Special Study
Collision with Trees IMPACT Study; Fatal vs Nonfatal Crashes

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Data Comparisons: CY2018-2022 Fatal Tree Collisions vs Non-Fatal Tree Collisions
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Table of Contents

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0.0 Introduction

Unless otherwise stated, this document presents the results of a comparison of Fatal Tree Crashes (FTCs) compared to Non-Fatal Tree Crashes (NFTCs) over a recent five-year period (CY2016-2020). The purpose of this comparison is to determine the cause and then reduce fatalities caused by tree crashes. This is different from most of the special IMPACT studies that have been performed, which have had the goal of reducing all of a particular type of crash regardless of severity. 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 Fatal Tree Crashes (FTC) than would be expected if its proportion were the same as that for the non-Fatal Tree Crashes (NFTC). That is, the NFTCs are serving as a *control* to which the Fatal Tree Crashes (FTCs) are being compared.

As an example, we found that FTCs for the Day-of-the-Week attribute value of Sunday had almost 30% higher proportion of crashes than did the NFTCs (Section 5.3; Odds Ratio = 1.278). When such differences are statistically significant (as in this case), this surfaces characteristics that should be given additional attention, and in some cases, further analyses are performed for countermeasure development. For example, additional selective enforcement for FTC causes (e.g., excessive speed) might be performed for Sunday and other days during times at which they have their highest over-representations. Unless otherwise stated, the output tables given above the charts are ordered by *Max Gain*. The *Max Gain* is the gain in FTC reduction that could be obtained if a countermeasure could be applied to reduce the proportion of the Fatal Tree Crashes (FTCs) to the proportion of non-Fatal Tree Crashes (NFTCs) within that particular attribute.

This report continues with two sections that provide a high-level summary of recommendations and findings for readers who just want an executive summary. These first two sections are called: (1) Recommendations, and (2) Summary of Findings. Section 3 is also introductory in that it provides a definition of the filters that were used to define Fatal and non-Fatal Tree crashes in the analytical sections that follow. After Section 3, the comparison between FTCs and NFTCs will be presented under the following headings, given here 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 sections of interest.

1.0 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 the more detailed IMPACT 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) Large Tree Removal from the Roadside, (2) Clear Roadside of Trees – Supporting Information, (3) Law enforcement concentration and direction, (4) Legal and judicial countermeasure development, and (5) PI&E information content on Fatal Tree crashes. The ordering of these recommendations, either generally or within their respective categories, is not meant to imply priority. 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 FTCs in Alabama:

- **Large Tree Removal from the Roadside**

  Sections 4.5a and 4.5b contain the analyses from which an optimal policy of large tree removal can be based. Counter to intuitions, the idea of getting rid of all tree that are very close to the roadside might be somewhat helpful, but it is not optimal. This is because most of the FTCs occur over 10 feet from the roadway. The following table shows how the cross-tabulation in Section 45b translates into the probability of a tree strike being fatal as a function of the distance of the tree strike off the roadway edge.

Crashes; Tree Removal Distance from Roadway	Probability of Fatal Crash
27; 8+ to 10 feet	1197/27 = one in 44.3
77; 10+ to 15 feet	2035/77 = one in 26.4
74; 15+ to 20 feet	1734/74 = one in 23.4
42; 20+ to 25 feet	1281/42 = one in 30.5
37; 25+ to 30 feet	1024/37 = one in 27.7
42;30+ to 40 feet	899/42 = one in 21.4
30; 40+ to 50 feet	743/30 =one in 24.7
53; Over 50 feet	1052/53 = one in 19.8

While the probabilities of the crash being fatal generally increase with the distance from the roadway, the distribution is anything but uniform. This should not be interpreted that if we do not clear the roadside as wide it will lead to fewer FTCs. On the contrary, the impact speed would be expected to be larger to take the vehicle further from the roadway before impact. The following table gives the probabilities of the crash being fatal for the range of impact speeds.

Crashes; Speed at Impact to Tree	Probability of Fatal Crash
59; 51 to 55 MPH	2325/59 = one in 39.4
48; 56 to 60 MPH	1185/48 = one in 24.6
56; 61 to 65 MPH	1071/56 = one in 19.1
63; 66 to 70 MPH	1031/63 = one in 16.3
34; 71 to 75 MPH	278/34 = one in 8.2
27; 76 to 80 MPH	186/27 = one in 6.9
12; 81 to 85 MPH	57/12 =one in 4.8
16; 86 to 90 MPH	57/16 = one in 3.6

To obtain an optimal tree-clear roadside, it will be necessary to combine the numbers in these two tables along with the costs involved in tree removal. Since this also has to involve costs of fatality reduction in other types of crashes, this more detailed analysis is beyond the scope of this study. However, most of the data required for such an optimization is available here.

- **Clear Roadside of Trees – Supporting Information**
    - **Grade and Curvature.** Special emphasis in roadway clear zones should be given to: (1) left curves level and downgrade; (2) right curves level and downgrade; and (3) left and right curves and upgrades. See Section 4.8, which puts grade and curvature in Max Gain order.
    - **Advisory Speed Limits.** 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 Tree crashes is caused by their comparatively high impact speeds (6.1, 6.2) coupled with a failure of these drivers and their passengers to use restraints (6.5, 6.6). New approaches to increase the effectiveness of law enforcement methods are required 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 Tree crashes are caused by Impaired Driving (ID), all of the ID countermeasures (given in Sections 8.3 and 8.4) should be increased. Hotspot analyses should be performed to determine locations where Tree crash selective enforcement will be most effective.

- More effective drug detection techniques (8.4) should be identified, and law enforcement officers need increased training in their use. This is true of reducing all types of ID-caused crashes.
- Law enforcement training to reduce FTCs should focus 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) Tree crash 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 Tree crash 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 localized 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 Tree crashes (4.2) should be given special guidance and perhaps additional funding to address their Tree crash problems. Many such large city areas have a considerable amount of Open Country (4.6) that would tend to multiply their Tree crash severity.
- Additional hotspot analysis needs to be done to surface FTC those County Roads (4.5), which account for their overall 3.671 times the NFTC proportion (247 fatal crashes), in order to focus law enforcement presence on these roads. It is possible that impaired causal drivers may be using the county roads in attempts to avoid being apprehended.
- Additional emphasis needs to be given to the recognized Tree-crash over-represented days of Saturday and Sunday (5.3). Consideration on holidays should be given to the number of persons not working on a given day, who might over-indulge in alcohol or other drugs the night (and early morning) before (5.3-5.4) their days off.
- 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 of unemployment 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 Tree

crashes and unemployment is not surprising because of the underlying drug/alcohol root cause of many FTCs (8.3-8.4). The correlation between not having a job and being involved in a FTC should be watched carefully 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 FTCs directly, (8.3-8.4) the fact that they are over-represented is an indication that this could be a cause since the presence of drugs/alcohol often do not reach the reporting threshold, especially in cases involving prescription drugs.

- **PI&E Information Content on Fatal Tree 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 close to four times (3.671) more FTCs than NFTCs. The promotion of using Interstates is good, but this should also contain warnings against speeding.
  - One of the most critical needs to prevent fatalities is for the drivers and their passengers to buckle up (6.6). There is much less hope of surviving a crash if this is not realized, since the odds of death increases over seven times, from one in 68.6 to one in 9.4.
  - While clearly the problems found in this study are those of striking large trees, other driver behaviors (8.2) that are correlated with FTCs might provide alternatives for complimentary countermeasure development. These behaviors are:
    - Over Speed Limit,
    - DUI (Impaired Driving),
    - Ran off Road,
    - Aggressive Operation, and
    - Crossed Centerline.

    These were the Primary Contributing Circumstances that were over-represented in FTCs.

2.0 Summary of Findings

Note: subsection numbers 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 FTCs vs NFTCs over all five years (CY2018-2022):

- **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-speed and low- severity crashes that occur there that are separate and apart from Tree crashes. See the rural-urban comparison below (4.3). Placed in Max Gain order, the counties with the highest potential for reduction in expected proportions were: Blount, Walker, St. Clair, Limestone, Montgomery and Morgan. [Terminology: *Expected proportion* (AKA *expectation*) of FTCs here and below are obtained from the comparison of FTCs with the proportion for their corresponding NFTCs.]
  - City Comparisons of FTCs to NFTCs, viewing rural areas of counties as separate cities, i.e., virtual cities (4.2). 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 ten or more FTCs. The county rural areas (virtual cities) with Max Gains in excess of five FTCs over their expected numbers are: Rural Blount, Rural Walker, Rural St. Claire, Rural Mobile and Rural Morgan.
  - 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 FTCs 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 – email brown@cs.ua.edu.
  - Rural/Urban Fatal Tree Crash Proportion (4.3) – FTCs occurred in 85.39% rural and 14.61% urban areas. These differences between the Fatal and NFTCs are statistically significant in both the rural (over-represented) and the urban (under-represented) areas.

- Severity of Crash by Rural-Urban (4.4) – 85.39% of the FTCs occurred in rural areas, while those in the urban areas, while only 14.61% of the FTCs occurred there. Similar results were found for the highest severity non-Fatal crashes (Suspected Serious Injury). This seems clearly the result of higher travel speeds (and thus impact speeds) in the rural areas. Note that additional causes of increased severity are given in the Factors Affecting Severity, see Section 6, below.
- Highway Classifications (4.5) – County roads had a proportion of FTCs that was about four (3.671) times higher than their expected proportion of crashes (as given by the NFTCs). State routes had about 20.5% (odds ratio 1.205) more FTCs than expected. All other roadway classifications were under-represented. County road characteristics no doubt contribute to the crash frequency (see Section 4.4). County roads are also known to be less "crashworthy" (i.e., they result in more severe crashes at comparable impact speeds). Also, their potential remote locations tend to make EMS delay times longer.
- Distance to fixed Object (4.5a). Generally, those collisions in excess of 10 feet had higher speeds at impact (see Section 6.2). If speed were not a factor in those crashes involving longer distances to the tree, then clearing the roadside out to 20 feet would cause a major reduction in FTCs (avoiding 211 fatal crashes).
- Tree Crash Severity by Distance to Fixed Object (4.5b). This cross-tabulation should be extremely useful to engineers who are responsible for improving the safety of the roadside. The over-represented cells from 30+ to 40 feet through "Over 50 feet" indicates that clearing the roadside up to 30 feet may not be as effective as clearing it another 20 feet (up to 50 feet). The higher severities of the tree strikes over 30 feet are indicative of the higher speeds needed to attain these longer distances from the roadway before impact.
- Locale (4.6) – Open Country FTCs show a high level of over-representation (2.977 Odds Ratio) as compared with the more urbanized area types, especially Residential, which only has a little over a third (0.390) of its expected proportion.
- Most Harmful Event (4.7) – ordered by frequency. The following items had the largest number of fatality occurrences in the five years:

Collision with Tree	396
Overturn/Rollover	36
Fire/Explosion	32

  Overturned/Rollover was a distant second with 36 Fatal crashes and an odds ratio of 2.668. This was followed by Fire/Explosion. After that, the frequencies and/or over-representations fell off dramatically.
- Roadway curvature and Grade (4.8). FTCs are dramatically over-represented on all most curve 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 probably because the vehicle making a left curve is closer to the roadside. Level and down grades are more of a problem than up-grades.

- **2.5 Time Factors (5.0)**
    - Year (5.1) – The years 2019 and 2022 were over-represented, but not significantly so. There seems to be no pattern either in FTCs or the NFTCs over the five years.
    - Month (5.2) – The highest FTC over-representations by month were in June (1.145), and July (1.215), but these were not statistically significant. The number of FTCs correlated fairly well with NFTCs, although April and August were noticeably 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 (ID). Since many Tree crashes are caused by ID, that would create this distribution for FTCs 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 these roads are in any way deficient in design. Assuming that a significant number of Tree crashes are caused by ID, the days can be classified as follows:
        - Typical work weekday (Monday through Thursday) – these days are under-represented in FTC crashes due to the need for many users to go to work the following day. Wednesday was the only statistically significant under-representation.
        - Friday – this pattern is also reflected in the day before a weekend (or holiday), i.e., before a day off. The relatively high FTC 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 NFTC crashes on Fridays causes Friday to be not statistically significant in its over-representation. The only day that had a significant over-representation was Sunday.
        - Saturday – the "Saturday" pattern is the worse for FTCs in that it has both an early morning component (like Sunday) and a late night component (like Friday). While it had the highest FTC frequency (96), its proportion was still not statistically significant.
        - Sunday – since this is the last day of a holiday or weekend sequence, 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 close to 30% (1.278) above its expected number of FTC crashes.

- “Holiday Weekends” (5.4-5.7) – these can be viewed as a combined 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 all types 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. Qualifier: in the past decade the over-representation of Wednesdays before Thanksgivings has been reduced by the number of travelers leaving earlier that week.
- Time of Day (5.5-5.6) – The extent to which night-time hours are over-represented is quite striking. Optimal times for FTC enforcement would start immediately following any rush hour details, and would continue through at least 2:00 AM to 2:59 AM (odds ratio 2.073). Some of the late-night FTCs 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 Fatal Tree crash concentrations on Fridays, Saturday mornings and nights and early Sunday mornings and Sunday Evenings. This is a very useful summary for deploying selective enforcement details, especially during the weekend hours.

- **2.6 Factors Affecting Severity (6.0)**
  - FTC Crash Severity (6.1) -- The rate of injuries and fatalities are consistently higher in Tree crashes than that in non-Tree crashes. Fatality crashes are nearly 5.976 times their expected proportion, while the next two highest non-Fatal injury classifications have 4.375 and 2.252 times their expected proportions, respectively when compared with non-Tree crashes.
  - Speed at Impact (6.2) – All impact speeds above 56 MPH are over-represented with most Odds Ratios indicating statistically significant. The over-representations of FTCs increase, as expected, with increased speeds with 56-60 MPH having an odds ratio or 1.292, while 96-100 MPH being 18.830. 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).
  - C224 Speed at Impact vs. C021 Distance to Fixed Object (6.2a). All of the number in this cross-tabulation are for FTCs. The major question here is: to what extent will a clear roadside reduce FTCs? The problem is that the wider distances are generally the result of higher speeds, which result in a higher proportion of fatal crashes. The determination of an optimal clearance width is an important

and useful objective. It will require that costs be involved, since the length of the clear roadside is as important as its width.

- Severity by Impact Speed (6.3-6.4) for various Highway Classifications. 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. This discussion was given in the 1.0 Recommendations (section), LARGE Tree Removal from the Roadside subsection).
- Restraint Use by Fatal Tree Crash Causal Drivers (6.5) – The FTC unrestrained occupants are over 17 (17.72) times more likely to be killed than the FTC passengers who are properly restrained. Clearly drivers involved in FTCs lose a good part of their concept of risk when they drive impaired and/or at speeds that result in running off the road and hitting a tree.
- Cross tabulation: Crash Severity by Restraint Use (C323) for All Tree Crashes. A comparison of the probability of a fatal crash indicates that a fatality is about 7.3 times more likely if the involved driver is not using proper restraints. Generally, one in 68.6 crashes are fatal if restraints are used; but without restraints, the fatal crash ratio is 1 in about 9.4 crashes, an increase in probability by well over seven 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 Tree crashes.
- Number of Vehicles Involved (6.7) – the number of single vehicle FTCs is over-represented by an Odds Ratio of 4.600 (proportion was close to five time more than expected). Over 9 out of 10 (99.16%) of the FTCs were single vehicle crashes. This is expected since most of the crashes involved running off the road and crashing into a tree as opposed to crashing into another vehicle.
- Police Arrival Delay (6.8) – Generally, the police response times to FTCs was not favorable. Arrival delays were quite comparable between those that were Fatal and non-Fatal., with the arrival time being ten minutes or less only about 14% to 16% of the time. All arrival delays over 15 minutes were over-represented. There can be little doubt that this has to do with so many of them occurring in rural areas (see Section 4.3).
- EMS Arrival Delay (6.9) – For much the same reasons as the police arrival delays, EMS delays were significantly over-represented for all Tree crashes in the 21-30 and 31-45 minute categories. There were relatively few in these very long categories, which were probably caused by late night single-vehicle crashes not being immediately discovered.

- **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 16 through 39 are all above the average for all other ages, although the Odds Ratios tend to drop off above the age of 23. Drivers tend to be under-represented in most crash types above the age of 43. However, the most over-represented age interval for FTCs is from 50-64, which can be seen in both the table and the chart.
- RS Crash Driver Gender (7.2) – the breakdown in FTC causal drivers is 78.29% male and 20.88% female. For non-Fatal Tree cashes, the percentage is 59.57 male and 32.21 female, which also tends to be a good estimate for male/female crash causes in general. These differences in proportions certainly indicate that males are a greater cause of the problems of FTCs, and if there are countermeasures that can be directed toward males, this would be much more cost-effective than those directed toward all drivers, all other things being equal.
- Cross-tabulation of Driver Gender by Speed at Impact (7.3). To get better insight into the reason for male drivers being in more FTCs, this analysis shows that males had impact speeds in excess of the 70 MPH speed limit in 24.23% of their fatal crashes, while comparable speeds for females was only at 15.05%.
- Causal Vehicle Type (7.4) – This analysis was based on a comparison of FTC causal unit type against the same for NFTCs. Motorcycles have the highest over-representation (Odds Ratio 8.345) and Max Gain (13.203), indicating well over 8 times their expected proportion in comparison with the NFTC subset. This reflects the general vulnerability of motorcycle driver/passengers for all crashes in which they are involved. The other vehicle types with over-representations, in order, are Tractor/Semi Trailer, 4-Wheel Off Road ATVs and Minivans. Some vehicles, notably Pick-Ups and Sport Utility Vehicles (SUVs) and Passenger Cars were under-represented indicating their tendency to avoid serious Tree crashes.
- Driver License Status (7.5) – FTCs are significantly over-represented in being caused by drivers without legitimate licenses. About 21.72% of the Fatal Tree crash 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 (35), Unlicensed (40), Revoked (24), and Expired (814).
- Driver Employment Status (7.6) – 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 all types of crashes is important. This analysis indicated that the employment rate for the FTCs was about 31.32%, while that for NFTCs was 47.90%. This relationship is not surprising because of the underlying drug/alcohol root cause of many Tree crashes (see Sections 8.3-8.4). The correlation between not having a job and being involved in a Tree crash should be watched carefully going forward in that it could affect the type and location of

countermeasures, and also to determine if there is some countermeasure that could be implemented in conjunction with their unemployment payments.

- **2.8 Driver Behavior (8.0)**
  - Primary Contributing Circumstances – PCC (8.1 and 8.2) While clearly the problems found in this study are those of Tree strikes, other driver behaviors that are correlated with Tree crashes might provide alternatives for countermeasure development. Those behaviors that had over 50% more than their expected PCC proportion for FTCs when compared to NFTCs are:
    - Over Speed Limit
    - Impaired Driving (DUI)
    - Ran Off Road
    - Aggressive Operation
    - Crossed Centerline
    - These were the Primary Contributing Circumstances that were at least 50% higher than expected in their over-representations.
  - CU Officer's Opinion Impaired Driving – Alcohol (8.3). We saw ample evidence for Tree crashes being caused by Impaired Driving (ID) in the time of day and day of the week attributes. The two ID attributes (C122 and C123) indicate the degree that ID was involved in Tree crashes as opposed to non-ID crashes. For alcohol, the proportion of ID crashes was 2.260 times as many for FTCs as for NFTCs. For drugs this multiplier was even greater at 2.888. This was sufficient to verify that the Fatal Tree crash time over-representations reported above, were correlated very closely with ID.

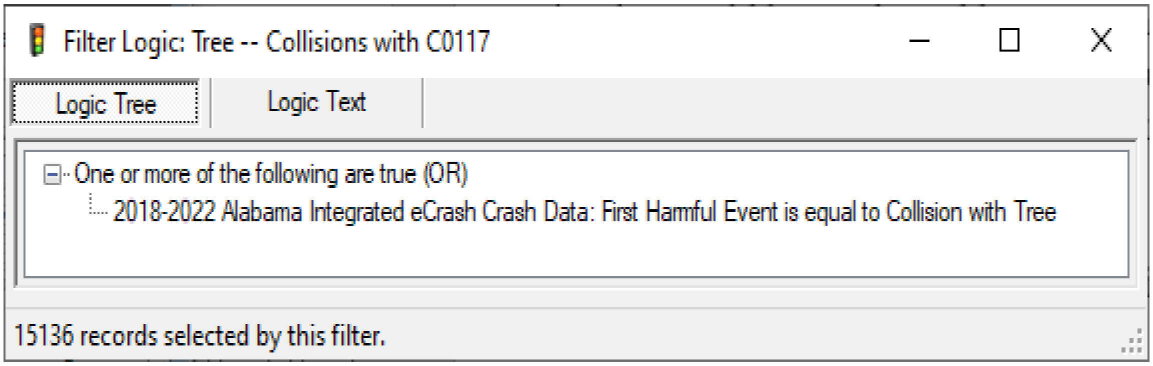
3.0 Tree Crashes CY2018-2022 (Fatal vs Non-Fatal)

As part of the ongoing Alabama Department of Economic and Community Affairs (ADECA) problem identification efforts, UA-CAPS and ATI compared FY2018-2022 Fatal Tree Collisions crashes against non-Fatal tree collisions over this same 5-year time period. The objective was to determine all significant differences between these two subsets of data in order to get an improved understanding as to the fatality crash causes (who, what, where, when, how and causal driver demographics). This was accomplished by pinpointing common factors and assess strategies that could be used to address any major inconsistencies between these two subsets of crash data. The findings that are presented should be taken into consideration when planning the large variety of countermeasures that exist to reduce both the frequency and the severity of Tree crashes.

