"IF WE WIN, WE'LL ROLL ALL NIGHT":

A STUDY OF EMERGENCY MEDICAL CALLS

IN TUSCALOOSA, ALABAMA

ON THE WEEKENDS OF THE ALABAMA FOOTBALL GAME

2006-2012

by

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ABSTRACT

This study has explored the relationship between the University of Alabama football games and 911 calls in the City of Tuscaloosa, Alabama from 2006-2012. The main research objective was to use variables defined by the magnitude of the football game to explain the spatio-temporal patterns of 911 calls relative to the game weekends. The study did show the spatio-temporal pattern of 911 calls and the variation of the requests for EMS services around the football game. Two different datasets, one provided by the Tuscaloosa Fire and Rescue Service and the other by NorthStar EMS were utilized for the study. By use a of kernel density mapping the spatio-temporal pattern of 911 calls was geographically depicted as a view to the movement of a population to Bryant Denny Stadium and then it's dispersal following the game. A line graph was then utilized for a time line analysis of 911 call volume compared to the time of the football game. The line graphs define the pre-game spike in run volume, decrease to normal call volume during the game and then a post-game spike following the event. A chi square and chi square cross-tabulation was employed to evaluate the relationships between categorical variables. The outcomes of these statistical tests were not significant. To further evaluate the distribution of 911 calls across the City of Tuscaloosa, all 911 calls from the NorthStar EMS dataset were re-classed into four call natures and then were tested for their spatial distribution using Getis Ord G from ArcMap. Hot spot maps were then used to identify concentration of calls to the census tract.

DEDICATION

To my daughters, Hanna and Lela, I love you. To my Mother, Joan C. Mills, I love you. To my Grandfather, William Samuel Clark (1929-2006), who sat with me on the floor of his dogtrot house and made a game of placing his finger on the bare spot of a National Geographic map, wondering aloud just what was there.

LIST OF ABBREVIATIONS AND SYMBOLS

CPR	Cardio-Pulmonary Resuscitation
EMD	Emergency Medical Dispatch
EMS	Emergency Medical Services
ETOH	Ethyl-Alcohol or Intoxicated from consumption of alcohol.
FIPS	Federal Information Processing Standard
IPV	Intimate Partner Violence
MGMC	Mass Gathering Medical Care
MI	Myocardial Infarction
MUR	Medical Usage Rates
NACRS	National Ambulatory Care Reporting System
NIBRS	National Incident Based Reporting System
PPR	Patient Presentation Rate
PPT	Patients per Ten Thousand
SCDF	Singapore Civil Defense Force
SEC	Southeastern Conference
TF&RS	Tuscaloosa Fire & Rescue Service
TTHR	Transported to Hospital Rate

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1. Introduction

Waldo Tobler gave to geography the First Law (Tobler, 1970) stating “the first law of geography: everything is related to everything else but near things are more related than distant things” (p. 236). This is apparent in many different contexts and this law is no different for an autumn day in a southern city where the only game in town is college football. The success of a college football program and its marketing are key factors in determining spectator attendance ((DeSchriver & Jensen, 2002). Though many factors contribute to rates of community usage of 911, population is seen as one of the key variables (Cardigan, Bugarin, 1989). Bryant-Denny Stadium, the location for the University of Alabama football games, currently has seating for 101,821 spectators (Walker, 2010). This number does not account for all of the personnel at the stadium in support of the event itself. The City of Tuscaloosa has a current estimated population of 93,357 people ("Tuscaloosa (City) QuickFacts," 2013). The student population for the University of Alabama as of the 2012 census is listed as 33,602 (Census Enrollment Report, 2012). By the Census estimate and the demographics of the University there are possibly 126,959 people residing in Tuscaloosa, Alabama. The Alabama football game has the potential to draw enough spectators alone to almost double the population of Tuscaloosa, Alabama. The game magnitude, or how much the game matters to the end result of a season; affects the crowd size and therefore also affects the demand for emergency medical services. An event such as a college football game does not exist alone and unsupported but is dependent on the surrounding

municipality for the same infrastructure and support typical of a high density city. The effect of the game on local EMS calls is not dependent on the event being at the home venue only. Our technologically connected society is typified by what is defined as a "synchronous telepresence" that allows for us to experience an event through technology and yet not be actually present (Miller, 2004). The effect on local EMS operations in populations that are not present at a sporting event has been reported by previous studies including Deakin, Thompson, Gibson, & Green (2007) and Redelmeier, Vermeulen, (2011). By evaluating the spatio-temporal patterns of EMS calls relative to the time of the football game, no matter if the game is home or away, the effects of the magnitude of the sporting event can be seen.

Utilizing two datasets (one provided by Tuscaloosa Fire & Rescue Service and the other by NorthStar EMS) comprised of the weekends of the University of Alabama football game, this study seeks to establish a relationship between the magnitude of the football game and the occurrence of 911 calls in the City of Tuscaloosa, Alabama. Kernel density maps are used to establish the spatio-temporal pattern of 911 calls. Time line analysis is performed with the use of line graphs that compare the hourly count of 911 calls to the time of the University of Alabama football games. Categorical variables were defined as to the time of the 911 call, the call nature and the game magnitude. Variables were then assigned to all runs and statistical tests (a chi square statistical test and chi square cross-tabulation) were employed for analysis. Using the 911 calls from the NorthStar EMS dataset with their assigned call nature a hotspot map was created to identify clusters by census tract.

2. Literature review

A mass gathering is defined by Arbon 2007 as an "event during which crowds gather and where there is potential for a delayed response to emergencies because of limited access to patients or other features of the environment or location" (p.103). To understand how local 911 calls are affected by a mass gathering it is necessary to identify the event as a catalyst. It is therefore prudent to look to the literature on the subject of mass gatherings and review the issues that create the catalyst. Key issues at question in the literature are what actually constitutes a mass gathering, what critical factors affect the event and how to best predict/quantify the medical care that will be needed.

Shelton, Haire & Gerard, 1997, related the experience of one fall season of medical care provided during 1995 games held at William-Brice Stadium at the University of South Carolina. The purpose was to define the different medical complaints that were presented and the count of the patients transported away from the stadium. The mean attendance for the games was 69427 spectators per game. Five hundred and twenty six patients were seen that year. The author's reported a Patient Presented Rate (PPR) of 1.08+/- 0.37 per 1000 spectators (Shelton, Haire & Gerard, 1997). Headache was the most common complaint and nineteen patients required medical transport to a local hospital. The objective was to provide planners of similar events a list of complaints commonly seen and possible rates for patients moved by ambulance to local hospitals. This article is significant as it contributes to the early debate as to what constitutes a mass gathering and how to quantify the planning process for the medical care required.

Arbon, Bridgewater& Smith, 2001, evaluated the effect of environmental factors that influence how many patients and the types of medical complaints commonly seen at mass gatherings. The factors presented here include: crowd size, temperature, humidity and venue type. The objective was a design of data framework and a forecasting model with a process that could be applied across all mass gatherings and not be restricted to a specific type. The definition of a mass gathering is limited here to include a spectator range of greater than 25,000 in attendance. The PPR was again described as the count of patients presenting per 1000 spectators. This article also proposes the tracking of patients transported by an ambulance from an event termed as Transport to Hospital Rate which is defined as patients transported per 1,000 patrons (Arbon, Bridgewater& Smith, 2001). A regression was chosen and three models were created to aid with the forecasted presentation rate. The authors conclude that varying factors of the event situation impact the presentation rates of patients and that any forecast of medical workload in the venue can be intricate and multifaceted (Arbon, Bridgewater& Smith, 2001).

Milstein, Maguire, Bissell & Seaman, 2002, provided a review of the literature concentrating on the factors that affect the degree and category of medical complaints. The specific factors that were searched for included: weather, event type, event duration, age, crowd mood, density, attendance, alcohol and drug use (Milstein, Maguire, Bissell & Seaman, 2002). The article sums up the different factors identified in the articles and then reaches conclusions about which one should be of primary concern in the planning for a mass gathering. One of the major issues illuminated here is that there is no customary and precise protocol that can help with the provision of medical care at an event. The convoluted interplay of variables restricts the

ability of governing bodies to create a formal policy. The definition for a Mass Gathering is again stated to be a collection of greater than 25,000 people for an event but here we have the introduction of the concept that the definition must also extend to areas in which populations are clustered and restricted from Emergency Medical Services (EMS). This concept creates an inclusion for mass transit or perhaps refugee camps into non-traditional settings of a mass gathering. The article also mentions that there is no established framework in which to define a mass gathering and that the definition transcends a concept based on staffing requirements alone. A very key point included here is that the goal of Mass Gathering medical care is not only provision of medical services inside a venue but also the preservation of existing services outside the stadium. An event does not exist in a void but is dependent upon and affects the EMS system it is either formally or informally created from. The article also goes on to clearly state that the effect a mass gathering event has on the surrounding local EMS is not clearly understood. The article also introduces the concept of the Medical Usage Rate (MUR) and equates this concept as the measure of patients treated per 10,000 patrons. The often used PPR is shown to differ by event type. The most critical factors to base planning for Mass Gathering Medical Care (MGMC) are related as climate, alcohol and drug use, attendance (although attendance alone as a factor is said to be uncertain), the time the event lasts, event type, indoors or outdoors, mobility of spectators and crowd backgrounds (Milstein, Maguire, Bissell & Seaman, 2002). Concerts have the highest usage rates of all event types. This applies to my thesis in that it establishes the relationship between emergency services inside the stadium and the accustomed level of service outside the event.

Milstein, Seaman, Liu, Bissell & Maguire, 2003, took up the debate over which of the known variables create the necessity for more medical care and what are the injuries associated with those variables. The concept is that if a set of factors can be established as being reflected in the MUR then a plan can be created to meet those needs. The method used here was a historical review of patient care reports from a medical aid stations at three event classes over a three year time span. The selected classes of events included Major League Baseball, National League Football and rock concerts (Milstein, Seaman, Liu, Bissell & Maguire, 2003). A MUR was also calculated as rate or Patients per Ten Thousand (PPTT). Five thousand eight hundred and ninety-nine occurrences of medical care were logged. The medical care was provided at 168 baseball games, 27 football games and 21 concerts. The article provided a percentage of the total count of patients in contact at a respective event. Knowledge of possible medical emergencies would aid a planner in arranging for medical care. The PPTT, when provided could be of assistance to planners as it can be multiplied by estimated spectator crowd size and then used to ascertain a possible count of patients to seek treatment at medical aid stations. The definition of a mass gathering is again termed as an event with greater than 1000 people present but also includes the goals of the provision of medical care at the event. The MGMC is again tasked with the responsibility of safeguarding EMS in the community at large (Milstein, Maguire, Bissell & Seaman, 2002).

Arbon, 2004, discusses the overabundance of descriptive studies concentrating on individual event types. The field of study is also hampered by a shortage of a theoretical design and analytical guides. Greater work in theoretical design and analytical guides would aid the

field by fostering a framework in which to build a comprehensive knowledge base. Major concerns in the field include the diverse manners in which data is collected, loosely defined nomenclature, haphazard approaches to theory, weak design of inquiries, and no common definition of mass gathering. The author seeks to create a greater dialogue with the proposal of a model, termed a "proximity" model upon which to plot the interaction between major domains (Arbon, 2004). The combination of these domains creates a PPR and if utilized in the fore can help formulate a response by way of a health plan. The Proximity model has three domains: biomedical, environmental and psychosocial. The biomedical domain is the biomedical influence on the count and type of patients, psychosocial pertains to the influence of individual / crowd behavior and the environmental which involves the physical landscape and climate. The three domains connect and combine to produce a PPR. The author further states that the relationship between the domain and PPR is a production of three variables that include event type, count of spectators and climate conditions. This article is important in that it adds to the conceptual framework of the field at large while providing examples that invite commentary.

Zeitz, Zeitz & Arbon, 2005, compares two models that seek to calculate both a PPR and a TTHR. Then both calculated rates are compared to the actual rates from seven years of data collected from the Royal Adelaide Show (an annual nine day event) 1995 to 2001. The objective of the study was to evaluate the use of historical data to forecast a PPR and TTHR for a future event. The predictive model (proposed by Arbon et. al. 2001), seeks to calculate a PPR and a TTHR when the event in question is singular in nature or has no previous records upon which to base a comparison. This model uses a calculation based on event profile characteristics such as

crowd size, spectator maneuverability, the event being contained (such as behind fencing) or uncontained, inside or outside, day or night, and the average humidity. The retrospective analysis (proposed in Zeitz et. al.) used a calculation based on a predicted maximum temperature and crowd size to return a PPR for each day of the event. Both methods were then compared to actual PPR and TTHR from 2002 Royal Adelaide Show. The study showed that the Arbon et al. 2001 method overestimated PPR for all but one day of the event whereas the Zeitz et.al. Method returned a more accurate estimate. While both methods returned a similar total number of transports by ambulance per day, neither method accurately predicted the TTHR. The importance of this study is the practical application of models that can be used in planning for expected medical workload. The study does note that while they can both be used to estimate a workload they cannot advise the level of medical care that will be required.

Arbon, 2007 is a review of literature of which the objective is to chronicle the advancement in the critical knowledge of the field and their improvement of the provision of medical care in mass gathering events. The author again calls for studies to advance beyond the mere descriptive or being based on hearsay. Studies on MGMC should be based on more fundamental questions. These questions could include how factors and attributes would have application throughout the field. Fundamental factors for consideration include: climate, length (time) of event, if the event is outside or inside, the seating arrangements for the spectators, if the event is contained by crowd control (such as fencing) or is it unrestricted, kind (or type) of event, crowd behavior coupled with the access to alcohol and drugs and the age of the crowd (Arbon, Bridgewater & Smith, 2001) and (Milstein et. al., 2002). Arbon also relates a set of six

prospective milestones for further study. These possible topics include the identification of vulnerable populations (the elderly, children or the disabled), efforts to encourage preventative measures of identified health risks of a mass gathering (such as heat related initiatives), Standardizing of terms, interpretations and research guidelines so as to simplify correlation between studies and further study of non-traditional or unexpected mass gatherings (Arbon, 2007). The author also calls for continued study on the possible occurrence of mass casualties' events involving mass gatherings. This study can be applied to the research of my topic in that it advocates furthering the field of study by a focus on non-traditional mass gatherings.

Khorram-Manesh, Berner, Hedelin & Örtenwall, 2010, is an evaluation of the usefulness of the Risk Assessment Tool (Risk Assessment Guide from the "Event Safety Guide" (created in the United Kingdom for concerts) to be used as a device to estimate requirements for emergency medical services at sporting events in Sweden. To carefully implement the Event Safety guide template a pilot study was formed with six providers of pre-hospital emergency medicine. The providers tested the template at 15 events. After the testing phase a questionnaire was submitted to the provider inquiring as to the use, implementation and impressions of the template. After the affirmation by the pilot study, a survey group of 27 professionals was trained in the use of the template. Several training scenarios were run including a comparison against actual totals from previous events. The study was then implemented in four soccer matches of the Swedish Premier League for use in live testing. The study concluded that the template could be used with a degree of accuracy although it would tend overestimate need and increase monetary costs for the service. The article applies to my study in that it the risk assessment tool could be applied locally

and then the totals added to the estimated medical workload in the community. The study also provides a possible road map for testing of future initiatives.

Meites, Brown, 2010, developed a method by which the ambulance requirements for an event could be ascertained by looking at the ambulance transports for the surrounding community. Forty-seven events were evaluated in the study. Events occurred from August 2006 to July 007 in the city and county of San Francisco, California. Any event that did not have an EMS plan submitted to the San Francisco Department of Public Health was excluded from the study. A rate for transports from mass gatherings was calculated by a division of ambulance transports by attendance figure from the event. For the ambulance use in the community, annual transports were divided by population for the county. The ambulance transports from events was then compared to those of the community. The calculations for mass gathering event transports were one transport per 59,000 for every six hours (Meites, Brown, 2010). The calculation for community transports resulted in one transport per 20,000 people for every six hours (Meites, Brown, 2010). Therefore the possibility of transport by ambulance in the community by hour was greater than that of transport from an event. Though this study represents a unique conceptual manner in which to examine the count of transports but it could be seen as intuitive. It did not include workers at the events in with calculation of those attending and has no say on what type of event produces less or more transports. This study is unique in that it looks to the surrounding community rather than just at the event to gauge the impact on EMS.

