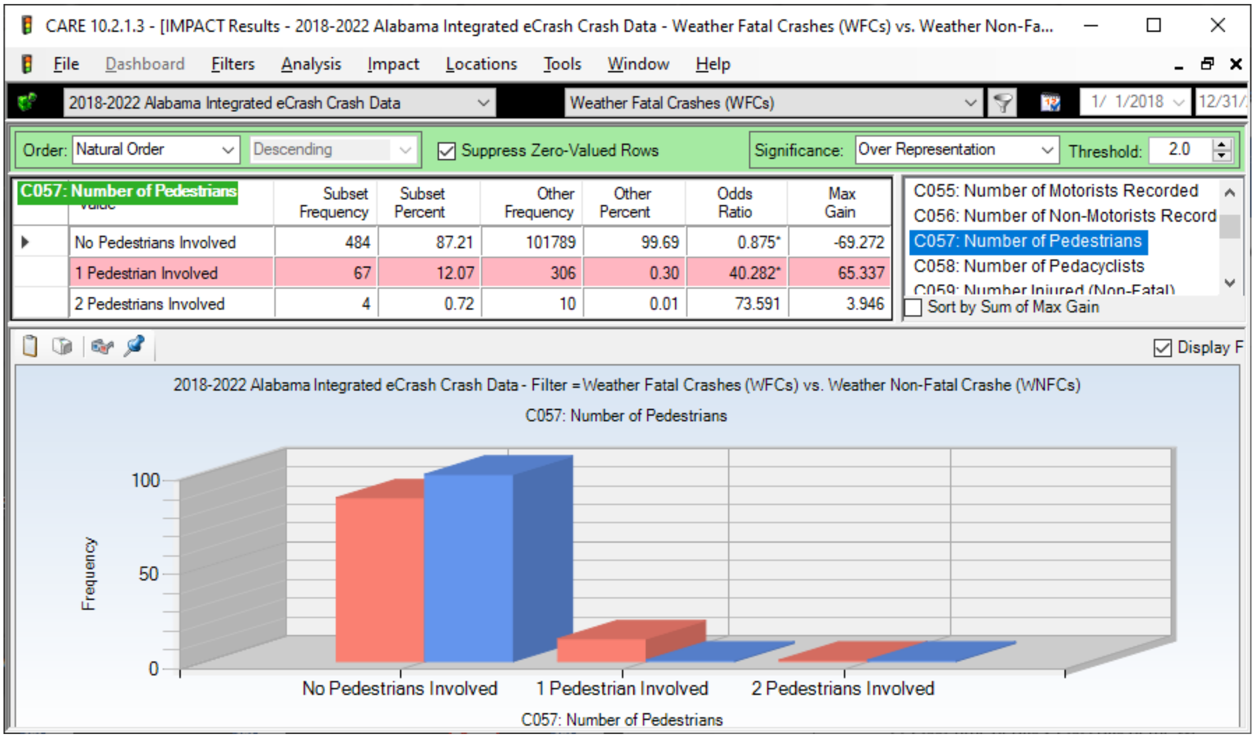
7.4 C101 Causal Vehicle Type WFCs vs WNFCs



C101: Causal Unit (CU) Type Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Pedestrian	42	7.57	119	0.12	64.933*	41.353
Motorcycle	13	2.34	280	0.27	8.542	11.478
E 4-Wheel Off Road ATV	3	0.54	14	0.01	39.424	2.924
Pick-Up (Four-Tire Light Tr...	99	17.84	17894	17.52	1.018	1.738
E Truck (6 or 7) with Trailer	3	0.54	257	0.25	2.148	1.603
E Tractor/Semi-Trailer	12	2.16	1974	1.93	1.118	1.270
E Bicyclist	1	0.18	38	0.04	4.841	0.793
Motor Home/Recreational ...	1	0.18	40	0.04	4.599	0.783
E Passenger Van	2	0.36	260	0.25	1.415	0.587
E Single-Unit Truck (3 Axle...	2	0.36	276	0.27	1.333	0.500
E Cargo Van (10000 lbs or ...	4	0.72	728	0.71	1.011	0.043
E Single-Unit Truck (2-Axle...	4	0.72	861	0.84	0.855	-0.680
E Mini-van	9	1.62	1781	1.74	0.930	-0.681
E Unknown Type of Motori...	1	0.18	755	0.74	0.244	-3.104
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877
Passenger Car	253	45.59	51024	49.97	0.912	-24.340
E Sport Utility Vehicle (SUV)	92	16.58	21725	21.28	0.779*	-26.086

