U.S. Department of
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**Federal Railroad
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Trespass Event Risk Factors

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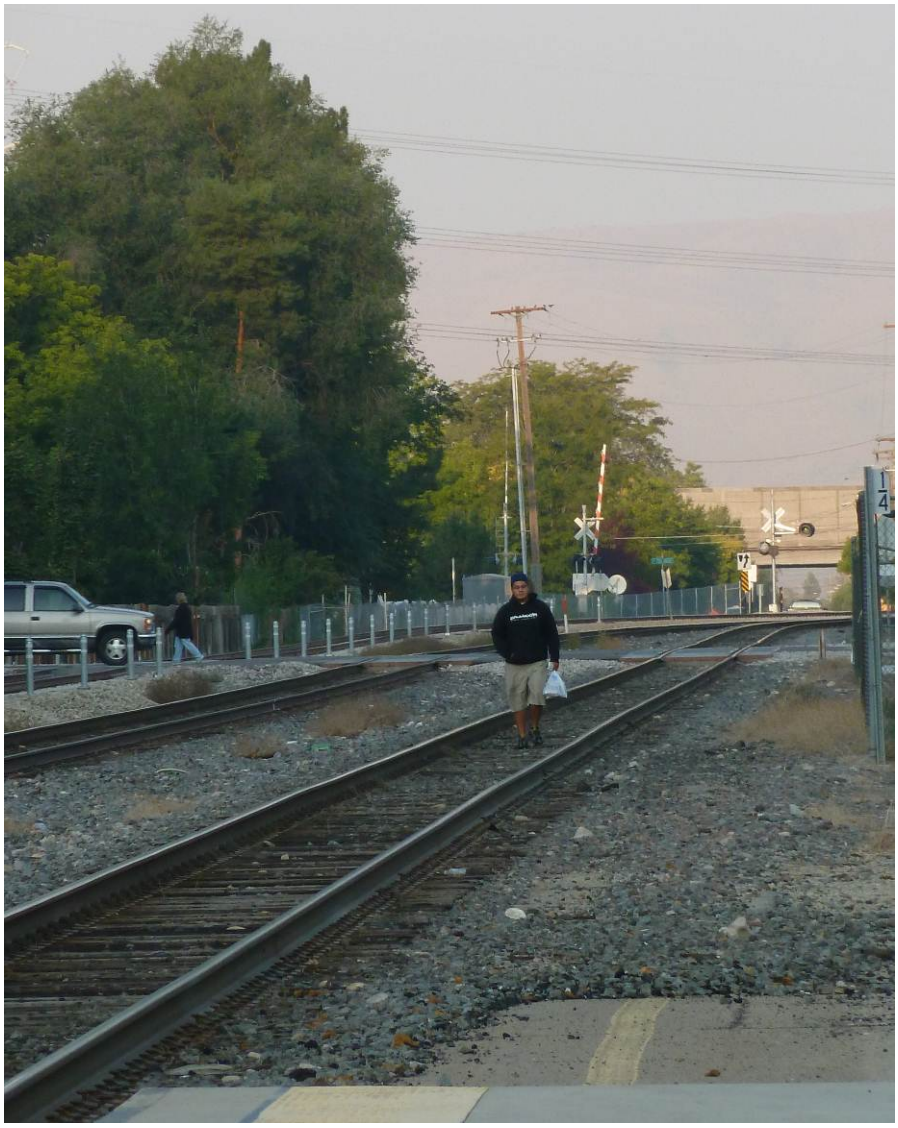

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13. ABSTRACT (Maximum 200 words)

The Volpe Center has used three sources of data—the Federal Railroad Administration's required accident reports, locomotive video, and U.S. Census data—to investigate common risk factors for railroad trespassing incidents, the leading cause of rail-related deaths in the U.S. Risk factors found include (1) a disregard for grade crossing warning signs, (2) trespasser intoxication, (3) use of distracting electronic devices, and (4) right-of-way proximity to stations, bridges, and rail yards. This research report offers several suggestions for improved data availability to support future studies.

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1 mile (mi) = 1.6 kilometers (km)	1 meter (m) = 1.1 yards (yd)
	1 kilometer (km) = 0.6 mile (mi)
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1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)	10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres
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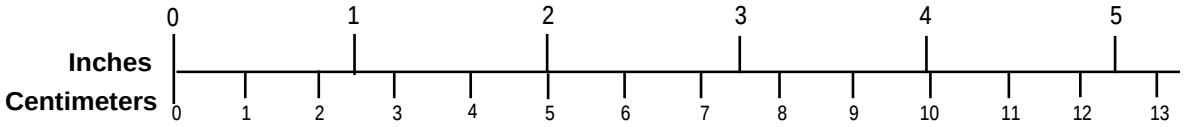

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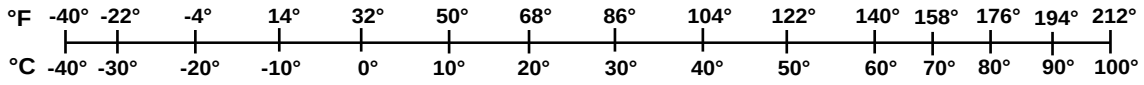

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Executive Summary

The Volpe National Transportation Systems Center investigated potential risk factors for railroad trespassing using reports submitted by railroads to the Federal Railroad Administration (FRA) as required by 49 CFR Part 225, geographic information and imaging systems, video recordings from a forward-facing camera placed in a locomotive, and U.S. Census demographic and economic data. In this report, a trespasser is considered to be any person who enters or remains on railroad property that he or she is not legally authorized to access, including railroad equipment or in facilities located on or near railroad property or right-of-way (ROW). Only pedestrian trespassers or those riding bicycles or recreational vehicles are considered trespassers for the purposes of this research study.

Between 2008 and 2012, 4,353 railroad trespassing casualties were reported to FRA's Office of Railroad Safety [1]. A total of 2,389 of these victims died as a result of their injuries. These trespassing incidents occurred in 1,052 counties in 49 States across the United States. The decedents were of all ages: from infants of less than 1 year to the advanced elderly. Approximately 110 railroads were affected, including large and small passenger and freight carriers, public and private. Trespassing incidents are one of the most prevalent types of railroad safety occurrences, resulting in more deaths than any other railroad type of accident and affecting all segments of the national population. Given the persistent nature and magnitude of the problem, any new insights into trespassing incidents and their prevention could bring measurable benefits to the railroad community and society as a whole. Thus, understanding attitudes and beliefs about the risks and hazards associated with railroading, and deterring the behaviors that lead to rail trespassing casualties is vitally important.

Researchers typically use data from three primary sources to examine potential injurious or trespass event risk factors: (1) data from the FRA's Railroad Accident and Incident Reporting System (RAIRS), (2) video footage from a locomotive camera in south Florida that was collected through a related trespass prevention research study, and (3) demographic and economic data from the U.S. Census Bureau. These data are used to describe common trespassing incident scenarios and characteristics that could be risk factors for otherwise preventable life altering injuries or deaths..

The potential risk factors identified in this report are split into two main categories: those that apply to the individual trespasser and those that apply to the location of the trespassing incident. Pedestrian and bicyclist disregard for highway-rail grade crossing warning systems, intoxication, and the use of electronic handheld devices by the trespasser are the most commonly observed risk factors for such events. The presence of grade crossing, nearby passenger rail or transit stations, rail yards and bridges are location-based characteristics that could be risk factors for trespassing.

Trespassing occurs during all months of the year, but is most prevalent in the summer months. Trespassing incidents also occur during all hours of the day, but according to two independent data sets, they are more prevalent in the evening hours.

Little correlation was found between trespassing and demographic factors or trespassing and

economic indicators, except where population density was factored in. Half of the trespassing casualties reviewed occurred in counties with less than 500 people per square mile. Many more incidents occurred at relatively low population densities than at the higher density urban areas, although several were concentrated in urban hot spots.

Several transportation safety researchers have investigated risk factors that could potentially lead to railroad trespassing casualties, but much of the academic literature is inconclusive. Many past researchers, including those studying this issue within the last decade, encountered challenges caused by limited data resources and uncertain data quality; the same problems were faced during this research effort. The vast majority of available data is of trespassing casualties, which are events resulting in a casualty, and not of incidents, which are trespass events that may or may not result in an accident. More data on incidents that do not result in casualties would be valuable to railroad safety researchers. While the accident/incident reports submitted to FRA by railroads have proven to be extremely helpful to railroad researchers, there are many updates to the reporting system that could make research into trespass incidents more efficient. Some of these improvements may include a way to easily filter motor vehicle operating trespassers from pedestrian trespassers and fields to mark intoxication, bicycle use, or use of potentially distracting electronic devices. In future studies, researchers could also look for information gathered through transportation agencies' growing efforts to collect their own data and establish trespass prevention programs.

1. Introduction

Between 2008 and 2012, 4,353 railroad trespassing casualties were reported to FRA's Office of Safety [1]. A total of 2,389 of the victims died as a result of their injuries. These trespassing incidents occurred in 1,052 counties in 49 states across the United States. The victims were of all ages: from infants of less than 1 year to the advanced elderly. Approximately 110 railroads were affected, including both large and small operations and both passenger and freight lines, public and private. Trespassing accidents are one of the most prevalent types of railroad accidents, result in more deaths and life-changing injuries than many other railroad accident types, and affect all strata of the national population.

1.1 Background

While significant progress has been made to improve safety in other areas of railroad operations, the incidence of casualties related to railroad trespassing has remained relatively consistent. This is undoubtedly because the individual and group behaviors leading to trespass casualties are difficult to prevent. A trespassing incident invariably involves a willful effort on the part of an individual or persons to illegally circumvent any precautions the railroad has taken to prevent trespassing. Given the magnitude of the problem, any new insights into trespassing incidents and their prevention could bring measurable benefits to the railroad community and society as a whole.

1.2 Objectives

This report attempts to use available data sources to characterize trespassing incidents and define risk factors that could lead to trespass events by identifying common characteristics of trespassers and the locations at which such behaviors occur. In the process of defining risk factors, this report reviews the accuracy and utility of existing trespassing data sources and provides a geographic information system framework for analyzing it.

1.3 Overall Approach

Data from three primary sources is used to examine potential risk factors: accident data from FRA's Railroad Accident and Incident Reporting System (RAIRS), video footage from a forward-facing locomotive camera in use during a related trespass prevention research study in south Florida, and demographic and economic data from the U.S. Census Bureau. This data is used to describe common trespassing incident scenarios and event characteristics that could also be risk factors for trespassing incidents.

The risk factors can be classified into two categories—those that are a direct function of the trespasser and those that are related to the location at which trespassing incidents occur. The risk factors are reviewed qualitatively. Many reports in many subject areas, including railroad transportation, strive to quantify risk by defining probabilities that identified hazards will occur and lead to property damage, injuries or deaths. This is often a worthwhile task, but depends greatly upon the availability of comprehensive data, including frequency and exposure data, which is very conspicuously lacking for trespassing incidents. Any attempt to definitively quantify the risks posed by the factors discussed in this report, beyond the descriptive statistics presented, would likely serve to further obscure, rather than illuminate, the utility of the data

available. Additionally, a best course of action for trespass mitigation might not be to target the most common types of incidents—for which data is most limited—but rather to pinpoint incident types for which data is more available and for which prevention measures are most readily apparent.

1.4 Scope

This report considers trespassing incidents involving pedestrian trespassers and trespassers operating bicycles or recreational motor vehicles. The report does not consider events involving motor vehicles or suicides to define a set of risk factors, although suicides are parenthetically addressed.

1.5 Organization of the Report

This report is organized into seven primary sections:

- The first is this introduction.
- The second defines a trespassing incident for the purposes of this report—a necessary place to begin.
- The third section provides a substantial literature review of data sources and accident risk factors, which was useful to augment the findings of the data review in this report.
- The fourth section describes the FRA RAIRS data, beginning with a description of the data collection method. It defines the data fields, explains their usefulness in analyzing trespassing incidents, and displays for most frequent data field entries. The fourth section then explains the use of geographic data from the RAIRS reports to develop trespassing risk factors. Finally, the fourth section defines common accident characteristics.
- The fifth section is similar to the fourth, but addresses data provided by a camera mounted in a locomotive.
- The sixth section explains the use of U.S. Census Bureau data in an attempt to correlate trespassing accidents with demographic and economic information.
- The seventh, and final, section provides conclusions based on the data analysis. It identifies trespassing event risk factors based on the individual trespasser and the trespassing location and gives basic recommendations for data collection.

2. Definition of Trespassing Incidents

2.1 What is a Trespassing Incident?

In this report, a trespasser is considered to be any person who enters or remains upon an area on railroad property that he or she is not authorized to access, including railroad equipment, or in railroad facilities near railroad equipment and on rail ROW. A trespasser may be a rail passenger who ventures into off-limits territory. A trespassing incident occurs whenever a trespasser willfully enters into these restricted areas, and a trespassing incident occurs when a trespasser suffers bodily injury or is killed as a direct result of his or her presence on railroad property.

The vast majority of railroad trespassing data is of incidents specifically, not discrete occurrences or violations. It would require constant and comprehensive surveillance to detect trespassing offenses or violations, which are generally clandestine or so commonplace that the behavior does not draw additional scrutiny or concern by others. Although train crews routinely report the presence of trespassers to dispatchers and railroad police on some properties and territories, railroads are typically only alerted to the occurrence of a trespassing incident when it results in an injury or death, which must be reported to FRA. Thus, this report mostly considers trespassing casualties, although incident data sources are also discussed.

Often trespassing incidents and highway-railroad grade crossing collisions are grouped together in the available data. Certainly both involve the illicit, dangerous, and often illegal act of accessing railroad property. This report, however, does not consider highway-railroad grade crossing incidents as trespassing incidents; only pedestrian trespassers or those riding bicycles or recreational vehicles are considered in this analysis. Incidents in which the trespasser is the operator or passenger of a highway motor vehicle are not considered.

2.2 A Note on Trespasser Suicides

Trespassing incidents and suicides by railroad trespassing are commonly discussed as one type of railroad accident. However, trespassing casualty data used in this research study does not include data for events that have been confirmed as suicides. It is, indeed, often difficult to determine if trespassers were attempting to commit suicide, particularly if the person involved was killed. Often witnesses only interpret unambiguous trespasser actions, such as the trespasser lying or sitting on the track with no flight action as a train approaches, as evidence of intent to commit suicide. Several FRA casualty reports allude to suicide, even if the accident was not officially declared one by a medical examiner or coroner. It should be noted that FRA has also conducted research in developing demographic profiles of intentional fatalities and that body of work greatly expands on the suicide issue [2].

This report does not consider any data from confirmed suicides, but instead reviews suicides in a greater context as one of many trespassing risk factors. It focuses on the characteristics of trespassing incidents that are unrelated to suicide attempts, such as accidents in which trespassers are actively crossing tracks to get from one place to another, are distracted by electronic devices, or are intoxicated. This report also focuses on situations in which trespassers may be at least partially responsible for their own casualty, such as events in which trespassers were engaged in horseplay, purposeful thrill-seeking, crime, etc. as part of the trespassing scenario.

3. Literature Review

This literature review discusses and evaluates, in brief, conclusions from and based on previous research and sources relevant to this project. It is divided into two sections—data sources and risk factors/pre-crash scenarios. This review does not provide overly technical descriptions or comparisons of the methods described in the sources. The literature references are provided at the end of this report. The sources reviewed include those from FRA, the Volpe National Transportation Systems Center (Volpe Center), Transportation Research Board (TRB) reports, research from other Department of Transportation (DOT) modal administrations, State-sponsored research, and international research. Insight provided by transportation agencies from a ROW Fatality and Trespass Prevention Workshop (2008 Trespass Workshop) is also included.

3.1 Data Sources

Several of the literature resources contained descriptions of data sources and collections. A 2008 report on trespasser demographic profiling by Cadle Creek Consulting for FRA [3], a 2013 report on rail trespasser fatalities by North American Management [4], a 2012 report on headphone and pedestrian casualties by Lichenstein, et al. [5], a 2009 Volpe Center/FRA report on ROW incident analysis by Chaudhary, et al. [6], and a pair of Volpe Center/National Highway Traffic Safety Administration (NHTSA) reports by da Silva, et al. regarding highway-pedestrian and highway-pedalcyclist crashes [7, 8] provided explanations of the data used in their analyses, which was mostly acquired from national and State safety and statistical databases. Many of the agencies at the 2008 Trespass Workshop presented their own data collection initiatives, including employee reports, security reports, and incident logs [9]. Another type of data discussed in the literature that could potentially be useful for trespass prevention research is data obtained from video surveillance sources described by Moses Schulz, et al.[10].