This preliminary section of the report will contain some information that will be good in obtaining an overall orientation toward the IMPACT results that will follow.

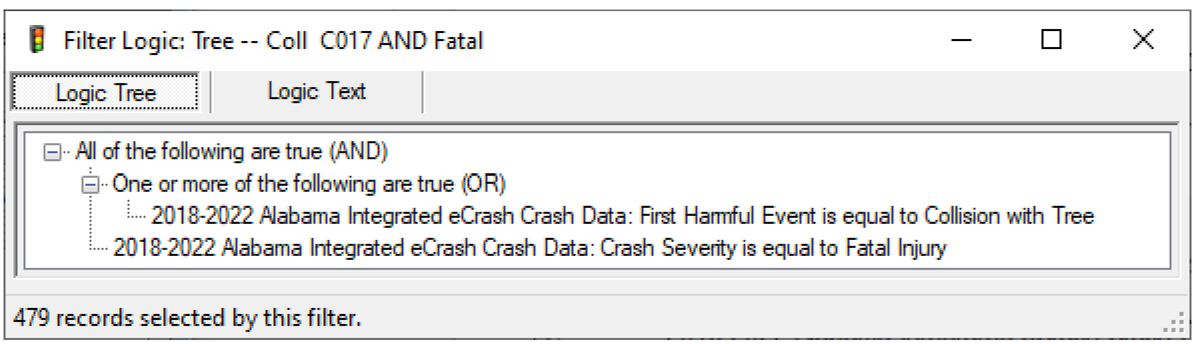
3.1 Filter Definitions (All Tree, Fatal Tree, and Non-Fatal Tree)

The following is the formal filter definition for all Tree crashes:

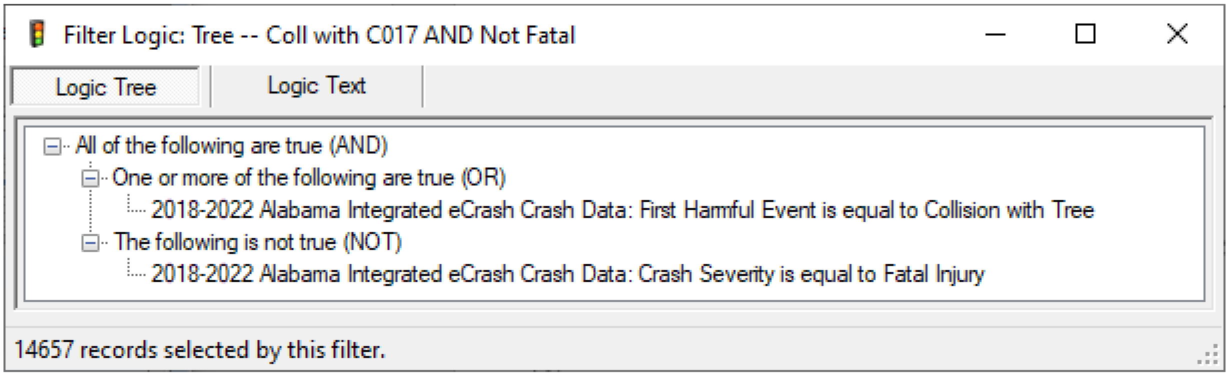


This formalizes the definition of the crashes in the Tree subset of crash reports being considered here. IMPACT will only use this subset when needed. For the most part it will be comparing FTCs against NFTCs using the following filters:

Fatal Tree Crashes (FTCs):



Non-Fatal Tree Crashes (NFTCs):



Using the filters above, the next sections will get an overall introduction to the crash and/or fatality effects before getting into the IMPACT details.

3.2 Overall Tree Crashes by Year 2018-2022 Data

Before analyzing the Tree subsets, it is good to get a feel for their overall difference in the crash frequencies by severity over recent years. The following table gives a comparison of all tree crashes (fatal and non-fatal) in the CY2018-2022 time frame by severity.

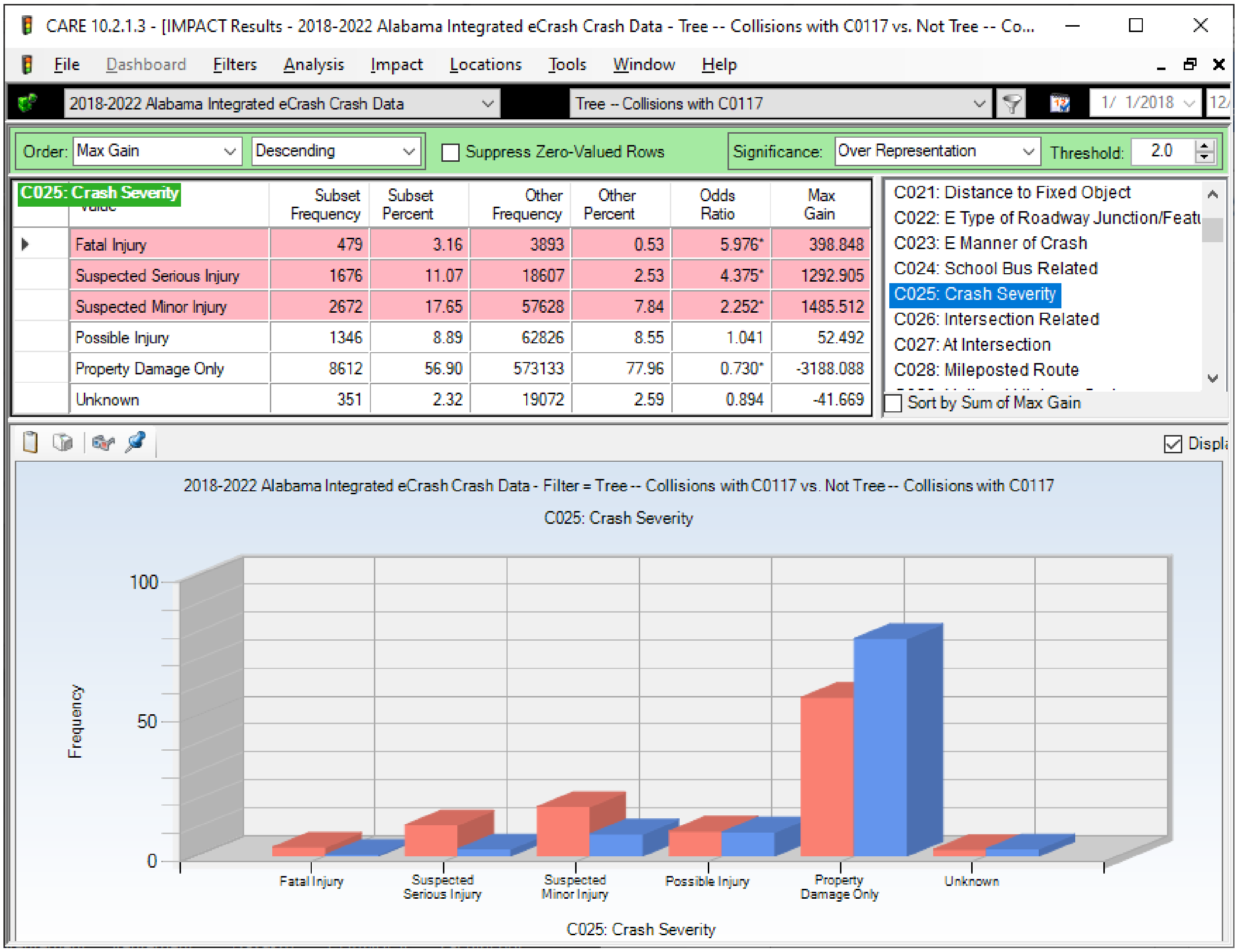
Tree Crashes by Severity for Calendar Years 2018-2022

	2018	2019	2020	2021	2022	TOTAL
Fatal Injury	95 2.99%	103 3.40%	89 2.90%	93 3.07%	99 3.49%	479 3.16%
Suspected Serious Injury	423 13.32%	329 10.85%	295 9.63%	326 10.77%	303 10.67%	1676 11.07%
Suspected Minor Injury	570 17.95%	549 18.11%	548 17.89%	508 16.78%	497 17.51%	2672 17.65%
Possible Injury	240 7.56%	334 11.02%	270 8.81%	266 8.79%	236 8.31%	1346 8.89%
Property Damage Only	1748 55.06%	1646 54.31%	1804 58.88%	1767 58.37%	1647 58.01%	8612 56.90%
Unknown	99 3.12%	70 2.31%	58 1.89%	67 2.21%	57 2.01%	351 2.32%
TOTAL	3175 20.98%	3031 20.03%	3064 20.24%	3027 20.00%	2839 18.76%	15136 100.00%

We conclude from considering the percentage numbers at the bottom of the table that 2022 was significantly lower in total crashes than those in the other years.

3.3 Tree Crash Severity Comparisons (All Tree vs All Non-Tree Crashes)

The following presents a comparison by severity of the of Tree and non-Tree crashes over the five-year period (2018-2022). The *Subset Frequency* and *Percent* columns are for Tree crashes, while the *Other Frequency* and *Percent* columns are for non-Tree crashes. Comparisons must be against the percentage proportions to determine if Tree crashes are more or less severe than non-Tree crashes in general.



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	479	3.16	3893	0.53	5.976*	398.848
Suspected Serious Injury	1676	11.07	18607	2.53	4.375*	1292.905
Suspected Minor Injury	2672	17.65	57628	7.84	2.252*	1485.512
Possible Injury	1346	8.89	62826	8.55	1.041	52.492
Property Damage Only	8612	56.90	573133	77.96	0.730*	-3188.088
Unknown	351	2.32	19072	2.59	0.894	-41.669

It is clear that Tree crashes are generally more severe than their non-Tree counterparts. All four of the injury values are over-represented, and the three top most severe have at least twice the proportion of the NFTCs. For FTCs the Odds Ratio multiplier is close to six (5.976). In the other injury severities, there is still a very significant increase in both the Suspected Minor Injury and the Possible Injury categories. The Suspected Serious Injury difference tends to confirm the increase in the FTCs, since quite often the characteristics of Serious Injury crashes are not that different from those crashes being fatal.

3.4 Introduction to the IMPACT Analyses

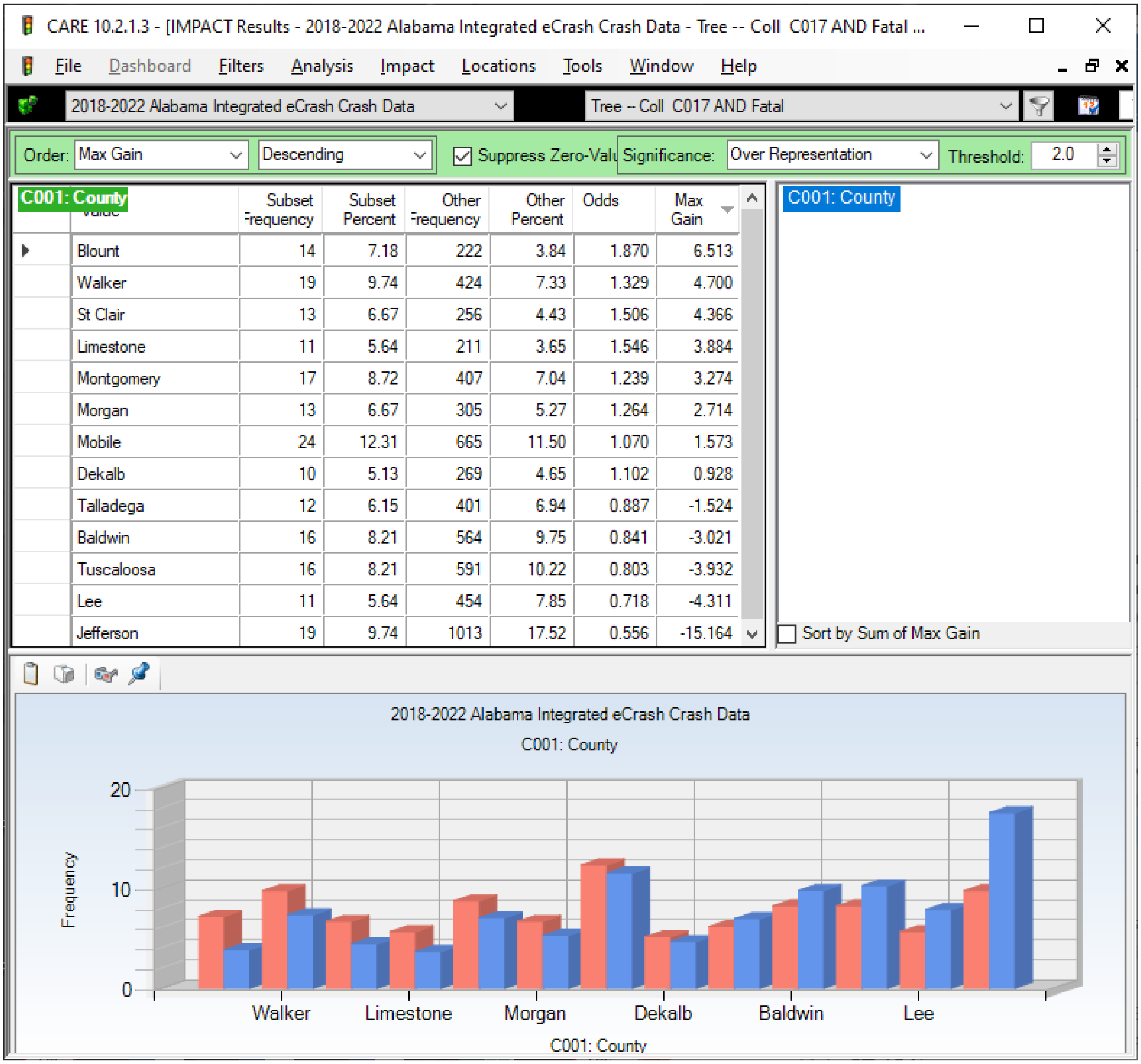
The results in the following sections (4.0-8.0) provide the IMPACT displays for the various attributes that could have an influence on countermeasure development, and especially FTCs. Unless otherwise indicated in the "Order" box, the outputs will be in highest Max Gain first. The Max Gain is a term that CARE users have assigned to indicate the number of crashes that would be reduced if its 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 Tree crashes than would be expected if it were the same as that attribute in non-Tree crashes. These comparisons will be FTCs against their non-Fatal Tree crash counterparts. That is, the NFTCs are serving as a control to which the FTCs are being compared. In this way anything different about FTCs 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/

The IMPACT analses will be grouped by general attribute subjects as follows: Geographical, Time, Severity, Demographics, and Driver Behavior.

4.0 Geographic and Harmful Event Factors

4.1 C001 County (>10+)



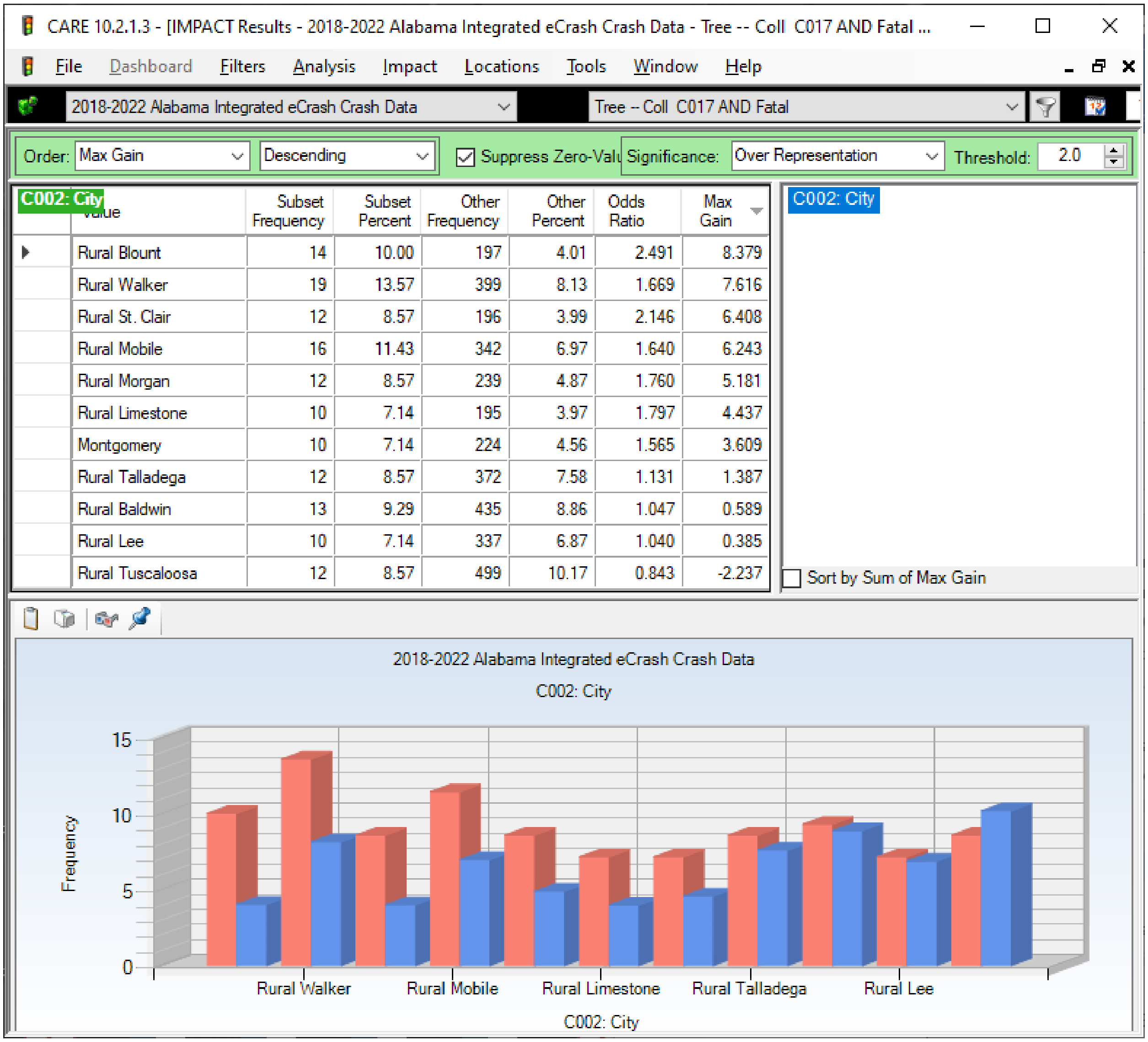
C001: County Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Blount	14	7.18	222	3.84	1.870	6.513
Walker	19	9.74	424	7.33	1.329	4.700
St Clair	13	6.67	256	4.43	1.506	4.366
Limestone	11	5.64	211	3.65	1.546	3.884
Montgomery	17	8.72	407	7.04	1.239	3.274
Morgan	13	6.67	305	5.27	1.264	2.714
Mobile	24	12.31	665	11.50	1.070	1.573
Dekalb	10	5.13	269	4.65	1.102	0.928
Talladega	12	6.15	401	6.94	0.887	-1.524
Baldwin	16	8.21	564	9.75	0.841	-3.021
Tuscaloosa	16	8.21	591	10.22	0.803	-3.932
Lee	11	5.64	454	7.85	0.718	-4.311
Jefferson	19	9.74	1013	17.52	0.556	-15.164

The above display has been arranged in highest Max Gain order to indicate the counties that have the highest potential for gain in reducing their over-representations. Blount, Walker, St Clair, Limestone, Montgomery, Morgan, Mobile, and Dekalb have the highest potentials for Tree fatality reductions, with positive Max Gains. The display above contains all of the counties with Odds Ratios greater than 1.000.

4.2 C002 Cities (>10+) with Highest Max Gains (Rural Areas = Virtual Cities)

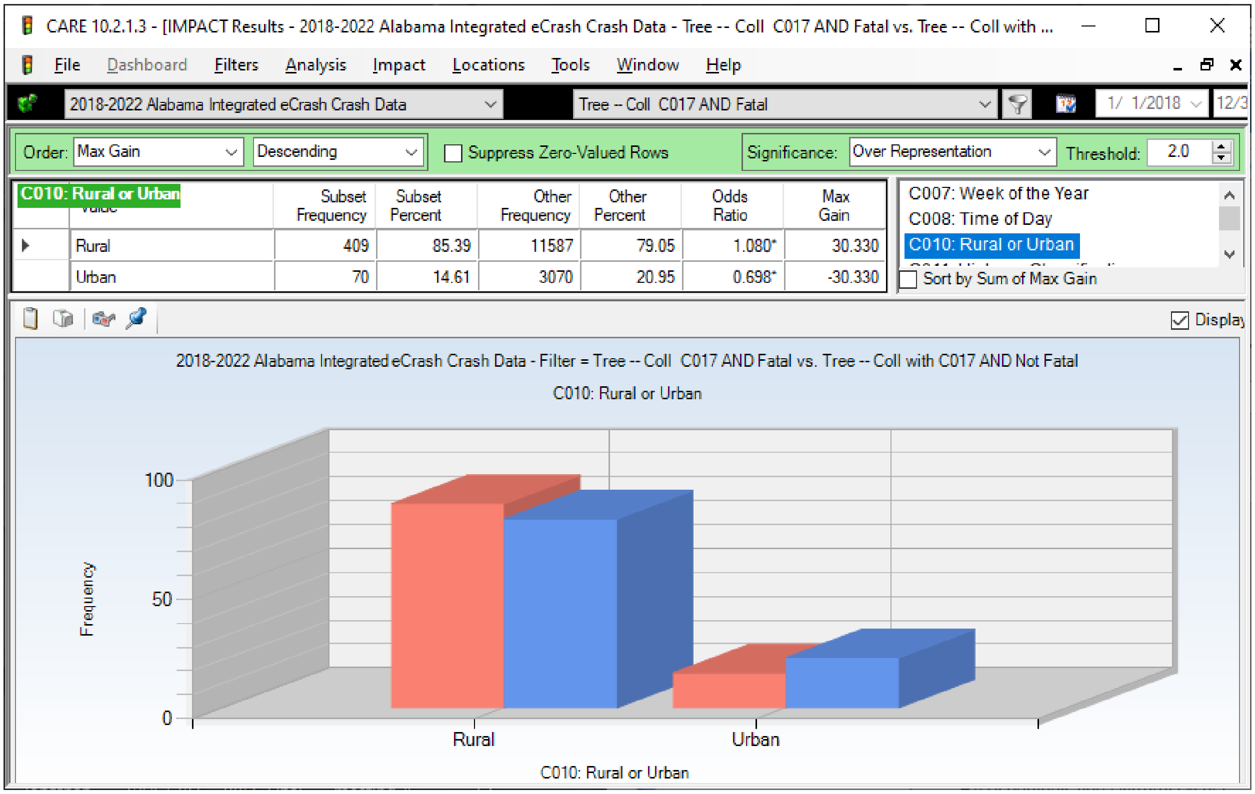
For comparison purposes, the rural areas of counties are considered to be “virtual cities” in that crashes that occur there are listed as “Rural County Crashes” so that these crashes can be effectively accounted for and compared. Generally, these rural areas are adjacent to (or contain) significant urban areas. Montgomery was the only non-rural city with 10 or more FTCs.