Pedestrians were the most over-represented, with a frequency of 42 but an Odds Ratio of 64.933. Clearly bad weather is not the time to be walking. The next highest over-representations were Motorcycles (2.34%, 13), 4-Mheel Off Road ATVs (0.54%, 3), and Pick-Ups (17.84%, 99). Pick Ups and Motorcycles had the highest proportional over-representations for WFCs. The proportion of Sport Utility Vehicles (16.58%, 92) and Passenger Cars (45.59%, 253) resulted in their placement at the bottom of the list, indicating that they were under-represented in WFCs despite their high frequencies.

7.5 C057 Number of Pedestrians

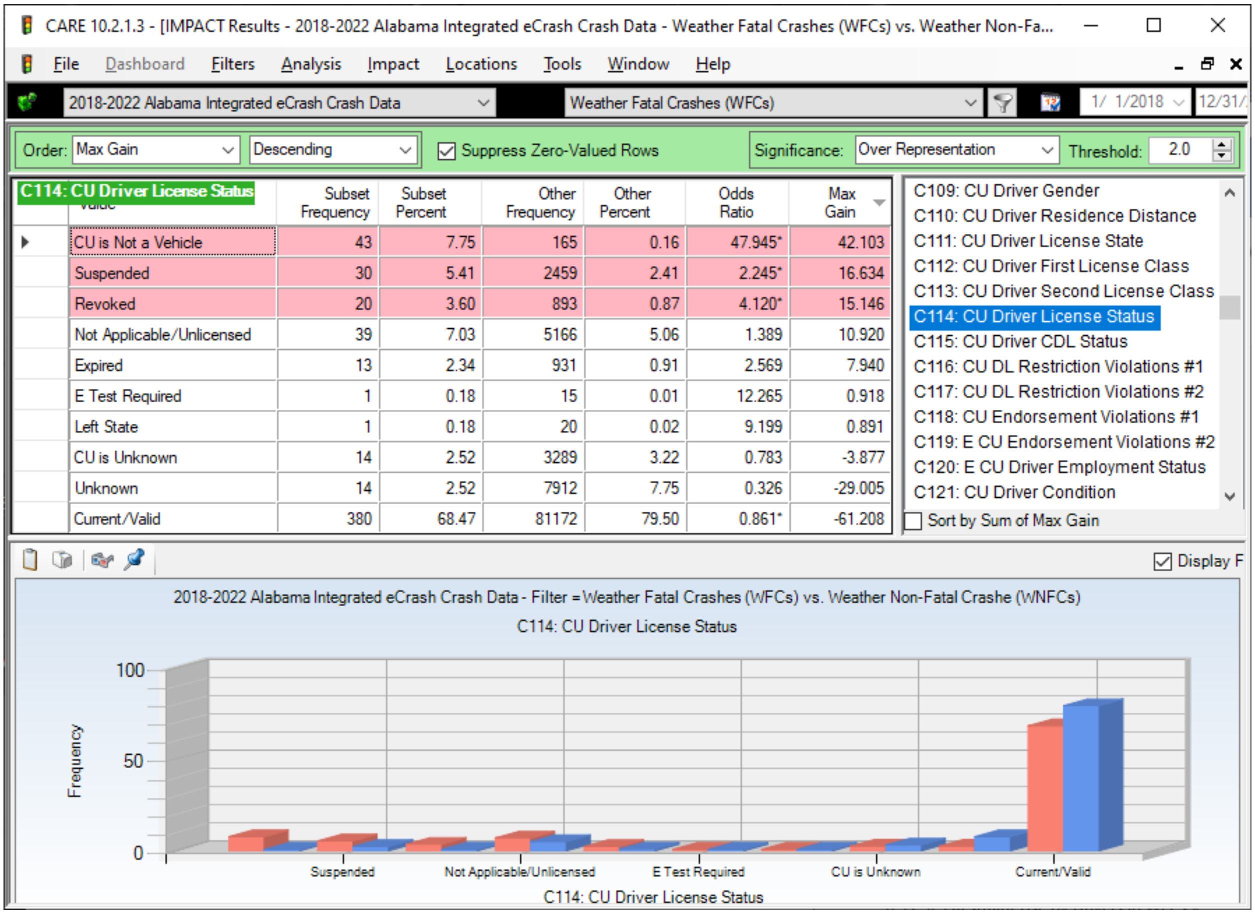


There were a total of 75 Weather related pedestrian fatality crashes, and 326 pedestrian weather-involved crashes were recorded as not fatal.

Single pedestrian WFC pedestrian crashes occur at a proportion 12.07%. which is 40.282 times greater than their Weather Non-Fatal proportion. See the reference at the end of this blurb for a study that concentrated on pedestrians. Both ID (Impaired Driving) and Impaired Walking, contribute to pedestrian collisions, as well as pedestrians not taking the maximum means for being seen at all times, but especially at night. Wearing reflective clothing, and keeping a flashlight lit at night to be seen of vehicle drivers are two of the most important recommendations since lack of visibility was cited for several pedestrian fatal crashes. Both day and night visibility needs to be emphasized in the lower school grades and continued through the young adult years. Pedestrian training needs to be increased to include the advantages of walking against traffic, wearing of reflective clothing at night, and all the other rules for pedestrian safety, including a strong prohibition of walking while intoxicated with either alcohol or other drugs.

For a detailed study of pedestrian crashes in Alabama, please see:
http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf

