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Time-Space Analysis of Terrorist Planning Cycles

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Time-Space Analysis of Terrorist Planning Cycles

Time-Space Analysis of Terrorist Planning Cycles

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Geography

by

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James Madison University
Bachelor of Science in Geographic Science, 2012

August 2014
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This thesis is approved for recommendation to the Graduate Council.

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Abstract

Terrorism is among the largest threats to national and international security in today's global community. Acts of terrorism have resulted economic and societal impacts throughout the world. Improvements in technology have increased the capacity of terrorists to maximize the impact of their actions. The increasing influence and prevalence of terrorist activity has demanded research focused on the prevention of terrorist acts. A known method of terrorism prevention is uncovering a plot during its planning and preparation phase. Terrorist planning can be evaluated based on how actors move through space and time prior to the execution of their attack. General patterns and insights into terrorist planning activities can offer the intelligence, defense, and law enforcement communities with information on how where terrorists can be located in relationship to their target throughout their planning cycle. This movement within a planning cycle can be easily visualized and analyzed through the use of a Time-Space Signature. This research assesses the movements of actors involved in past terrorist activities in order to determine how terrorists move in space and time during their planning cycle.

Acknowledgements

This research including the analysis into terrorist planning cycles was made possible due to the efforts of my committee consisting of Dr. Fiona Davidson, Dr. Jackson Cothren, and Dr. Brent Smith.

Thanks to Paxton Roberts at the Terrorism Research Center in Fulbright College for help with the "American Terrorism Study" data and his assistance and commitment to this research.

Thanks to the Terrorism Research Center in Fulbright College for their diligent work in hosting the American Terrorism Study (ATS) database and conducting invaluable terrorism related research.

Thanks to the University of Arkansas Department of Geosciences.

Thanks to my family for their support and guidance throughout my academic career.

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I. Introduction

The world has been plagued by acts of terrorism for centuries. As terrorists become increasingly capable of organizing and executing attacks that influence policy and security concerns at all territorial levels, it becomes more vital to prevent such attacks. While a considerable amount of terrorist activity goes unnoticed by the general public, larger impact terrorist attacks such as the Oklahoma City Bombing, Word Trade Center attacks, and the Boston Marathon Bombing serve as an alarming reminder of terrorist presence. Citizens are informed or reminded of their vulnerability to such attacks. A nation's steadfast goal to protect its citizens from domestic and international acts of terrorism, combined with the publics demand for safety has fostered a push for prevention of future incidents of terrorism.

Despite the increasing amount of research within the field of terrorism, including attack prevention and mitigation, there is still little known regarding the planning phase of a terrorist plots. The planning phase, however, is critical to the success of a terrorist attack. Effective planning of a terrorist plot can minimize or essentially eliminate the chances of an attacks failure; once an attack has been meticulously planned and is set in motion it can easily become impossible to stop (United States, Army Training and Doctrine Command, and Office of the Deputy Chief of Staff for Intelligence 2005). Unsuccessful or interrupted planning, however, is likely to lead to a failed, prevented, or unexecuted attack.

Research has shown that terrorism or political violence is the result of rational thought, planning, and strategy; terrorism is rarely carried out in a senseless or random fashion (Martin 2011, 20). Violence and criminal activity is employed in terrorist plots as a strategic choice in an attempt to force change or draw attention to a movement or belief (Martin 2011). Violence and intimidation is perceived as a morally acceptable strategy that can be invaluable in the

communication of minority beliefs or opinions (Schmid and Graaf 1982). Terrorists often perceive their acts as methods to prevent impending dangers or changes to society and the general public; this mindset allows for the justification of negative externalities of a terrorist plot. Terrorists select targets and execute acts based on the characteristics, ideologies, and objectives of their groups. Additionally, terrorists often commit additional or supplemental crimes in order to support their campaign; these activities can include robberies for funding or supplies as well as travel to gather forces or avoid detection (Hoffman 1998). The movement of a terrorist group in space and time is a reflection of their tactics and strategies. The rational, methodical, and strategic nature of terrorist planning shows that terrorist plots can be studied and analyzed in an effort to detect and prevent future acts of terrorism.

The objective of this research is to test the methodology for a time-space analysis of documented terrorist plots in order to detect potential patterns that exist between terrorist planning cycles. The goal of this research will be to determine how broader scale patterns exist between how terrorists move over time during the planning and preparatory phase of their terrorist plot. An insight into the patterns of terrorist movement in space and time leading up to the commission of a terrorist act could prove beneficial for counterintelligence efforts and understanding of terrorism at large. Terrorist attacks are often thwarted through collecting data relative to terrorist actor movement in order to predict their behavior and future movements (Martin 2011). Investigations have been able to link known components of terrorist plots in order to locate individuals, bases of operation, and targets. These methods have been used to successfully apprehend terrorists and foil looming terrorist attacks (United States et al. 2011).

Patterns with terrorist planning cycles discovered could provide an idea of how terrorist members move throughout the preparation for an attack; understanding where a terrorist is in

relation to the target could aid prevention efforts by determining a scope area of investigation. A clearer understanding of terrorist planning cycles is certainly invaluable, as it is known that terrorist attacks are neither random nor unplanned (Hoffman 1998). The results of this research will attempt to characterize the planning cycles of terrorists and contribute to the overall knowledge and understanding of terrorism. This research will produce a methodology for assessing terrorist-planning cycles individually and within groups. Additionally, the observations and conclusions derived from this methodology will describe patterns in movement throughout terrorist planning cycles, as the results are obtained the time-space movement of actual actors within terrorist plots. As terrorism becomes a growing concern in contemporary society, it becomes increasingly important to discover new measures to thwart potential terrorist attacks and thus mitigate would be effects of an attack (Stewart 2012). This research is an effort to contribute towards the knowledge and understanding of terrorism and terrorist activity.

II. Literature Review

Terrorism Background

The term terrorism originates from the French Revolution of 1789-1794. The original meaning of terrorism referred to the government intimidation directed and carried out by the French political party in power during the revolution (Baker 2006, Furet 1981). Since its inception, the meaning of the word terrorism has evolved to include actions of citizens towards other groups and governments. In fact, in contemporary discussion, the term is almost exclusively applied towards political dissidents that are acting against a government as apposed to government actions towards citizens. There are a number of criteria that distinguish terrorists from other criminals. The motivations of terrorists are normally politically or religiously derived and have political implications and aims. The actions of terrorists are violent and are generally designed to have psychological or political repercussions that extend beyond the immediate destruction or victims. Terrorists have also been defined as non-state entities that are organized in cell structures with identifiable chains of command (Hoffman 1998).

The Federal Bureau of Investigation (hereinafter FBI) has developed a useful definition of the word terrorism; the bureau considers terrorism to be the "unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." This definition is useful as it provides the conditions for a criminal act to be considered for a terrorist investigation and for the convicted criminal to be considered a terrorist (Smith 2006). The US Department of Defense has a definition almost identical to the definition provided by the FBI, though it includes threatened use of violence and it states that terrorism can be used to achieve religious and ideological objectives (United States and Department of the Army 1990). These definitions essentially outline that an act of terrorism is an illegal and violent act committed in

pursuit of a political aim (Hoffman 1993). It must be noted that terrorism as a term is applied based on perspective. Those committing acts of terrorism are often doing so based on the idea that they are 'freedom fighters' or 'urban guerillas' using unconventional, yet necessary, means to pursue an agenda that needs attention (Hoffman 1993).

There are a number of different types of terrorist groups; these groups are classified based on their core beliefs that may range from ethical preferences, to political ideals or religious beliefs.

Today acts of terrorism are widely considered acts that have political purpose and motivations embedded within their primary objective. These are rational acts that are enacted as a strategic choice in an effort to achieve change and bring a specific agenda to discussion (Martin 2011). Though terrorism has been practiced officially since the eighteenth century, the increasing prevalence and impact of terrorism within our modern world is thought to originate from the political environment and technological improvements that were initiated in the late 1960s. Guerrilla warfare and militant revolution theories advocated by Mao Zedong resulted in the development of 'people's war' strategies. Militant action became accessible to common revolutionaries and was no longer exclusive to the military. Technological developments and improvements with travel, communication, media, and weapons have improved the ability for individuals to plot and execute terrorist acts, including acts of a much larger scale (Jenkins 1986).

Following the attacks of September 11, a massive effort to enhance national security was initiated. Professionals and scholars throughout various fields began to investigate terrorist activity in order to increase and improve intelligence and develop more effective preventative measures. Due to the elusive nature of terrorist networks and the methods they employ in their

attacks, terrorism is very difficult to prevent or defend against; however, the monumental impacts of terrorist attacks result in the need for a wealth of knowledge on terrorism to better enable attack prevention (Jenkins 1986).