3.1.1 National and State Safety Databases

FRA requires that railroad agencies report all casualties that occur on railroad property, including those involving trespassers. These reports are publicly available in an online database provided as part of the FRA Office of Safety's RAIRS. Until July 1, 2011, however, railroads were not required to report deaths and injuries resulting from suicide attempts, and aside from the aggregate form publicly available from the FRA [1] the data on specific suicide events reported since are not publicly available. RAIRS also does not include any records of trespassing incidents that did not result in an injury or fatality. Therefore, only data on non-suicide trespass incidents resulting in a casualty are publicly available. One ongoing study from the Northwestern University Transportation Center notes that there are discrepancies between the FRA accident data and data from other sources.

Chaudhary, et al. [6] note that the following location-specific data can be extracted from RAIRS: number of mainline tracks, mix of freight and passenger trains, number of switch trains per day, maximum timetable speed, and whether the accident occurred on mainline or yard track. Unfortunately, many of these data fields are not included on the casualty reporting forms. They are only on the form required for train accidents resulting in a significant amount of equipment damage—not common for trespassing —and thus would be more difficult to extract for a

location in which a trespassing accident occurred. RAIRS is often one of the sources used in accident analysis studies in the United States. It is used as a primary data source in this research study, but given its limitations, is likely less useful for studying trespassing incidents than for studying other types of train accidents.

Chaudhary et al. [6] also discuss the use of data from the U.S. Census and from Geographic Information Systems (GIS). The U.S. Census databases contain a plethora of demographic data, including information on population density and income. GIS can be used to provide infrastructure information, such as rail segment lengths for a quantitative risk analysis and a rail crossing or accident location's distance from community landmarks, such as bridges, schools, or playgrounds as of a specific date or timeframe. Together, U.S. Census and GIS data might be used to define at-risk populations in the railroad environment.

Safety data collected by other modes, if not able to directly supplement railroad trespassing research, can at least inform future data collection efforts. NHTSA maintains national motor vehicle highway crash information databases. Unlike FRA's safety data, data in NHTSA's National Automotive Sampling System – General Estimates System is based on a representative sample of cases taken from police reports around the country and is designed to track trends rather than to query specific accident information. Highway accidents are much more frequent than train accidents, so it is feasible that FRA can maintain detailed information on all accidents rather than only a sample, as NHTSA does.

NHTSA's Fatality Analysis Reporting System is similar to FRA's casualty reporting system in that it provides annual data from a national census of fatal injuries. The University of North Carolina (UNC) maintains the Highway Safety Information System, a database of highway information collected at the State level. Eight States currently participate: California, Illinois, Maine, Michigan, Minnesota, North Carolina, Utah, and Washington. The NHTSA and UNC databases were used by da Silva, et al. [7, 8] to analyze highway-pedestrian and highway-pedalcyclist crashes.

Other notable data sources used by researchers for the literature review include: the National Electronic Injury Surveillance System and the U.S. Consumer Product Safety Commission, which were used by Lichenstein, et al. [5]; the United States Coast Guard National Response Center, which tracks the release of hazardous materials; and the California Public Utilities Commission. The last two sources were used by Chaudhary, et al. [6] to supplement accident data from FRA.

3.1.2 Data from Transportation Agencies

Transportation agencies are very concerned with preventing trespasser casualties. A suicide attempt or an injury or fatality caused by trespassing may result in many consequences for a freight railroad or public transit agency, ranging from lost revenue due to service interruptions to criticism from the local community (and customer base). Several agencies that presented at the 2008 Trespass Workshop [9] described their methods for reducing trespasser casualties. These methods typically involved internal data collection from varied sources, including employee and security staff observations, and review of surveillance footage. Active prevention techniques might also provide sources of data, such as logs of citation issuance. (Video surveillance data will be covered in more detail in the next subsection.) The following are some trespassing data collection efforts by transportation agencies:

- Metrolink of southern California collates trespassing incident information from incident reports, sheriffs' logs, and "Trouble Ticket" reports.
- The Toronto Transit Commission conducts a Gatekeeper Program in which employees are trained in behavior profiling. Employees might then be able to identify suspicious activity and prevent trespassing and suicide accidents. The program information can also be used as a source of data.
- The Metropolitan Transportation Authority (MTA) of New York has initiated a ROW Task Force that has compiled a database with information from daily incident logs, public affairs complaints, employee reporting cards, hazardous condition reporting cards, and annual property audits. The Long Island Rail Road of the MTA is focusing on using this data for location prioritization in resource allocation schemes.
- New Jersey Transit (NJT) is also using location prioritization methods for resource allocation. NJT identifies "hot spots" based on historical data and field personnel reports.
- Caltrain collects grade and pedestrian crossing data and uses this data to perform hazard assessments.
- The Minnesota North Star conducts counts of trespassers in stations to evaluate public address and safety publication efforts.
- Metra of Chicago conducts "Safety Blitzes" in which citations and fines are distributed to trespassers. A record of citations is kept.
- The Burlington Northern Santa Fe (BNSF) railroad collects train crew observations and reports of trespassing activity.
- Singapore Mass Rapid Transit (SMRT) collects track intrusion statistics and instructs employees on how to identify mentally ill customers.

3.1.3 Video Surveillance Data

Video data is one promising source of trespassing incident information, particularly regarding "close-call" or "near-miss" incidents that are not captured in safety incident databases. A Trespass Prevention Research Study conducted by FRA and the Volpe Center [11, 12] utilizes outward-facing cameras in locomotive cabs along the South Florida TriRail Corridor to capture some ROW trespassing activity. This video data is then used to identify high-risk locations.

Moses Schulz, et al. [10] examine, in detail, the use of a camera and recording equipment by transit agencies. Video is most often used to provide a record of criminal activity and to protect against fraudulent claims. According to the report, the 2005 London Underground bombing experience indicated that video surveillance may be more useful as an investigation tool than as a crime deterrent. A 1979 survey likewise showed that crime prevention was often not an original reason for implementing camera surveillance technologies in agencies; agencies were more interested in mitigating problems with new automatic fare collection systems. Video use by transit agencies is currently much more common in Europe and Asia than in North America.

Moses Schulz, et al. [10] surveyed U.S. transit agencies about their use of video surveillance technologies. A total of 43 out of 58 surveys were returned:

- Forty agencies reported using cameras in stations, and 20 agencies reported that they monitor 76–100 percent of their stations, platforms, and shelters.
- Thirty-three agencies reported using cameras in passenger areas onboard railroad cars.
- Fourteen agencies reported using cameras along the ROW.
- Two agencies reported using cameras at grade crossings, including one "old, established West Coast multimodal" system and one trolley system.
- Seven agencies reported camera use in other places such as subways, bridges, and tunnels.

Few agencies implement cameras for the explicit purpose of monitoring trespassers traversing or walking along the ROW, mostly because of cost or ROW-ownership restrictions. Most cameras are positioned to monitor employees, record damage to railroad property, or enhance customers' feeling of safety. A few agencies do use cameras in high-risk areas such as stations, bridges, and tunnels. Open, above-ground ROW is the least-monitored of all railroad infrastructure. (FRA is in the process of developing a rule on the use of recording devices through the Railroad Safety Advisory Committee task 14-01 in response to NTSB recommendations and other mandates.[1])

Moses Schulz, et al. [10] do list some examples of video camera use specific to trespassing and/or motor vehicle grade crossing violations. A few agencies represented at the 2008 Trespass Workshop [9] also described video surveillance techniques for reducing trespassing attempts:

- The Los Angeles County Transportation Authority (LACTMTA) has installed photo-enforcement cameras along its Blue Line.
- In El Mirage, AZ, BNSF uses REDFLEX Rail Crossing Enforcement cameras, which detect whether or not a vehicle will stop at flashing crossbucks marking a highway railroad crossing.
- Minnesota Metro Transit uses cameras equipped with analytics to monitor tunnel paths along its network.
- Valley Metro of Phoenix uses cameras equipped with analytics to monitor tunnel paths along its network.
- The Washington Metropolitan Area Transportation Authority (WMATA) has a minimum of eight cameras per station.
- Agencies that use other sensors (such as motion detectors) include: the MTA of New York, the MTA of Maryland, LACTMTA, Amtrak, WMATA, NJT, the Southeastern Pennsylvania Transportation Authority (SEPTA), and the Massachusetts Bay Transportation Authority (MBTA).
- In 2006, the Union Pacific Railroad (UP) began to install surveillance video and sensors in 7,000 locomotives, which could be useful for detecting trespassing activity if positioned to face out of the locomotive and monitor the ROW in the direction of travel.

[1] https://rsac.fra.dot.gov/document.php?type=public&name=2014-01.pdf viewed October 23, 2014.

- Also in 2006, CSX initiated the National Capital Region Rail Pilot Program & Amtrak Security Pilot Program to create an 8-mile virtual boundary of the District of Columbia (DC) corridor using "video camera technology integrated with intelligent vision interpretation software." CSX Railroad (CSX) and Amtrak both have real-time monitoring centers in Jacksonville, FL.
- The metro system in Sydney, Australia, has integrated the use of Spycam cameras into their security plan.
- CSX has been in the process of implementing a Virtual Security Fence along its ROW using pan/tilt/zoom cameras and video interpretation technology.
- Edmonton Transit has installed 551 fixed and pan/tilt/zoom cameras, half of which are specifically for ROW protection.
- SMRT of Singapore implements closed-circuit television in its infrastructure to monitor trespassing activity.

3.1.4 Other Potential Data Sources and Data Concerns

Lichenstein, et al. [5] used the Google News Archives search feature to find media reports of headphone-related ROW accidents. The information from media reports was used to augment accident and demographic data obtained from public safety databases. The authors warn that media reports are generally biased towards the most tragic, fatal accidents and contain no data about close-call incidents. While this search method may not be an effective way to obtain information about non-reported incidents, a targeted search for reporting regarding specific incidents may yield additional information not collected in databases.

Cadle Creek Consulting [3], North American Management [4], and Lichenstein, et al. [5] employed surveys as a means of obtaining information. Cadle Creek Consulting, under contract to FRA's Office of Railroad Safety, sent surveys to 471 county medical examiners and coroners. The intent of the survey was to obtain demographic information about trespassing fatality victims, including the sex, age, race, and address, that could be used in a standard market analysis. Sixty-nine percent of the surveys were completed and returned to Cadle Creek Consulting; however, fewer than 50 percent of the fatality reports from the respondents included an address that could be used for a market analysis (the remainder either had missing address information or listed the address as "unknown", "homeless", "transient", "no fixed address", or returned the survey with a foreign address [3]). The Cadle Creek Consulting report notes that questions about race and ethnicity are particularly difficult for the medical examiners and coroners to answer in a survey, as there were instances of confusion between race and ethnicity in survey responses.

Personal data about victims' identities collected from medical examiners and coroners is generally confidential. Typically, data collected by Federal government offices is subject to the Freedom of Information Act (FOIA) and must be disclosed upon request. In the case of Cadle Creek Consulting [3], the personal data was collected and analyzed by a private contractor, and results were summarized and submitted to FRA, excluding any identifiable data and thus avoiding the possibility that the raw data could be subject to future FOIA requests. The possibility of a FOIA disclosure may also be an important consideration when requesting video surveillance data. Releasing information regarding video surveillance systems may compromise

a transit agency's security strategy, and releasing video data may subject the agency to incident liability.

Surveys directly from the Federal government may also be subject to Paperwork Reduction Act requirements. Information requests under this act must be approved by the Office of Personnel Management to ensure that they do not impose excessively upon the time and resources of the public. This approval process can take up to a year or more; time factors must therefore be considered when planning the timeline of a study that requires new survey data.

3.2 Risk Factors/Pre-Crash Scenarios

Much of the literature considered in this review drew conclusions regarding trespassing risk factors and common pre-crash scenarios. The demography of trespassing victims, including their age, gender, and lifestyle characteristics, was the focus of Cadle Creek Consulting's research [3], but that information was also covered in other studies that identified trespassing risk factors. Several of the 2008 Trespass Workshop [9] attendees described their experience with high-risk location identification. The NHTSA Pedestrian and Pedalcyclist highway crash reports from da Silva, et al. [7, 8] identify common pre-crash scenarios that may influence vehicle and pedestrian and pedalcyclist behavior. Although those sources are studying events occurring on fixed infrastructure where motorists and or pedestrians have a legal right to travel, the factors they identify may be used to develop a similar study of pedestrian-railroad accidents if the proper data is available. Silla and Luoma [13] likewise cover demography and pre-crash behavior. The existing literature also discusses alcohol use by trespassers and suicide victims, as well as headphone use, which is covered thoroughly by Lichenstein, et al. [5].

3.2.1 Demographic Trends

The majority of studies reported that trespassing casualty victims were mostly male and young to middle-aged adults. Cadle Creek Consulting [3] stated that trespasser fatalities were overwhelmingly male: 87 percent of victims were male, while 13 percent were female. (The same was true for the North American Management study [4] which found that 82 percent of victims were male.) The mean age of victims was found to be 37.5. (The mean age of the U.S. population was 36 in 2004.) Fifty-one percent of trespasser fatalities were between the ages of 30 and 49. At the 2008 Trespass Workshop [9], Amtrak reported that 90 percent of trespassers are male, 50 percent of whom are between the ages of 20 and 39. Silla and Luoma [13] found that in Finland, the ratio of male to female suicide victims was 2.4:1, and the ratio of male to female trespassers involved in accidents was 3.4:1. The study also found that 44.3 percent of suicide victims were 20 to 39 years old, and 51.4 percent of accident victims were 10 to 29 years old. The ages given in the reports are difficult to compare because the ranges used do not directly overlap. It appears that some researchers concluded that victims were commonly middle-aged, while others focused on the young adult trespasser population.

Based on the results from their market analysis, Cadle Creek Consulting [3] stated that fatality victims were slightly poorer (also found by North American Management [4]) and slightly less-educated than the general population, but the data is not particularly strong for this conclusion. The populations most affected were generally urban and suburban. Silla and Luoma [13] report that train-pedestrian fatalities were concentrated in areas with high population density and dense train traffic.

It is often difficult for investigators and researchers to determine whether a trespassing casualty was the result of a suicide attempt or whether it was intended by the victim. The FRA RAIRS data collection system only recently (in July of 2011) began requiring suicide incident reports, so there is little definitive U.S. data about which type of incident is most common. Silla and Luoma [13] suggest that casualties from railroad suicide attempts are much more common than accidental casualties. In that study, of 311 pedestrians killed between 2005 and 2009, 264 were determined to be suicides, 35 were accidents, and 12 were unclassified.

The NHTSA Pedestrian and Pedalcyclist reports by da Silva, et al. [7, 8] describe crash victims that are possibly younger than railroad trespassing victims. (The age ranges presented in the railroad and motor vehicle reports do not directly overlap.) Fourteen percent of pedestrians in motor vehicle crashes were 5 to 9 years old. Twenty-two percent of victims that were walking along the roadway at a non-junction at the time of the crash were 15 to 19 years old. This type of trespassing event appears analogous to that of a railroad trespasser walking along the ROW away from a designated crossing, which might be common behavior for a victim who did not intend suicide. Forty-six percent of pedestrians involved in motor vehicles crashes were 5 to 24 years old. Twenty-seven percent of pedalcyclists were 10 to 14 years old, while 72 percent were 5 to 29 years old.

3.2.2 Trespasser Use of Alcohol and Drugs

Alcohol and drug intoxication was consistently found to be common among trespassing casualties. At the 2008 Trespasser Workshop [9], the Toronto Transit Commission presented information from their Gatekeeper (behavior profiling) Program, which showed that out of 20 to 30 suicides per year, two-thirds of the victims were under the influence of drugs or alcohol at the time of the incident. Amtrak also reported that two-thirds of trespasser casualties involved alcohol. Silla and Luoma [13] stated that approximately 50 percent of all train-pedestrian accident victims in Finland were intoxicated (meaning that recent use of alcohol, drugs, or medication by the victim was detected).

As a comparison, da Silva et al. [7] found that alcohol and drugs were a contributing factor in 7 percent of all highway-pedestrian accidents and a contributing factor in 21 percent of accidents involving an improper roadway crossing. Crossing a roadway (or railway) is arguably riskier than walking alongside it. Thus, alcohol and drug use might have led pedestrians to make riskier choices or to act in a way that was likelier to contribute to pre-crash scenarios.