This display is in Max Gain ordering to put those (mostly virtual) cities that have the highest potential for Tree Fatal crash reduction at the top.



C002: City Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Rural Blount	14	10.00	197	4.01	2.491	8.379
Rural Walker	19	13.57	399	8.13	1.669	7.616
Rural St. Clair	12	8.57	196	3.99	2.146	6.408
Rural Mobile	16	11.43	342	6.97	1.640	6.243
Rural Morgan	12	8.57	239	4.87	1.760	5.181
Rural Limestone	10	7.14	195	3.97	1.797	4.437
Montgomery	10	7.14	224	4.56	1.565	3.609
Rural Talladega	12	8.57	372	7.58	1.131	1.387
Rural Baldwin	13	9.29	435	8.86	1.047	0.589
Rural Lee	10	7.14	337	6.87	1.040	0.385
Rural Tuscaloosa	12	8.57	499	10.17	0.843	-2.237

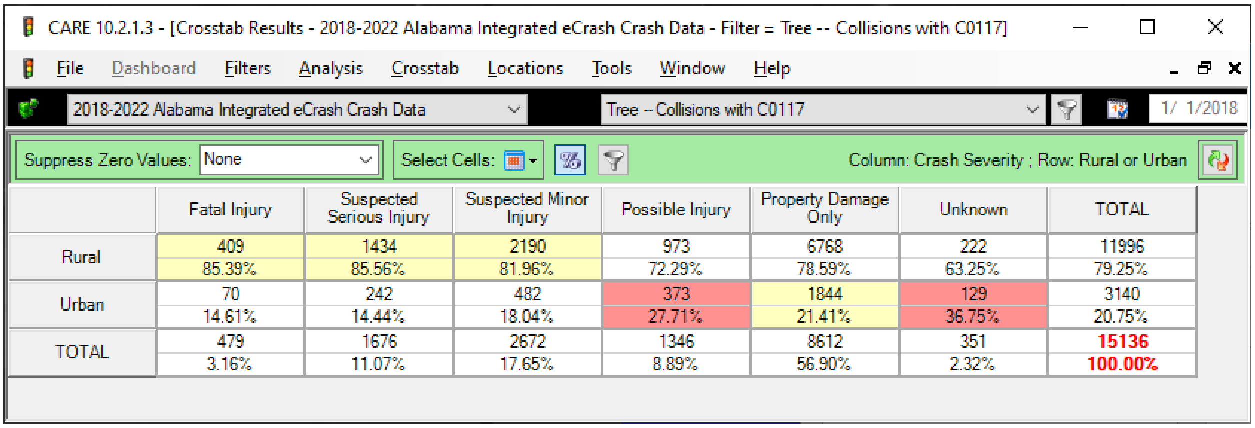
4.3 C010 Rural or Urban



Over 85% of the FTCs were in rural areas. This is attributed to the comparative speed at impact in the rural areas, which will be considered again in Section 6.2, C224 Speed at Impact. Speed not only can cause a crash, but it also dramatically increases its severity (see Section 6.0, as well as 4.4 below).

4.4 Severity of Crash by Rural-Urban

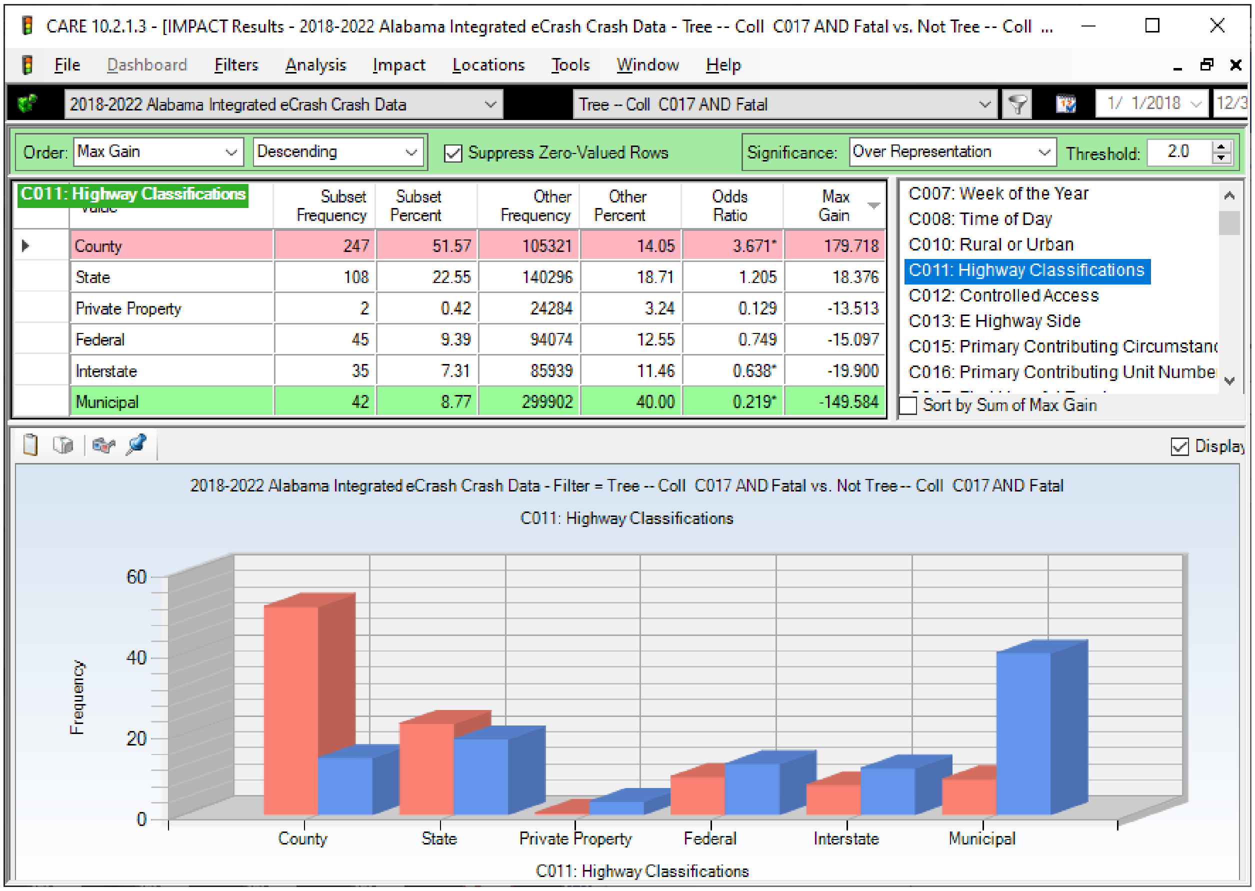
It is obvious in the above outputs that the proportion of FTCs tends to be greatly over-represented in the rural areas. It is interesting to perform a cross-tabulation for all tree crashes over the rural and urban areas to determine to what extent their crashes might be resulting in more fatalities than would be expected. The following, *which is for all Tree crashes*, gives this analysis.



	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
Rural	409 85.39%	1434 85.56%	2190 81.96%	973 72.29%	6768 78.59%	222 63.25%	11996 79.25%
Urban	70 14.61%	242 14.44%	482 18.04%	373 27.71%	1844 21.41%	129 36.75%	3140 20.75%
TOTAL	479 3.16%	1676 11.07%	2672 17.65%	1346 8.89%	8612 56.90%	351 2.32%	15136 100.00%

The red cells in the cross-tabulation above indicate over-representation by more than 10%. Those that are over-represented by less than 10% have a yellow background. For example, while 79.25% of tree crashes occurred in rural areas, 85.39% of the FTCs occurred there. It is imperative to take into consideration crash severity when making geographical decisions regarding countermeasure implementation. Clearly, tree-crash fatalities and their highest severity of injuries are over-represented in the rural areas, since all three of the most severe crash types are over-represented there.

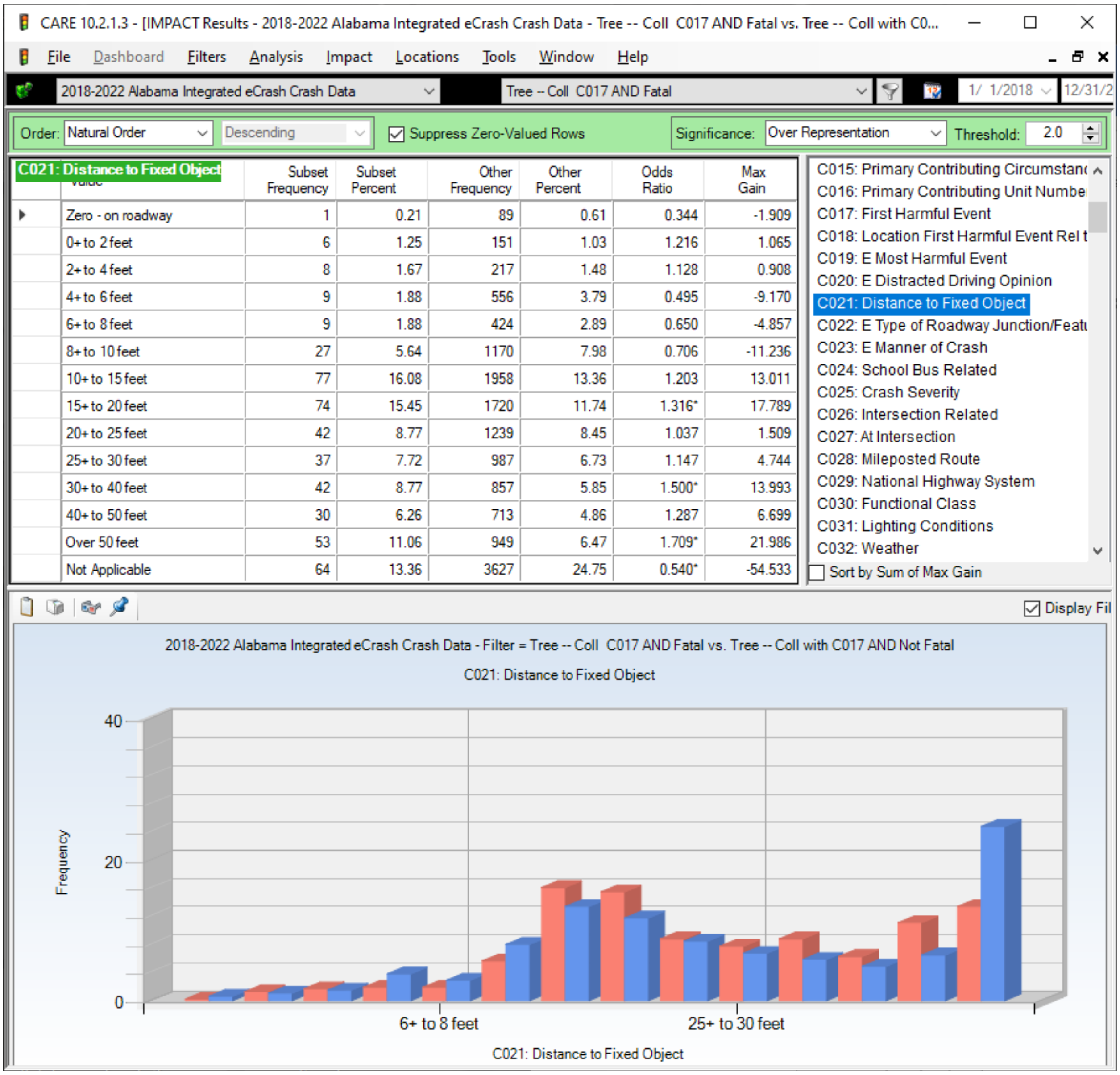
4.5 Highway Classifications



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
County	247	51.57	105321	14.05	3.671*	179.718
State	108	22.55	140296	18.71	1.205	18.376
Private Property	2	0.42	24284	3.24	0.129	-13.513
Federal	45	9.39	94074	12.55	0.749	-15.097
Interstate	35	7.31	85939	11.46	0.638*	-19.900
Municipal	42	8.77	299902	40.00	0.219*	-149.584

Analysis of highway classifications indicates that Tree crashes had their greatest over-representation on county roads (3.671, close to four times higher than expected). State routes were also over-represented but by a much smaller degree (1.205). Federal, Interstate and Municipal roads were also all under-represented. It is recommended that hotspot analysis be performed to identify the specific county roads that are most highly over-represented. Also, that tree-removal be conducted on the county roads to assure that this traffic will have a safer, more forgiving, roadways with clearer roadsides. Law enforcement presence alone could have a large effect here, since a major problem is speed, as will be shown below (Section 6.2).

4.5a C021 Distance to Fixed Object



C021: Distance to Fixed Object	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Zero - on roadway	1	0.21	89	0.61	0.344	-1.909
0+ to 2 feet	6	1.25	151	1.03	1.216	1.065
2+ to 4 feet	8	1.67	217	1.48	1.128	0.908
4+ to 6 feet	9	1.88	556	3.79	0.495	-9.170
6+ to 8 feet	9	1.88	424	2.89	0.650	-4.857
8+ to 10 feet	27	5.64	1170	7.98	0.706	-11.236
10+ to 15 feet	77	16.08	1958	13.36	1.203	13.011
15+ to 20 feet	74	15.45	1720	11.74	1.316*	17.789
20+ to 25 feet	42	8.77	1239	8.45	1.037	1.509
25+ to 30 feet	37	7.72	987	6.73	1.147	4.744
30+ to 40 feet	42	8.77	857	5.85	1.500*	13.993
40+ to 50 feet	30	6.26	713	4.86	1.287	6.699
Over 50 feet	53	11.06	949	6.47	1.709*	21.986
Not Applicable	64	13.36	3627	24.75	0.540*	-54.533

Generally, those collisions in excess of 20 feet had a higher speed at impact (see Section 6.2). If this speed were not a factor, then clearing the roadside out to 20 feet would cause a major reduction in Fatal Tree crashes (avoiding 137 fatal crashes). See Section 4.5b next.

4.5b C025 Severity (All Tree Crashes) by C021 Distance to Tree Cross-tab

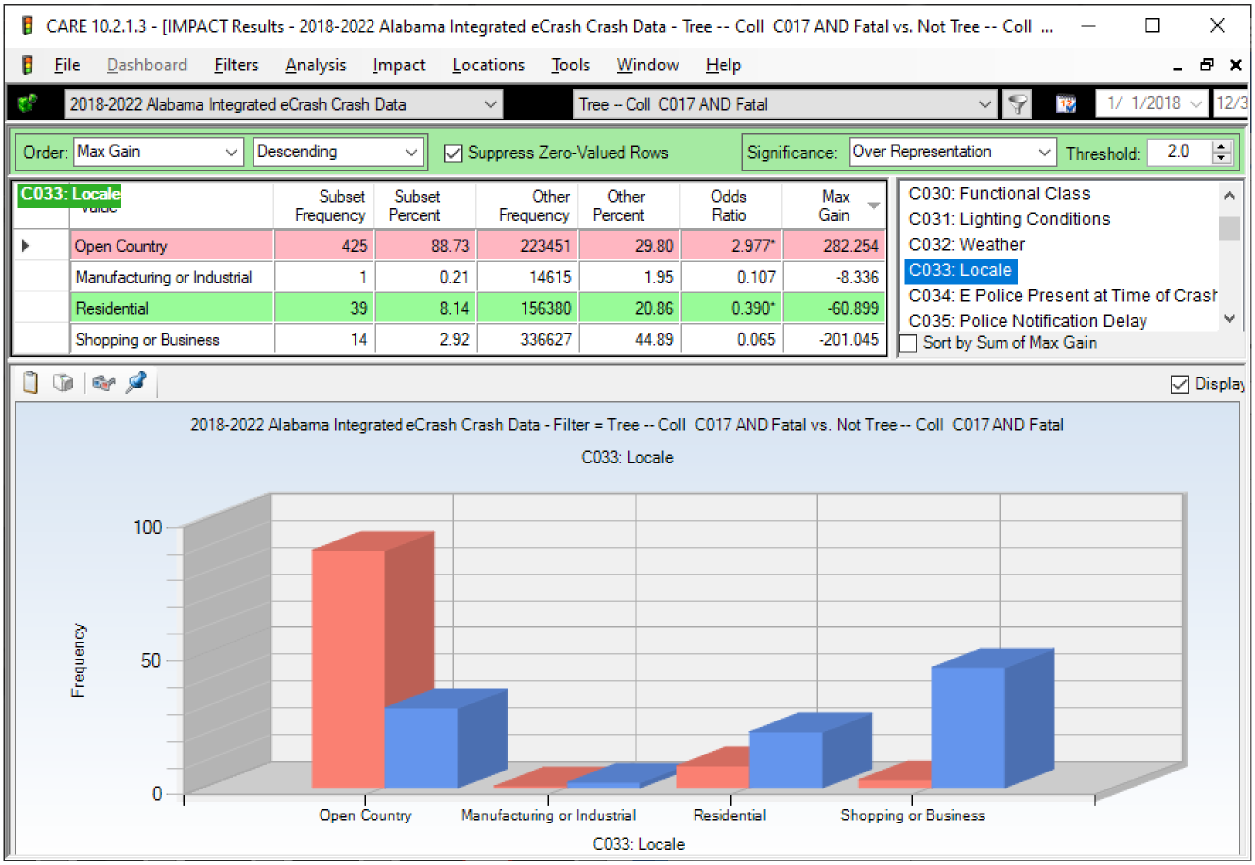
CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Tree -- Collisions with C0117]

Column: Crash Severity ; Row: Distance to Fixed Object

	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
Zero - on roadway	1	4	16	7	58	4	90
0+ to 2 feet	6	15	22	18	93	3	157
2+ to 4 feet	8	24	47	22	121	3	225
4+ to 6 feet	9	61	107	47	329	12	565
6+ to 8 feet	9	56	82	47	234	5	433
8+ to 10 feet	27	140	234	113	665	18	1197
10+ to 15 feet	77	281	403	165	1087	22	2035
15+ to 20 feet	74	231	366	154	946	23	1794
20+ to 25 feet	42	164	270	120	662	23	1281
25+ to 30 feet	37	147	191	99	527	23	1024
30+ to 40 feet	42	106	175	70	491	15	899
40+ to 50 feet	30	102	110	64	421	16	743
Over 50 feet	53	123	164	85	568	9	1002
Not Applicable	64	222	485	335	2410	175	3691
TOTAL	479	1676	2672	1346	8612	351	15136

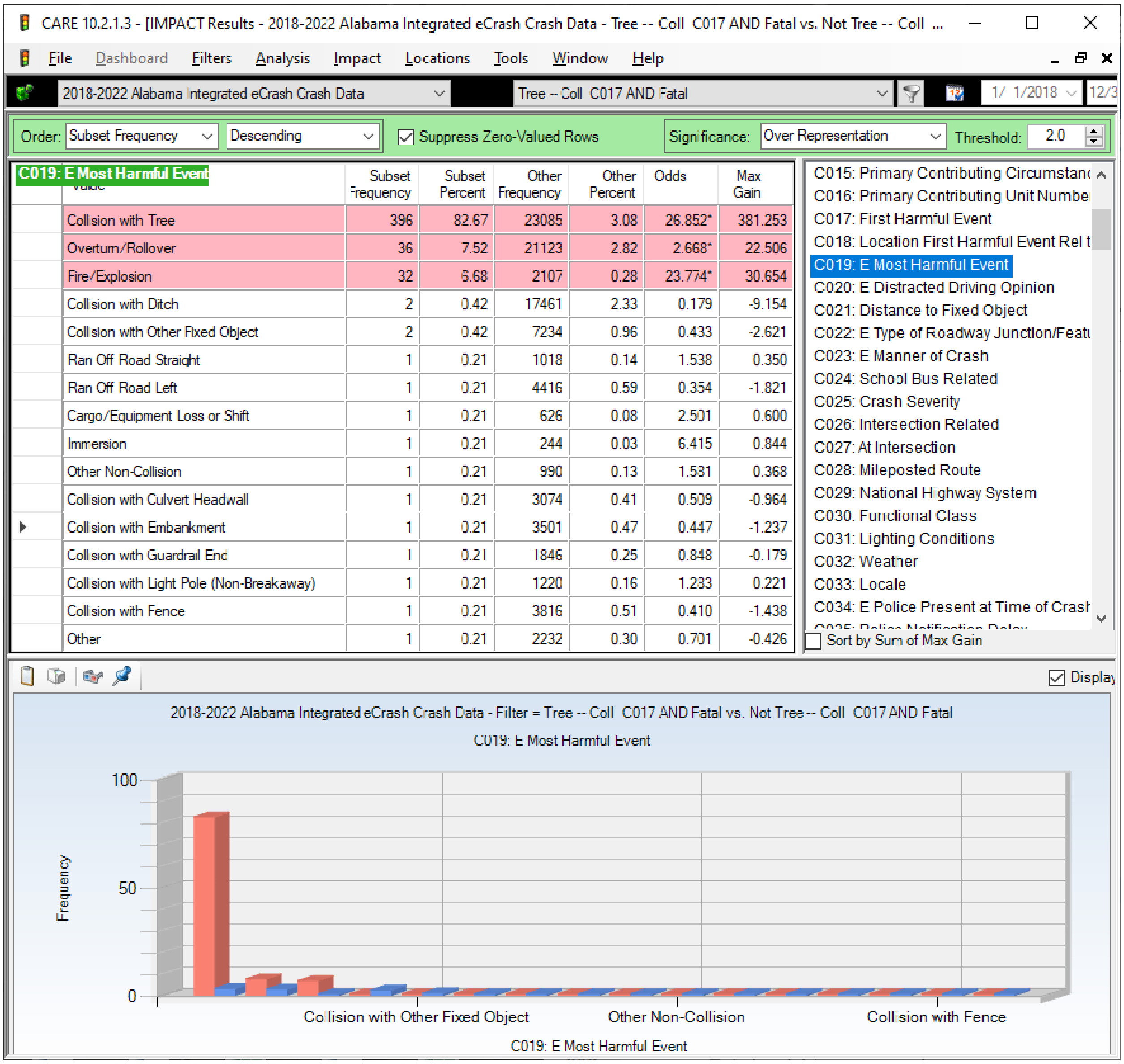
Unlike most of the analyses in this section, the above considers all Tree Collisions, not just those that are fatal. It shows that a wider clear roadside could save additional lives. For example, increasing the clear roadside to 40 feet would save an additional 79 FTCs in addition to the 137 saved from widening it to 20 feet (total of 216 FTCs reduced by 40-foot clear roadside over the five-year period of the study). All of these crashes may not be avoided, since rollovers and other obstacles (e.g. ditches) would still present severe hazards. It takes a higher speed for a vehicle to traverse a wider roadside, which accounts for the increase in severity in those crashes over 10 feet from the roadway.