There is an increasing amount of research within the field of terrorism studies. A substantial portion of the research on terrorism today involves the field of emergency management. This research includes the study of methods to reduce the impacts and externalities of impending acts of terrorism. There are countless studies involving methods of infrastructure design and assessment (French 2013) that aim to mitigate the effects of an attack through effective design, maintenance, and planning.

Terrorism as a Study of Sociology

Traditionally, the study of terrorism has been considered an aspect of sociology, with its roots extending into other fields such as political science and psychology. Analysis of the actions of terrorists has historically involved philosophical and theoretical approaches. The socio-political conditions that encourage acts of terrorism are invaluable in determining the cause of the incident. An examination of foreign and domestic policy, international relations, religious beliefs, ethical disputes, economic concerns, and social interactions can be very revealing when assessing the actions that lead to terrorist incidents. Research based on root causes of terrorist motivation as well as their viewpoints and justifications is used to study terrorism (Williams 2003).

Theoretical and philosophical studies of terrorism can be aided with the addition of spatial analysis. The spatial component of human behavior has proved to be a valuable method of assessment (Bahgat 2013) and its consideration can result in previously unseen yet useful conclusions.

Spatial analysis techniques have long been incorporated into research within the field of criminology. Scientific criminology began in the early nineteenth century with the work of Andre-Michael Guerry and Adolphe Quetelet in the field of moral statistics. Spatial analysis techniques challenged traditional concepts by incorporating the importance of place and quantitative measures within crime assessment (Lowman 1986). Historic examples of spatial studies in criminology are widely available. An early study of juvenile delinquency in 1916 showed that the location of residence was a more significant influence on an individual's appearance in juvenile court than age, sex, and race (Burgess, 1915). Over time, the field of criminology transitioned through several phases including the Chicago ecological school of the 1920s and 1930s, and the factor analytic school of the 1950s and 1960s. The methods that emerged from the factor analytics increased interest in spatial perspectives in the study and analysis on crime (Lowman, 1986).

A sub field deemed as environmental criminology emerged from the research that placed emphasis upon the spatial dimensions of criminal behavior. These studies placed the focus on the spatial locations and situations that encouraged or facilitated crime rather than the social conditions and individual decisions that cause crime. This field began to form a link with geographical research, as it attempted to explain where criminal opportunities exist as a function of why they occur (Herbert 1985). Place based analysis of patterns in crime developed with the improved capabilities of computerized mapping and spatial analysis. These assessments were further enhanced with the advent of spatial statistics in the 1990s (Anselin 2000). Social theories are used in combination with measures of crime in order to conduct analyses of criminal activity and at risk populations. A study in Vancouver, Canada used spatial regression techniques to support criminal activity theories and determine at risk populations (Andersen 2006).

A number of regional conflict studies, including regional terrorism, incorporate GIS and spatial analysis. Though these studies are conducted within the field of conflict studies, they examine events similar or relating to terrorism and employ the same analysis techniques; their research places an importance on geography as an added element of assessment. A study of state terror and massacres within Guatemala utilized the mapping of massacres to visualize patterns and trends (Steinberg 2003). Another similar study assesses the presence of xenophobia and racism in the Netherlands through the use of geographical and temporal assessments. The results of the study attempt to show the ways in which concepts of racism spread (Braun 2011). The temporal variable has also been incorporated into crime analysis to determine patterns within both space and time. Research of crime in Stockholm, Sweden employed a space-time analysis of clusters of crime in order to show changes in types of crime based on seasonal change (Uittenbogaard A and Ceccato V 2012). In a similar study, space-time and statistical analysis was used to investigate near repeat patterns of serial offenders involved in dwelling burglary (Johnson 2013).

Though the study of terrorism is often considered a field within sociology, as it pertains to criminology, it has an apparent geographical nature, thus it has become a topic of study for many of the nations leading geographers (Mathewson 2003).

The Geography of Terrorism

Geography has long been considered the study of mapping and territorial discovery; however, in more recent decades the study of geography has expanded and diffused to include interactions of human societies and natural environments (Blij 2005). The field of geography is concerned with any material that exhibits three components, a region, a technique, and a theory. The study of terrorism naturally falls within the field of geography; terrorism has an observable

locational component that can be studied throughout a defined region, it can be studied with geomatic and statistical techniques, and the patterns observed can be theorized. These characteristics make it an appealing topic for geographers. At this point there is a limited extent of research within the geography of terrorism, including spatial analysis of terrorism; however, the fields value is becoming more pronounced and recognized as research within the field increases (Braithwaite 2007; Nunn 2007).

A geographical approach can inform new understandings of social and political incidents and relationships. Though historically researchers have not investigated terrorism within the geographical framework, its apparent geographical or spatial nature has resulted in studies within the geography of terrorism. Assessing terrorism as a function of geography can offer new outlooks on patterns and trends. Terrorism is often related to the field of geography due to its strong sociocultural foundations that exhibit human geographic characteristics (Bahgat 2013). Daanish Mustafa advocates for the use of a geographic hazards perspective in the assessment of terrorism. He suggests that a society can also be vulnerable to terrorism as a result of social structures and their impacts on individuals or societies in the same way that a society can be vulnerable to a natural hazard depending on the biophysical characteristics of the environment (Mustafa, 2003). Geographical thinking can be applied towards numerous aspects of terrorism research including the causes of terrorism, the spatiality of terrorist networks as well as their movements and actions, an the assessment of counter-terrorism efforts (Flint, 2008).

Much of the theoretical and empirical geographic research on terrorism involves analysis into the factors that influence terrorism. The interplay of geographic factors within or between countries can effectively curb or alternatively encourage terrorism. The roots of terrorism can therefore be seen as a function of geographic phenomena such as state fractionalization, poverty,

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or political freedom (Bandyopadhyay 2011). Terrorism can also be studied as a function of land use and environmental settings in order to provide insights into areas where acts of terrorism are likely to occur (Nunn 2007). There are a number of factors that influence the emergence of terrorist agendas and activities; these factors are the product of areas geographical attributes.

Spatial and Quantitative Analysis of Terrorism

Advances in spatial technology and quantitative analysis techniques have enabled more efficient observance of spatial patterns. Criminal activity, which includes terrorism, is comprised of an observable and measureable spatial attribute; consequentially spatial analysis can be applied to relevant data. Locational and attribute data regarding an incidence of terrorism can be collected, geographically referenced, and projected. Once captured, the geospatial data can be visualized and utilized as maps, images, and models in order to make inferences, assessments, or explanations. Much of these techniques and research have developed into a field known as geospatial intelligence (Bahgat 2013). Additionally, terrorism research often builds on previous work used to forecast criminal behavior.

The September 11, 2001 terrorist attacks on the World Trade Center, planned and orchestrated by the terrorist group al Qaeda, had a monumental effect on the study of terrorism. Not only did the World Trade Center attacks greatly increased the need and use of Geographic Information Systems (GIS) within emergency management and preventative models for planning (Kevany 2011; and Koch 2010) they also demanded further research on terrorist activity. Overall the 2001 terrorist attacks served as a catalyst that changed the focus and concern of terrorism research.

One of the major problems that terrorism researchers are faced with is the lack of available data. This shortcoming results in the lack of widespread innovative analysis on the

subject. An early attempt at an empirical analysis into the dynamics of terrorism, carried out by L. C. Hamilton and J. D. Hamilton in 1983, was afflicted by the lack of data. The results of the study showed some evidence that the tendency of terrorist acts to incite further violence was not as prevalent in less democratic, poorer, and less educated societies than in other areas; however, improved data would have contributed towards more solidified results (Hamilton 1983).

Data is becoming more widely available. A number of databases have been created, with varying success, in order to provide terrorism data to researchers and further topical research. A database that is commonly cited in relevant research is the Global Terrorism Database (GTD), which was created by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) to address the lack of empirical data as well as code and verify previously inaccessible and unavailable data (LaFree 2006). There are a number of additional databases that contain terrorism data; Bowie and Schmid have compiled a list of twenty major terrorism databases in their Routledge Handbook of Terrorism Research; the aspiration of their compilation is to make terrorism data more discoverable for researchers. Their discussion includes a detailed history, methodology, and evaluation of each of the databases (Schmid 2011). Much of the data available on incidents of terrorism is retained at the country level; limiting the detail of forthcoming analysis. The lack of data has resulted in a relatively limited amount of geo-spatial research regarding terrorism (Gao 2006); however despite the apparent lack of data, the importance of this topic has resulted in an increasing amount of geospatial assessments of terrorist activities.