7.6 C114 Driver License Status

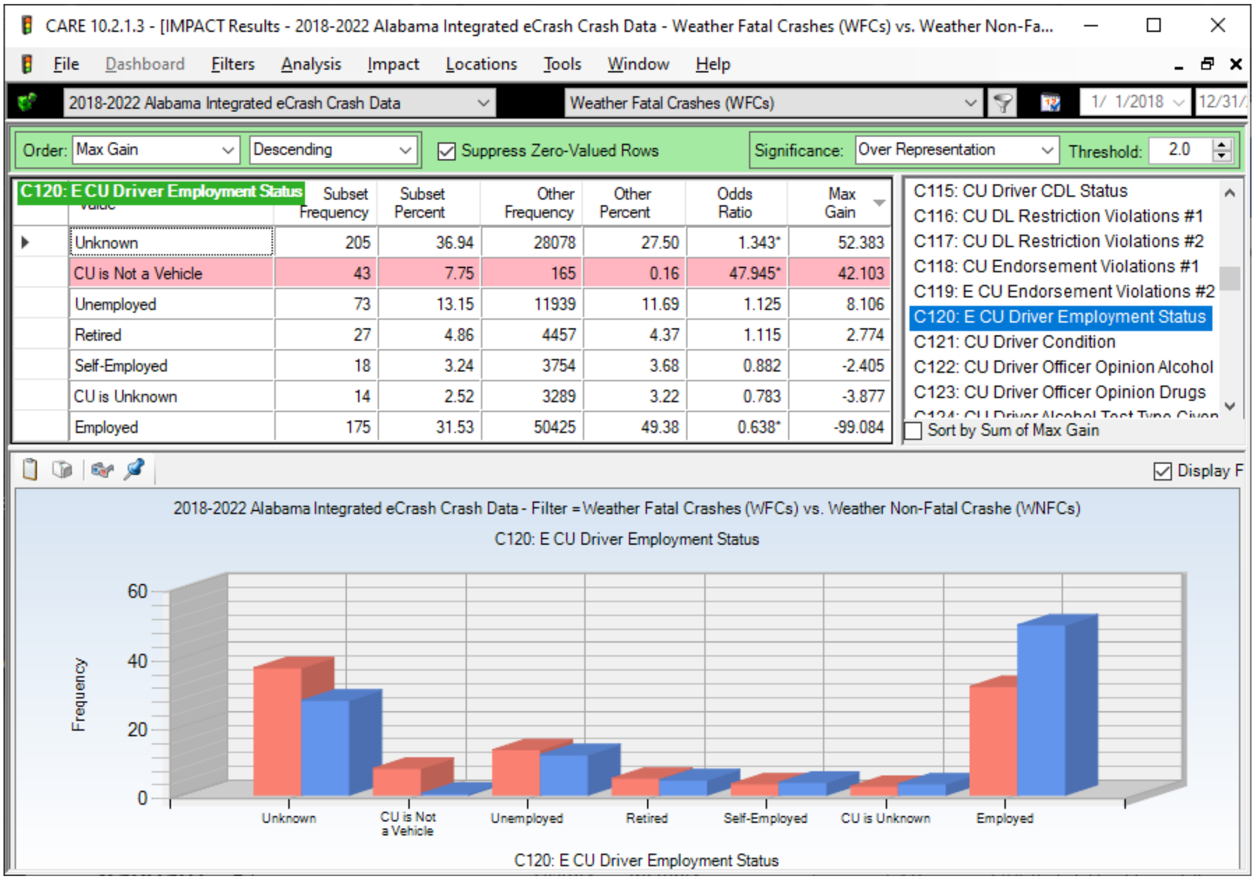


C114: CU Driver License Status	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
CU is Not a Vehicle	43	7.75	165	0.16	47.945*	42.103
Suspended	30	5.41	2459	2.41	2.245*	16.634
Revoked	20	3.60	893	0.87	4.120*	15.146
Not Applicable/Unlicensed	39	7.03	5166	5.06	1.389	10.920
Expired	13	2.34	931	0.91	2.569	7.940
E Test Required	1	0.18	15	0.01	12.265	0.918
Left State	1	0.18	20	0.02	9.199	0.891
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877
Unknown	14	2.52	7912	7.75	0.326	-29.005
Current/Valid	380	68.47	81172	79.50	0.861*	-61.208

WFC drivers were significantly under-represented in their causal drivers having Current/Valid drivers' licenses, which indicates that many of these have had problems in obeying the driving rules. The percentage of Current/Valid for WFCs was 68.47%, while it was 79.50% for WNFCs. In addition, Suspended 30 and Revoked 20 were significantly over-represented with Odds Ratios of 2.245 and 4.120. Expired 13 was also over-represented with an odds ratio of2.569.

This would lead us to believe that drivers who caused fatal crashes often had habits of not operating within the law.