4.6 Locale



Open Country roadways show the highest level of over-representation as compared to the more urbanized locales. This might be more useful than the 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 FTCs are occurring. For example, 30 FTCs occurred in urban areas classified as Open Country. All areas within a city limits is considered to be urban in the urban-rural analysis.

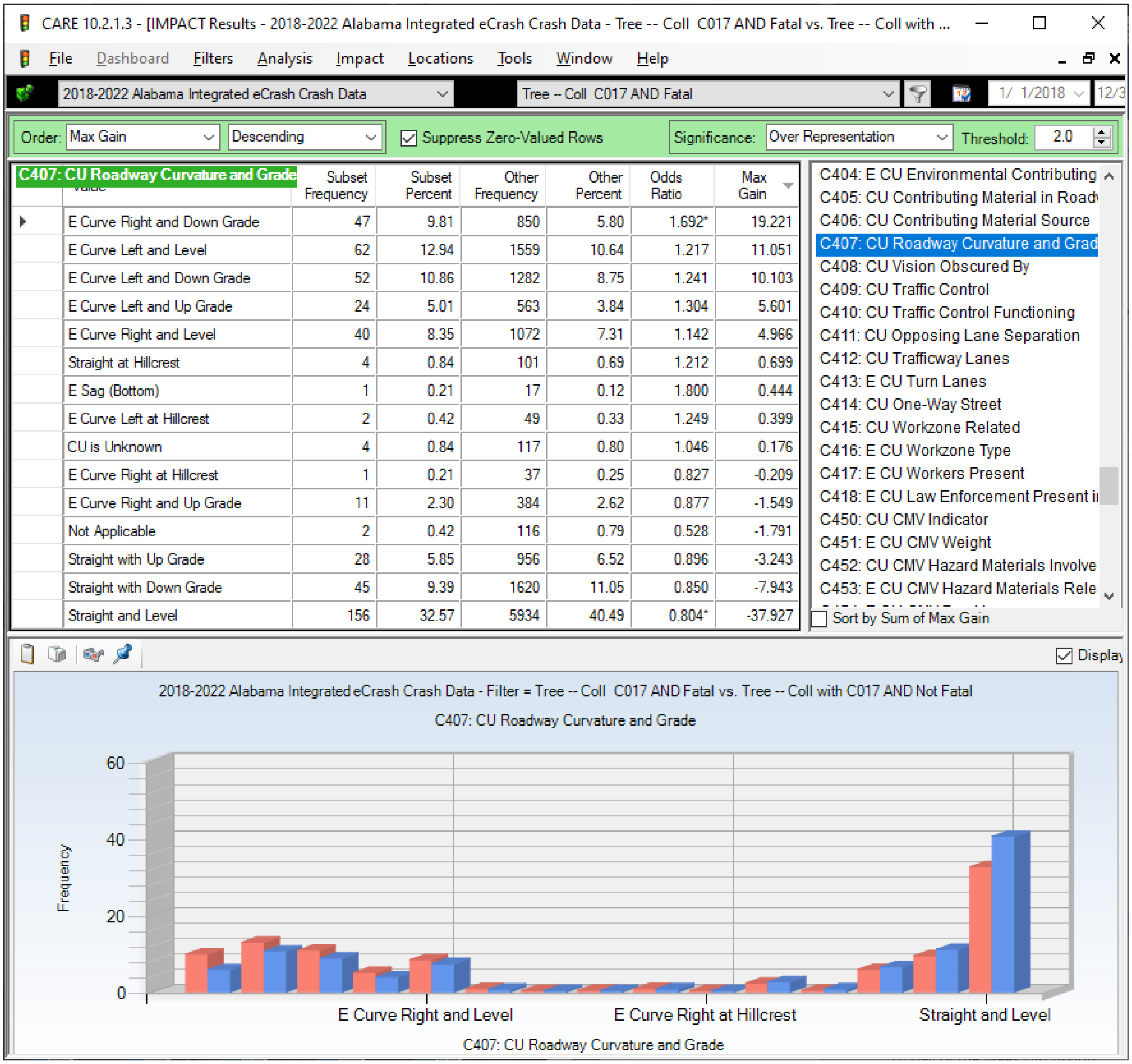
4.7 Most Harmful Event (ordered by MaxGain for Fatal Tree crashes)



C019: E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Collision with Tree	396	82.67	23085	3.08	26.852*	381.253
Overturn/Rollover	36	7.52	21123	2.82	2.668*	22.506
Fire/Explosion	32	6.68	2107	0.28	23.774*	30.654
Collision with Ditch	2	0.42	17461	2.33	0.179	-9.154
Collision with Other Fixed Object	2	0.42	7234	0.96	0.433	-2.621
Ran Off Road Straight	1	0.21	1018	0.14	1.538	0.350
Ran Off Road Left	1	0.21	4416	0.59	0.354	-1.821
Cargo/Equipment Loss or Shift	1	0.21	626	0.08	2.501	0.600
Immersion	1	0.21	244	0.03	6.415	0.844
Other Non-Collision	1	0.21	990	0.13	1.581	0.368
Collision with Culvert Headwall	1	0.21	3074	0.41	0.509	-0.964
Collision with Embankment	1	0.21	3501	0.47	0.447	-1.237
Collision with Guardrail End	1	0.21	1846	0.25	0.848	-0.179
Collision with Light Pole (Non-Breakaway)	1	0.21	1220	0.16	1.283	0.221
Collision with Fence	1	0.21	3816	0.51	0.410	-1.438
Other	1	0.21	2232	0.30	0.701	-0.426

This display is 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. This shows that Overturn/Rollovers (36 fatal crashes) and Fire/Explosion (32 fatal crashes) can occur even with the removal of trees. In ultimate practice hotspot analyses can be conducted to find those roads most in need of roadside improvement. Analyses of these locations can then produce the particular First Harmful Events and Most Harmful Events to guide the roadside clearance efforts.

4.8 CU Roadway Curvature and Grade

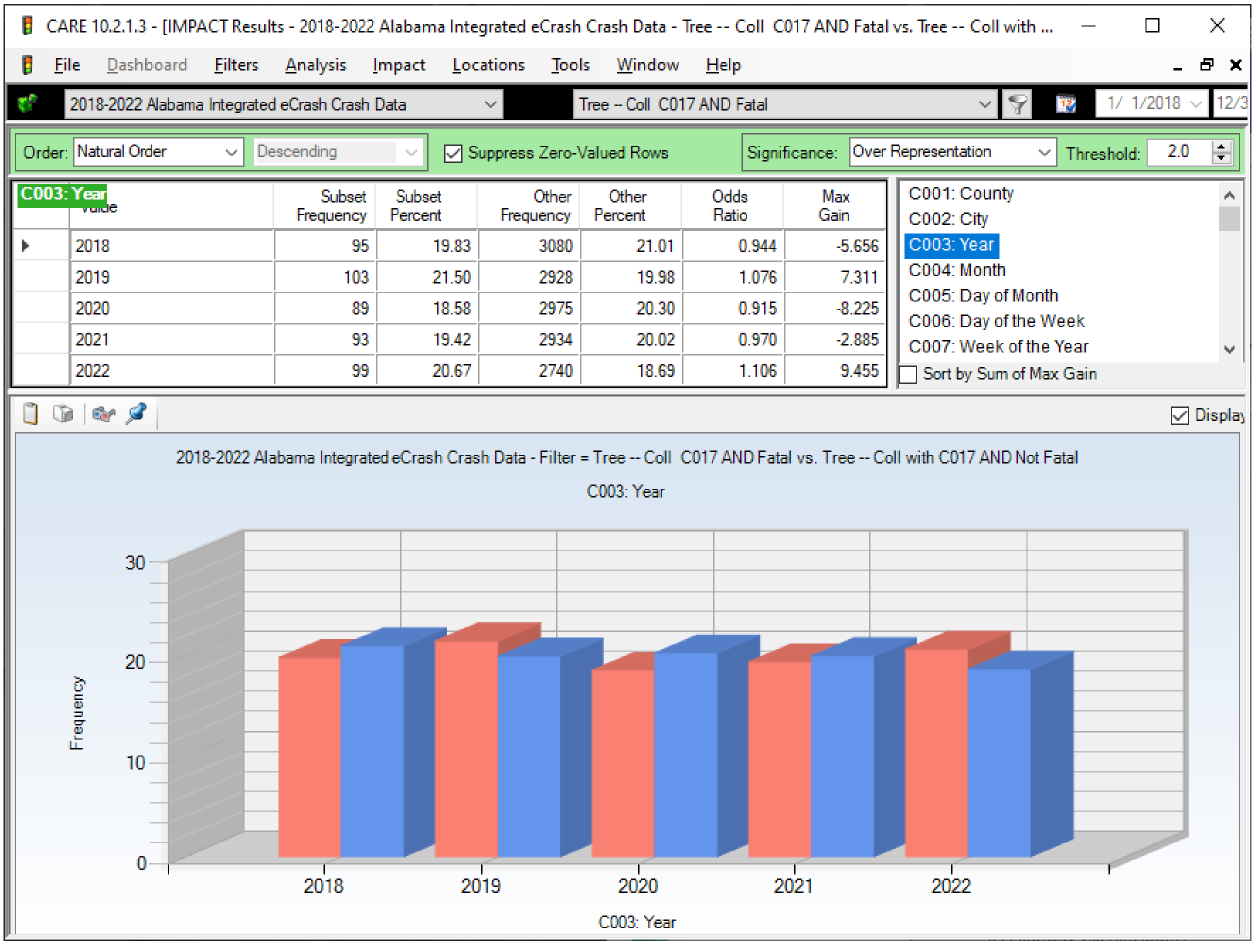


C407: CU Roadway Curvature and Grade	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Curve Right and Down Grade	47	9.81	850	5.80	1.692*	19.221
E Curve Left and Level	62	12.94	1559	10.64	1.217	11.051
E Curve Left and Down Grade	52	10.86	1282	8.75	1.241	10.103
E Curve Left and Up Grade	24	5.01	563	3.84	1.304	5.601
E Curve Right and Level	40	8.35	1072	7.31	1.142	4.966
Straight at Hillcrest	4	0.84	101	0.69	1.212	0.699
E Sag (Bottom)	1	0.21	17	0.12	1.800	0.444
E Curve Left at Hillcrest	2	0.42	49	0.33	1.249	0.399
CU is Unknown	4	0.84	117	0.80	1.046	0.176
E Curve Right at Hillcrest	1	0.21	37	0.25	0.827	-0.209
E Curve Right and Up Grade	11	2.30	384	2.62	0.877	-1.549
Not Applicable	2	0.42	116	0.79	0.528	-1.791
Straight with Up Grade	28	5.85	956	6.52	0.896	-3.243
Straight with Down Grade	45	9.39	1620	11.05	0.850	-7.943
Straight and Level	156	32.57	5934	40.49	0.804*	-37.927

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

5.0 Time Factors

5.1 Year



Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2018	95	19.83	3080	21.01	0.944	-5.656
2019	103	21.50	2928	19.98	1.076	7.311
2020	89	18.58	2975	20.30	0.915	-8.225
2021	93	19.42	2934	20.02	0.970	-2.885
2022	99	20.67	2740	18.69	1.106	9.455

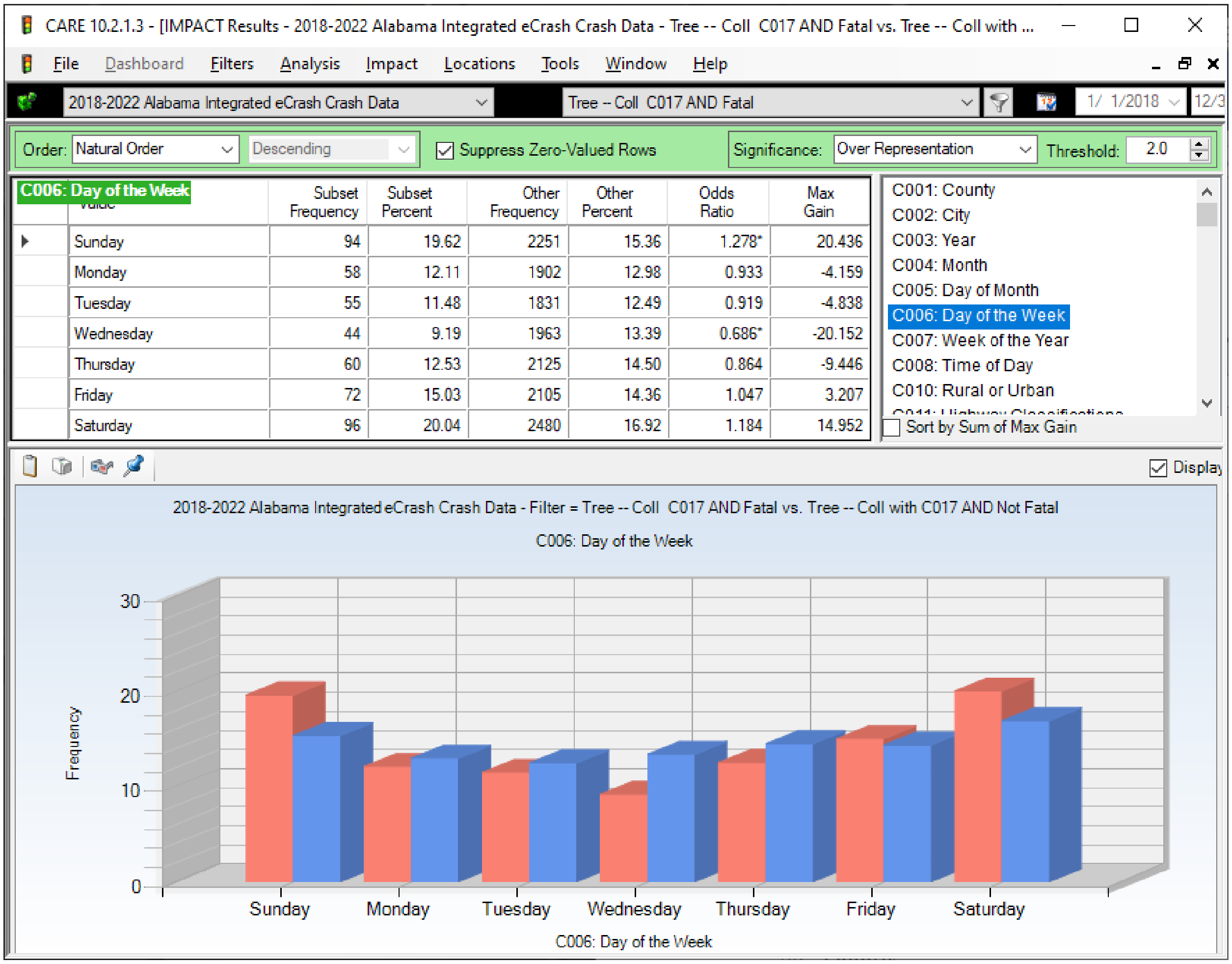
The chart above is useful for tracking the relative changes by directly comparing the number of FTCs to the NFTCs by year. Years 2019 and 2022 had a significantly larger proportion of FTCs than NFTCs. The other three, 2018, 2020 and 2021 had lower proportions than expected. There is no apparent trend in any of the Tree proportions as indicated by the lack of statistical significance.

5.2 Month

C004: Month Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
January	45	9.39	1247	8.51	1.104	4.247
February	38	7.93	1114	7.60	1.044	1.594
March	37	7.72	1192	8.13	0.950	-1.955
April	33	6.89	1229	8.39	0.822	-7.164
May	42	8.77	1204	8.21	1.067	2.653
June	46	9.60	1229	8.39	1.145	5.836
July	49	10.23	1234	8.42	1.215	8.672
August	33	6.89	1245	8.49	0.811	-7.687
September	38	7.93	1102	7.52	1.055	1.986
October	41	8.56	1290	8.80	0.973	-1.158
November	39	8.14	1183	8.07	1.009	0.339
December	38	7.93	1388	9.47	0.838	-7.361

Over-representations by month were found in January, May, June, and July. Large under-representations by month were found for April,, August and December. However, none of these differences were significant. The reason for these differences should be sought in the basic causes of Tree crashes, which often stem from speed and/or Impaired Driving.

5.3 Day of the Week



C006: Day of the Week	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Sunday	94	19.62	2251	15.36	1.278*	20.436
Monday	58	12.11	1902	12.98	0.933	-4.159
Tuesday	55	11.48	1831	12.49	0.919	-4.838
Wednesday	44	9.19	1963	13.39	0.686*	-20.152
Thursday	60	12.53	2125	14.50	0.864	-9.446
Friday	72	15.03	2105	14.36	1.047	3.207
Saturday	96	20.04	2480	16.92	1.184	14.952

The above is a well-established and recognized pattern for Impaired Driving (ID) crashes, with their concentrations on the weekend periods, and it confirms what was suggested above for the monthly results. A possible conclusion is that ID is a central cause for Fatal Tree crashes. See the further discussions below with regard to day of the week, and the involvement of alcohol and other drugs.