Prior to the World Trade Center attacks, terrorism research was focused on the modest actions of single domestic non-state actors towards civilians and security forces. These groups included large, long-standing groups such as the Irish Republican Army and the Palestinian

Liberation Organization; however, large portions of terrorist groups were small in size and influence and vague in ambition and agenda, including Black September and Red Brigades. The second wave of terrorist research was concerned with large-scale, international, and direct attacks that would be executed as an act of war (Pape 2009). The realization of the capabilities of elaborate and organized terrorist networks, as well as the fear of future attacks, has increased the prominence of research within the field. Much of the recent terrorism research has been based on the use of spatial and quantitative techniques that incorporate the use of Geographic Information Science (GIS).

Geographic literature on terrorism that involved the use of GIS was initially based on the idea that spatial studies could provide valuable contributions to homeland security. Common studies included the use of spatial data, spatial statistics, and models. Relevant studies also incorporated geographic techniques through other means. An example of one such study was research that employed geographic profiling studies aimed at locating and apprehending those involved in terrorist activities (Bennel 2007), or studies that attempt to predict the spatial distribution of terrorist cells in order to forecast terrorist risk and vulnerabilities (Schmidt 2007).

The most basic, and perhaps fundamental, capability of geospatial data and analysis is visualization. Being able to see the data in the context of its location can offer insight into patterns that may lead to new and potentially valuable observations and conclusions. GIS has proved to be a very useful tool for visualizing spatial patterns of terrorist activities. There have been studies involving the development of Graphical User Interfaces that make use of geo-referenced terrorism data through automated visualization processes. These visualization environments are developed to enable researchers to detect and explore patterns through the use of new perspectives (Guo 2006). Another visualization software was developed in an effort to

show the most fundamental concepts in analysis; known as the 5 W's, these include who, what, where, when, and why. The intention is that focusing on these aspects in a visual analytic system will allow the large and complex datasets to be investigated with improved efficiency (Vilanova 2008). These studies have shown how visualization is important in the study of terrorism; so naturally the mastery of this visualization is vital in portraying the data accurately and effectively. A study of visualization methods for terrorism data resulted in cartographic techniques to appropriately symbolize data lacking specific coordinates. This is an important step that prevents falsely portraying the data's geo-spatial location while still preserving and displaying the attributes of the data (Jones, 2008). More elaborate visualization systems have been developed to investigate space-time and multivariate patterns of data (Guo 2006); however, the intention of systems like these is not specific towards the field of terrorism research and therefore may need to be adapted before useful information can be extracted.

There have been numerous studies that have utilized spatial analysis techniques to investigate terrorist activity (Bahgat and Medina 2013). These studies involve widely varying geographic locations or extents and analysis techniques; additionally these studies consider and focus on a diverse range of aspects of terrorism. Geographical studies in terrorism can range from the study of a specific type of act, such as patterns within suicide bombings, to studies of terrorist cell structures. An example of a study that focused on a single aspect of terrorism is a study that employed geographic modeling techniques to forecast the spatial choice of suicide bombers. The analysis technique combined mathematical modeling of environmental characteristics and demographic features to predict locations of suicide bombings (Brown 2004).

The geographic hot spot analysis, commonly used in crime analysis, has also emerged as a popular method of analyzing incidents of terrorism. Hot spot analysis is a technique to identify

statically significant spatial clusters of a certain value. This Hot spot analysis has been used to investigate transnational terrorism at the country level in order to assess future patterns (Braithwaite 2007)

The structure of terrorist groups often exhibit patterns, these patterns can provide an insight to how terrorist groups carry out their actions. A global investigation into the social networks of terrorist groups used complex visualization and multi-agent modeling to analyze interaction, proximity, and relocation of terrorist cells (Moon 2007). A study of terrorism incidents and terrorist cell sites in Turkey was conducted by mapping cell locations and calculating and analyzing the distance between cell sites and incident sites as well as the distance from cell sites to other cell sites (Rossomo 2009). Terrorist network structures are a common focus of spatial analysis as these networks are an important and complex systems of people, finances, and technology arranged across space. One such study of terrorist networks addressed these networks as systems composed of nodes that are connected by edges or links. Classification and analysis of the nodes and links within the network can reveal patterns or models of how terrorist networks are constructed (Medina 2008).

The temporal sequence involved in the planning and execution of terrorist activity is an important aspect of terrorism research. Temporal aspects can be combined with spatial analysis to improve pattern detection. An assessment of the spatio-temporal trends in terrorist incidents in the United States, from 1970 to 2004 was conducted using data from the Global Terrorism Database. The research aimed to examine the frequency and characteristics of domestic terrorist attacks in order to conclude broad patterns with the geography of terrorism. The research looked at weapon types, attack types, group types, and other characteristics (Webb 2009). Similar research was done on the patterns of terrorist incidents in Iraq from 2004-2009. This research

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used GIS to understand spatial, social, political, and cultural triggers that influence incidents of terrorism in order to inform counterterrorism efforts (Medina 2011). Another study involving an assessment of temporal patterns involved research on terrorist attacks by the Spanish group ETA between 1970 and 2007. The methodologies used resulted in spatial patterns as well as temporal patterns, amongst other discoveries, the research found that against Madrid were unlikely to be followed immediately by more attacks on Madrid or surrounding provinces (LaFree 2012). Space-time clustering has also been used to investigate terrorism outbreaks. One investigation of this nature involved detecting clusters of terrorist events at various time stamps; space-time relationships between the clusters were investigated to detect terrorism outbreaks (Guo 2012).

Spatial technologies and techniques have been used not only for analysis of past events, but also for prediction of future events. These studies can be invaluable for tactical and preventative purposes. One study examined the use of kernel density estimation models for predicting the next event in a criminal or terrorist event series. The temporal weights of the events are determined by their influence. The methodology then attempts to predict the next event location within the time series (Porter 2013).

More advanced techniques have been developed to model the effects of a terrorist attack based on input conditions. The results produced by the models can be used to determine appropriate foreign policy and emergency management practices; these models represent an effort to discover the most effective methods of terrorism prevention and damage mitigation (Das 2014).

Prevalence of terrorism is often studied in relation to other factors such as economic, social, and political conditions in order to see what patterns may be revealed. A study of terrorism in Turkey used geographically weighted regression (GWR) to examine spatial

variations of terrorism and their relationships to external factors. The study concluded that increases in income and schooling tend to reduce provincial terrorism while increases in unemployment enhance terrorism (Yildirim 2013).

The recent wealth of literature on terrorist activities that utilizes geo-spatial analysis techniques is a testament to their value and importance. Though there is an increasing amount of research dedicated to the field of terrorism, it has been noted that there are a number of common problems that persist in recent studies. Examples of these fallacies include failure to distinguish among different types of terrorism, using the wrong units of analysis; failure to make these considerations can affect the fundamentals of the results (Young 2011). It clear, however, that as more research is conducted regarding terrorism and the patterns exhibited by terrorist groups, the general public will be safer from the incidences of terrorism.

III. Methodology

The study of terrorist planning cycles involves an investigation into the movement of terrorist actors in time and space prior to the commission of the attack. The purpose of this study is to investigate the possible presence of relationships or trends between the movements of terrorists through both geographic space and time with relation to their ultimate target location and attack time. These patterns can be investigated through an assessment of all recorded terrorist attacks as a whole or through recorded terrorist attacks based on relevant variables, such as terrorist group type or weapon type.

Time Space Signature Development

This investigation will involve the analysis and assessment of constructed time-space signatures for recorded terrorist planning cycles. The signatures are represented on a line graph where values on the horizontal (x) axis represent time in days before the attack and values on the vertical (y) axis represent Euclidian distance in miles from the attack. The time value (x) and distance value (y) combine to create a Cartesian coordinate. These Cartesian coordinates will all be plotted on the same quadrant (Quadrant I) of a two dimensional Cartesian system as all of the values are positive. There can be no negative values in time as all the records occur before the attack and none occur after the attack. There can be no negative distances as all the distances are calculated as positive distances between the incident and the attack. The cardinal direction between the attack and the recorded incident is not necessary in this research as the study is only concerned with the distance in relation to the target rather than the direction. Once the distance and time between each preparatory incident and the ultimate attack are calculated, the coordinate can be plotted on the Cartesian system. Once all of the incidents are plotted the graph will show a series of points that tell the story of a terrorist plot or generalize a grouping of terrorist plots. It

should be noted that the line of best fit representing the time signature for the set of points may run into the negative space; this is due to the computation for the line and is not the result of negative values.