Cadle Creek Consulting [3] usefully notes that detecting alcohol or drug use is easier than determining whether or not alcohol or drug use was actually a factor in a trespassing incident and subsequent casualty.

3.2.3 Trespasser Use of Headphones and Other Electronic Devices

Lichenstein, et al. [5] examine the risk factor (and pre-crash scenario) involving a trespasser wearing headphones. Wearing headphones or being otherwise engaged with electronic devices can distract a trespasser and cause him or her to unintentionally make dangerous decisions. The report states that fatalities involving headphones are on the rise. Warnings are often made ineffective by headphones because of the effects of environmental isolation (the trespasser cannot hear sounds from local surroundings) and inattentional blindness (the amount of cognitive resources available to process outside stimuli is reduced). Incidents in which the victim was

distracted by headphones or electronic devices might be interesting because such incidents are most likely unintentional and not the result of a suicide attempt. Thus, they may be potentially more easily preventable by outside resources such as railroads, safety workers, law enforcement, community organizations, and researchers.

Lichenstein, et al. [5] found that out of pedestrian casualties tied to headphone use, 68 percent of the victims were male, 67 percent were under the age of 30, and 55 percent of the accidents were train-pedestrian crashes, as opposed to highway vehicle-pedestrian crashes. Given that highway vehicle-pedestrian incidents are much more prevalent, it may be that headphone users are particularly susceptible to environmental isolation in the railroad environment.

3.2.4 Pre-Crash Behavior and Pre-Crash Scenarios

Silla and Luoma [13] briefly describe common pre-crash behaviors exhibited by victims: 38.5 percent of accident victims (as opposed to suicide victims) were crossing the tracks, and 34.6 percent were lying or sitting on the tracks. All except one were intoxicated. Most suicide victims waited for the train on the ROW. Both suicides and accidents occurred most frequently from Friday to Sunday (49.2 percent and 65.7 percent, respectively).

At the 2008 Trespass Workshop [9], Amtrak reported that they consider four categories of trespassing: loitering near the ROW, suicides, looking for transportation, and other. These categories are essentially considered rudimentary pre-crash scenarios.

The NHTSA Pedestrian and Pedalcyclist reports by da Silva, et al. [7, 8] develop pre-crash scenarios as an organized method of accident analysis and may be a useful model for railroad trespasser data analysis, given detailed data availability. The NHTSA reports develop pre-crash scenarios using data describing three types of crash characteristics: physical setting characteristics, causal factors, and crash consequences.

Both the Pedestrian [7] and Pedalcyclist [8] reports define pre-crash scenarios based on available incident data and then rank the scenarios in order of prevalence. Several of these scenarios are analogous to pre-crash situations for railroad trespassing incidents. The pre-crash scenarios that are most like potential railroad trespasser situations for motor vehicle-pedestrian crashes are listed below:

- In 25 percent of accidents the vehicle was going straight and the pedestrian was crossing the roadway at a non-junction.
    - Railroad-trespasser analogy: Train was moving along the ROW and the trespasser was crossing the ROW away from a designated crossing.
- In 18.5 percent of accidents the vehicle was going straight and the pedestrian was crossing the roadway at an intersection.
    - Railroad-trespasser analogy: Train was moving along the ROW and the trespasser was crossing the ROW at or near a designated crossing.
- In 16 percent of accidents the vehicle was going straight and the pedestrian darted onto the roadway at a non-junction.

    - Railroad-trespasser analogy: Train was moving along the ROW and the trespasser very quickly moved onto the track away from a designated crossing (perhaps from behind forest or brush).

- In 3.7 percent of accidents the vehicle was going straight and the pedestrian was walking along the roadway at a non-junction.
    - Railroad-trespasser analogy: Train was moving along the ROW and the trespasser was within the gauge or alongside the ROW away from a designated crossing.

One pre-crash scenario for which there is no analogy in the NHTSA reports, but that is often discussed by railroad stakeholders, is the second-train-coming situation, in which a trespasser may have waited for a train to pass before crossing a two-track ROW, unaware of a second train passing in the opposite direction because it was obscured by the first. At the 2008 Trespass Workshop [9], a SEPTA presentation referred to second-train-coming situations as "recipes for disaster," and NJT reported that they have been trying to mitigate second-train-coming situations.

3.2.5 High-Risk Location Identification

Many agencies and researchers identify trespass risk factors based on location attributes. They then use previously identified risk factors to identify other high-risk locations. daSilva, et al. [14] note that factors that contribute to trespassing include ease of access to the ROW, poor visibility, and shortcut potential (i.e. an opportunity of convenience). A presentation by FRA at the 2008 Trespass Workshop [9] echoed this report's findings by stating that pedestrians will seek to travel the shortest distance between two points. Several agencies discovered trespassing problems in locations where pedestrians simply tried to find the quickest way to get from a spot on one side of the tracks to a spot on the other side. The agencies further presented on other location-based risk factors identified by their employees:

- BNSF described a local business that had created an unauthorized route across the ROW so that potential customers could access their business more easily. From employee reports, BNSF learned about visible "rabbit paths" across the ROW, especially near parking lots and rivers, creeks, and streams.
- SEPTA identified location-based risks as "recipes for disaster." These risks included multiple crossing points, no train early-warning system, and stations located on curves.
- NJT reported that they identify trespassing "hot spots" to which they allocate resources. These "hot spots" include parks and schools, locations with high service frequency, traditionally dangerous locations based on historical data, and locations with many trespassers as determined by field personnel reports.

Silla and Luoma [13] found that train-pedestrian fatalities are concentrated in areas with dense train traffic and a high population density. They further found that 24.1 percent of Finnish train-pedestrian fatalities occurred within 100 meters of current or former railway stations.

4. FRA RAIRS Data Analysis

The primary source of data for this analysis is the FRA Office of Safety's RAIRS. This research study used FRA RAIRS data for trespassing incidents from a 5-year period (2008 to 2012).

4.1 Collection of FRA Trespassing Data

The FRA Office of Safety collects trespassing data with Form 55A [15]. This form is used to report all casualty data; one form must be filled out per casualty. Incidents that specifically result from trespassing can be found by using the "TYPPERS" data field for Type of Person = E, trespasser. There are a few evident shortcomings to this system:

- Only casualties are reported. The vast majority of trespassing incidents do not result in a casualty. As already mentioned, very little data has ever been collected on trespassing incidents that do not result in a casualty.
- The term "trespasser," as the person to whom the casualty occurred, is not well-defined in the FRA RAIRS guidebook [15]. Many of the casualty incidents that are listed as trespassing incidents occurred as a result of a highway-rail grade crossing accident. While drivers of motor vehicles who ignore grade crossing warnings can certainly be thought of as technically trespassing, most accident prevention researchers think of grade crossing incidents and trespassing incidents as different types of events and analyze them separately.

The second shortcoming listed above poses a challenge to researchers who would like to use FRA data to analyze trespassing accidents. The definition for "Trespassers (Class E)" [15] has a note that states:

> *A person on a highway-rail crossing should not be defined as a trespasser unless the crossing is protected by gates, or other similar barriers that were closed when the person went on the crossing, or unless the person attempted to pass over, under, or between cars or locomotives of a consist occupying the crossing.*

This definition of a trespasser could include drivers of motor vehicles. There is no simple way—such as using a filter for one data field—to separate the highway-rail grade crossing accident reports from the records pedestrian and recreational vehicle trespassing accidents. For the purposes of this report, highway-rail grade crossing accidents involving motor vehicles were filtered from the rest of the trespassing data using one or more of the data categories shown in Table 1 below:

Table 1. FRA RAIRS data fields used to distinguish between highway motor vehicle accidents and others

RAIRS Data Field	Data Field Entry
PHYACT	21 – Driving (motor vehicle, forklift, etc.)
LOCB	51 – Automobile
	60 – Truck
	61 – Van (utility)
	62 – Van (passenger)
	64 – Motorcycle
	66 – Tractor
EVENT	18 – Collision/impact – auto, truck, bus, van, etc.
	32 – Highway-rail collision/impact
TOOLS	7K – Motor vehicle, non-rail

It should be noted that some of these entries did not immediately exclude a report from this study as a highway-rail grade crossing accident. Many accidents listed in these categories involved recreational motor vehicles, which were considered in this report, and others may have been categorized as collisions/impacts, but involved pedestrians and bicycles rather than motor vehicles. The entire accident report, including the narrative, if provided, was reviewed to determine whether or not to include it in this study. This study did not consider any reports in which the narrative mentioned the trespasser being in or driving a highway motor vehicle at the time of the casualty. There were a few records in which trespassers were injured or killed after exiting their vehicles, which were stuck on the ROW; these records were also not considered because the incidents were classified as highway-railroad grade crossing events.

(To assist with future studies, it should also be noted that the "LOCA" and "LOCB" fields have entries for highways and crossings. Many pedestrian trespassing incidents occur on highways and at crossings. These data fields are not effective for filtering motor vehicle accidents from the other trespasser accidents.)

4.2 FRA RAIRS Data Field Results

All of the RAIRS fields were used to develop a set of trespass risk factors. Some were more useful than others. This section of the report aims to define the RAIRS data fields, give readers an idea of the reporting options available to accident reporters, illustrate basic trespassing accident trends, and highlight the usefulness (or lack of usefulness) of the various data fields.

4.2.1 Casualty

All trespassing reports made to FRA are generated by an injury incident, so each reported trespassing event resulted in a casualty of some sort. Of the 4,353 trespassing casualties reported to FRA between 2008 and 2012, 2,389 (over 54 percent) eventually resulted in fatalities. Another 288 of those resulted in amputations. In total, over 60 percent of trespassing incidents reported to FRA resulted in death or serious injury.

The type of injury in each FRA report can be determined from the RAIRS field "NATINJ." Table 2 lists the total number of each injury type and its corresponding RAIRS code.

Table 2. The types of injuries experienced by railroad trespassers

Nature of Injury	FRA Data Code	# of Accidents
Fatally Injured	90	2,389
Cut/laceration or abrasion	30	437
Fracture (broken bone)	70	386
Bruise or contusion	10	314
Amputation	80	288
All other injuries	99	276
Crushing injury	13	93
Internal injury	95	54
Concussion/closed head injury	93	42
Sprain or strain	20	35
Electrical shock or burn	40	15
Dislocation	60	11
Gunshot/knife wounds	72	3
Other burns	50	2
Rupture/tear	71	2
Symptoms due to one-time inhalation	9A	1
Nervous shock (injury related)	94	1
Animal/snake/insect bite	74	1

4.2.2 Railroad

Beyond the bodily harm, trauma, and associated lifestyle impacts to victims and their friends and family, trespassing accidents can have significant economic effects on the railroads involved. (The financial costs of highway-rail grade crossing accidents are discussed in detail by Brod, et al. [16]. Many of the secondary cost effects they discuss, including vehicle delay, rerouting, and supply chain costs, are applicable to trespassing accidents, as well.) The shipping and/or commuter lines on which the accident occurred may be out of service for several hours while emergency crews investigate and clear the ROW. In the case of a locomotive cab collision with a trespasser, the locomotive engineer who operated the equipment and witnessed the accident may experience work-impairing post-traumatic stress.

Perhaps the most relevant reason to collect data on the trespassing incidents with which each railroad is involved is because any location-based mitigation efforts will need to involve at least the cooperation of the railroads that own and operate equipment through the ROW. It is also likely that these railroads will need to finance most, if not all, of the cost of the mitigation effort, especially in the case of the private freight companies. Passenger railroad lines are often managed by some form of public-private partnership, may already have solid connections with law enforcement and civic agencies, and may be eligible for public funding.

The FRA data that associates accidents with railroads is consistent and thorough. The casualty report requires the name of just one railroad involved. Unfortunately, there is no field for any

other railroads that may be involved in the accident, unlike other types of FRA accident reports such as the *Rail Equipment Accident/Incident Report* (6180.54) [1]. Sometimes the owner of the equipment involved in the accident and the owner of the ROW are different. Since the consequences of a trespassing accident would affect both, and both might be involved in mitigation efforts, it would be useful to have information to approximate the impact of trespassing accidents on both railroads.

Table 3 lists all railroads associated with 10 or more trespassing accidents between 2008 and 2012. (Appendix A provides a complete list of all railroads involved in trespassing accidents.) A total of 25 railroads were involved in 10 or more trespassing accidents during this time period. As might be expected, in general the railroads that operate the most trains over the largest networks are involved in the most trespassing accidents. Several passenger railroads are included in this list. Passenger railroads may not operate over the longest total track mileage, but they do tend to run several trains at busy times of the day in areas of high population density, and are thus exposed to trespassers. A total of 110 railroads were involved in at least one trespassing incident. Of that number, 32 were passenger railroads, accounting for 26 percent of the total number of trespassing incidents (1,141 incidents).

Table 3. Railroads involved in 10 or more trespassing accidents between 2008 and 2012

Railroad	FRA Data Code	# of Accidents
Union Pacific Railroad	UP	788
CSX Transportation	CSX	773
Norfolk Southern Corp.	NS	610
Amtrak	ATK	603
BNSF Rwy Co.	BNSF	585
Florida East Coast Rwy Co.	FEC	105
Long Island Rail Road	LI	86
N.J. Dept. of Transportation	NJTR	79
Kansas City Southern Rwy Co.	KCS	73
Northeast IL Regional Commuter Rail Corp.	NIRC	66
Massachusetts Bay Transportation Authority	MBTA	44
Southeastern Pennsylvania Transportation Authority	SEPA	41
Illinois Central RR Co.	IC	40
SOO Line RR Co.	SOO	39
Southern California Regional Rail Authority	SCAX	34
Caltrain Commuter RR Co.	PCMZ	33
Metro North Commuter RR Co.	MNCW	28
South Florida Regional Transportation Authority	SFRV	25
Grand Truck Western Inc.	GTW	18
Wisconsin Central Ltd.	WC	17
Union Pacific Metra	UPME	15
Montana Rail Link	MRL	12
Dakota, Minnesota & Eastern RR	DME	11
Los Angeles County Metropolitan Trans Authority	LACZ	10
Burlington Northern Santa Fe Suburban Operations	BNSO	10

4.2.3 Age

The FRA casualty reports have a field for age of the victim. However, the victim's age is not always recorded by the reporting railroad—sometimes this is an oversight, but in other cases, the railroad simply does not know, or does not find out from the emergency services providers before the report is due. Approximately 89 percent of the trespassing incident reports (3,895 of 4,353 reports) listed an age for the victim.

Figure 1 displays the age distribution of trespassing accident victims, as recorded in the FRA casualty data. In brief, trespassing accidents happen to people of all ages, from infants to the elderly. There are, however, some general trends. The number of trespassing victims peaks at age 19 and stays elevated through the early 20s. It rises again at age 40 and is elevated from 45 through 50.

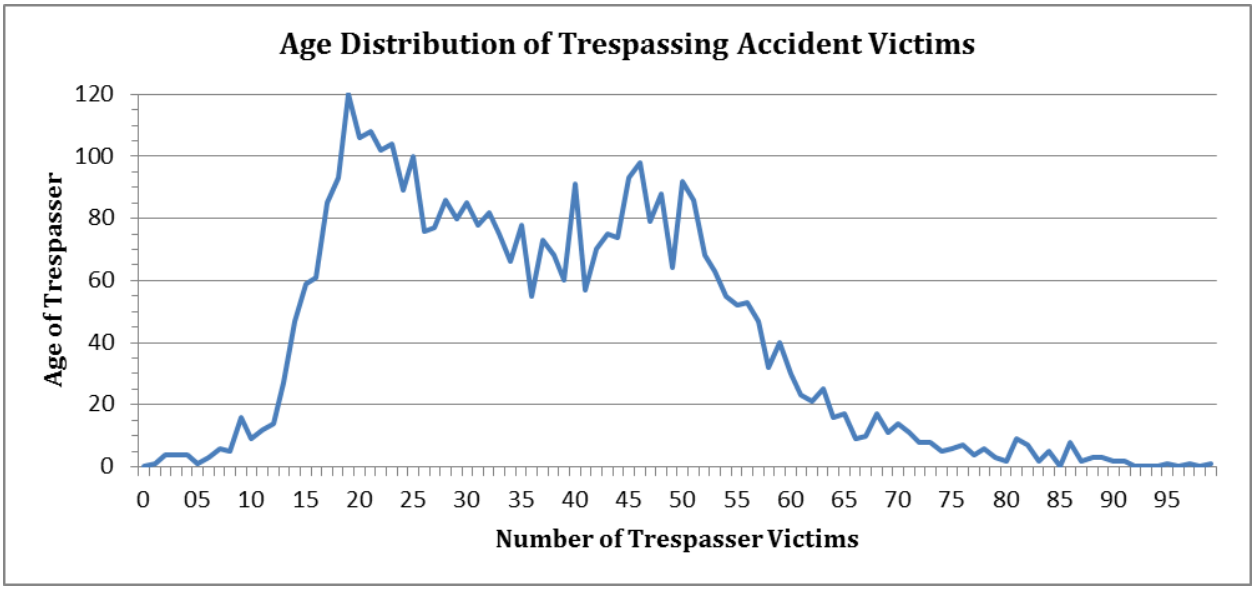

Figure 1. Age distribution of trespassing accident victims

4.2.4 Temporal Data

Time of Day

Trespassing accidents occur at all hours of the day. They peak at 12 p.m., again between 4 p.m. and 6 p.m., then remain elevated throughout the evening. The occurrence of trespassing accidents is considerably lower, by approximately 30–50 percent, throughout the morning. Figure 2 shows the distribution of trespassing accidents from 2008 to 2012, as gathered from FRA casualty reports, according to the time of day during which the accidents occurred.