5.4 Day of the Week Discussion

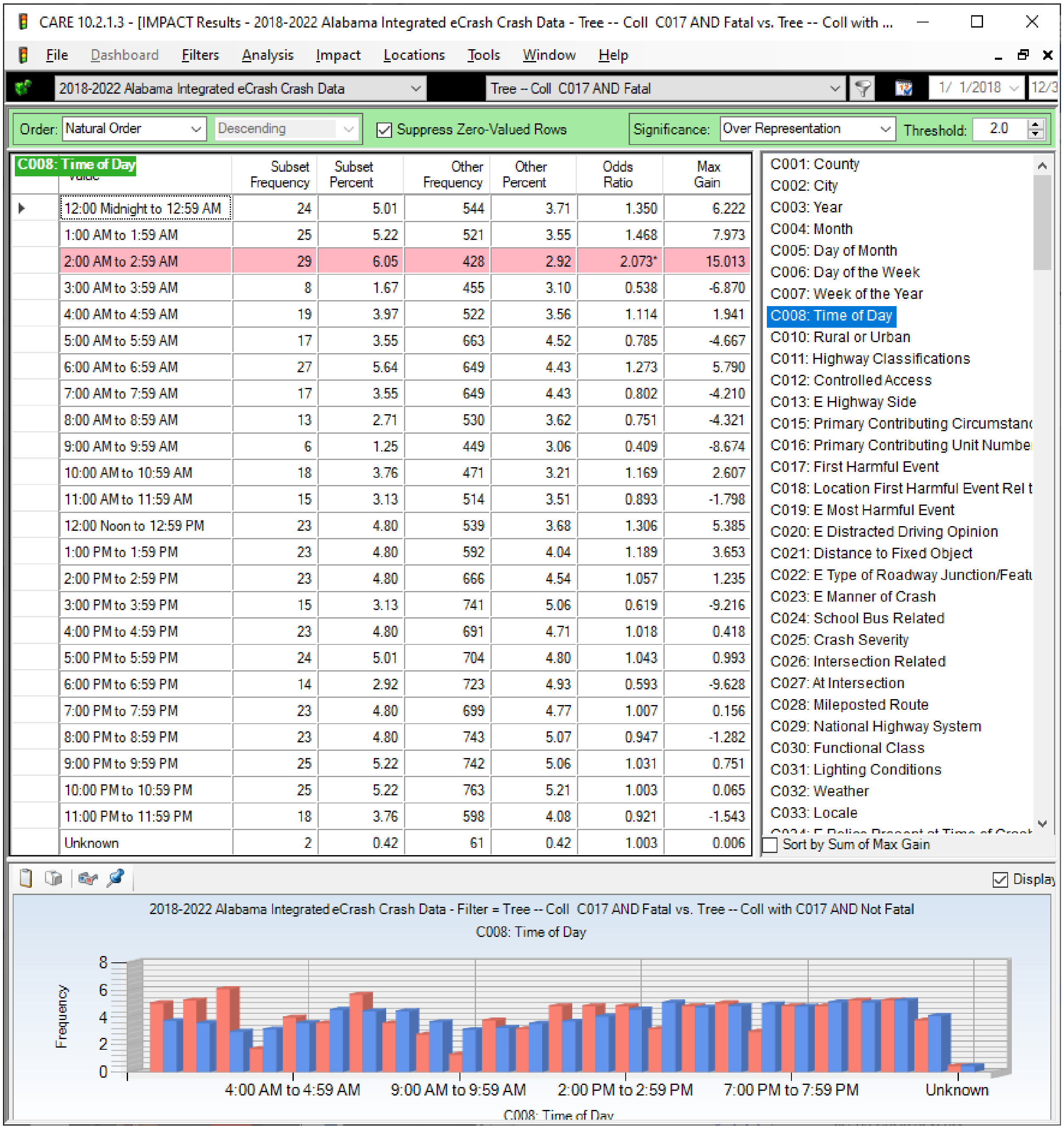
The chart above shows the typical non-holiday week pattern that has been experienced for Impaired Driving (ID) for decades. The days can be classified as follows:

- Weekday (Monday through Thursday) – these days are under-represented in Tree 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 only slightly over-represented in Tree crashes, not because they do not occur more frequently than weekdays, but because non-Tree 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 hazardous 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 also being initiated on Friday afternoons.
- Saturday – the "Saturday" pattern is the worse for ID 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 traffic mix 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 mostly from those who start on Saturday night and do not complete their use of alcohol/drugs until after midnight.

Holidays. 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 Tree 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 Tree crashes in that, as the evidence indicates, a large proportion of Tree 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 12:59 AM	24	5.01	544	3.71	1.350	6.222
1:00 AM to 1:59 AM	25	5.22	521	3.55	1.468	7.973
2:00 AM to 2:59 AM	29	6.05	428	2.92	2.073*	15.013
3:00 AM to 3:59 AM	8	1.67	455	3.10	0.538	-6.870
4:00 AM to 4:59 AM	19	3.97	522	3.56	1.114	1.941
5:00 AM to 5:59 AM	17	3.55	663	4.52	0.785	-4.667
6:00 AM to 6:59 AM	27	5.64	649	4.43	1.273	5.790
7:00 AM to 7:59 AM	17	3.55	649	4.43	0.802	-4.210
8:00 AM to 8:59 AM	13	2.71	530	3.62	0.751	-4.321
9:00 AM to 9:59 AM	6	1.25	449	3.06	0.409	-8.674
10:00 AM to 10:59 AM	18	3.76	471	3.21	1.169	2.607
11:00 AM to 11:59 AM	15	3.13	514	3.51	0.893	-1.798
12:00 Noon to 12:59 PM	23	4.80	539	3.68	1.306	5.385
1:00 PM to 1:59 PM	23	4.80	592	4.04	1.189	3.653
2:00 PM to 2:59 PM	23	4.80	666	4.54	1.057	1.235
3:00 PM to 3:59 PM	15	3.13	741	5.06	0.619	-9.216
4:00 PM to 4:59 PM	23	4.80	691	4.71	1.018	0.418
5:00 PM to 5:59 PM	24	5.01	704	4.80	1.043	0.993
6:00 PM to 6:59 PM	14	2.92	723	4.93	0.593	-9.628
7:00 PM to 7:59 PM	23	4.80	699	4.77	1.007	0.156
8:00 PM to 8:59 PM	23	4.80	743	5.07	0.947	-1.282
9:00 PM to 9:59 PM	25	5.22	742	5.06	1.031	0.751
10:00 PM to 10:59 PM	25	5.22	763	5.21	1.003	0.065
11:00 PM to 11:59 PM	18	3.76	598	4.08	0.921	-1.543
Unknown	2	0.42	61	0.42	1.003	0.006

5.6 Discussion on Time of Day

It is no surprise to find Fatal Tree Crashes (FTCs) 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 its relevance to Tree crashes.

The extent of these time over-representations is quite amazing. Typical traffic patterns of high traffic results on more crashes in the morning and afternoon rush hours. ID, and thus Tree 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 Tree 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 FTCs 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, eclipses the Friday numbers, even though they were higher than any other day except Sunday.

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 4.80% for FTCs. 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% more than that expected from the total (right column) are red.

5.7 Time of Day by Day of the Week

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Tree -- Coll C017 AND Fatal]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Tree -- Coll C017 AND Fatal | 1/ 1/2018 | 12/31/2022

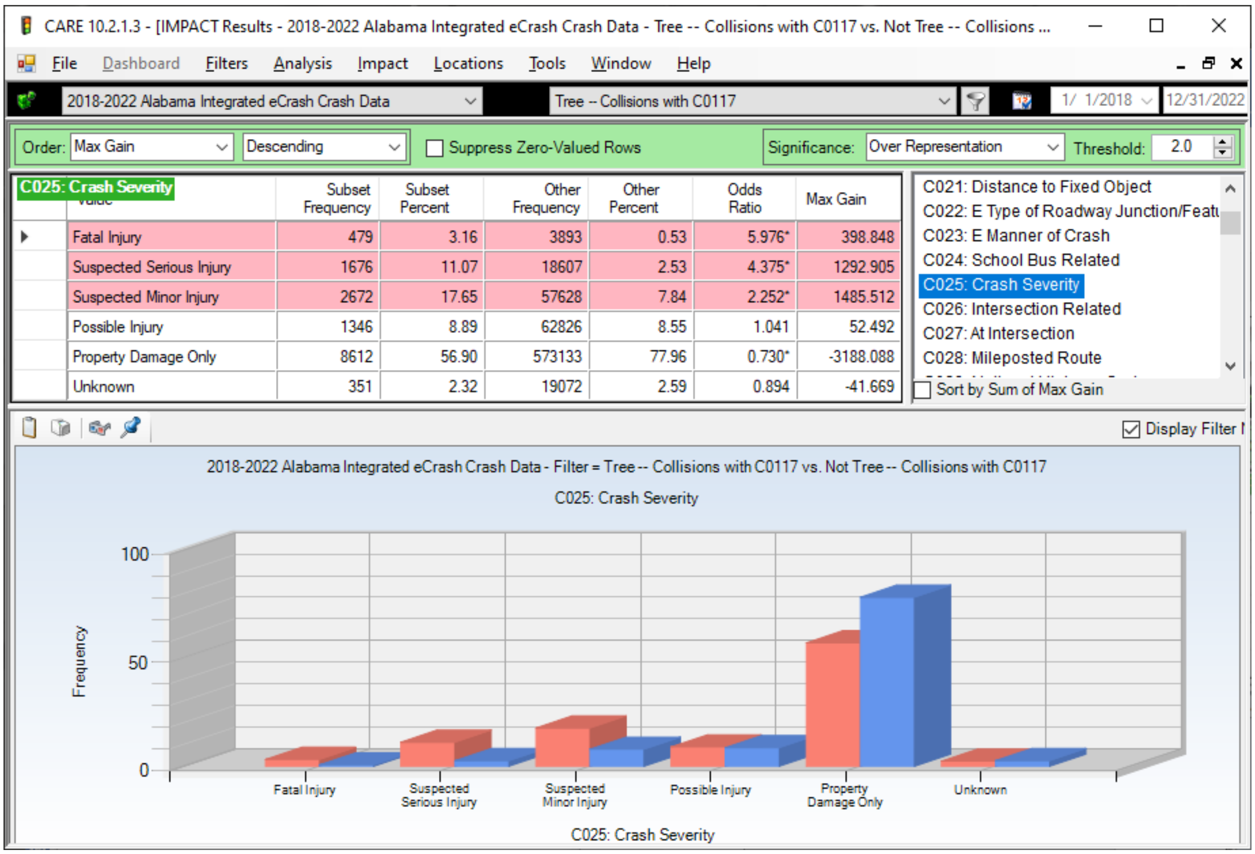
Suppress Zero Values: None | Select Cells: | Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	5 5.32%	5 8.62%	1 1.82%	3 6.82%	2 3.33%	3 4.17%	5 5.21%	24 5.01%
1:00 AM to 1:59 AM	8 8.51%	1 1.72%	5 9.09%	1 2.27%	0 0.00%	3 4.17%	7 7.29%	25 5.22%
2:00 AM to 2:59 AM	7 7.45%	3 5.17%	1 1.82%	2 4.55%	2 3.33%	3 4.17%	11 11.46%	29 6.05%
3:00 AM to 3:59 AM	3 3.19%	0 0.00%	0 0.00%	3 6.82%	1 1.67%	0 0.00%	1 1.04%	8 1.67%
4:00 AM to 4:59 AM	8 8.51%	1 1.72%	1 1.82%	1 2.27%	2 3.33%	4 5.56%	2 2.08%	19 3.97%
5:00 AM to 5:59 AM	2 2.13%	2 3.45%	1 1.82%	1 2.27%	2 3.33%	4 5.56%	5 5.21%	17 3.55%
6:00 AM to 6:59 AM	5 5.32%	2 3.45%	3 5.45%	2 4.55%	2 3.33%	5 6.94%	8 8.33%	27 5.64%
7:00 AM to 7:59 AM	5 5.32%	1 1.72%	1 1.82%	4 9.09%	2 3.33%	2 2.78%	2 2.08%	17 3.55%
8:00 AM to 8:59 AM	5 5.32%	1 1.72%	3 5.45%	2 4.55%	0 0.00%	0 0.00%	2 2.08%	13 2.71%
9:00 AM to 9:59 AM	0 0.00%	1 1.72%	2 3.64%	0 0.00%	2 3.33%	1 1.39%	0 0.00%	6 1.25%
10:00 AM to 10:59 AM	0 0.00%	2 3.45%	1 1.82%	4 9.09%	3 5.00%	3 4.17%	5 5.21%	18 3.76%
11:00 AM to 11:59 AM	6 6.38%	3 5.17%	0 0.00%	0 0.00%	4 6.67%	1 1.39%	1 1.04%	15 3.13%
12:00 Noon to 12:59 PM	3 3.19%	6 10.34%	6 10.91%	0 0.00%	0 0.00%	4 5.56%	4 4.17%	23 4.80%
1:00 PM to 1:59 PM	4 4.26%	2 3.45%	4 7.27%	0 0.00%	5 8.33%	7 9.72%	1 1.04%	23 4.80%
2:00 PM to 2:59 PM	3 3.19%	2 3.45%	4 7.27%	1 2.27%	3 5.00%	3 4.17%	7 7.29%	23 4.80%
3:00 PM to 3:59 PM	1 1.06%	2 3.45%	2 3.64%	0 0.00%	4 6.67%	3 4.17%	3 3.13%	15 3.13%
4:00 PM to 4:59 PM	2 2.13%	4 6.90%	2 3.64%	3 6.82%	4 6.67%	5 6.94%	3 3.13%	23 4.80%
5:00 PM to 5:59 PM	3 3.19%	3 5.17%	4 7.27%	5 11.36%	3 5.00%	3 4.17%	3 3.13%	24 5.01%
6:00 PM to 6:59 PM	1 1.06%	4 6.90%	2 3.64%	1 2.27%	1 1.67%	2 2.78%	3 3.13%	14 2.92%
7:00 PM to 7:59 PM	7 7.45%	2 3.45%	3 5.45%	1 2.27%	3 5.00%	3 4.17%	4 4.17%	23 4.80%
8:00 PM to 8:59 PM	6 6.38%	2 3.45%	1 1.82%	4 9.09%	2 3.33%	3 4.17%	5 5.21%	23 4.80%
9:00 PM to 9:59 PM	2 2.13%	2 3.45%	2 3.64%	4 9.09%	4 6.67%	5 6.94%	6 6.25%	25 5.22%
10:00 PM to 10:59 PM	7 7.45%	3 5.17%	2 3.64%	2 4.55%	5 8.33%	1 1.39%	5 5.21%	25 5.22%
11:00 PM to 11:59 PM	1 1.06%	4 6.90%	3 5.45%	0 0.00%	3 5.00%	4 5.56%	3 3.13%	18 3.76%
Unknown	0 0.00%	0 0.00%	1 1.82%	0 0.00%	1 1.67%	0 0.00%	0 0.00%	2 0.42%
TOTAL	94 19.62%	58 12.11%	55 11.48%	44 9.19%	60 12.53%	72 15.03%	96 20.04%	**479** **100.00%**

6.0 Factors Affecting Severity

6.1 Tree Crash Severity (for all tree collisions vs. all nontree collisions)

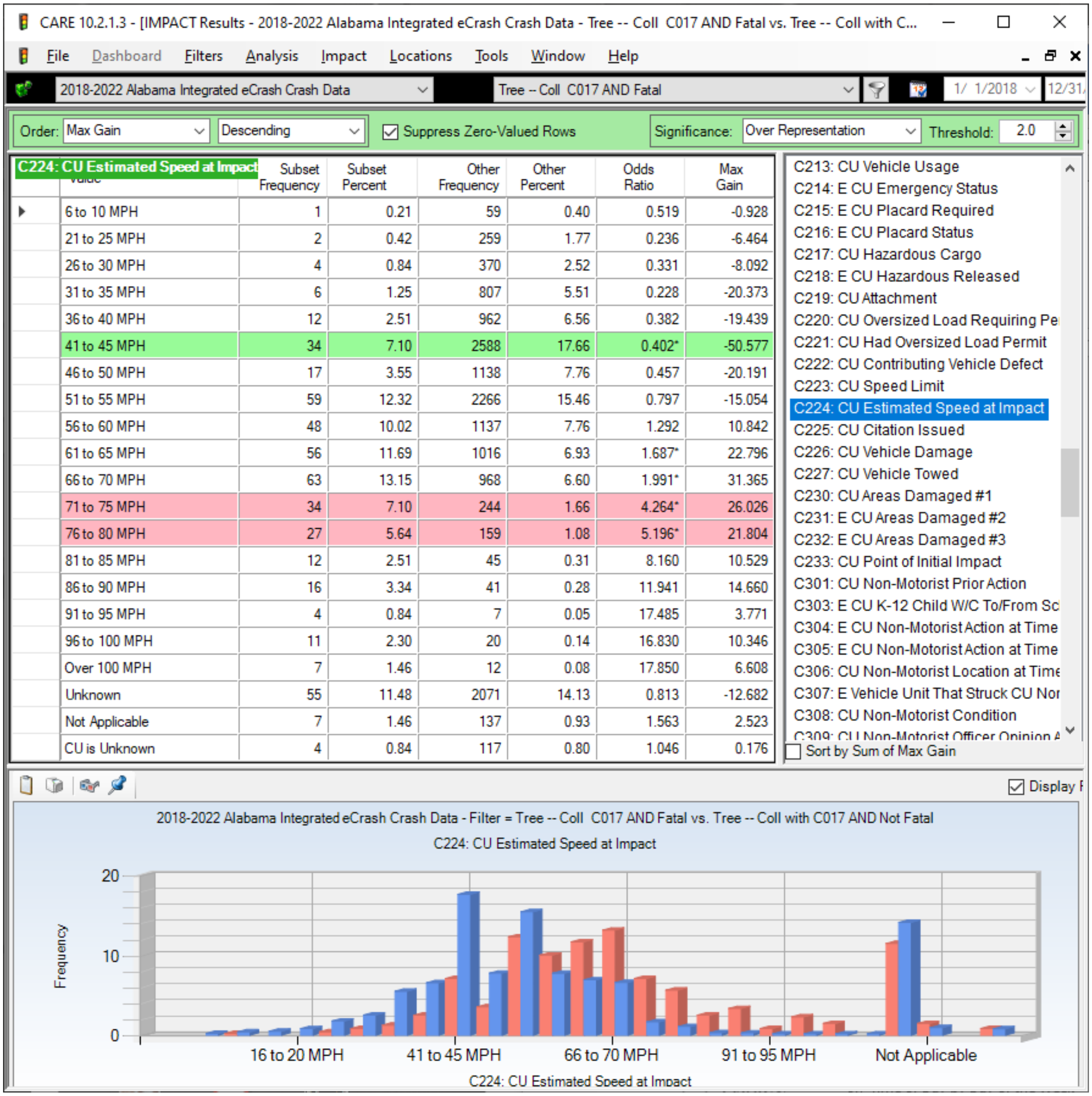
The following compares crash severities for Tree (Subset, red bars) vs. Non-Tree crashes (Other, blue bars below table). *Note that this is different from most of the IMPACT displays that compare FTCs with NFTCs.*



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	479	3.16	3893	0.53	5.976*	398.848
Suspected Serious Injury	1676	11.07	18607	2.53	4.375*	1292.905
Suspected Minor Injury	2672	17.65	57628	7.84	2.252*	1485.512
Possible Injury	1346	8.89	62826	8.55	1.041	52.492
Property Damage Only	8612	56.90	573133	77.96	0.730*	-3188.088
Unknown	351	2.32	19072	2.59	0.894	-41.669

The rate of fatal injury crashes and the two highest injury classifications are consistently higher in Tree crashes than in non-Tree crashes. Fatality crashes have 5.976 times their expected proportion, while the next two highest non-fatal injury classifications have 4.375 and 2.252 times their expected proportions when compared with non-Tree crashes. The Speed-at-Impact variable, considered next, indicates one of the primary reasons for this. However, another one of the greatest causes of Tree increased severity and death is their lack of proper restraints.

6.2 Speed at Impact (back to the Fatal vs Non-Fatal Tree comparison)



C224: CU Estimated Speed at Impact	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
6 to 10 MPH	1	0.21	59	0.40	0.519	-0.928
21 to 25 MPH	2	0.42	259	1.77	0.236	-6.464
26 to 30 MPH	4	0.84	370	2.52	0.331	-8.092
31 to 35 MPH	6	1.25	807	5.51	0.228	-20.373
36 to 40 MPH	12	2.51	962	6.56	0.382	-19.439
41 to 45 MPH	34	7.10	2588	17.66	0.402*	-50.577
46 to 50 MPH	17	3.55	1138	7.76	0.457	-20.191
51 to 55 MPH	59	12.32	2266	15.46	0.797	-15.054
56 to 60 MPH	48	10.02	1137	7.76	1.292	10.842
61 to 65 MPH	56	11.69	1016	6.93	1.687*	22.796
66 to 70 MPH	63	13.15	968	6.60	1.991*	31.365
71 to 75 MPH	34	7.10	244	1.66	4.264*	26.026
76 to 80 MPH	27	5.64	159	1.08	5.196*	21.804
81 to 85 MPH	12	2.51	45	0.31	8.160	10.529
86 to 90 MPH	16	3.34	41	0.28	11.941	14.660
91 to 95 MPH	4	0.84	7	0.05	17.485	3.771
96 to 100 MPH	11	2.30	20	0.14	16.830	10.346
Over 100 MPH	7	1.46	12	0.08	17.850	6.608
Unknown	55	11.48	2071	14.13	0.813	-12.682
Not Applicable	7	1.46	137	0.93	1.563	2.523
CU is Unknown	4	0.84	117	0.80	1.046	0.176

It should be noted that the speed limit on County roads is generally 45 MPH, and it is generally lower on Municipal roads. All impact speeds above 51 MPH are significantly over-represented, and the over-representation generally increases with the increase in impact speeds up to 70 MPH,

6.2a C224 Speed at Impact vs. C021 Distance to Fixed Object (all fatal)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Tree -- Coll C017 AND Fatal]

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2018-2022 Alabama Integrated eCrash Crash Data | Tree -- Coll C017 AND Fatal | 1/ 1/2018 | 12/31/20

Suppress Zero Values: Rows and Columns | Select Cells: | Column: CU Estimated Speed at Impact ; Row: Distance to Fixed Object

	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH	76 to 80 MPH	81 to 85 MPH	86 to 90 MPH
Zero - on roadway	1	0	0	0	0	0	0	0
0+ to 2 feet	0	0	0	0	0	0	0	0
2+ to 4 feet	2	0	0	0	1	0	0	0
4+ to 6 feet	1	4	0	1	0	0	0	1
6+ to 8 feet	1	0	1	2	0	0	0	0
8+ to 10 feet	3	4	4	5	3	2	0	0
10+ to 15 feet	8	12	13	11	5	2	1	4
15+ to 20 feet	10	10	7	7	3	3	0	4
20+ to 25 feet	6	3	6	5	5	4	2	2
25+ to 30 feet	5	4	8	1	4	2	1	0
30+ to 40 feet	7	6	6	6	4	3	3	0
40+ to 50 feet	5	0	3	4	2	6	1	1
Over 50 feet	5	2	5	15	4	2	4	2
Not Applicable	5	3	3	6	3	3	0	2
TOTAL	59	48	56	63	34	27	12	16

The Fatal Tree crash problem does not seem to be trees within 10 feet of the roadway. See also Section 4.5a.