Figure 1 below shows a clear example of a terrorist time space signature for an Environmental terrorism incident. The coordinates represent the time and distance of preparatory incidents from the time and location of the attack. The time and distance values increases as their distance away from the origin (0,0) increases. The graph can be most easily read from right to left. In this incident the earliest recorded incident, a surveillance mission, occurs a short distance from the target while the following incidents, meetings, manufacturing, and travel, are recorded at a greater distance from the target. The attack is then staged and executed at the origin (0,0), or the time and place of the attack. The line of best fit, a loess type curve, is included to aid visualization of the signature. The line of best fit helps to shows that recorded incidents of planning for the attack began at a close proximity to the target, subsequently planning incidents were moved a greater distance from the target, and finally the attack was commenced at the target location. In addition, the confidence interval is shaded around the line of best fit.

The grey envelope, or confidence region, surrounding the loess smoothed fit curve in Figure 1 represents the standard error. The standard error envelope is shown at a 95% confidence interval in this analysis, meaning that the actual line falls within the interval at a 95% confidence level. An increased confidence region represents a lack of data points and thus an uncertainty regarding the actual position of the loess type curve. The degree of the polynomials used varied depending on the dataset. The confidence regions were removed in a number of visualizations. Overlapping confidence regions obstructed certain graphs with larger numbers of signatures; the signatures could much more efficiently be visualized without the confidence regions.

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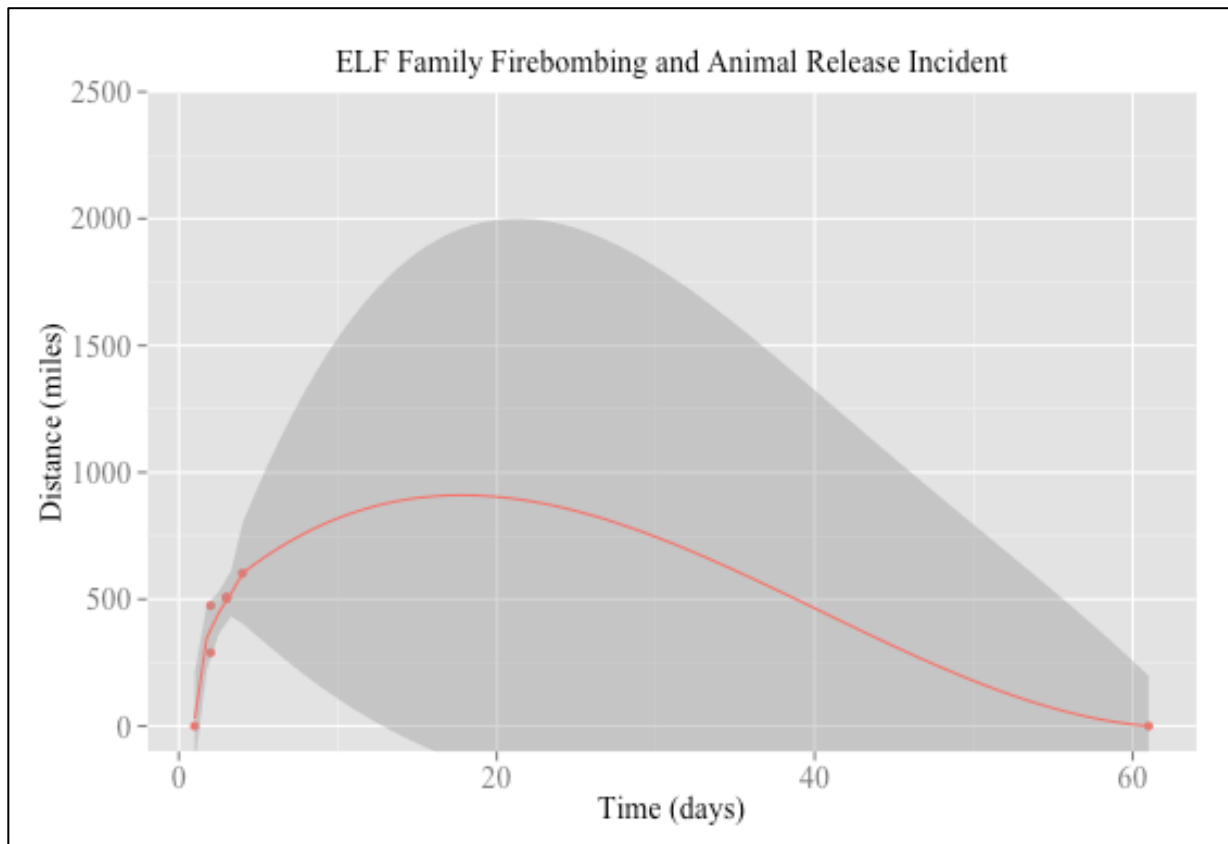
Figure 1. Example of Time-Space Signature for ELF Family Incident

The Time-Space signatures are constructed within R. R is a free software programming language and environment used across disciplines for statistical analysis, computing, and graphing. The user-created package ggplot2 enables data visualization within the R environment. The incidents of terrorism as well as all the relative attributes are exported from the oracle database as a master spreadsheet (.csv file). Individual files are derived from the master spreadsheet where necessary. These files contain records based on relative categories; for example, individual files are created for each of the four terrorist group types. This helps to organize the data and makes it easier to graph, as unneeded records are removed before attempting to plot.

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The data is then imported and read into R, and the ggplot2 package is activated within the R environment. Various commands from the ggplot2 library are used to create plots and graphs. The commands identify the data to be graphed and allow for the addition and removal of graphing components, such as titles, regression lines, legends, etc.

Figure 2 below shows an example of scripting in R used to create a time space signature. The first line defines the name of the graph object (i.e. IncidentPlot), the second line is the most important of the commands as it identifies the dataset (Complete), and defines the fields to be used as the *x* (DAYS) and *y* (DIST) values. This line also identifies the variable, or colour, that the coordinates will be grouped by. In this example the variable is CATEGORY; this means that the records will be grouped and plotted based on their terrorist category type. The following lines contain commands that determine the components of the graph. In the order they appear, these commands call for and define the inclusion of points, smoothed conditional mean line, title, x-axis label, y-axis label, legend, Cartesian coordinate limits. The final line instructs the program to plot the newly created graph variable. There are additional commands that can be inserted to change formatting and enable multi-plot faceting.

```
# Graph of all incidents by Category
IncidentsCategory <-
        ggplot(Complete, aes( x=DAYS, y = DIST, colour = CATEGORY)) +
        ggtitle("Incidents by Category")
        geom_point(alpha=.3)
        geom_smooth(alpha=.2, size=1) +
        xlab("Time (days)") +
        ylab("Distance (miles)") +
        labs(colour = "Category") +
        coord_cartesian(ylim=c(-100,2500))
print(IncidentsCategory)
```

Figure 2. R Scripting for the Production of a Time-Space Signature

The R code can be edited slightly to produce graphs for different datasets. All that is required to produce a different graph is simple modification of the dataset name, color field, and other components such as graph title.

Once produced, these graphs provide visualizations of the data that enables further analysis of potential patterns in the time-space relationships between terrorist planning activities. Commands and operations within R are used to plot the all the antecedent acts based on their distance to the target location in miles and the time in days from the commission of incident. The locations are plotted as points and a line of best fit derived from the data and displayed within the same graph.

Time Space Signature Analysis

Time-Space Signatures can be created and analyzed for each individual terrorist plot as a unique incident; however, the value of the time space signature analysis will be in the investigation of generalized groups of terrorist incidents. More information can be realized by grouping various time-space signatures based on categorized attributes of the recorded incidents. Analyzing terrorist incidents based on existing groups and categories will be more effective in determining overall patterns and generalizations that can describe terrorist activity on a more broad scale. These broad scale assumptions can be used to describe how terrorists move in space and time during the planning phase of their attack based on their group type as well as other attributes of their attack.

The signatures were first grouped and graphed based on an attribute, called CATEGORY, describing the terrorist category that the terrorist cell best fits in. The four categories used were Environmental, Far Left, Far Right, and Islamic. Studies have shown that the various categories of terrorist groups, classified most commonly by their political agenda, exhibit very

distinguishable behaviors (Williams 2003). Terrorists have been grouped into four main categories for research; these include the Right Wing Extremists, or Far Right, which include groups such as the Ku Klux Klan (KKK), and Left Wing Extremists, or Far Left, which includes groups such as Marxists orientations, Patronage and Special Interest Groups formed around a single issue agenda, as well as Cults or Gangs (Camp 2000). Additionally, groups were created for the Islamic Extremist terrorist groups, such as al Qaeda, and Environmental Extremists, such as the Environmental Liberation Front (ELF) and Animal Liberation Front (ALF).