A myocardial infarction (MI) or commonly referred to as a heart attack has a high rate of occurrence in the first few hours of being awake and is possibly attributable to a rapid

transition in cognitive and physiological state (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002). The occurrence of early morning acute myocardial infarction is the connected to a triggering event such as emotional turmoil and/ or heavy physical exertion (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002). Past events that have acted as an impetus for the triggering mechanism have included natural disasters, such as earthquakes and war. An especially stressful football game (while not being equated to level of stress that occurs during a natural disaster or war) can theoretically act as a triggering mechanism for acute myocardial infarction.

In Carroll, D., Ebrahim, S., Tilling, K., Macleod, J., & Smith, G. 2002, the authors relate that there is anecdotal evidence of deaths due to acute myocardial infarction during the 1996 European Cup soccer match between France and the Netherlands (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002). The hypothesis stated here is that a sporting event that represents a critical match or close score can act as an impetus or trigger for an acute cardiovascular event. The objective of this study is the evaluation of hospital admission records for acute cardiac events on the day of and two days after the English matches in the 1998 World Cup. A dataset was procured from the Department of Health episode statistics database (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002). The information included patient age, gender, area of residence and the reason for the admission. Admission records were queried for specific complaints including acute MI, stroke, suicidal injuries and motor vehicle accident injuries. As a control, data was included from the month before and the same time period in 1997 and 1998. The dataset of admissions was then classified as “exposed” or “unexposed” for the days with in the target time of the English matches (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002). The

author's then compared counts using a Poisson regression and then a negative binomial regression. The author's discovered a 25% increase on the match of England versus Argentina. This game was highly stressful as it included a penalty shoot-out in which England lost. The authors also found that the incidence of acute myocardial infarction was higher for men than women but that the other complaint classes were not significant. Daily numbers of admissions were related to year, month, daily temperature, day of the week and gender (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002).

Sivarajasingam, V., Corcoran, J., Jones, D., Ware, A., & Shepherd, J. (2003) is a study of the time component to injury sustained by violent behavior including daily, weekly and monthly time frames. The temporal occurrences of the injury are juxtaposed to local atmospheric conditions, sporting events and yearly festivals. Five years (May 1995 to 30 April 2000) of admission records from the Accident & Emergency department in Cardiff, England were used for the study. The data recorded included the patient's age, gender, date of presentation to the emergency department. Time frames for the data capture were comprised of a daily midnight to midnight; a weekly capture, Monday through Sunday and then monthly. To classify the range of injuries sustained by age group and gender, five age categories were created. Age groups selected were zero to ten, eleven to seventeen, eighteen to thirty and thirty-one to fifty. Climatic conditions were also obtained and included hours of sunlight, rain totals and temperature. This data was then compared to dates for holiday festivals, local soccer games and rugby international events. To validate patterns intimated by the descriptive statistics, a Pearson correlation was used to evaluate the relationship between the variables. The database included 19,264 injuries,

seventy-two percent of which were males. The eighteen to 30 year old age group made up the largest portion of the data at forty-seven percent. There were eleven average daily patients reporting to emergency department with injuries from violent behavior. The days with the least amount of admissions included Tuesday, Wednesday and Thursday. The days with highest numbers of admissions (seventy-four days with twenty or more admissions) included Saturday and Sunday. The months with the highest numbers of violent injuries included December and August. There was no clear bias towards season or climatic conditions. Local soccer matches, though being held on Tuesdays and Saturday's had no correlation with the presentation of patients at the hospital. A positive correlation was detected between rugby international events and the New Year Eve holiday. The study found that four out of the ten most active days for assault included four of the five New Year holidays. Over the five year period there was consistent rise in visits to emergency department. The authors concluded that the decision making process involved in the choice to undertake criminal behavior include favorable conditions (night vs. day, low visibility), current events (such as a sporting event) and current ongoing crisis (such as a disaster or riot). These factors also contribute to occurrence of assault related injuries. The difference in this study and past research is the use of law enforcement generated data. The authors state that problem with the use of these type datasets is the reluctance of victims or criminals to report injuries due to the possible legal repercussions of the actual behavior or associated criminal behavior. Data derived from a hospital is based on the presence or absence of the injury and is not dependent on a profession of the event by the patient. The correlation between occurrence of injuries and the rugby international match dates and New

Year's events are predicated on the attraction of large populations to certain geographic locations such as entertainment districts that have clubs and pubs. Also the standard consumption of alcohol contributes to these events but was not included in this study. The author's concede that the lack of correlation of soccer matches with the incidence of assault injuries are possibly affected by a heavy law enforcement presence.

This study relates to my thesis topic in that a relationship between large sporting events and an injury requiring medical care is confirmed. It fails to relate the outcome of the events to reported injuries but it does give credence to a temporal-spatial connection with a need for medical care. The author state that injury from violence is connected with time / event and could represent an opportunity to mitigate an expected level of occurrence. The limitations of the study is that it has no way of identifying how many events that involved violence and did not necessarily require treatment in a formal hospital setting but still require a level of service from the community emergency medical system.

As other studies have proposed, a televised sporting event has an effect on the viewing populace (Redelmeier & Vermeulen, 2011). The question becomes to what extent does the effect have on the viewership and can that be seen in decisions for the welfare of someone dependent on the spectator for their needs. In Farrell, Doherty, McCallion & Shields, 2005, the objective is to explore the relationship between pediatric emergency department's admissions (and the possible resulting surgical admission) with a nationally televised sporting event. The televised sporting event chosen for the study was the Union of European Football Association Champions League (soccer). The games were held on weekday nights from 1900 hours to 2200 hours. The

years of the study were from 1997 to 2002. Data from the nights with the televised football games were then compared to nights in which no game was played. After hours pediatric admissions records for the emergency department were obtained (as well as surgical admits for the subsequent day) from the Royal Belfast Hospital. To adjust for a climate factor, weather data was also included. The study utilized the following factors: maximum temperature, minimum temperature, rain and snowfall. An independent sample t-test was used for the study. No significant variation in the pediatric admissions on the nights of the televised soccer match versus the nights without soccer games was identified. The following day surgical admits also showed no significance. The study concluded that a televised sporting event did not affect patient presentation and there was no basis for the alteration of emergency department staffing in an emergency department. It is important to state that the event in question was not held in the same city as the study. The sporting event being held in another town has application to my study in that the game being in town is proven to move population and has an effect on Emergency department admits. There is no mention in the study of following the actual matches of the local favorite team.

One of the more interesting articles included here is the Joiner et al. (2006) article entitled "On Buckeyes, Gators, Super Bowl and the Miracle on Ice: "Pulling Together". The author's propose that winning is associated with lower suicide rates. This article compared the results of three different US studies on how sport matches influence the occurrence of suicide. The first study was a ranking of college football teams versus suicide rates in counties in Florida and Ohio. As both Alachua County, Florida and Franklin County, Ohio are both home to college

football programs that are literally “the only games in town” (p. 186) then this study has a direct relationship with Tuscaloosa County, Alabama. A rate of suicide per 100,000 was determined for each county from 1990-2000 and then correlated with final national rankings for the respective team for each of those years (Joiner et al., 2006). A control for the gross domestic product was used to manage the confounding factor of economic influence on suicide rates. The study found limited significance but enough that further research of the phenomenon was warranted. The second study was that of the count of occurrence on the date of the U.S. versus Russia hockey match known as the “Miracle on Ice” that took place 22 February 1980. Utilizing a dataset from the National Center for Health Statistics Vital Statistics of the United States, a comparison of the diurnal rate of suicides on February 22 from 1972-1989 was then conducted. The author’s found a significant relationship for the difference in suicide rates of February 22, 1980 to any other February 22nd for all other years of the study. The final study included in the comparison was a count of incidents on the Sunday of the Super Bowl versus occurrences on all other Sundays since 1984. Joiner et al. (2006) found that there are reduced numbers of suicides in counties with successful football programs, less suicides on the day of the “Miracle on Ice” than other 22 February dates and less occurrences on Super Bowl Sunday than on other Sundays.

Deakin, C., Thompson, F., Gibson, C., & Green, M. (2007) is an analysis of the requests for emergency services and their call nature that took place on 10 June 2006 in Hampshire County, England to ascertain the influence of World Cup soccer matches. The World Cup soccer matches took place in Germany. The author's state that (Deakin, Thompson, Gibson & Green, 2007) "limited resources struggling to meet performance targets, unforeseen demand precludes

the ability to tailor resources to cope with increased call volumes, and can have a marked detrimental effect on performance and hence patient care (p. 405). The dataset comprised the requests for emergency services from the days of soccer matches when the England versus Paraguay match was played and then were scrutinized by hour. The highest reoccurring call natures, with particular attention paid to assaults, were evaluated. As a control, the data collected from the period of the soccer match was compared to the volume of the request for services and nature from all Saturdays from the month of March 2006. Requests for emergency medical response were classified as either life threatening or urgent. Life-threatening requests were designated with an eight min response and the urgent requests were designated with a 19 minute response. The second busiest day in 2006, 734 calls 50% higher requests than average Saturdays used as controls, Peak times were experienced before and after the England versus Paraguay match with a return to normal levels during the game, 134% increase in assaults with spikes experienced before and after the game, 131 life threatening requests were made the day of the match as compared to 98 requests on the control Saturdays. The percentage of 8 minute responses was 62.6% on the day of the game. On the control days the average was 76.2%. There were increased requests for emergency medical services with spikes both before and after the event, along with substantial increase in assault calls, calls related to alcohol consumption and increased in response times.

Andriessen, K., & Krysinska, K., 2009, added to the studies on the impact to the viewing of televised sporting events and how sporting events influence human behavior (Redelmeier & Vermeulen, 2011). This article focuses on the influence of sporting events on mental health as

seen through suicidal behavior. Sporting events can act as both as a safeguard and a liability in certain individuals. As a preventative, a win in a match can increase a sense of belonging, act as tension release, elevate productive mood enhancements and provide moments of escapism (Andriessen & Krysinska, 2009). Defeats can produce high levels of mental strain that mimics the stress levels in natural disasters. The objective for this article is a review of the existing literature regarding suicidal behavior and the influence of sporting events. The authors conducted a search of online databases (PubMedline and Psycinfo) from the advent of their publication to June of 2008. The terms utilized for the search included the following: sports, mass sports, sports event, football, basketball, soccer, rugby, hockey and Olympics in combination with suicide, attempted suicide* and suicidal behavior* (Andriessen & Krysinska, 2009). The search identified in nine studies that evaluated the interplay of sporting events to suicidal and attempted suicidal behavior. The dates of the articles were from 1986-2006. The sports that were studied American football, baseball, soccer, hockey and basketball. Three of the articles explored the occurrence of completed suicidal acts. Four articles were concerned with the relationship of sports to suicide and homicide and two evaluated attempted suicide and/or suicidal ideation. All studies found were in English and were from countries where the official language is English (United States, Britain and Canada).

Andriessen, K., & Krysinska, K., 2009, concluded that sporting events can act as an influence in suicidal conduct. A sporting event can act as either safeguard against, or as a mechanism. The ability of the event to act in either fashion is dependent upon other criteria such as age, gender, and marital status, characteristics of the sporting event and the results of the

event. Alcohol coupled with the influence of the event can trigger aggression. Sporting events inflict less stress than seasonal festivities. Limitations of this study include the small number of studies that were English only with no input of non-English behavior. A small number of sport types (football, baseball, etc.) were searched for and as a result the information was relegated to only the specified types. Because of the dissimilar types of methodology used in the studies, there is a limited understanding of the possible mediating variables. The lack of patient case by case evaluation also contributes to a weak understanding of a sport event and the exposure of the individual to suicidal ideation and behavior.

Cusimano, Marshall, Rinner, Jiang & Chipman, 2010, offers a specific look and evaluation of the spatio-temporal attributes of violent injury in Toronto, Canada. This study combines the use of a 911 dataset with that of a hospital admissions dataset to explore the occurrence of assault. The Emergency Medical Services of Toronto was used for the ambulance data and the National Ambulatory Care Reporting System (NACRS). It makes this comparison by utilizing kernel density mapping to depict 911 call locations for assaults based on four hour time periods in a twenty-four time frame. The locations of the EMS dataset were based on the latitude and longitude of the dispatch location. The NACRS dataset provided the emergency department admissions and the information derived from those records included the time of admit, age and gender, a diagnosis code and a postal code. By associating the postal code with the census tract, a patient's residential area could then be established. A kernel density map based on a rate of patients from the neighborhood, ages eighteen to sixty-four who reported to the emergency department in 2002-2003 and 2003-2004. Neighborhood information was gained

at the census tract level from the 2001 Census of the Population (Cusimano, Marshall, Rinner, Jiang & Chipman, 2010). The information from the census tracts included unemployment rates and household income. The author's also mapped social housing areas and indigent shelters and then evaluated the occurrence of assaults versus socioeconomic variables (Cusimano, Marshall, Rinner, Jiang & Chipman, 2010). To create a rate of occurrence for the census tract level, density maps for each tract were prepared and then the occurrence from both datasets was calculated per one thousand people. The study utilized a Poisson regression to fit the multivariable design with the dependent variable being the count of assaults in the census tract for the specified time frames (Cusimano, Marshall, Rinner, Jiang & Chipman, 2010). The independent variables included the count of bar/nightclubs, the working age of the population, low income housing areas by count, the unemployment rate and the average household income (Cusimano, Marshall, Rinner, Jiang & Chipman, 2010). The study found that assaults depicted in the twenty-four time frame exhibited a temporal pattern that showed a low point in the morning, gradual increase in the afternoon with an apogee at night. Two of the four time periods were significant. The 2000 hours to 2359 hours accounted for 26.2% of all occurrences. The early morning period from 000 hours to 0359 hours attributed for 26.8%. The spatial distribution of assaults injuries showed the highest occurrence in the downtown area of Toronto (particularly, on the east side). The spatio-temporal patterns broken into the four hour time periods reflected the distribution already shown by the twenty-four hour temporal pattern. The early morning time frame of 000 hours to 0359 hours corresponded with areas having bar/nightclubs. The areas where hot spots occurred corresponded with the factors of socio-economic deprivation (Cusimano, Marshall, Rinner, Jiang

& Chipman, 2010). Patterns of assault normalized for population were equivalent to the patterns of assault density. The multivariate tests defined a significant relationship between the numbers of assaults and the population density, social housing areas, average household income (Cusimano, Marshall, Rinner, Jiang & Chipman, 2010). High risk areas that were identified included the eastern portions of downtown Toronto and areas with a predominance of bar/nightclubs at nighttime and into the early morning hours. The study is limited by the possibility of victims choosing to leave an assault to go unreported. The rates of assault were based on population counts in a census tract which implies a more sedentary occurrence. A more accurate depiction of rates of assault would be based off the numbers of population moving through an area. The authors note the danger of the ecological fallacy in relating events occurring in a census tract as typifying the individual living there. This study is important as it defines events in spatio-temporal phenomenon and comparing it to characteristics of the population and the built-up landscape. Important concepts presented include the dynamic nature of a human phenomenon and ways to map it are carefully considered.