The next cross-tabulation quantifies how Speed at Impact relates to the Highway Classification of Tree crashes.

6.3 (C011) Highway Classification by (C224) Speed at Impact Cross-Tabulation

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Tree -- Coll C017 AND Fatal]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Tree -- Coll C017 AND Fatal | 1/ 1/2018

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

	Interstate	Federal	State	County	Municipal	Private Property	TOTAL
6 to 10 MPH	0	0	0	0	0	1	1
21 to 25 MPH	0	0	0	2	0	0	2
26 to 30 MPH	0	0	0	3	1	0	4
31 to 35 MPH	0	0	1	5	0	0	6
36 to 40 MPH	0	0	0	10	1	1	12
41 to 45 MPH	1	0	2	29	2	0	34
46 to 50 MPH	1	2	3	11	0	0	17
51 to 55 MPH	0	9	26	24	0	0	59
56 to 60 MPH	1	1	6	39	1	0	48
61 to 65 MPH	1	9	17	29	0	0	56
66 to 70 MPH	16	2	8	34	3	0	63
71 to 75 MPH	0	9	9	15	1	0	34
76 to 80 MPH	4	4	8	10	1	0	27
81 to 85 MPH	2	3	3	4	0	0	12
86 to 90 MPH	2	1	9	4	0	0	16
91 to 95 MPH	1	1	0	2	0	0	4
96 to 100 MPH	2	1	3	4	1	0	11
Over 100 MPH	1	0	1	4	1	0	7
Unknown	2	3	12	18	20	0	55
Not Applicable	0	0	0	0	7	0	7
CU is Unknown	1	0	0	0	3	0	4
TOTAL	35	45	108	247	42	2	479

6.4 Dicussion: (C011) Highway Classification by (C224) Speed at Impact

The display above presents information on the effect of increased impact speed on the severity of Tree 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:

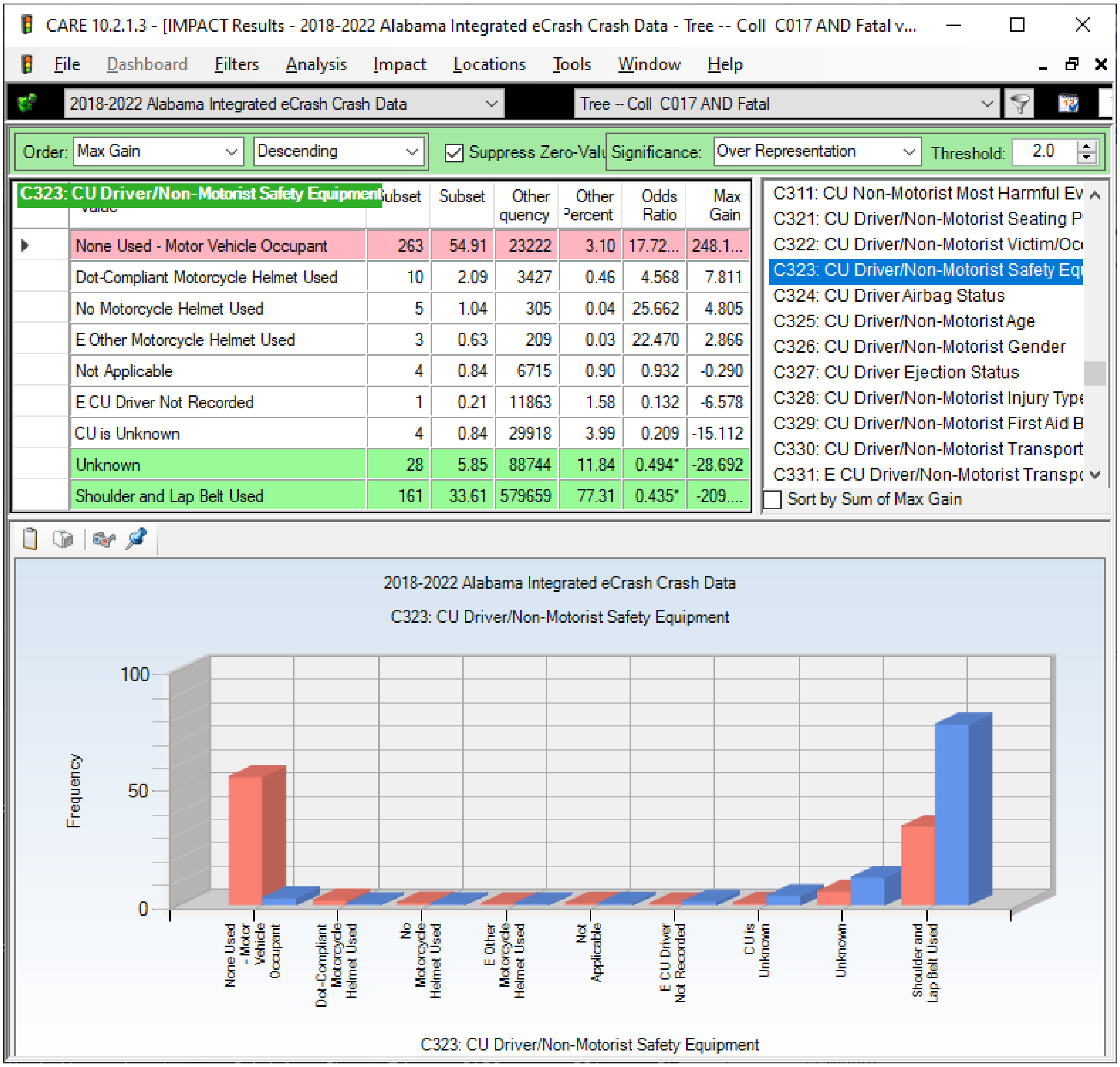
Speed at Impact	Fatality Odds (1 in …)	Increase Probability above 31-35
31-35	813/6 = 136	1.0
36-45	974/12 = 79	1.7
46-55	3480/76 =46	3.0
56-65	2257/104 = 22	8.8
66-75	1309/97 = 13	10.4
76-85	243/39 = 6.2	21.9
86-95	68/20 = 3.4	40.0
Above 95	50/18 = 2.8	48.6

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 one reason that selective enforcement is effective – officer presence generally causes a speed reduction.

However, there is another major factor in effect here as well – the failure of FTC drivers to be properly restrained, which will be covered in the next separate attribute below (6.5; Restraint Use by Causal Drivers in Tree Crashes), which is also correlated with Impaired Driving. Impaired drivers have a much lower restraint use that those not impaired.

6.5 Restraint Use by Drivers in Fatal Tree Collisions

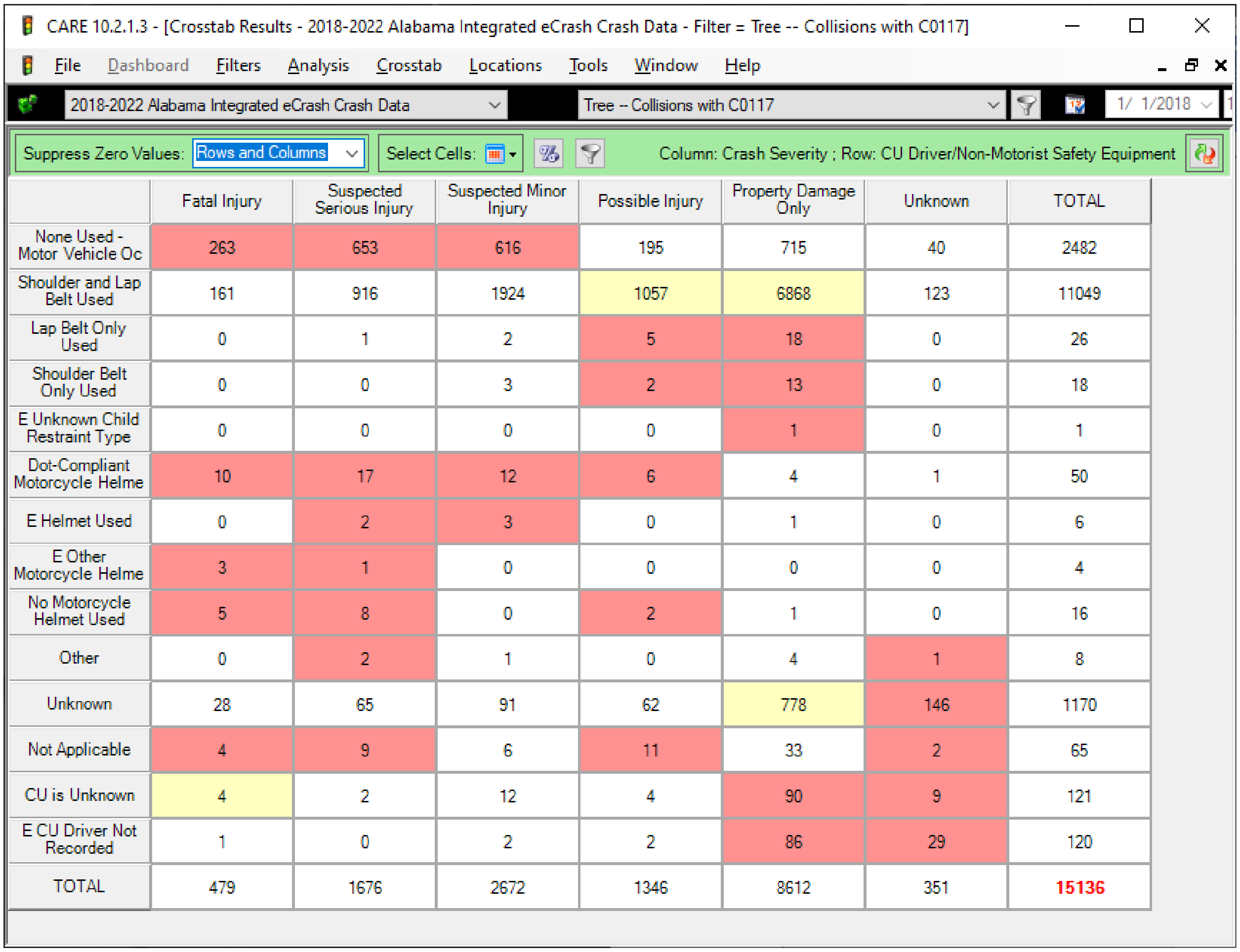
The following display presents a comparison of FTC driver safety belt use compared to all other crashes, over the same five-year time period.



C323: CU Driver/Non-Motorist Safety Equipment Value	Subset	Subset	Other Frequency	Other Percent	Odds Ratio	Max Gain
None Used - Motor Vehicle Occupant	263	54.91	23222	3.10	17.72...	248.1...
Dot-Compliant Motorcycle Helmet Used	10	2.09	3427	0.46	4.568	7.811
No Motorcycle Helmet Used	5	1.04	305	0.04	25.662	4.805
E Other Motorcycle Helmet Used	3	0.63	209	0.03	22.470	2.866
Not Applicable	4	0.84	6715	0.90	0.932	-0.290
E CU Driver Not Recorded	1	0.21	11863	1.58	0.132	-6.578
CU is Unknown	4	0.84	29918	3.99	0.209	-15.112
Unknown	28	5.85	88744	11.84	0.494*	-28.692
Shoulder and Lap Belt Used	161	33.61	579659	77.31	0.435*	-209....

Fatal risk-taking involved in most of the Tree crashes does not stop with excess speed; it extends to being not properly restrained. The above analysis demonstrates that the causal driver in a Fatal Tree crash is over three (3.627) times more likely to be unrestrained than in the Non- Fatal Tree crash. The next analysis demonstrates how this contributes to crashes becoming fatal.

6.6 Crosstabulation: Crash Severity by Restraint Use (C323) - All Tree Crashes



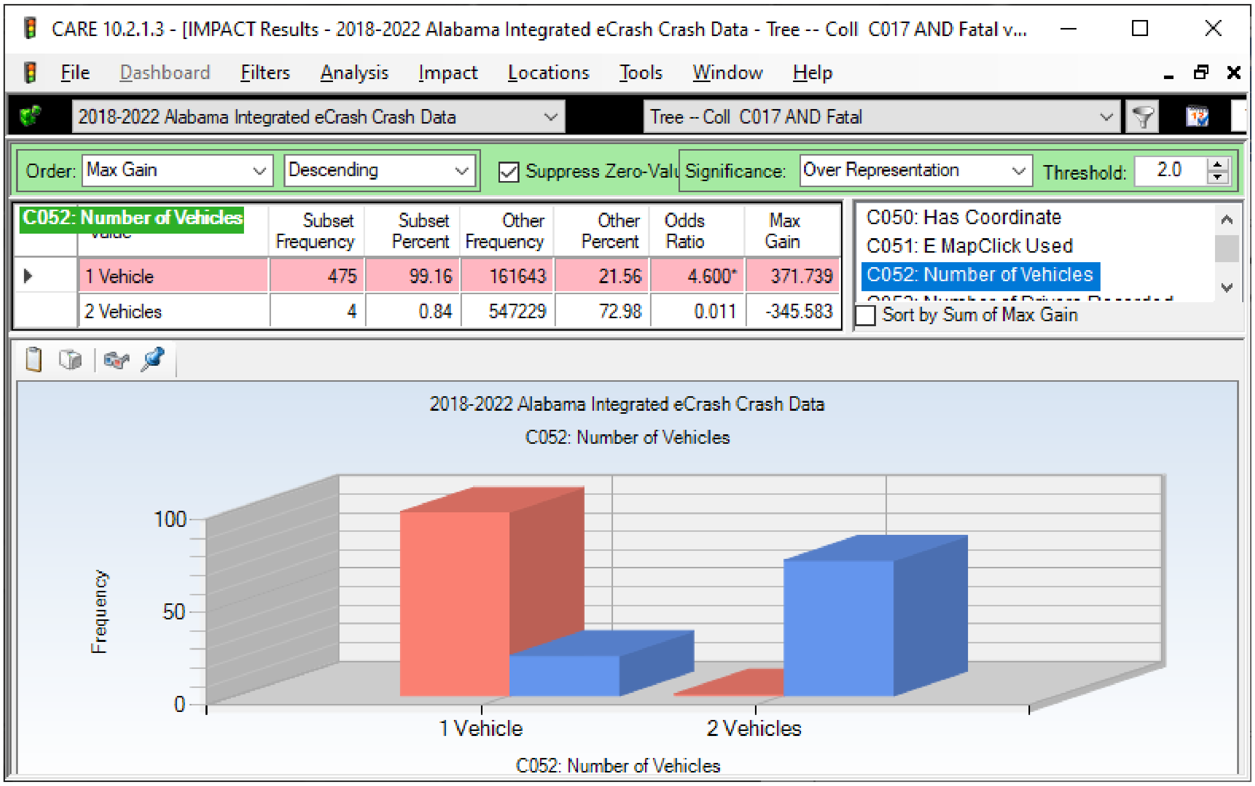
	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
None Used - Motor Vehicle Oc	263	653	616	195	715	40	2482
Shoulder and Lap Belt Used	161	916	1924	1057	6868	123	11049
Lap Belt Only Used	0	1	2	5	18	0	26
Shoulder Belt Only Used	0	0	3	2	13	0	18
E Unknown Child Restraint Type	0	0	0	0	1	0	1
Dot-Compliant Motorcycle Helme	10	17	12	6	4	1	50
E Helmet Used	0	2	3	0	1	0	6
E Other Motorcycle Helme	3	1	0	0	0	0	4
No Motorcycle Helmet Used	5	8	0	2	1	0	16
Other	0	2	1	0	4	1	8
Unknown	28	65	91	62	778	146	1170
Not Applicable	4	9	6	11	33	2	65
CU is Unknown	4	2	12	4	90	9	121
E CU Driver Not Recorded	1	0	2	2	86	29	120
TOTAL	479	1676	2672	1346	8612	351	15136

Odds of death not using restraints = 2,482crashes/263 deaths = one in 9.4 crashes.
Odds of death using restraints = 11,049 crashes/161 deaths = one in 68.6 crashes.

Risk of death is approximately increased by a factor of 7.3 when not using proper restraints.

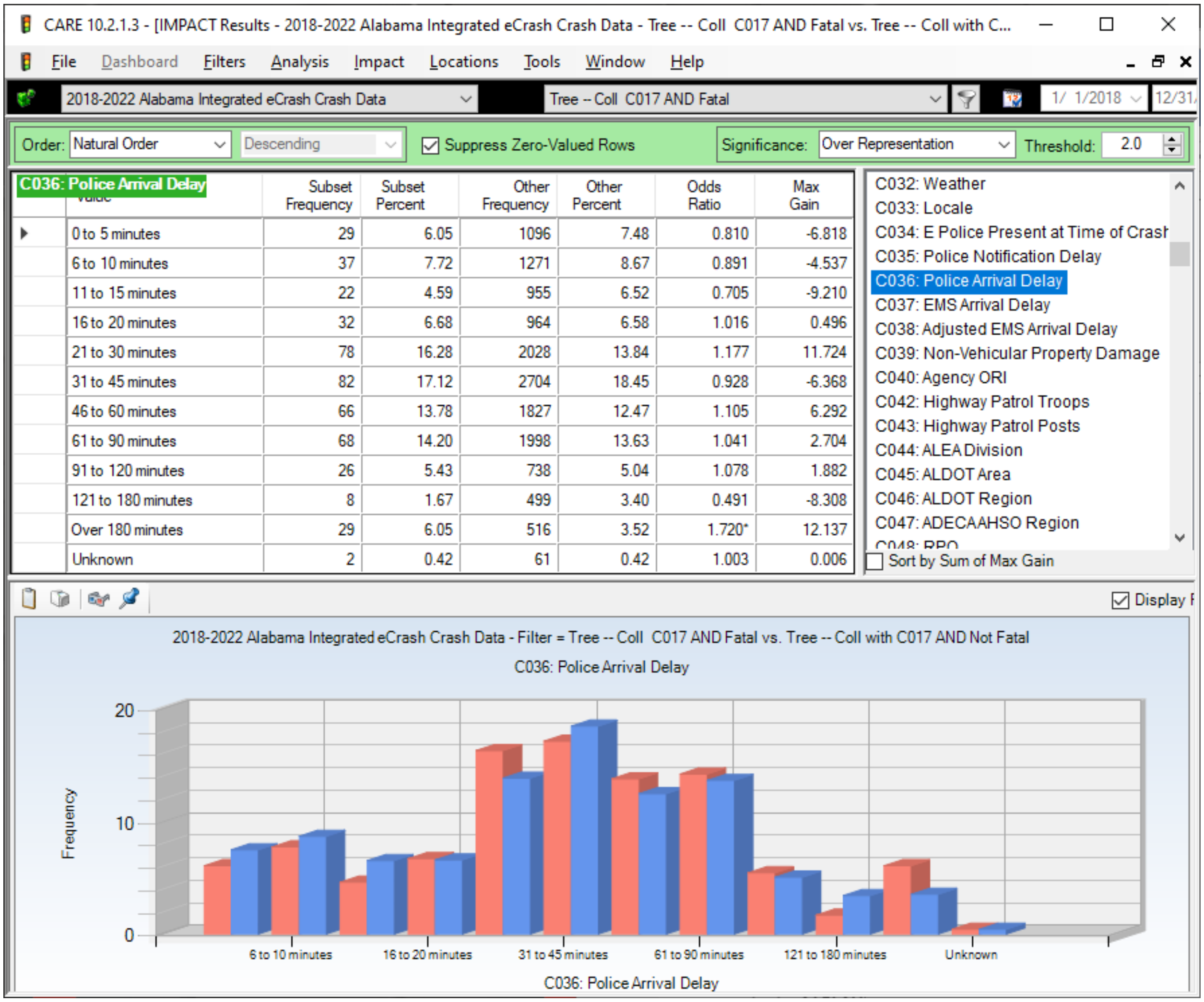
6.7 Number of Vehicles Involved

The following display presents a comparison of the number of vehicles in FTCs against number of vehicles in NFTCs over the five-year time period of the study.



Very few (less than 1% of) FTCs involve more than a single vehicle.

