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Frequency and Severity of Tree and Other Fixed Object Crashes in Florida, 2006–2013

Jeffery W. Van Treese II, Andrew K. Koeser,
George E. Fitzpatrick, Michael T. Olexa, and Ethan J. Allen

Abstract. Roadside trees provide benefits to drivers such as traffic calming, roadway definition, and driver stress reduction. However, trees are also one of several roadway infrastructure elements commonly involved in single-vehicle crashes. In this study, Florida Highway Saftey and Motor Vehicle records were analyzed to: evaluate the relative frequency of tree-related crashes compared to other fixed-object crashes; assess the impact of roadway-, vehicle-, and driver-related factors on tree crash frequency; and compare the severity of tree crashes relative to other single-vehicle crashes. In accessing 3,033,041 crash records from 2006 to 2013 (all complete years), we identified 323,581 single-vehicle accidents (10.6%) and 47,341 tree-related accidents (1.6%). Trees were the third most common fixed object hit in urban single-vehicle accidents and the second most common fixed object hit in rural single-vehicle accidents. Driver gender, vehicle type, light conditions, weather conditions, and land use all were correlated with the frequency. Additionally, the injuries associated with tree crashes were more severe than all other single-vehicle crash types except vehicle rollovers.

Key Words. Risk; Single-Vehicle Collisions; Transportation; Tree Hazards; Urban Forestry.

INTRODUCTION

Risk is a combination of the probability of an event occurring and the consequence of the event should it occur (Frank and Bernanke 2004). When urban foresters and other professionals assess tree risk, they typically focus on the probability that a tree (or part of a tree) will fail and strike a target such as a person or property. Smiley et al. (2011) describes a tree as hazardous if it has both a structural defect that predisposes the tree to failure and a target that would be struck if it were to fall. Smiley et al. (2011) goes on to say that healthy trees may be hazardous if they obstruct a motorist's vision, raise sidewalks, interfere with utilities, or are particularly attractant to lightning. To the extent trees are evaluated as roadside hazards, research in arboriculture and urban forestry has been limited to the risk posed by a tree or branch should it fall on, or immediately in front of, a passing vehicle (Ellison 2005; Rooney et al. 2005; Laefer and Pradhan 2006; Klein et al. 2016). In contrast, research from transportation and planning has largely focused on trees and their potential involvement in fixed-object vehicle crashes (Zeigler 1986; Turner and Mansfield 1990; Lee and Mannering 1999; Naderi 2003; Dumbaugh 2005; Holdridge et al. 2005; Dumbaugh 2006; Mok et al. 2006; Wolf and Bratton 2006; Abdin et al 2009; Park and Abdel-Aty 2015).

Roadside vegetation is a significant component of roadway planning. Between 2008 and 2013, the Florida (United States) Department of Transportation spent $209 million on highway landscaping (Khachatryan et al. 2014). This roadside beautification led to $46 million in annual output impacts (total state expenditure) and $28 million in annual value added impacts (wages, increased property income, proprietor income, indirect business taxes, and capital consumption) (Khachatryan et al. 2014). While harder to quantify than the economic benefits noted above, tree-lined roadsides increase the aesthetic appeal of streetscape vegetation, reduce driver stress, and facilitate a more pleasant driving experience when compared to more barren streetscapes (Wolf 2003). These benefits may be especially important for drivers who become frustrated with traffic congestion and long commutes

(Cackowski and Nasar 2003). The psychological health benefits of roadside vegetation are an important consideration for landscape planning.

At the same time, streetscape trees are fixed objects that can be struck during run-off-road (ROR) accidents (Turner and Mansfield 1990; Wolf and Bratton 2006). The relative risk of tree crashes is dependent on a number of variables, including roadway design, roadway conditions, vehicle weight, and roadway geometry (Wolf and Bratton 2006; Abdin et al. 2009). However, there is some disagreement among researchers as to the effect of fixed objects (such as trees) on crash frequency. Some researchers such as Ewing and Dumbaugh (2009) argue that roadside trees promote safety by enhancing roadway definition, whereas other researchers posit that roadside trees are hazardous (Hall et al. 1976; Zeigler 1986; Turner and Mansfield 1990).