Card, D., & Dahl, G. 2011, examined of the relationship between a televised sporting event and the incidence of domestic violence. The author's hypothesize that hazard of domestic violence is associated with a "gain-loss" utility of game outcome relative to defined reference points (Card & Dahl, 2011). The objective of this study was the use of law enforcement data to evaluate the emotional warning signs of violent behavior relative to regular season National Football League (NFL) games. The reasoning for this type study include the attachment NFL fans exhibit for their local club, the sports-betting industry with its well-established practice of

point spread wagering that enables a presumed winner/loser for each game and the structure data derived from NFL competition. The authors identify a domestic violence occurrence as Intimate Partner violence or IPV which is defined as "simple assault, aggravated assault, or intimidation by a spouse, partner or boyfriend/girlfriend" (p. 111). The law enforcement database utilized for the study was the National Incidence Based Reporting System (NIBRS) which tracks statistical data of crime occurrence but specifically used in this study for information on domestic violence. Card & Dahl (2011) then combined this with data from six National Football League teams over a twelve year time span. The six teams were chosen based on the numbers of state and local agencies within the home state of the NFL team that report to NIBRS. Two mathematical models were created to study the effect of results from the football games to the incidence of domestic abuse. By identifying the game as the catalyst for the violent incident a structure was then created to measure the effect. Two mathematical models were created. A "Loss of Control" model had its genesis from the concept that males were more likely to experience uncontrolled aggression when confronted with adverse outcome (Card & Dahl 2011). The bargaining mathematical model was created from the economic theory that an individual will accept violent behavior in bartering or exchange system inherent in the relationship. Card & Dahl (2011) admit that outside of economic theory, the bargaining model has no realistic basis and there is no advocacy that a payoff exists worth the cost of violent behavior. A Poisson count model was then utilized to test for the emotional catalyst derived from the football game. To create a classification for a projected outcome of the football games, the Las Vegas point spread was used. The point spread helped to define games as likely to be won by the local team, likely to be

won by the opponent and games that were likely to be close. This classifier, coupled with the results of win/loss was fit to the model for testing the rate of occurrence of domestic violence. Then this rate of activity was equated with the results of the football game. To further explore the behavioral response to positive or negative information, a comparison was then tested for the magnitude of the effect of an upset loss or upset win (Card & Dahl, 2001).

Summary statistics from the NIBRS database included an occurrence of 1.28 incidents of domestic violence per hour for 100,000 people from noon till 11:59p.m. Due to NIBRS database having only one variable to identify the influence of alcohol & drugs to the occurrence of domestic abuse, 20% of the male to female incidents relate alcohol/drugs as a factor. The study identified a 10% increase of the occurrence of domestic violence relative to upset loss for the home team.

In the science of geography the highest order of fulfillment is to understand phenomena so as to control the outcome. To this objective, the authors of the article, Ong, M., Ng, F., Overton, J., Yap, S., Andresen, D., Yong, D., Lim, S., & Anantharaman, V. ,2009, attempt to create an ambulance mobilization pattern to meet future request for Emergency Medical Services (EMS) in the city-state of Singapore based on the historical run data from a 6 month period of time. EMS services are provided by the Singapore Civil Defense Force (SCDF). The article states that the question to be defined is the location and spatial pattern of requests for EMS services. This pattern is interrelated with demographics of the population and its movement. The article references the notion of the Chain of Survival in that early defibrillation is one of the key processes in the survival of a cardiac arrest outside of a hospital setting. Early defibrillation

begun within 3 minutes of the patients collapse has shown promise with increased survivability rates of up to 74%. The current EMS response system is based on a static plan with 34 ambulances based in 14 fire stations and 10 satellite fire posts. Using data provided by the Cardiac Arrest and Resuscitation Epidemiology (CARE) project (an ongoing program whose purpose is to research the spatial location of cardiac arrests and requests for EMS in Singapore) the mean for ambulance response time was 10.2 minutes. From the time of call to start of defibrillation the mean was 16.7 minutes. Additionally, a four-minute response to requests is both cost prohibitive and represents significant operational challenges to the SCDF. With an increase in the number of requests for emergency services (a rise of 6.5% to 8.0% in requests for emergency medical services every year from 1998 to 2006 culminating in total of 96,006 of such requests in 2006).

To improve response time in an economically feasible manner, the authors propose to utilize both call prioritization (a triage of calls based on call nature and responses to questions from the initial contact with the individual reporting the emergency) and a requisite number of ambulances provided by the demand analysis. By researching the spatial origin of requests for service, the author's intent was to develop a cost effective ambulance mobilization plan to significantly reduce response times. The article did not state a formal hypothesis but rather a set of objectives the authors were trying to attain.

Utilizing data from the ongoing CARE research, the authors included all calls made to 995 (the emergency telephone number administered by the SCDF). Excluded were the calls that did not require an ambulance or were false calls. A multitude of run specific data was

accumulated by use of standardized reports, dispatch data and patient care reports. For the data analysis the authors used data mining software: SPSS version 14, (SPSS Inc., Chicago, Illinois). The spatial distribution of the calls was mapped utilizing ArcGIS 9 (ESRI, Redlands, California). Graphically the calls were portrayed by postal code and organized by other criteria such as time of day and day of week.

The article relates that a spatial pattern of EMS calls based on geography/time was defined by the use of GIS. The findings lend credence to the idea that medical emergencies and ambulance requests are not by chance but rather by observable patterns and trends that can be discerned in a historical context. Cardiac arrests occur along a circadian rhythm with an increasing incidence in the mornings until noon. Patterns of occurrence of cardiac arrest are also shown during the week with an increased regularity on Mondays. Seasonal variations due exist. The Eastern and Southern suburban town centers of Singapore showed the highest occurrence of requests for service which correlates with the population densities being highest in those communities. Call occurrence totals from the day (0701 to 1900 hours) were twice that of nighttime (1901 to 0700 hours). By day of the week, Monday had the most calls. Requests for service during the day were grouped in the Southern commercial and business zones versus those at night. The study defined the 35 districts with the highest call volume by 4-hour time blocks. These finding provide the basis for an ambulance mobilization plan. It suggests a flexible mobilization plan based on deployments to the districts with the highest historical call volumes for the hour. The call volume and locations would have to be monitored in real time to be flexible and allow for adjustments. As a result of the study the SCDF have adjusted staffing per

hour for call volume. The deployment strategy was strengthened to additional firehouses and 10 satellite fire posts.

While the article answers the simplistic question of where the calls occur and in what time frame, it fails to address a larger question of the analysis of medical calls based on causation within the context of time/geographical location. The authors admit that future studies will include the association of population and socio-economic spread to the analysis.

In Quigg, Hughes & Bellis, 2010, the authors examined the effect of World Cup tournament on ED visits because of assault related injuries. The authors reference earlier studies on World Cup related violence including Sivarajasingham, Moore, Shepherd (2005) and Deakin, Thompson, Gibson, Green (2007). The hypothesis for the article is that there exists a relationship between World Cup soccer tournament, violence and alcohol. Data was gathered utilizing the Trauma and Injury Intelligence Group Injury Surveillance System. This information system allowed access to emergency department visits made in fifteen (15) hospitals in northwest England. The visits were then grouped by nature into injury groups which allowed for the creation of classes and further defining of assaults. The time frame of the study included a prior to, during and post-game analysis of visits to the emergency department in relation to each match. The 7th of May to 6th of June was utilized in the "prior to" selection. The 11th of June to the 11th of July was utilized in the "during" time period of the active game play. The "after" period included the time from 16th of July to the 15th of August. For a control, the time period of the event was paired with an identical time period of previous years (2007-2009). This pairing of a control used weekdays instead of weekends. The independent variables selected for the

study included patient age, sex, time, date of emergency department visit, days in England participated World Cup events, prior to, during and post-game events. The analysis of the dataset began with a calculation the standard error of the mean using descriptive statistics with a 95% confidence interval. Then, using paired sample t-test, the difference between the means was evaluated. The authors utilized a generalized linear model to evaluate World cup connected activity with the occurrence of emergency department visits. An average of 44.6 visits to the emergency department was attributed to an assault. Male patients between the ages of 18-34 comprised 70.1% of the population. The greatest number of assault attributed visits to the emergency departments was the day of the first event that England played (England vs. USA) with eighty-eight (88) visits. There was no significant difference compared across all years of the study but there was a downward trend observed.

Shook, J., & Hiestand, B., 2011, is an article concerning the effects of the active imposition of a previously seldom enforced "open container" law in Columbus, Ohio in 2003. The authors sought to identify the numbers of alcohol dependent visits to a local emergency department during home games of similar football seasons both before and after the active enforcement of the law. The hypothesis presented here is that the alcohol connected complaints for visiting an emergency department (ED) would become decreased after the active enforcement of the open container law. The authors compared the emergency department records for the 2002 and the 2006 seasons. Emergency department attendance was categorized in the following ways: alcohol related or not alcohol related, medical versus traumatic and intentional or unintentional. A nature classified as intentional would include injuries sustained during an assault or a medical

complaint caused by an intentional act (such as an overdose). The following data was collected for the weekend of the football game: high and low temperatures, precipitation, time of kickoff, opponent Associated Press (AP) rank, final score and if undergraduate classes were in session (Shook & Hiestand, 2011). A multiple variable logistic regression was utilized to examine the influence of the independent variables. A regression was chosen so as to ascertain the likelihood that the cause for seeking medical aid was connected with the use of alcohol. This study audited 2,220 visits throughout the 8 games of the 2002 season and 2,146 visits over 7 games of the 2006 season. The number of home games differed due to the season schedules. There was a significant rise in alcohol related traumatic events in the 2006 season and the likelihood of the nature of the emergency department visit being connected to alcohol. Among the independent variables tested, if the final score was less seven points difference then this variable influenced the model. There was a rise in the number of alcohol related visits to the ED between similar undefeated seasons of 2002 and 2006 (Shook & Hiestand, 2011). The weekends associated with a football game where the final score was less seven points in difference experienced an increase in likelihood of patients presenting with alcohol related complaints. As a reaction to increased enforcement of open container laws, the authors suggest that the higher number of arrests and ED visits could be because of binge drinking and the use of liquor instead of beer. The authors also reference studies which show an increase in the use of alcohol among college students in general.

In Redelmeier, Vermeulen, 2011, the objective of the article was to examine if a mass media broadcast would cause patients to refrain from seeking emergency medical care during the event. The author's concept as stated (Redelmeier & Vermeulen, 2011) "healthcare patterns are

not immune to analogous variations in individual choice" (p. 113). The setting chosen for the study was Ontario, Canada and the event which would generate mass media broadcast was the Olympic Men's ice hockey gold medal game that took place on the 28 February 2010 in Vancouver. The event received an unprecedented 16.6 million viewers representing nearly fifty percent of the population of Canada (Redelmeier & Vermeulen, 2011). The event duration was in excess of three hours but the author's limited their study to three hours of actual play. For a control the author's chose six Sundays to relieve any daily variations. For the data the author's utilized the National Ambulatory Care Reporting System which provided admitting records for 170 emergency departments across Ontario. Patient characteristics included patient age, gender, home location, neighborhood income and date of death. Visit specific data included an arrival time, facility name and duration of visit. The health of the individual patients was defined by a national triage and severity ranking, reason for visit and a main diagnosis (Redelmeier & Vermeulen, 2011). The study concentrated on the totals of patient arrivals during the hours of the broadcast in comparison with the totals that visited the emergency department during the same time period on the six control Sundays. The author's reported a marked difference of 764 visits during each hour of the three hour televised event (1,941 visits in total during the hours of the broadcast) as compared to 783 during the control hour (2,349 for the control hours during the time frame of the broadcast in the six control days). The results of the study was that there were 409 fewer visits to emergency departments during the three hours of the broadcast as compared to the same time frame of the control days (Redelmeier & Vermeulen, 2011). This reduction in visits represented a 17% decrease. There was no marked disparity between the day of the event

and the control days for the average number of patient visits per hour, in the time before or after the event. The highest number of visits by age was for patients less than fourteen years of age (441 of the visits for 22% of the total during the broadcast). The study concluded that there were 17% less emergency room visits during the time of the one of the most watched sports television broadcast in Canadian history when compared to the same time frame as the control days. The limiting factors included that it considered one unique sporting event and a single part of the healthcare industry. The database from which the information was derived gave no consideration for actually who was watching the broadcast and so, decision as to patient's healthcare choices could be subject to choices made by another individual. The study showed that fluctuations in emergency department arrivals are affected by individual patient decisions. The study makes the case that the behavioral sciences have a larger role in the choices to seek medical care and therefore, must play a larger role in the study of the demand for medical care.

The effect a mass gathering has on the local EMS of a city that hosts the event has been only lightly researched and has largely approached the problem without looking at the spatio-temporal distribution of call volume. Identification of how the magnitude of an event affects local 911 calls would provide a further understanding of how the event affects the provision of city services. The event itself acts as a catalyst for the movement of population to participate in the event. The magnitude of the game affects the size of the population movement and the results of the game influences 911 call volumes afterwards. The spatio-temporal patterning of 911 calls reflects this population movement. With an increased population comes the heightened need for city services. Since an increase in population also inhibits movement

across a city, knowledge of the patterns of 911 calls and their call nature relative to the mass gathering event would aid in the provision of services. An important point brought forth in literature is that the game does not have to be at home for the event to affect local EMS (Deakin, Thompson, Gibson & Green, 2007). The occurrence of the University of Alabama football game and the magnitude of the event affect the spatio-temporal patterns of 911 calls. By using historical 911 call data, compared with variables reflecting the magnitude of the event, a spatio-temporal pattern can be identified. With the pattern identified plans can be implemented to provision EMS services to meet a predicted need.

3. Data and Methods

To explore EMS calls on the weekend of the University of Alabama Football game a dataset was procured from both NorthStar EMS and the Tuscaloosa Fire & Rescue Service. To capture the events of the weekends and in reference to a lag effect (Moody, Hendry, Muscatello, 2007) the time for the data collection was set from 1700 on Friday of the game weekend until 0800 the following day (Sunday). The NorthStar EMS dataset spanned from 2006 to 2012. The dataset was restricted to the calls received through 911. The NorthStar EMS dataset included a date & call received time, an address, a set of geographic coordinates for the call location, a call nature and a source of the call (911). The TF&RS dataset (n = 2832, average call volume of .538 per hour) was from 2006-2011 and included a date & time of the received call, an address, and a non-specific call nature. Formal ethical approval was not required as the information included in the dataset was stripped of any specific patient information before being received for the study.

From 2006 until 2011 there were two private ambulance companies providing emergency medical services in Tuscaloosa, Alabama. The City of Tuscaloosa 911 center received the 911 calls initially and then transferred the call to a private ambulance company in rotation. For that reason the NorthStar EMS dataset (n = 3785 calls) represents approximately half the EMS calls made in the city at that time. Both TF&RS and the private ambulance company would respond to the call. In October of 2011 the City of Tuscaloosa awarded NorthStar EMS with a sole contract to provide transport services within the city. The NorthStar EMS dataset after that point is considered to represent all the runs. Calls from the NorthStar EMS dataset were excluded if they

did not have accurate coordinates (a set response given in place of coordinates if the call location did not match a pre-geocoded address), were outside the city limits of Tuscaloosa or had nature that was not consistent with an emergency call (i.e. discharge).

NorthStar EMS also provided emergency medical dispatch services which included a call interrogation and, if necessary, pre-arrival instructions (i.e. CPR instructions) to the caller. Three different systems of EMS dispatch and pre-arrival instructions were in use in the time period of 2006-2012. They included Power Phone (Power Phone, Madison, Connecticut) APCO Emergency Medical Dispatch (APCO International, Daytona Beach, Florida) and Medical Priority Dispatch System (International Academies of Emergency Dispatch, Salt Lake City, Utah). The call nature provided in the dataset was defined in three different manners by the various products in use. Call natures were reclassified to their core definition. For example, if a call was listed as "21-Hemorrhage/Lacerations A-1" then the call was relabeled as "Hemorrhage/Laceration". The base call nature was then assigned into four criteria (See Table 1).