7.7 C120 Driver Employment Status



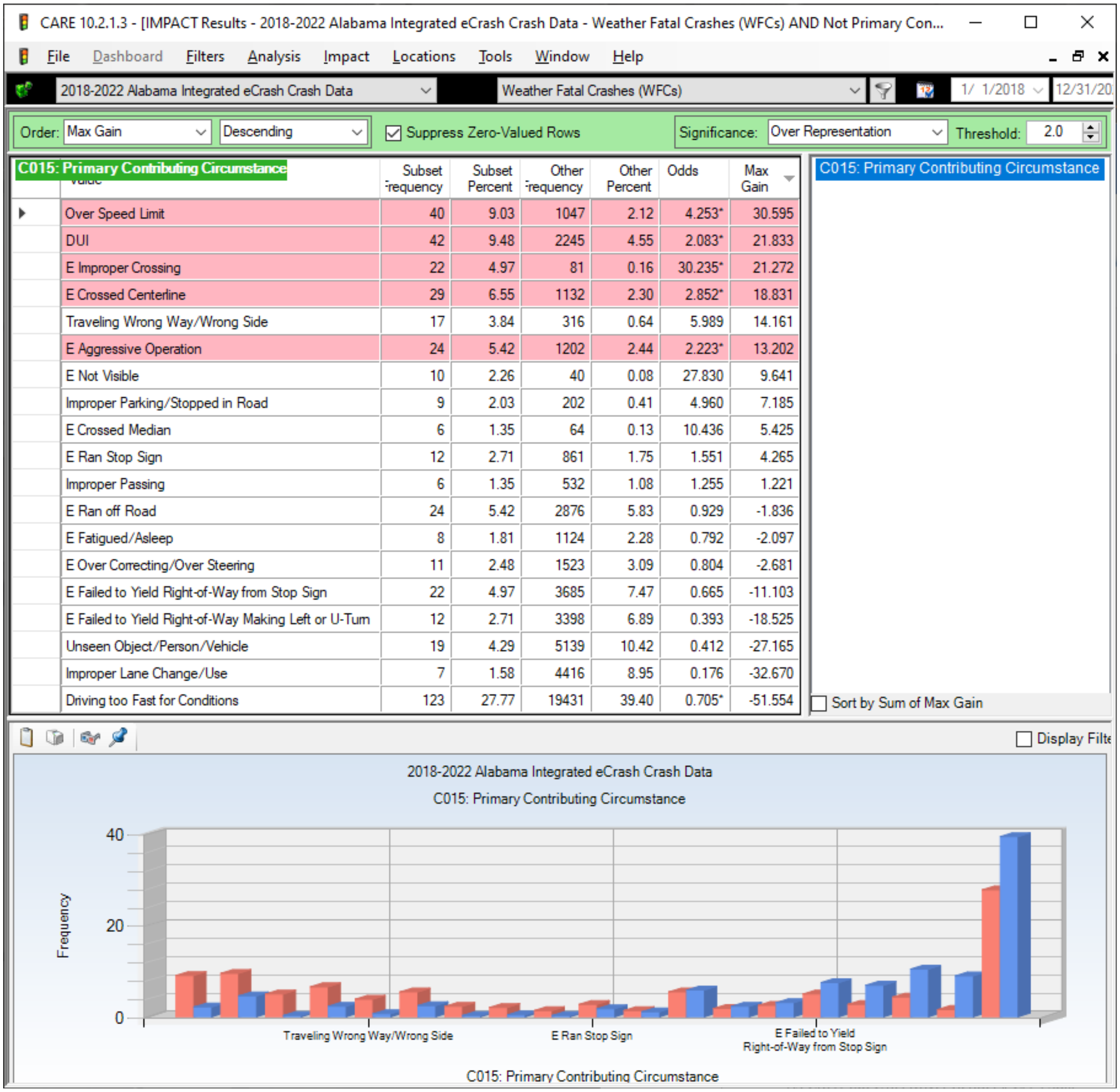
This analysis indicated that the employment rate for the WFCs was about 31.53%, while that for WNFCs was 49.38%. The following gives the proportion comparisons for WFCs and WNFCs, with over-representation indicated by (*):

Status	WFCs	WNFCs	ODDS RATIO
Unemployed	13.15%	11.69%	1.125
Self-Employed	3.24%	3.68%	0.882
Employed	31.53%	49.38%	0.638*

WFCs were significantly under-represented in the employment category. Consistency in their employment to the degree indicated, shows that a moderate proportion of those who cause fatalities in weather-related crashes do not hold down long-term employment.

8.0 Driver Behavior

8.1 C015 Primary Contributing Circumstances (Items < 5 Crashes Removed)



C015: Primary Contributing Circumstance Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Over Speed Limit	40	9.03	1047	2.12	4.253*	30.595
DUI	42	9.48	2245	4.55	2.083*	21.833