In addition to crash frequency, it is important to identify crash-related factors associated with severe injuries or death. Holdridge et al. (2005) modeled injury severity in fixed-object crashes and found that trees, utility poles, and the leading ends of guardrails increase the probability of fatal injuries in ROR crashes. Harvey and Aultman-Hall (2015) conducted a logistic regression study of 244,684 crashes in New York City between 2011 and 2013 and found that smaller, more enclosed streetscapes were characterized by less severe crashes. The authors suggested that a more constrained streetscape makes drivers more aware of potential hazards and causes them to engage in less risky driving behavior (Harvey and Aultman-Hall 2015). While these works offer key insights, other factors related to the driver, vehicle, site, and fixed object struck during an ROR collision may impact crash severity.

Quantifying the relative frequency and severity of tree-related, single-vehicle ROR crashes is an important step in assessing past roadside vegetation management efforts and developing future management plans. In assessing the frequency and severity of tree-related crashes, we posed the following research questions: (1) What is the impact of land use (urban/rural), vehicle type, light conditions, and weather conditions on tree and non-tree crash frequency? and (2) How does the severity of tree-related accidents compare to other single-vehicle accidents? Our results highlight the potential costs of roadside trees with regard to injury and death. In identifying these potential costs, those managing trees along roadways can begin to assess whether the benefits of roadside trees outweigh the potential risks.

MATERIALS AND METHODS

Archival vehicle accident data collected by the Florida Department of Highway Safety and Motor Vehicles (FL DHSMV) from 2006 to 2014 were analyzed between December 2016 and February 2017. These data was collected from reports (HSMV Long Report Form 90005) filled out by police officers responding to crash events. The DHSMV data included 3,033,048 crashes in total. Of these, only single-vehicle crashes were included in our analysis of crash severity. Within the single-vehicle crash data, motorcycle crashes and commercial vehicle crashes were excluded—leaving a final dataset containing 323,581 unique events. Data were standardized as needed to account for revisions made to the long report form in 2011. For example, before 2011, there were multiple ways to record seatbelt use (e.g., lap belt only, shoulder harness only, both lap belt and shoulder harness). With the revised form, this was a simple yes or no response. In cases where differences in data resolution were noted, choices were aggregated (if possible) to make direct comparisons. In some cases, the 2011 revisions made it impossible to match variables across the entire data set. These variables were ultimately dropped from the analysis.

Chi-square tests were used to assess the impact of various driver-, site-, and vehicle-related factors that influenced crash frequency. These tests were completed using the prop.test() function in R (R Development Core Team, 2017). Specifically, we assessed whether or not the number of tree-related collisions varied by driver gender, suspected alcohol/drug use (i.e., yes vs. no), vehicle type, land use (i.e., rural vs. urban), light conditions (i.e., daylight, dark with lighting, dark, dusk/dawn), and weather conditions (i.e., clear, cloudy, low visibility, precipitation, severe winds).

In modeling crash severity, we utilized the variable *First Harmful Event* to determine what type of single-vehicle collision occurred (e.g., striking one of several fixed objects, rollover, or simply going off the road). The DHSMV (2008) defines *First Harmful Event* as the *"*injury or damage producing event which characterizes *the* crash type and identifies the nature of the first harmful event." *First Harmful Event* (hereafter, *Crash Type*) levels were standardized as one of the following: tree, barrier, ditch, fence, no fixed object (and no rollover), pole, sign, structure, water, and rollover. Additional predictors beyond first harmful event are listed in Table 1.

The outcome variable *severity* was recorded as one of four levels: none, minor, severe, and fatal.

Table 1. Predictor variables and the associated levels/baselines used when modeling injury severity for single-vehicle accidents in Florida (United States) from 2006–2013.