Medical	Abdominal Pain Alteration of Conciousness Altered Mental Status Asthma Attack Back Pain Bleeding / Hemorrhage Blood Pressure Problems Breathing Problems Cardiac Respiratory Arrest Chest Pain Childbirth Obstetrics Convulsion / Seizure Diabetic Problems General Illness	Headache Heart Problems Nausea Vomiting Pain Person Down Pregnancy Childbirth Miscarriage Respiratory Arrest Sick person Stroke Syncope Unconscious / Fainting Unknown Problem Unresponsive
Environmental	Allergic Reaction Allergy Sting Bite Hyperthermia Hypothermia Poisoning Ingestion Carbon Monoxide Hazmat Choking Drowning / Near Drowning	
Trauma	Animal Bite Attack Bicycle Wreck Burn Scalds Explosion Eye Problem Injury Fall Fracture Dislocation Head / Neck / Spine Injury Hemorrhage / Laceration	Machine Industrial Accident Motorcycle Wreck MVA Pedestrian Struck Traumatic Injury
Behavioral	Assault Rape / Sexual assault Attempted Suicide Drug Overdose HCCI Sick / Gunshot Wound / Penetrating Overdose Poisoning Psychiatric Abnormal Behavior Suicide	Public Assist Withdrawal / Detention Transport

Table 1: Reclassification of call nature from NorthStar EMS dataset

The two datasets (NorthStar EMS and TF&RS) were organized and cleaned using Microsoft Excel (2007). The two datasets were not consolidated due to a large number of duplicate calls and problems with differing geo-coding processes. The resulting spreadsheets were individually loaded into respective map documents using ArcMap (2010, ESRI, Redlands, California), projected in North American Datum 1983, State Plane Alabama West FIPS 0102 (US feet) for further study.

A football game data set was created from the University of Alabama Athletics website. The dataset included the date of the game, kick-off time, game end time, opponent, site,

attendance, results of game, home or away, and scores for both teams. Opponents were then classified by ranked, conference or non-conference. An opposing team was categorized as "ranked" if at the time of the game they were ranked in the top twenty-five teams of the Associated Press Poll.

To aid in the classification of games, a sports betting point spread was referenced to provide a favorite for the game and the point margin for the favored team to clear (Kuester, Sanders, 2009). Kuester, Sanders, 2009, explain that a point spread will usually feature a final pre-game spread that constitutes a median game outcome or a point spread that the favored team is expected to cover half the time (p.119). The Glantz-Culver Line was referenced for this information and the favorite and point spread was incorporated into the dataset (See Table 2).

Win	Alabama favored to win with a point spread of greater than 7 points.
Upset Win	Alabama favored to win with a point spread of less than 7 points or Opponent favored to win.
Upset Loss	Alabama favored to win with a point spread of greater than 7 points.
Loss	Opponent favored to win with a point spread of greater than 7 points or Alabama favored to win with less than 7 points.

Table 2. Game Magnitude

A Kernel Density Map was utilized as the initial map for evaluation of 911 calls. Kernel density maps are useful for the creation of a surface with continuous data which is derived point or line feature. Practically, this depicts densities of features but also obscures the location of a

911 call so as to provide a measure of privacy. The 911 calls that took place were broken down into three hour time blocks. A raster image depicting the density of the EMS calls was then created for each time block.

In order to depict call volumes relative to the playing time of the University of Alabama football games, line graphs were generated. To capture all the runs in town, the TF&RS dataset was utilized. Select games were chosen based on the classified magnitude of the football game. These line graphs were then grouped by magnitude for evaluation.

To further evaluate the connections between the data, several chi square statistical tests were employed to assess for statistical significance. A chi square test was also utilized to examine the relationship between game time and 911 calls. A categorical variable was assigned to all calls in the TF&RS dataset based on when the call occurred relative to game time. The categories included greater than 6 hours before kickoff, greater than three hours before kickoff, less than three hours before kickoff, during game time, less than three hours after kick-off, greater than three hours after kickoff and greater than six hours after kickoff. A chi square cross-tabulation was also utilized to test for a relationship between the call nature reclassification, game magnitude and opponent classification.

A hot spot map can be utilized to depict spatial clustering of calls based on select criteria. Getis Ord G (Spatial Statistics in the ArcTool Box of ArcMap) was employed to study the possibility of clustering of the 911 calls based on the call nature reclassification. This spatial clustering was evaluated at the census tract level. An average nearest neighbor tool was utilized

to first test for clustering for each of the four call nature reclassifications. The important statistics to consider in this test was whether the observed mean distance was less than the expected mean distance, z-score and the p-value. Next, all call data was aggregated to the census tract level. A hot spot analysis was then performed on the 911 point data by using the Getis Ord G statistical tool. The resulting statistics were then joined back to census tracts to create a choropleth map that would identify hotspots of the specific nature reclassification.

4. Results

4.1 Kernel density maps

The resulting kernel density maps display the variability of 911 calls by hour and over space. Though there is no statement here of absolute causation based on a 911 call simply being located near the call location of a prior or subsequent call there are still patterns that can be identified. The kernel density maps depict call locations in 3 hour blocks from Friday at 1700 hours to Sunday at 0800 hours. In the kernel density map of Time Block 1 (See Figure 1) we see that the call densities with the highest values are located in the entertainment districts and near major intersections. Lower concentrations of calls are shown in residential areas in the east of Tuscaloosa but are contrasted with higher value in the west side of Tuscaloosa. This time block call density could be attributed to normal patterns of population movement on a Friday afternoon in Tuscaloosa. There are the beginnings of a higher call density pattern near the University of Alabama (UA).

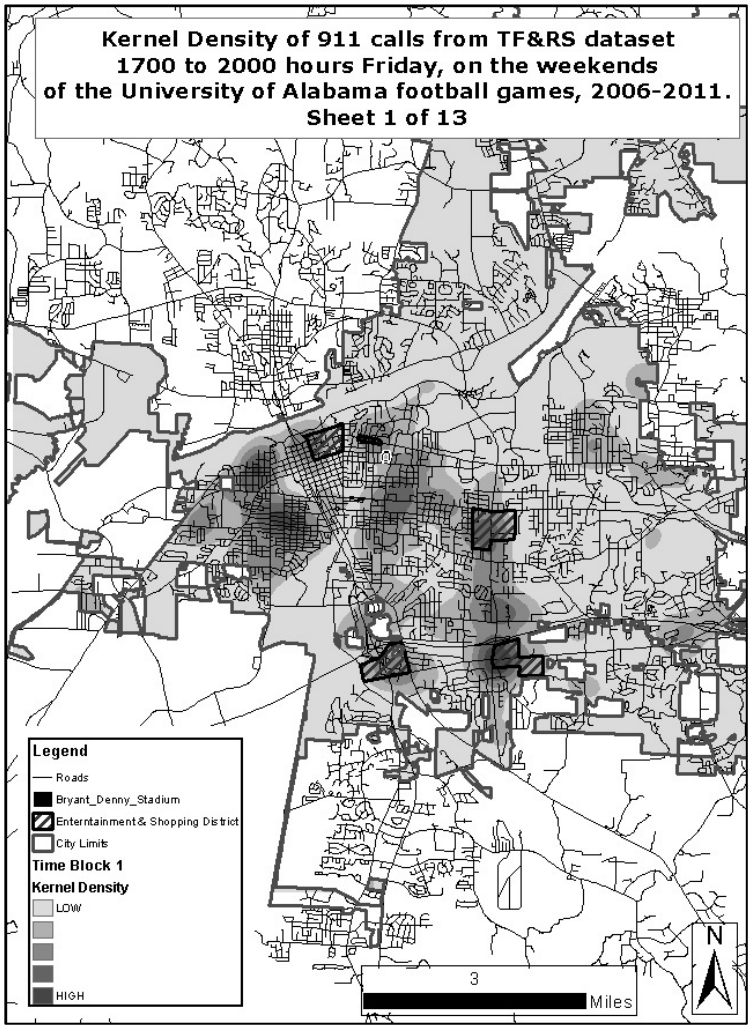

Figure 1. Kernel density map 1700-2000 hours Friday

In the 2000 hours to 2300 hours kernel density map of Time Block 2 (See Figure 2) there is apparent the beginning concentration around the UA. Highest densities are seen in proximity to the entertainment districts just north and west of Bryant-Denny Stadium. Higher densities are also seen in residential neighborhoods south and west of the University. There is a concentration

of calls apparent to the east in Alberta. This map relates to the movement of population in and around the popular entertainment districts of the University Strip and Downtown Tuscaloosa.

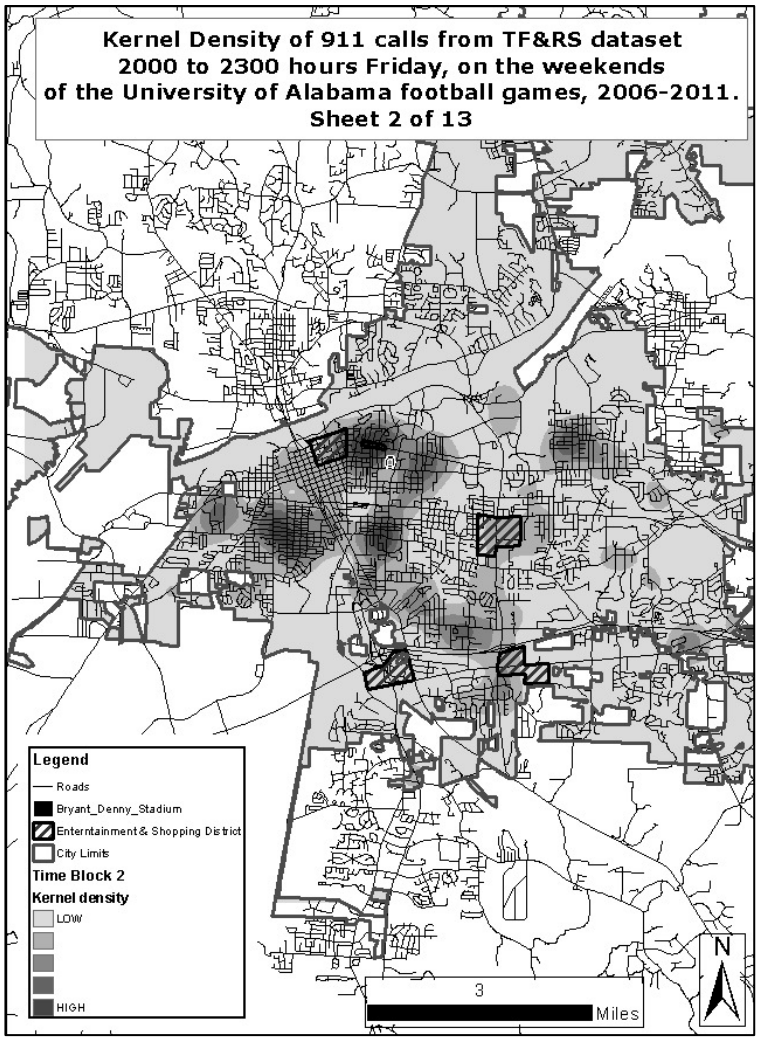

Figure 2. Kernel density map 2000-2300 hours Friday

At 2300 hours to 0500 hours on Saturday morning (See Figure 3 & 4) we see the continuance of high densities in and around the entertainment districts of Downtown Tuscaloosa and the University Strip. There are continuing densities shown in residential neighborhoods west and south of the University. Local bars and nightclubs are still open primarily Downtown and the

University Strip but begin closing around 0300 hours. There are light to moderate densities around some intersections.

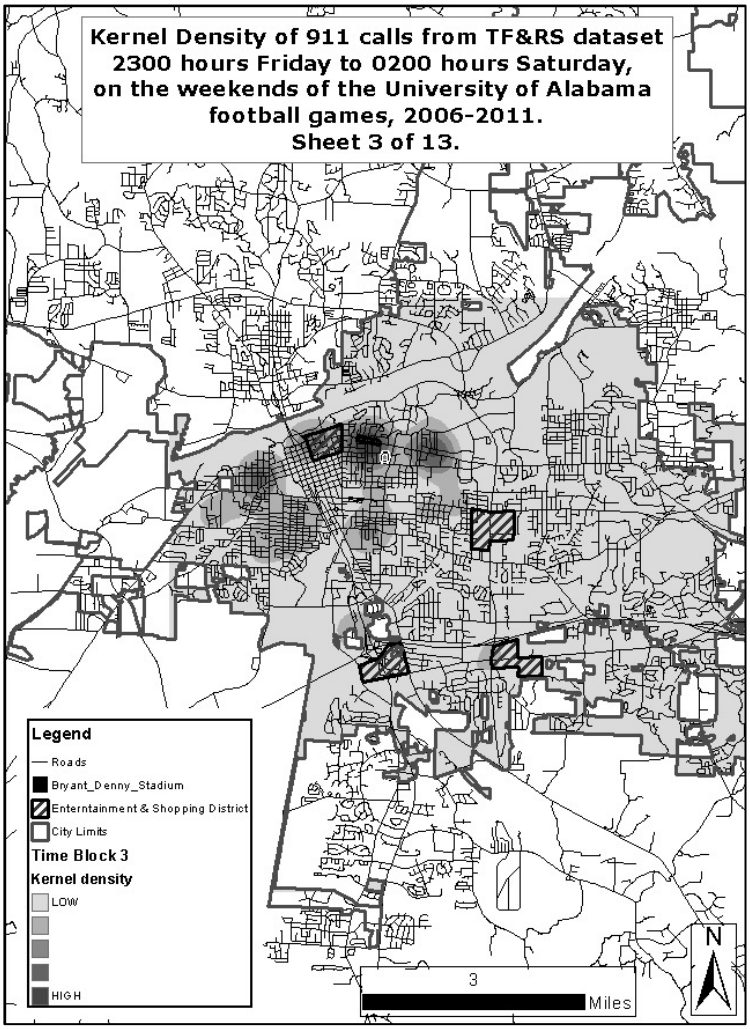

Figure 3. Kernel density map 2300 hours Friday-0200 hours Saturday

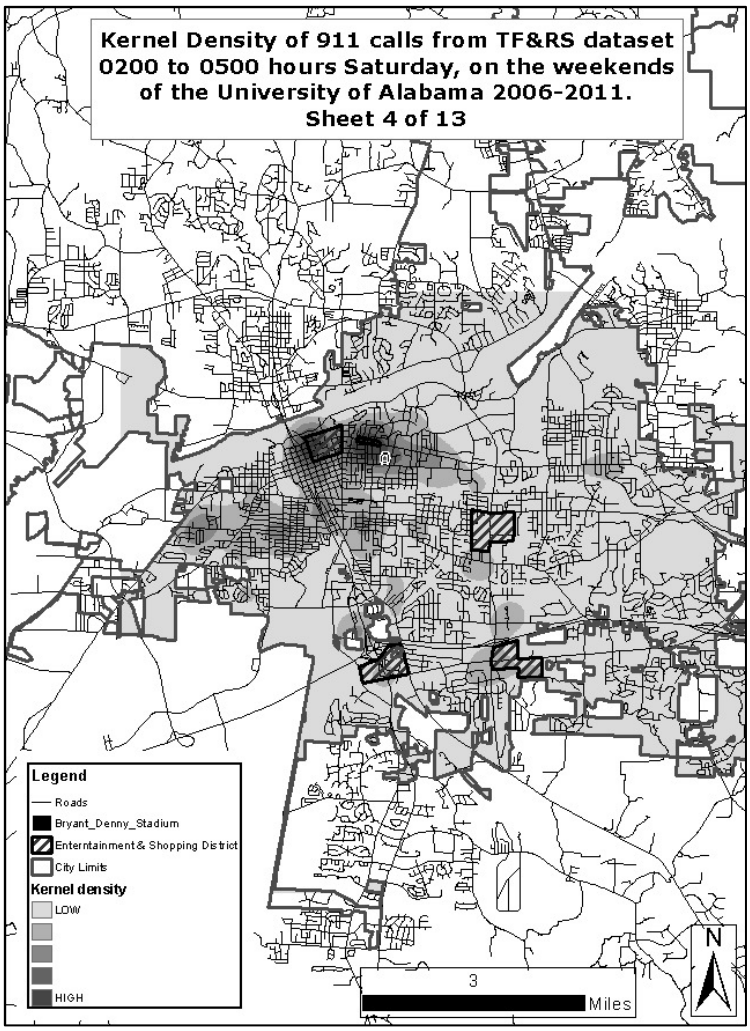

Figure 4. Kernel density map 0200 -0500 hours Saturday

From 0500 to 0800 (See Figure 5), we see a tighter density around Bryant-Denny Stadium with some concentrations in the major intersections. There are lighter concentrations in the residential neighborhoods. By 0800 to 1100 hours (See Figure 6), call densities have increased in the residential neighborhoods in western Tuscaloosa. The high densities of call remain around the stadium. There are areas of moderate densities along major roadways. This is

suggestive of the population movement that would be taking place for the football games where kick-off was in the 11 o'clock hour. Gates for Bryant Denny Stadium open two hours prior to kick-off.