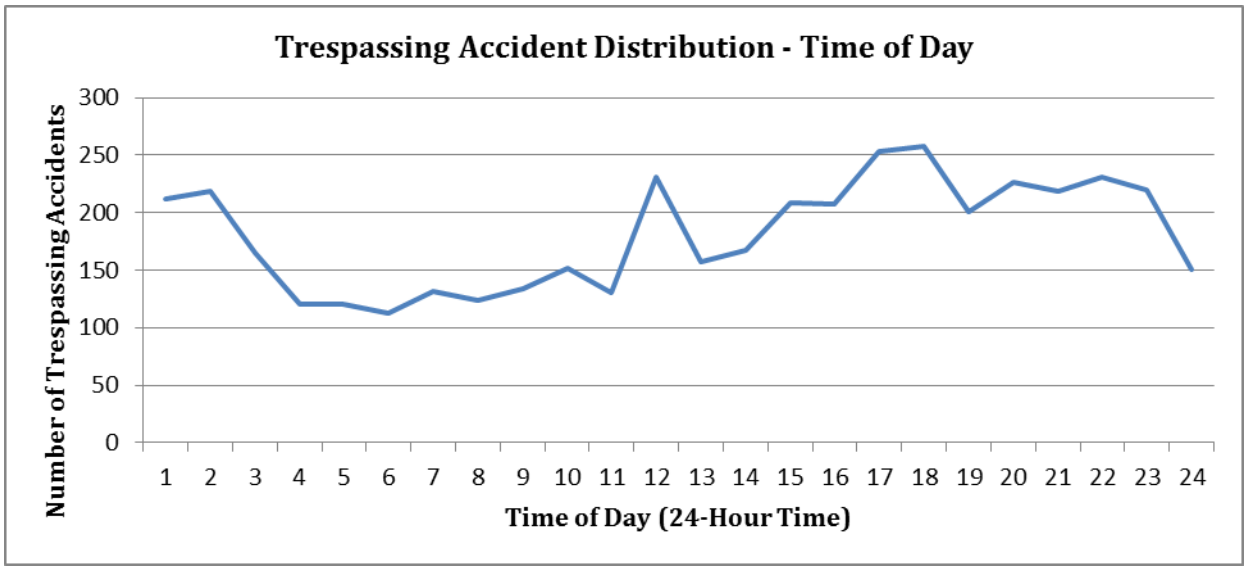

Figure 2. Distribution of trespassing accidents according to the time of day during which the accidents occurred

Month and Year

Trespassing accidents occur in all seasons and all months of the year. Figure 3 shows the distribution by month of trespassing accidents reported to FRA from 2008 to 2012. There is a notably distinct pattern of more casualties by railroad trespassing in the summer months, presumably because people are more likely to be walking outdoors. This same pattern can be observed for each year in which data was collected; the number of trespassing accidents consistently falls in the winter and rises again in the summer. Figure 4 shows the number of trespassing accidents by month from the 5-year time period over which data was collected.

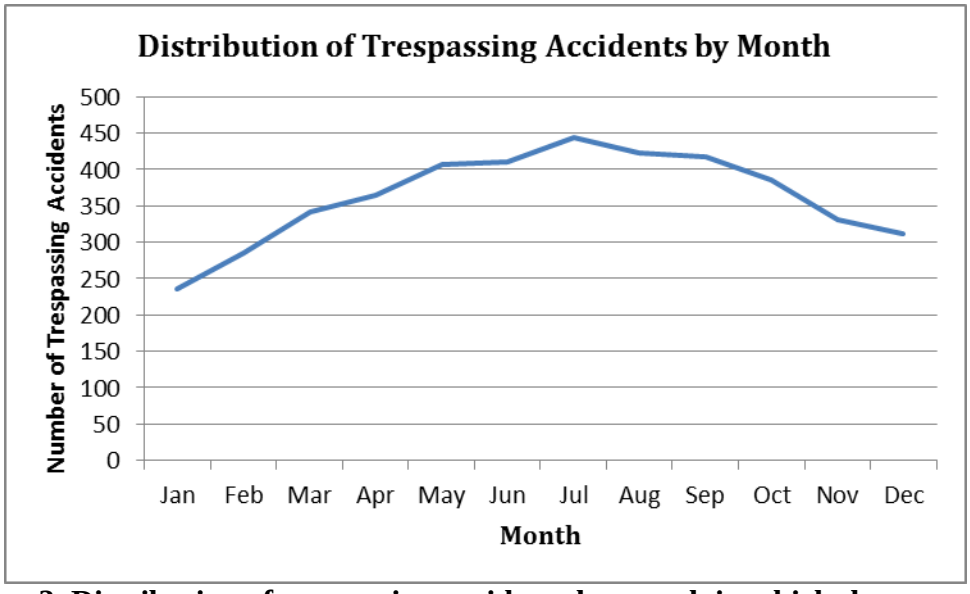

Figure 3. Distribution of trespassing accidents by month in which they occurred

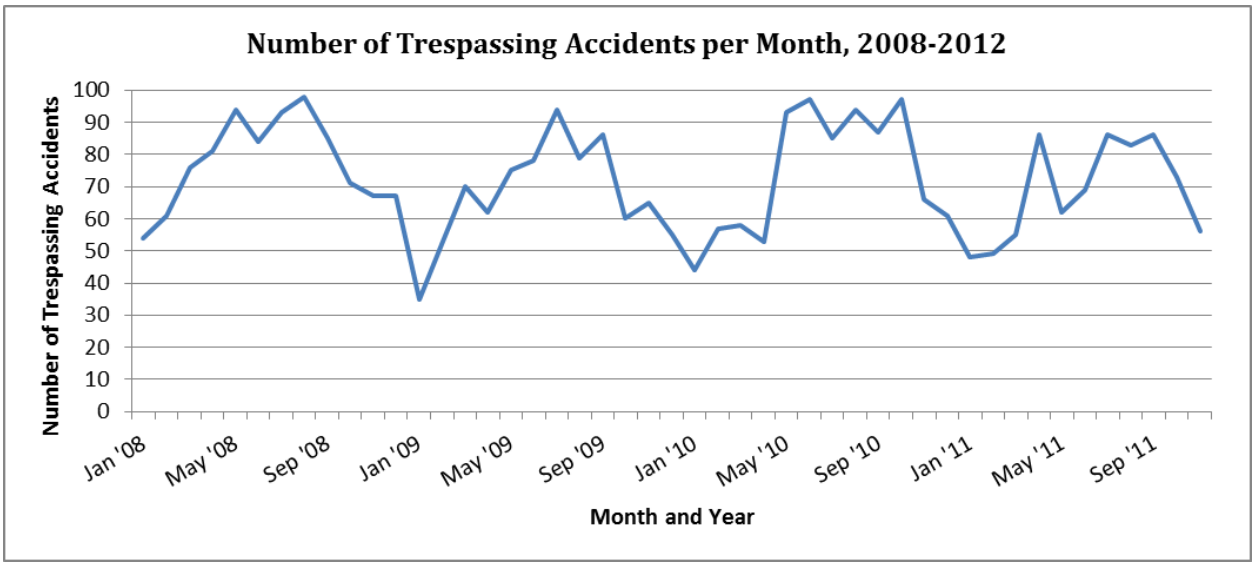

Figure 4. Number of trespassing accidents per month

4.2.5 Event Description

The FRA casualty reporting form includes several descriptor fields to illustrate the actions involved in the trespassing event, including the physical act of the victim, the location of the incident, the event directly leading to the casualty, and the tool or implement that caused the casualty. Since most accident reports do not include a narrative describing the events, these categories are essential to understanding the factors leading to the incident; nevertheless, the utility of this data varies.

Physical Act

The physical act data field ("PHYACT") in the casualty reports describes the bodily action of the victim immediately prior to the casualty-causing incident. Table 4 lists the 10 most frequently observed actions. The trespasser was most often described as "walking." Descriptions of "lying," "laying," or "sitting" might be construed as purposeful, suicidal actions—or, perhaps, those of an intoxicated person—as these descriptions indicate that the trespasser made no attempt to escape. Other common actions indicate horseplay or other likely non-suicidal activity, such as "climbing," "riding," or "running." In general, it is difficult to glean much useful information from the data provided in this field. It is difficult to know the intention of the trespasser simply from his or her actions, although those actions might be grouped by level activity—"laying" and "sitting" being somewhat more passive than others.

Table 4. Physical actions of trespassing accident victims

Physical Act	FRA Code	# of Accidents
Walking	72	1,593
Lying down	B6	539
Standing	62	459
Laying	42	357
Sitting	60	316
Running	59	235
Riding	58	158
Jumping from	40	135
Other (narrative must be provided)	99	112
Climbing over/on	09	97

Location

The FRA reporting form provides three different fields to describe the location of the accident. The first, "LOCA," is used to report the type of track, passageway, or interior location at which the incident occurred. The second, "LOCB," is used to report the on-track equipment type involved in the incident. The third, "LOCC," describes the relative location of the trespasser—for example, where he or she was in relation to the track or a piece of equipment. Table 5 lists the most frequently reported "A" locations, and Tables 6 and 7 do the same for "B" and "C," respectively. Table 8 lists the most frequent combinations of these locations.

The vast majority of trespassing accidents occurred on mainline track and involved moving on-track equipment. These events also include those in which the trespasser was riding or climbing moving equipment. Perhaps more interesting, due to their relatively large frequency, is the number of accidents that occurred on highway-rail grade crossings. A total of 461 accidents had "on highway-rail crossing" listed as their "C" location. The definition of a trespasser [15] indicates that these accidents must have occurred at activated, protected crossings being occupied by a consist at the time of the accident. Another 152 accidents were reported as having occurred on a bridge/trestle. And 124 incidents occurred in a yard, which is compelling because accessing yard property seems unmistakably like an illegal trespassing activity, whereas walking along or crossing track that meanders through neighborhoods and downtowns might seem like less of an illegal activity to those trespassers. (The RAIRS trespasser designation could also include employees that are off duty but on railroad property, but none of the accident reports with narratives suggest that this was the case.)

Table 5. Responses to "Location A" field of RAIRS trespassing reports

Location A	FRA Code	# of Accidents
Main/branch	A	4,095
Yard	B	124
Highway or roadway	J	35
Passenger terminal	P	26
Siding	C	17
Other location (describe in narrative)	Z	17
Industry	D	11
Sidewalk or walkway	S	9
Other track (explain in narrative)	Y	8
Office environment	M	2

Table 6. Responses to "Location B" field of RAIRS trespassing reports

Location B	FRA Code	# of Accidents
Freight train – moving	03	2,606
Passenger train – moving	14	1,001
The A/I was not associated with on-track equipment or any listed vehicle type.	99	352
Locomotive(s), not remote controlled – moving	10	160
Freight car(s) – moving	06	89
Off-road vehicle – recreational	57	31
Freight train – standing	04	27
Passenger car(s) – moving	15	20
Freight car(s) – standing	05	16
Camp car – moving	01	11

Table 7. Responses to "Location C" fields of RAIRS trespassing reports

Location C	FRA Code	# of Accidents
Track, on	B7	1,716
Track, beside	A3	716
Track, between	A4	707
On highway-rail crossing	B4	461
Alongside on-track equipment – on ground	A1	200
On bridge/trestle	B3	152
Between cars/locomotives	A5	79
Car, on side of (rail car)	B6	78
Car, in (rail car)	A7	40
Other location (describe in narrative)	X9	40

Table 8. Collective responses to the location fields of RAIRS trespassing reports

# of Accidents	Location A	LOCA FRA Code	Location B	LOCB FRA Code	Location C	LOCC FRA Code
858	Main/branch	A	Freight train – moving	03	Track, on	B7
653	Main/branch	A	Passenger train – moving	14	Track, on	B7
564	Main/branch	A	Freight train – moving	03	Track, between	A4
453	Main/branch	A	Freight train – moving	03	Track, beside	A3
240	Main/branch	A	Freight train – moving	03	On highway-rail crossing	B4
146	Main/branch	A	Passenger train – moving	14	On highway-rail crossing	B4
138	Main/branch	A	Freight train – moving	03	Alongside on-track equipment – on ground	A1
96	Main/branch	A	The A/I was not associated with on-track equipment or any listed vehicle type	99	Track, beside	A3
79	Main/branch	A	Passenger train – moving	14	Track, beside	A3
61	Main/branch	A	Locomotive(s), not remote controlled – moving	10	Track, on	B7

Event

The “Event” field on the reporting form is used to describe the occurrence that led directly to the injury. Most accidents were of the train-trespasser collision type, as evidenced by the fact that “struck by on-track equipment” was the most frequently entered event code. Table 9 shows the most frequently entered event codes. The second most frequently occurring is the highway-rail collision/impact. Since the motor vehicle occupant accidents have been removed from the form, this code refers strictly to pedestrian and recreational vehicles. The frequency of this code corroborates the information from the location fields that suggests trespassing accidents occurred relatively frequently at highway-rail grade crossings. Some of the event codes are especially useful because they indicate purposeful actions by the trespasser. A “thrill-seeking” trespasser may be difficult to deter in any scenario.

Table 9. Responses to the "Event" field of RAIRS trespassing reports

Event	FRA Code	# of Accidents
Struck by on-track equipment	59	2,999
Highway-rail collision/impact	32	445
Slipped, fell, stumbled, other	70	285
Other (describe in narrative)	99	111
Lost balance	34	65
Thrill seeking	67	62
Struck by object	58	31
Caught, crushed, pinched, other	68	31
Struck against object	61	29
Slipped, fell, stumbled, etc. because of object (e.g., ballast, spike, material, etc.)	54	25
On track equipment, other incidents	69	25

Tools

The "Tools" RAIRS field allows the accident reporter to indicate the physical instrument that caused the casualty. Since "Other" is the second most frequently cited code in the "Tools" field, it is generally of limited use. Table 10 lists the 10 most frequently occurring inputs for this field.. The most frequently listed tool was "Locomotive, other," which indicates common train-trespasser collisions. The "Tools" field is most useful when trying to pinpoint very specific accidents—for example, when categories like "Electrical connections – wiring" or "Weapon" might be useful.

Table 10. Responses to the "Tools" field of RAIRS trespassing reports

Tool	FRA Code	# of Incidents
Locomotive, other	82	1,050
Other (describe in narrative)	99	1,006
Ground	14	963
Track (rail)	81	607
Highway, street, road	18	332
Ballast, stone, etc.	02	92
Bridge/trestle	04	90
Motor vehicle, non rail	7K	33
Coupler	06	31
Step/stirrup, equipment	36	23

4.2.6 Narrative Reports

The narrative fields are often the most useful parts of the RAIRS accident reports. While non-narrative fields, when considered collectively, might give the same information, the narrative fields are much easier for researchers to review and often include additional data for which there are no code options. Some of the RAIRS fields for "Other" indicate that the reporter should include the additional information in the narrative. Unfortunately, many reports do not include

narratives, even those that have options for fields that indicate they should provide other information in the narrative.

Of the 4,353 trespasser casualty reports made to FRA between 2008 and 2012, 1,771 (41 percent) did not include a narrative. It is optional on the forms, but extremely helpful for railroad safety researchers who often have no other information about the accidents to consider.