Predictor	Levels of predictor	Base level for model
Gender	Female Male	Female
Age	Continuous variable	None
Seatbelt use	Yes No	No
Airbag deployed	Yes No	No
Occupant ejected	Yes No Partially	No
Drug/Alcohol use	Yes No	No
Estimated speed	Continuous variable	None
Land use	Rural Urban	Rural
Road type	County/State Forest Interstate/Tollway Local	County/State
Shoulder type	Curb Paved Unpaved	Curb
Road surface conditions	Dry Loose Slippery Standing water	Dry
Light conditions	Daylight Dark Dark w/lighting Dawn/Dusk	Daylight
Weather conditions	Clear Cloudy Low visibility Precipitation Severe winds	Clear
Crash type	Barrier Ditch Fence No fixed object Other Pole Rollover Sign Structure Tree Water	Tree

None corresponded to no injury. *Minor* injuries were defined as injuries that were non-incapacitating and non-disabling (DHSMV 2008). Examples of minor injuries included lacerations, scrapes, or bruises. *Major* injuries were defined as injuries that were incapacitating or disabling (DHSMV 2008). Examples of major injuries included broken bones and severed limbs. *Fatal* injuries were defined as injuries resulting in death within 30 days of the crash (DHSMV 2008).

Crash severity was modeled via ordered logistic regression using the polr() function from the MASS package in R (Venables and Ripley 2002). Odds ratios and their associated 95% confidence intervals were calculated for greater ease in interpretation. A *P*-value of 0.05 was chosen as the threshold for statistical significance for all of the above-mentioned tests.

RESULTS AND DISCUSSION

Relative Frequency of Tree-Related Crashes

Of the 323,581 single-vehicle crashes analyzed, 47,341 (14.6%) involved a collision with a tree. In urban areas, tree collisions were the third most common crash type observed (Figure 1). In rural areas, tree-related crash types were the second most common crash type. That said, the percentage of tree-related crashes was quite similar for urban (14.2%) and rural (15.0%) settings (Figure 1). Given the large sample size, this small difference was still statistically significant (*P*-value < 0.0001).

Beyond land use, the relative proportion of tree-related crashes differed given light condition (*P*-value < 0.0001). Nearly a quarter (23.1%) of single-vehicle crashes occurring at night under lighted conditions involved a tree. In contrast, trees were only involved in 10.0% of crashes occurring during the day, 9.8% of crashes occurring at dusk or dawn, and 8.2% of crashes occurring at night without supplemental lighting. The difference in proportions between “dark with lighting” and the other three lighting scenarios (especially dark without lighting) suggests street lighting may be ineffective in preventing tree collisions. The presence or absence of lighting at night may impact driving behavior (perhaps drivers traveling along unlit roads are more cautious). It may also highlight a relationship between illuminated roadways, tree crashes, and some unmeasured predictor variable.

Given the data available, we were not able to normalize for vehicle-miles travelled/road use intensity.