E Improper Crossing	22	4.97	81	0.16	30.235*	21.272
E Crossed Centerline	29	6.55	1132	2.30	2.852*	18.831
Traveling Wrong Way/Wrong Side	17	3.84	316	0.64	5.989	14.161
E Aggressive Operation	24	5.42	1202	2.44	2.223*	13.202
E Not Visible	10	2.26	40	0.08	27.830	9.641
Improper Parking/Stopped in Road	9	2.03	202	0.41	4.960	7.185
E Crossed Median	6	1.35	64	0.13	10.436	5.425
E Ran Stop Sign	12	2.71	861	1.75	1.551	4.265
Improper Passing	6	1.35	532	1.08	1.255	1.221
E Ran off Road	24	5.42	2876	5.83	0.929	-1.836
E Fatigued/Asleep	8	1.81	1124	2.28	0.792	-2.097
E Over Correcting/Over Steering	11	2.48	1523	3.09	0.804	-2.681
E Failed to Yield Right-of-Way from Stop Sign	22	4.97	3685	7.47	0.665	-11.103
E Failed to Yield Right-of-Way Making Left or U-Turn	12	2.71	3398	6.89	0.393	-18.525
Unseen Object/Person/Vehicle	19	4.29	5139	10.42	0.412	-27.165
Improper Lane Change/Use	7	1.58	4416	8.95	0.176	-32.670
Driving too Fast for Conditions	123	27.77	19431	39.40	0.705*	-51.554