4.2.7 Geographic Data

Since 2011, reporting railroads have been required to provide the latitude and longitude data for the accident location in their reports. Of the FRA trespasser data from 2008 through 2012 collected for this research study, 1,467 (33.7 percent) of the reported accidents have latitude and longitude information. This information is very helpful for illustrating the environment in which accidents occur, as will be shown in other sections of this report.

Not all of the geographic data provided is of equal use, however. A total of 149 accident reports included geographic information data that indicated the trespassing event occurred more than 0.5 miles (mi) away from any track. This finding was investigated using the trespassing data and GIS railroad track files provided by the Bureau for Transportation Statistics (BTS). A few of these instances were found to be accurate—some railroad property is far from tracks. But, it appears that a few of the accident locations were simply pinpointed to the nearest station, regardless of the actual location of the event.

In assessing location factors, it is important to consider the accuracy of the latitude and longitude data. In the FRA data, this information is presented with decimal degrees, but the number of decimal places varies throughout the data set. When no decimal places are provided, the accuracy of the latitude-longitude coordinate is within 1 degree, or 69.171 mi—hardly accurate enough to provide any useful information. With one decimal place provided, it is accurate to 6.971 mi; with two decimal places, to 0.69 mi; with three decimal places, to 0.069 mi; and with four decimal places, to 36.4 feet. Essentially, at least three decimal places are necessary to determine qualifying information about the accident, such as which bridge or highway-rail grade crossing was involved.

GIS Data

For this report, the FRA data that included latitude and longitude coordinates was plotted using ArcGIS software and correlated with additional GIS data from BTS and ESRI, the GIS software manufacturer. Rail line and grade crossing GIS information all came from BTS 2011 files. A file from the Department of Education with school locations (“DOE U.S. Schools 2010”) was used to review accidents with underage trespassing victims [17].

Google Earth Data

Google Earth is a useful new Web-based tool that was explored while conducting the research for this report. Even the no-cost version proved to be very useful for this research. Images from the satellite data are used in several sections of this report, and they provide a quick and easy glimpse of the different environments in which trespassing accidents occur. In the Google Earth application, Google also provides a large repository of additional place data, which researchers can use to define accident environments in more detail. For instance, it is very easy to see if an

accident occurred near a school, or if an intoxicated victim was in an area with many bars and restaurants. It is also very easy to see the number of tracks or highway lanes without looking up the information in an additional database. Figure 5 is a Google Earth map that shows trespassing accidents associated with common risk factors. The yellow “thumbtack” symbol marks the location of an accident.

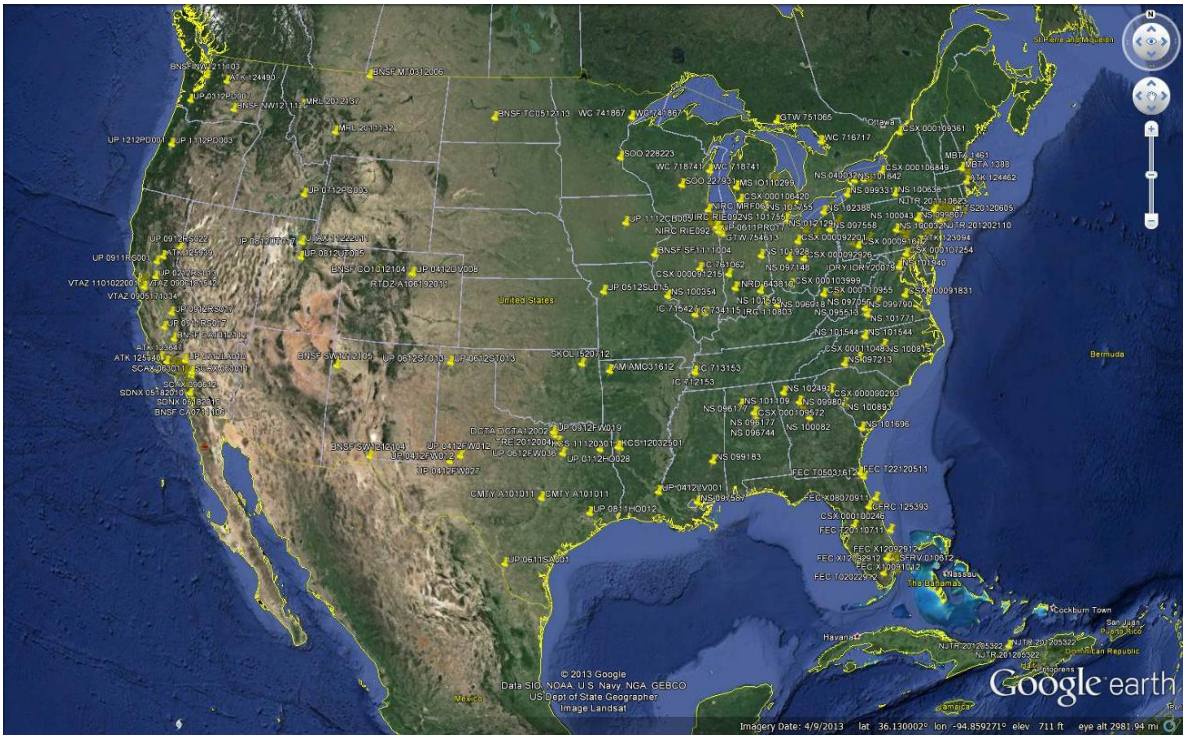

Figure 5. Google Earth image showing the locations of trespassing accidents

4.3 Common Trespassing Accident Characteristics

There are many common accident characteristics evident upon examination of the FRA RAIRS data. These are either potential risk factors or could help point to risk factors. Alleged suicides that have a public RAIRS report are discussed first. The remainder of the common characteristics described thereafter is indicative of unintentional casualties. These common accident characteristics are discussed in the following subsections of this report:

- Assault/Crime
- Bicycles
- Bridges
- Child Victims
- Disregard for Crossing Warnings
- Electrical/Third Rail
- Handheld Electronic Devices
- Homelessness
- Intoxication
- Recreational Motor Vehicles

- Stations
- Tunnels
- Woods/Brush/Cover
- Yards

4.3.1 Suicides (Alleged)

Although there are separate reporting systems for accidental railroad trespasser casualties and suicides, some of the RAIRS accident report narratives do refer to the casualty as a suicide or suicide attempt. A total of 28 accident reports referred specifically to suicide in the narrative section. In one case, the report was resubmitted as an accident rather than a suicide because the victim's family disagreed with the medical examiner's report. Four of the report narratives simply say "trespasser committed suicide," with no further explanation. In another case, the trespasser was highly intoxicated yet stated to the railroad employees that she was going to commit suicide.

Other reports include descriptions of the trespasser as looking sad or despondent, but given the difficulty of getting accurate witness reports, these are inconclusive. There are many other accident reports that do not directly suggest suicide but do describe the trespasser as having made no attempt to avoid an oncoming train once warning signals were activated.

4.3.2 Assault/Crime

Forty-two accidents indicated that the trespassing event occurred as part of a criminal activity or assault. At least three were homicides, including one in which someone was pushed onto the path of an incoming train. At least four of the victims were attempting to escape police custody. Four were stealing wire and scrap metal from railroad property. In one of these cases, the trespasser stealing wire came into contact with a catenary line. It is possible that some of these 42 accidents were listed as criminal events simply because of the trespassing act, but those with narrative reports all list some additional crime or assault event.

The details of these accidents were provided by the narrative reports: filtering the "PHYACT" field for "Arresting/apprehending/subduing"; filtering for "EVENT" codes for "Apprehending/removing from property," "Assaulted by other," "Committing vandalism/theft," "Shot," and "Stabbing, knifing, etc"; and filtering the "TOOLS" field for "Weapon."

4.3.3 Bicycles

The narrative sections of 35 accident reports indicated that the trespasser was riding a bicycle at the time of the accident. Twenty-six of these accidents occurred at grade crossings where the bicyclist trespassers failed to heed warning devices and yield to oncoming train. Two of the bicyclist trespassers simply fell when riding over the uneven railroad tracks. The RAIRS data fields do not include an option to specify that the trespasser was riding a bicycle, so the narrative reports provided the only indication.

4.3.4 Bridges

A total of 189 trespassing accidents occurred on bridges or trestles, which for a number of reasons appear to be attractive to trespassers. If no pedestrian-accessible bridge is present, a railroad bridge can often be a much shorter path to cross over a waterway, roadway, or large ditch. They are also attractive to thrill-seekers and youths. In one case, children were jumping off a bridge trestle to go swimming. In other cases, pedestrians were walking along highway bridges when they attempted to jump onto a train passing below. In at least one case, the trespasser was intoxicated when he or she fell from a bridge. In yet another case, two trespassers were walking on a lowered bridge that began to rise into the up position. Several trespassers deliberately jumped from railroad bridge trestles; at least one of these is referred to as a suicide in the narrative report.

To determine which accidents involved bridges or trestles, the "LOCC" field was searched for the "On bridge/trestle" input. The location field was not comprehensive, however, as some trespassing accidents on bridges were simply listed as occurring on track. Sixty-eight of the accidents determined to involve bridges included latitude and longitude data in their accident reports. These were plotted in Google Earth and reviewed for possible similar characteristics. Few patterns were found, although many were one-track bridges in rural areas. Surprisingly, in several instances the bridge was supplying grade separation or was parallel to a road bridge. In these cases, trespassers may have viewed a railroad bridge with infrequent train traffic as preferable to a road with consistent motor vehicle traffic.

4.3.5 Disregard of Crossing Warnings

Seventy-six accident reports indicated in their narratives that the trespassing victims explicitly disregarded activated warning signals during the trespassing event. The definition of a trespasser in [15] indicates that the grade crossing must be protected with activated warning devices to classify the person as a trespasser. Over 20 of these accident reports were of trespassers on bicycles disregarding the grade crossing warning signals.

For 40 of these accidents, latitude and longitude coordinates were provided and were plotted into Google Earth to provide a better idea of the types of crossing environments in which these accidents occurred. At least seven locations had a single-track ROW, 13 occurred on a two-track ROW, two occurred on a ROW with three or more highway lanes, one occurred at a highway-rail grade crossing with at least eight highway lanes, and at least four occurred in multi-track/switching areas. Figures 6 and 7 show Google Earth images of a multiple-lane highway-rail grade crossing and a multi-track switching area, respectively. In both figures, the yellow "thumbtack" symbol marks the trespass accident. From this limited data, it appears that more complicated crossing areas, with multiple lanes and tracks, present more of a hazard. It is possible that in areas with many trains, pedestrians grow overly accustomed to the crossings. Likewise, in areas where there are few trains, residents may underestimate the risk.

Figure 6. Trespass accident location marker on multiple-lane highway-rail grade crossing

Figure 7. Trespass accident location marker in switching area

All the trespassing accidents from the FRA RAIRS data with latitude and longitude information were plotted against the database of highway-rail grade crossing locations provided by BTS. A total of 1,160 (79 percent) occurred within 0.5 mi of a highway-rail grade crossing. A total of 141 occurred within 0.5 mi of 10 or more highway-rail grade crossings. While it is not possible to draw a concrete correlation from any of the data presented in this section, designated rail crossing areas do bring people closer to the ROW than they would normally get; these zones could therefore be considered higher-risk locations.

4.3.6 Electrical/Third Rail

In 29 accidents, the trespassers suffered shocks and burns due to run-ins with stationary electrical railroad equipment, not collisions with moving railroad equipment. Many of these cases for which narrative reports were written describe horseplay of some sort. Ten of the victims were under the age of 18. All of the victims may have been unaware of the dangers of coming into contact with the third rail or the catenary system. These accidents were identified from the FRA RAIRS data by the "NATINJ" field for "Electrical shock or burn," by the "EVENT" field for "Electrical shock […]," the "TOOLS" field for "Electrical connections, wiring, etc." and by examining the narrative reports.

4.3.7 Handheld Electronic Devices

The narrative sections of 21 accident reports indicated the use of an electronic handheld device by the trespasser immediately prior to the casualty-causing event. Such events occurred primarily in rural areas with many pedestrians. The accidents typically involved trespassers wearing headphones and talking on cellular telephones. One trespasser was in the process of sending a text message when she was hit. Most were walking, although one was wearing headphones on a bicycle. Four ignored grade crossing warning devices. In at least one case, the conductor activated the train's warning alarms once he saw the trespasser, but the trespasser did not heed the warning, possibly because he or she was distracted by the electronic device. The RAIRS data fields do not include an option for specifying that the victim was possibly distracted by an electronic device, so the narrative reports provide the only indication.

4.3.8 Homelessness

Eight accidents in which the trespassing victim was homeless were positively identified from the FRA RAIRS data. These trespassing events included the violation of crossing devices, an assault at a station, and pushing a shopping cart along the tracks when struck. The data is possibly skewed toward accidents in which the trespasser survived (six of the eight accidents), which might be the only way to obtain information about the trespasser's personal economic situation. There is no RAIRS data field entry to indicate that the trespasser was homeless, so only the narrative reports provided any indication. Often, railroads have a difficult time learning anything about the victims, especially by the time the report needs to be submitted to FRA, so these eight reports are likely unrepresentative of the total number of trespassing incidents involving homeless individuals. Railroad infrastructure can be attractive to the homeless because it provides many options for shelter. There were even more accidents reported that described the trespasser as sleeping on the track or under platforms, but the reports did not definitively identify

the trespasser as homeless. Figure 8 is a photo of a homeless trespasser who has set up a camp on a platform beside a wheelchair lift enclosure at a passenger station in California.

Figure 8. Trespasser sleeping on passenger station platform, with ROW in background

4.3.9 Intoxication

Fifty-three accident reports described the trespassing victim as intoxicated. There are RAIRS data fields for the presence of drugs and alcohol, but these were not used in the trespasser accident reports. Trespasser victims were identified as intoxicated in the narrative reports only. There may have been several more accidents in which intoxication was involved but not mentioned in the narrative or for which a narrative report was not provided.

A common intoxication trespassing scenario involved an incapacitated trespasser sitting on, lying on, or otherwise unintentionally fouling the tracks when a train passed by. One was engaged in criminal activity—stealing wire—when he came into contact with a catenary line and suffered an electric shock. Latitude and longitude data was provided for 25 of the accidents identified as involving intoxication. Using Google Earth, nine of these were found to have occurred in downtown urban areas of very large to medium-sized cities. Three of these nine were in the New York metropolitan area. The rest occurred mostly in the downtown area of smaller, rural towns. Eight occurred very close to highway-rail grade crossings, and one of these occurred near a rail crossing that was required to access a recreational dockyard.

Google Earth may be more helpful for analyzing trespassing incidents involving intoxication in the future. Google has a crowd-sourced network of continuously updated places that provides geographic data for the locations of bars and restaurants. These might be considered high risk areas. For now, there is too little data, especially in urban areas, to show any correlation, and much of the latitude and longitude data provided in the reports is not accurate enough to show proximity. Figure 9 is a Google Earth image showing the proximity of nightlife to a trespassing accident in which the trespasser was intoxicated. The yellow “thumbtack” symbol marks the

location of the trespassing accident, while the purple “cocktail glass” symbol to the lower left of the accident marker designates a bar/club.