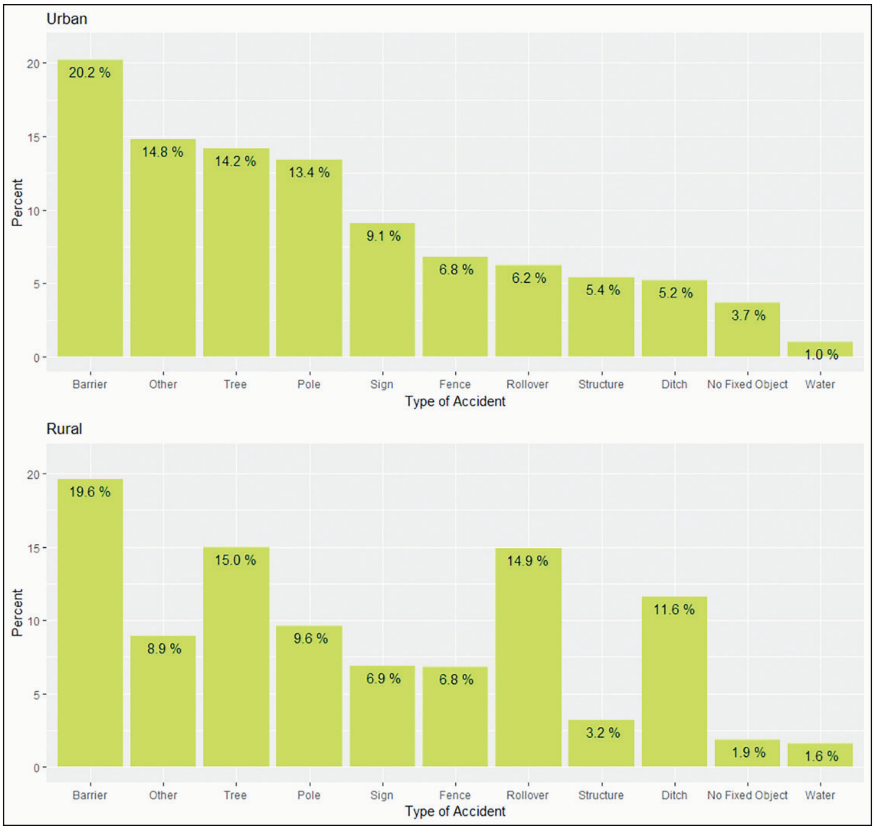

Figure 1. Comparison of single-vehicle (excluding commercial vehicles and motorcycles) crash types for urban and rural settings. The figure represents 323,581 crash events that occurred in Florida (United States) from 2006 to 2013. Parked car crashes not shown as less than 1% (0.6% for urban and 0.0% for rural).

Therefore, it is possible that differences in crash frequency could be attributed to greater road use, rather than the variable in question (e.g., lit roadways are traveled more often than unlit roadways, which is reflected in the elevated accident rates).

Of course, the inability of the authors to normalize road use intensity limits any definitive extrapolations. In addition, trees and lights may co-occur, leading to greater crash frequency in a “dark with lighting” scenario. In order to fully understand the effect of lighting on trees, it would be necessary to normalize road use intensity and the presence of trees in varying scenarios.

The proportion of single-vehicle crashes involving trees also varied by weather conditions (*P*-value < 0.0001). The order of tree crash frequency for weather conditions (most frequent to least frequent) is (1) severe crosswinds (14.29%), (2) low visibility (9.48%), (3) clear weather (6.8%), (4) precipitation (4.48%), (5) cloudy weather (3.72%). An equality of proportions test for drug/alcohol use showed no significant difference in tree-crash frequency for drug/alcohol use as compared to no drug/alcohol use (proportion of tree crashes for drug/alcohol use [10.83%], proportion of tree crashes for no drug/alcohol use [11%], $p = 0.2521$). It should be noted that this does not imply that drivers under the influence of drugs/alcohol are as safe as sober drivers (we do not have the data to address this question).

Impact of Crash Type and Other Factors on Injury Severity

Of the 47,341 tree-related crashes, 22,061 (46.6%) were without injury (Figure 2). The second most common injury level for tree-related crashes was “minor.” There were 19,315 tree-related accidents (40.8%) where minor injuries were recorded. Severe injuries and death were the two least common consequences of a tree-related car accident, making up 10.8% and 1.7% of crashes recorded, respectively (Fig. 2).

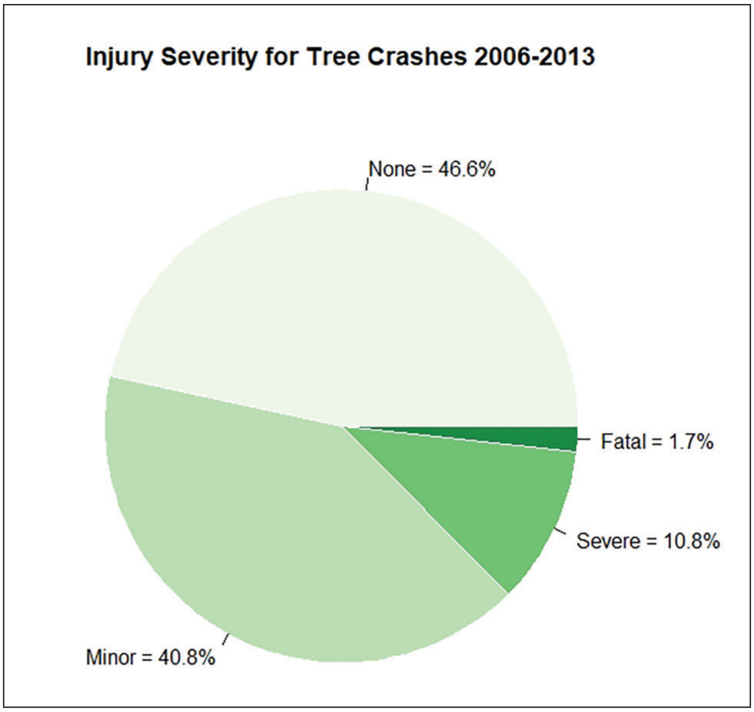

Figure 2. The proportion of tree-related crashes that resulted in no, minor, severe, and fatal injuries. The figure depicts the relative severity of 47,341 tree-related car crashes recorded in Florida (United States) from 2006 to 2013.

