Special Study
Roadside (RS) Crashes IMPACT Study

By David B. Brown (brown@cs.ua.edu)
University of Alabama Center for Advanced Public Safety (CAPS)
and
Alabama Transportation Institute (ATI)
Data Comparisons: CY2016-2020 RS vs Non-RS
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0.0 Introduction

This document presents the results of a comparison of Roadside (RS) crashes compared to non-RS crashes over a recent five-year period (CY2016-2020). The determination of whether a crash was an RS or not was determined by whether the crash event was preceded by a Run-Off-the-Road (ROR) event. ROR events were determined from either Primary Contributing Circumstances (C015) or First Harmful Event (C017).

The analytical technique employed to generate most of the displays below 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/

The main objective of performing IMPACT comparisons is to surface "over-representations." An *over-represented value* of an attribute is found (for this study) when that attribute has a greater share of RS crashes than would be expected if its proportion were the same as for the non-RS crashes. That is, the non-RS crashes are serving as a *control* to which the RS crashes are being compared.

As an example, we found that RS crashes for the Day-of-the-Week attribute value of Sunday had almost 71% higher proportion of crashes than did the non-RS crashes (Section 5.3; Odds Ratio = 1.705). When such differences are statistically significant (as in this case), this surfaces characteristics that should be given attention, and in some cases, further analyses performed for countermeasure development. For example, additional selective enforcement for RS causes (e.g., excessive speed) might be performed on Sunday and other days in times at which they have their highest over-representations. Unless otherwise stated, the output tables given above the charts are in *Max Gain* order. The *Max Gain* is the gain in crash reduction that could be obtained if somehow a countermeasure could be applied to reduce the proportion of the RS crashes to the proportion of non-RS crashes within that particular attribute.

This report continues with two short sections that provide a high-level summary of recommendations and findings for those who just need an executive summary. The sections are called: (1) Executive Summary and Recommendations, and (2) Summary of Findings. Section 3 is also introductory in that it provides a detailed definition of the filter that was used to define RS crashes in the analytical sections that follow. After Section 3, the comparison between RS and non-RS crashes will be presented under the following headings with their section numbers:

- 4. Geographic Factors,
- 5. Time Factors,
- 6. Factors Affecting Severity,
- 7. Driver and Vehicle Demographics, and
- 8. Driver Behavior.

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

1.0 Executive Summary and Recommendations

The recommendations of this special study are presented first 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 analyses. Recommendations are referenced to the more detailed analyses so that questions regarding the source of any given recommendation can be easily accessed.

Recommendations are organized into the three areas of: (1) Law enforcement concentration and direction, (2) Legal and judicial countermeasure development, and (3) PI&E information on RS content. The ordering of these, either generally or within their respective categories, is not meant to imply priority. However, the more detailed information given should be quite useful in the further prioritization and allocation of traffic safety resources. This process should consider all of the recommendations, which should be validated against the information presented in the IMPACT sections 4.0-7.0 (referenced sections will be given in parenthesis).

The following recommendations are made to reduce the frequency and/or severity of Roadside (RS) crashes in Alabama:

- **Clear roadside and crash severity mitigation**
    - Most of the IMPACT analyses (after Section 3) concentrate on driver behavior modifications. It is reasonable that many crashes could either be avoided or their severity reduced by crash clear roadside, cushioning, or other roadway modifications. The following presents a condensed review of the extensive documentation that has been produced by FHWA, AASHTO, and others. It is recommended that all of these documents, and the many others that will be found while accessing these, be reviewed. The resulting information should be formulated into a cost-benefit approach to allocate roadside countermeasure funds in an optimal way. It is expected that separate optimizations will be required for each independent source of funds.
        - AASHTO; Roadside Design Guide 10; https://pdflife.one/download/4591425-aashto-roadside-design-guide-10
        - FHWA-AASHTO; Roadside Design Guidance including Manual for Assessing Safety Hardware; https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/aashto_guidancecfm.cfm
        - FHWA; Clear Zones (last modified May 21, 2021); https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones/; “This document provides guidance to help highway agencies develop their own standards and policies for determining the widths of clear zones along roadways based on speed, traffic volume, roadside slope and curvature. The recommended clear zone ranges are based on a width of 30 to 32 feet for flat, level terrain adjacent to a straight section of a 60mph highway with an average daily traffic of 6000 vehicles.

For steeper slopes on a 70 mph roadway the clear zone range increases to 38 to 46 feet, and on a low speed, low volume roadway the clear zone range drops to 7 to 10 feet. For horizontal curves the clear zone can be increased by up to 50 percent from these figures."

        - AASHTO; Clear Zone Conflicts in AASHTO Publications; Presented at the AASHTO Sub Committee on Design Meeting June 2007 Burlington, Vermont; http://sp.design.transportation.org/Documents/DickAlbin_Clear-ZoneinAASHTODocuments-SCOD2007.pdf; "The width of the clear zone should be based on risk (also called exposure). Key factors in assessing risk include traffic volumes, speeds, and slopes. Clear roadsides consider both fixed objects and terrain that may cause vehicles to rollover."
    - **Grade and Curvature.** Special emphasis in roadway clear zones should be given to (4.9, in Max Gain order): (1) left curves level and downgrade; (2) right curves level and downgrade; and (3) left and right curves and upgrades.
        - The study of advisory speed limits could benefit from the recent release of GDOT_16-31 (trb.org); An Enhanced Network-Level Curve Safety Assessment and Monitoring Using Mobile Devices; GDOT_16-31 (trb.org); http://www.safehomealabama.gov/tag/road-improvements/

- **Law enforcement concentration and direction**
    - Increased recognition is essential, both on the part of law enforcement and the general public, that the relatively high deadly combination in RS crashes is caused by their comparatively high impact speeds (6.1, 6.2) coupled with a failure of RS crash drivers and their passengers to use restraints (6.5, 6.6). Seek out new ways to increase law enforcement methods to address these issues, both of which stem from the acceptance of risk-taking behaviors, especially on the part of younger drivers (age less than 25).
    - Since a relatively large proportion of RS crashes are caused by Impaired Driving (ID), all of the ID countermeasures (8.3, 8.4) should be increased. Hotspot analyses should be performed to determine where RS selective enforcement will be most effective, and consideration should be given to using RS as a proxy for ID.
    - More effective drug detection techniques (8.4) should be identified, and law enforcement officers need increased training in their use.
    - Law enforcement training should focus on the concentration on the times of day, days of the week (5.3-5.7), and the particular over-represented vehicle types e.g., Passenger Cars and Motorcycles (7.3).
    - Training needs to focus on the specific driver over-representations: 1) males (7.2), 2) age groups (7.1, ages 24-35), 3) the locations that these over-represented groups (determined by hotspot analyses); and 4) the over-represented times.
    - Counties with a combination of medium to large metropolitan areas and fairly large rural areas (4.3, 4.6) should generally be given additional emphasis in RS selective enforcement programs (4.1, 4.2). These should be evaluated on a county-by-county basis taking the population and traffic volume crash rates into

consideration. Over-represented cities and counties should be subjected to Hotspot analyses.

- The rural areas (4.6) of these counties, and especially the County Roads (4.5) should be given special consideration for enforcement, since that is where relative increased fatalities occur (4.4, 4.8).
- Those cities with a high frequency of RS crashes (4.2) should be given special guidance and perhaps additional funding to address their RS crash problems. Many such large city areas have a considerable amount of Open Country (4.6) that would tend to multiply their RS crash severiy. It should be recognized that Residential areas of these cities also have a significant RS over-representation, but it is only about a third of that of Open Country areas (4.6)
- Additional hotspot analysis needs to be done to surface those County Roads (4.5), which account for their overall 66.9% over-representation in crash proportion, in order to focus law enforcement presence on these roads. It appears that impaired RS causal drivers may be using the county roads in attempts to avoid being apprehended.
- Additional emphasis needs to be given to the recognized RS over-represented days, Saturday, Sunday, and to some extent Friday (5.3). Special 3-day holiday attention needs to address irregular days such as Sunday, which behave as a "virtual Saturday" when the three-day holiday weekend includes Monday (5.4-5.7). Consideration should be given to the number of persons not working on a given day and thus might over-indulge the night (and early morning) before (5.3-5.4) their day off.
- The increase in RS crashes in the springtime (5.2, March, April and July) should be recognized in general law enforcement strategic planning.
- Time for enforcement might be optimized by local culture, but for the average statewide picture, if workers are typically "off" the following day, the optimal times for enforcement would begin shortly after the Friday afternoon rush hour and continue through at least 3 AM (5.5-5.7).

- **Legal and judicial countermeasure development**
  - 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* (7.1).
  - The role that unemployment plays should be considered in formulating remedial measures (7.6). Methods should be explored to communicate with appropriate individuals through their respective unemployment offices. The relationship between RS crashes and unemployment is not surprising because of the underlying drug/alcohol root cause of many RS crashes (8.3-8.4). The correlation between not having a job and being involved in an RS crash should be watched carefully going forward in that it could affect the type and location for countermeasures.

- Ideally, breath-alcohol ignition interlock devices are greatly reducing the problem caused by problem drinkers in Alabama. An in-depth study needs to be conducted to determine if problems exist within the current program, and how this countermeasure can be expanded to be made more generally effective. While the data do not show a high level of drugs/alcohol causing RS crashes directly, (8.3-8.4) the fact that they are over-represented is an indication that this could be a cause even if the presence of drugs/alcohol do not reach the reporting threshold, especially in cases involving prescription drugs.

- **PI&E information content on RS crashes**
  - Combinations of recreational or medical drugs and alcohol can be particularly lethal, and medical practitioners should warn against such problems and discourage all alcohol use for their patients who have indicated or displayed these problems, or who are taking other prescription drugs.
  - Legalized recreational drugs are not a good alternative to alcohol use and should not be advertised as such. PI&E programs should take the opposite approach to warn drivers that legalization does not relax their responsibilities.
  - Promote the use of those roadways that avoid county roads, which have 66.9% more RS than non-RS crashes. While Interstates are also over-represented (by 12.4%), the largest cause of these crashes is Driving too Fast for Conditions and other speed-related behaviors, driver errors that can be avoided easily. The promotion of Interstates should also contain warnings against speeding.
  - One of the most critical needs is for the RS drivers and their passengers to buckle up (6.6). There is little hope of surviving a crash for a large proportion of them if they fail to realize this. This is seen not only in increased fatal crashes, but in the number of injured in single-vehicle crashes (6.7).
  - While clearly the problems found in this study are those of RS, other driver behaviors (8.2) that are correlated with RS might provide alternatives for countermeasure development. These behaviors are:
    - Aggressive Operation,
    - Traveling Wrong Way/Wrong Side,
    - Over Speed Limit,
    - Fatigued/Asleep,
    - Ran Stop Sign and
    - Crossed Centerline.

    These were the Primary Contributing Circumstances that were over-represented exclusive of RS even though the standard RS filter was in effect (indicating that RS was identified by attributes other than that of PCC (i.e., First Harmful Event).

2.0 Summary of Findings

Note: subsections 2.1, 2.2 and 2.3 have been omitted in order to keep the numbering system in this Section consistent with that of the IMPACT displays that follow. The following findings are mainly from the IMPACT analysis below that compared RS vs Non-RS crashes for all five years (CY2016-2020):

- **2.4 Geographical Factors (4.0)**
  - County (4.1) - Generally, the over-represented counties are those with combined fairly large population centers bordering on rural areas, as opposed to the highly urbanized counties or the extremely rural counties. One reason that the highly urbanized counties are under-represented is the large number of low severity crashes that occur there that are separate and apart from RS crashes. See the rural-urban comparison below. Placed in Max Gain order, the ones with the highest potential for reduction were: Etowah, St. Clair, Clarke, Jackson, Chambers and Chilton. [Terminology: *Expected proportions* (AKA *expectations*) here and below are obtained from the proportion for non-RS crashes.]
  - City Comparisons of RS to Non-RS crashes, including rural areas of counties (virtual cities). There is little surprise in this output, which tracks the areas by population. Traffic safety professionals should look for any locations that fall counter to this trend. City (and rural area) Comparisons are presented for all areas that had a Max Gain in excess of 100 RS crashes over the five-year period of the study. The county rural areas (virtual cities) with Max Gains in excess of 160 RS crashes over their expected numbers are: Rural Randolph, Rural Etowah, Rural Clark, and Rural Jefferson.
  - Overall Area Comparisons Conclusions (4.1-4.2) – Generally those rural areas that are adjacent to (or contain) significant urbanized areas are over-represented, since their urban areas generate more traffic in the rural areas. Possible factors for *relatively fewer severe RS crashes* within urban areas include:
    - Less need for motor vehicle travel and shorter distances;
    - Larger police presence in the metropolitan areas; and
    - Lower speeds in urban areas.

    Note: The city, county, and area comparisons are, of necessity, a selection of the total outputs that could be generated. They are given to illustrate the capabilities as much as to present the numerical results. Anyone wishing additional cities, counties, or other areas, please contact CAPS – see e-mail address above.
  - Rural/Urban RS Crash Proportion (4.3) – RS crashes appear in a proportion that is only slightly different from their non-RS counterparts. RS crashes occurred in 22.23% rural and 77.77% urban areas. While the large sample sizes indicate that the differences with the non-RS are statistically significant, the very close non-RS proportions (22.93% and 77.07%, respectively) is not of practical significance.

Thus we conclude that the number of RS crashes is mainly determined by the traffic volume and not the rural/urban environments.

- Severity of Crash by Rural-Urban (4.4) – While only 22.23% of crashes occurred in rural areas, 38.51% of the fatal crashes occurred there. Similar results are found for the highest severity non-fatal crashes. This is obviously the result of higher impact speeds in the rural areas. Note that additional causes of increased severity are given in the Factors Affecting Severity, Section 6, below.
- Highway Classifications (4.5) – County roads had a proportion of RS crashes that was 66.9% higher than their expected proportion of crashes (as given by the non-RS crashes), and Interstate routes had about 12.4% more than expected. Municipal Roads, which had 41.56% of all of the RS crashes, were only over-represented by 3.1% due to the large amount of traffic in the urban areas. All other roadway classifications were under-represented. County road characteristics no doubt contribute to the crash frequency (see 4.4). County roads are also known to be less "crashworthy" (i.e., they result in more severe crashes at comparable impact speeds).
- Locale (4.6) – Residential and Open Country roadways show a high level of over-representation (1.941 and 1.430 Odds Ratios, respectively) as compared with the more urbanized area types, especially Shopping or Business, which only has a little over a third of its expected proportion.
- Most Harmful Event (4.7) – ordered by frequency. The goal of ordering by frequency is to indicate where the removal of roadside obstacles might be most effective (4.9). The following items were fixed roadside obstacles that have over 500 occurrences in five years (at least 100 per year):

Overturn/Rollover	2,958
Collision with Tree	2,825
Collision with Ditch	2,133
Collision with Utility Pole	1,351
Collision with Other Fixed Object	879
Collision with Fence	517

- Most Harmful Fatal Event (4.8) – ordered by Max Gain. Collision with Tree was by far the greatest problem with 202 fatal crashes and an Odds Ratio of 2.648. Overturned/Rollover was a distant second with 136 fatal crashes and an odds ratio of 1.891. After that, the frequencies and/or over-representations fell off dramatically.
- Roadway curvature and Grade (4.9). RS crashes are dramatically over-represented on all types, and especially left curves. Left curves either Level or with Down Grades are generally more of a problem than right curves with the same grades. Level and down grades are more of a problem than up-grades.

- **2.5 Time Factors (5.0)**
  - Year (5.1) – The years 2017, 2018 and 2020 were over-represented. There seems to be no pattern either in RS or non-RS over the five years.
  - Month (5.2) – The only significant over-representations by month were in January, June, July. And December. The number of RS crashes correlated fairly well with non-RS crashes during the rest of the months, with the exception of September, October, and November, which were significantly under-represented.
  - Day of the Week (5.3-5.4) – This analysis is not only useful for the typical work week, but it also reflects the typical "holiday weekend" patterns. Traffic safety professional will notice that the distribution throughout the week is quite similar to that of impaired driving. Since many RS crashes are caused by ID, that would create this distribution for RS as well. However, this pattern is further reinforced by drivers who are not familiar with the new roads that they might be traveling, especially if they are in any way deficient in design. Assuming that a significant number of RS crashes are caused by ID, the days can be classified as follows:
    - Typical work weekday (Monday through Thursday) – these days are under-represented in RS crashes due to the need for many users to go to work the following day.
    - Friday – this pattern is also reflected in the day before a weekend (or holiday), i.e., before a day off. The high RS frequency on this day is due to those who are getting an early substance abuse start to the weekend, recognizing that they have no work responsibilities the following day. However, the large numbers of non-RS crashes on Fridays causes Friday to be statistically under-represented in RS crash proportion compared to non-RS crashes. This is the typical Friday general increase due to the normal rush hours coupled with individuals leaving for vacations and weekend activities.
    - Saturday – the "Saturday" pattern is the worse for RS crashes in that it has both an early morning component (like Sunday) and a late night component (like Friday). So, it could be viewed as a combination of the typical Friday and Sunday.
    - Sunday – since this is the last day of a holiday sequence or weekend, its over-representation comes mainly from those who start on Saturday night and do not complete their use of alcohol/drugs until after midnight. Sunday is the most over-represented day with over twice its expected number of RS crashes; however, the low number of non-RS crashes on Sunday also contributes to this proportional over-representation.
  - "Holiday Weekends" (5.4-5.7) – these can be viewed as a sequence of the weekend-pattern sequence. For example, the Wednesday before Thanksgiving would follow the Friday pattern assuming that most are at work on Wednesday. The

Thursday, Friday and Saturday would follow the Saturday pattern, and the Sunday at the end of the weekend would follow the typical Sunday pattern. This is the reason that long holiday events (i.e., several days off) can be much more prone to RS crashes than the typical weekend. Three-day weekends typically give Monday off, so that Monday would behave like the typical Sunday, and both the Saturday and Sunday would follow the Saturday pattern. Exception: in the past decade the over-representation of Wednesdays before Thanksgivings has been reduced by the number leaving earlier during the week.

- Time of Day (5.5-5.6) – The extent to which night-time hours are over-represented is quite striking. Optimal times for RS enforcement would start immediately following any rush hour details, and would continue through at least 3:00 to 3:59 AM (odds ratio 4.390). The 4-5 and 5-6 AM hours are also significantly over-represented, but with lower odds ratios of 3.514 and 2.446, respectively. Some of the late-night RS crashes will also be due to drowsiness and/or the diminished ability to see road edge lines.
- Time of Day by Day of the Week (5.7) – This quantifies the extent of the crash concentrations on Friday nights, Saturday mornings and Saturday nights and early Sunday mornings. This is a very useful summary for deploying selective enforcement details, especially during the weekend hours.

- **2.6 Factors Affecting Severity (6.0)**
  - RS Crash Severity (6.1) -- The rate of injuries and fatalities are consistently higher in RS crashes than that of non-RS crashes. Fatality crashes are nearly 2.561 times their expected proportion, while the two highest non-fatal injury classifications also have about twice their expected values (2.000 and 1.806) when compared with non-RS crashes.
  - Speed at Impact (6.2) – All impact speeds above 45 MPH (with the exceptions of 61-70 and 66-70 MPH) are dramatically over-represented with Odds Ratios above 2.00. See the next attribute for the effect this has on fatalities. The over-representations increase, as expected, with increased speed with 46-50 MPH having an odds ratio or 1.835, while 96-100 MPH being 10.129. Past analyses have found the general rule of thumb that for every 10 MPH increase in impact speeds, the probability of the crash being fatal doubles. This was validated in the discussion below of the cross-tabulation of impact speeds by severity (6.4).
  - Severity by Impact Speed (6.3-6.4) –Past analyses have found the general rule of thumb that for every 10 MPH increase in speeds, the probability of the crash being fatal doubles. This was further validated in the discussion of this cross-tabulation. In the 31-35 MPH impact speed the probability is only a little over one in every 397 crashes. As impact speeds climb to the 46-55 MPH, this probability more than doubles to one in about 59 crashes. At 76-85 MPH it increases again

(exponentially) to one in about every 13 crashes, and at 91-95 it is about one in nine, which is about double again. For above 95 MPH it is about one in 8 crashes.

- Restraint Use by RS Crash Causal Drivers (6.5) – The RS causal drivers are over 3 times more likely to be unrestrained than the non-RS causal drivers. Clearly RS drivers lose a good part of their concept of risk when they are willing to drive while impaired or at speeds that result in running off the road.
- Fatality Crashes by Restraint Use for Impaired Drivers (6.6) – A comparison of the probability of a fatal crash indicates that a fatality is almost 18 (17.92) times more likely if the RS causal driver is not using proper restraints. Generally, one in 74 RS crashes are fatal; but without restraints, the fatal crash ratio is 1 in about 11, an increase in probability by well over six times. So the combined effect of lower restraint use and higher speeds is a devastating combination that accounts for much of the high lethality of RS crashes.
- Number of Vehicles Involved (6.7) – the number of single vehicle RS crashes is over-represented by an Odds Ratio of 5.592 (proportion was close to six time more than expected). Over 9 out of 10 (93.45%) of the crashes were single vehicle. This is expected since most of the crashes involved running off the road and crashing against something in the roadside environment as opposed to another vehicle.
- Police Arrival Delay (6.8) – RS crashes generally had good police response times. Arrival delays were quite favorable, with the arrival time being ten minutes or less over 57% of the time. All arrival delays over 10 minutes were significantly under-represented. There can be little doubt that this has to do with so many of them being either in or close to urban areas (77.77%, see Section 4.3). The analysis below shows how this impacts EMS arrival time, which is a comparison of those crashes that only include injuries, and thus would generally call for an EMS response.
- EMS Arrival Delay (6.9) – For much the same reasons as the police arrival delays, EMS delays were significantly over-represented for Roadside (RS) crashes in the 6-10 and 11-16 minute categories. All longer delay times were under-represented up until the very high categories (91-120; 121-180; and Over 180 minutes). There were relatively few in these very long categories, which were probably caused by the single vehicle crash not be discovered late night.

- **2.7 Driver and Vehicle Demographics (7.0)**
  - Driver Age (7.1) – Younger (16-20 year old) drivers have a very serious problem in crash causation in general. Ages 15 through 39 are all statistically significant in being over-represented, although the Odds Ratios tend to drop off above the age of 24. Drivers tend to be under-represented above the age of 43.

- RS Crash Driver Gender (7.2) – the breakdown in RS causal drivers is 62.76% male and 37.24% female. For non-RC, the percentage is 56.15 male and 43.85 female, which also gives a good estimate for male/female drivers in general. These differences in proportions certainly indicate that males are a greater cause of the RS problems, and if there are countermeasures that can be directed toward them, doing so would be much more cost-effective than those directed toward all drivers, all other things being equal.
- Causal Vehicle Type (7.3) – Passenger Cars have the highest for potential crash reduction according to the Max Gain. However, Motorcycles have a much higher over-representation (2.591 Odds Ratio), indicating well over twice their expected proportion as compared to their non-RS crash proportion. None of the other classifications have significant over-representations, indicating that their proportions are about as expected. Some vehicles, notably Tractor/Semi-Trailers, Mini-vans, Pick-Ups and Sport Utility Vehicles (SUVs) are *under*-represented indicating their tendency to avoid RS crashes.
- Number of Pedestrians (7.4). Pedestrians are generally under-represented in RS crashes, indicating that most pedestrian crashes occur when pedestrians venture into the roadway as opposed to vehicles hitting them when they are walking off the road on the Roadside. This is good information for pedestrian crash reduction.
- Driver License Status (7.5) – RS crashes are significantly over-represented in being caused by drivers without legitimate licenses. About 15% of the RS causal drivers did not have a legitimate driver's license. The following gives the highest over-represented categories along with the number of crashes (in parenthesis) that were attributed to the DL Status: Suspended (1,815), Revoked (893), Expired (814), and Cancelled (33).
- Driver Employment Status (7.6) – RS driver unemployment rate at 22.37%, and its proportion is over 24.6% higher than expected. This factor should be watched carefully going forward specially to determine if there is not some countermeasure that could be implemented in conjunction with their unemployment payments.

- **2.8 Driver Behavior (8.0)**
  - Primary Contributing Circumstances (8.1-8.2). This was introduced at the end of Section 1.0. While clearly the problems found in this study are those of RS, other driver behaviors (8.2) that are correlated with RS might provide alternatives for countermeasure development. Those behaviors that had over twice their expected PCC proportion when compared to non-RS crashes are:
    - Driving too Fast for Conditions
    - Impaired Driving (DUI)
    - Swerved to Avoid Vehicle
    - Fatigued/Asleep,

    - Aggressive Operation,
    - Over Correcting/Over Steering
    - Swerved to Avoid Animal [most often deer]
    - Over Speed Limit
    - Swerved to Avoid Object.