8.2 Discussion of Primary Contributing Circumstances (PCC) Results Above

These results demonstrate the driver behaviors as they were defined by the C015, Primary Contributing Circumstances (PCCs), which accompanied WFCs and WNFCs. All WFC over-representations in their expected proportion are as follows, with percentages:

WFCs PCC Overrepresented/Freq	**WFC%**	**WNFC%**
Over Speed Limit 40	9.03%**	2.12%
DUI 42	9.48%	4.55%
Improper Crossing Pedestrian 22	4.97%**	0.16%
Crossed Centerline 29	6.55%**	2.30%
Traveling Wrong Way/Side 17	3.84%	0.64%
Aggressive Operation 24	5.42%**	2.44%
Not Visible 10	2.26%	0.08%
Improper Parking/Stopping 9	2.03%	0.41%
Crossed Median	1.35%	0.13%
Ran Stop Sign 12	2.71%	1.75%
Improper Passing 6	1.35%	1.08%
WFCs Under-represented:		
Ran off Road 24	5.42%	5.83%
Failed to Yield ROW at Stop 22	4.97%	7.47%
Driving too Fast for Conditions 123	27.77%	39.40%*

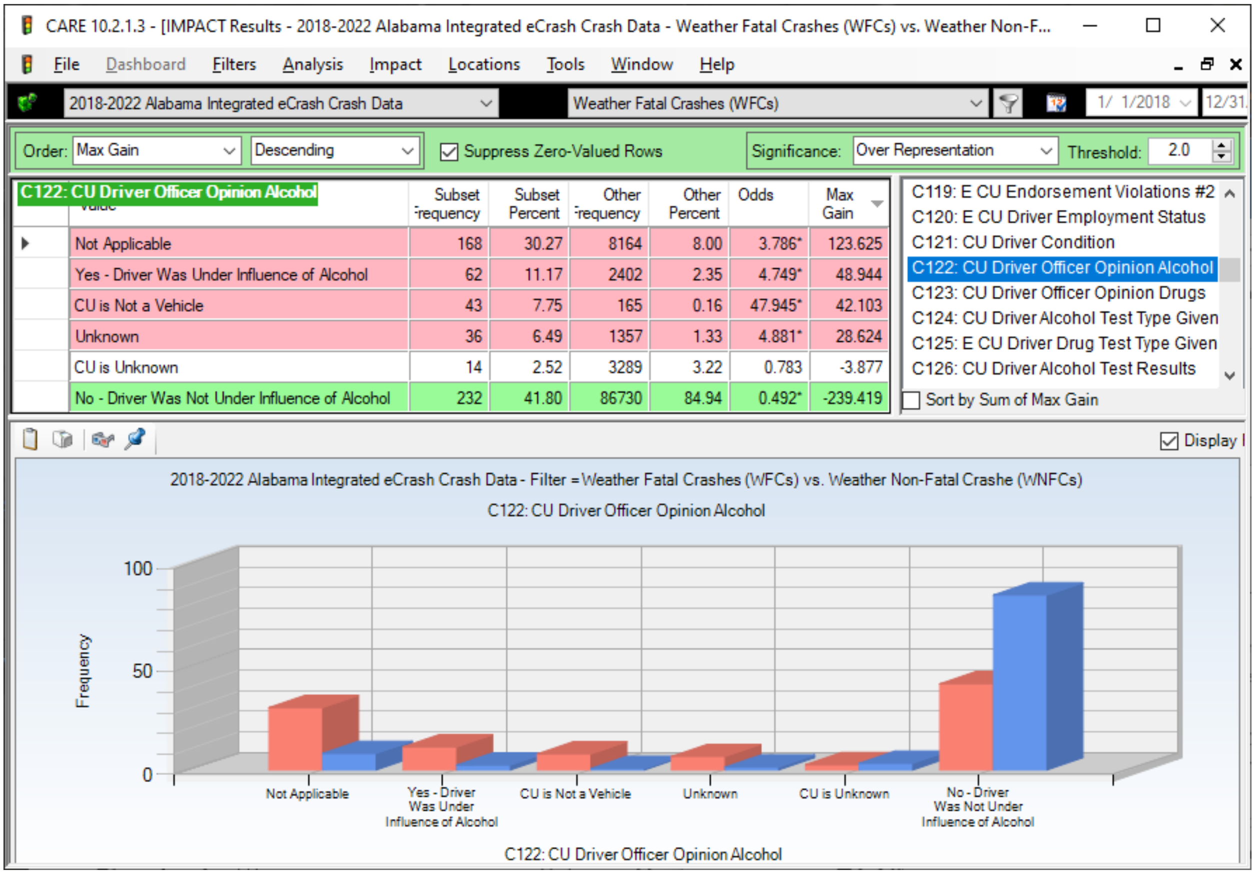
* Statistically significant difference
** Highly significant difference (more than 10%)