The results of the regression model show that tree crashes were more severe than all other single-vehicle crash types except rollovers (*P*-value < 0.0001; Table 2). In Table 2, the crash type *Tree* serves as the base level for the crash type factor. The odds ratios correspond to the odds of crash type *Tree* being one severity level higher (e.g., minor as opposed to none, severe as opposed to minor, and fatal as opposed to severe) than each of the listed crash types. When compared to all non-rollover crash types, tree-related crashes were 1.2 to 2.5 times more likely to have an increased severity (all other factors held constant; Table 2) than crashes with other fixed objects. Crashes with signs and structures tended to be among the least severe as compared to tree-related crashes.

In contrast, rollover crashes were 1.5 times more likely to have an increased severity level than tree crashes (all other factors held constant; Table 2). In fact, rollovers were more severe than all other single-vehicle crash types. Rollovers were nearly twice as prevalent (proportionally) in rural areas compared to urban areas (proportion of rollovers in urban areas [6.1%], proportion of rollovers in rural areas [14.72%], *P*-value < 0.0001).

STUDY LIMITATIONS

Comparison to Other Literature on Tree Crashes

The relatively higher tree-crash frequency in rural areas compared to urban areas in the present study is consistent with existing literature on tree crashes (although the difference was very small in our study). Wolf and Bratton (2006) found that tree crashes were more frequent and more severe in rural areas when compared to urban areas. The authors argued that higher speeds in rural areas contributed to this difference. Dumbaugh (2005) suggests that fixed objects in an urban roadside promote safety by reducing speed and enhancing driver caution. Dumbaugh (2005) compared two similar urban roadways and found that the roadway with larger lane widths and clear zones had more crashes than the roadway with narrower lanes and clear zones. In other words, if a more "forgiving" roadway with larger clear zones and lane widths induces drivers to increase speed, this explains why rural areas with the attributes above have more severe and more frequent tree crashes compared to urban areas. Also, Harvey and Aultman-Hall (2015)

Table 2. Factors influencing crash severity (i.e., none vs. minor vs. severe vs. fatal) for single-vehicle crashes. Model derived from 323,581 single-vehicle crash events (not including commercial vehicles and motorcycles) that occurred in Florida (United States) from 2006—2013.