After the data was organized and separated by terrorist group type, the time-space signatures were grouped and categorized based on a number of additional attribute factors. Each terrorist category group was then assessed based on the attributes of the attack; these variables include (1) case study (2) incident subtype (3) weapon type, (4) target type, and (5) incident ID. To assess these variables, Time-Space Signatures were graphed in the same manner as described above, however the records were grouped based on the attribute values within the selected variable. Additionally, a line of best fit for each attribute group within the variable was plotted. For example, Environmental Extremist incidents would be graphed based on Environmental Extremist case studies; the graph would then show points classified based on each of the attributed case studies (i.e. ELF Critter, ELF Family, ALF Davis, etc).

Visualizing the time-space signatures based on various attributes can potentially reveal additional information and insights. While plotting incidents based on the case study and incident ID will aid analysis by showing a line of best fit for incidents and case studies. Plotting incidents base on incident subtype, weapon type, and target type can be useful in showing if attacks committed with similar agendas or similar weapon types exhibit similar planning cycles. Once

generated, these Time-Space signature lines can be compared and analyzed in search characteristics that distinguish the various categories of planning cycles.

Distribution of Spatial and Temporal Values Analysis

In addition to the analysis of the Time-Space Signatures, analysis will be conducted on the distribution of values representing temporal and spatial locations involved in the terrorist planning cycles. A statistical summary will be calculated for the values in each of the four terrorist categories (Environmental, Far Right, Far Left, and Islamic). The statistical summary will include calculations for the (1) minimum, (2) 1st quartile, (3) median, (4) mean, (5) 3rd quartile, and (6) maximum. A set of figures will be calculated for the attribute values representing the amount of days between the planning event and the time of the attack (DAYS) as well as the attribute value representing the number of miles between the planning event and the location of the attack (DIST). The statistical summary can be easily calculated within the R programming language environment. Figure 3 below shows the scripting involved in the calculation of a statistical summary. Line 2 reads in the dataset while Line 4 generates a summary of the dataset. Summaries of all of the columns within the dataset are then shown within the console of the R software interface.

```
# Import Environment csv
Environment = read.csv(Environment.csv')  # Environment Category

# Generate Summary of Environment csv
summary(Environment)
```

Figure 3. R Scripting for the Calculation of a Statistical Summary

The distribution of values will also be plotted in a histogram in order to aid visualization of the distribution of values. The process for creating the histogram within R is shown in Figure 4. The first section involves creating a variable that contains only the column of values to be

included in the histogram, in this case the distance variables. The next section includes

calculating the mean, quartile breaks, and medians from the dataset. These variables will be used

when plotting the histogram. The third section includes the scripting that produces the histogram

while the fourth and final section contains scripting to add mean, quintile, and median lines.

```
# Create variable edist for Environmental Distance values
edist = Environment$INC_TO_ANT_DIST
summary(edist)

# Calculate dataset statistics
edistm = mean(edist) # Calculate mean
edistq = quantile(edist) # Calculate quantiles
edistmed = median(edist) # Calculate median

# Create Histogram
e_dist = hist(edist, breaks = "Sturges", col="grey", main="Distribution of Environment
Distance Values", xlab="Distance (miles)") +
xfit = seq(min(edist),max(edist),length=40)
yfit = dnorm(xfit,mean=mean(edist),sd=sd(edist))
yfit = yfit*diff(e_dist$mids[1:2])*length(edist)

# Add lines for dataset statistics
lines(xfit, yfit, col="red", lwd=2)
abline(v = edistm, col = "blue", lwd = 4)
abline(v = edistq, col = "darkgreen", lwd = 2)
abline(v = edistmed, col = "darkgreen", lwd = 4)
```

Figure 4. R Scripting for the Construction of Histograms

The statistical summaries and histograms were be calculated for the time and distance

variable for each of the four categories. These summaries and histograms provide a numerical

insight into where planning activities occur in time and space in relation to the attack.

Statistical summaries were also calculated to assess the temporal and spatial distribution

of events at the start of a terrorist planning cycle. To accomplish this, the earliest event in each

incident was transferred to a new excel document and split up by category. The 1st quartile,

median, mean, 3rd quartile, and maximum value were calculated for each of the four datasets and

summarized in a table. The tables were then assessed to see if there were any patterns in where terrorist plot planning was initiated in relation to time from the attack and distance from the target.

Database

The ATS Database was used as the foundation for this research. The American Terrorism Study (ATS) has been in development for over 25 years and is supported by a large number of persons and institutions. The drive for the ATS was due to the lack of a sufficient database from which empirical terrorism research could be conducted. The ATS began in 1989 when the Federal Bureau of Investigation (FBI) released a list of individuals indicted as a result of investigation under the FBI's Counterterrorism Program. The FBI subsequently released a series of lists including indicted individuals from later time periods. The lists contained information on numerous terrorists from a wide range of terrorist groups. The Terrorism Research Center (TRC) in Fulbright College at the University of Arkansas was established in 2003 to conduct research on terrorism and continues to build from the ATS foundation. Information regarding individuals indicted for acts of terrorism continues to be extracted from court case documents and coded into the ATS database.

The ATS database, an Oracle relational database housed at the University of Arkansas, is composed of two primary components. The first component is comprised of demographic, group, and legal data extracted from federal court case documents. The second component is geospatial and temporal data associated with pre-cursor activities and incidents that are associated and contained within the court case records.

Within the database, each terrorist attack is organized as a sequence of precursor preparatory acts that lead up to the final attack. Each record of a precursor act contains attributes

describing their distance in miles and time in days from the ultimate attack. Each record also contains the terrorist group type, weapon type, target type, and incident subtype. A complete list of variables and descriptions included in the dataset used in the analysis can be found in Appendix A.

The longitude and latitude of the precursor attacks is calculated through a geocoder included in Oracle Spatial. The coordinates are calculated based on the smallest address component. The centroid of an area is used for incomplete addresses, such as records that only contain a city name. The linear distance from the attack to the preparatory act is calculated through the Oracle Spatial database toolset.

The records within the database are organized depending on the incident they belong to. The Incident ID identifier is the smallest unit of organization and it represents a single act of terrorism as a unique act, such as a bombing or assassination. Each Incident consists of Antecedent Activities, or activities identified as precursor behaviors associated with the terrorist incident. These Antecedent Activities are further broken down into Preparatory Activities and Ancillary Activities. Preparatory activities are Antecedent Acts committed by individuals that are tied to the preparation for a terrorist incident while Ancillary Activities are both criminal and non-criminal acts committed by terrorist for order maintenance, internal security, or personal reasons. A bank robbery could be considered a preparatory activity or an ancillary activity depending on the motivation. If the bank robbery was committed to gain funds to directly support an attack, it can be considered a Preparatory Activity. If the bank robbery was committed as part of the group's general agenda without direct support of an attack, it can be considered an Ancillary Activity. It is important to note that individual antecedent activities can be attributed to multiple incidents if the activity was conducted in support of multiple terrorist plots. For

example, a bank robbery could be included in multiple incidents if the funds were used to support multiple attacks.