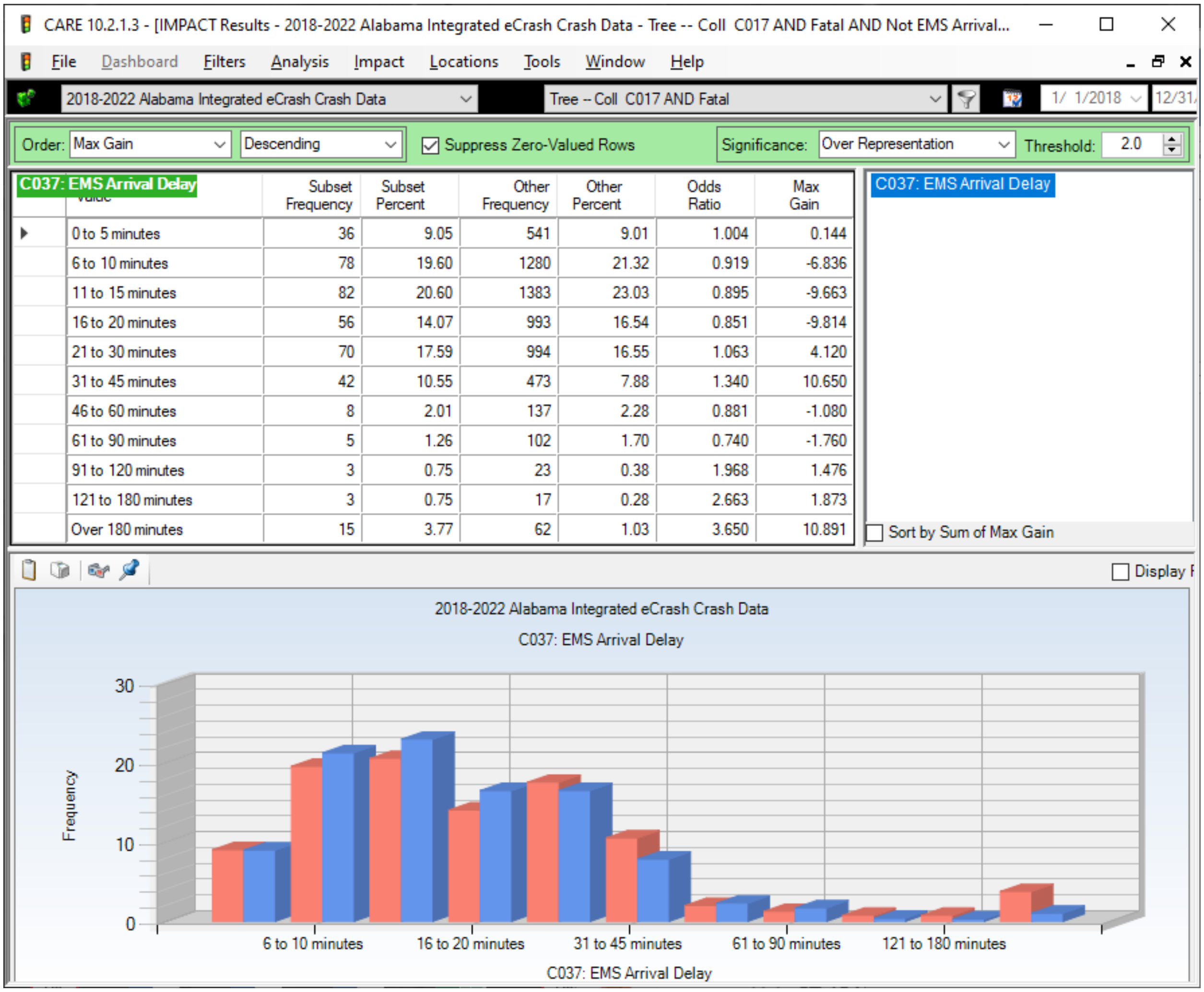
6.8 Police Arrival Delay



C036: Police Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	29	6.05	1096	7.48	0.810	-6.818
6 to 10 minutes	37	7.72	1271	8.67	0.891	-4.537
11 to 15 minutes	22	4.59	955	6.52	0.705	-9.210
16 to 20 minutes	32	6.68	964	6.58	1.016	0.496
21 to 30 minutes	78	16.28	2028	13.84	1.177	11.724
31 to 45 minutes	82	17.12	2704	18.45	0.928	-6.368
46 to 60 minutes	66	13.78	1827	12.47	1.105	6.292
61 to 90 minutes	68	14.20	1998	13.63	1.041	2.704
91 to 120 minutes	26	5.43	738	5.04	1.078	1.882
121 to 180 minutes	8	1.67	499	3.40	0.491	-8.308
Over 180 minutes	29	6.05	516	3.52	1.720*	12.137
Unknown	2	0.42	61	0.42	1.003	0.006

Tree crash police arrival delays reflected the rural nature of tree crashes. 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

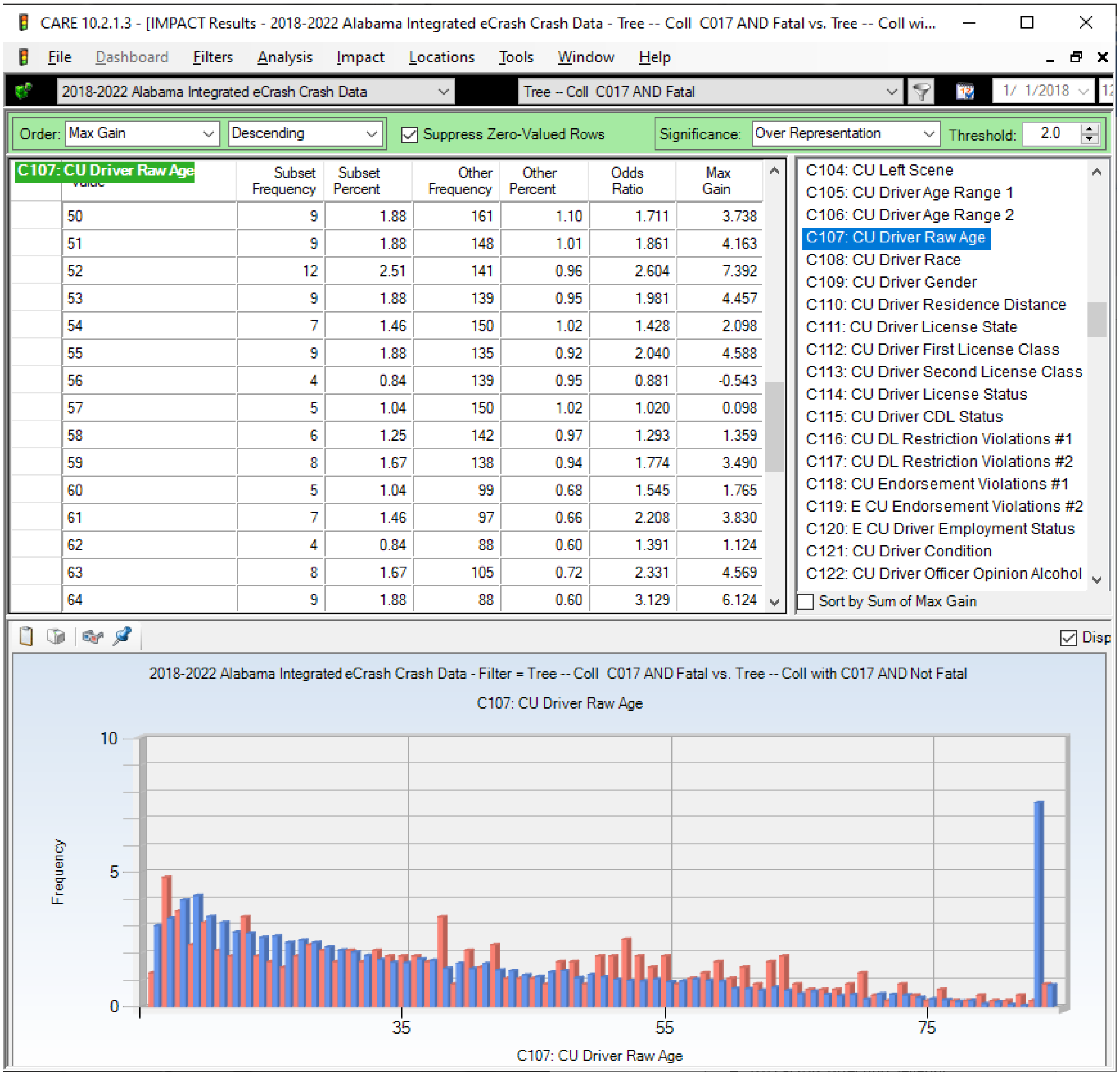


C037: EMS Arrival Delay	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	36	9.05	541	9.01	1.004	0.144
6 to 10 minutes	78	19.60	1280	21.32	0.919	-6.836
11 to 15 minutes	82	20.60	1383	23.03	0.895	-9.663
16 to 20 minutes	56	14.07	993	16.54	0.851	-9.814
21 to 30 minutes	70	17.59	994	16.55	1.063	4.120
31 to 45 minutes	42	10.55	473	7.88	1.340	10.650
46 to 60 minutes	8	2.01	137	2.28	0.881	-1.080
61 to 90 minutes	5	1.26	102	1.70	0.740	-1.760
91 to 120 minutes	3	0.75	23	0.38	1.968	1.476
121 to 180 minutes	3	0.75	17	0.28	2.663	1.873
Over 180 minutes	15	3.77	62	1.03	3.650	10.891

For much the same reasons as the police arrival delays, EMS delays were under-represented for the 0 to 20 minute delays. They were over-represented at the 21-45 minute levels as well as times above 91 minutes. There were relatively few in these very long categories, which were probably caused by the vehicles not be discovered late night on sparsely-traveled roadways (e.g., county roads).

7.0 Driver and Vehicle Demographics

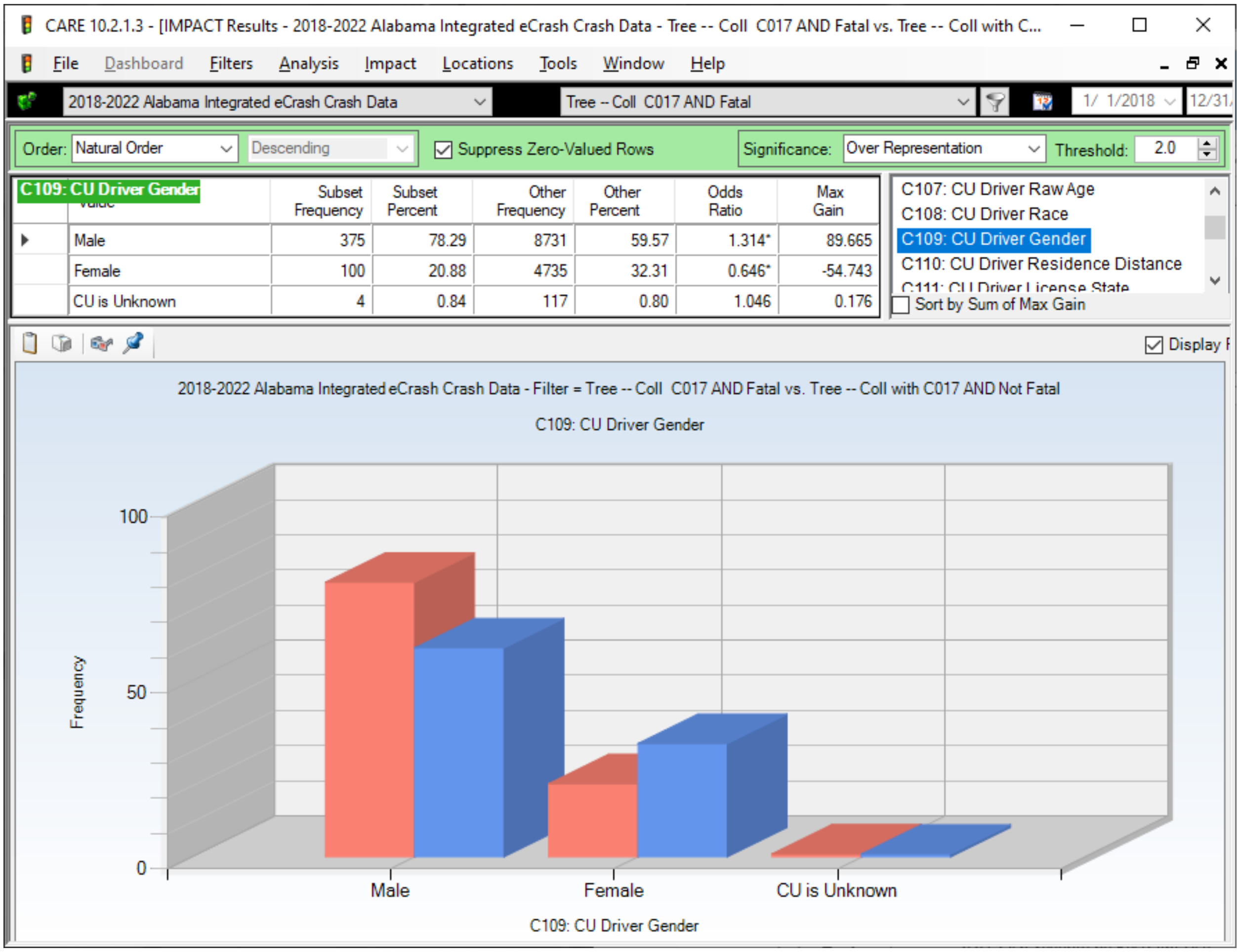
7.1 Driver Age



C107: CU Driver Raw Age Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
50	9	1.88	161	1.10	1.711	3.738
51	9	1.88	148	1.01	1.861	4.163
52	12	2.51	141	0.96	2.604	7.392
53	9	1.88	139	0.95	1.981	4.457
54	7	1.46	150	1.02	1.428	2.098
55	9	1.88	135	0.92	2.040	4.588
56	4	0.84	139	0.95	0.881	-0.543
57	5	1.04	150	1.02	1.020	0.098
58	6	1.25	142	0.97	1.293	1.359
59	8	1.67	138	0.94	1.774	3.490
60	5	1.04	99	0.68	1.545	1.765
61	7	1.46	97	0.66	2.208	3.830
62	4	0.84	88	0.60	1.391	1.124
63	8	1.67	105	0.72	2.331	4.569
64	9	1.88	88	0.60	3.129	6.124

The table display above presents a comparison of Fatal Tree crash causal driver ages against the same for Tree crashes that were not fatal. The blue (Non-Tree) bars illustrate the problems that 16-20-year-old drivers have in all crashes, which are generally not over-represented in FTCs. The most over-represented age interval is in ages from 50-64, which are also shown in the table above.

7.2 Fatal Tree Crash (FTC) Driver Gender



The red bars and the blue bars each sum to 100%. So the breakdown in FTC causal drivers is 78.29% male and 20.08% female. For NFTCs, the percentage is 59.57% male and 32.31% female. These differences in proportions certainly indicate that males are a greater cause of FTCs, 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.

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

7.3 Cross-tabulation of C109 Driver Gender by C224 Speed at Impact

2018-2022 Alabama Integrated eCrash Crash Data | Tree -- Coll C017 AND

Suppress Zero Values: Rows and Columns | Select Cells: | Column: CU Driver Gender ; R

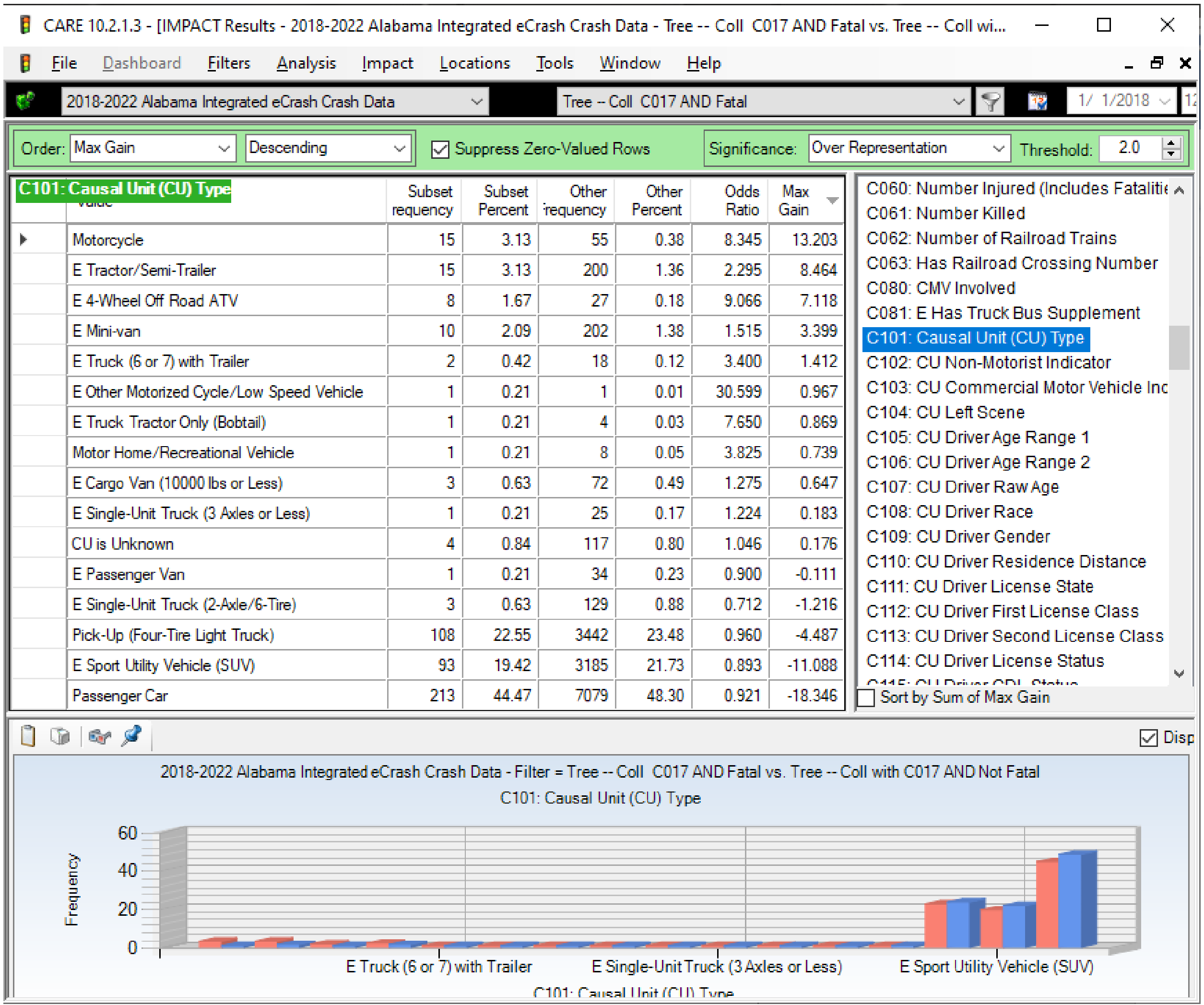
	Male	Female	CU is Unknown	TOTAL
6 to 10 MPH	1 0.27%	0 0.00%	0 0.00%	1 0.21%
21 to 25 MPH	2 0.53%	0 0.00%	0 0.00%	2 0.42%
26 to 30 MPH	2 0.53%	2 2.00%	0 0.00%	4 0.84%
31 to 35 MPH	5 1.33%	1 1.00%	0 0.00%	6 1.25%
36 to 40 MPH	5 1.33%	7 7.00%	0 0.00%	12 2.51%
41 to 45 MPH	25 6.67%	9 9.00%	0 0.00%	34 7.10%
46 to 50 MPH	16 4.27%	1 1.00%	0 0.00%	17 3.55%
51 to 55 MPH	45 12.00%	14 14.00%	0 0.00%	59 12.32%
56 to 60 MPH	36 9.60%	12 12.00%	0 0.00%	48 10.02%
61 to 65 MPH	46 12.27%	10 10.00%	0 0.00%	56 11.69%
66 to 70 MPH	48 12.80%	15 15.00%	0 0.00%	63 13.15%
71 to 75 MPH	26 6.93%	8 8.00%	0 0.00%	34 7.10%
76 to 80 MPH	25 6.67%	2 2.00%	0 0.00%	27 5.64%
81 to 85 MPH	11 2.93%	1 1.00%	0 0.00%	12 2.51%
86 to 90 MPH	15 4.00%	1 1.00%	0 0.00%	16 3.34%
91 to 95 MPH	4 1.07%	0 0.00%	0 0.00%	4 0.84%
96 to 100 MPH	9 2.40%	2 2.00%	0 0.00%	11 2.30%
Over 100 MPH	6 1.60%	1 1.00%	0 0.00%	7 1.46%

Percent male and female over the 70 MPH speed limit:

Male = 25.60%

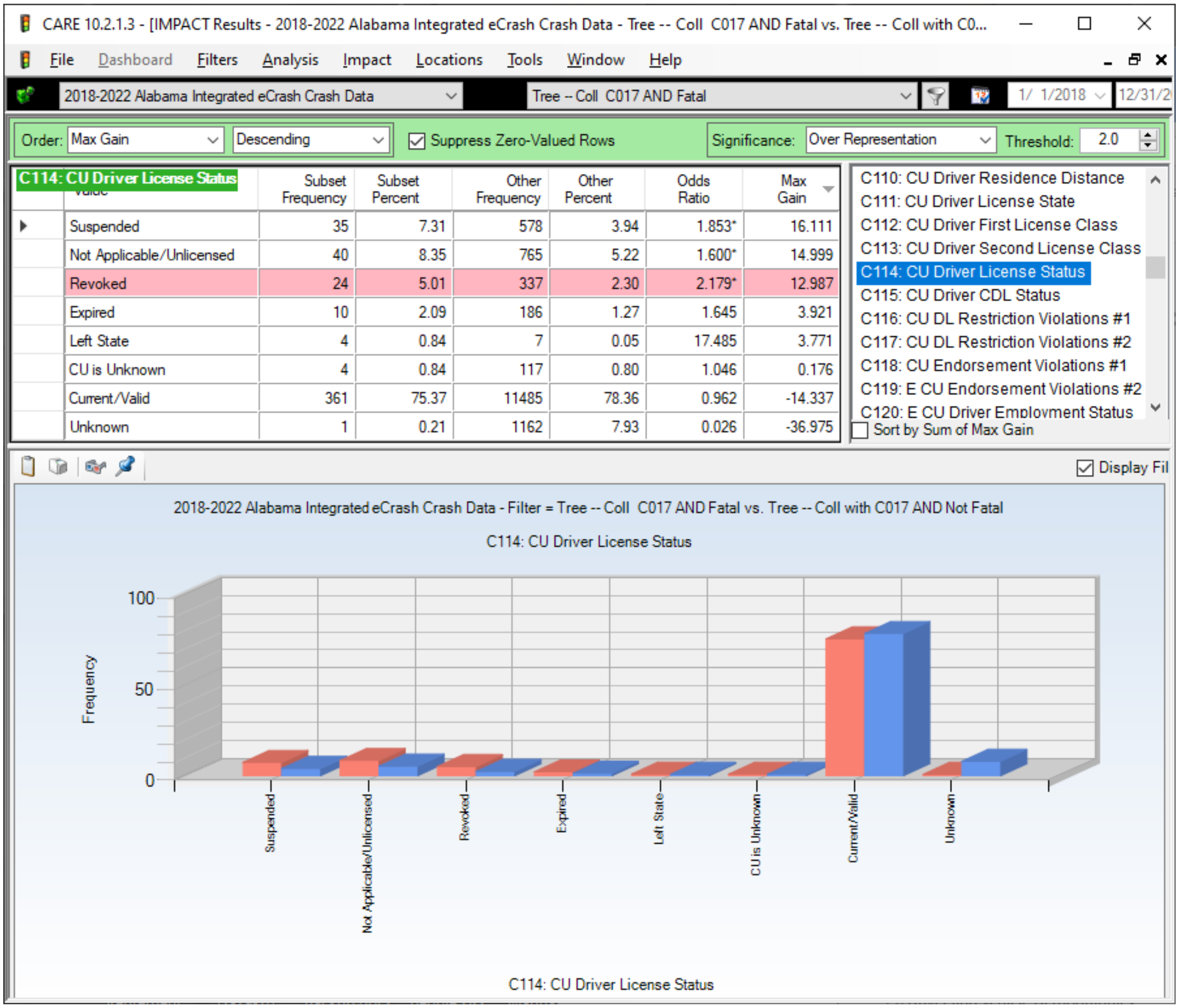
Female = 15.05%.