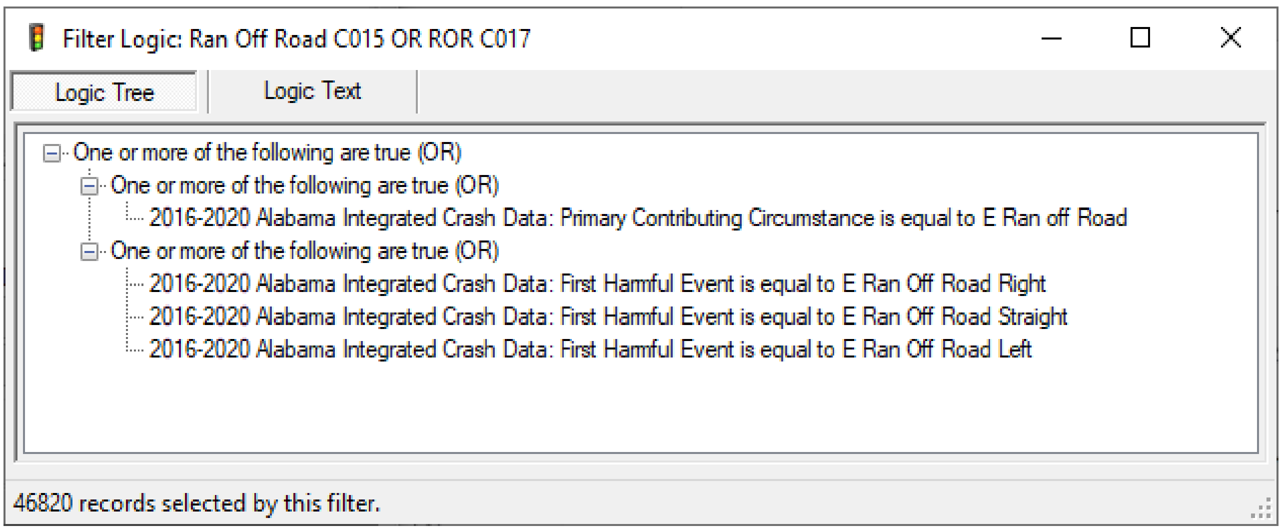
  These were the Primary Contributing Circumstances that were at least doubly over-represented even though the standard RS filter was in effect (indicating that RS was identified by attributes other than that of PCC).
- CU Officer's Opinion Impaired Driving – Alcohol (8.3). We saw ample evidence for RS crashes being caused by Impaired Driving (ID) in the time of day and day of the week. The two ID attributes (C122 and C123) indicate the degree that ID was involved in RS crashes as opposed to non-RS crashes. For alcohol, the proportion of ID crashes was 3.619 times as many for RS crashes as for non-RS crashes. For drugs this multiplier was even greater at 3.894. This was sufficient to verify that the RS time over-representations reported above, were correlated almost perfectly with ID.
- CU Officer's Opinion Impaired Driving – Non-alcohol Drugs (8.4). The reported non-alcohol drug cases for RS crashes is less than half of that for alcohol. The 1,464 cases are only about 4.00% of all RS crashes. However, the Odds Ratio indicates that it has an over-representation comparable to alcohol. In both cases (RS and non-RS), drug use is difficult to detect compared to alcohol, which has well-established tests for the blood-alcohol level that are relatively easy to administer. Our conclusion is that both alcohol and non-alcohol drug use are major contributors to increasing the frequency of RS crashes, and their use and severity is further compounded by trying to avoid detection by using county roads.

3.0 Roadside (RS) crashes CY2016-2020

As part of the ongoing Alabama Office of Traffic Safety (AOTS) problem identification efforts, UA-CAPS and ATI compared FY2016-2020 Roadside (RS) crashes against non-RS crashes over this same 5-year time period. The objective was to determine all significant differences between these two subsets of data. The goal was to pinpoint common factors and assess strategies that could be used to combat any major inconsistencies between these two subsets of crash data. The findings are presented to be taken into consideration when planning the large variety of counter-measures that exist to reduce the frequency and/or severity of these crashes.

3.1 RS Filter Definition

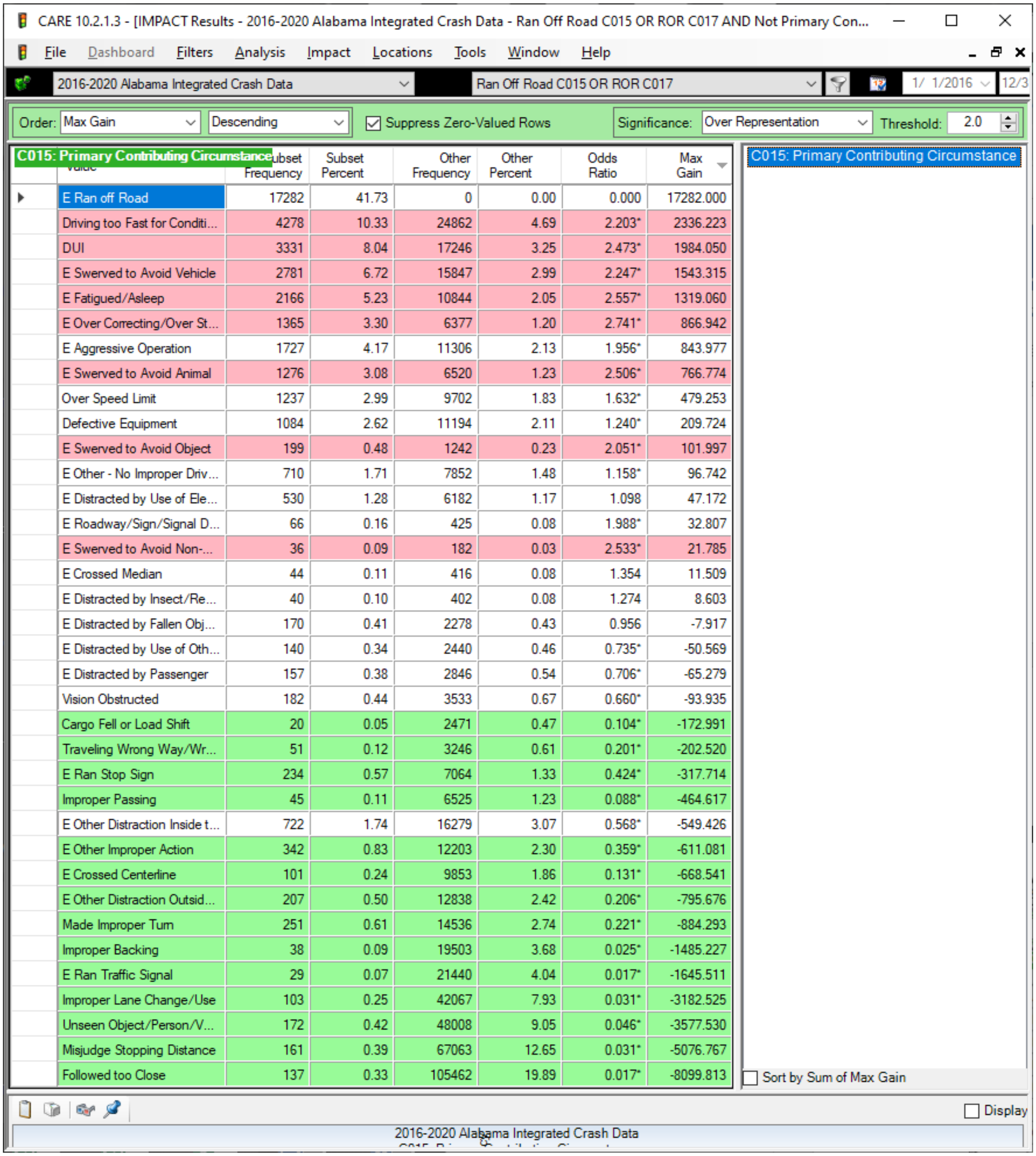
The following is the formal filter definition for Roadside (RS) crashes:



This formalizes the definition of the crashes in the RS subset of crash reports being considered here. As mentioned above, these crashes are those reported to have either a Primary Contributing Circumstance (C015) of Run-Off-the-Road and/or a First Harmful Event to be Run-Off-Road (either Right, Straight, or Left), or both.

With this filter in effect, we will now present the frequency distributions for each of the attributes that appear in the filter. These attributes are ORed together, so if any one of them showed RS, the record will be included in the RS subset. These two IMPACT displays essentially show in a nutshell those non-RS attributes that are highly correlated with RS crashes. For C015, it is the correlation with the RS defined by C017; and for C017, it is the correlation with the RS defined by C015.

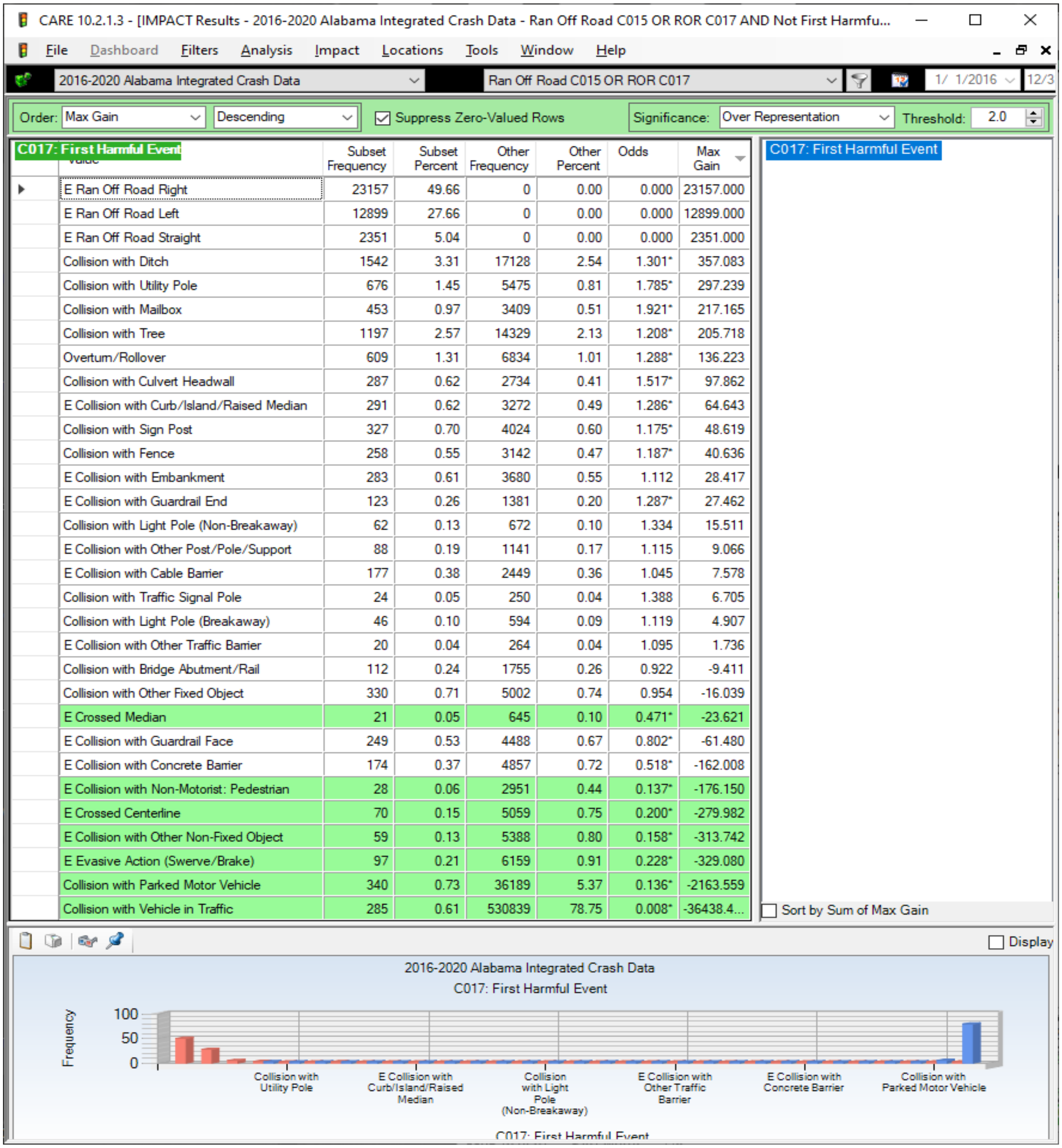
3.1.1 C015 Primary Contributing Circumstances with RS Filter in Effect



C015: Primary Contributing Circumstance Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Ran off Road	17282	41.73	0	0.00	0.000	17282.000
Driving too Fast for Conditi...	4278	10.33	24862	4.69	2.203*	2336.223
DUI	3331	8.04	17246	3.25	2.473*	1984.050
E Swerved to Avoid Vehicle	2781	6.72	15847	2.99	2.247*	1543.315
E Fatigued/Asleep	2166	5.23	10844	2.05	2.557*	1319.060
E Over Correcting/Over St...	1365	3.30	6377	1.20	2.741*	866.942
E Aggressive Operation	1727	4.17	11306	2.13	1.956*	843.977
E Swerved to Avoid Animal	1276	3.08	6520	1.23	2.506*	766.774
Over Speed Limit	1237	2.99	9702	1.83	1.632*	479.253
Defective Equipment	1084	2.62	11194	2.11	1.240*	209.724
E Swerved to Avoid Object	199	0.48	1242	0.23	2.051*	101.997
E Other - No Improper Driv...	710	1.71	7852	1.48	1.158*	96.742
E Distracted by Use of Ele...	530	1.28	6182	1.17	1.098	47.172
E Roadway/Sign/Signal D...	66	0.16	425	0.08	1.988*	32.807
E Swerved to Avoid Non-...	36	0.09	182	0.03	2.533*	21.785
E Crossed Median	44	0.11	416	0.08	1.354	11.509
E Distracted by Insect/Re...	40	0.10	402	0.08	1.274	8.603
E Distracted by Fallen Obj...	170	0.41	2278	0.43	0.956	-7.917
E Distracted by Use of Oth...	140	0.34	2440	0.46	0.735*	-50.569
E Distracted by Passenger	157	0.38	2846	0.54	0.706*	-65.279
Vision Obstructed	182	0.44	3533	0.67	0.660*	-93.935
Cargo Fell or Load Shift	20	0.05	2471	0.47	0.104*	-172.991
Traveling Wrong Way/Wr...	51	0.12	3246	0.61	0.201*	-202.520
E Ran Stop Sign	234	0.57	7064	1.33	0.424*	-317.714
Improper Passing	45	0.11	6525	1.23	0.088*	-464.617
E Other Distraction Inside t...	722	1.74	16279	3.07	0.568*	-549.426
E Other Improper Action	342	0.83	12203	2.30	0.359*	-611.081
E Crossed Centerline	101	0.24	9853	1.86	0.131*	-668.541
E Other Distraction Outsid...	207	0.50	12838	2.42	0.206*	-795.676
Made Improper Turn	251	0.61	14536	2.74	0.221*	-884.293
Improper Backing	38	0.09	19503	3.68	0.025*	-1485.227
E Ran Traffic Signal	29	0.07	21440	4.04	0.017*	-1645.511
Improper Lane Change/Use	103	0.25	42067	7.93	0.031*	-3182.525
Unseen Object/Person/V...	172	0.42	48008	9.05	0.046*	-3577.530
Misjudge Stopping Distance	161	0.39	67063	12.65	0.031*	-5076.767
Followed too Close	137	0.33	105462	19.89	0.017*	-8099.813

Items with less than 20 occurrences have been omitted from the above.

3.1.2 C017 First Harmful Event



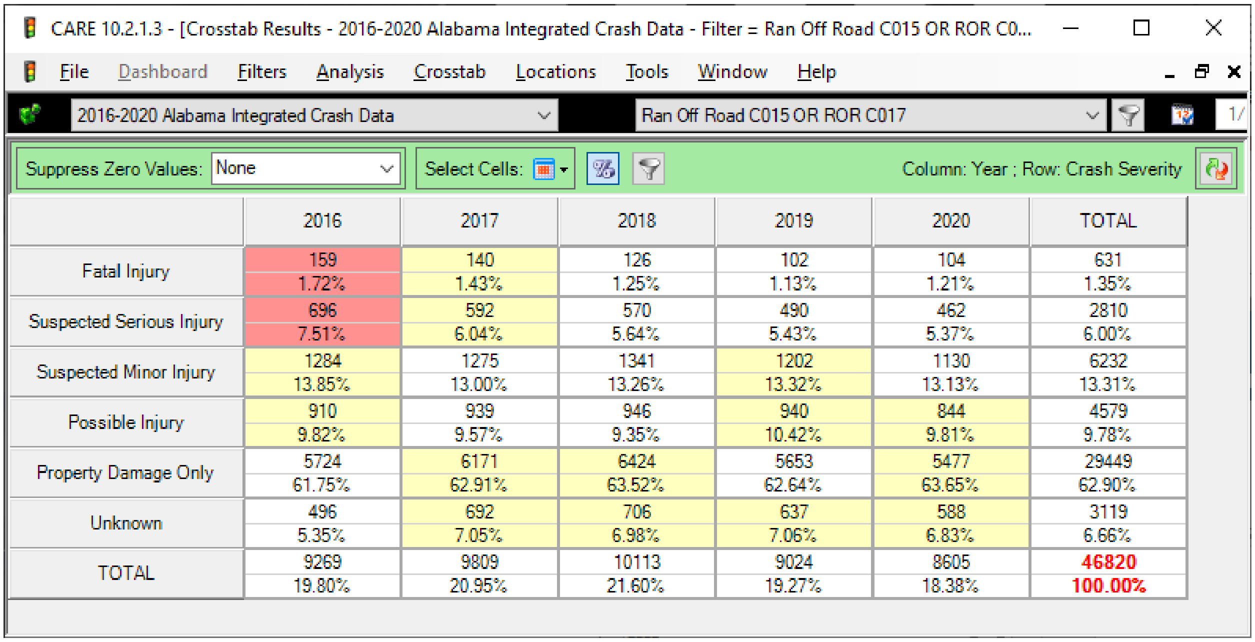
C017: First Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
E Ran Off Road Right	23157	49.66	0	0.00	0.000	23157.000
E Ran Off Road Left	12899	27.66	0	0.00	0.000	12899.000
E Ran Off Road Straight	2351	5.04	0	0.00	0.000	2351.000
Collision with Ditch	1542	3.31	17128	2.54	1.301*	357.083
Collision with Utility Pole	676	1.45	5475	0.81	1.785*	297.239
Collision with Mailbox	453	0.97	3409	0.51	1.921*	217.165
Collision with Tree	1197	2.57	14329	2.13	1.208*	205.718
Overturn/Rollover	609	1.31	6834	1.01	1.288*	136.223
Collision with Culvert Headwall	287	0.62	2734	0.41	1.517*	97.862
E Collision with Curb/Island/Raised Median	291	0.62	3272	0.49	1.286*	64.643
Collision with Sign Post	327	0.70	4024	0.60	1.175*	48.619
Collision with Fence	258	0.55	3142	0.47	1.187*	40.636
E Collision with Embankment	283	0.61	3680	0.55	1.112	28.417
E Collision with Guardrail End	123	0.26	1381	0.20	1.287*	27.462
Collision with Light Pole (Non-Breakaway)	62	0.13	672	0.10	1.334	15.511
E Collision with Other Post/Pole/Support	88	0.19	1141	0.17	1.115	9.066
E Collision with Cable Barrier	177	0.38	2449	0.36	1.045	7.578
Collision with Traffic Signal Pole	24	0.05	250	0.04	1.388	6.705
Collision with Light Pole (Breakaway)	46	0.10	594	0.09	1.119	4.907
E Collision with Other Traffic Barrier	20	0.04	264	0.04	1.095	1.736
Collision with Bridge Abutment/Rail	112	0.24	1755	0.26	0.922	-9.411
Collision with Other Fixed Object	330	0.71	5002	0.74	0.954	-16.039
E Crossed Median	21	0.05	645	0.10	0.471*	-23.621
E Collision with Guardrail Face	249	0.53	4488	0.67	0.802*	-61.480
E Collision with Concrete Barrier	174	0.37	4857	0.72	0.518*	-162.008
E Collision with Non-Motorist: Pedestrian	28	0.06	2951	0.44	0.137*	-176.150
E Crossed Centerline	70	0.15	5059	0.75	0.200*	-279.982
E Collision with Other Non-Fixed Object	59	0.13	5388	0.80	0.158*	-313.742
E Evasive Action (Swerve/Brake)	97	0.21	6159	0.91	0.228*	-329.080
Collision with Parked Motor Vehicle	340	0.73	36189	5.37	0.136*	-2163.559
Collision with Vehicle in Traffic	285	0.61	530839	78.75	0.008*	-36438.4...

As with C015, items with less than 20 occurrences have been omitted from the above.

3.2 Overall Crashes by Year 2016-2020 Data

Before analyzing the RS subset, it is good to get a feel for the overall difference in the crash frequencies over the past years. The following table gives a comparison of total crashes over CY2016-2020 by severity.

RS Crashes by Severity for Calendar Years 2016-2020



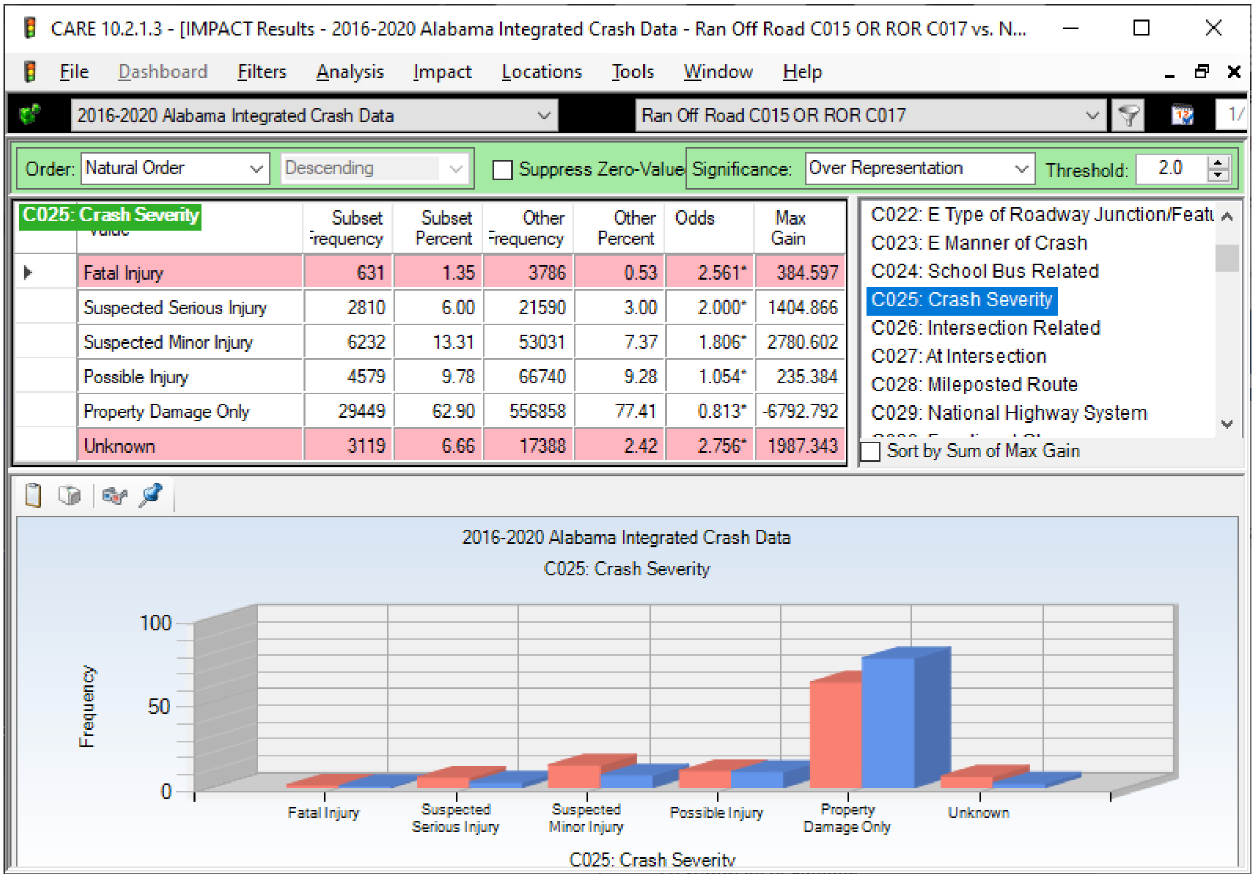
	2016	2017	2018	2019	2020	TOTAL
Fatal Injury	159 1.72%	140 1.43%	126 1.25%	102 1.13%	104 1.21%	631 1.35%
Suspected Serious Injury	696 7.51%	592 6.04%	570 5.64%	490 5.43%	462 5.37%	2810 6.00%
Suspected Minor Injury	1284 13.85%	1275 13.00%	1341 13.26%	1202 13.32%	1130 13.13%	6232 13.31%
Possible Injury	910 9.82%	939 9.57%	946 9.35%	940 10.42%	844 9.81%	4579 9.78%
Property Damage Only	5724 61.75%	6171 62.91%	6424 63.52%	5653 62.64%	5477 63.65%	29449 62.90%
Unknown	496 5.35%	692 7.05%	706 6.98%	637 7.06%	588 6.83%	3119 6.66%
TOTAL	9269 19.80%	9809 20.95%	10113 21.60%	9024 19.27%	8605 18.38%	46820 100.00%

We conclude from considering the percentage numbers at the bottom of the table that 2018 was significantly higher in total crashes than 2016 and 2017. However, there was clearly a reduction in crashes in 2020 due to the COVid-19 restrictions. Fatal and Suspected Serious Injury crashes had a dramatic increase in 2016, but there was a regression to the mean for these categories in 2017 through 2020.

Considerable study has been performed in an attempt to identify the reason for the 2016 outlier in fatal crashes. The conclusions drawn pointed to increased speed and ID, and a high correlation between ID crashes and those not properly restrained. Similar things are being found for RS causal drivers. The increase in fatal crashes due to speed will be considered below (3.3, 6.2-6.4).