The Case Study is a larger unit of terrorist incident organization. The Case Study is recorded terrorist activity that pertains to one or more terrorist incidents that have the same group of persons involved. A case study can consist of a terrorist subgroup; for example, case studies within the environmental terrorism category would be divided between ELF Critter, ELF family, and other ELF cells, instead of being grouped together in one group with all ELF activity.
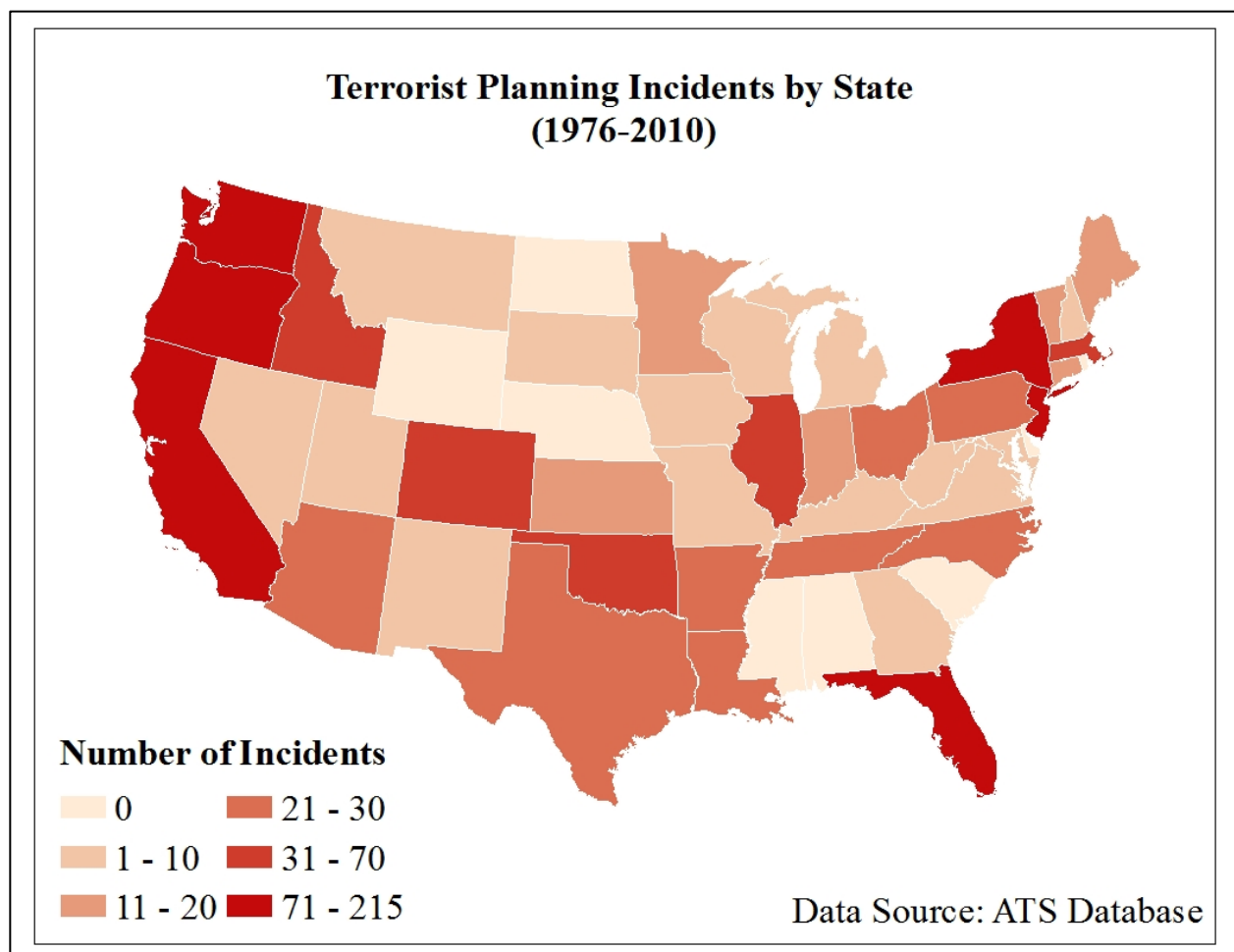
Data Selection

One of the most common ways of organizing data relating to terrorism is through the use of existing terrorist categories. These categorized groups of terrorist actors are generally based on the similarities between terrorist ideologies and motivations. The four categories used in this research were (1) Environmental, (2) Far-Left, (3) Far-Right, and (4) Islamic Extremist. These are four generally acknowledged terrorism categories and are four of the six categories defined in the ATS database. Two categories of terrorism, including Nationalist/Separatist and Single Issue, were removed from this research, as there were only 56 and 13 records respectively for each of the categories. The number of records within each category of terrorism can be seen in Figure 5 below. The ATS Records column indicates the number of record within the ATS database that have geocoded locations while the Selected ATS Records indicate the number of records within the various categories that were used in the analysis.

	ATS Records	Selected ATS Records
Environmental	373	257
Far-Left	394	341
Far-Right	343	307
Islamic Extremist	385	379
Total	**1495**	**1284**

Figure 5. ATS Records and Selected ATS Records Included in the Analysis

The geographic distribution of the data records used in the analysis is shown in Figure 6 below. This map identifies the context of where the incidents are occurring throughout the United States.

Figure 6. Map Showing Terrorist Planning Incidents by State (1976-2010)

Data selection was based on the nature of the recorded Incident, as the Incident is the smallest organization or grouping of terrorist activity. If an incident was removed from the dataset it would be removed from all analysis within the study. The records that were removed from the database prior to the analysis include incidents, identified by their Incident ID, that did not contain a considerable time-space series within their planning cycle; examples of these incidents include vandalisms, such as spray-painting, that did not require a significant or measureable amount planning. Additionally, the inclusion of these types of incidents would prevent successful graphing of the datasets through the ggplot2 package within R. Incidents that contain less than three records, or less than three x-y coordinate locations produced errors in the graphing process. A limited number of records or x-y locations within an incident results in an error for the computation of a loess-smoothed line; however, when a specific Incident ID consisted of more than three records, the series would plot along with the loess-smoothed line. The removal of the described incidents from the database not only allows the data to be graphed without error, but it also produces a dataset that better represents terrorist time-space planning cycles in general as incidents that do not contain substantial planning activity are not included.

IV. Discussion and Results

Individuals or groups who advocate their political ideologies and agendas through the use of various forms of violence against governments or the general public are considered to be terrorists (Weinberg, 2003). Though the terrorist crimes committed may seem senseless and delusional to the general public, terrorist plots are in fact generally conceived through rational though processes with the goal of achieving specific strategic objectives (Nance, 2008). Due to the methodical nature of most terrorist plots, data representing various terrorist plots that have occurred in the United States can be used to identify patterns and trends in terrorist planning cycles. The analysis of space-time signatures for terrorist planning cycles shows is included for all terrorist categories, and subsequently each of the four main terrorist categories. Qualitative research into the categories is included alongside the description of the Time-Space Signatures in order to explain possible patterns observed.

All Terrorist Categories

Terrorist attacks are most commonly premeditated and thoroughly planned. The planning phase is recognized as an important process for minimizing risk and ensuring success and impact. Terrorist attacks are designed to convey and spread the beliefs and opinions of the group and ideally force a political or social change that will strive towards their ideological goal (Hoffman 1998). Terrorists and terrorist groups occupy a wide spectrum of political ideologies and employ a variety of tactics, targets selections, and weapon choices; despite these differences; all recorded incidents of terrorism can be analyzed for patterns in regards to their planning cycles as a single group of criminal actors.

Though there is no universal model for terrorist attacks, the planning cycle has been generalized into a series of steps that describe how terrorist actors move in time and space prior

to an attack (Stratfor 2012). The generalized method used for terrorist attacks has been simplified into a process involving seven stages in the military training handbook titled A Military Guide to Terrorism in the Twenty-First Century. The stages of a terrorist attack are varied through other sources, however they follow a similar pattern. The general theory regarding terrorist planning cycle stages suggest that terrorists select a target, conduct surveillance and planning, and then execute the attack. The seven sages can be seen in Figure 7 below while the descriptions of the stages follow.
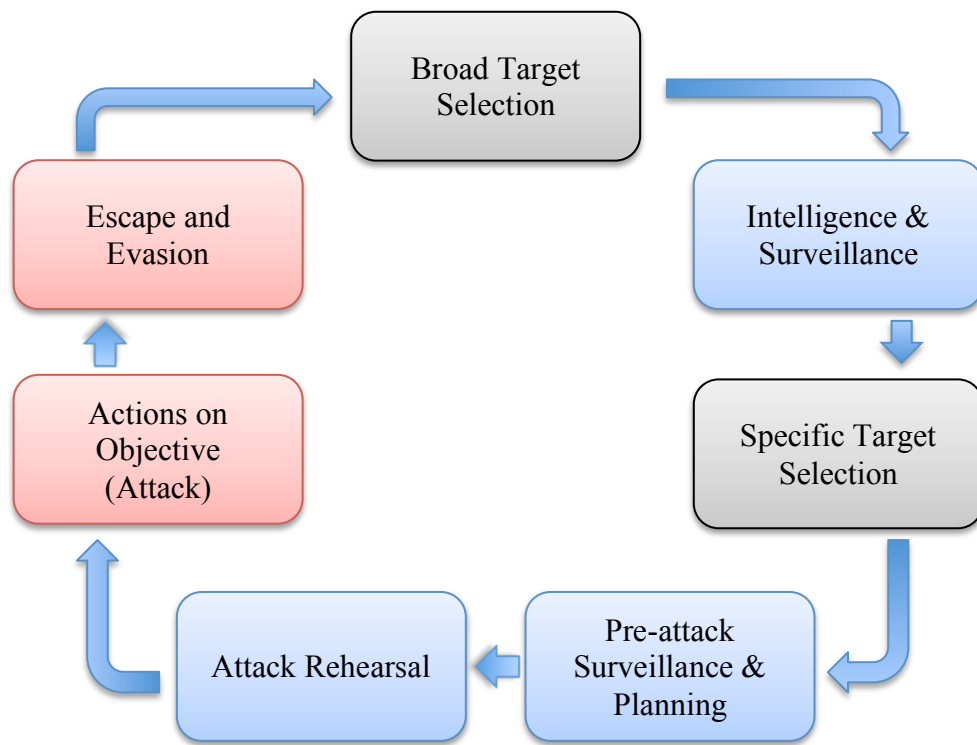
Figure 7. The Seven Stages of a Terrorist Attack

The first step of the terrorist planning cycle is known as *Target Selection*; this step involves determining prospective targets pursuant to the ideology of the group. Information on prospective targets is gathered through the use of information from the media and other sources (United States et al. 2005). This step is often conducted at a location remote from the potential targets to avoid detection. The next series of steps involve more detailed planning for the attack.