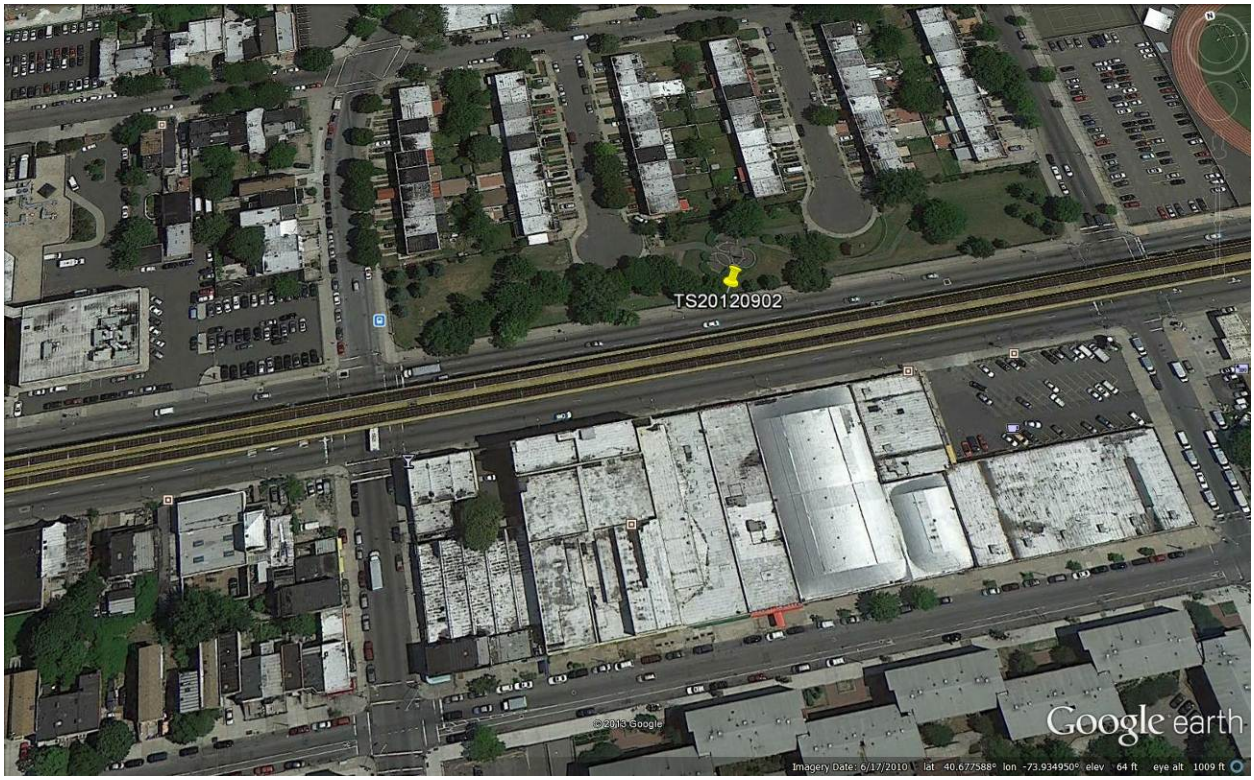

Figure 9. Trespass accident location marker near alcohol-serving establishment

4.3.10 Recreational Motor Vehicles

In 40 accidents, the victims were operating a recreational motor vehicle such as an all-terrain vehicle (ATV). At least one case involved a dirt bike, and another a snowmobile. Unsurprisingly, these accidents occurred most often in rural areas where people are more likely to operate ATVs. In the majority of the accident reports for which narratives were provided, the vehicle was unable to navigate the uneven ROW infrastructure, and the vehicle crashed or was stuck and subsequently hit by a train. In one case, it was the ATV that struck the train. In three events, the vehicle operator was attempting to beat a train at a crossing; one of these happened at a private crossing. In at least three events, the trespasser was riding on a bridge when he or she fell, or when the vehicle fell between the tracks.

The RAIRS “LOCB” field provides an option for “Off road vehicle – recreational,” and this was used with the narrative reports to help determine which accidents involved recreational motor vehicles.

4.3.11 Schools

A total of 452 trespassing accidents (just over 10 percent) had victims 18 years old or younger. A hundred and fifty of these accident reports included latitude and longitude data. BTS GIS data for elementary, middle, and high schools was plotted with the FRA RAIRS accident locations for

accidents with child victims. Eighty-five (57 percent) occurred within 0.5 mi of at least one school. It is possible that children will wander onto railroad tracks around their school area, and may even cross or walk along the tracks as they walk to and from school. Between 7 a.m. and 9 a.m., 14 accidents involving children near schools were reported, and 24 similar accidents were reported between 2 p.m. and 5 p.m. in the data set. While simply showing that many accidents happened near schools does not correlate the accidents with their proximity to the schools, it does show that prioritizing track protection around schools may help prevent trespassing accidents that involve children.

4.3.12 Stations

A total of 107 trespassing accidents occurred at or near stations. Like highway-rail or pedestrian-rail grade crossings, proximity to stations could be a risk factor simply because potential trespassers are drawn closer to the ROW at and near stations since those locations are on the ROW. Two accidents were simply the result of trespassers slipping and falling in or near the station building and did not involve the ROW or ROW equipment at all. Another two accidents involved trespassers in substations who received electrical equipment-related injuries. In at least 12 of these accidents, the trespasser fell or jumped from the platform and was unable to move out of the way of the oncoming train. In one case, the trespasser had waited for the first train to pass, but did not notice that a second train was coming from the opposite direction and was struck by the second train.

Intoxication played a large role in many of the trespassing accidents at stations, particularly in trespassing events in which the trespasser fell from the platform. In one accident, an intoxicated passenger was slumped over the edge of the platform and struck by the oncoming train. In another, one trespasser was sleeping under the platform after a night of drinking and was struck by a train upon exiting in the morning.

Accidents that happened at stations were mostly determined from the narrative reports, as many reports simply listed on track or ROW for the location. The “LOCA” field option for “Passenger terminal” and the “LOCB” field options for “On station platform” and “On platform” were also used.

4.3.13 Tunnels

Eight accidents were identified as having occurred in ROW tunnels or on other underground railroad property. In six of these accidents, the trespasser was struck by on-track equipment. In one of these, the trespasser was sleeping in the tunnel when struck. In another accident, the trespasser was injured by an electric shock while stealing wire from a substation, and in the other, a trespasser was injured when the emergency hatch door through which she was exiting hit her on the head.

Because they are on well-defined sections of railroad property, these accidents might be amenable to mitigation measures; however, tunnels and similar areas are also generally well-protected, and these trespassers often go to greater means to access them than do those who simply walk from one side of an open and unfenced ROW to another. It is important to note that tunnels often pose many considerable objective hazards – including the possibility of electric shock – other than the possibility of being struck by an oncoming train. Potential trespassers may

be unaware of these hazards because tunnels are essentially warm, protected places and may be attractive to those without homes or any other place to sleep.

The accidents in tunnels were identified from the FRA RAIRS reports by using the "LOCC" field for "In tunnel" and by examining individual narrative reports.

4.3.14 Woods/Brush Cover

In 14 of the accidents in the FRA RAIRS data, the narrative report described the trespasser as emerging suddenly from behind some cover, including brush, woods, and in one instance, a catenary pole. According to the Track Safety Standards, railroads are expected to keep the ROW clear because it may be too late to stop a train if a trespasser is spotted in the line of sight of the locomotive engineer. In the 14 accidents referenced above, the locomotive engineer had no time to activate the on-board warning devices, and it is possible that the cover also prevented the trespassers from seeing the oncoming train.

4.3.15 Yards

A total of 141 trespassing accidents occurred not on mainline track, but in yards. Yards appear to be attractive places for trespassers interested in horseplay like climbing ROW equipment. At least eight victims fell when climbing equipment in the yard. Others were injured by trying to pass between cars in a consist to get from one part of the yard to another, some while the train was moving. One trespasser was struck while placing pennies on the track. Yard areas might also attract theft—at least one trespasser was injured during the course of arrest for stealing scrap metal. According to several narrative reports, there were no witnesses to many accidents. The injured or deceased trespassers were found later by railroad employees who had not realized an accident occurred.

Accidents that occurred in yards were classified separately in the narrative reports: the "LOCA" field options for "Yard," "Industry," and "Freight terminal," and the "LOCC" option for "At freight terminal."

5. Locomotive Video – SFRTA TriRail Rail Corridor

In 2010, FRA's Office of Research and Development and the Volpe Center collaborated with a large group of stakeholders to investigate the occurrence of trespassing incidents along the South Florida Regional Transportation Authority (SFRTA) TriRail commuter rail corridor in West Palm Beach, FL, as part of the Trespass Prevention Research Study. One aspect of this project included collecting trespass occurrence data using an outward-facing camera in a locomotive to record activity in front of the train during trips up and down the corridor. This project is further described in daSilva [12].

5.1 Locomotive Video Data Collection

Between March 5, 2010, and July 5, 2010, a camera onboard the locomotive recorded several trips along the West Palm Beach ROW. Samples were collected during all time periods of operation and during all days of the week. The video was then reviewed for evidence of trespassers. Figure 10 provides a sample screen shot of a recorded trespassing event.

Figure 10. A trespassing event recorded using a camera placed in a locomotive

Some limitations to the data were discovered during the analysis. The video was often grainy; the early morning runs occurred in the dark or at times of limited visibility, and the camera placement was such that the video did not follow curves, so sometimes only one side of the track was visible. There are other inherent limitations to this data collection method, the most prominent of which is that it is still not comprehensive. Data is only collected during the discrete times a train passes a certain point. Despite these limitations, this data provides a unique

opportunity to view trespassing incidents "in action," so to speak, including incidents that did not result in a casualty. Note: That project only considers data that did not result in a casualty.

This report does not provide a full description of the Trespass Prevention Research Study. More information about that project can be found in the project's final report [12].

5.2 Description of Trespassing Incidents

During the period of collection, 176 trespassing events were captured by the locomotive camera. Of these, 116 occurred on the ROW, and 60 occurred at a designated track crossing.

5.2.1 Time of Day

The time of day at which the incidents occurred was recorded. This information is provided in Figure 11 for 3-hour blocks of time. Twenty-eight percent of recorded trespassing events occurred between the hours of 3 p.m. and 6 p.m., more than during any other block of time. (Of course, data was only collected when the trains were running, so the late night and early morning data is limited or non-existent.) According to this data, trespassing is more prevalent in the latter half of the day, particularly in the early evening. This is true for both ROW and grade crossing trespassers.

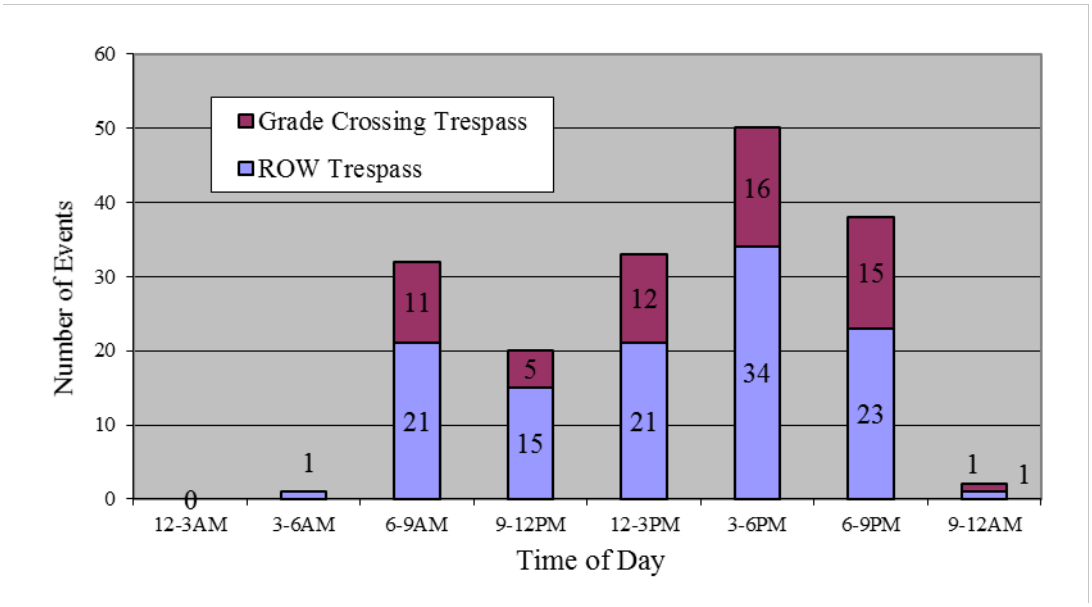

Figure 11. Time of occurrence of trespassing incidents along the SFRTA corridor

5.2.2 Common Accident Characteristics

Just like with the FRA RAIRS data, there are common incident characteristics or scenarios that can be identified in the SFRTA locomotive video data. For the ROW trespassing events (those that did not occur at a designated crossing site), a primary distinguishing factor is whether or not the trespasser actually crossed from one side of the tracks to the other. Of the 116 ROW events, 31 involved trespassers who crossed the tracks. Given that the video captures only short time intervals that do not always equal the full duration of the trespassing event, it is unclear whether

trespassers that were not seen crossing the tracks in fact did so elsewhere at a different time and were simply not caught by the locomotive camera. Regardless, it is evidently fairly common for trespassers along the ROW to commit the dangerous action of walking over the tracks. In these cases, the action is even more dangerous because the moving train, with its locomotive camera in place, must have been close enough to the offending trespasser to capture the incident.

In 24 of the ROW trespass events captured by the locomotive video, trespassers were at some point on a worn footpath near a station. This provides some evidence for the belief that trespassers are likely to "follow the crowd" and walk along a previously established path, even if it involves trespassing on the ROW. This data also shows that outdoor station areas are a potential hotspot for trespassers. Many of the captured trespass events showed trespassers traversing to or from a station platform area. These areas necessarily attract pedestrians who are often unwilling to walk to a designated crossing area if trespassing across the tracks presents the shortest path to their intended destination.

The trespass events that occurred at a grade crossing mostly involved trespassers violating activated, lowered gates. In 46 of the 60 grade crossing trespass events captured by the locomotive camera, the trespassers violated the gates after the train had already passed. This may seem safer than crossing before a train (which was the case in seven events), but there is always the possibility of a second, unnoticed train. In fact, three of the trespass events at established crossings involved two trains passing the crossing in quick succession. Two of these trespassers passed in between the two trains.

The Trespass Prevention Research Study showed that many trespassing events occur within a relatively short period of time, and so the vast majority of trespassing events are unrecorded and unavailable to transportation safety researchers. The number of accidents captured by the FRA RAIRS data likely pales in comparison with the number of trespassing incidents that do not result in a casualty. The locomotive video data from the Trespass Prevention Research Study captured 116 trespassing events in a very small, localized urban area; in the same period of time, only 13 trespassing casualties were reported to FRA for the entire State of Florida. Ongoing work in the Trespass Prevention Research Study includes the installation of fixed cameras at known trespass locations to determine the scope of trespassing. In one location just south of a train station, 131 trespassers were captured on video over a 24-hour period. This indicates that trespassing incidents at one location could be many orders of magnitude larger than the number of trespassing accidents; it further suggests that fixed-camera data capture studies are a promising way to determine the total number of trespassers at a given location.

6. U.S. Census Demographic and Economic Data

6.1 U.S. Census Data Collection

The State and county information provided in the FRA RAIRS accident reports was analyzed with corresponding U.S. Census data. The RAIRS data lists the State and county in which the accident occurred; this information was plotted with the U.S. Census' USA Counties data set. The demographic characteristics reviewed against the accident data were Median Household Income, Percent of Population in Poverty, Population Density, Percent Minority Population, Unemployment Rate, and Crime Rate. Table 11 lists the specific U.S. Census datasets from which data was drawn.

(Although some of the RAIRS data does include GIS coordinates and could be reviewed at a closer scale than by county, the U.S. Census Bureau does not have a finer split of demographic data than by county. It would have been a massive effort to collect uniform demographic data from individual locations. Unfortunately, the U.S. Census Bureau has recently terminated its support for the USA Counties database, which will make uniform local demographic analyses in any field much more difficult in the future.)

Table 11. U.S. Census county data fields used in analysis

U.S. Census Data Field ID	U.S. Census Data Field Description
IPE010209D	Median Household Income 2009
IPE120209D	People of all age in poverty – percent 2009
POP010210D	Resident population (April 1 – complete count) 2010
POP060210D	Population per square mile 2010
POP225210D	Population of one race – percent White alone, not Hispanic or Latino 2010 (complete count)
CLF040210D	Civilian labor force unemployment rate 2010
CRM110208D	Number of violent crimes known to police 2008 (used with POP010210D to create a dataset of county crime rates)

6.2 Demographic and Economic Review Results

Each demographic and economic factor was plotted against the number of accidents in U.S. counties and a simple linear regression was performed to test for correlation. None of these demographic factors are significantly correlated to the occurrence of railroad trespassing accidents, with the exception of population density. This underscores the idea that railroad trespassing accidents can happen everywhere and to everyone. While this information can raise awareness, it is not very helpful in determining factors that may lead to an increased risk of trespassing incidents and accidents or in developing ways to mediate accident occurrence.