3.3 Overall Severity Comparisons

The following presents a comparison of the severities of RS crashes over the five-year period (2016-2020) against non-RS crashes. The *Subset Frequency* and *Percent* are for RS crashes, while the *Other Frequency* and *Percent* are for non-RS crashes. Comparisons must be against the percentage proportions to determine if there is a trend direction being set in increased or decreased severity for these crashes.



C025: Crash Severity Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Fatal Injury	631	1.35	3786	0.53	2.561*	384.597
Suspected Serious Injury	2810	6.00	21590	3.00	2.000*	1404.866
Suspected Minor Injury	6232	13.31	53031	7.37	1.806*	2780.602
Possible Injury	4579	9.78	66740	9.28	1.054*	235.384
Property Damage Only	29449	62.90	556858	77.41	0.813*	-6792.792
Unknown	3119	6.66	17388	2.42	2.756*	1987.343

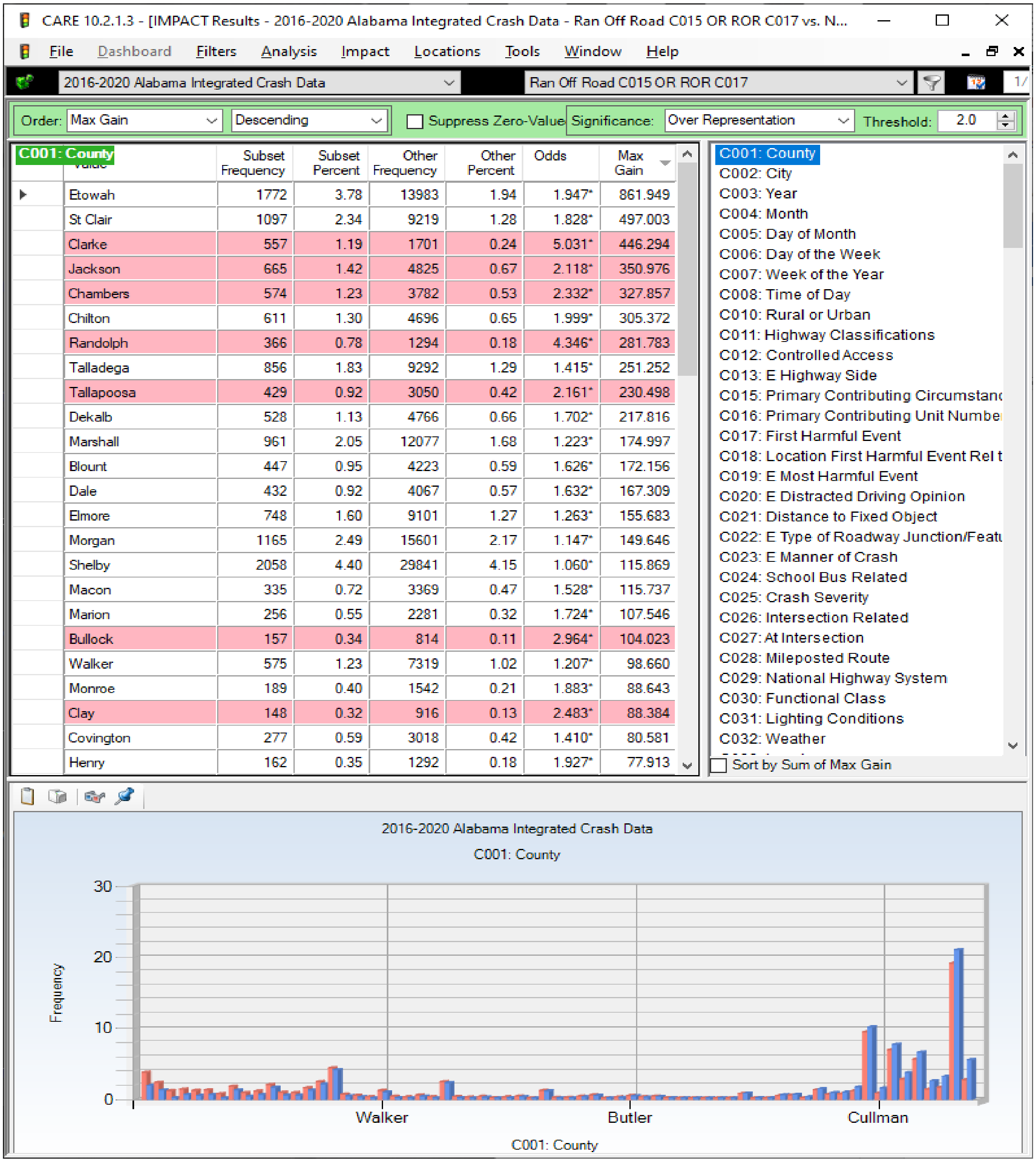
It is clear that RS crashes are generally more severe than their non-RS counterparts. All four of the injury values are over-represented, and the two top most severe have at least twice the proportion of the non-RS crashes. For fatal crashes the Odds Ratio multiplier is well over double (2.561). In the other injury severities, there is still a very significant increase in both the Suspected Minor Injury and the Possible Injury. The Suspected Serious Injury difference tends to confirm the increase in the fatal crashes, since quite often the characteristics of Serious Injury crashes are not at that different from those crashes being fatal.

The following sections (4.0-8.0) provide the IMPACT displays for the various attributes that could have an influence on countermeasure development. Unless otherwise indicated in the "Order" box, the outputs will be in highest Max Gain first. The Max Gain is a term that CARE users have assigned to indicate the number of crashes that would be reduced if the respective proportion value was not at all over-represented (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 of RS crashes than would be expected if it were the same as that attribute in non-RS crashes. That is, the non-RS crashes are serving as a control to which the RS crashes are being compared. In this way anything different about RS crashes surfaces and can be subjected to further analyses. The analytical technique employed to generate most of the displays below is called Information Mining Performance Analysis Control Technique (IMPACT). For a detailed description of the meaning of each element of the IMPACT outputs, see:

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

4.0 Geographic and Harmful Event Factors

4.1 County



C001: County Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Etowah	1772	3.78	13983	1.94	1.947*	861.949
St Clair	1097	2.34	9219	1.28	1.828*	497.003
Clarke	557	1.19	1701	0.24	5.031*	446.294
Jackson	665	1.42	4825	0.67	2.118*	350.976
Chambers	574	1.23	3782	0.53	2.332*	327.857
Chilton	611	1.30	4696	0.65	1.999*	305.372
Randolph	366	0.78	1294	0.18	4.346*	281.783
Talladega	856	1.83	9292	1.29	1.415*	251.252
Tallapoosa	429	0.92	3050	0.42	2.161*	230.498
Dekalb	528	1.13	4766	0.66	1.702*	217.816
Marshall	961	2.05	12077	1.68	1.223*	174.997
Blount	447	0.95	4223	0.59	1.626*	172.156
Dale	432	0.92	4067	0.57	1.632*	167.309
Elmore	748	1.60	9101	1.27	1.263*	155.683
Morgan	1165	2.49	15601	2.17	1.147*	149.646
Shelby	2058	4.40	29841	4.15	1.060*	115.869
Macon	335	0.72	3369	0.47	1.528*	115.737
Marion	256	0.55	2281	0.32	1.724*	107.546
Bullock	157	0.34	814	0.11	2.964*	104.023
Walker	575	1.23	7319	1.02	1.207*	98.660
Monroe	189	0.40	1542	0.21	1.883*	88.643
Clay	148	0.32	916	0.13	2.483*	88.384
Covington	277	0.59	3018	0.42	1.410*	80.581
Henry	162	0.35	1292	0.18	1.927*	77.913

The above has been arranged in highest Max Gain order to indicate the counties that have the highest potential for gain by reducing their over-representations. Etowah, St. Clair, Clarke, Jackson, Chambers and Chilton have the highest potentials for RS reductions, with Max Gains over 300 crashes each. The display above contains all of the counties with Odds Ratios greater than 2.000 (red backgrounds).

At the other end of the spectrum, the counties with large cities (e.g., Tuscaloosa, Jefferson, Lee, Houston, Montgomery, and Baldwin) were the most under-represented counties, although some of their numbers of RS crashes are still very large.

4.2 Cities Over-represented by Highest Max Gains (Including Rural Areas)

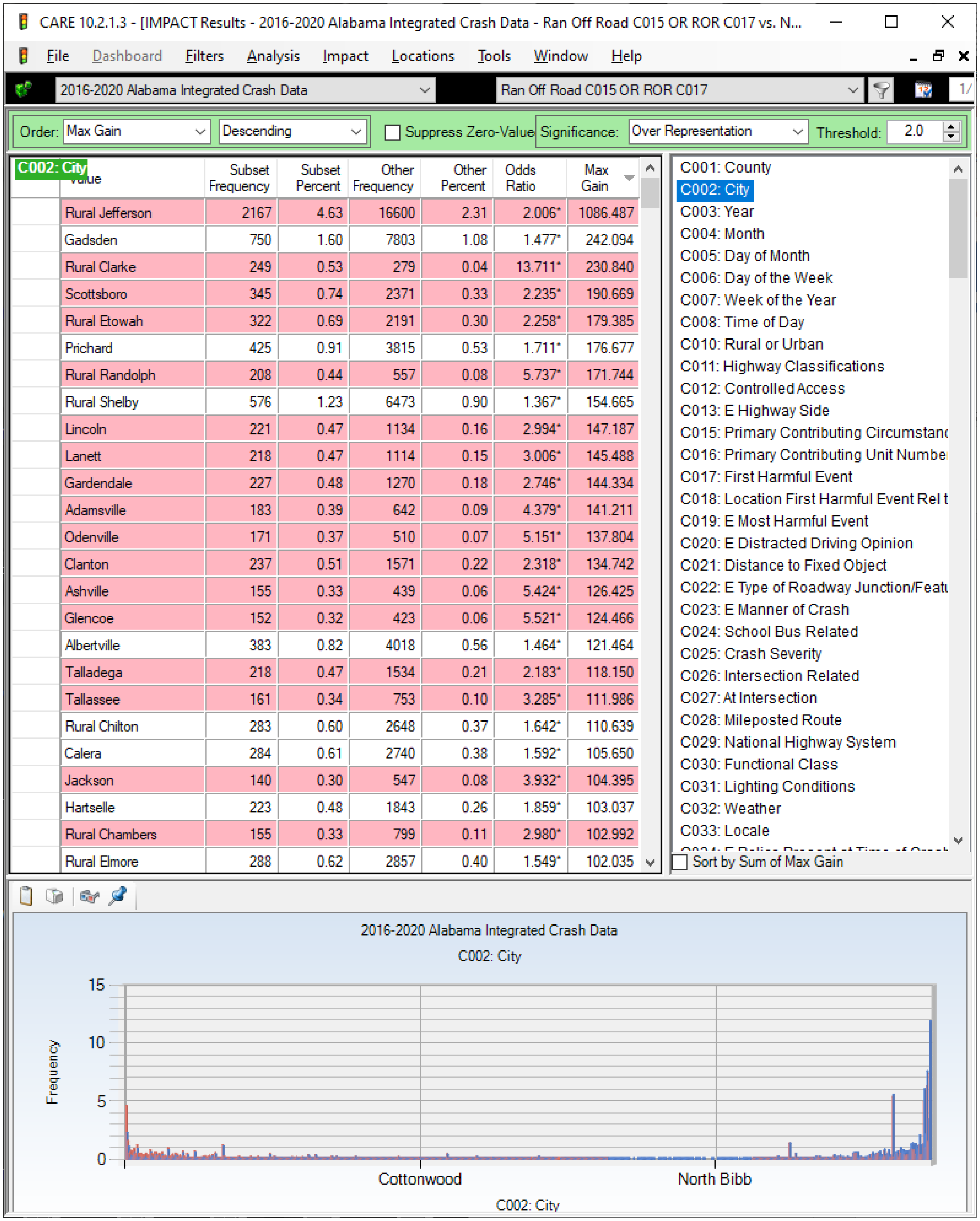
For comparison purposes, the rural areas of counties are considered to be "virtual cities" in that crashes that occur there are listed as "Rural County Crashes" so that these crashes can be effectively accounted for and compared. Generally, these rural areas are adjacent to (or contain) significant urban areas. Contrasted with this finding, there was significant under-representation for Roadside (RS) crashes in the largest cities themselves (e.g., Birmingham, Tuscaloosa, Mobile, Dothan, Montgomery, and Auburn, etc.). This can be attributed to a number of possible factors in urban areas:

- Roadways have less roadside areas that reporting officers could site at the crash location;
- Larger police presence in the metropolitan areas; and
- Lower speeds in urban areas resulting in a lower severity of crashes, which may be less apt to be reported as caused by the Roadside obstacles. Urban crashes contain many described as fender-benders or low-speed rear-end bumper crashes.

However, these findings were just for the largest cities. Urban areas in general were not under-represented, as will be shown below.

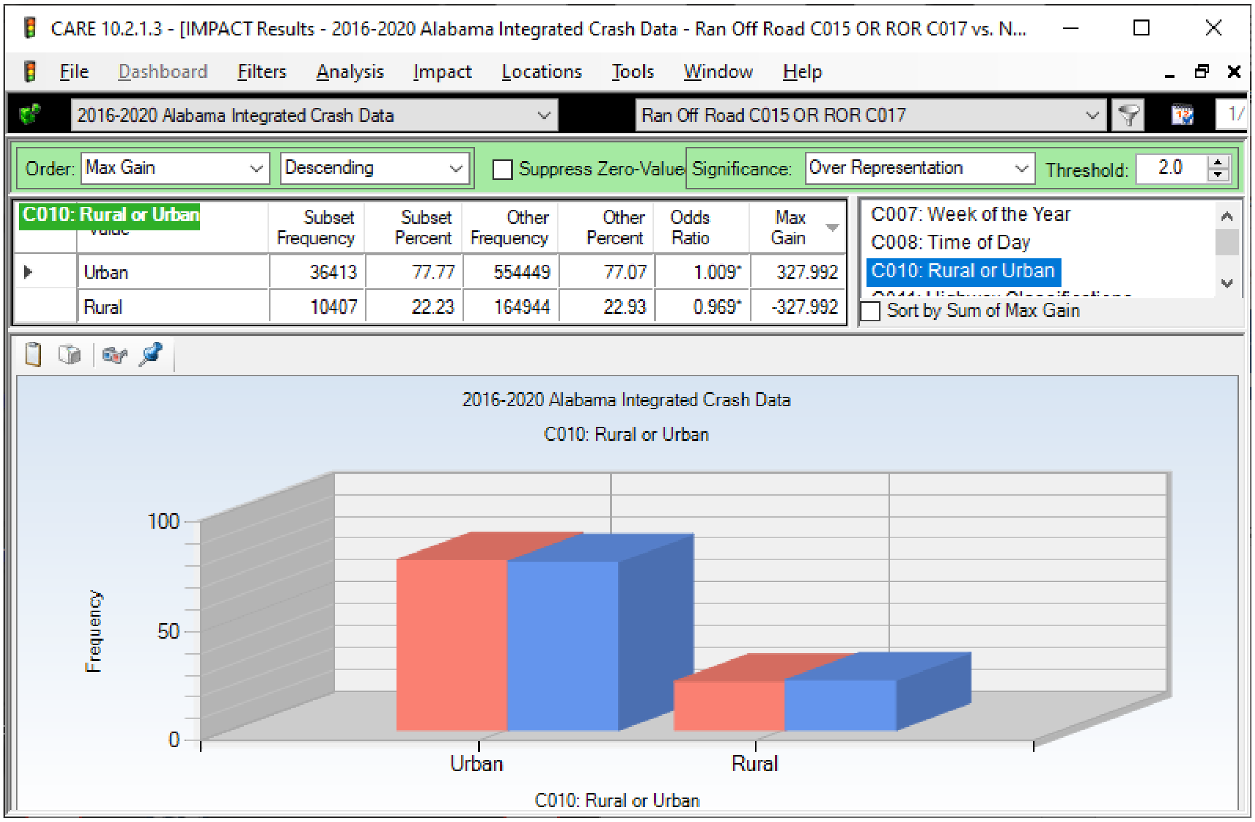
The output display below is a list of what are considered to be the most critical cities and county rural areas (virtual cities) because of their high Max Gains, which indicate the potential for crash reduction. The criterion for this list was a Max Gain of 100 or more crashes. The red background indicates those (virtual) city areas that had over twice their expected proportion of RS crashes (Odds Ratio).

This display is in Max Gain ordering to put those cities that have the highest potential for RS crash reduction at the top.



Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Rural Jefferson	2167	4.63	16600	2.31	2.006*	1086.487
Gadsden	750	1.60	7803	1.08	1.477*	242.094
Rural Clarke	249	0.53	279	0.04	13.711*	230.840
Scottsboro	345	0.74	2371	0.33	2.235*	190.669
Rural Etowah	322	0.69	2191	0.30	2.258*	179.385
Prichard	425	0.91	3815	0.53	1.711*	176.677
Rural Randolph	208	0.44	557	0.08	5.737*	171.744
Rural Shelby	576	1.23	6473	0.90	1.367*	154.665
Lincoln	221	0.47	1134	0.16	2.994*	147.187
Lanett	218	0.47	1114	0.15	3.006*	145.488
Gardendale	227	0.48	1270	0.18	2.746*	144.334
Adamsville	183	0.39	642	0.09	4.379*	141.211
Odenville	171	0.37	510	0.07	5.151*	137.804
Clanton	237	0.51	1571	0.22	2.318*	134.742
Ashville	155	0.33	439	0.06	5.424*	126.425
Glencoe	152	0.32	423	0.06	5.521*	124.466
Albertville	383	0.82	4018	0.56	1.464*	121.464
Talladega	218	0.47	1534	0.21	2.183*	118.150
Tallassee	161	0.34	753	0.10	3.285*	111.986
Rural Chilton	283	0.60	2648	0.37	1.642*	110.639
Calera	284	0.61	2740	0.38	1.592*	105.650
Jackson	140	0.30	547	0.08	3.932*	104.395
Hartselle	223	0.48	1843	0.26	1.859*	103.037
Rural Chambers	155	0.33	799	0.11	2.980*	102.992
Rural Elmore	288	0.62	2857	0.40	1.549*	102.035

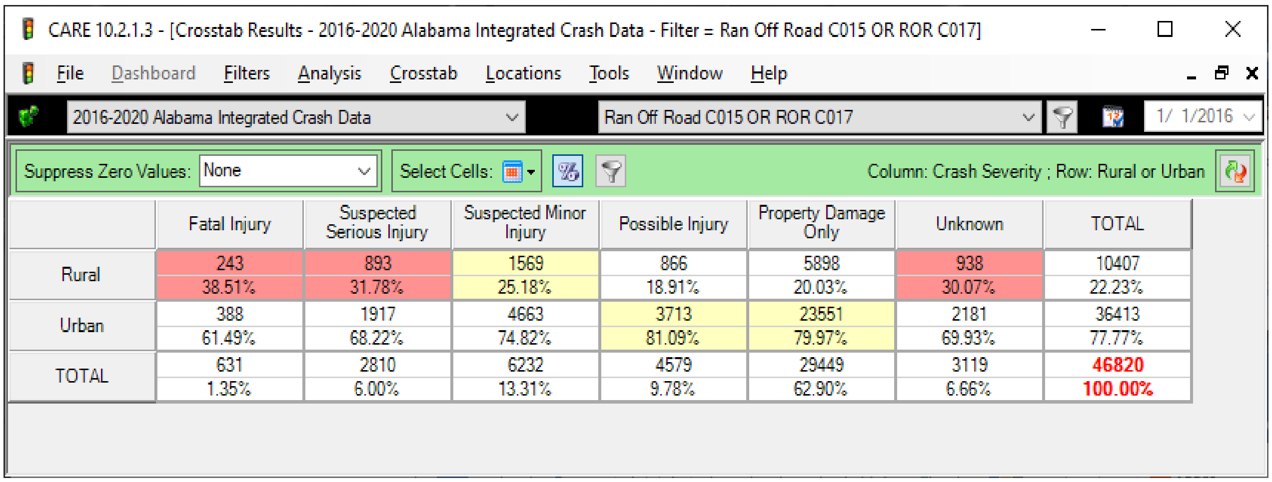
4.3 Rural or Urban



The result here is seen more in a comparisons of the percent columns than in the Odds Ratios and Max Gains. This is because with a huge sample sizes into the tens and hundreds of thousands, very small measured differences are calculated to be statistically significant. However, the difference (between RS and non-RS) in the Urban proportions is 0.07%, and for the Rural proportion difference, it is 0.70%. So, it is hard to conclude that the rural/urban mix is different in the RS and non-RS crashes. It will be interesting to study other similar attributes, such as Locale. The severity comparison immediately below indicates that the Rural areas crashes were *much more lethal* in their severity than were the Urban area crashes.

4.4 Severity of Crash by Rural-Urban

It is obvious in the above outputs that the proportion of RS crashes tends to be almost the same in rural and urbanized areas. It is interesting to perform a cross-tabulation over the rural and urban areas to determine to what extent their crashes might be causing more fatalities than would be expected from just a comparison of their crash frequency proportions. The following, *which is strictly for RS crashes*, gives this analysis.

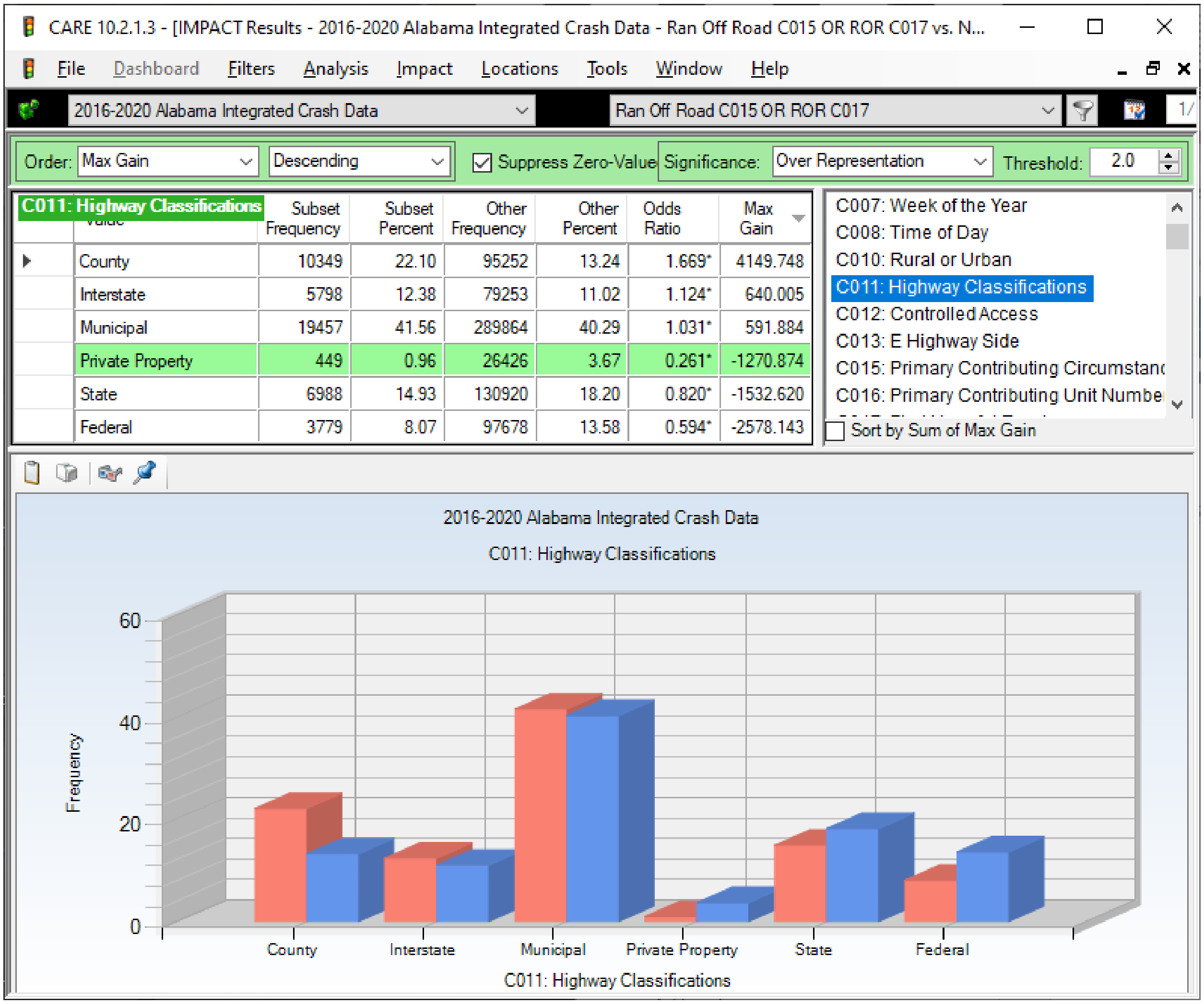


	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
Rural	243 38.51%	893 31.78%	1569 25.18%	866 18.91%	5898 20.03%	938 30.07%	10407 22.23%
Urban	388 61.49%	1917 68.22%	4663 74.82%	3713 81.09%	23551 79.97%	2181 69.93%	36413 77.77%
TOTAL	631 1.35%	2810 6.00%	6232 13.31%	4579 9.78%	29449 62.90%	3119 6.66%	46820 100.00%

The red cells in the cross-tabulation above indicate over-representation by more than 10%. For example, while 22.23% of crashes occurred in rural areas, 38.51% of the fatal crashes occurred there. It is imperative to take into consideration crash severity when making geographical decisions regarding countermeasure implementation. Any of the geographic analyses shown in this report could be restricted to fatal crashes or some combination of fatal and severe injury crashes.