Predictor variable	Coefficient	Standard error	P-value	Odds ratio	Lower 95% CI	Upper 95% CI
Gender – male	-0.4506	0.0115	<0.0001	0.6373	0.6231	0.6518
Age	0.0119	0.0004	<0.0001	1.0120	1.0113	1.0127
Drug/Alcohol use – yes	-0.1010	0.0165	<0.0001	0.9039	0.8752	0.9336
Vehicle – truck	0.0692	0.0127	<0.0001	1.0716	1.0454	1.0986
Vehicle – van	0.0585	0.0273	0.0320	1.0602	1.0050	1.0986
Land use – urban	-0.0481	0.0128	0.0002	0.9530	0.9294	0.9772
Road – local	-0.1819	0.0156	<0.0001	0.8337	0.8087	0.8596
Road – interstate	-0.3631	0.0168	<0.0001	0.6955	0.6721	0.7188
Road surface – loose	-0.4175	0.0916	<0.0001	0.6587	0.5505	0.7882
Road surface – water	-0.2329	0.0219	<0.0001	0.7923	0.7590	0.8270
Shoulder – paved	-0.0536	0.0196	0.0062	0.9478	0.9121	0.9849
Shoulder – unpaved	0.0655	0.0176	0.0002	1.0677	1.0315	1.1051
Light conditions – dark w/lights	-0.1988	0.0149	<0.0001	0.8198	0.7961	0.8441
Light conditions – dark	-0.0791	0.0156	<0.0001	0.9240	0.8961	0.9527
Light conditions – dawn/dusk	-0.0761	0.0266	0.0043	0.9267	0.8796	0.9764
Weather – cloudy	0.1246	0.0164	<0.0001	1.1326	1.0969	1.1695
Weather – low visibility	0.1445	0.0548	0.0084	1.1555	1.0378	1.2865
Seatbelt – yes	-1.2963	0.0226	<0.0001	0.2735	0.2617	0.2859
Airbag – not deployed	-1.1149	0.0122	<0.0001	0.3279	0.3202	0.3359
Ejected – partially	2.5154	0.1134	<0.0001	12.3720	9.9054	15.4525
Ejected – yes	1.8757	0.0538	<0.0001	6.5254	5.8723	7.2512
Crash type – barrier	-0.6619	0.0191	<0.0001	0.5159	0.4969	0.5355
Crash type – ditch	-0.1412	0.0223	<0.0001	0.8683	0.8312	0.9070
Crash type – fence	-0.5793	0.0307	<0.0001	0.5603	0.5276	0.5950
Crash type – no fixed object	-0.4855	0.0561	<0.0001	0.6154	0.5514	0.6869
Crash type – other	-0.5622	0.0278	<0.0001	0.5700	0.5397	0.6019
Crash type – parked car	-0.9448	0.2771	0.0006	0.3888	0.2258	0.6692
Crash type – pole	-0.4089	0.0216	<0.0001	0.6644	0.6369	0.6931
Crash type – rollover	0.4120	0.0212	<0.0001	1.5099	1.4483	1.5740
Crash type – sign	-0.8497	0.0262	<0.0001	0.4276	0.4061	0.4501
Crash type – structure	-0.9076	0.0361	<0.0001	0.4035	0.3759	0.4331
Crash type – water	-0.4574	0.0479	<0.0001	0.6329	0.5762	0.6952

found that smaller, more enclosed streetscapes were characterized by less severe crashes and suggested that a more constrained streetscape makes drivers more aware of potential hazards and causes them to engage in less risky driving behavior. Harvey and Aultman-Hall (2015) argue that in-fill development and roadside trees may create smaller, more enclosed streetscape along urban arterials, which may improve traffic safety by encouraging safer driver behavior.

Naderi (2003) found that inclusion of features such as trees and concrete planters along the roadside resulted in statistically significant reductions in the number of mid-block crashes along the sampled roadways, with the number of crashes decreasing between 5% and 20%. Lee and Mannering (1999) also found that in urban areas, the presence of trees was associated with a decrease in the probability that a run-off-roadway crash would occur, and the opposite effect was found in rural areas. Park and Abdel-Aty (2015) found that safety measures such as wide shoulders and reduced speed limits had less effect on promoting safety as driveway density and pole density increased. It appears there is a body of research suggesting that a defined roadside boundary, as enhanced by roadside trees and other fixed objects, has a traffic-calming effect that enhances safety in some circumstances.

The present study found that rural tree crashes were more frequent and more severe as compared to urban tree crashes, which may support the assertions of Dumbaugh (2005) and Harvey and Aultman-Hall (2015). The present study also found that tree crashes are most frequent at nighttime with lighting and least frequent at nighttime without lighting. Low visibility is similar to fixed objects in that they are both obvious hazards, which may induce drivers to reduce speed, thus lowering accident severity and frequency. Of course, the unique characteristics of the roadway and surrounding land use will impact driver perception of hazards. Ultimately, urban driving patterns differ from rural driving patterns, and this impacts both the frequency and severity of tree- and other run-off-road collisions.

Holdridge et al. (2005) modeled injury severity in fixed object crashes and found that trees, utility poles, and the leading ends of guardrails and bridge rails increase the probability of fatal injuries in run-off-road crashes. Other variables that contributed to fixed-object crash severity include speed, intoxication, and falling asleep at the wheel/inattention. By contrast, the present study did not find a significant impact of intoxication on tree crash frequency.