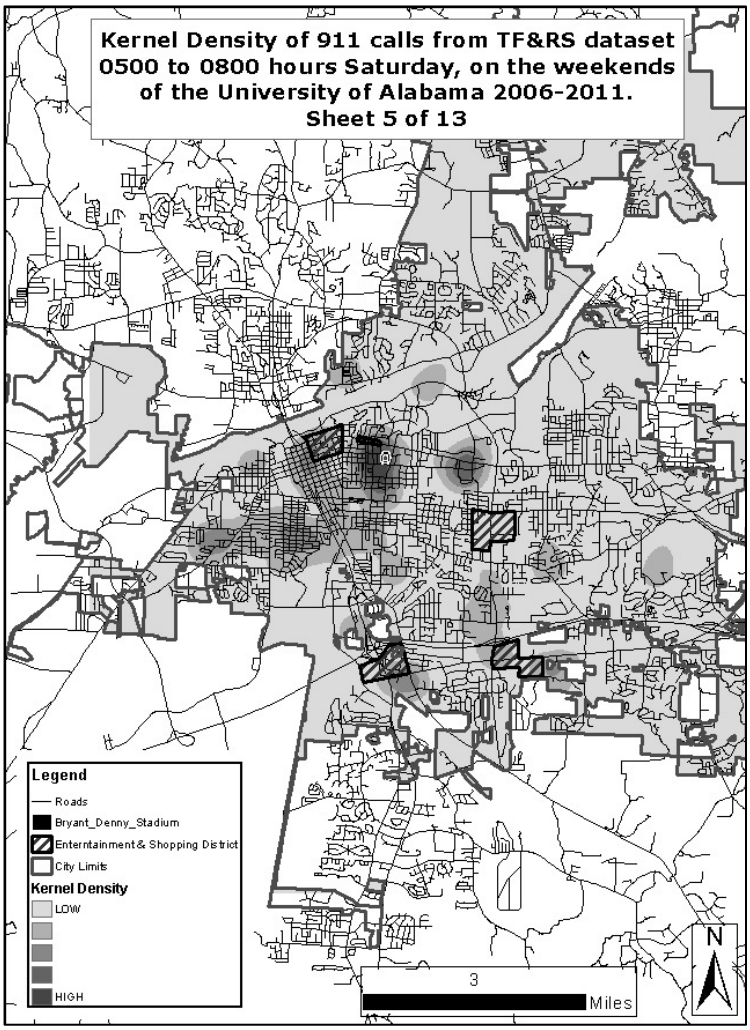

Figure 5. Kernel density map 0500 – 0800 hours Saturday

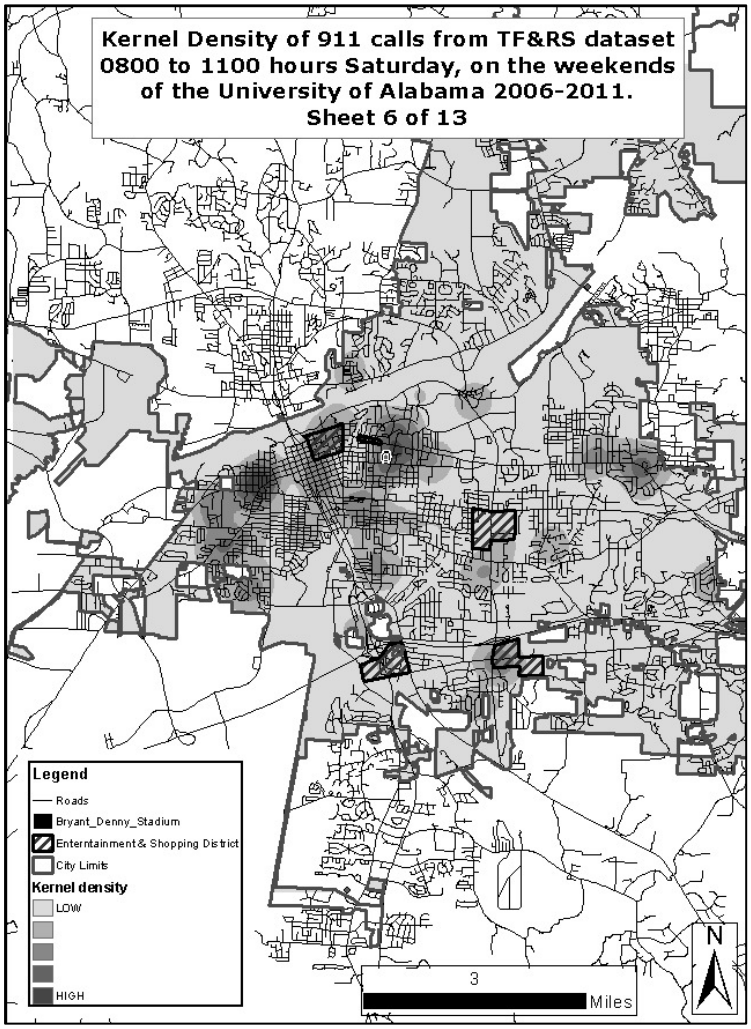

Figure 6. Kernel density map 0800-1100 hours Saturday

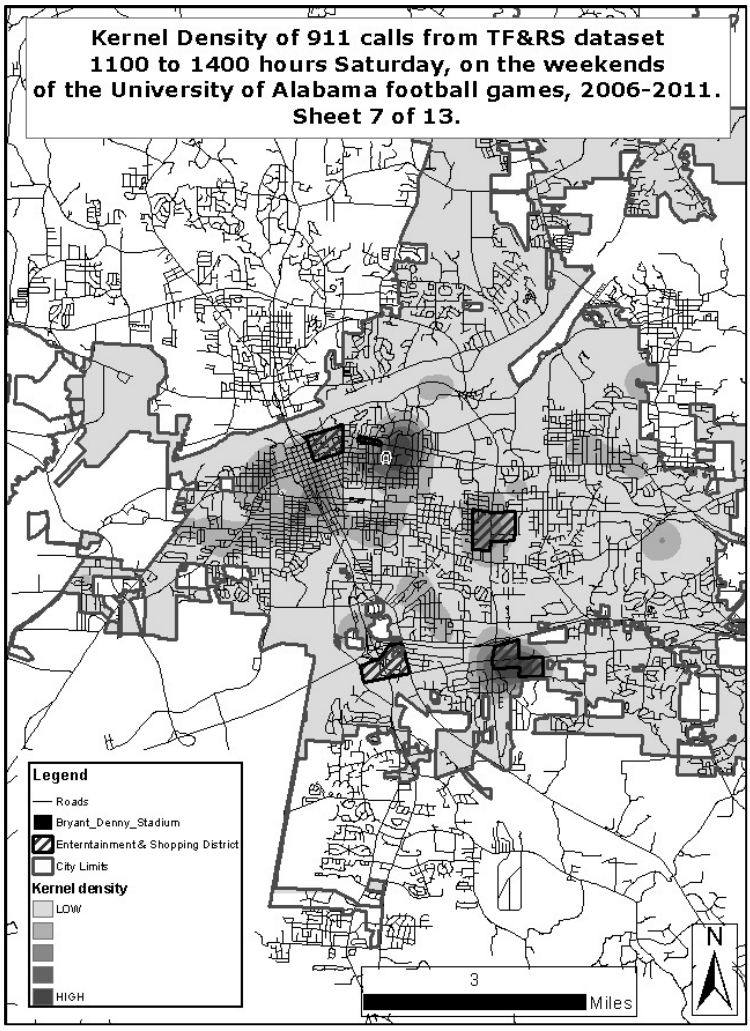

Figure 7. Kernel density map 1100 – 1400 hours Saturday

By 1100-1400 hours (See Figure 7), the highest densities are on the Quadrangle of the University and the retail district in the south of Tuscaloosa. The residential neighborhoods have a low density of calls. There are a high density of calls near the southeastern shopping and entertainment district

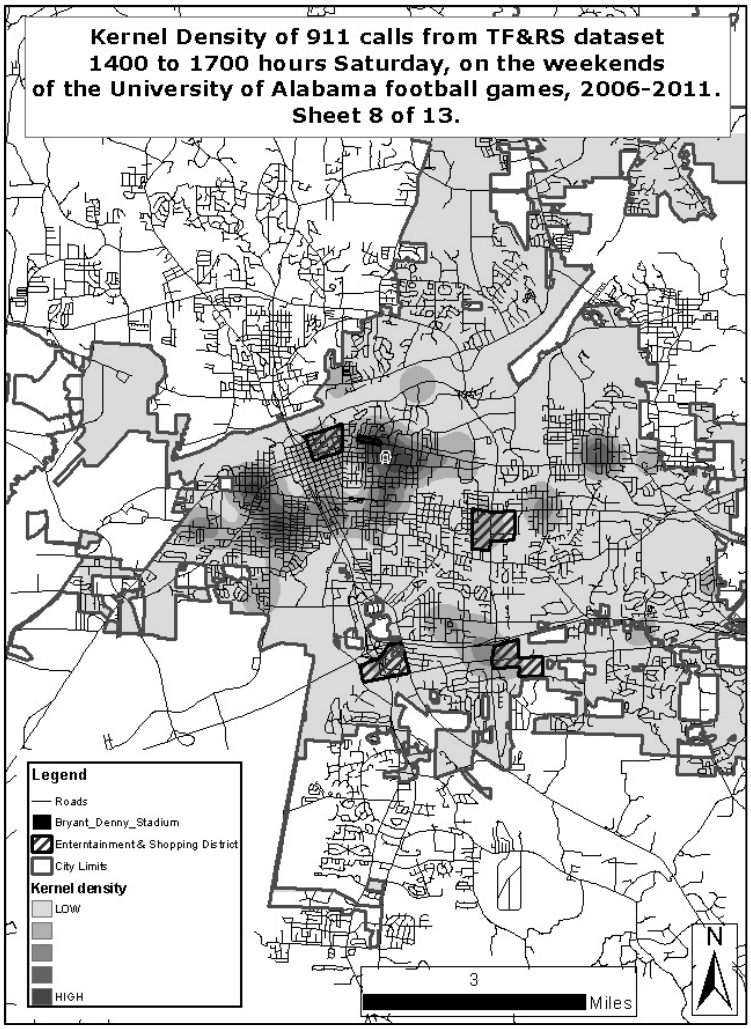

Figure 8. Kernel density map 1400 to 1700 hours Saturday

By 1400-1700 (See Figure 8) the areas with greatest densities stretch from the University Strip to six blocks east of Bryant Denny Stadium. This again reflects a movement population to the Stadium for kick-off. A concentration has now appeared in the east side of Tuscaloosa

(Alberta) near a low income apartment complex that was present until the tornado of April 2011. The west residential neighborhoods are also exhibiting high densities of calls.

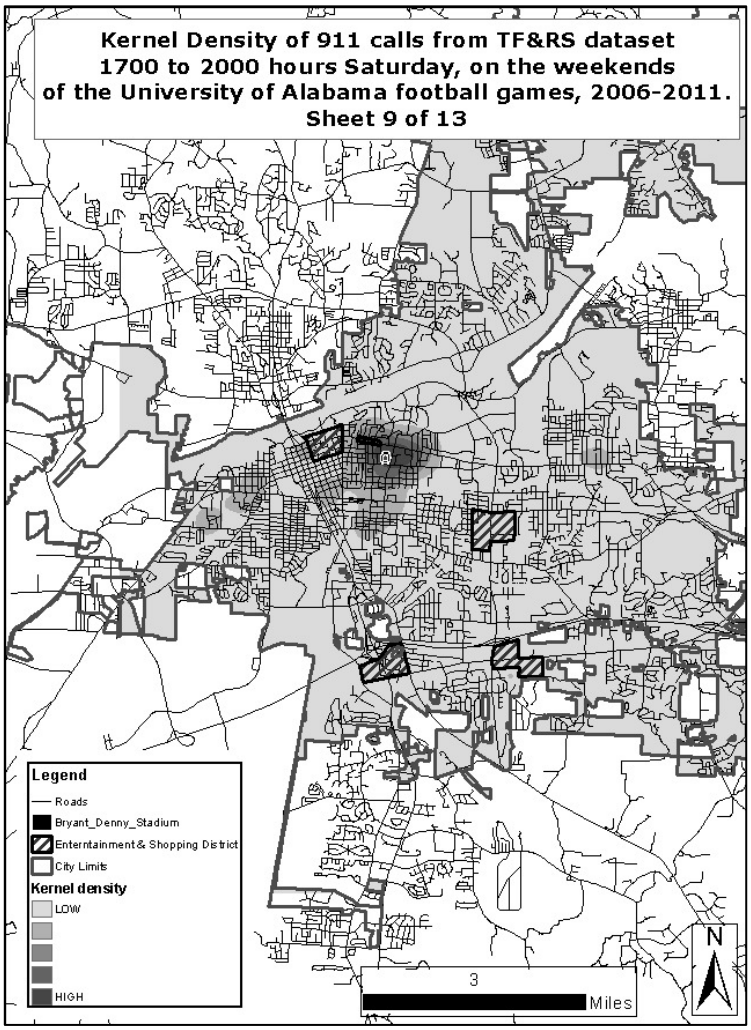

Figure 9. Kernel density map 1700-2000 hours Saturday

From 1700-2300 hours (See Figure 9 & Figure 10) the call densities are concentrated tightly around Bryant-Denny Stadium. A moderate density is apparent in the Downtown entertainment district. All other areas exhibit low densities.

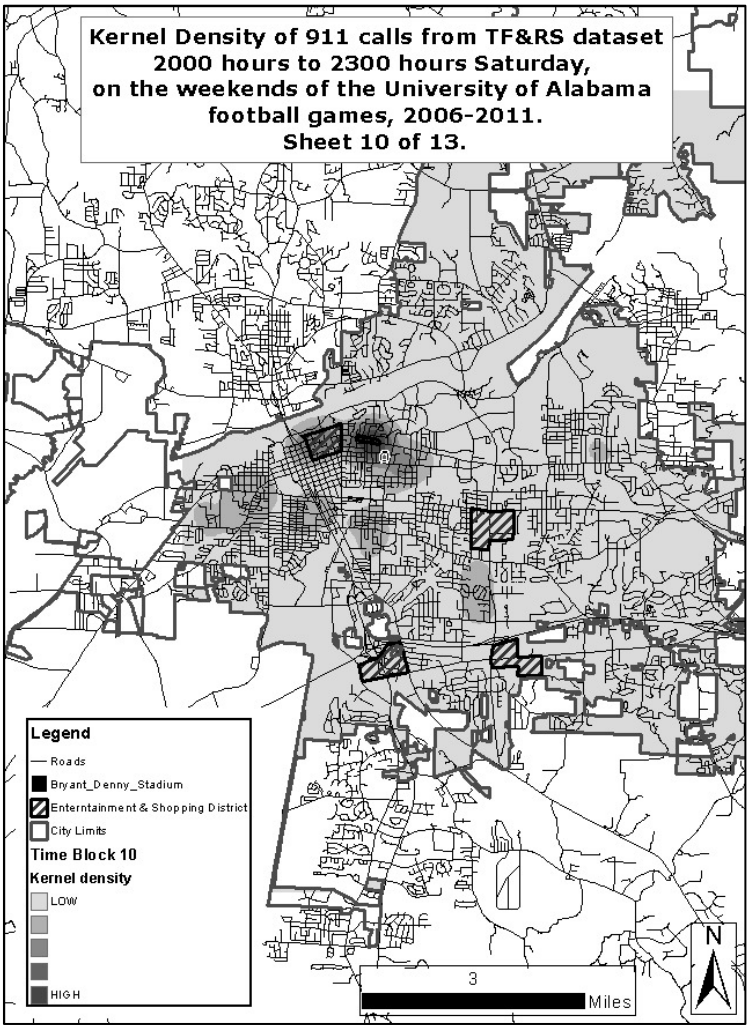

Figure 10. Kernel density map 2000-2300 hours Saturday

From 2300 hours on Saturday to 0200 Sunday (See Figure 11) the area of high density around Bryant-Denny Stadium has shifted more towards the University Strip and Downtown Tuscaloosa. By this point the games are over and the call locations have shifted west. All other areas exhibit low density.