Clearly fatalities and the highest severity of injuries are over-represented in the rural areas, since all three of the most severe crashes are over-represented there. The reason for this is the higher speeds in the rural areas that result in higher impact speeds (see Section 6.2), as well as the lack of clear roadsides in the rural areas (especially of county roads).

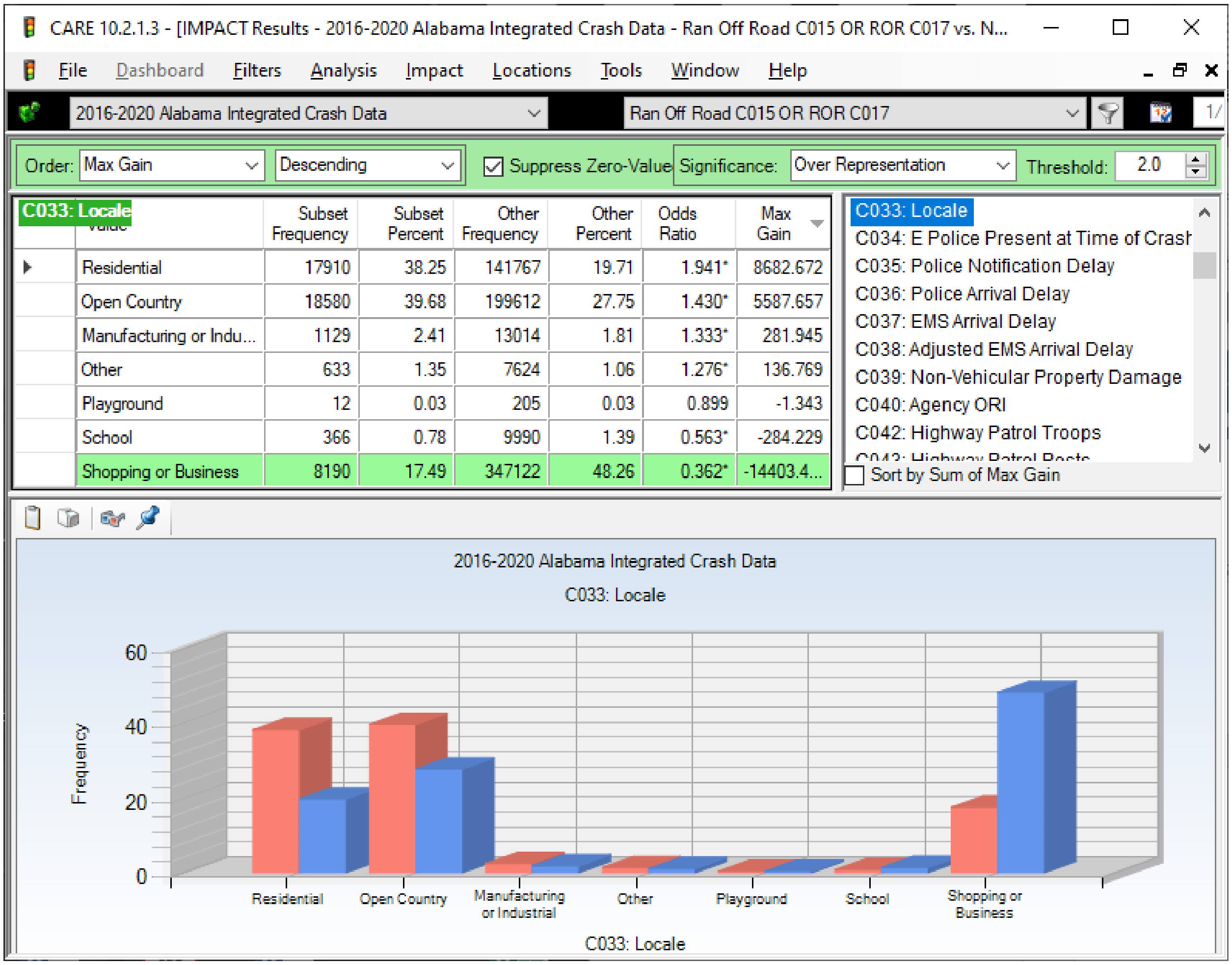
4.5 Highway Classifications



C011: Highway Classifications Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
County	10349	22.10	95252	13.24	1.669*	4149.748
Interstate	5798	12.38	79253	11.02	1.124*	640.005
Municipal	19457	41.56	289864	40.29	1.031*	591.884
Private Property	449	0.96	26426	3.67	0.261*	-1270.874
State	6988	14.93	130920	18.20	0.820*	-1532.620
Federal	3779	8.07	97678	13.58	0.594*	-2578.143

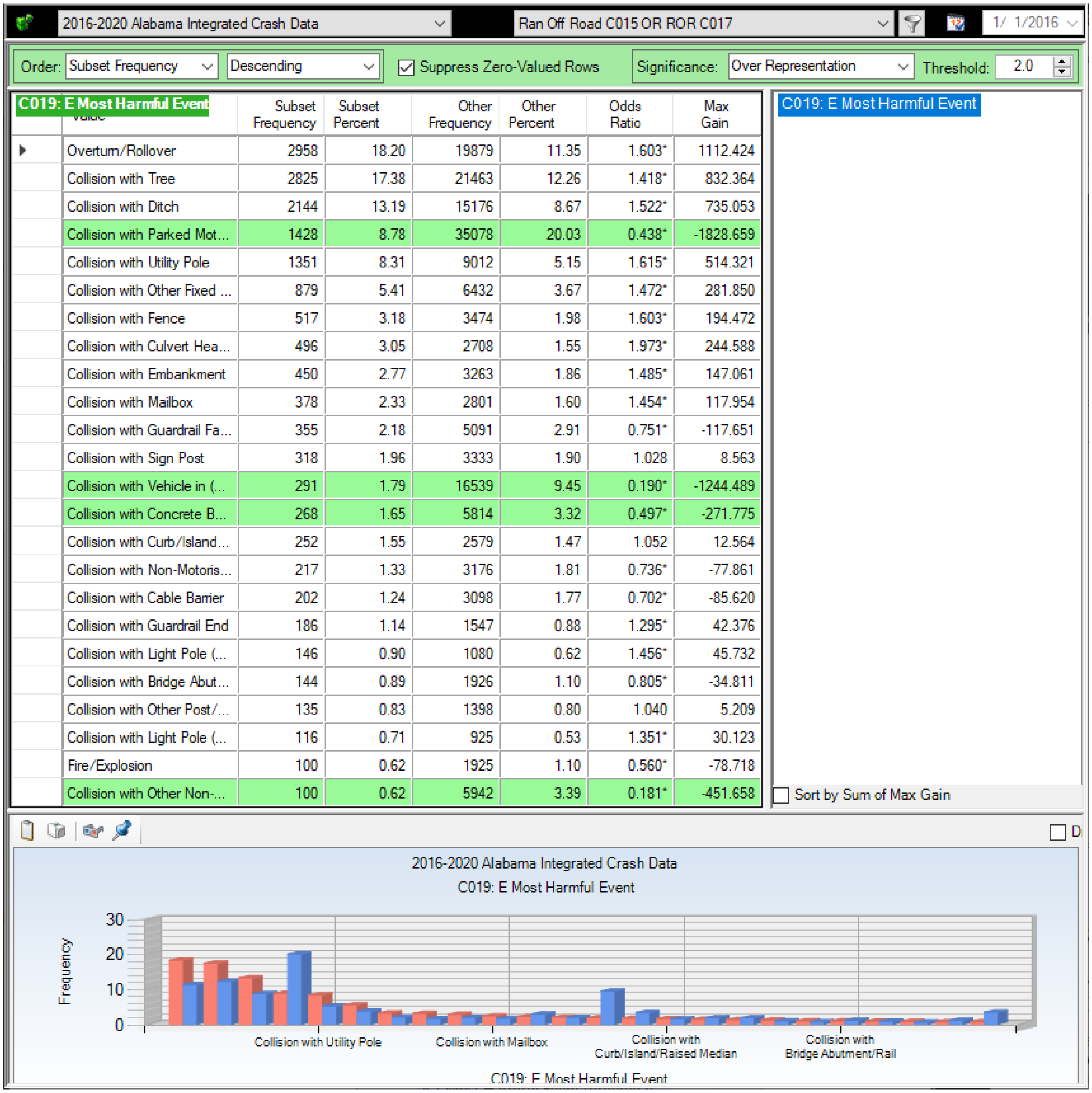
Analysis of highway classifications indicates that RS crashes had their greatest over-representation on county roads (66.9% higher than expected). Interstate and Municipal roads were also over-represented but by much smaller Odds Ratios (12.4% for Interstates, and 3.1% for Municipal roads.). It is recommended that hotspot analysis be performed to identify the specific county roads that are most highly over-represented, and that some enforcement activities be conducted on the county roads in an attempt to move this traffic onto the safer (more forgiving) roadways. Law enforcement presence alone could have a major effect here, since a major problem is speed, and will be shown below (Section 6.2).

4.6 Locale



Residential and Open Country roadways show a higher level of over-representation as compared to the more urbanized roadways. This might be more useful than a flat rural/urban specification, which we found above to be not as definitive. There are considerable “Open Country” areas within the formal city limits of most cities, and this seems to be where a large number of the RS crashes are occurring.

4.7 Most Harmful Event (ordered by frequency)

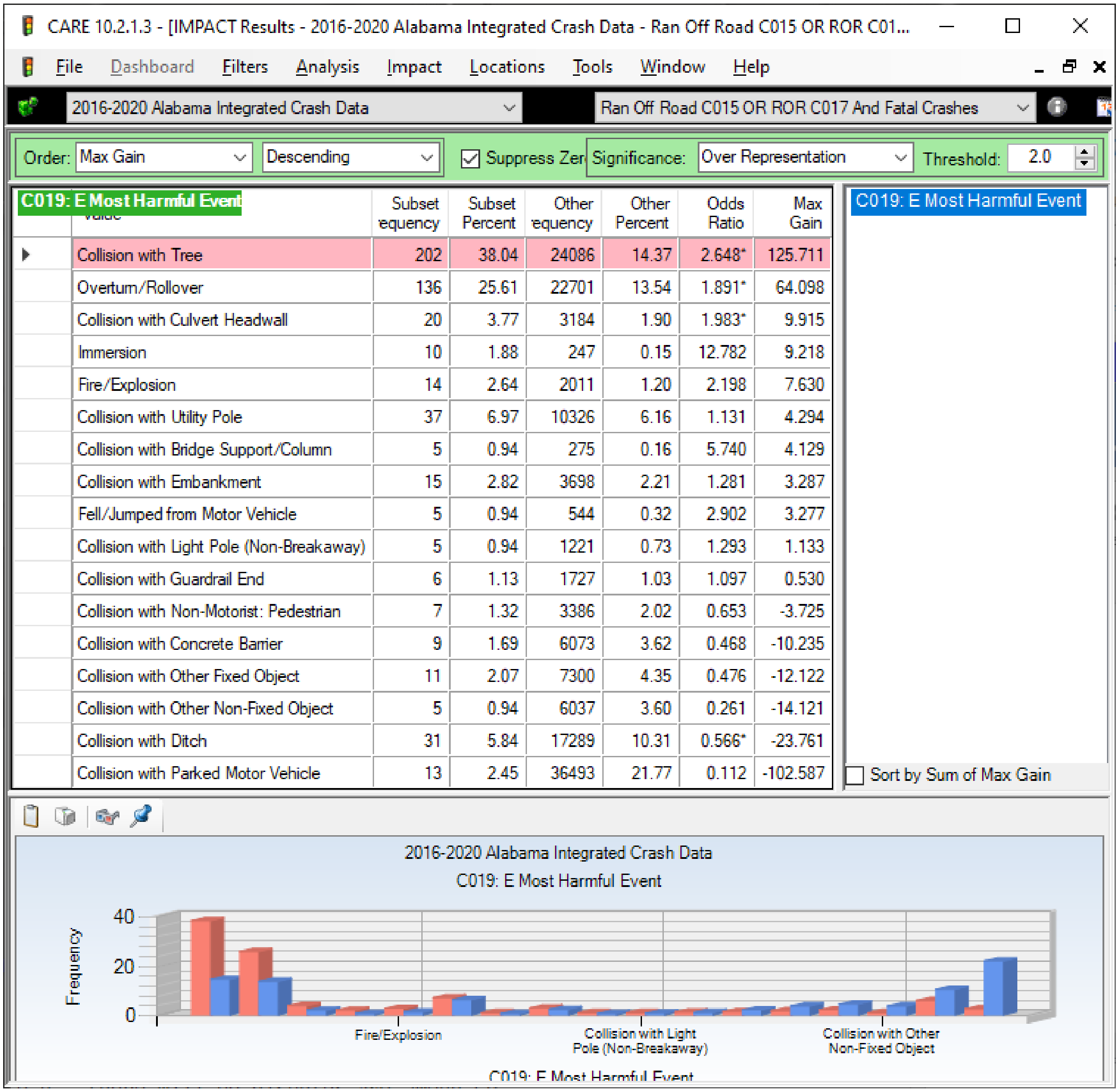


C019: E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Overturn/Rollover	2958	18.20	19879	11.35	1.603*	1112.424
Collision with Tree	2825	17.38	21463	12.26	1.418*	832.364
Collision with Ditch	2144	13.19	15176	8.67	1.522*	735.053
Collision with Parked Mot...	1428	8.78	35078	20.03	0.438*	-1828.659
Collision with Utility Pole	1351	8.31	9012	5.15	1.615*	514.321
Collision with Other Fixed ...	879	5.41	6432	3.67	1.472*	281.850
Collision with Fence	517	3.18	3474	1.98	1.603*	194.472
Collision with Culvert Hea...	496	3.05	2708	1.55	1.973*	244.588
Collision with Embankment	450	2.77	3263	1.86	1.485*	147.061
Collision with Mailbox	378	2.33	2801	1.60	1.454*	117.954
Collision with Guardrail Fa...	355	2.18	5091	2.91	0.751*	-117.651
Collision with Sign Post	318	1.96	3333	1.90	1.028	8.563
Collision with Vehicle in (...	291	1.79	16539	9.45	0.190*	-1244.489
Collision with Concrete B...	268	1.65	5814	3.32	0.497*	-271.775
Collision with Curb/Island...	252	1.55	2579	1.47	1.052	12.564
Collision with Non-Motoris...	217	1.33	3176	1.81	0.736*	-77.861
Collision with Cable Barrier	202	1.24	3098	1.77	0.702*	-85.620
Collision with Guardrail End	186	1.14	1547	0.88	1.295*	42.376
Collision with Light Pole (...	146	0.90	1080	0.62	1.456*	45.732
Collision with Bridge Abut...	144	0.89	1926	1.10	0.805*	-34.811
Collision with Other Post/...	135	0.83	1398	0.80	1.040	5.209
Collision with Light Pole (...	116	0.71	925	0.53	1.351*	30.123
Fire/Explosion	100	0.62	1925	1.10	0.560*	-78.718
Collision with Other Non-...	100	0.62	5942	3.39	0.181*	-451.658

These displays are intended to give safety engineers a knowledge of what is being hit most often on the roadside so that effective obstacle clearance may be facilitated. In ultimate practice hotspot analyses can be conducted to find those roads most in need of roadside improvement. These analyses can then produce the particular First Harmful Events and Most Harmful Events to guide the roadside clearance efforts.

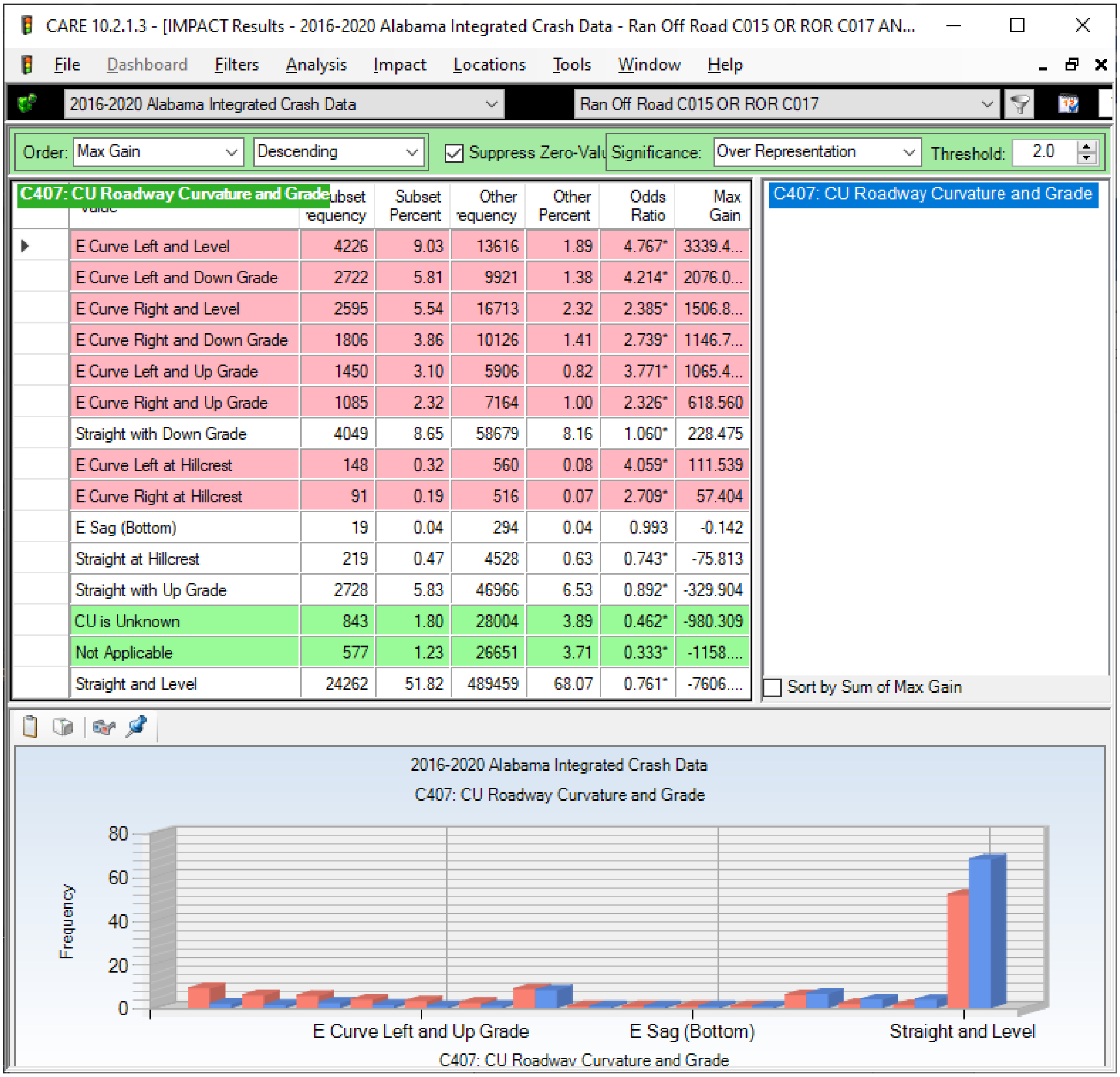
4.8 Most Harmful Fatal Event; C019 and Fatal

The above Most Harmful Event analysis was repeated below for RS fatality crashes. In general, trees are the most often causing death. The second most lethal crash type is Overturn/Rollover. After that, the number of fatal crashes caused drops off quickly. However, the frequencies of two others stand out: Collision with Utility Pole (37), and Collision with Ditch (31).



C019: E Most Harmful Event Value	Subset equency	Subset Percent	Other equency	Other Percent	Odds Ratio	Max Gain
Collision with Tree	202	38.04	24086	14.37	2.648*	125.711
Overturn/Rollover	136	25.61	22701	13.54	1.891*	64.098
Collision with Culvert Headwall	20	3.77	3184	1.90	1.983*	9.915
Immersion	10	1.88	247	0.15	12.782	9.218
Fire/Explosion	14	2.64	2011	1.20	2.198	7.630
Collision with Utility Pole	37	6.97	10326	6.16	1.131	4.294
Collision with Bridge Support/Column	5	0.94	275	0.16	5.740	4.129
Collision with Embankment	15	2.82	3698	2.21	1.281	3.287
Fell/Jumped from Motor Vehicle	5	0.94	544	0.32	2.902	3.277
Collision with Light Pole (Non-Breakaway)	5	0.94	1221	0.73	1.293	1.133
Collision with Guardrail End	6	1.13	1727	1.03	1.097	0.530
Collision with Non-Motorist: Pedestrian	7	1.32	3386	2.02	0.653	-3.725
Collision with Concrete Barrier	9	1.69	6073	3.62	0.468	-10.235
Collision with Other Fixed Object	11	2.07	7300	4.35	0.476	-12.122
Collision with Other Non-Fixed Object	5	0.94	6037	3.60	0.261	-14.121
Collision with Ditch	31	5.84	17289	10.31	0.566*	-23.761
Collision with Parked Motor Vehicle	13	2.45	36493	21.77	0.112	-102.587

4.9 CU Roadway Curvature and Grade

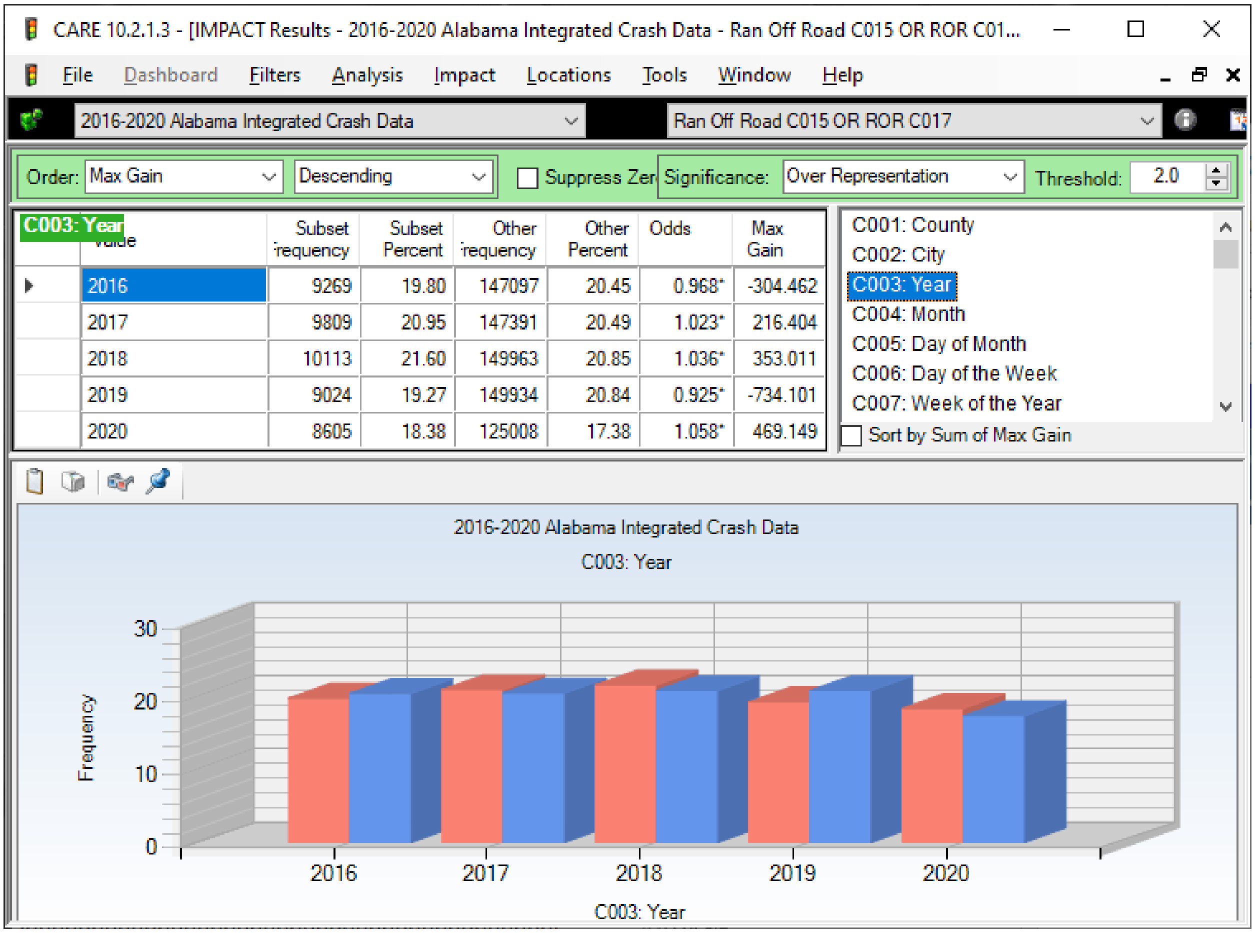


C407: CU Roadway Curvature and Grade	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Curve Left and Level	4226	9.03	13616	1.89	4.767*	3339.4...
E Curve Left and Down Grade	2722	5.81	9921	1.38	4.214*	2076.0...
E Curve Right and Level	2595	5.54	16713	2.32	2.385*	1506.8...
E Curve Right and Down Grade	1806	3.86	10126	1.41	2.739*	1146.7...
E Curve Left and Up Grade	1450	3.10	5906	0.82	3.771*	1065.4...
E Curve Right and Up Grade	1085	2.32	7164	1.00	2.326*	618.560
Straight with Down Grade	4049	8.65	58679	8.16	1.060*	228.475
E Curve Left at Hillcrest	148	0.32	560	0.08	4.059*	111.539
E Curve Right at Hillcrest	91	0.19	516	0.07	2.709*	57.404
E Sag (Bottom)	19	0.04	294	0.04	0.993	-0.142
Straight at Hillcrest	219	0.47	4528	0.63	0.743*	-75.813
Straight with Up Grade	2728	5.83	46966	6.53	0.892*	-329.904
CU is Unknown	843	1.80	28004	3.89	0.462*	-980.309
Not Applicable	577	1.23	26651	3.71	0.333*	-1158....
Straight and Level	24262	51.82	489459	68.07	0.761*	-7606....