The second step of the process is known as *Intelligence Gathering and Surveillance*. This step involves recording and gathering information on a selection of potential targets at the target site. Information gathered can involve noticeable routines, transportation, and security (United States et al. 2005). The surveillance can involve observations into the strengths and weaknesses of the security at the target location, including direct contact or questioning with personnel. Information is often recorded in various forms including pictures, maps, and notes (NYS Office of Counter Terrorism 2014).

The third step of the process is known as *Specific Target Selection*. In this step, the ultimate target is determined if it was previously unselected from a larger collection of targets. Factors including the attack audience, media response, and message portrayed, are all assessed in order to establish the target (United States et al. 2005).

The fourth step of the attack process is called *Pre-Attack Surveillance and Planning*. This is effectively a second round of surveillance that provides more details about the target and generates more information regarding patterns and processes at the target site. Certain aspects of the attack begin to be established and tested including near by safe houses, entrance plans, and escape routes (United States et al. 2005). This process can also involve funding and supply acquisition. Attempts for funding can involve criminal activity that is not pursuant to the ideas of the group but is seen as a necessary in order to carry out the objective; funding can be derived through smuggling, theft, robbery, and sales of goods.

The next stage of the attack is known as *Rehearsals*, also known as dry runs or trial runs. This stage includes detailed planning and training for the attack. The goal of this phase is to eliminate the chance of failure and ensure that the attack will go through as planned. This phase

involves testing the plan and escape routes, as much as possible, in order to identify flaws and determine if final adjustments need to be made.

The next step, and perhaps the most important step of the attack, is called *Actions on the Objective*, or Deployment and Attack. During this phase, equipment and personnel are put in position and attack is executed following the predetermined plan. Though careful planning enables for a success, mistakes made during this phase will ultimately prevent or limit the success of an attack. It is suggested that if the attack reaches this phase, and the plan has been developed with detail and thorough information, the attack is beyond prevention (United States et al. 2005).

The final step is called *Escape and Evasion.* Following the actions on the target, the terrorist attempt their escape, if escape is included in the plan (United States et al. 2005). The escape often involves the retreating to a predetermined safe house that is not easily detected (Nance 2008). This step can also involve attempts to exploit the effects of their attack through the media or other venues in order to push the agenda of the attackers.

The space-time movement of terrorists during a terrorist plot is easy to extrapolate from the process listed above. It would seem that the terrorists determine a target from a remote location. Following the determination of a location, terrorists move closer to the target temporarily to gather intelligence through surveillance. After information is gathered, the terrorists return to the remote location in order to plan and prepare for the attack while acquiring funds and supplies. Finally the terrorists return to the target location for a final time to execute the attack.

Figure 8 below shows a theorized time-space signature for the terrorist attack cycle based on the full seven-step terrorist attack described in the Military Guide to Terrorism in the Twenty

First Century. The graph shows how the terrorist resides at a distance away from the target but visits the target on multiple occasions to conduct surveillance, attack rehearsals, and ultimately the attack.
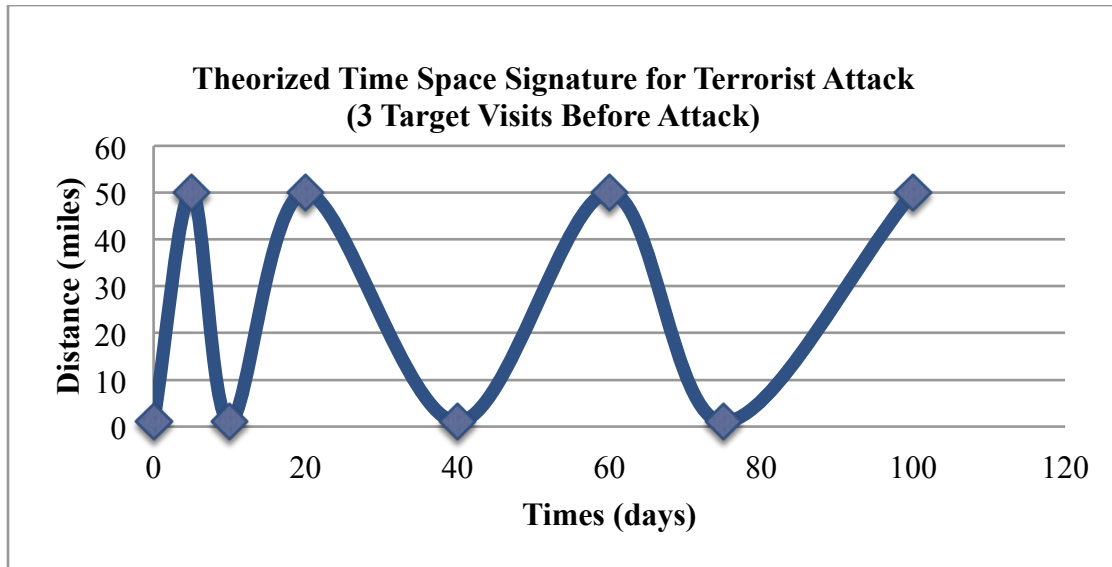
Figure 8. Theorized Time-Space Signature for Terrorist Attacks (3 Target Visits)

Figure 9 below shows a similar representation of a theorized time-space signature for a terrorist attack. In this representation, the terrorist has the target identified prior to initiating the attack and visits it once for surveillance and a second time for an attack rehearsal before committing the attack. This graph reveals how a slightly different attack sequence can change the structure of the time-space signature.

Theorized Time-Space Signature for Terrorist Attack
**(2 Visits Before Attack)**
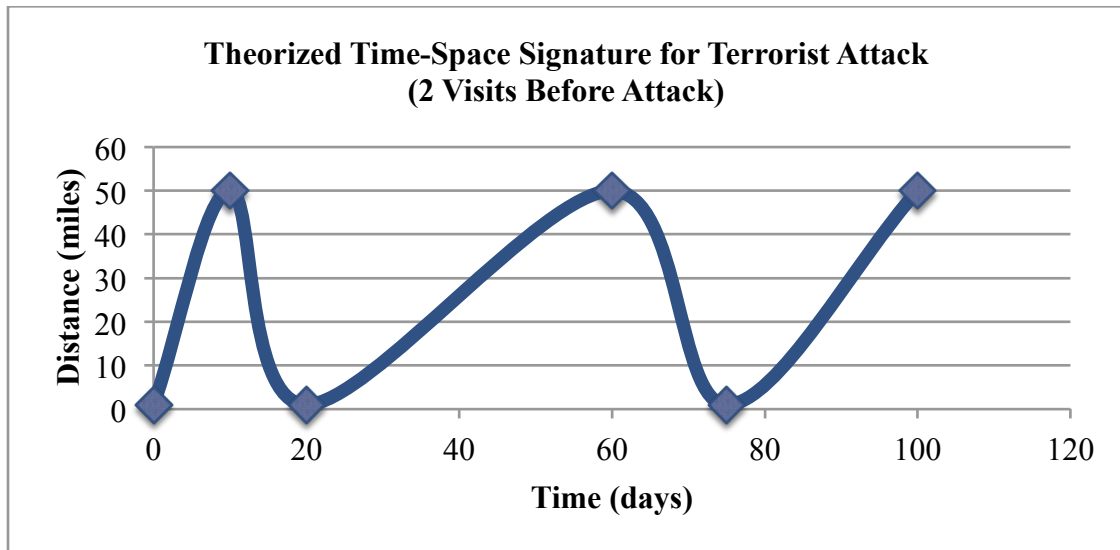
Figure 9. Theorized Time-Space Signature for Terrorist Attacks (2 Target Visits)

It is important to note the limitations of these terrorist attack sequence theories and their model Time-Space Signatures. Though these attack sequences theories have been developed based on general observations of terrorist plots, they lack the use of large-scale datasets containing geo-spatial records for terrorist movement. Additionally, they seem to illustrate a back and fourth movement between a safe house and the target location without providing much information on travel for supplies acquisition, recruitment, or funding operations. In general these representations show that terrorists begin from a remote location and visit their attack site prior to the ultimate attack.