Implications for Planning

In looking at all traffic accidents (i.e., not just single-vehicle), tree-related crashes accounted for 1.5% of all crash events recorded (*n* = 3,033,048) during the eight-year study period. While somewhat disproportionate given crash frequency, tree-related traffic crash fatalities accounted for just 3.5% of the total road fatalities recorded from 2006 to 2013 (FDOT Office of Planning 2017). On average, 94 people died each year in tree-related car crashes. During the same time frame, there was an average of 15,464,241 licensed Florida drivers (FDOT Office of Planning 2017). Ignoring unlicensed or visiting motorists, this equates to an average annual risk of harm (based on fatalities) of 1:164,513 for tree-related, single-vehicle crashes. This calculated risk of harm assumes the driver is the only occupant. By comparison, the annual risk of harm for motor vehicle occupants in general in the United States is 1:9,008 (National Safety Council 2017). Interestingly, the annual risk of harm associated with working in the finance and insurance industry in the United States is double (1:84,367) the risk of harm posed by Florida's roadside trees (National Safety Council 2017).

While risk assessment in the United States is largely qualitative (Smiley et al. 2011), arborists and urban foresters in the United Kingdom assess and manage tree risk by estimating risk of harm (Ellison 2005). Drawing on the Tolerability of Risk (ToR) framework (Health and Safety Executive 2001), the Quantitative Tree Risk Assessment method defines situations with an annual risk of harm 1:1,000,000 or less as being broadly acceptable (Ellison 2017). Situations, such as tree-related car crashes in Florida where the calculated annual risk of harm falls between 1:10,000 and 1:1,000,000, are deemed tolerable to the public if the risk has been mitigated to be as low as reasonably possible (ALARP) given the costs and benefits of risk reductions efforts (Ellison 2017). Future research to quantify the costs of current roadside clear zones and relative changes in safety and management costs (and loss of tree benefits) for more or less aggressive management scenarios could help determine if risks are currently ALARP.

While potential risks such as second-hand smoke inhalation offer no benefit to those subjected to it, roadside trees differ in that they can do both harm and good. In fact, excessive tree removal has its risks. In a study on the effects of drastic urban tree removal following infestations of the highly destructive emerald ash borer, researchers found that areas that lost tree canopy over a 17-year period experienced an additional 6,113 deaths related to respiratory illness and an additional 15,080 deaths linked to cardiovascular-related deaths (Donovan et al. 2013). Even the act of removing trees itself increases the likelihood of death, as forestry is consistently ranked one of the most dangerous occupations (National Safety Council 2017).

As such, roadside tree removal or retention decisions are a balance of risk versus benefit. Removal efforts should focus on high-risk and low-value trees, leaving trees with lower risks and higher benefits. Ultimately, risk is situation-specific, and the character of the road and land use must be considered in evaluating trees as crash hazards.

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Jeffery Van Treese (corresponding author)
School of Natural Resources and Environment
103 Black Hall, Box 11645
Gainesville, FL 32611-6455, United States
jvt2law@gmail.com

Andrew K. Koeser
Department of Environmental Horticulture, CLCE, IFAS
University of Florida Gulf Coast Research and Education Center
14625 County Road 672
Wimauma, FL 33598, United States

George E. Fitzpatrick
Department of Environmental Horticulture, IFAS
University of Florida Fort Lauderdale Research and Education Center
3205 College Avenue
Ft. Lauderdale, FL 33314, United States

Michael T. Olexa
Food and Resource Economics Department
University of Florida, PO Box 110240
Gainesville, FL 32611, United States

Ethan J. Allen
Florida Atlantic University Libraries, Florida Atlantic University
5353 Parkside Drive
Jupiter, FL 33458, United States