7.4 Causal Vehicle Types



The display above presents a comparison of FTC causal unit type against the same for NFTCs. Motorcycles have the highest over-representation (8.345) and Max Gain (13.203), indicating well over 8 times their expected proportion in comparison with the NFTC subset. The other vehicle types with over-representations, in order, are Tractor/Semi Trailer, 4-Wheel Off Road ATVs and Minivans. Some vehicles, notably Pick-Ups and Sport Utility Vehicles (SUVs) and Passenger Cars were under-represented indicating their tendency to avoid serious Tree crashes.

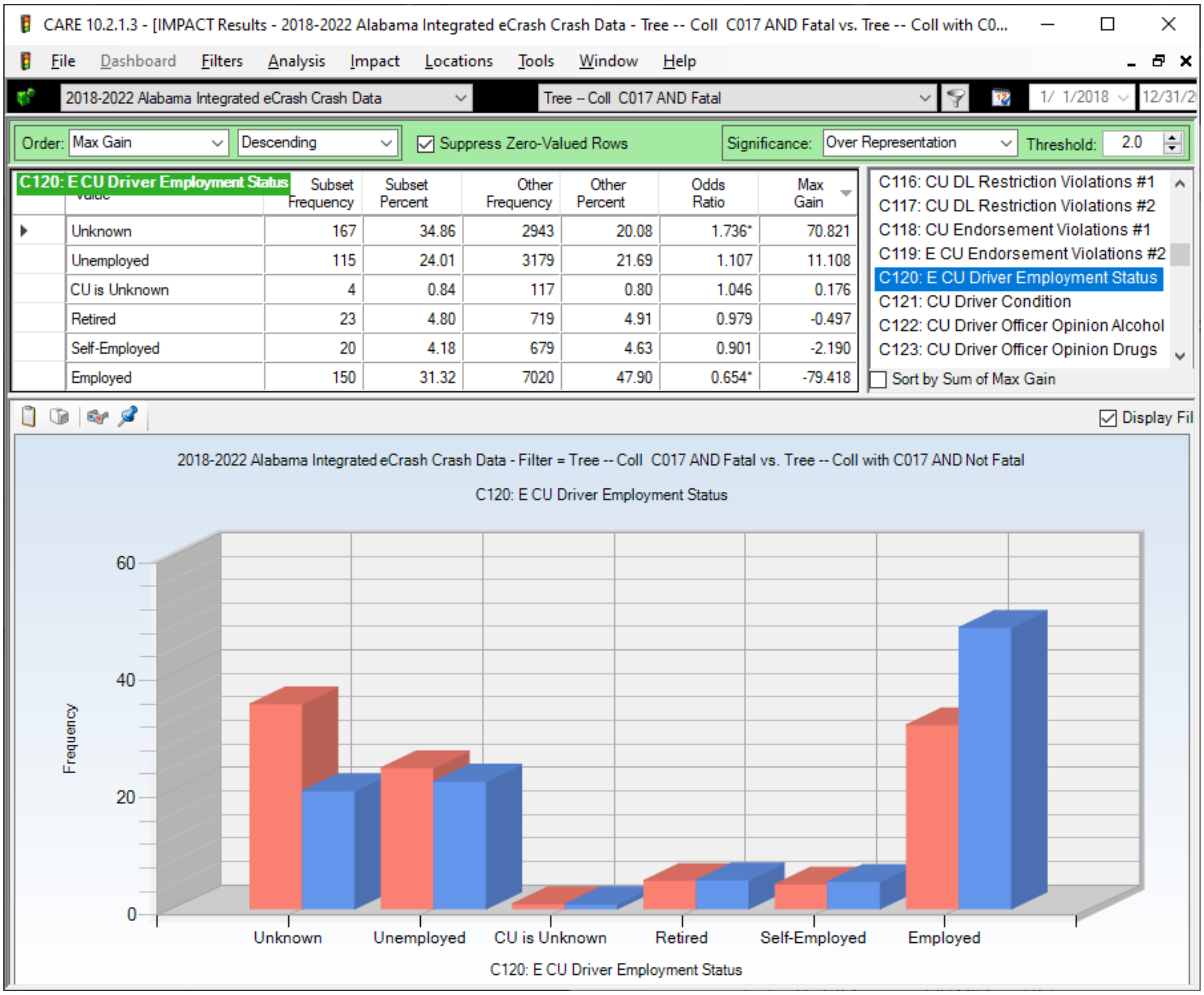
7.5 Driver License Status



C114: CU Driver License Status Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Suspended	35	7.31	578	3.94	1.853*	16.111
Not Applicable/Unlicensed	40	8.35	765	5.22	1.600*	14.999
Revoked	24	5.01	337	2.30	2.179*	12.987
Expired	10	2.09	186	1.27	1.645	3.921
Left State	4	0.84	7	0.05	17.485	3.771
CU is Unknown	4	0.84	117	0.80	1.046	0.176
Current/Valid	361	75.37	11485	78.36	0.962	-14.337
Unknown	1	0.21	1162	7.93	0.026	-36.975

FTCs are over-represented in their causal drivers not having legitimate licenses. They make up over 30% (30.67%) of FTCs. Significant over-representations were found in Suspended (35), Not Applicable/Unlicensed (40), and Revoked (24), all of which had very comparable Max Gains.

7.6 Driver Employment Status

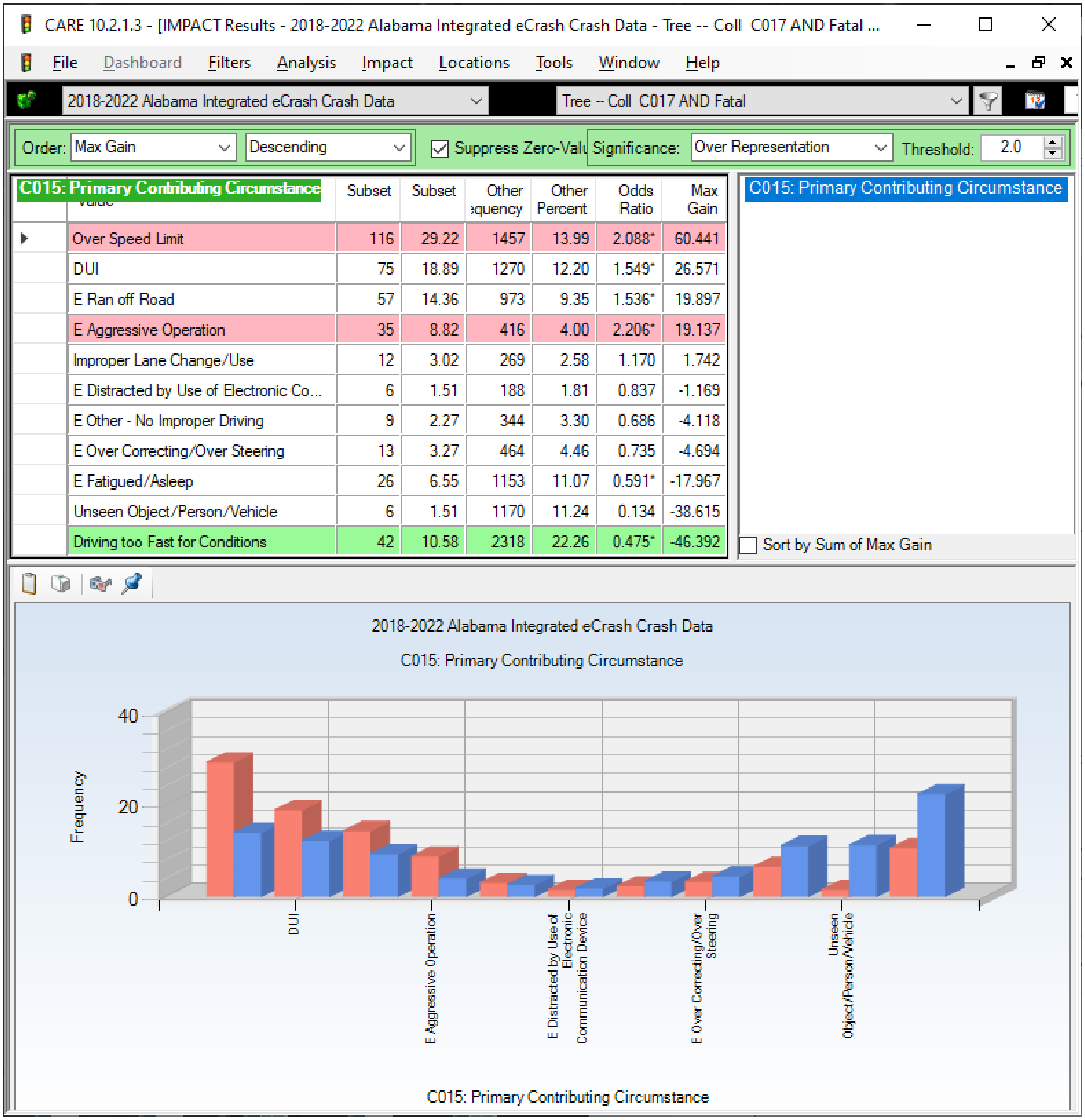


C120: E CU Driver Employment Status Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Unknown	167	34.86	2943	20.08	1.736*	70.821
Unemployed	115	24.01	3179	21.69	1.107	11.108
CU is Unknown	4	0.84	117	0.80	1.046	0.176
Retired	23	4.80	719	4.91	0.979	-0.497
Self-Employed	20	4.18	679	4.63	0.901	-2.190
Employed	150	31.32	7020	47.90	0.654*	-79.418

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 all types of crashes is important. The above indicates that their employment rate is 16.58 lower than expected. This relationship is not surprising because of the underlying drug/alcohol root cause of many Tree crashes (8.3-8.4). The correlation between not having a job and being involved in a Tree crash should be watched carefully, in that it could affect the type and location of countermeasures.

8.0 Driver Behavior

8.1 Primary Contributing Circumstances (Items < 5 Crashes Removed)



C015: Primary Contributing Circumstance Value	Subset	Subset	Other equency	Other Percent	Odds Ratio	Max Gain
Over Speed Limit	116	29.22	1457	13.99	2.088*	60.441
DUI	75	18.89	1270	12.20	1.549*	26.571
E Ran off Road	57	14.36	973	9.35	1.536*	19.897
E Aggressive Operation	35	8.82	416	4.00	2.206*	19.137
Improper Lane Change/Use	12	3.02	269	2.58	1.170	1.742
E Distracted by Use of Electronic Co...	6	1.51	188	1.81	0.837	-1.169
E Other - No Improper Driving	9	2.27	344	3.30	0.686	-4.118
E Over Correcting/Over Steering	13	3.27	464	4.46	0.735	-4.694
E Fatigued/Asleep	26	6.55	1153	11.07	0.591*	-17.967
Unseen Object/Person/Vehicle	6	1.51	1170	11.24	0.134	-38.615
Driving too Fast for Conditions	42	10.58	2318	22.26	0.475*	-46.392

8.2 Discussion of Primary Contributing Circumstances (PCC) Result Above

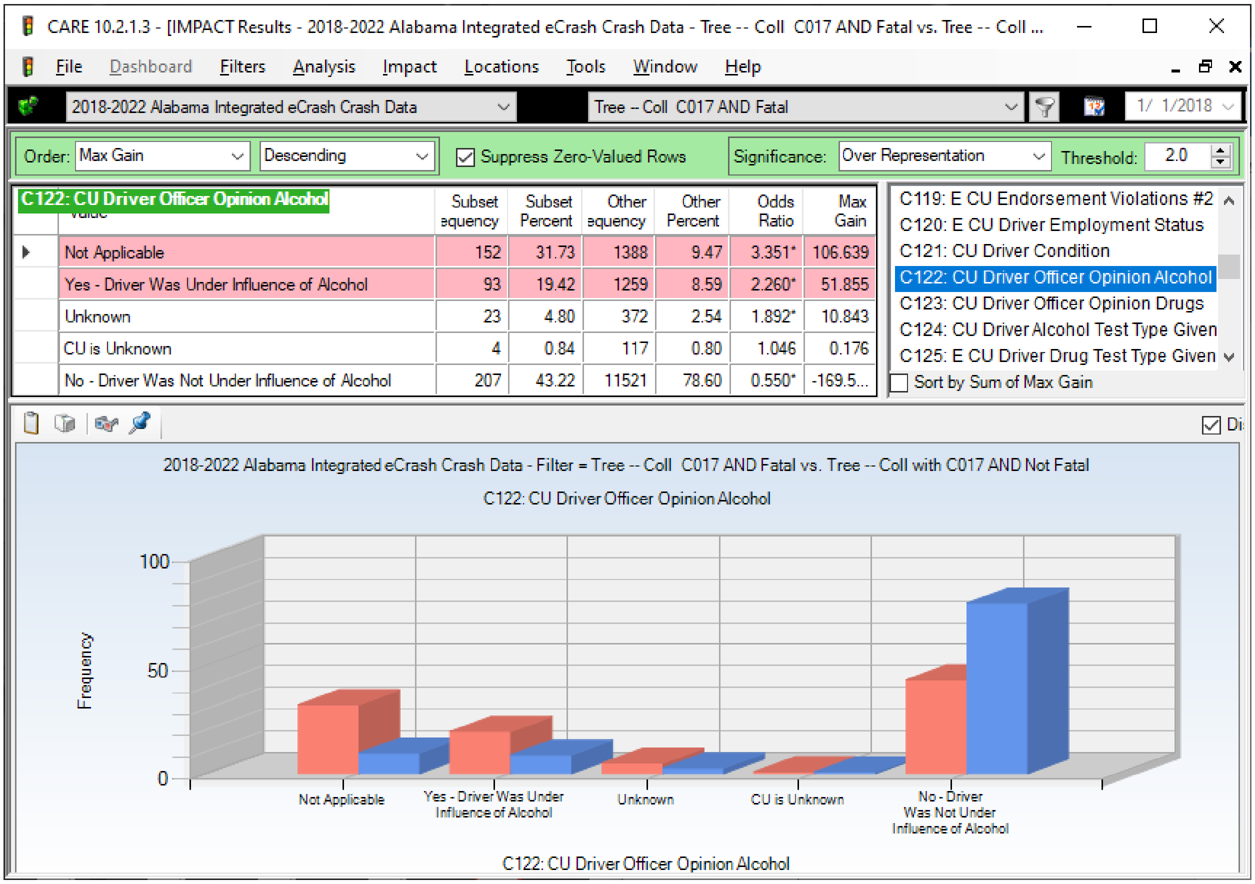
These results demonstrate the driver behaviors that accompanied FTCs as they were defined by the C015, Primary Contributing Circumstances.

FTC items over-represented in their expected proportion (when compared to NFTCs) are ordered by Max Gain as follows:

- Over Speed Limit,
- DUI (Impaired Driving),
- Ran off Road,
- Aggressive Operation, and
- Improper Land Change/Use.

Most of the above are reasonably associated with running off the road and hitting whatever obstacle might exist. Each should be viewed in terms of their relative positions in the table as opposed to any one of them being the absolute cause.

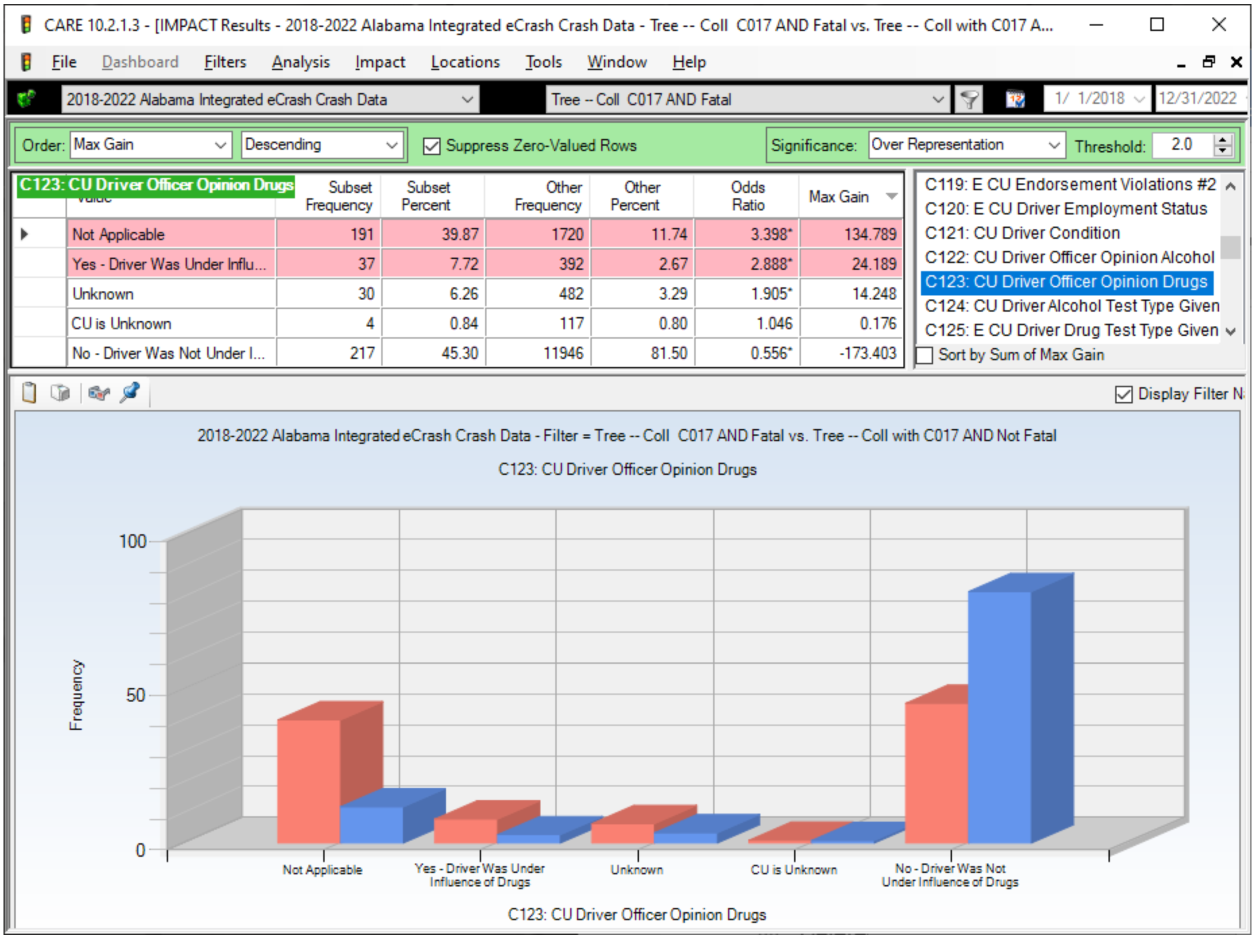
8.3 CU Driver Officer's Opinion Alcohol



Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Not Applicable	152	31.73	1388	9.47	3.351*	106.639
Yes - Driver Was Under Influence of Alcohol	93	19.42	1259	8.59	2.260*	51.855
Unknown	23	4.80	372	2.54	1.892*	10.843
CU is Unknown	4	0.84	117	0.80	1.046	0.176
No - Driver Was Not Under Influence of Alcohol	207	43.22	11521	78.60	0.550*	-169.5...

While Impaired Driving/Alcohol was indicated as the cause of the crash for 19.42% of the FTCs, the fact that this proportion was over-represented by a factor of 2.260 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 FTCs.

8.4 CU Driver Officer's Opinion Drugs



The reported non-alcohol drug use in FTCs is less than half of that for alcohol. The 37 cases are only about 7.72% of all FTCs. However, the Odds Ratio (2.888) indicates that it has an over-representation comparable to that of alcohol. In both cases (FTC and NFTC), 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 FTCs, and their use is further compounded it they choose to avoid detection by using county roads.

9.0 Appendix: Supplementary Information

Available Literature. 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 to eliminate or mitigate the hazard of large trees. 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.

The following were some supplementary documents found:

- 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_ClearZoneinAASHTODocuments-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."