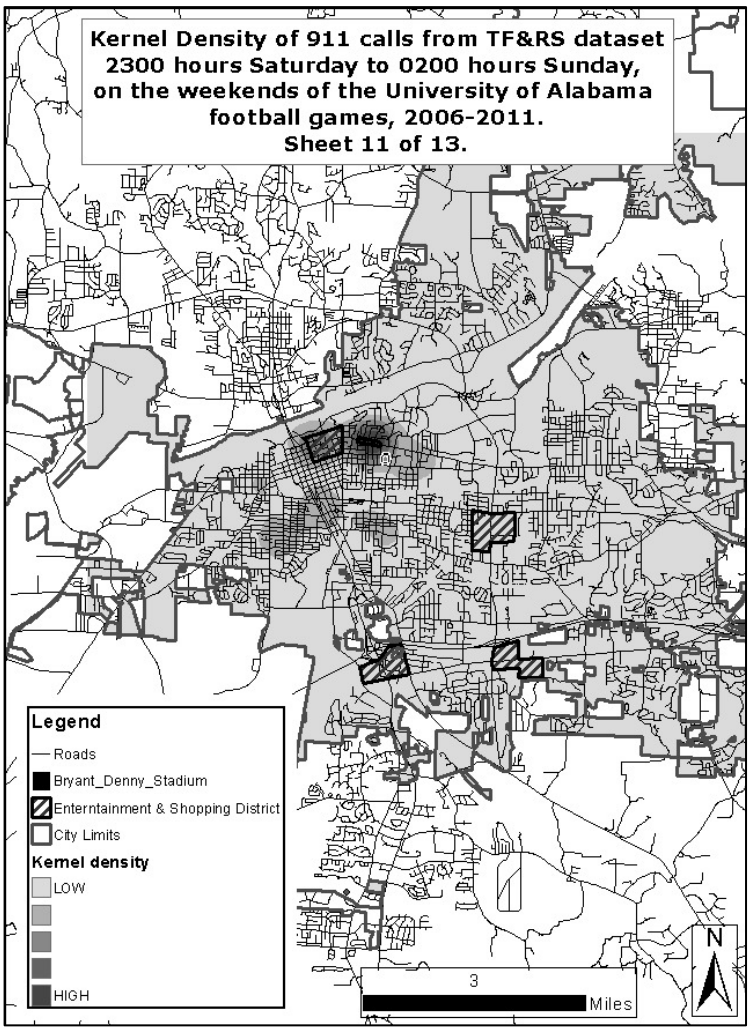

Figure 11. Kernel density map 2300 hours Saturday to 0200 hours Sunday

In the 0200-0500 (See Figure 12) time block the call density is primarily concentrated on campus and to the University Strip. There are some moderate densities apparent in the west side of Tuscaloosa. It should be noted that the bars close at 0200 on Sunday morning.

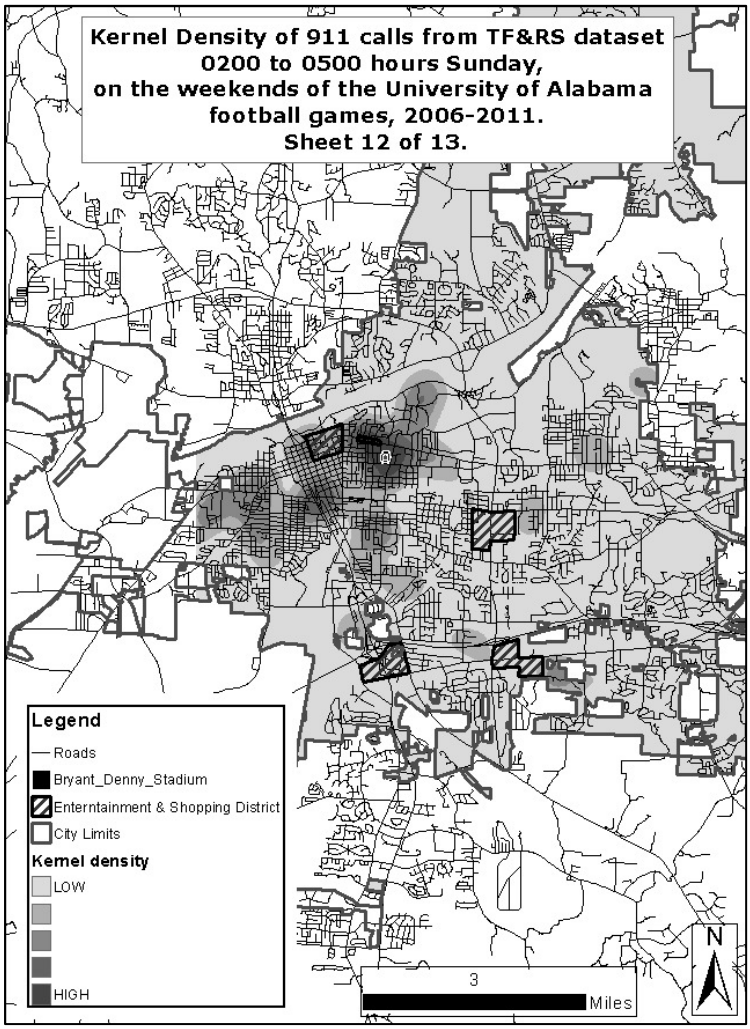

Figure 12. Kernel density map 0200-0500 hours Sunday

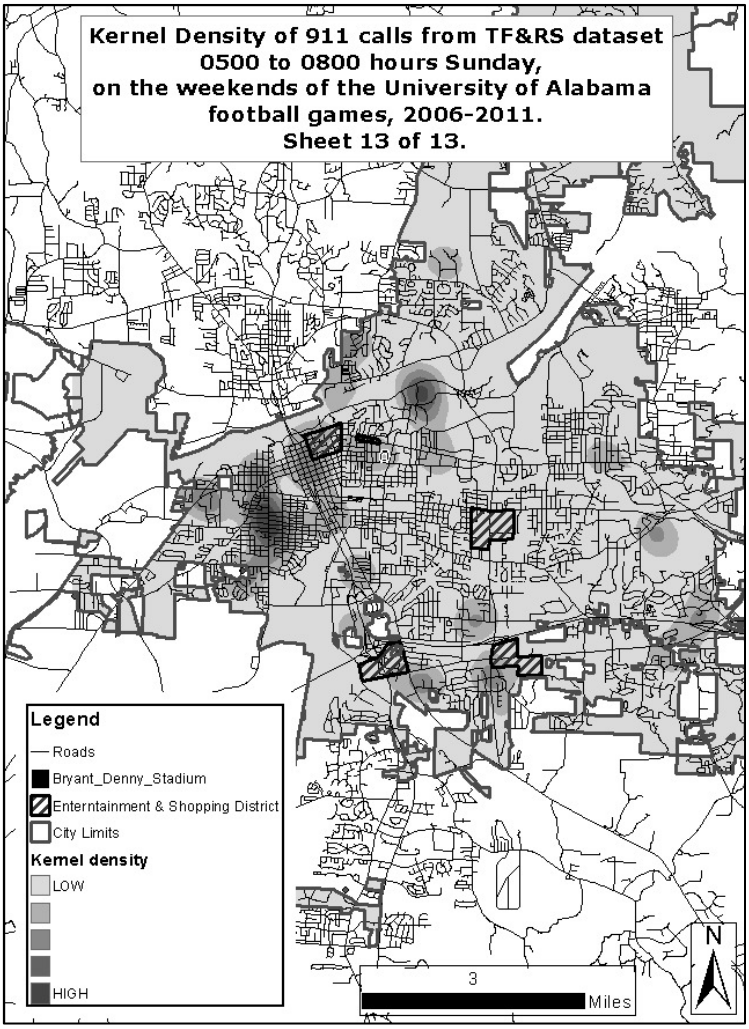

Figure 13. Kernel density map 0500-0800 hours Sunday

By 0500-0800 (See Figure 13) the call densities around the University have diminished. The only moderate areas are in the western neighborhoods. There are no areas of high density suggesting that the event has ended and the population that was present has dispersed.

4.2 Time Line Analysis

To follow-up on the evaluation of 911 call density, a line graph was utilized to compare the thirty-nine hour time window, the count of runs by hour and the time of the football game. A selection of the line graphs were then depicted based on the magnitude of the game. Figure 14 is included as an example of line graphs. Of note is that the Hawaii game represents the first home game of the 2006 season. Apparent in the graph is the pregame increase, mid-game drop to a normal call volume of one call an hour and the post-game increase with a reduced in call volume after two a.m. Increased 911 call activity is designated as such for a "spike" or a sharp increase in call volume within a single hour or a sustained activity level over a two to three hour period. Since the call volume averages .538 across all hours of the study and increase of two runs with in a single hour is designated a spike in call volume.

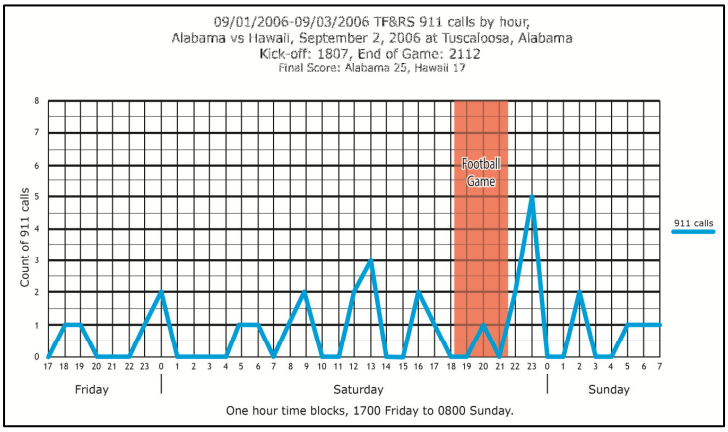

Figure 14. Example line graph.

The TF&RS dataset was utilized for these graphs as they comprise all the 911 calls from 2006 to 2011. Eight game weekends were selected based on the assigned game magnitude classification.

Figure 15. Comparison of Game magnitude and call volume: "Win"

All selected weekends for the “Win” magnitude were home games (See Figure 15). A normal pattern relative to the game is presented in this selection. A spike in 911 call volume is evident in the two to three hours before the game coupled with a decrease in 911 call volumes during the game. It should be noted again that for all home games the gates for Bryant Denny Stadium open two hours before kick-off. In the first three hours after the game a spike in 911 call volume is evident on all game days. Four of the weekends are in September; three are in October and the remaining weekend is in November. A drop in call volume is also evident after two a.m. on Sunday morning. Four of the selected game weekends (Alabama vs. Hawaii on 2 September 2006, Alabama vs. Kentucky on 4 October 2008, Alabama vs. Tennessee 24 October 2009 and Alabama vs. Florida on 2 October 2010) exhibit post games spikes (four more calls in the first three hours after the sporting event).

A comparison of the weekends with games defined as a “Loss” resulted in two home games and six away games (See Figure 16). Four of the selected game’s final score have a difference of less than seven points which is indicative of a game that would induce greater stress for spectators and audiences. The games with seven points or less difference in the final score have sustained call volumes of four to eight calls after the game but before two a.m. Games with greater than seven points difference in the final score exhibited limited to no effect (Alabama vs. LSU, 11 November 2006) or a mimic of a loss at home (Alabama vs. Florida, 29 September 2007). Sharp increases as well as sustained volumes are evident prior to the home games. Decreases in call volume during the game are evident in all selected weekends. Home games have a sustained normal call volume during the game. Only one of the away losses (Alabama vs.

Arkansas 23 September 2006) has a slight spike in call volume during the game. Of the six away games, five have a below normal call volume during the game

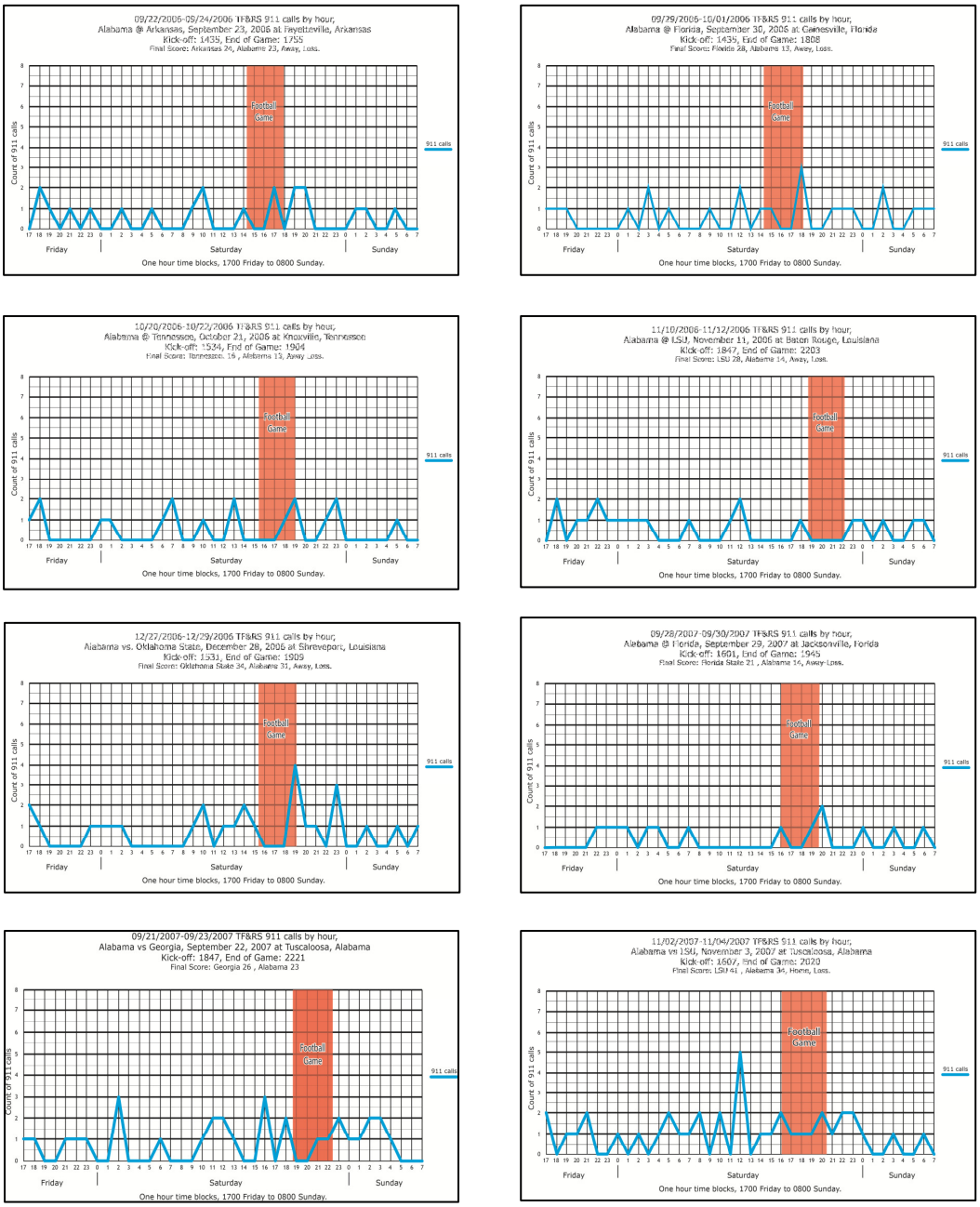

Figure 16. Comparison of game magnitude and call volume: “Loss”.