There are several characteristics of this data that make it difficult to test for correlation. One is that trespassing accidents are, in terms of data availability, rare events. There are many more counties with one or two accidents (or none at all) than there are with more accidents. This is, of

course, a good thing. Another reason is that accidents are generally clustered wherever railroads are present. This analysis did not take into account any factors of railroad traffic because of the difficulty of obtaining that data. A third reason is that there are many outlying points of data for both number of accidents in each county and the demographic and economic characteristics, mostly on the higher end for all data categories. To make up for these limitations, the data is presented in the subsections below in "bins" of various intervals to make any correlation more clearly visible. The median value of each demographic or economic characteristic for the counties with at least one trespass accident between 2008 and 2012 is provided for comparison in the text immediately preceding each data chart.

Most importantly, it should be emphasized that the data shown in this section tests correlation with *community* (specifically county) demographics and economic indicators. Counties themselves are large areas with many varied sub-communities, each with its own characteristics. No conclusions can be drawn about the racial or economic statuses of the individual trespassers. To do this, much more detailed information would be needed, as was discovered in the Cadle Creek Consulting and North American Management studies [3, 4].

6.2.1 Demography

Population Density

The median population density in 2010 (number of people per square mile) of U.S. counties with at least one trespass accident between 2008 and 2012 was 113.15. Figure 12 shows the number of trespassing accidents that occurred in counties of various population densities. It is immediately apparent that the vast majority of trespassing accidents occurred in counties with low population densities—counties that are mostly rural. There are many more rural counties than urban ones in the United States, but there are still many trespassing accidents in those few urban areas. Urban areas can be "hot spots" for trespassing activity; however, the chart below indicates that most trespassing accidents do not occur in areas of high population density.

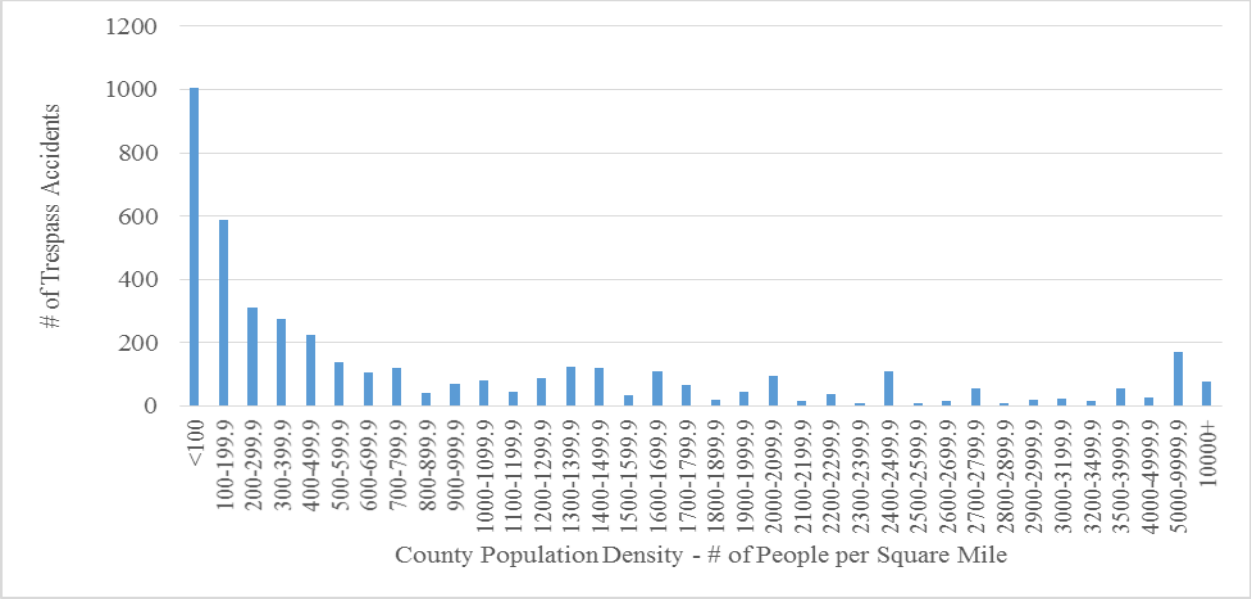

Figure 12. Population density (county) and trespass accidents

Racial Composition

The median minority rate in 2010 (percent of total population of non-white ethnicity) of U.S. counties with at least one trespass accident between 2008 and 2012 was 20.25 percent. Figure 13 shows the number of trespassing accidents that occurred in counties of differing racial compositions according to minority rate. A significant number of trespassing accidents occurred at all minority rate percentage intervals, although the majority of trespassing accidents occurred in counties with higher than the median minority population rates. This suggests that there may be a slight correlation between minority population rate and trespassing accidents, and that those accidents may disproportionately occur in counties with higher minority compositions. More data, particularly exposure data and a comparison with counties in which trespass accidents did not occur at all, would be needed to test this correlation before a conclusion could be made.

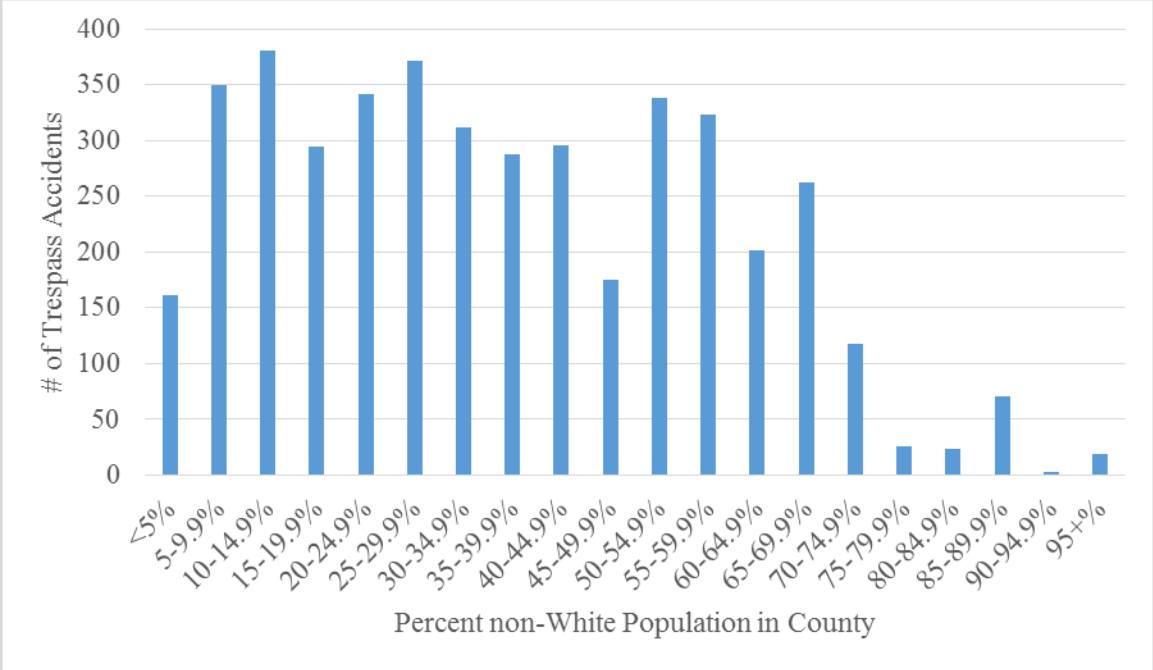

Figure 13. Percent minority rate (county) and trespass accidents

6.2.2 Economic Indicators

Household Income

The median household income in 2009 in counties with at least one trespassing accident was $43,665. (This is the “median of the median” for counties with at least one trespassing incident.) Figure 14 shows the number of trespassing accidents that occurred in counties with various median household income levels. Most trespassing accidents occurred in counties with ‘at or just slightly higher than the median’ income levels, indicating that there is no correlation between the numbers of trespassing accidents and relatively low household income.

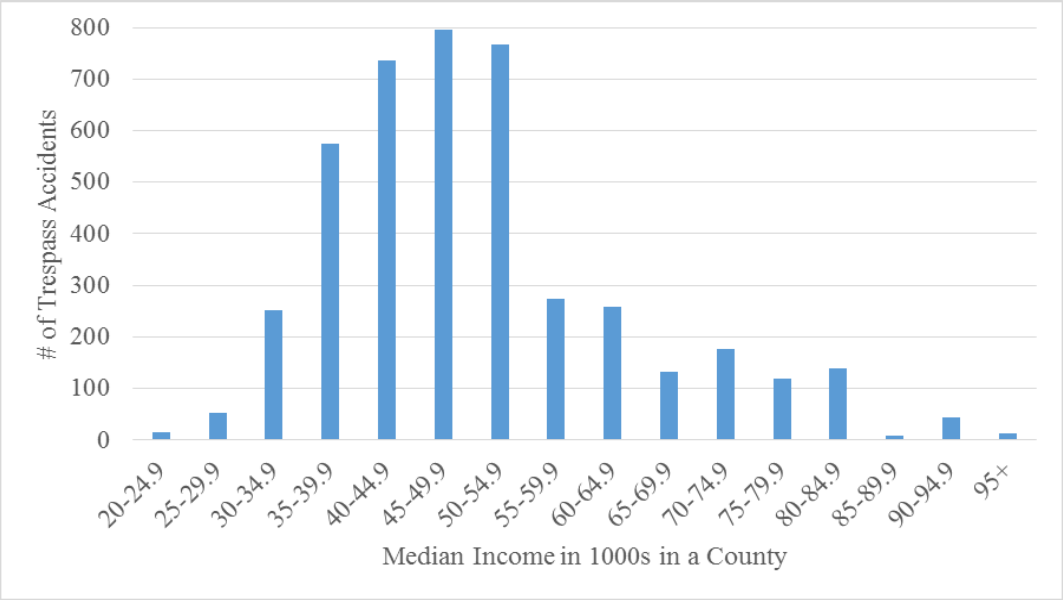

Figure 14. Median income (county) and trespass accidents

Poverty Rate

The median poverty rate in 2009 (percent of total population with an income below the designated poverty thresholds [18]) in U.S. counties with at least one trespassing accident between 2008 and 2012 was 14.9 percent [19]. This is slightly higher than the 2009 overall U.S. poverty rate of 14.3 percent. Figure 15 shows the number of trespass accidents that occurred in counties with different poverty rates. It shows that trespassing accidents did not occur disproportionately in counties with either low or high poverty rates; most accidents occurred in counties with close to the median poverty rate. This finding indicates that trespass accident occurrence is not correlated with impoverished communities, which agrees with the findings for household income.

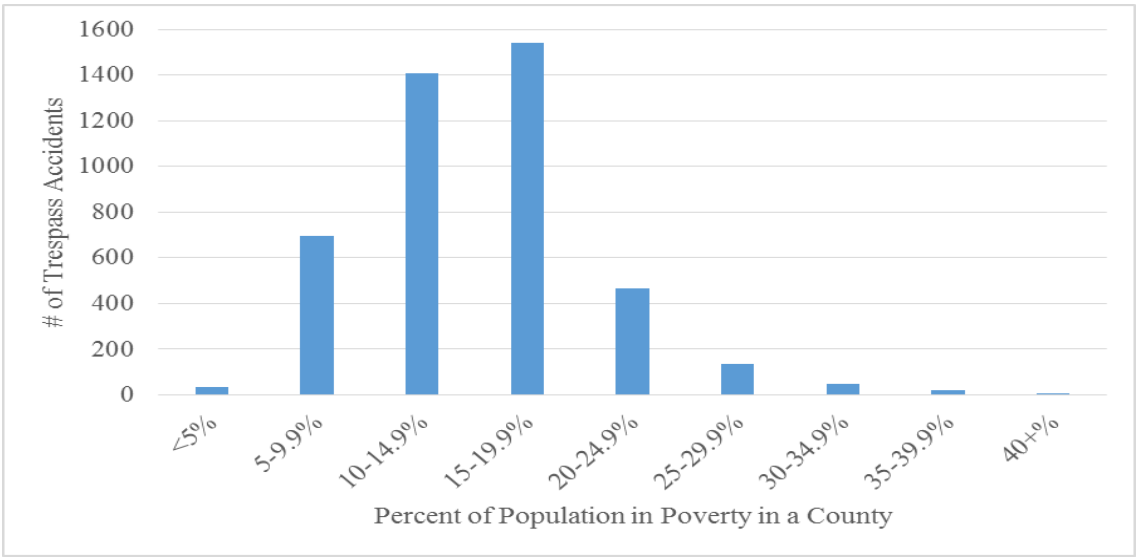

Figure 15. Poverty rate (county) and trespass accidents

Unemployment

The median unemployment rate in 2010 in U.S. counties with at least one trespassing accident between 2008 and 2012 was 9.3 percent. Figure 16 shows the number of trespassing accidents that occurred in counties with varied unemployment rates. Most trespassing accidents occurred in counties with 'at or near the median' unemployment rates, and unemployment is not significantly correlated with the occurrence of trespassing accidents.

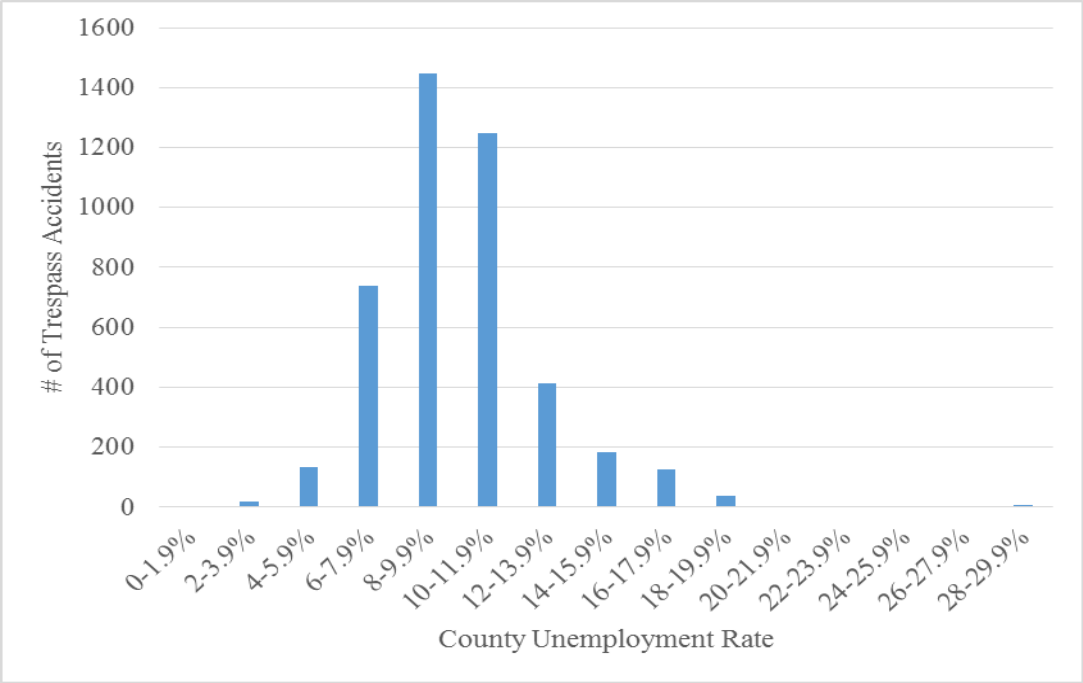

Figure 16. Unemployment rate (county) and trespass accidents

Crime Rate

The median violent crime rate in 2008 (number of violent crimes per 1,000 people) in U.S. counties with at least one trespassing accident was 2.75. Figure 17 shows the number of trespass accidents that occurred in counties with different crime rates. It shows that trespassing accidents peaked in counties with close to the median crime rate, but that more accidents overall occurred in counties with higher than the median crime rate. This finding suggests that trespassing has a slight correlation with violent crime rates.