It is not surprising that RS crashes are dramatically over-represented on all types of curves. Left curves either level or with a downgrade are generally more of a problem than right curves with the same grades. Level and down grades are more of a problem than up-grades.

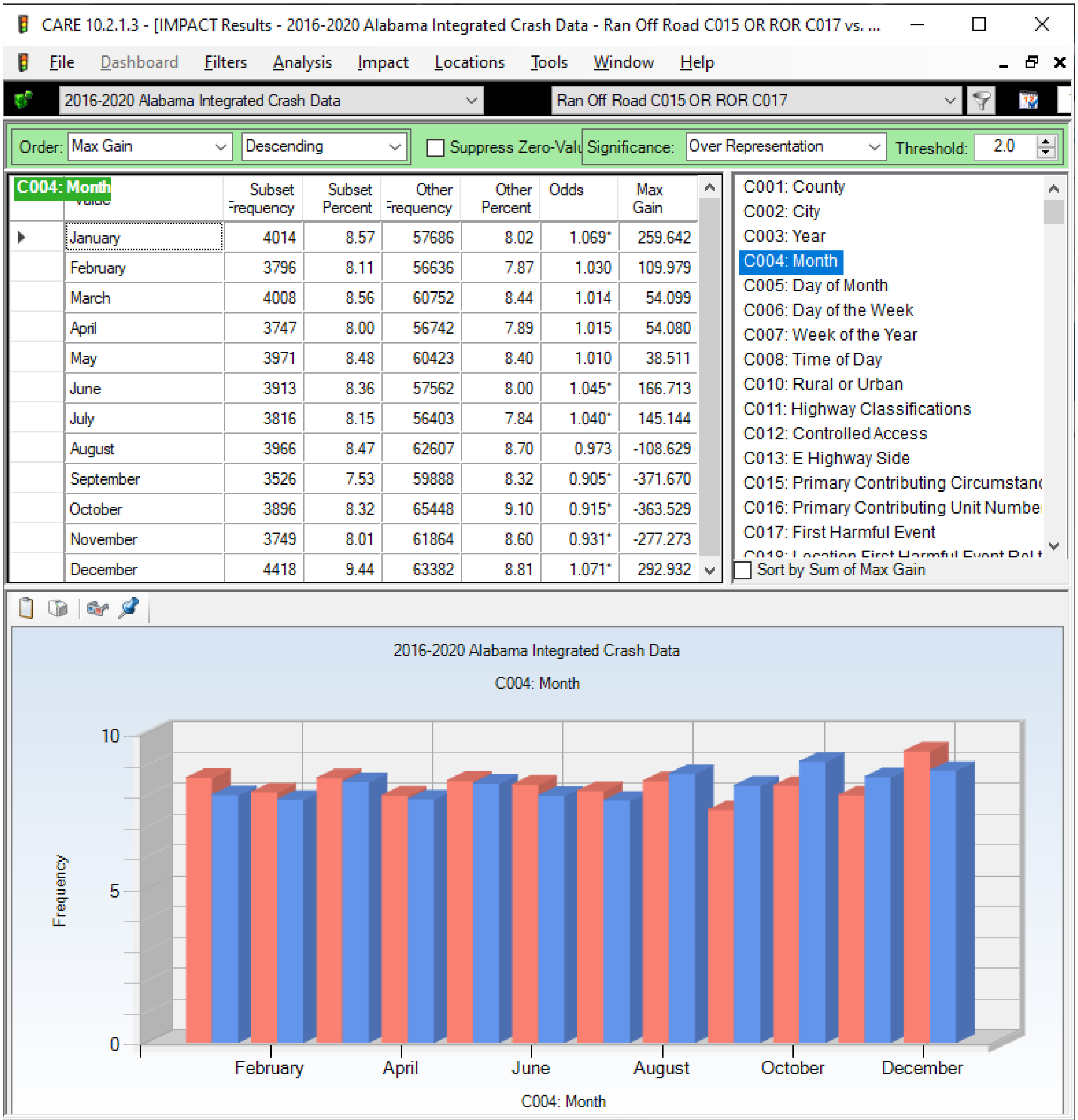
5.0 Time Factors

5.1 Year



The chart above is useful for tracking the relative changes by directly comparing the number of RS crashes to the non-RS crashes by year. All of the comparisons were significantly different from the non-RS crashes, but the results are quite mixed. Years 2016 and 2019 had a significantly smaller proportion than the non-RS. The other three, 2017, 2018 and 2020 had more than expected. There is no apparent trend in the RS proportion.

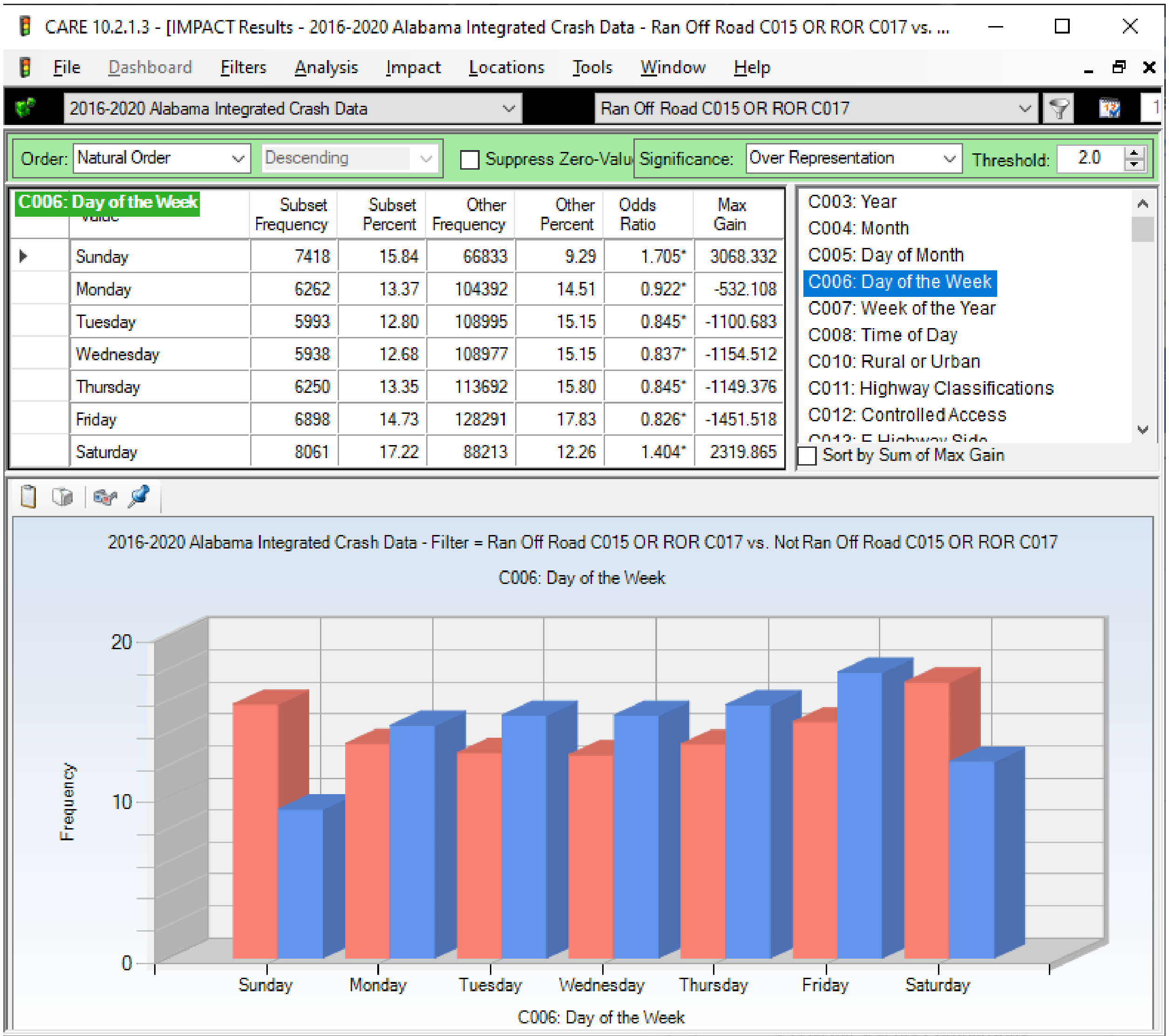
5.2 Month



C004: Month Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
January	4014	8.57	57686	8.02	1.069*	259.642
February	3796	8.11	56636	7.87	1.030	109.979
March	4008	8.56	60752	8.44	1.014	54.099
April	3747	8.00	56742	7.89	1.015	54.080
May	3971	8.48	60423	8.40	1.010	38.511
June	3913	8.36	57562	8.00	1.045*	166.713
July	3816	8.15	56403	7.84	1.040*	145.144
August	3966	8.47	62607	8.70	0.973	-108.629
September	3526	7.53	59888	8.32	0.905*	-371.670
October	3896	8.32	65448	9.10	0.915*	-363.529
November	3749	8.01	61864	8.60	0.931*	-277.273
December	4418	9.44	63382	8.81	1.071*	292.932

Significant over-representations by month were found in January, June, July and December. Significantly under-representations by month were found in September, October and November. The reason for these differences should be sought in the basic causes of RS crashes, which most often stem from speed and/or Impaired Driving.

5.3 Day of the Week



C006: Day of the Week Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Sunday	7418	15.84	66833	9.29	1.705*	3068.332
Monday	6262	13.37	104392	14.51	0.922*	-532.108
Tuesday	5993	12.80	108995	15.15	0.845*	-1100.683
Wednesday	5938	12.68	108977	15.15	0.837*	-1154.512
Thursday	6250	13.35	113692	15.80	0.845*	-1149.376
Friday	6898	14.73	128291	17.83	0.826*	-1451.518
Saturday	8061	17.22	88213	12.26	1.404*	2319.865

The above is a well-established and recognized pattern for Impaired Driving crashes, with their concentrations on the weekend periods, and it confirms what was suggested above for the monthly results. The main conclusion is that impaired driving is a major central cause for RS crashes.

5.4 Day of the Week Discussion

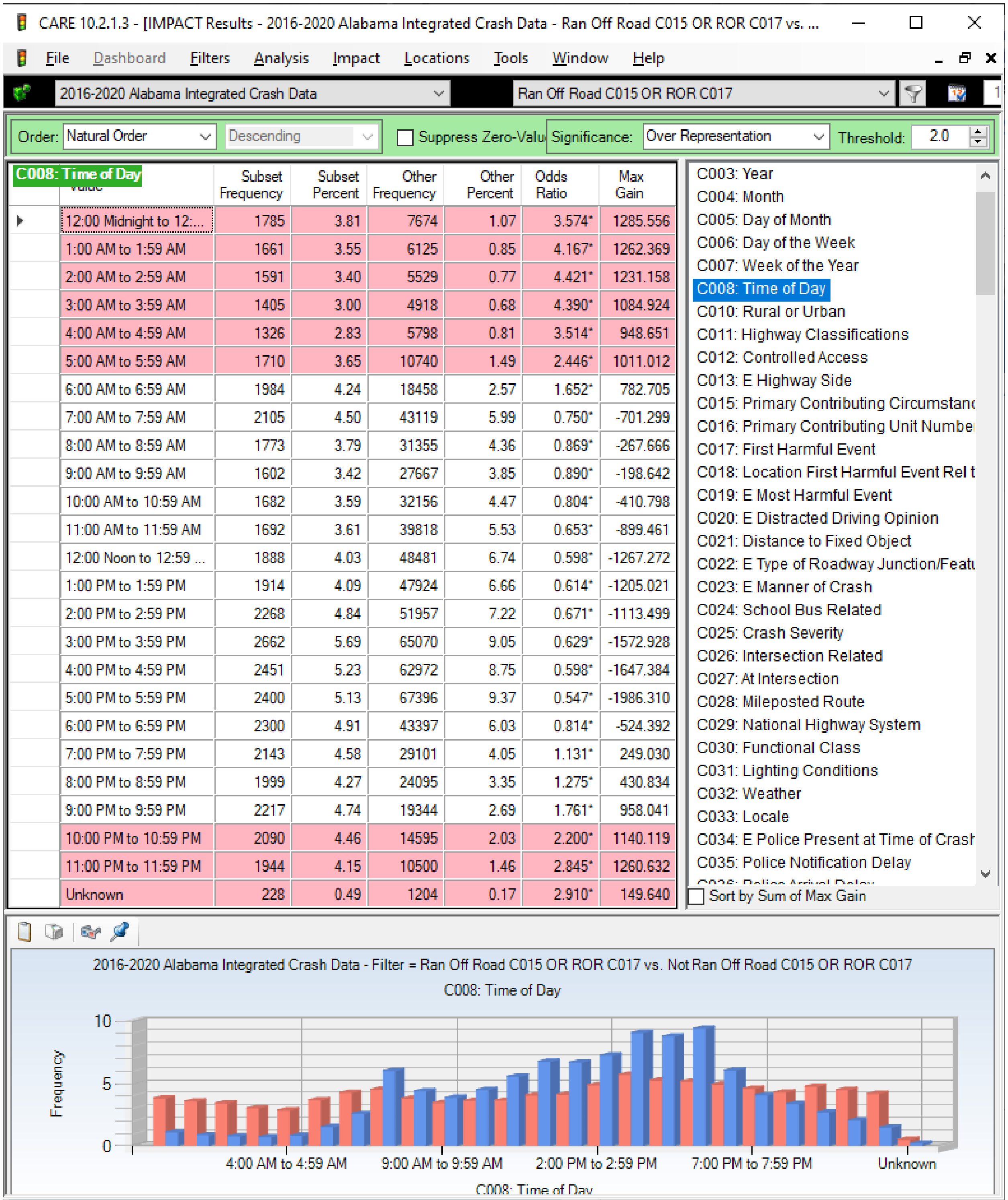
The chart above shows the typical non-holiday week pattern that has been experienced for Impaired Driving (ID) for decades. The days can be classified as follows:

- Weekday (Monday through Thursday) – these days are under-represented in RS crashes we would surmise due to the need for many to go to work the following day.
- Friday – the day before a weekend (or holiday) before a day off work. The Friday pattern is slightly under-represented in RS crashes, not because they do not occur more frequently than weekdays, but because non-RS crashes occur even more. Friday is both "work commuting day" and a "departure for recreation" time, causing increased traffic of combined commuters and vacationers (including short week-end vacations) that also resulting in a bad traffic mix. It may be only slightly denser than a typical rush hour, but it is not homogeneous and restricted to commuters as is the case during most weekday rush hours. No doubt much drug use and increased alcohol consumption is initiated on Friday afternoons.
- Saturday – the "Saturday" pattern is the worse for ID (and thus RS) crashes in that it has both an early morning component (like Sunday) and a late (pre-midnight) night component (like Friday). So, it could be viewed as a combination of the typical Friday and Sunday, with one exception. It does not have the increased complexity of the Friday afternoon commuters.
- Sunday – this is the last day of a holiday sequence or as given above, the weekend. Its over-representation comes strictly from those who start on Saturday night and do not complete their use of alcohol/drugs until after midnight.

A holiday "weekend," such as Thanksgiving, can be viewed as a sequence of a Friday-, Saturdays- and Sunday-pattern sequence. The Wednesday before Thanksgiving would follow the Friday pattern assuming that most are at work that Wednesday. The Thursday, Friday and Saturday would follow the Saturday pattern, and the Sunday would follow the typical Sunday pattern. Holidays that fall mid-week could also be so mapped. This is the reason that long holiday events (i.e., several days off from work) can be much more prone to RS crashes than the normal weekend. There could be a cumulative effect that could show up at any time of the day for some problem abusers. Recently the trend on the pre-Thanksgiving week has been for the holiday to start earlier and earlier in the week, so that Wednesday itself is not one of the worse crash days of the year, as it had been a decade or more ago. This if favorable in reducing the concentration of the traffic and the resultant conflicts.

While the discussion above concentrates on Impaired Driving (aka DUI), it relates to RS crashes in that, as we shall see going forward below, a large proportion of RS crashes turn out to be single vehicle ID crashes.

5.5 Time of Day



C008: Time of Day Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
12:00 Midnight to 12:...	1785	3.81	7674	1.07	3.574*	1285.556
1:00 AM to 1:59 AM	1661	3.55	6125	0.85	4.167*	1262.369
2:00 AM to 2:59 AM	1591	3.40	5529	0.77	4.421*	1231.158
3:00 AM to 3:59 AM	1405	3.00	4918	0.68	4.390*	1084.924
4:00 AM to 4:59 AM	1326	2.83	5798	0.81	3.514*	948.651
5:00 AM to 5:59 AM	1710	3.65	10740	1.49	2.446*	1011.012
6:00 AM to 6:59 AM	1984	4.24	18458	2.57	1.652*	782.705
7:00 AM to 7:59 AM	2105	4.50	43119	5.99	0.750*	-701.299
8:00 AM to 8:59 AM	1773	3.79	31355	4.36	0.869*	-267.666
9:00 AM to 9:59 AM	1602	3.42	27667	3.85	0.890*	-198.642
10:00 AM to 10:59 AM	1682	3.59	32156	4.47	0.804*	-410.798
11:00 AM to 11:59 AM	1692	3.61	39818	5.53	0.653*	-899.461
12:00 Noon to 12:59 ...	1888	4.03	48481	6.74	0.598*	-1267.272
1:00 PM to 1:59 PM	1914	4.09	47924	6.66	0.614*	-1205.021
2:00 PM to 2:59 PM	2268	4.84	51957	7.22	0.671*	-1113.499
3:00 PM to 3:59 PM	2662	5.69	65070	9.05	0.629*	-1572.928
4:00 PM to 4:59 PM	2451	5.23	62972	8.75	0.598*	-1647.384
5:00 PM to 5:59 PM	2400	5.13	67396	9.37	0.547*	-1986.310
6:00 PM to 6:59 PM	2300	4.91	43397	6.03	0.814*	-524.392
7:00 PM to 7:59 PM	2143	4.58	29101	4.05	1.131*	249.030
8:00 PM to 8:59 PM	1999	4.27	24095	3.35	1.275*	430.834
9:00 PM to 9:59 PM	2217	4.74	19344	2.69	1.761*	958.041
10:00 PM to 10:59 PM	2090	4.46	14595	2.03	2.200*	1140.119
11:00 PM to 11:59 PM	1944	4.15	10500	1.46	2.845*	1260.632
Unknown	228	0.49	1204	0.17	2.910*	149.640

5.6 Discussion on Time of Day

It is no surprise to find RS crashes over-represented during the late night/early morning hours, since their other correlations with aspects of Impaired Driving (ID) is clear. The following narrative was developed with regard to a special study that was done for ID. We include it here because of it relevance to RS crashes.

The extent of these over-representations is quite amazing. The blue bars above follow the typical traffic patterns of high traffic in the morning and afternoon rush hours. ID, and thus RS crashes, are just getting started in the afternoon rush hours and they continue to grow through midnight and the early morning hours, not tapering off until about 7:00 AM. It is clear that if selective enforcement is going to have an effect on RS crashes, it would have to be conducted at the times when these crashes are most occurring. Optimal times for Friday enforcement would start immediately following any rush hour details, and would continue through at least 3:00 AM.

The *Time of Day by Day of the Week* cross-tabulation (given in the next section for RS crashes only) shows the optimal times for selective enforcement. Generally, the worst times in any day are given in red for that day. This works well for Saturday and Sunday mornings, but not too well for Friday night. The reason is that proportions on Saturday night, eclipsed the Friday numbers, even though they were higher than any other day except Saturday.

Notice that the total number of RS crashes is 46,820, while the total ID crashes was 28,300; thus there are over 65% more RS crashes than reported ID crashes. RS crashes could be an excellent (although clearly not perfect) proxy for ID crashes. Sometimes ID crashes will not be reported as such because of the imperfections in ID measurement, especially for drugs. This is not as much of a problem with RS since it is clear when a crash occurs on the roadside.

This is an excellent example to demonstrate how the color coding of CARE cross-tabulations can be misleading in some special cases. The red background indicates that the over-representation of the cell is greater than expected. The expected proportion for all cells in a given row is given at the extreme right in the total row percentage for that row. If there were absolutely no over-representations across the columns, then all of the proportions for those cells would be identical to the one for the total. Notice for example, the 7 AM to 7:59 AM row has a total percentage value of 4.50%. Those that are under this value have a neutral (white) background. Those that are higher, but not more than 10% of the proportion are yellow; and those above 10% of the proportion are red.

5.7 Time of Day by Day of the Week

CARE 10.2.1.3 - [Crosstab Results - 2016-2020 Alabama Integrated Crash Data - Filter = Ran Off Road C015 OR ROR C017]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2016-2020 Alabama Integrated Crash Data | Ran Off Road C015 OR ROR C017 | 1/ 1/2016 | 12/31/2020