In a comparison of games and game weekends designated as “Upset Win” (See Figure 17) resulted in eight away games with seven of the eight selected against opponents ranked in the top 25 of the associated press poll. In seven of the eight graphs there is a noticeable lack of the normal lull in call volumes seen during the game. The exception to this is the Alabama vs. University of Texas in the National Championship on 7 January 2010. Spikes in call volume are evident before game in six of the eight games. After the game seven out of eight of the selected calls have a decrease after two a.m.

The selected graphs of “Upset Loss” (See Figure 18) have four home games and four away games. Four of the selected games are losses that exceed seven points in the difference of the final score. Of the home games, two of the four have sharp peaks in call volume before or during the game. The Alabama vs. LSU game held on 5 November 2011 is particularly noticeable with thirteen calls before the game and fourteen calls after the game. Home upset loss of high magnitude games results in higher spikes (due to increased population into the community) and more sustained call volumes after the game, especially if the final score was close. In three of those games there is a decrease to zero calls after the end regulation play. Of the away game, three of the four exhibit a spike before the game. Normal call volume continues during the away games and only one of the four has eight calls before midnight.

Figure 17. Comparison of game magnitude and call volume "Upset Win".

Figure 18. Comparison of game magnitude and call volume "Upset Loss".

4.3 Statistical Tests

To statistically test for relationships in my datasets a simple chi square and a chi square cross tabulation were employed. The simple chi square was performed after the all calls from the TF&RS dataset was categorized as occurring before, during or after the game. My null hypothesis is that the time of the game has no impact on when a 911 call will occur. The alternative hypothesis is that game time does impact when a 911 call occurs. In the first calculation all calls in the TF&RS dataset were included. The result was that the time of the game had no effect on the time of a 911 call, χ^2 (6, N=2832) = 1588.23, p = 0.05. After eliminating on of the variables from the dataset that had as many calls as three other classes (the category "greater than 6 hours before the game" had 1135 calls compared to 392 for "greater than six hours after"), the calculation was performed again. Again, the time of the game had no effect on the time of a 911 call, χ2 (5, N=1697) = 71.09, p = 0.05.

A chi square cross tabulation was utilized to explore the relationship between the call nature reclassification and the opponent classification. As this would include the call nature reclassification the NorthStar EMS dataset was utilized. The null hypothesis is that the opponent classification has no impact on what type of 911 calls occur. The alternative hypothesis is that opponent classification has an effect on the call nature of a 911 call. The results were that the opponent classification has no effect on 911 call nature, (6, N=3785) = 5.37, p = 0.05.

To explore the possible relationship of the game magnitude with the call nature reclassification a chi square cross tabulation was employed. The NorthStar EMS dataset was used as call nature reclassification was necessary for the testing. The null hypothesis for this test

was that game magnitude has no effect on what type of 911 calls occur. The alternative hypothesis is that there is a relationship between game magnitude and the 911 call nature. Again, my results found that the game magnitude has no effect on the nature of the 911 call, (9, N=3785) = 12.986, p = 0.05.

4.4 Hot spot maps

A hotspot map was then employed to define if there were existent clusters of 911 calls based on the call nature reclassification. Evidence of clustering was needed to provide a logical basis for use of hot spot map. The average nearest neighbor tool available in ArcMap provided a manner in which to provide evidence of clustering among the 911 calls. Five measures are provided by the nearest neighbor tool to define if the null hypothesis of a random distribution should be rejected. The observed mean distance is the average of length between each 911 call of the specified recoded nature. The expected mean distance is the length between arbitrary arrangements of the same points. A nearest neighbor ratio is a proportion of the observed mean distance compared to the expected mean distance. A value of less than one in the nearest neighbor ratio identifies clustering among the 911 calls. To test for statistical significance, a z-score and a p-value are included in the results from the nearest neighbor analysis. A z-score of less than -2 or -3 and a very small p-value allows for the choice to reject the null hypothesis (Mitchell, 2005). The results of the average nearest neighbor are found in Table 3.

Recoded Nature	Observed Mean Distance	Expected Mean Distance	Nearest Neighbor Ratio	Z-Score	p-value
Medical	246.797	522.621	0.47223	-42.777	0.00
Trauma	456.45	839.899	0.53459	-23.025	0.00
Behavioral	604.755	988.251	0.61194	-16.633	0.00
Environmental	1571.56	2725.51	0.57661	-6.5803	0.00

Table 3. Results of Average Nearest Neighbor.

A Getis-Ord Gi statistical tool, available in the Spatial Statistics tool set in ArcMap, was then employed identify hot spots among census tracts. The Hot Spot Analysis of Census Tracts, medical call nature (See Figure 19) revealed a clustering of medical calls on the University Campus. It also identified a band of tracts that run from the east (from the VA Medical Center), west into the west side of Tuscaloosa and then north ending at the Black Warrior River.

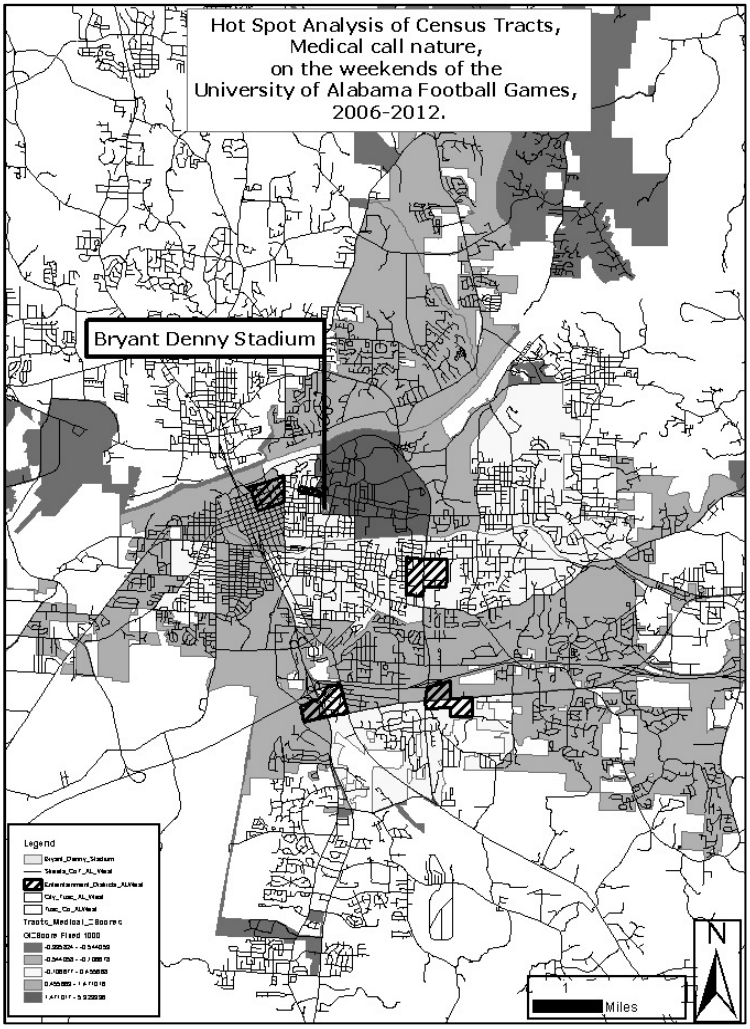

Figure 19. Hot Spot analysis of Census Tracts, Medical Call Nature

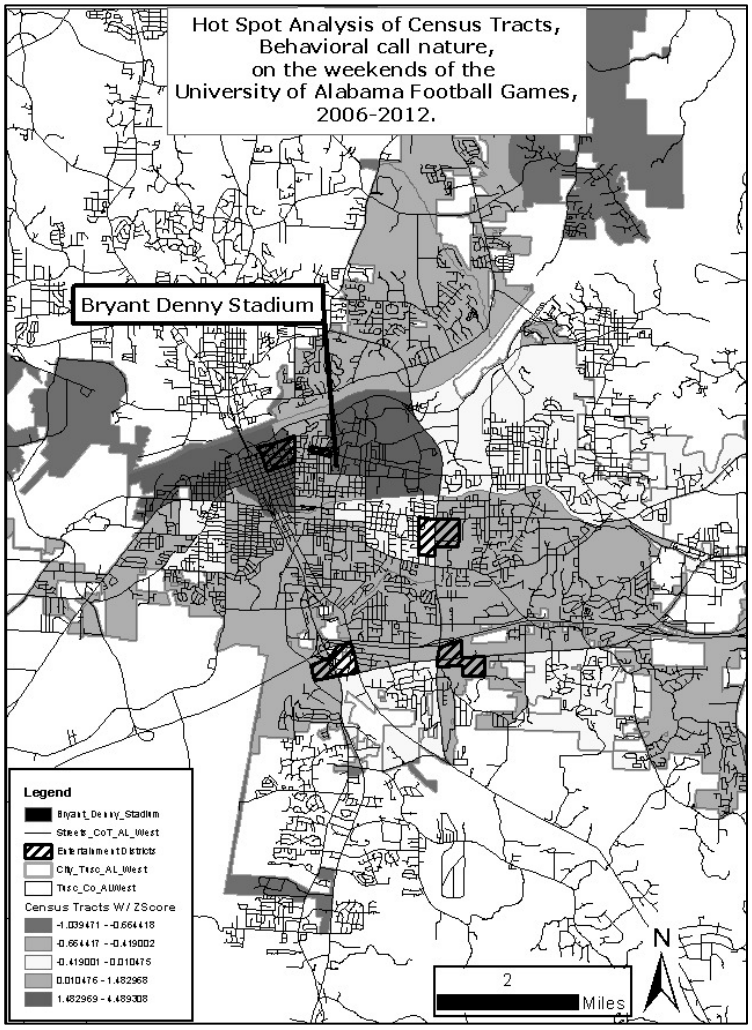

Figure 20. Hot spot analysis of Census Tracts, Behavioral call nature

The Hot Spot Analysis of the Behavioral call nature (See Figure 20) presented a high clustering in two of the tracts. Both the tract that is the University campus and the tract that extends from the Downtown Entertainment District west to Hunt Oil have high clustering of behavioral related calls. All other areas have moderate to low clustering.

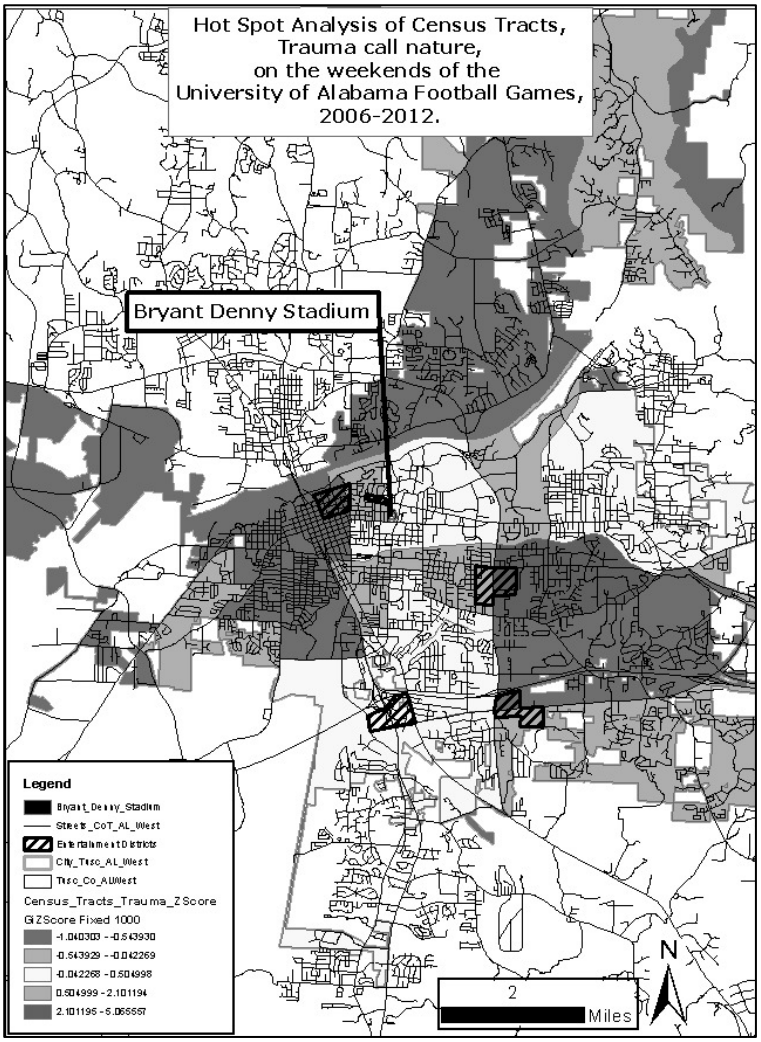

Figure 21. Hot spot analysis of Census Tracts, Trauma call nature

The Trauma call nature registered in high clustering in the census tract that is bordered by McFarland Blvd to the west and extends east to the intersection of Veteran's Memorial Parkway

and Loop Road (See Figure 21). The environmental call nature identified the census tract that is the University campus as the highest cluster with all other areas having low scores.

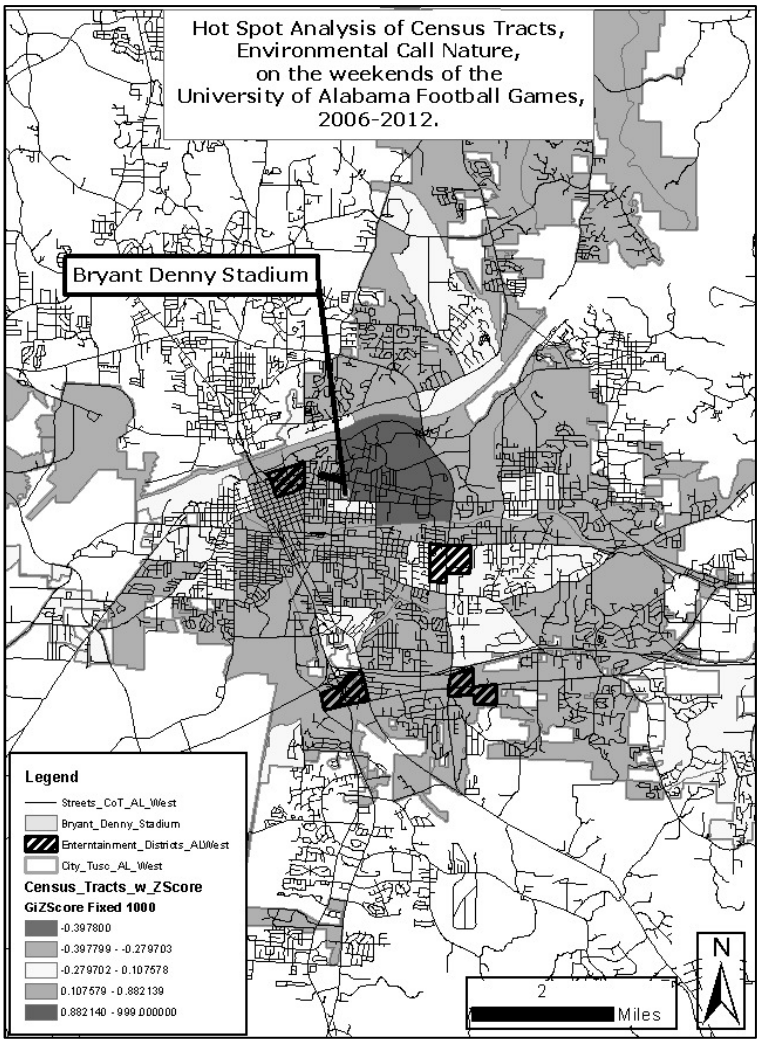

Figure 22. Hot spot analysis of Census Tracts, Environmental call nature

The Environmental call nature presented high levels of clustering in the census tract coincident with the University of Alabama. In the recoding of the call nature from the NorthStar

EMS dataset those emergencies predicated on outside influences or physically surrounding conditions and not traumatic, medical or behavioral in context were defined as environmental. High levels of clustering in this census tract reflect the numbers of emergency calls where individuals were exposed to environmental triggers (such as high temperatures). Since Bryant Denny Stadium is partially an outside venue and the event includes extended periods exposed to climatic conditions this is a logical result.