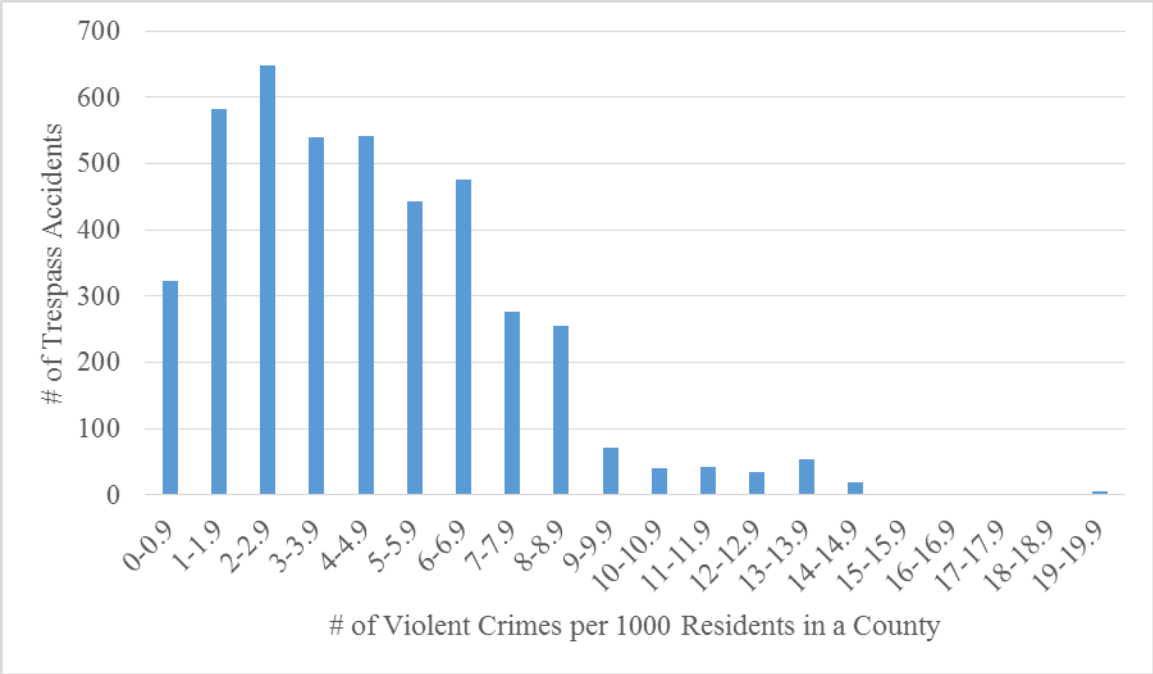

Figure 17. Violent crime rate (county) and trespass accidents

7. Conclusions

The literature review and data analyses in this report investigate many possible risk factors for trespassing incidents and accidents. Many of the results are more suggestive than conclusive, but are still worthy of note and discussion. Below, the most notable potential risk factors are described. They are split into two main categories, those that apply to the individual trespasser and those that apply to the location of the trespassing accident. Below the lists of risk factors is a list of data recommendations to enrich future railroad trespassing studies.

Several accidents involved compounding risk factors, such as a trespasser riding an ATV on a bridge, a trespasser ignoring crossing warnings while listening to headphones, or a grade crossing being located near a station. Future efforts to prioritize resources for trespassing protection might look to accident scenarios that involve several risk factors.

7.1 Risk Factors – Individual

1. **Disregard for Highway-Railroad Grade Crossing Warnings**

   Many trespassing victims were in fact at designated crossings when the accidents occurred, but they did not heed the required warnings intended to keep them safe. Accidents due to disregard for grade crossing warnings occurred to both on-foot pedestrians, bicyclists, and operators of recreational motor vehicles. Frequent disregard for grade crossing warning systems was found in both the FRA RAIRS data and the SFRTA locomotive video data.

2. **Intoxication**

   Many trespassing victims were intoxicated at the time of their accidents. At the 2008 Trespass Workshop [9], both the Toronto Transit Commission and Amtrak noted that many trespassing victims were intoxicated. Silla and Luoma [13] suggested that approximately half of train-pedestrian trespassing accident victims in Finland were intoxicated. The FRA RAIRS accident reports agree. Many narratives suggest that a number of trespassing accident victims were intoxicated.

3. **Use of Electronic Devices**

   Several narrative reports in the FRA RAIRS data note that trespassers were using headphones or cellular phones at the time of the accident, which likely kept them from observing crossing warning devices and the signs of an oncoming train. Lichenstein, et al. [5] write extensively about trespass accidents involving portable electronic devices and suggest that a high proportion of train-pedestrian crashes are partly caused by this type of distraction.

7.2 Risk Factors – Location

1. **Time of Day and Year**

   Both the FRA RAIRS data and the data collected from the SFRTA locomotive video indicated that trespassing events are more common during evening hours. The FRA

RAIRS data from each year covered by this study also consistently showed that trespassing accidents are more common in the summer months than in the winter.

2. **Grade Crossings**

   Grade crossings are likely locations for trespassing because they draw trespassers close to the ROW. Many trespassing accident pedestrians—i.e., on-foot pedestrians, bicyclists, and operators of motor vehicles—violated crossing gate warnings, including lowered gate warnings. This was found in two sets of data—the FRA RAIRS accident reports and the SFRTA locomotive video.

3. **Stations**

   Stations, like grade crossings, provide inherent opportunities for trespassers because they draw potential trespassers near the ROW. In several trespassing accidents, victims were injured or killed as a result of falling off the platform or trying to cross the tracks near a station away from or in violation of the designated pedestrian crossing. Several victims who trespassed at stations appeared also to be intoxicated.

4. **Schools**

   Over half of all trespassing accidents with child victims occurred within 0.5 mi of a school. While this data result does not show a significant correlation between proximity to a school and the likelihood of a trespassing incident, it does indicate that concentrating anti-trespassing efforts in areas near schools could prevent a significant number of child casualties.

5. **Yards**

   Yards appear to be particularly attractive to railroad trespassers intent on thrill-seeking or horseplay and might be a difficult risk factor to mediate because yards tend to be already secured areas that do not pose any advantage of access (like a bridge might) to a trespasser. Nonetheless, severe trespassing accidents occur relatively frequently in yards. One course of action may be better surveillance. Many trespassing casualties in yards are not discovered until employees eventually find an injured or deceased person. Posted warnings about the constant possibility of moving trains may discourage trespassers from attempting to climb or pass through equipment.

6. **Bridges**

   Bridges and trestles were other common points of trespass on railroad property. They often attract trespassers as a shortest path between two points. Locations in which a railroad bridge is present without a nearby pedestrian bridge might be considered in trespassing accident mitigation, although geographic imaging shows that trespassing accidents also occur on railroad bridges even when there is a nearby, parallel highway bridge. Bridges are also attractive to thrill-seekers who climb and jump from them. The FRA RAIRS accident reports indicated that highway bridges that cross over railroad tracks pose a trespassing hazard because they draw trespassers who attempt to jump onto the ROW or even onto trains.

7. **Population Density**

   The FRA RAIRS accidents data and the U.S. Census demographic data showed that most trespassing accidents happen in relatively less-populated areas. While urban areas may be hot spots in that multiple accidents happen in a small number of counties, the bulk of trespassing accidents have, in recent history, not occurred in the most densely populated areas of the country. Although small towns and counties with low populations may only experience one or two trespassing accidents within a couple of years, these areas far outnumber urban areas and collectively account for the majority of accidents.

8. **Lack of Correlation with Economic Indicators**

   The review of FRA RAIRS data with U.S. Census data did not show any significant correlation between any of the explored economic indicators. Most trespassing accidents happen in counties with close to the county median levels of household income, percentage of residents in poverty, and unemployment. More trespassing accidents occurred in counties with higher than the median violent crime rate than in counties with lower, but trespassing accidents are still very common in those counties with low violent crime rates, as well. The Cadle Creek Consulting [3] demographic research study concluded that trespassing fatality victims are slightly poorer than the general population. The North American Management study [4], as part of its market analysis of trespassing accident victims, concluded that effective outreach efforts to reduce trespassing would target low income market clusters. While this report correlated data with societal economic characteristics (on a county level) and not individual characteristics, the somewhat conflicting results between this report and the previous studies [3, 4] suggest that neither are conclusive and more detailed and complete data sets would be needed to determine any correlation.

7.3 Data Recommendations

1. **Incidents, not just Accidents**

   The vast majority of trespassing data is of casualties, not instances or occurrences. It is possible that the casualties present a representative sample of trespassing incidents, but as of right now, there is not enough data to test that idea. More data on trespassing incidents—particularly of their frequency, even if just within a limited area—would be extremely valuable to railroad transportation researchers. Unfortunately, our ability to find out more information from the trespassers themselves is limited. Collecting more data on incidents that do not result in casualties may address this gap in data collection.

2. **Coordinate with Transportation Agencies**

   Several transportation agencies at the 2008 Trespass Workshop [9] spoke of their internal efforts to collect data, either for research purposes or as part of a larger trespass prevention program. Many agencies also described video surveillance data that they collect. By coordinating data collection efforts with these agencies, transportation safety researchers may be able to better inform railroad trespassing studies. The Trespass Prevention Research Study [12] is an excellent example of Federal researchers working with State, local, and private stakeholders to collect better data to solve the trespassing problem.

3. Fortify FRA RAIRS Trespassing Accident Reports

The FRA RAIRS accident reports are undoubtedly very useful to railroad researchers. They provide a complete list of casualties where otherwise there would be effectively no data. There are, however, a number of adjustments to the data collection that might make accident records more useful for researching trespassing accidents.

- The first is to create a simple and consistent way to distinguish between highway-rail grade crossing casualties involving motor vehicle-operator trespassers and casualties involving pedestrian trespassers. Most researchers consider highway-rail grade crossing and trespassing accidents to be two different categories, but the casualty data does not reflect the difference.
- The second would be to encourage the writing of detailed narrative reports. Right now the database allows only a limited number of characters in the narrative, cutting some off, and many agencies do not provide reports at all. While the data fields with codes are much easier to sort and separate, it is often only after the narrative that a researcher can picture the accident in detail.
- The third suggested adjustment is to provide a way for accident reporters to easily note if the trespasser was riding a bicycle, potentially distracted by an electronic device, and/or intoxicated. These are prevalent risk factors for which there is currently no code in RAIRS.

8. References

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[18] http://www.census.gov/hhes/www/poverty/data/threshld/index.html accessed on January 24, 2014

[19] http://www.census.gov/hhes/www/poverty/data/incpovhlth/2009/highlights.html accessed on January 24, 2014.

Appendix A.
Additional FRA RAIRS Data

Table A1. Number of trespassing accidents per railroad entity between 2008 and 2012

Railroad	FRA Code	# of Incidents
Union Pacific Railroad	UP	788
CSX Transportation	CSX	773
Norfolk Southern Corp.	NS	610
Amtrak	ATK	603
BNSF Rwy Co.	BNSF	585
Florida East Coast Rwy Co.	FEC	105
Long Island Rail Road	LI	86
N.J. Dept. of Transportation	NJTR	79
Kansas City Southern Rwy Co.	KCS	73
Northeast IL Regional Commuter Rail Corp.	NIRC	66
Massachusetts Bay Transportation Authority	MBTA	44
Southeastern Pennsylvania Transportation Authority	SEPA	41
Illinois Central RR Co.	IC	40
SOO Line RR Co.	SOO	39
Southern California Regional Rail Authority	SCAX	34
Caltrain Commuter RR Co.	PCMZ	33
Metro North Commuter RR Co.	MNCW	28
South Florida Regional Transportation Authority	SFRV	25
Grand Truck Western Inc.	GTW	18
Wisconsin Central Ltd.	WC	17
Union Pacific Metra	UPME	15
Montana Rail Link	MRL	12
Dakota, Minnesota & Eastern RR	DME	11
Los Angeles County Metropolitan Trans Authority	LACZ	10
Burlington Northern Santa Fe Suburban Operations	BNSO	10
San Diego Trolley Inc.	SDTI	9
Delaware & Hudson Rwy Co.	DH	9
Paducah* Louisville Rwy Co.	PAL	9
Pan Am Rwys/Guilford System	GRS	8
Elgin, Joliet & Eastern Rwy Co.	EJE	7
New Mexico Rail Runner Express	NMRX	7
Consolidated Rail Corp.	CRSH	6
Southern New Jersey Light Rail Group	SNJX	6
Alaska RR Corp.	ARR	5
New York, Susquehanna & Western RR Co.	NYSW	5
MARC Train Service	MACZ	5
Providence & Worcester RR Co.	PW	4

Twin City & Western RR	TCWR	4
Indiana Rail Road Co.	INRD	4
Arizona Eastern RR	AZER	4
Denton County Transportation Authority	DCTA	4
Trinity Rwy Express	TRE	4
UTA FrontRunner Commuter Rail	UFRC	4
Altamont Commuter Express Authority	ACEX	4
Conn. Dept. of Transportation	CDOT	4
San Diego Northern Rwy	SDNX	3
Chicago, Central & Pacific RR Co.	CC	3
Portland & Western RR, Inc.	PNWR	3
Sierra Northern Rwy	SERA	3
Huron & Eastern Rwy	HESR	3
Santa Clara Valley Transportation Authority	VTAZ	3
Indiana Harbor Belt RR Co.	IHB	2
South Kansas & Oklahoma RR Co.	SKOL	2
Santa Maria Valley RR Co.	SMV	2
Maryland Midway Rwy, Inc.	MMID	2
Central RR Co. of Indiana	CIND	2
Marquette Rail LLC	MQT	2
Alabama & Tennessee River Rwy LLC	ATN	2
Connecticut Southern RR Inc.	CSO	2
Arizona & California RR Co.	ARZC	2
Chicago Southshore & South Bend RR	CSS	2
Buffalo & Pittsburgh RR, Inc.	BPRR	2
Arkansas & Missouri RR Co.	AM	2
Belt Rwy Co. of Chicago	BRC	2
Louisville & Indiana RR Co.	LIRC	2
Michigan Shore RR	MS	2
Lake State Rwy Co.	LSRC	2
Pacific Sun RR, LLC	PSRR	2
Utah Transit Authority	UTAX	2
Virginia Rwy Express	VREX	2
Iowa Chicago & Eastern Rwy*	ICE	1
Allegheny Valley RR Co.	AVR	1
First Coast RR Inc.	FCRD	1
Dallas, Garland & Northeastern RR	DGNO	1
New England Central RR	NECR	1
Duluth, Missabe & Iron Range Rwy Co.	DMIR	1
Evansville Western Rwy Inc.	EVWR	1
New Orleans Public Belt RR	NOPB	1
Reading Blue Mountain & Northern RR Commission	RBMN	1
Grand Elk RR, LLC	GDLK	1
Massachusetts Coastal RR LLC	MCRL	1
Fort Worth & Western RR	FWWR	1

Iowa Interstate RR	IAIS	1
West Tennessee RR Corp.	WTNN	1
Mississippi Delta RR	MSDR	1
Wisconsin & Southern RR. Co.	WSOR	1
San Joaquin Valley RR Co.	SJVR	1
Alabama & Gulf Coast Rwy LLC	AGR	1
Winston-Salem Southbound Rwy	WSS	1
Indiana & Ohio Rwy	IORY	1
Kansas & Oklahoma RR	KO	1
Delaware Lackawanna RR	DL	1
Columbus & Ohio River RR	CUOH	1
R.J. Corman RR Co./Pennsylvania Lines, Inc.	RJCP	1
Minnesota Transportation System	MNTX	1
Stillwater Central RR Co., Inc.	SLWC	1
Tacoma Municipal Belt Line Rwy	TMBL	1
Seminole Gulf RR	SGLR	1
Youngstown & Southeastern RR Co., Inc.	YSRR	1
South Central Florida Express, Inc.	SCXF	1
Ann Arbor RR	AA	1
Central Florida Rail Corridor	CFRC	1
Regional Transportation District	RTDZ	1
Sounder Commuter Rail	SCR	1
Capital Metropolitan Transportation Authority	CMTY	1
Regional Transportation Authority – Nashville, TN	NRTX	1
Port Authority Trans Hudson	PATH	1
Rochester Southern RR, Inc.	RSR	1
Bay Line RR L.L.C.	BAYL	1
Ontario Midland RR Corp.	OMID	1

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Abbreviations and Acronyms

2008 Trespass Workshop	ROW Fatality and Trespass Prevention Workshop
ATV	All-Terrain Vehicle
BNSF	Burlington Northern Santa Fe Railroad
BTS	Bureau for Transportation Statistics
CSX	CSX Railroad
DC	District of Columbia
DOT	Department of Transportation
FOIA	Freedom of Information Act
FRA	Federal Railroad Administration
GIS	Geographic Information Systems
LACMTA	Los Angeles County Transportation Authority
MBTA	Massachusetts Bay Transportation Authority
MTA	Metropolitan Transportation Authority of New York
NHTSA	National Highway Traffic Safety Administration
NJT	New Jersey Transit
RAIRS	Railroad Accident and Incident Reporting System
ROW	Right-of-Way
SEPTA	Southeastern Pennsylvania Transportation Authority
SFRTA	South Florida Regional Transportation Authority
SMRT	Singapore Mass Rail Transit
TRB	Transportation Research Board
UNC	University of North Carolina
U.S.	United States
Volpe Center	Volpe National Transportation Systems Center
WMATA	Washington Metropolitan Area Transportation Authority