None of the items listed here or in the IMPACT table are necessarily mutually exclusive from the others. Each should be viewed in terms of their relative positions in the table as opposed to any one of them being the absolute cause.

It is clear that the big killers are Over Speed Limit 40, DUI (ID) 42, Improper Crossing for Pedestrians 22, Crossed Centerline 29, Traveling Wrong Way/Wrong Side 17, and Aggressive Operation 24. Related: Speed: Driving too Fast for Conditions 123; Pedestrians: Not Visible10, Unseen Object/Person/Vehicle 19.

The others (lower on the list) have less than half the frequency and proportions. There are some high frequency items lower down on the list, but their proportions are not as high as the corresponding WNFCs.

8.3 C122 CU Driver Officer's Opinion Alcohol

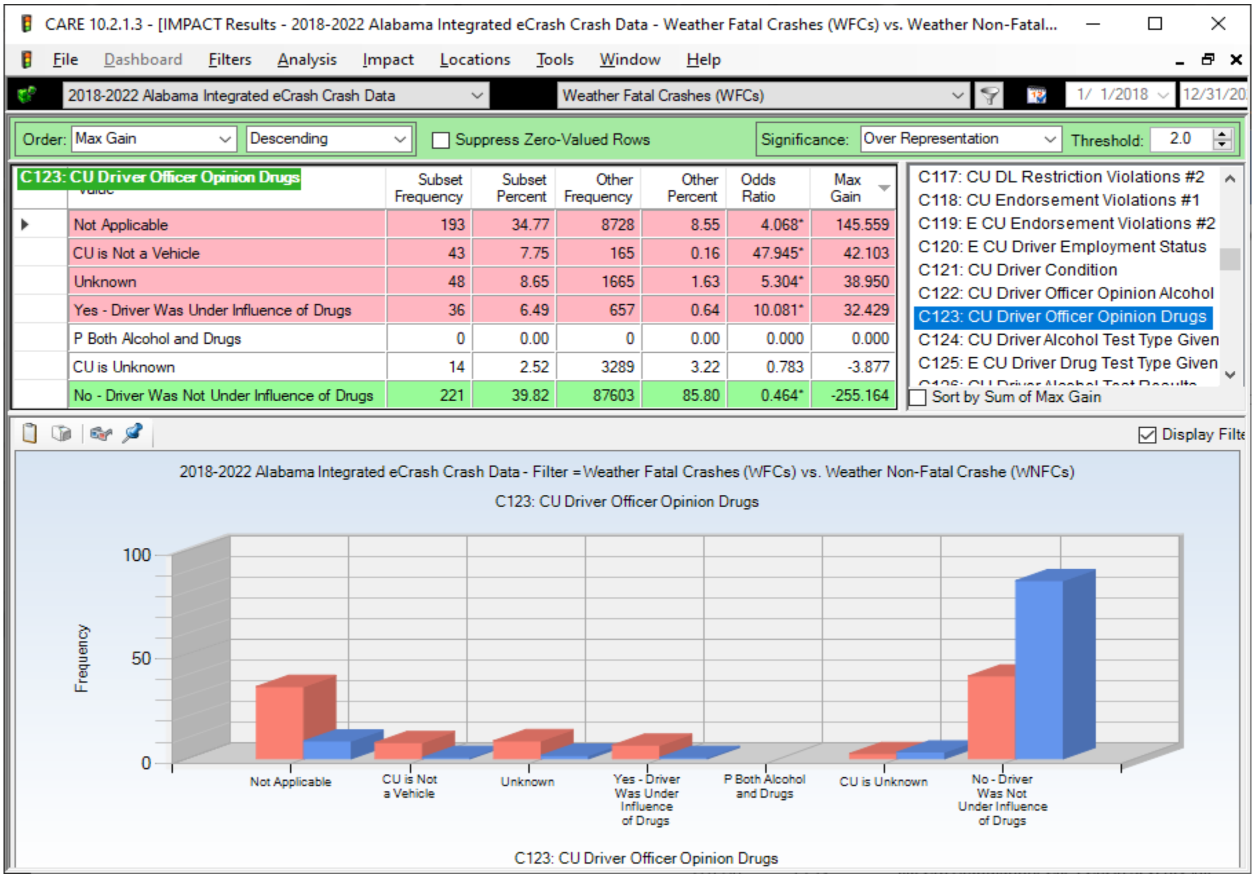


C122: CU Driver Officer Opinion Alcohol	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Not Applicable	168	30.27	8164	8.00	3.786*	123.625
Yes - Driver Was Under Influence of Alcohol	62	11.17	2402	2.35	4.749*	48.944
CU is Not a Vehicle	43	7.75	165	0.16	47.945*	42.103
Unknown	36	6.49	1357	1.33	4.881*	28.624
CU is Unknown	14	2.52	3289	3.22	0.783	-3.877
No - Driver Was Not Under Influence of Alcohol	232	41.80	86730	84.94	0.492*	-239.419

Impaired Driving/Alcohol was indicated as one cause of the crash for 11.17% of the WFCs, and 2.35% of the WNFCs. This gives an Odds Ratio of 4.749. ID/DUI tends to be under-reported, and there is no doubt that its reduction would have a major impact on reducing the number of weather fatal crashes. From the positive perspective, 84.94% of the WNFCS were reported to be not ID alcohol, but only 41.80% of the WFC drivers were sober in this regard.