5. Conclusion

5.1 Discussion

Presentation of the spatio-temporal pattern of 911 calls was identified by dividing the TF&RS dataset into three hour time blocks and then creating a kernel density map from the points. This series of maps present the high and low densities of 911 calls from 2006-2012. After establishment of a pattern, a series of time line analysis were performed comparing the hourly count of 911 calls to the time of the University of Alabama football game. Statistical analysis was then performed using a chi square and a chi square cross-tabulation to establish relationships in the assigned categorical variables. Finally, a hot spot analysis of 911 calls based on call nature was then performed using the Getis Ord G statistical test and the subsequent result were assigned back to the census tracts to create choropleth maps specific to the call nature.

The kernel density maps of 911 calls provide a window in which to see the historic movement of a population. This movement is both along the normal established patterns as evident through 911 calls that occurred in residential areas and major intersections within time frames that a population would normally be present. While presenting the normal patterns of population movement the kernel density maps also demonstrate the movement of a population relative the University of Alabama football games. Call densities show a convergence towards the stadium before the game, a concentration during the game with low call densities in all other areas followed by a movement of 911 calls to the entertainment districts of the University Strip and Downtown Tuscaloosa. Finally on Sunday morning the high density of calls disperses back to the normal pattern found at intersections and residential neighborhoods. The kernel density

maps provide evidence of spatio-temporal patterns and of 911 calls being affected by other forces. There is the suggestion that the football game has greater effect than simply a movement of population (Shook, Hiestand, 2011) (Andriessen, Krysinska, 2009). The spatio-temporal variation affirms the concentration of 911 calls in entertainment district with in certain hours (Cusimano et al., 2010). With a movement of a population adding to necessity for services (Arbon, 2007), then the question of when that movement reaches a critical point so that access to patients near the focal point of the event become restricted. There is very little work that has been done to study the effect of a sporting event on local EMS operations.

In the time series line graphs of the weekend of the football games, a view of individual game weekends is offered to again see the movement of population but at a closer time scale. Home games exhibit a pregame increase in the two to three hours' before kick-off and this coincides with the opening of the gates at Bryant Denny stadium two hours before kick-off. During the game the 911 call volume shows a decrease. This level of decrease varies from zero runs per hour to a maximum of two. Games with final scores of less than three points are characterized by more rapid changes in call volume per hour or two to three hour sustained call volumes. Away games as seen through the line graphs present smaller increases in 911 call volume in the time period before the game and the rise in volume are not dependent on a movement of population. During the game, normal call volume in town continues unless the football game is of a greater magnitude (i.e. National Championship, Bowl game). Post away game losses still show spikes after the game but with less frequency and in town 911 call volume decreases after two a.m. The line graph of calls by hour on the weekend of the football game

attests to the work already performed by Deakin, Thompson, Gibson & Green, 2007, in that there is a recurrent pattern and volume of 911 calls relative to the game. The hot spot analysis confirms the finding of Ong et al., 2009. Emergency calls in general have a tendency to cluster on established patterns of movement, and known circadian rhythms.

Both the chi square test on the timing of 911 calls relative to the game and the cross-tabulation of call nature reclassification to magnitude of the game and opponent classification were inconclusive. This demonstrates a misconception of the categorical variables and/or a very small dataset. The failure of chi square tests demonstrates a relationship between the occurrence of 911 calls and a mass gathering event that is far more complicated than can be easily depicted with categorical variables and a small dataset. Those same factors mentioned by Milstein et al., 2002; weather, event type, length of time, age, crowd behavior, numbers of patrons in what amount of space, numbers of spectators, use of alcohol and drugs all mix to affect 911 calls in the community. The kernel density map and the line graphs of call by hour all contribute to the concept that the event begins long before the coin toss.

The hot spot maps depict clusters of the recoded call nature at the census tract level. The low Z-score and low p-value allow for the rejection the null hypothesis of a random distribution of events. Highest level of clustering is found with medical call nature in the census tract that has the University of Alabama campus and Bryant Denny Stadium. This depiction gives evidence of the concentration of 911 call densities at the stadium during the time periods of normal game day events (Saturday 0800 -2300). The medical call nature also has medium to high clusters in

residential neighborhoods which again relates to the high densities of 911 calls in these areas. The behavioral call nature hot spot analysis illustrates the high clusters of calls in the census tract the University of Alabama campus and Bryant Denny Stadium but also the census tract west of campus that has a portion of the downtown entertainment area and a residential neighborhood. The section of the city is low income housing adjacent to an industrial park. Because the calls were aggregated to the census tract calls from the downtown entertainment area and the residential section contribute to the high clustering of behavioral calls. All other census tracts return a medium to low value of clustering. The Trauma call nature hot spot analysis depicted a high cluster of calls in a census tract in the eastern side of the city. This census tract has a six-lane principal arterial (Tuscaloosa County Highway Functional Classification System, 2013) that runs from the east to west (Veteran's Memorial Parkway or the previous identifier of 15th Street East). The east end of this road has less frequency of traffic lights and is known for higher speed traffic. As you move west from the intersection at Kicker Road, traffic lights become more numerous as does the numbers of business on either side of the street. This culminates at the western edge with the entertainment shopping district that has the University Mall and Midtown Village. The census tract with the second highest clustering values is immediately to the west and also has a portion of the same six lane principal arterial from east to west. The hot spot analysis of environmental call nature again depicts a high clustering of calls in the census tract that the University of Alabama campus and Bryant Denny Stadium. This clustering demonstrates a large population attending an event that is mostly outside and exposed to climatic conditions.

The medium to low values are spread throughout all other census tracts and identify that this type call natures is more evenly distributed than the other three call natures.

Thought the hot spot analysis attests to the correlation of calls in one area it does not approach causation as the basis for their occurrence. Care must be observed in the crafting of variables as the danger is to commit the ecological fallacy and project your finding on the individual (Cusimano et al., 2010). A key point made by Cusimano et al., 2010, is that a study of a place hosting an event is not so much a based off the people residing there (as would be related by using census data) but is a study of everyone moving through that area.

5.2 Limitations and further research

In retrospect if this study would be attempted again there are different choices that would aid the development of a more cohesive work. Data that is continuous instead of nominal variables would enable a selection of a stronger statistical test (possibly, EMS resource response times). Incorporation of a control (such as spring weekend dates where no game was being played) would strengthen the arguments of its validity. Additionally, the hot spot mapping should be performed to the block group level and, if possible, characteristics derived from the population that migrates through that area be used for the study.

Future studies would also have to consider the occurrence of other activities taking place in town or on campus on the weekends of the University of Alabama football game. These type activities would include art festivals, on campus fraternity/sorority events and concerts.

Examination of response EMS times within on the day of the football game would provide a measure of accessibility and how much the game inhibits movement across the urban landscape.

6. References

2006 Alabama Crimson Tide Football: Alabama Crimson Tide Game Results. (2007, March 1). Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2006-2007/teamgbg.html 18Sep2013

2007 Alabama Crimson Tide Football: Alabama Crimson Tide Game Results. (2008, January 4). Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2007-2008/teamgbg.html 18Sep2013

2008 Alabama Crimson Tide Football: Alabama Crimson Tide Game Results. (2008) Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2008-2009/teamgbg.html 18Sep2013

Alabama Crimson Tide Football: Alabama Crimson Tide Game (2009). Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2009-2010/teamgbg.html 18Sep2013

Alabama Crimson Tide Football: Alabama Crimson Tide Game (2010). Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2010-2011/teamgbg.html 18Sep2013

Alabama Crimson Tide Football: Alabama Crimson Tide Game (2011). Retrieved from http://www.rolltide.com/sports/m-footbl/stats/2011-2012/teamstat.html 18Sep2013

Alabama Crimson Tide Football: Alabama Crimson Tide Game (2012). Retrieved from http://www.rolltide.com/sports/m-footbl/archive/alab-m-footbl-sched-2012.html 18Sep2013

Arbon, P., Bridgewater, F., & Smith, C. (2001). Mass Gathering Medicine: A predictive model for patient presentation and transport rates. *Prehospital and Disaster Medicine*, 16(3), 150-158.

Arbon, P. (2004). The development of conceptual models for mass-gathering health. *Prehospital and Disaster Medicine*, 19(3), 209-212

Arbon, P. (2007). Mass-gathering medicine: A review of the evidence and future directions for research. *Prehospital and Disaster Medicine*, *22*(2), 131-135.

Andriessen, K., & Krysinska, K. (2009). Can Sports Events Affect Suicidal Behavior? *Crisis*, *30*(3), 144-152. doi: 10.1027/0227-5910.30.3.144

Card, D., & Dahl, G. (2011). Family violence: The effect of unexpected emotional cues on violent behavior. *The Quarterly Journal of Economics*, *126*, 103-143. doi: 10.1093qjeqjr001

Cardigan, R., & Bugarin, C. (1989). Predicting demand for emergency ambulance service. *Annals of Emergency Medicine*, *18*(6), 618-621.

Carroll, D., Ebrahim, S., Tilling, K., Macleod, J., & Smith, G. (2002). Admissions for myocardial infarction and World Cup football: database survey. *BMJ*, *325*, 1439-1442.

Census Enrollment Report: Fall 2012 | OIRA. (2012, October 10). Retrieved from http://oira.ua.edu/d/webreports/enrollment2/Fall_2012/e11.html

Cusimano, M., Marshall, S., Rinner, C., Jiang, D., & Chipman, M. (2010). Patterns of urban violent injury: a spatio-temporal analysis. *PLoS ONE*, *5*(1), e8669. doi: 10.1371/journal.pone.0008669

Deakin, C., Thompson, F., Gibson, C., & Green, M. (2007). Effects of international football matches on ambulance call profiles and volumes during the 2006 world cup. *Emerg Med J*, *24*, 405-407. doi: 10.1136/emj.2007.046920

DeSchriver, T., & Jensen, P. (2002). Determinants of spectator attendance at NCAA Division II football contests. *Journal of Sports Management*, *16*, 311-330.

Farrell, S., Doherty, G., McCallion, W., & Shields, M. (2005). Do major televised events affect pediatric emergency department attendances of delay presentation of surgical conditions? *Pediatric Emergency Care*, *21*(5), 306-308.

Joiner, T., Hollar, D., & Orden, K. (2006). On Buckeyes, Gators, Super Bowl Sunday, and the Miracle on Ice: "Pulling Together" is associated with lower suicide rates. *Journal of Social and Clinical Psychology*, *25*(2), 179-195.

Khorram-Manesh, A., Berner, A., Hedelin, A., & Örtenwall, P. (2010). Estimation of healthcare resources at sporting events. *Prehospital and Disaster medicine*, *25*(5), 449-455.

McCartney, G., Thomas, S., Thomson, H., Scott, J., Hamilton, V., Hanlon, P., Morrison, D., & Bond, L. (2010). The health and socioeconomic impacts of major multi-sport events: systematic review (1978-2008). *BMJ*, *340*(c2369), 1-9.

Meites, E., & Brown, J. (2010). Ambulance need at mass gatherings. *Prehospital and Disaster Medicine*, *25*(6), 511-514.

Milsten, A., Maguire, B., Bissell, R., & Seaman, K. (2002). Mass-Gathering medical care: A review of the literature. *Prehospital and Disaster Medicine*, 17(3), 151-162.

Milsten, A., Seaman, K., Liu, P., Bissell, R., & Maguire, B. (2003). Variables influencing medical usage rates, injury patterns, and levels of care for mass gatherings. *Prehospital and Disaster Medicine*, *18*(4), 334-346.

Mitchel, A. (2005). The ESRI Guide to GIS analysis, Volume 2: Spatial measurements and statistics. ESRI Guide to GIS analysis, 2.

Miller, H. (2004). Tobler's First Law and Spatial Analysis. *Annals of the Association of the American Geographers*. 94(2), 284-289.

Moody, W., Hendry, R., & Muscatello, D. (2007). Were attendances to accident and emergency departments in England and Australia influenced by the Rugby World Cup Final 2003? *European Journal of Emergency Medicine*, 14: 68-71.

Ong, M., Ng, F., Overton, J., Yap, S., Andresen, D., Yong, D., Lim, S., & Anantharaman, V. (2009). Geographic-time Distribution of Ambulance calls in Singapore: Utility of Geographic Information System in Ambulance Deployment (CARE3). *Annals of the Academy of Medicine*, 38(3), 184- 191.

Quigg, Z., Hughes, K., & Bellis, M. (2012). Effects of the 2010 world cup football tournament on emergency department assault attendances in England. *European Journal of Public Health*, *23*(3), 383-385. doi: 10.1093/eurpub/cks098

Redelmeier, D., & Vermeulen, M. (2011). Emergency department visits during an Olympic gold medal television broadcast. *Open Medicine*, *5*(2), 112-119.

Scoreboard. (2006, 09 02). Amarillo Globe-News (TX). Retrieved from http://infoweb.newsbank.com.libdata.lib.ua.edu/iw-search/we/InfoWeb?p_product=NewsBank&p_theme=aggregated5&p_action=doc&p_docid=113E6537359F99A0&p_docnum=33&p_queryname=3

Shelton, S., Haire, S., & Gerard, B. (1997). Medical Care for Mass Gatherings at Collegiate Football games. Southern Medical Journal, 90(11), 1081-1083.

Shook, J., & Hiestand, B. (2011). Alcohol-Related Emergency Department visits associated with Collegiate Football games. *Journal of American College Health*, *59*(5), 388-391.

Sivarajasingam, V., Corcoran, J., Jones, D., Ware, A., & Shepherd, J. (2004). Relations between violence, calendar events and ambient conditions. *Injury, International Journal of the Care of the Injured*, *35*, 467-473. doi: 10.1016S0020-1383(03)00241-9

Tobler, W. (1970). A Computer Movie Simulating Urban Growth in the Detroit Region. *Economic Geography*, *46*, 234-240.

Tuscaloosa (city) QuickFacts from the US Census Bureau. (2013, June 27). Retrieved from http://quickfacts.census.gov/qfd/states/01/0177256.html

Tuscaloosa County Highway Functional Classification System. (2013) Retrieved October 1, 2013, from: https://cpmsweb2.dot.state.al.us/TransPlan/Maps/HFC/63/63-Tuscaloosa-s1.pdf

Walker, T. (2010, October 17). Game day means millions to SEC schools, states. *The Tuscaloosa News*. Retrieved from http://www.tuscaloosanews.com/article/20101017/NEWS/101019715/0/SEARCH?p=4&tc=pg

White, G., Katz, J., & Scarborough, K. (1992). The Impact of Professional Football Games upon Violent Assault on Women. *Violence and Victims*, *7*(2), 151-171.

Zeitz, K., Zeitz, C., & Arbon, P. (2005). Forecasting medical work at mass-gathering Events: Predictive model versus Retrospective review. *Prehospital and Disaster Medicine*, 20(3), 165-168.

Zwiefelhofer, David B. "Batch Geocoding." Batch Geocode. N.p., n.d. Web. 22 Dec. 2012.