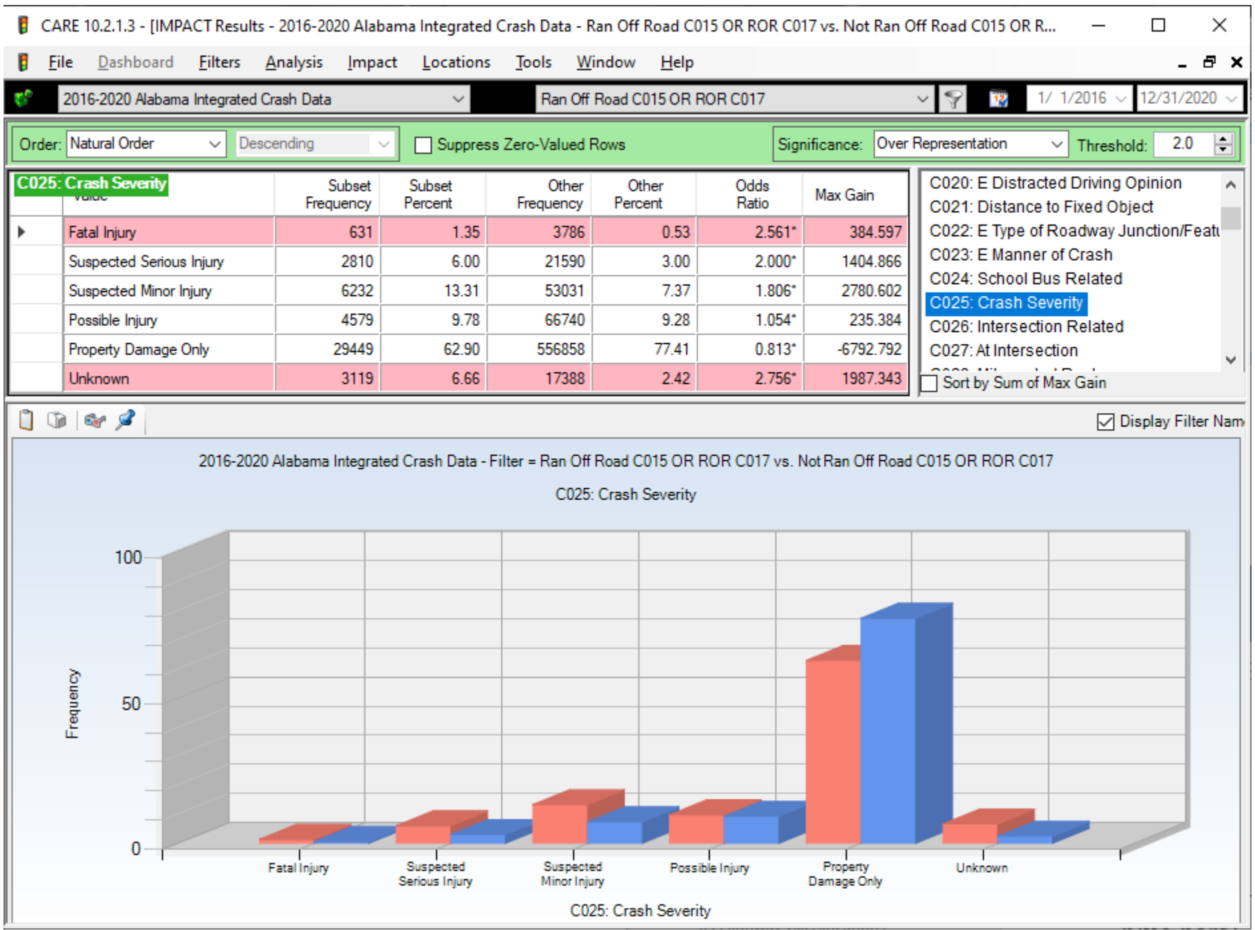
Suppress Zero Values: None | Select Cells: | Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	416 5.61%	228 3.64%	168 2.80%	188 3.17%	181 2.90%	226 3.28%	378 4.69%	1785 3.81%
1:00 AM to 1:59 AM	446 6.01%	155 2.48%	149 2.49%	156 2.63%	173 2.77%	212 3.07%	370 4.59%	1661 3.55%
2:00 AM to 2:59 AM	424 5.72%	137 2.19%	142 2.37%	145 2.44%	145 2.32%	197 2.86%	401 4.97%	1591 3.40%
3:00 AM to 3:59 AM	390 5.26%	126 2.01%	108 1.80%	135 2.27%	119 1.90%	172 2.49%	355 4.40%	1405 3.00%
4:00 AM to 4:59 AM	301 4.06%	138 2.20%	138 2.30%	146 2.46%	127 2.03%	169 2.45%	307 3.81%	1326 2.83%
5:00 AM to 5:59 AM	320 4.31%	209 3.34%	215 3.59%	216 3.64%	202 3.23%	233 3.38%	315 3.91%	1710 3.65%
6:00 AM to 6:59 AM	322 4.34%	274 4.38%	275 4.59%	278 4.68%	274 4.38%	270 3.91%	291 3.61%	1984 4.24%
7:00 AM to 7:59 AM	250 3.37%	307 4.90%	339 5.66%	337 5.68%	295 4.72%	312 4.52%	265 3.29%	2105 4.50%
8:00 AM to 8:59 AM	224 3.02%	267 4.26%	275 4.59%	251 4.23%	242 3.87%	275 3.99%	239 2.96%	1773 3.79%
9:00 AM to 9:59 AM	206 2.78%	261 4.17%	219 3.65%	250 4.21%	208 3.33%	232 3.36%	226 2.80%	1602 3.42%
10:00 AM to 10:59 AM	228 3.07%	271 4.33%	262 4.37%	214 3.60%	228 3.65%	248 3.60%	231 2.87%	1682 3.59%
11:00 AM to 11:59 AM	216 2.91%	264 4.22%	256 4.27%	195 3.28%	248 3.97%	243 3.52%	270 3.35%	1692 3.61%
12:00 Noon to 12:59 PM	259 3.49%	258 4.12%	268 4.47%	271 4.56%	268 4.29%	275 3.99%	289 3.59%	1888 4.03%
1:00 PM to 1:59 PM	272 3.67%	283 4.52%	241 4.02%	276 4.65%	270 4.32%	281 4.07%	291 3.61%	1914 4.09%
2:00 PM to 2:59 PM	320 4.31%	330 5.27%	324 5.41%	271 4.56%	336 5.38%	360 5.22%	327 4.06%	2268 4.84%
3:00 PM to 3:59 PM	360 4.85%	386 6.16%	352 5.87%	368 6.20%	413 6.61%	400 5.80%	383 4.75%	2662 5.69%
4:00 PM to 4:59 PM	302 4.07%	349 5.57%	369 6.16%	321 5.41%	361 5.78%	385 5.58%	364 4.52%	2451 5.23%
5:00 PM to 5:59 PM	334 4.50%	325 5.19%	327 5.46%	341 5.74%	373 5.97%	334 4.84%	366 4.54%	2400 5.13%
6:00 PM to 6:59 PM	343 4.62%	340 5.43%	304 5.07%	306 5.15%	326 5.22%	326 4.73%	355 4.40%	2300 4.91%
7:00 PM to 7:59 PM	316 4.26%	315 5.03%	283 4.72%	276 4.65%	289 4.62%	307 4.45%	357 4.43%	2143 4.58%
8:00 PM to 8:59 PM	289 3.90%	266 4.25%	245 4.09%	264 4.45%	281 4.50%	318 4.61%	336 4.17%	1999 4.27%
9:00 PM to 9:59 PM	301 4.06%	271 4.33%	267 4.46%	266 4.48%	305 4.88%	380 5.51%	427 5.30%	2217 4.74%
10:00 PM to 10:59 PM	286 3.86%	250 3.99%	228 3.80%	257 4.33%	289 4.62%	346 5.02%	434 5.38%	2090 4.46%
11:00 PM to 11:59 PM	252 3.40%	225 3.59%	213 3.55%	197 3.32%	263 4.21%	370 5.36%	424 5.26%	1944 4.15%
Unknown	41 0.55%	27 0.43%	26 0.43%	13 0.22%	34 0.54%	27 0.39%	60 0.74%	228 0.49%
TOTAL	7418 15.84%	6262 13.37%	5993 12.80%	5938 12.68%	6250 13.35%	6898 14.73%	8061 17.22%	46820 100.00%

6.0 Factors Affecting Severity

6.1 RS Crash Severity

See Section 4.8 for the most harmful event in fatal RS crashes. The following compares crash severities for RS (Subset, red bars) vs. Non-RS crashes (Other, blue bars below table).



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	631	1.35	3786	0.53	2.561*	384.597
Suspected Serious Injury	2810	6.00	21590	3.00	2.000*	1404.866
Suspected Minor Injury	6232	13.31	53031	7.37	1.806*	2780.602
Possible Injury	4579	9.78	66740	9.28	1.054*	235.384
Property Damage Only	29449	62.90	556858	77.41	0.813*	-6792.792
Unknown	3119	6.66	17388	2.42	2.756*	1987.343

The rate of fatal injury crashes and the two highest injury classifications are consistently higher in RS crashes than that of non-RS crashes. Fatality crashes have 2.561 times their expected proportion, while the two highest non-fatal injury classifications have 2.000 and 1.806 times their expected proportions when compared with non-Roadside (non-RS) crashes. The Speed-at-Impact variable, considered next, indicates one of the primary reasons for this. However, the greatest cause of RS increased severity and death is their lack of proper restraints.

6.2 Speed at Impact

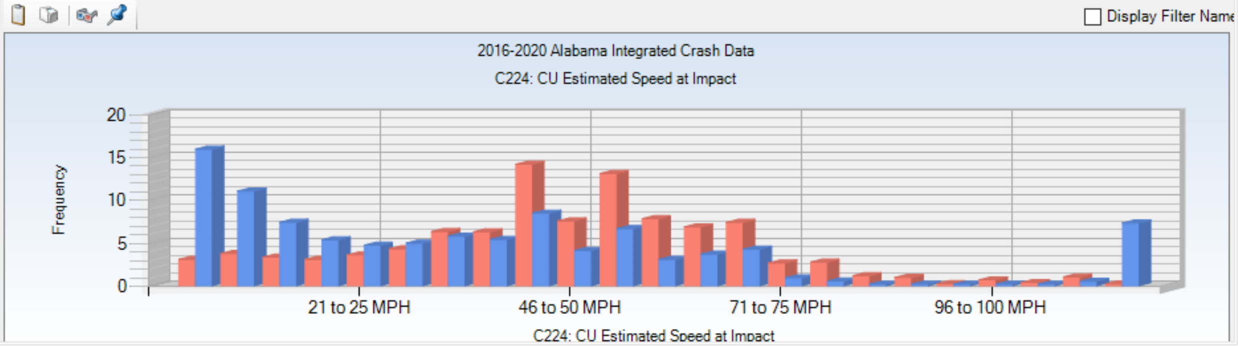
CARE 10.2.1.3 - [IMPACT Results - 2016-2020 Alabama Integrated Crash Data - DUI (Alcohol or Drugs) AND Not CU Estimated Speed at Impact = 2...

2016-2020 Alabama Integrated Crash Data | DUI (Alcohol or Drugs) | 1/ 1/2016 | 12/31/2020

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

C224: CU Estimated Speed at Impact Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 to 5 MPH	526	3.04	62844	15.87	0.192*	-2218.172
6 to 10 MPH	645	3.73	43533	10.99	0.339*	-1255.930
11 to 15 MPH	572	3.31	29167	7.36	0.449*	-701.618
16 to 20 MPH	528	3.05	21115	5.33	0.573*	-394.016
21 to 25 MPH	616	3.56	18569	4.69	0.760*	-194.842
26 to 30 MPH	739	4.27	19586	4.95	0.864*	-116.250
31 to 35 MPH	1085	6.27	22770	5.75	1.091*	90.716
36 to 40 MPH	1082	6.26	21270	5.37	1.165*	153.215
41 to 45 MPH	2441	14.11	33362	8.42	1.676*	984.201
46 to 50 MPH	1300	7.52	16228	4.10	1.835*	591.381
51 to 55 MPH	2254	13.03	26237	6.62	1.967*	1108.324
56 to 60 MPH	1345	7.78	12084	3.05	2.549*	817.335
61 to 65 MPH	1181	6.83	14507	3.66	1.864*	547.531
66 to 70 MPH	1271	7.35	16766	4.23	1.736*	538.889
71 to 75 MPH	455	2.63	3552	0.90	2.934*	299.897
76 to 80 MPH	471	2.72	2078	0.52	5.191*	380.261
81 to 85 MPH	200	1.16	590	0.15	7.763*	174.237
86 to 90 MPH	163	0.94	469	0.12	7.959*	142.520
91 to 95 MPH	37	0.21	100	0.03	8.473*	32.633
96 to 100 MPH	115	0.66	260	0.07	10.129*	103.647
Over 100 MPH	62	0.36	156	0.04	9.102*	55.188
CU is Not a Vehicle	174	1.01	2014	0.51	1.979*	86.056
CU is Unknown	33	0.19	28814	7.27	0.026*	-1225.204

Sort by Sum of Max Gain | Display Filter Name



It should be noted that the speed limit on County roads is generally 45 MPH, and it is generally lower on Municipal roads where the plurality of RS crashes occurs. All impact speeds above 21 MPH are significantly over-represented, and the over-representation generally increases with the increase in impact speeds up to 50 MPH, After that, the Odds Ratios stay in a range around 1.500.

The next cross-tabulation quantifies how this relates to the severity of the crash for RS crashes.

6.3 Severity by Impact Speed Cross-Tabulation

CARE 10.2.1.3 - [Crosstab Results - 2016-2020 Alabama Integrated Crash Data - Filter = Ran Off Road C015 OR ROR C017]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2016-2020 Alabama Integrated Crash Data | Ran Off Road C015 OR ROR C017 | 1/ 1/2016

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	1 0.16%	4 0.14%	16 0.26%	10 0.22%	296 1.01%	15 0.48%	342 0.73%
6 to 10 MPH	1 0.16%	7 0.25%	23 0.37%	26 0.57%	373 1.27%	17 0.55%	447 0.95%
11 to 15 MPH	0 0.00%	8 0.28%	36 0.58%	39 0.85%	438 1.49%	13 0.42%	534 1.14%
16 to 20 MPH	0 0.00%	12 0.43%	52 0.83%	65 1.42%	594 2.02%	18 0.58%	741 1.58%
21 to 25 MPH	2 0.32%	42 1.49%	113 1.81%	92 2.01%	921 3.13%	48 1.54%	1218 2.60%
26 to 30 MPH	7 1.11%	56 1.99%	161 2.58%	140 3.06%	1064 3.61%	73 2.34%	1501 3.21%
31 to 35 MPH	6 0.95%	83 2.95%	301 4.83%	227 4.96%	1640 5.57%	125 4.01%	2382 5.09%
36 to 40 MPH	18 2.85%	107 3.81%	307 4.93%	216 4.72%	1428 4.85%	104 3.33%	2180 4.66%
41 to 45 MPH	32 5.07%	260 9.25%	565 9.07%	369 8.06%	2254 7.65%	157 5.03%	3637 7.77%
46 to 50 MPH	26 4.12%	160 5.69%	316 5.07%	223 4.87%	1175 3.99%	71 2.28%	1971 4.21%
51 to 55 MPH	64 10.14%	331 11.78%	475 7.62%	293 6.40%	1438 4.88%	109 3.49%	2710 5.79%
56 to 60 MPH	31 4.91%	135 4.80%	269 4.32%	142 3.10%	755 2.56%	50 1.60%	1382 2.95%
61 to 65 MPH	32 5.07%	136 4.84%	197 3.16%	136 2.97%	866 2.94%	49 1.57%	1416 3.02%
66 to 70 MPH	46 7.29%	137 4.88%	210 3.37%	107 2.34%	848 2.88%	31 0.99%	1379 2.95%
71 to 75 MPH	12 1.90%	40 1.42%	45 0.72%	38 0.83%	187 0.63%	13 0.42%	335 0.72%
76 to 80 MPH	14 2.22%	35 1.25%	45 0.72%	17 0.37%	117 0.40%	8 0.26%	236 0.50%
81 to 85 MPH	7 1.11%	14 0.50%	10 0.16%	7 0.15%	25 0.08%	2 0.06%	65 0.14%
86 to 90 MPH	6 0.95%	13 0.46%	17 0.27%	5 0.11%	25 0.08%	2 0.06%	68 0.15%
91 to 95 MPH	2 0.32%	4 0.14%	4 0.06%	0 0.00%	2 0.01%	0 0.00%	12 0.03%
96 to 100 MPH	8 1.27%	13 0.46%	9 0.14%	6 0.13%	22 0.07%	2 0.06%	60 0.13%
Over 100 MPH	5 0.79%	4 0.14%	7 0.11%	5 0.11%	14 0.05%	0 0.00%	35 0.07%
E Stationary	0 0.00%	1 0.04%	6 0.10%	7 0.15%	47 0.16%	5 0.16%	66 0.14%
Unknown	292 46.28%	1143 40.68%	2838 45.54%	2224 48.57%	13528 45.94%	1941 62.23%	21966 46.92%
Not Applicable	13 2.06%	41 1.46%	132 2.12%	112 2.45%	842 2.86%	154 4.94%	1294 2.76%
CU is Unknown	6 0.95%	24 0.85%	78 1.25%	73 1.59%	550 1.87%	112 3.59%	843 1.80%
TOTAL	631 1.35%	2810 6.00%	6232 13.31%	4579 9.78%	29449 62.90%	3119 6.66%	46820 100.00%

6.4 Discussion of Severity vs Speed Cross-Tabulation

The display above presents information on the effect of increased impact speed on the severity of RS crashes. Notice the red in the Fatality and Serious Injury cells as speeds increase. What is more enlightening is the probability that the crash results in a fatality as a function of impact speed. This is given in the following table:

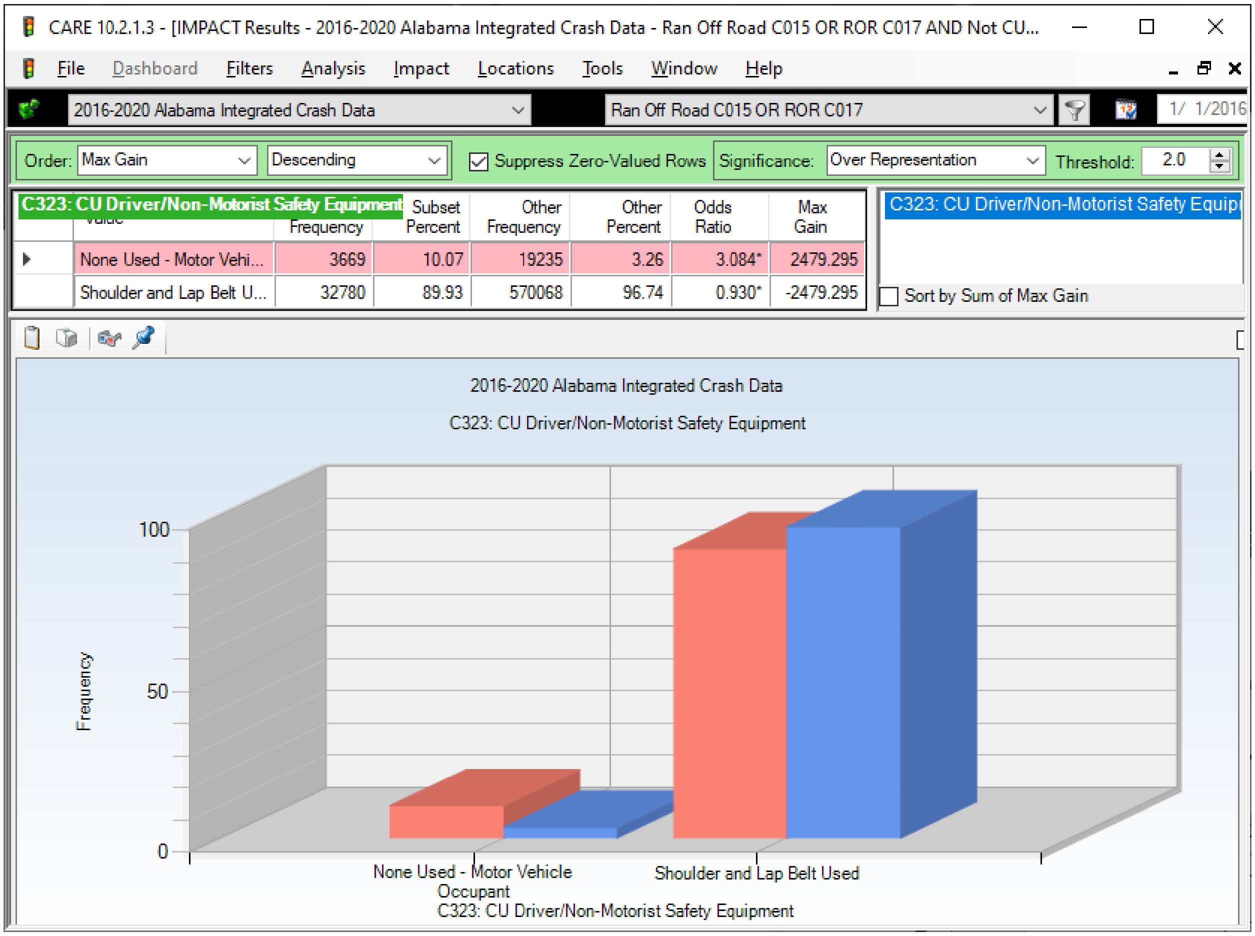
Speed at Impact	Fatality Odds (1 in …)	Increase Probability above 31-35
31-35	397	1.0
36-45	118	3.3
46-55	59	6.7
56-65	45	8.8
66-75	29	13.7
76-85	13	30.5
86-95	9	44.1
Above 95	8	49.6

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 will be fatal. A reduction in impact speeds by 10 MPH would cut the number of fatal crashes in half. This is the reason that selective enforcement is effective.

However, there is another major factor in effect here as well – the failure of RS drivers to be properly restrained, which will be covered in the next separate attribute below (6.5; Restraint Use by Causal Drivers in RS Crashes), which is also correlated with Impaired Drivers.

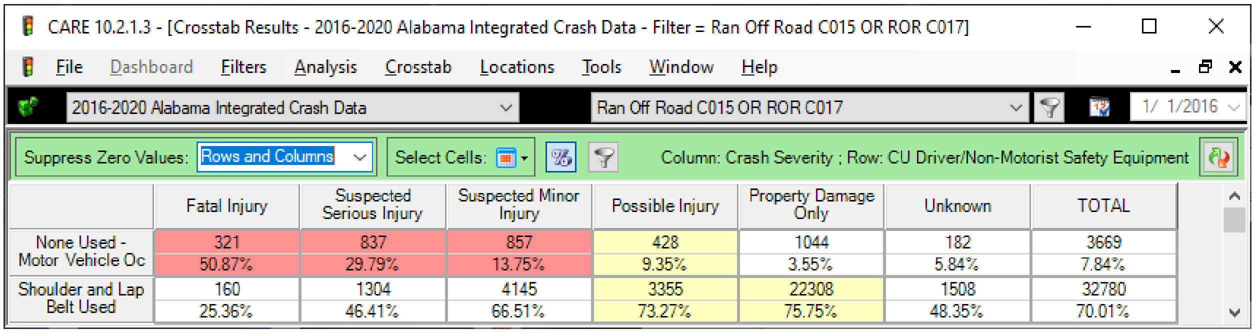
6.5 Restraint Use by Drivers in RS Crashes

The following display presents a comparison of RS-crash driver safety belt use against those who were not RS over the same five-year time period.



Risk-taking involved in most of the RS causes does not stop with excess speed; it extends to not being properly restrained. The above analysis demonstrates that the causal driver in an RS crash is over three (3.084) times more likely to be unrestrained than in the non-RS crash. The next analysis demonstrates how this contributes to crashes becoming fatal.

6.6 Crash Severity by Restraint Use (C323) for RS Crash CU Drivers

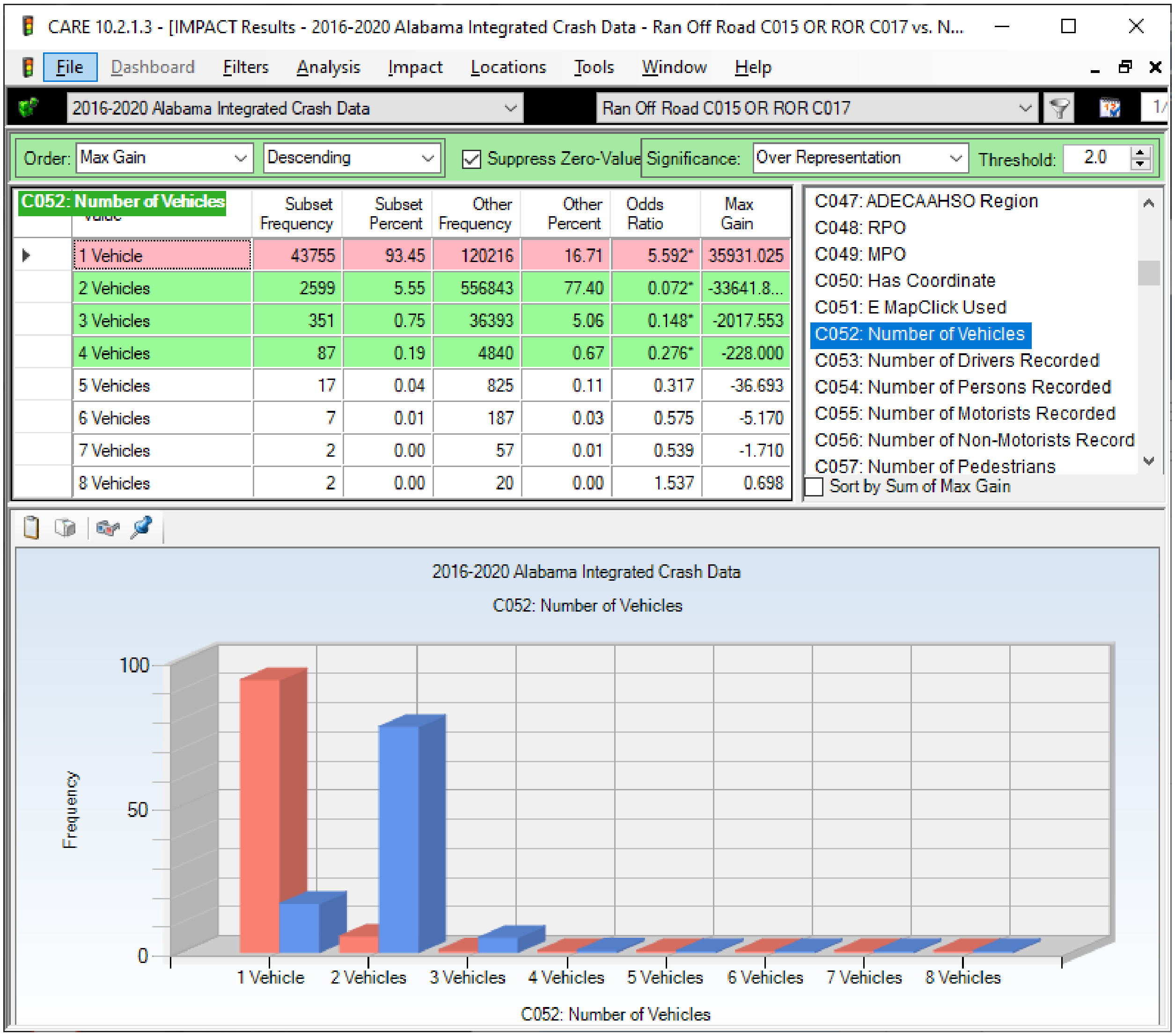


	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
None Used - Motor Vehicle Oc	321	837	857	428	1044	182	3669
	50.87%	29.79%	13.75%	9.35%	3.55%	5.84%	7.84%
Shoulder and Lap Belt Used	160	1304	4145	3355	22308	1508	32780
	25.36%	46.41%	66.51%	73.27%	75.75%	48.35%	70.01%

A comparison of the probability of a fatal crash for the two restraint categories of RS crashes indicates that a fatality is about 18 times (17.92) more likely if the RS causal driver is not properly restrainted. The probability is estimated by 321 fatality crashes out of 3,669 when restraints were not used (1 in 11.4), as opposed to only 160 fatal crashes out of 32,780 crashes when restraints were used (1 in about 205 crashes). So the combined effect of lower restraint use and higher speed is a devastating combination that accounts for the high lethality of RS crashes.