Probability of crash being fatal if causal driver is alcohol impaired (62+2402)/62 = one in 39.74.
Probability of fatal if CU driver is not alcohol impaired = (232+86730)/232 one in 374.84.
Alcohol ID Multiplier = 374.84/39.74 = 9.43 times the non-alcohol probability.

8.4 C123 CU Driver Officer's Opinion Drugs (other than alcohol)



The reported drug use proportion in WFCs (6.49%) was considerably less than that for alcohol (11.17%). In both cases (WFCs and WNFCs), drug use is difficult to detect compared to alcohol, which has well-established tests for the blood-alcohol level that are much easier to administer. Our conclusion is that both alcohol and non-alcohol drug use are major contributors to increasing the frequency and severity of Weather fatal crashes.

From the positive perspective, 85.80% of the WNFCS were not Under the Influence of Non-Alcohol Drugs, but only 39.82% of the WFC drivers were sober in this regard. This is amazingly consistent to the comparable results for Alcohol. Both indicate the increased probability of a crash being fatal if the causal driver (or pedestrian) is Impaired. Probability of crash being fatal if driver is drug impaired = (36+657)/36 = one in 20.85. Probability of fatal if driver is not drug impaired = (221+87603/221 one in 397.39. This results in a Drug ID Multiplier of 23.31. This indicates that the non-alcohol drugs multiplier (23.31) is much higher than the alcohol multiplier (which given above was 9.43). Potential reason indicated for this is that the effects of Drugs in a weather collision tends to be much deadlier than those of alcohol as far as survival is concerned.