Résumé. Les arbres bordant les routes confèrent des bénéfices pour les automobilistes dont la modération du trafic, l'articulation des voies et la réduction du stress chez les conducteurs. Les arbres sont cependant l'un des éléments, parmi d'autres, fréquemment en cause dans les accidents impliquant un seul véhicule. Pour cette recherche, les données du Florida Highway Safety and Motor Vehicle furent examinées afin : d'évaluer la fréquence relative des accidents impliquant des arbres en comparaison avec les collisions avec d'autres éléments fixes en bordure des routes; d'établir l'impact des facteurs reliés à la route, aux véhicules routiers et aux conducteurs sur la fréquence des collisions avec les arbres; et de comparer la gravité des collisions avec les arbres en relation avec les autres accidents impliquant également un seul véhicule. En accédant aux 3,033,041 rapports d'accidents pour la période de 2006 à 2013 inclusivement, nous distinguâmes 323,581 collisions ne concernant qu'un seul véhicule (10.5 %) et 47, 341 accidents impliquant des arbres (1.6 %). Les arbres constituaient la quatrième cause parmi les éléments fixes heurtés lors des accidents n'impliquant qu'un seul véhicule et la deuxième plus fréquente cause pour les accidents similaires mais en milieu rural. Le genre du conducteur, le type de véhicule, les conditions de luminosité, les conditions météorologiques et le type de milieu furent mis en corrélation avec la fréquence. De plus, les blessures associées avec les collisions impliquant les arbres étaient plus sévères que celles de tous les autres accidents avec un seul véhicule, à l'exception des renversements de véhicules.

Zusammenfassung. Straßenbäume liefern Vorteile für Fahrer, wie z. B. Verkehrsberuhigung, Trassenbegrenzung und Stressreduktion von Fahrern. Dennoch sind Bäume auch eines von den verschiedenen straßenseitigen Infrastrukturelementen, die gewöhnlich in Fahrzeugunfälle verwickelt sind. In dieser Studie werden die Aufzeichnungen der Florida Sicherheit auf Fernstraßen und Fahrzeugdaten analysiert, um die relative Frequenz von Unfällen mit Bäumen mit Unfällen mit anderen fixen Objekten zu vergleichen, den Einfluss von Straßen- , Fahrzeug- oder Fahrer-bezogenen Faktoren auf Unfälle mit Bäumen zu beurteilen und die Schwere von Unfalldaten mit Bäumen mit anderen Einzelfahrzeugunfällen zu vergleichen. Bei der Untersuchung von 3,003,041 Unfallberichten aus 2006-2013 (komplette Jahre) identifizierten wir 323,581 Einzelfahrzeugunfälle (10.5 %) und 47,341 baumbezogene Unfälle (1.6%). Bäume waren innerhalb der Stadt das viertmeiste fixe Objekt, welches bei einem Einzelfahrzeugunfall getroffen wurde und auf dem Land das zweit-meiste fixe Objekt, welches bei einem Einzelfahrzeugunfall getroffen wurde. Das Geschlecht der Fahrer, Fahrzeugtyp, Lichtverhältnisse, Wetterbedingungen und Landnutzung waren alle mit der Frequenz korreliert. Darüber hinaus waren die Verletzungen bei Unfällen mit Bäumen viel schlimmer als alle anderen Einzelfahrzeugunfälle, außer Fahrzeugüberschlägen.

Resumen. Los árboles en las carreteras brindan beneficios a los conductores, como tráfico tranquilo, la definición de las vialidades y la reducción del estrés del conductor. Sin embargo, los árboles también son uno de los varios elementos de la infraestructura vial en los choques de un solo vehículo. En este estudio, se analizaron los registros de seguridad en las carreteras y vehículos motorizados de Florida para evaluar la frecuencia relativa de choques relacionados con árboles en comparación con otros choques con objetos fijos; evaluar el impacto de los factores relacionados

con la carretera, el vehículo y el conductor en la frecuencia de caída de árboles; y comparar la gravedad de los choques de árboles en relación con otros choques de vehículos individuales. Al asesar 3, 033,041 registros de accidentes del 2006-2013 (todos los años completos), identificamos 323,581 accidentes de un solo vehículo (10.5%) y 47,341 accidentes relacionados con árboles (1.6%). Los árboles fueron el cuarto tipo de golpe de objetos fijos más común en accidentes urbanos de un solo vehículo y el segundo golpe de objetos fijos más común en accidentes rurales de un solo vehículo. El género del conductor, el tipo de vehículo, las condiciones de luz, las condiciones climáticas y el uso del suelo se correlacionaron con la frecuencia. Además, las lesiones asociadas con los choques de árboles fueron más graves que todos los otros tipos de choques de vehículos individuales, excepto los vuelcos de vehículos.

Arboriculture & Urban Forestry Quiz Questions

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CEU quiz by Richard Rathjens, The Davey Tree Institute, Kent, OH, U.S.A.