6.7 Number of Vehicles Involved

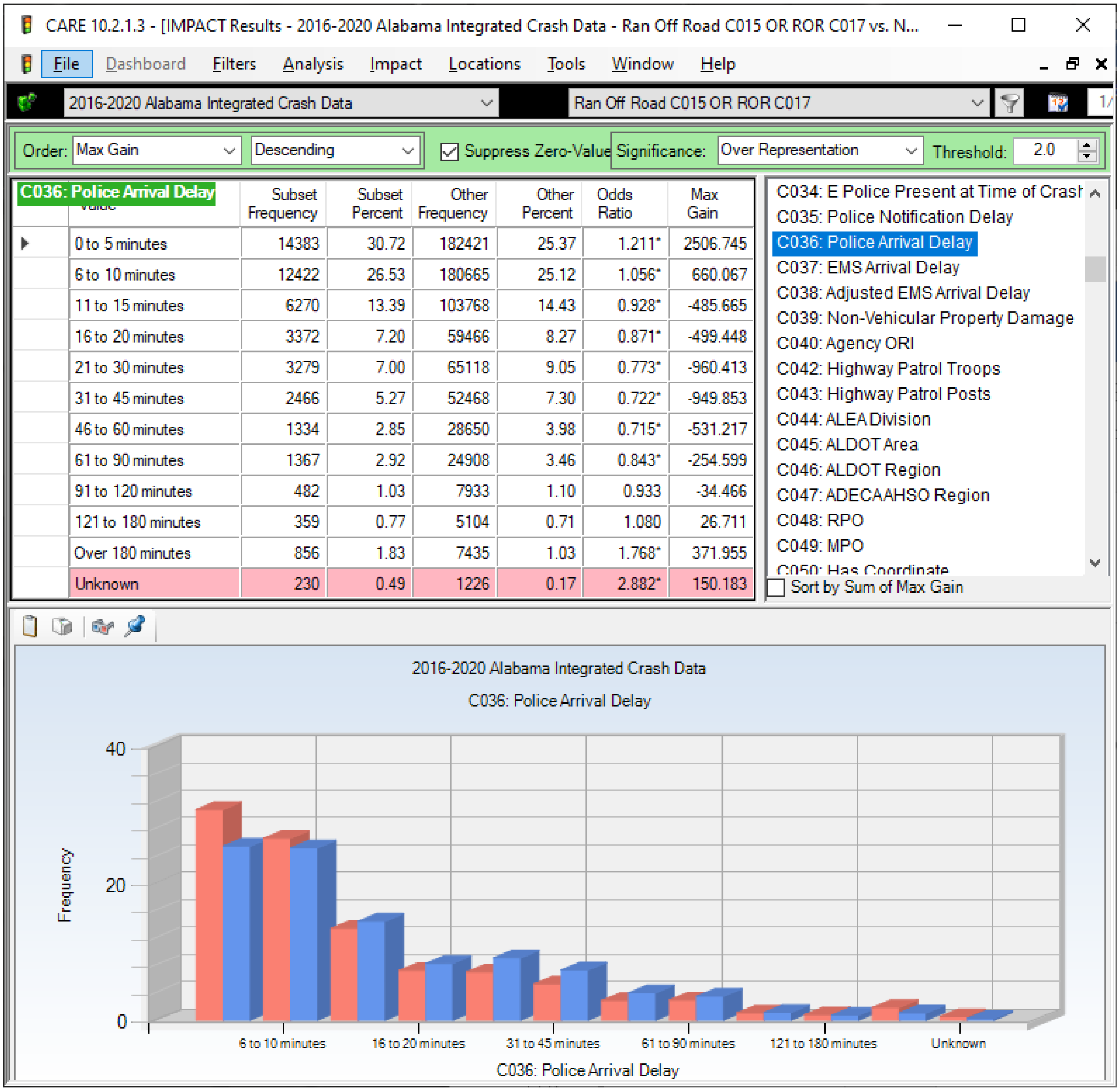
The following display presents a comparison of RS crash number of vehicles against number of vehicles in non-RA crashes over the five year time period of the study.



C052: Number of Vehicles Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	43755	93.45	120216	16.71	5.592*	35931.025
2 Vehicles	2599	5.55	556843	77.40	0.072*	-33641.8...
3 Vehicles	351	0.75	36393	5.06	0.148*	-2017.553
4 Vehicles	87	0.19	4840	0.67	0.276*	-228.000
5 Vehicles	17	0.04	825	0.11	0.317	-36.693
6 Vehicles	7	0.01	187	0.03	0.575	-5.170
7 Vehicles	2	0.00	57	0.01	0.539	-1.710
8 Vehicles	2	0.00	20	0.00	1.537	0.698

The above shows that the number of single vehicle RS crashes is over-represented by an Odds Ratio of 5.592 (proportion was close to six times more than expected). Over 9 out of 10 (93.45%) of the RS crashes were single vehicle. This would be expected when most of the crashes involved running off the road and crashing into something in the roadside environment.

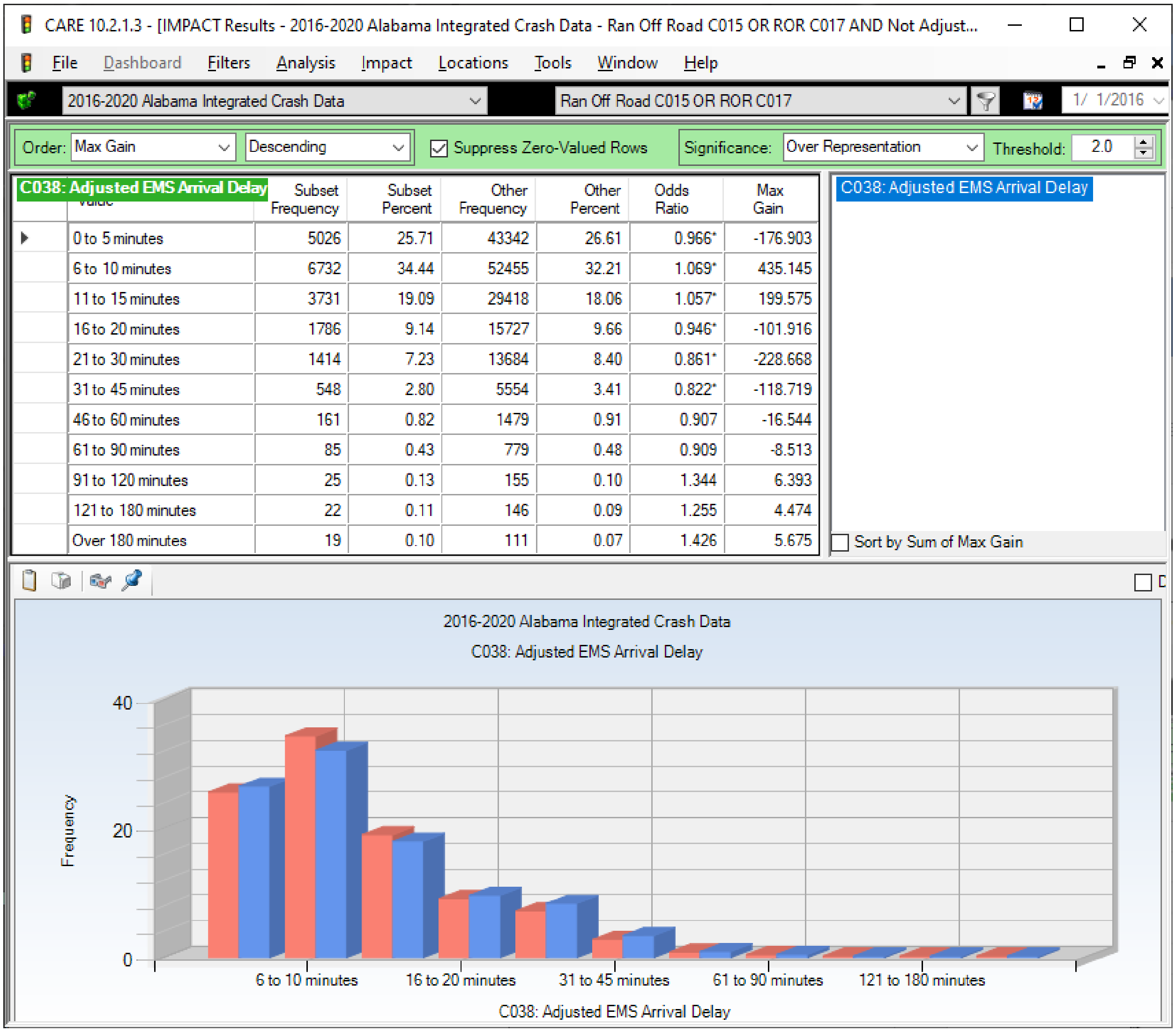
6.8 Police Arrival Delay



C036: Police Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	14383	30.72	182421	25.37	1.211*	2506.745
6 to 10 minutes	12422	26.53	180665	25.12	1.056*	660.067
11 to 15 minutes	6270	13.39	103768	14.43	0.928*	-485.665
16 to 20 minutes	3372	7.20	59466	8.27	0.871*	-499.448
21 to 30 minutes	3279	7.00	65118	9.05	0.773*	-960.413
31 to 45 minutes	2466	5.27	52468	7.30	0.722*	-949.853
46 to 60 minutes	1334	2.85	28650	3.98	0.715*	-531.217
61 to 90 minutes	1367	2.92	24908	3.46	0.843*	-254.599
91 to 120 minutes	482	1.03	7933	1.10	0.933	-34.466
121 to 180 minutes	359	0.77	5104	0.71	1.080	26.711
Over 180 minutes	856	1.83	7435	1.03	1.768*	371.955
Unknown	230	0.49	1226	0.17	2.882*	150.183

RS crashes police arrival delays were quite favorable, with the arrival time being ten minutes or less over 57% of the time. All arrival delays over 10 minutes were significantly under-represented. There can be little doubt that this has to do with the urban (or near-urban) nature of these crashes (77.77%, see Section 4.3). The analysis below shows how this impacts EMS arrival time, which is a comparison of only those crashes that included injuries, and thus would generally call for an EMS response.

6.9 EMS Arrival Delay

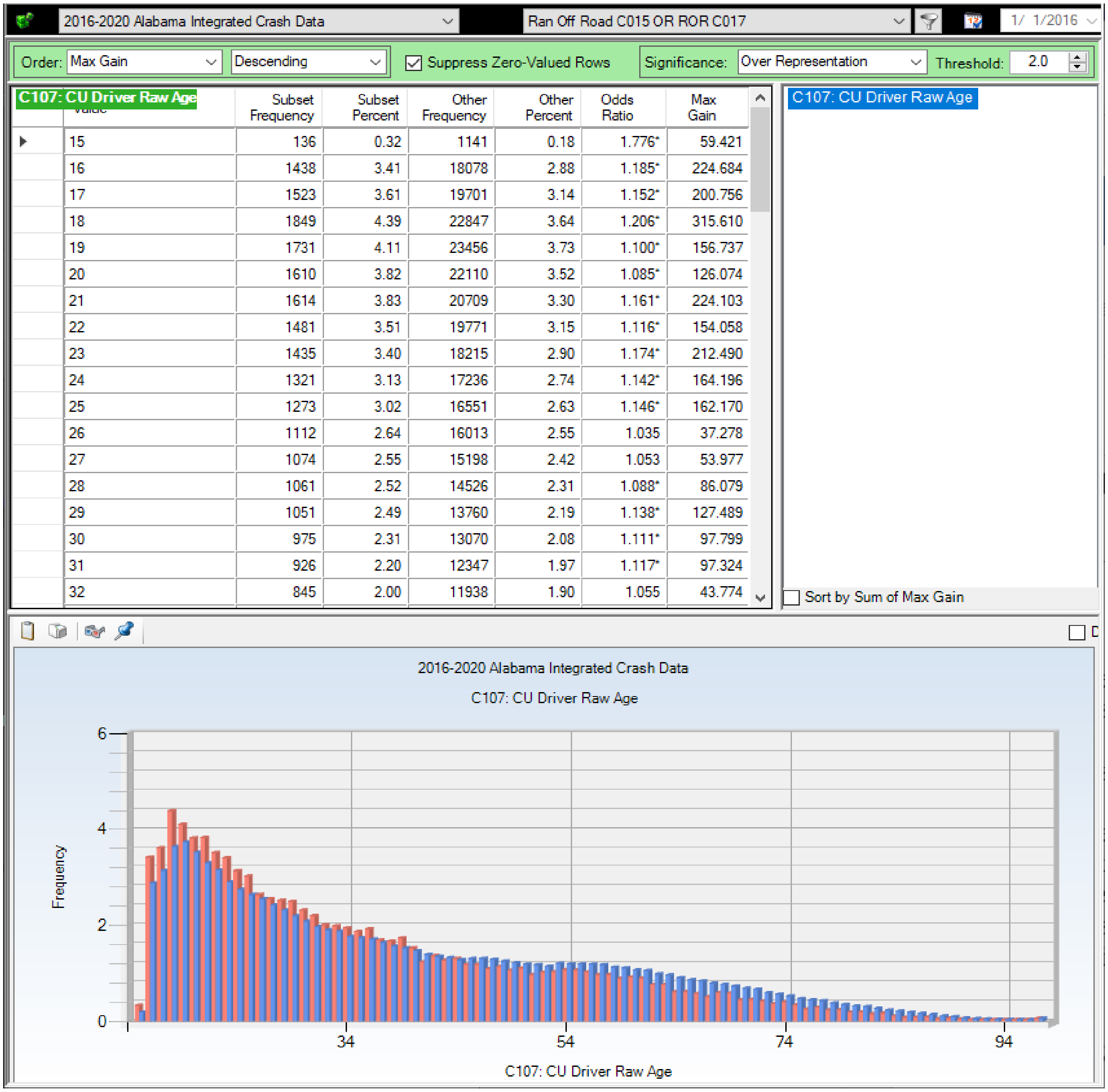


C038: Adjusted EMS Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	5026	25.71	43342	26.61	0.966*	-176.903
6 to 10 minutes	6732	34.44	52455	32.21	1.069*	435.145
11 to 15 minutes	3731	19.09	29418	18.06	1.057*	199.575
16 to 20 minutes	1786	9.14	15727	9.66	0.946*	-101.916
21 to 30 minutes	1414	7.23	13684	8.40	0.861*	-228.668
31 to 45 minutes	548	2.80	5554	3.41	0.822*	-118.719
46 to 60 minutes	161	0.82	1479	0.91	0.907	-16.544
61 to 90 minutes	85	0.43	779	0.48	0.909	-8.513
91 to 120 minutes	25	0.13	155	0.10	1.344	6.393
121 to 180 minutes	22	0.11	146	0.09	1.255	4.474
Over 180 minutes	19	0.10	111	0.07	1.426	5.675

For much the same reasons as the police arrival delays, EMS delays were significantly over-represented for Roadside (RS) crashes in the 6-10 and 11-16 minute categories. All longer delay times were under-represented up until the very high categories (91-120; 121-180; and Over 180 minutes). There were relatively few in these very long categories, which were probably caused by the vehicles not be discovered late night.

7.0 Driver and Vehicle Demographics

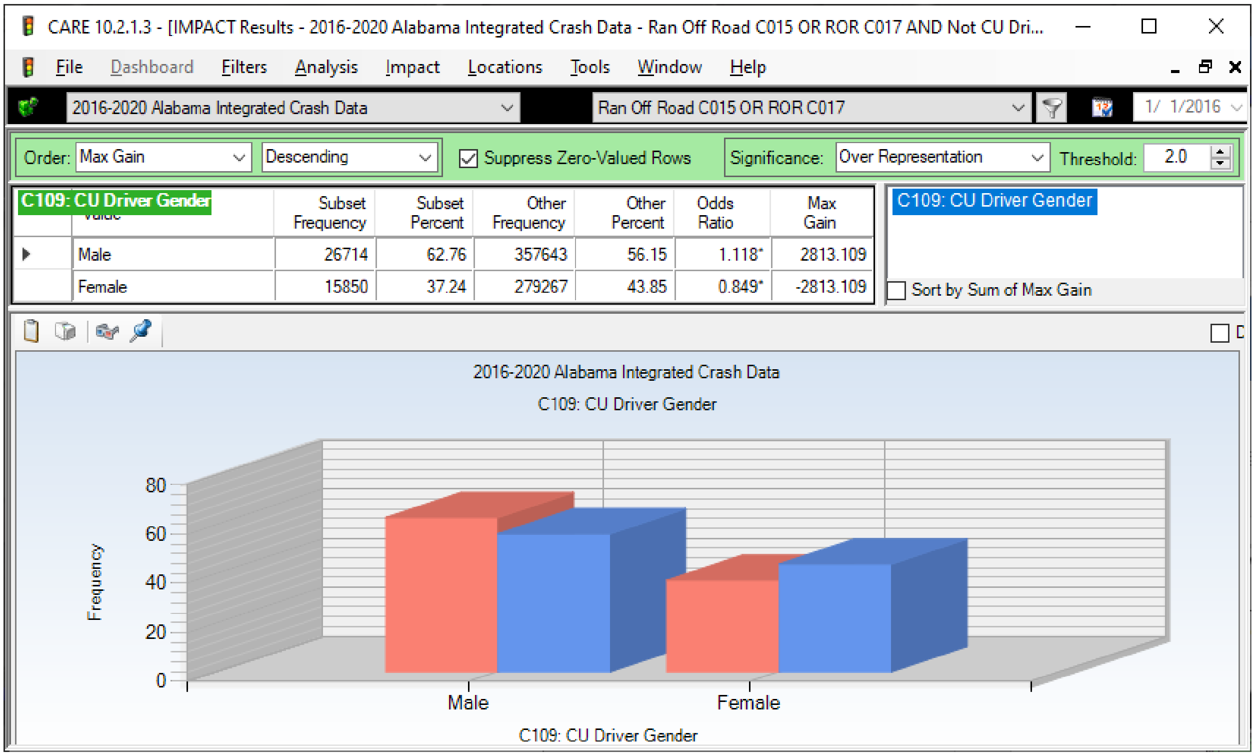
7.1 Driver Age



C107: CU Driver Raw Age Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
15	136	0.32	1141	0.18	1.776*	59.421
16	1438	3.41	18078	2.88	1.185*	224.684
17	1523	3.61	19701	3.14	1.152*	200.756
18	1849	4.39	22847	3.64	1.206*	315.610
19	1731	4.11	23456	3.73	1.100*	156.737
20	1610	3.82	22110	3.52	1.085*	126.074
21	1614	3.83	20709	3.30	1.161*	224.103
22	1481	3.51	19771	3.15	1.116*	154.058
23	1435	3.40	18215	2.90	1.174*	212.490
24	1321	3.13	17236	2.74	1.142*	164.196
25	1273	3.02	16551	2.63	1.146*	162.170
26	1112	2.64	16013	2.55	1.035	37.278
27	1074	2.55	15198	2.42	1.053	53.977
28	1061	2.52	14526	2.31	1.088*	86.079
29	1051	2.49	13760	2.19	1.138*	127.489
30	975	2.31	13070	2.08	1.111*	97.799
31	926	2.20	12347	1.97	1.117*	97.324
32	845	2.00	11938	1.90	1.055	43.774

The table display above presents a comparison of RS crash causal driver age against the same for crashes that were not RS for ages of 15 through 32. The blue (non-RC) bars illustrate the problems that 16-20-year-old drivers have in general, but the red bars show that they are even more over-represented in RS crashes. The target age groups would be up to about 39 years of age, with additional concentration in the 16-25-year-old group.

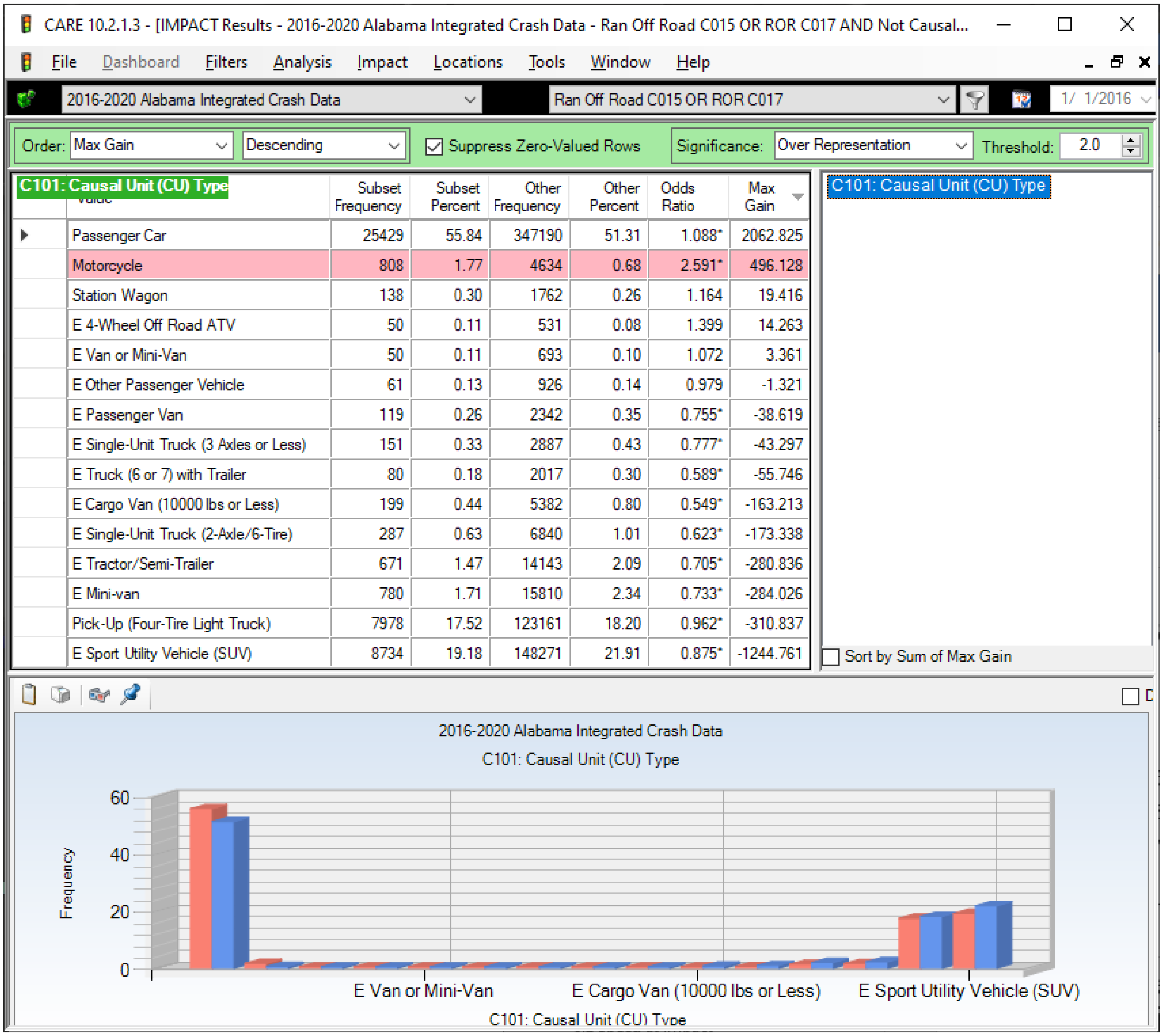
7.2 Roadside Crash Driver Gender



C109: CU Driver Gender	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Male	26714	62.76	357643	56.15	1.118*	2813.109
Female	15850	37.24	279267	43.85	0.849*	-2813.109

The red bars and the blue bars each sum to 100%. So the breakdown in RS causal drivers is 62.76% male and 37.24% female. For non-RC, the percentage is 56.15 male and 43.85 female, which also gives a good estimate for male/female drivers in general. These differences in proportions certainly indicate that males are a greater cause of the RS problems, and if there are countermeasures that can be directed toward them, doing so would be much more cost-effective than those directed toward all drivers, all other things being equal.

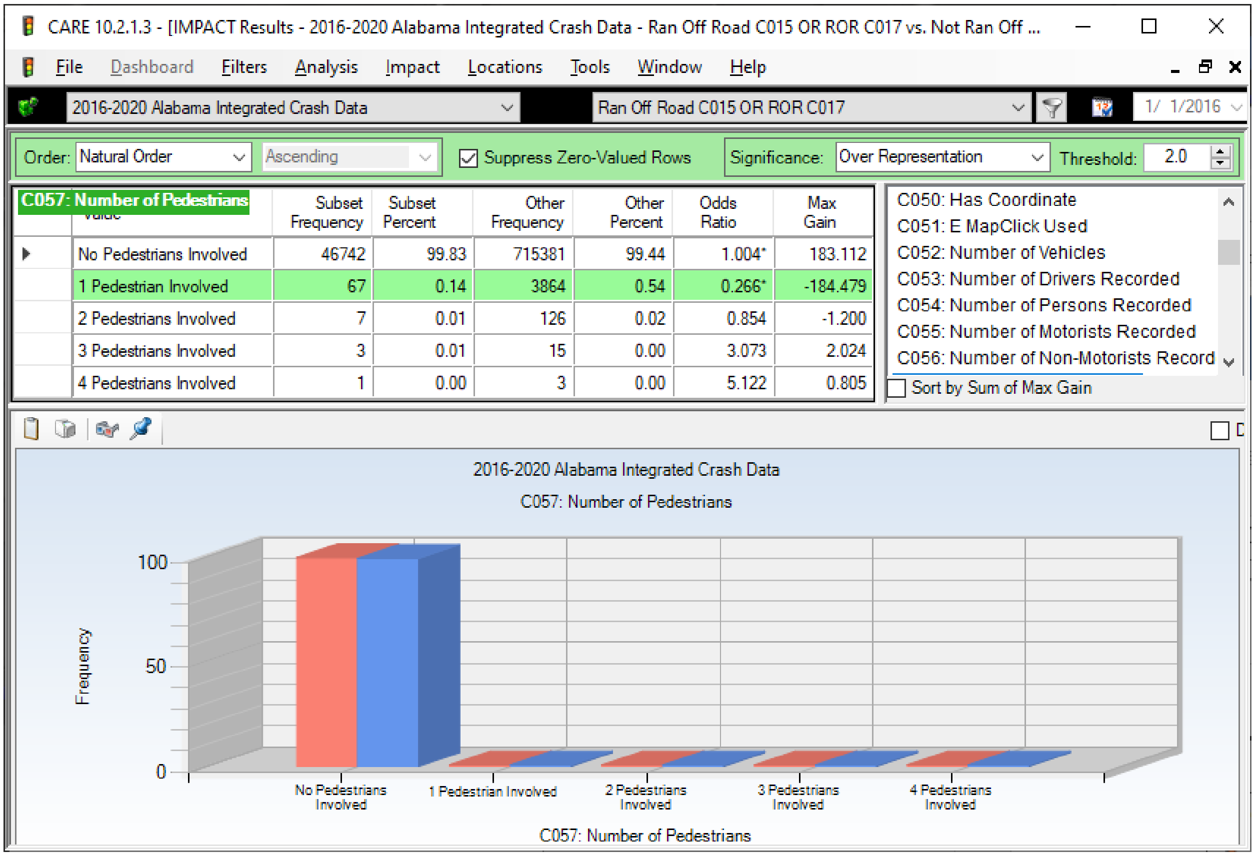
7.3 Causal Vehicle Types with 30 or more Crashes



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Passenger Car	25429	55.84	347190	51.31	1.088*	2062.825
Motorcycle	808	1.77	4634	0.68	2.591*	496.128
Station Wagon	138	0.30	1762	0.26	1.164	19.416
E 4-Wheel Off Road ATV	50	0.11	531	0.08	1.399	14.263
E Van or Mini-Van	50	0.11	693	0.10	1.072	3.361
E Other Passenger Vehicle	61	0.13	926	0.14	0.979	-1.321
E Passenger Van	119	0.26	2342	0.35	0.755*	-38.619
E Single-Unit Truck (3 Axles or Less)	151	0.33	2887	0.43	0.777*	-43.297
E Truck (6 or 7) with Trailer	80	0.18	2017	0.30	0.589*	-55.746
E Cargo Van (10000 lbs or Less)	199	0.44	5382	0.80	0.549*	-163.213
E Single-Unit Truck (2-Axle/6-Tire)	287	0.63	6840	1.01	0.623*	-173.338
E Tractor/Semi-Trailer	671	1.47	14143	2.09	0.705*	-280.836
E Mini-van	780	1.71	15810	2.34	0.733*	-284.026
Pick-Up (Four-Tire Light Truck)	7978	17.52	123161	18.20	0.962*	-310.837
E Sport Utility Vehicle (SUV)	8734	19.18	148271	21.91	0.875*	-1244.761

The display above presents a comparison of RS crash causal unit type against the same for crashes that were non-RS. Vehicles types with less than 30 crashes in the RS dataset were removed for the above display. Passenger Cars have the highest for potential crash reduction according to the Max Gain. However, Motorcycles have a much higher over-representation (2.591), indicating well over twice the expected proportion. None of the other classifications have significant over-representations, indicating that their proportions are about as expected. Some vehicles, notably Tractor/Semi-Trailers, Mini-vans, Pick-Ups and Sport Utility Vehicles (SUVs) were under-represented indicating their tendency to avoid RS crashes.

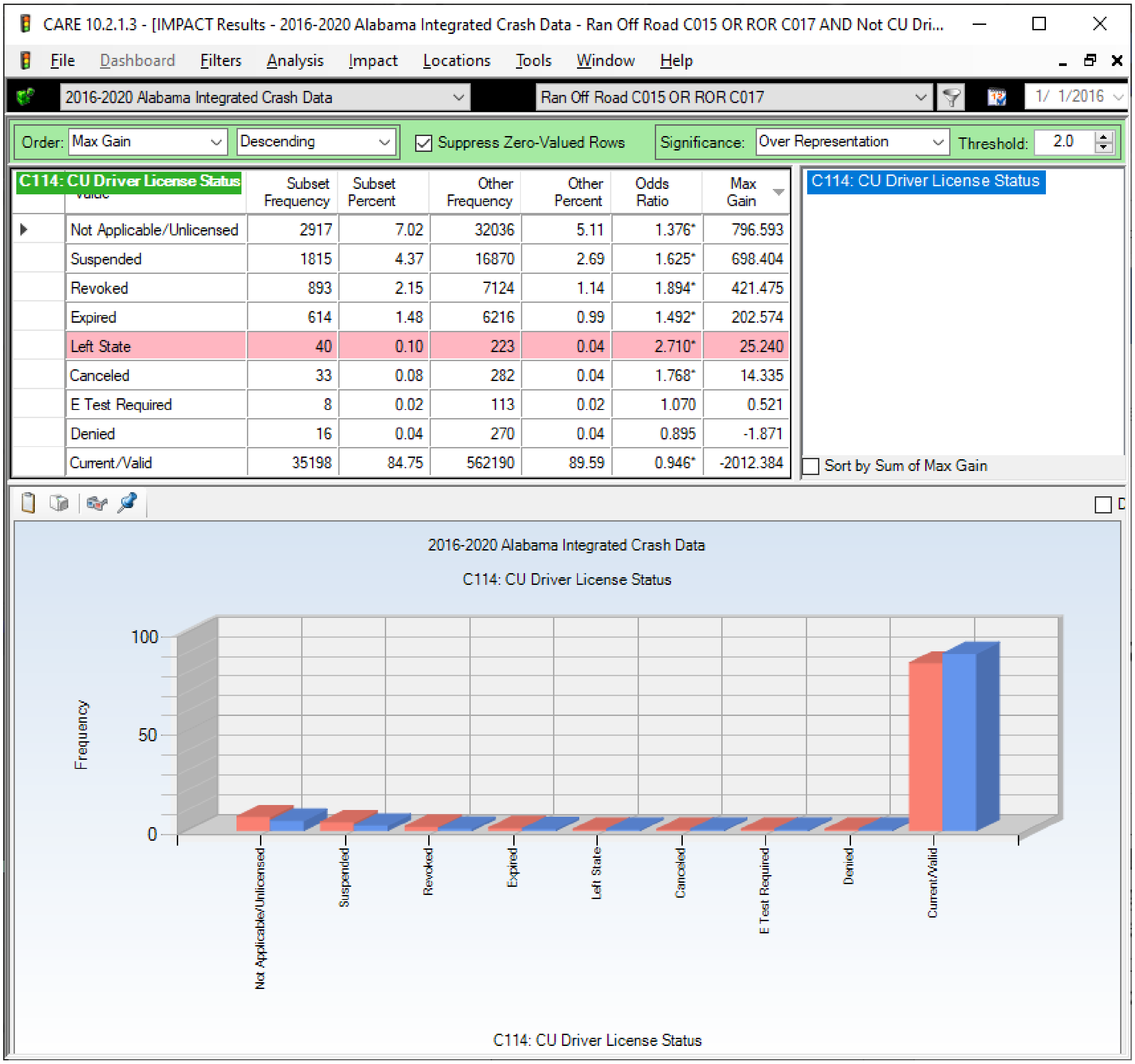
7.4 Number of Pedestrians



C057: Number of Pedestrians	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
No Pedestrians Involved	46742	99.83	715381	99.44	1.004*	183.112
1 Pedestrian Involved	67	0.14	3864	0.54	0.266*	-184.479
2 Pedestrians Involved	7	0.01	126	0.02	0.854	-1.200
3 Pedestrians Involved	3	0.01	15	0.00	3.073	2.024
4 Pedestrians Involved	1	0.00	3	0.00	5.122	0.805

Pedestrians are generally under-represented in RS crashes, indicating that most pedestrian crashes occur when pedestrians venture into the roadway. This positive finding may be useful in pedestrian countermeasures. Pedestrians need to be as far from the traffic stream as they can possibly be.

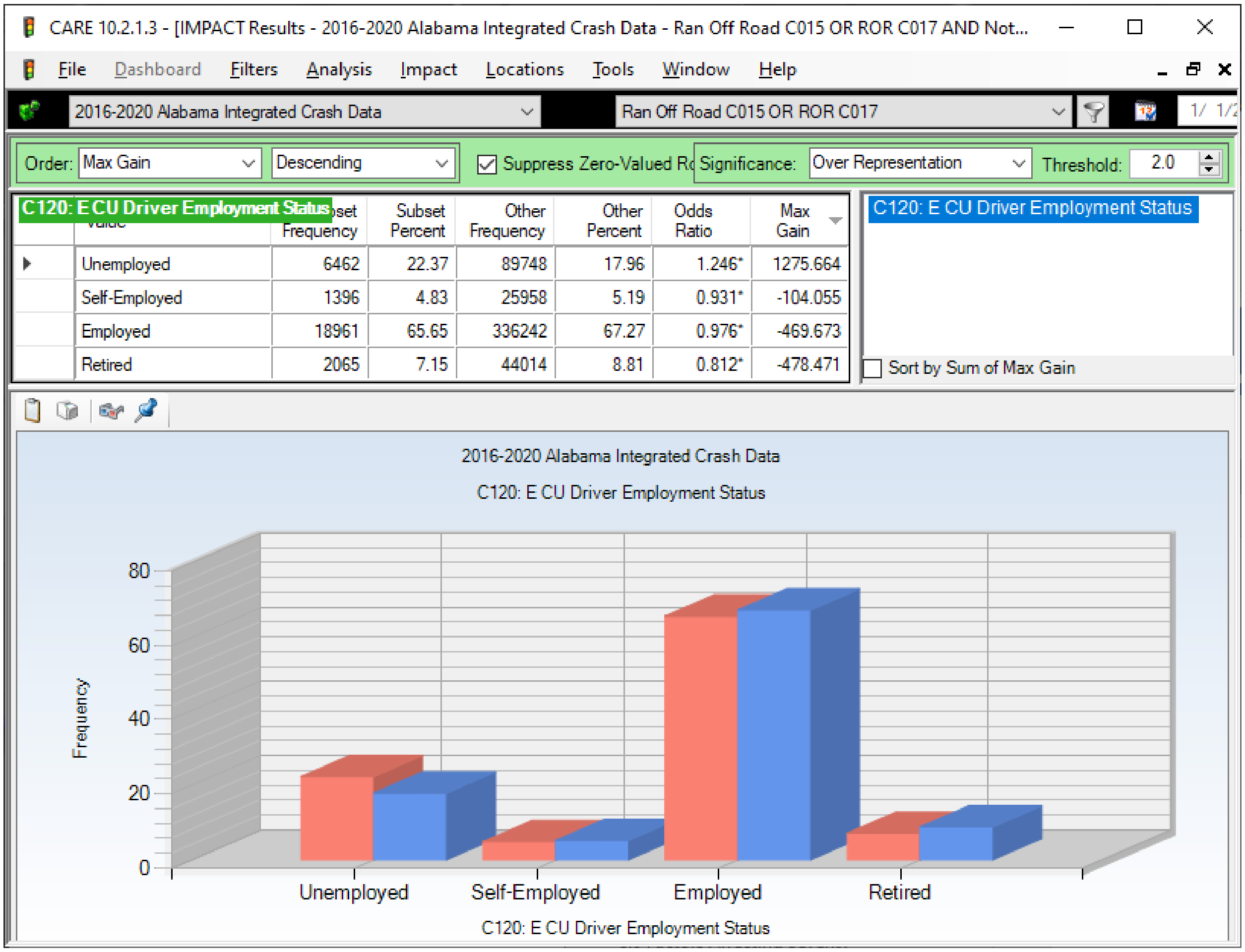
7.5 Driver License Status



C114: CU Driver License Status	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Not Applicable/Unlicensed	2917	7.02	32036	5.11	1.376*	796.593
Suspended	1815	4.37	16870	2.69	1.625*	698.404
Revoked	893	2.15	7124	1.14	1.894*	421.475
Expired	614	1.48	6216	0.99	1.492*	202.574
Left State	40	0.10	223	0.04	2.710*	25.240
Canceled	33	0.08	282	0.04	1.768*	14.335
E Test Required	8	0.02	113	0.02	1.070	0.521
Denied	16	0.04	270	0.04	0.895	-1.871
Current/Valid	35198	84.75	562190	89.59	0.946*	-2012.384

Clearly RS crashes are over-represented in RS causal drivers without legitimate licenses. They make up about 15% of RS causal drivers.

7.6 Driver Employment Status



C120: E CU Driver Employment Status	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Unemployed	6462	22.37	89748	17.96	1.246*	1275.664
Self-Employed	1396	4.83	25958	5.19	0.931*	-104.055
Employed	18961	65.65	336242	67.27	0.976*	-469.673
Retired	2065	7.15	44014	8.81	0.812*	-478.471

In our current era when the economy is playing such a big role in traffic safety, the quantification and tracking of the employment proportion of drivers involved in RS crashes is important. This indicates that their unemployment rate is about 24.6% higher than expected. This relationship is not surprising because of the underlying drug/alcohol root cause of many RS crashes (8.3-8.4). The correlation between not having a job and being involved in an RS crash should be watched carefully going forward in that it could affect the type and location for countermeasures.

8.0 Driver Behavior

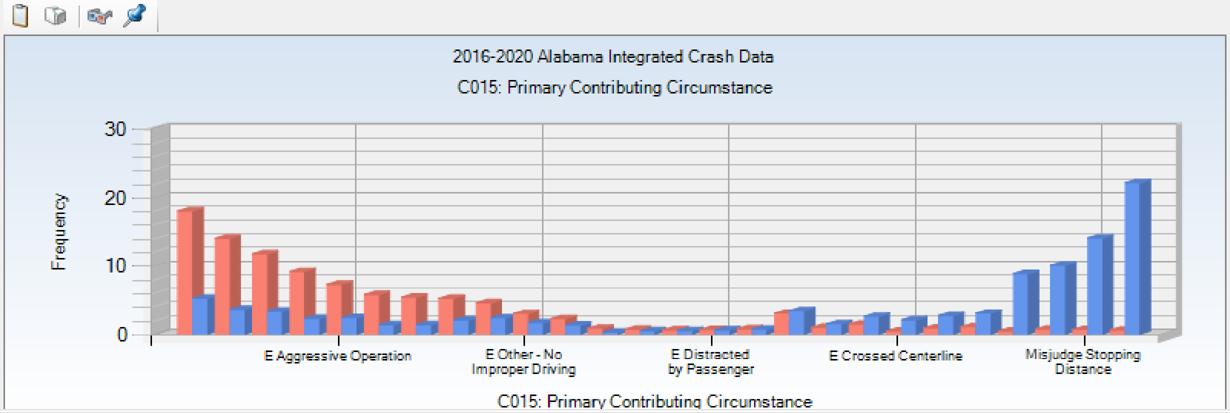
8.1 Primary Contributing Circumstances (RS & Items < 100 Crashes Removed)

2016-2020 Alabama Integrated Crash Data | Ran Off Road C015 OR ROR C017

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

C015: Primary Contributing Circumstance	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Driving too Fast for Conditions	4278	18.00	24862	5.21	3.455*	3039.852
DUI	3331	14.02	17246	3.61	3.878*	2472.135
E Swerved to Avoid Vehicle	2781	11.70	15847	3.32	3.524*	1991.807
E Fatigued/Asleep	2166	9.12	10844	2.27	4.011*	1625.960
E Aggressive Operation	1727	7.27	11306	2.37	3.067*	1163.952
E Over Correcting/Over Steering	1365	5.74	6377	1.34	4.298*	1047.420
E Swerved to Avoid Animal	1276	5.37	6520	1.37	3.930*	951.299
Over Speed Limit	1237	5.21	9702	2.03	2.560*	753.833
Defective Equipment	1084	4.56	11194	2.35	1.944*	526.530
E Other - No Improper Driving	710	2.99	7852	1.65	1.816*	318.964
E Distracted by Use of Electronic Communic...	530	2.23	6182	1.30	1.722*	222.131
E Swerved to Avoid Object	199	0.84	1242	0.26	3.217*	137.147
E Distracted by Fallen Object	170	0.72	2278	0.48	1.499*	56.554
E Distracted by Use of Other Electronic Devi...	140	0.59	2440	0.51	1.152	18.486
E Distracted by Passenger	157	0.66	2846	0.60	1.108	15.267
Vision Obstructed	182	0.77	3533	0.74	1.034	6.054
E Other Distraction Inside the Vehicle	722	3.04	16279	3.41	0.891*	-88.707
E Ran Stop Sign	234	0.98	7064	1.48	0.665*	-117.793
E Other Improper Action	342	1.44	12203	2.56	0.563*	-265.719
E Crossed Centerline	101	0.43	9853	2.06	0.206*	-389.687
E Other Distraction Outside the Vehicle	207	0.87	12838	2.69	0.324*	-432.343
Made Improper Turn	251	1.06	14536	3.05	0.347*	-472.904
Improper Lane Change/Use	103	0.43	42067	8.82	0.049*	-1991.9...
Unseen Object/Person/Vehicle	172	0.72	48008	10.06	0.072*	-2218.8...
Misjudge Stopping Distance	161	0.68	67063	14.05	0.048*	-3178.7...
Followed too Close	137	0.58	105462	22.10	0.026*	-5115.0...

☐ Sort by Sum of Max Gain



8.2 Discussion of Primary Contributing Circumstances (PCC) Result Above

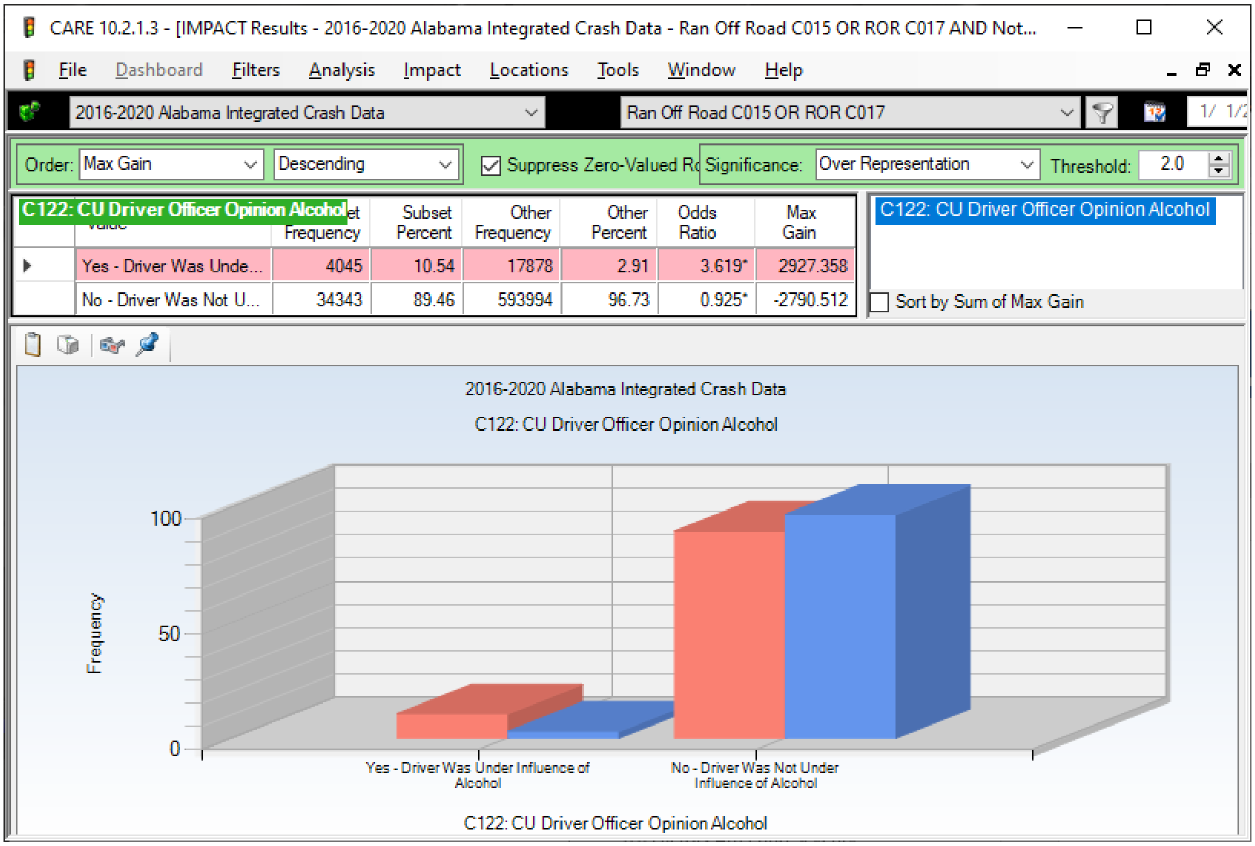
The RS PCC item, Ran off Road, (Frequency:17,282 ; Proportion: 36.91%) was removed from the comparisons for this analysis because it prevented some of the other items from being identified. It was forced to be this high by the filter (see 3.1). Items listed were reported for those RS crashes that were defined by other items in the RS filter. So, in essence, these results demonstrate the driver behaviors that *accompanied the RS* as it was defined by other attributes in the filter (i.e., C017, First Harmful Event). The display above is for those crash PCCs that had 100 or more occurrences.

Items over-represented by over twice their expected proportion (when compared to non-RS crashes) are ordered by Max Gain as follows:

- Driving Too Fast for Conditions,
- DUI (Impaired Driving),
- Swerved to Avoid Vehicle,
- Fatigued/Asleep,
- Aggressive Operation,
- Over Correcting/Over Steering,
- Swerved to Avoid Animal [most often deer]
- Over Speed Limit,
- Swerved to Avoid Object.

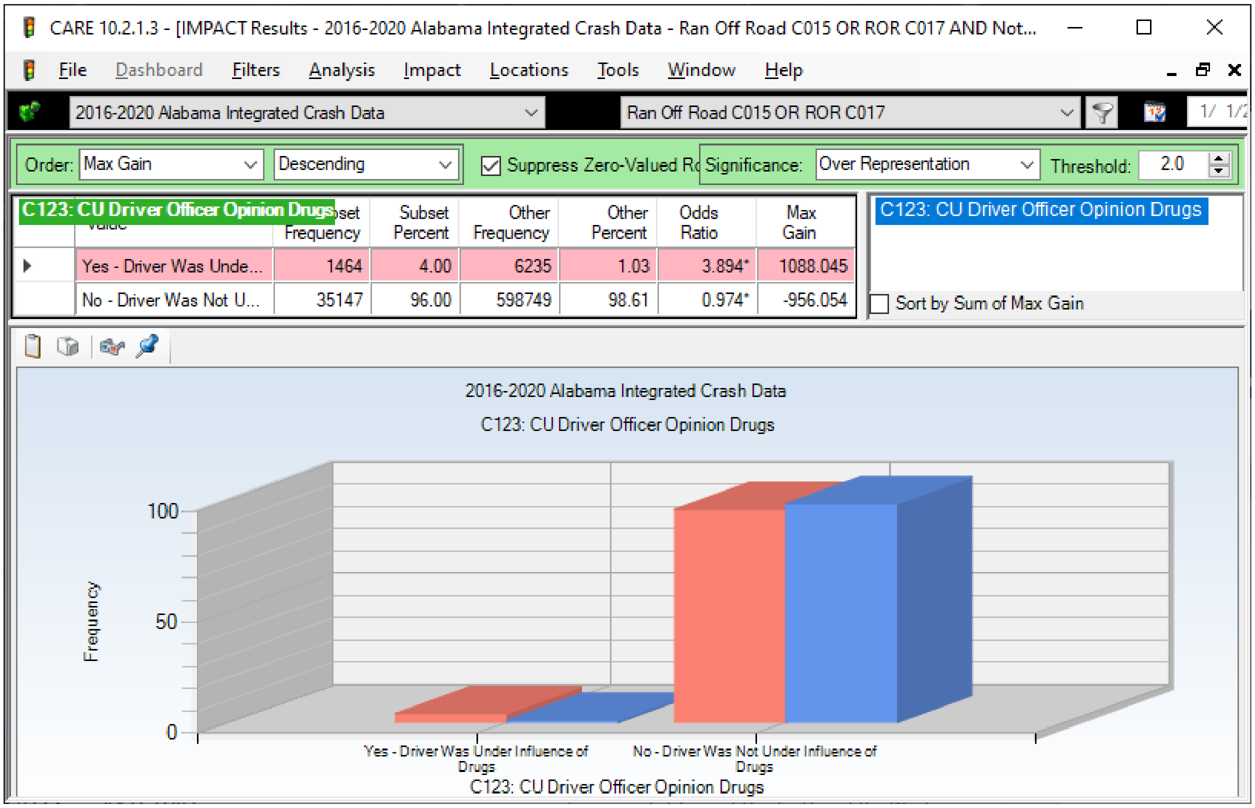
Most of the above are reasonably associated with running off the road. Each should be viewed in terms of their relative positions in the table as opposed to being the absolute cause.

8.3 CU Driver Officer's Opinion Alcohol



While Impaired Driving/Alcohol was indicated as the cause of the crash for only 10.54% of the RS crashes, the fact that this proportion was over-represented by a factor of 3.619 (close to 4 times the expected from the non-RS crashes indicates its importance. 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 RS crashes.

8.4 CU Driver Officer's Opinion Drugs



C123: CU Driver Officer Opinion Drugs	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Yes - Driver Was Unde...	1464	4.00	6235	1.03	3.894*	1088.045
No - Driver Was Not U...	35147	96.00	598749	98.61	0.974*	-956.054

The reported non-alcohol drug cases for RS crashes is less than half of that for alcohol. The 1,464 cases are only about 4.00% of all RS crashes. However, the Odds Ratio indicates that it has an over-representation comparable to alcohol. In both cases (RS and non-RS), drug use is difficult to detect compared to alcohol, which has well-established tests for the blood-alcohol level that are relatively easy to administer. Our conclusion is that both alcohol and non-alcohol drug use are major contributors to increasing the frequency of RS crashes, and their use is further compounded it they choose to avoid detection by using county roads.