Figure 10 below shows the actual Time-Space Signature for terrorist planning cycles is represented by a line of best fit for the selected ATS data. The graph does seem to have some similarities with the theorized time-space signature shown in Figure 8 and 9 above. The figure shows that the planning activities begin at a far distance from the target before approaching the target for the first time. Following the first visit to the target the planning activities occur at a more remote location from the target and once again approach the target before returning again

to a more remote location. The activities then ultimately approach the target and conclude at the

attack.
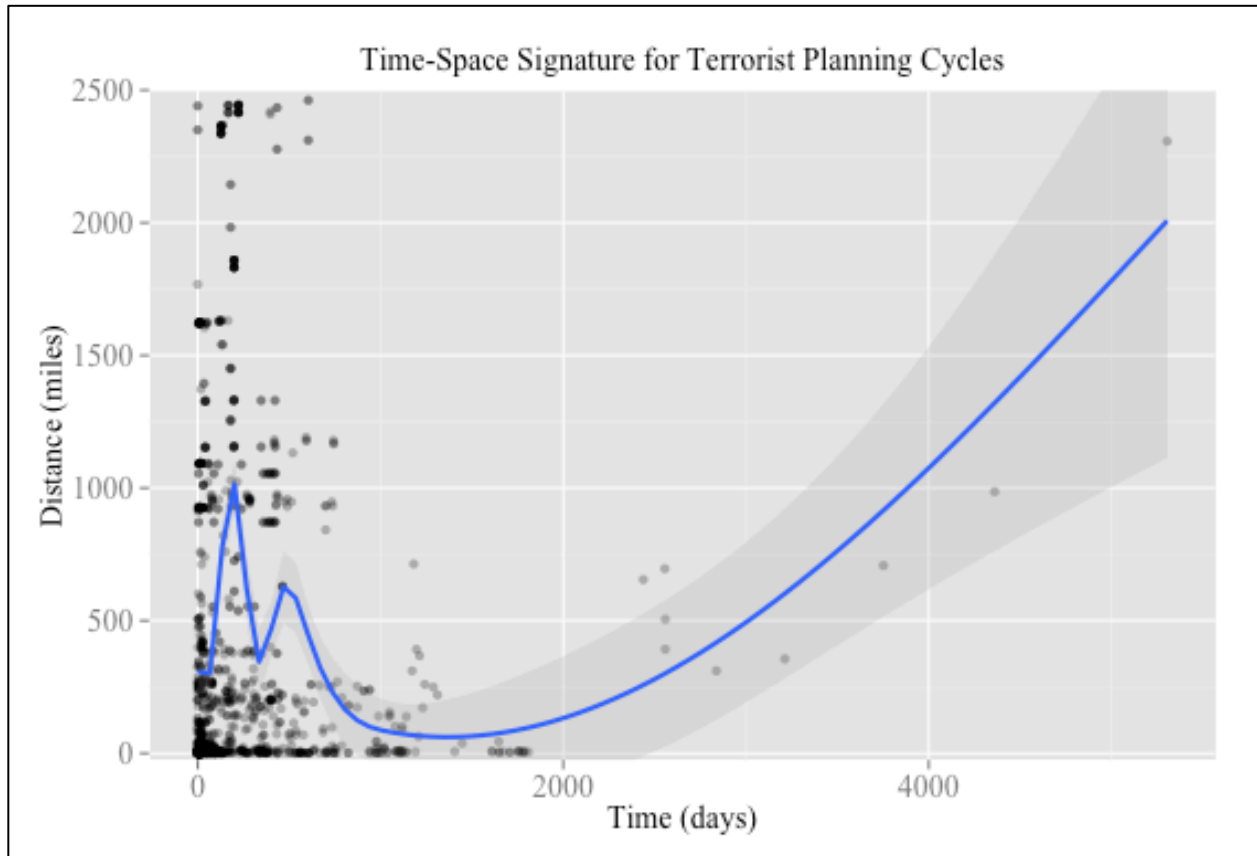
Figure 10. Time-Space Signature for Terrorist Planning Cycles

Though Figure 10 above is useful for demonstrating the general trend in all terrorist

planning activities, it fails to recognize the difference between identified categories of terrorists.

Figure 11 below shows all of the terrorist activities plotted and grouped based on the terrorist

category they belong to. The four terrorist categories are each fitted with their own line of best fit

as a representation of their average movement in time and space. Figure 11 illustrates that the

four terrorist categories each have unique time-space signatures and thus unique planning cycles.

In particular this graph reveals that the four different terrorist categories have noticeably

different temporal durations for their planning cycles. It appears that environmental terrorist

groups have the shortest planning cycles by far, while the Far-Left and Far-Right terrorist groups have the longest planning cycles; the Islamic Extremist planning cycle is represented as the second largest of the planning cycles.
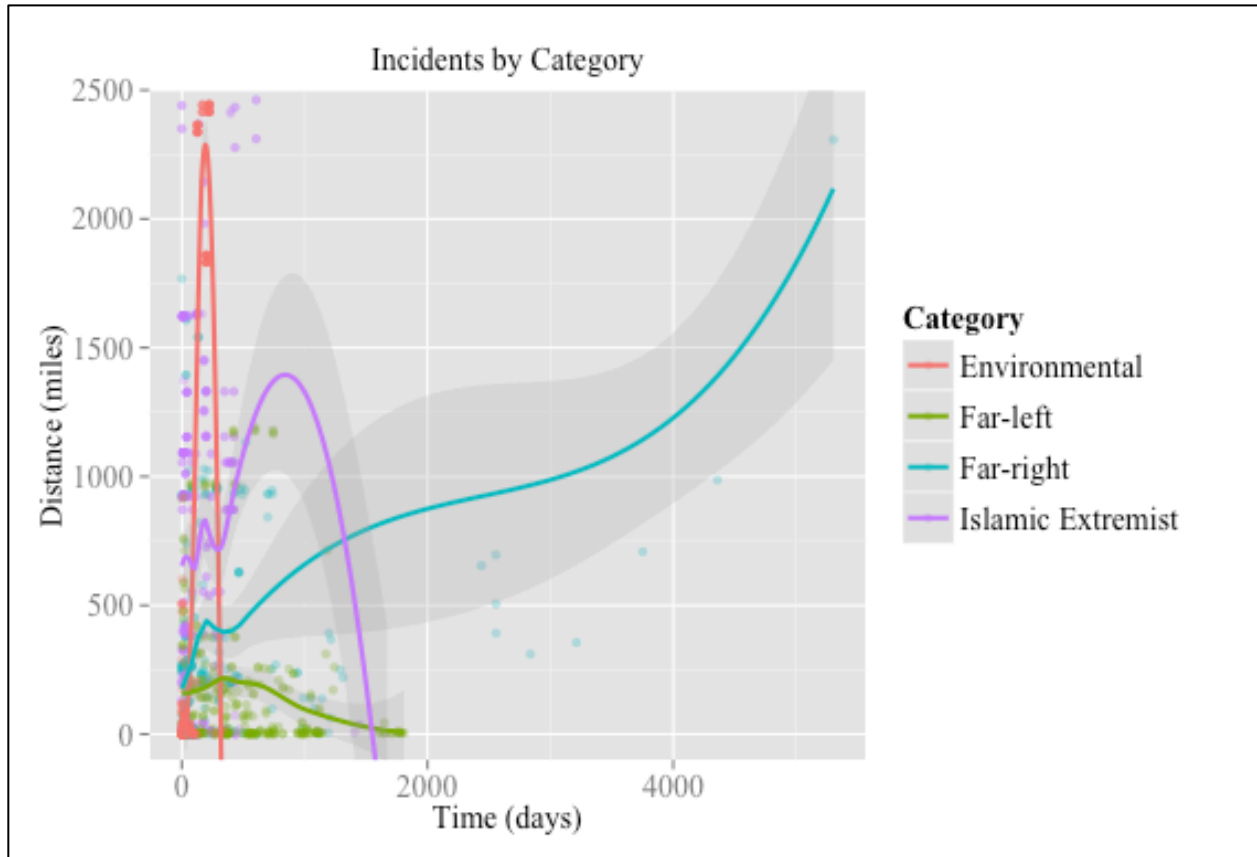
Figure 11. Time-Space Signature for All Incidents by Category

While Figure 11 is useful for showing relative temporal differences between terrorist planning cycles, the graphic representation can be improved to show spatial movement over time. Figure 12 shows the time-space signatures plotted in in individual graphs; this method is useful for assessing the difference in spatial movement over time. The Environmental time-space signature represents activity near the target long before the attack, followed by activity at a remote location prior the attack, and finally, heavy activity near the target directly before the attack. The Far-Left time-space signature seems to represent constant activity at a close

proximity from the target throughout the attack planning cycle. The Far-Right signature shows activity occurring gradually closer to the target as the time from the attack decreases; this curve also shows concentrated activity at a close proximity to the target directly prior to the attack. The Islamic Extremist signature generally reveals a decreasing distance between activity and the target as the attack approaches.
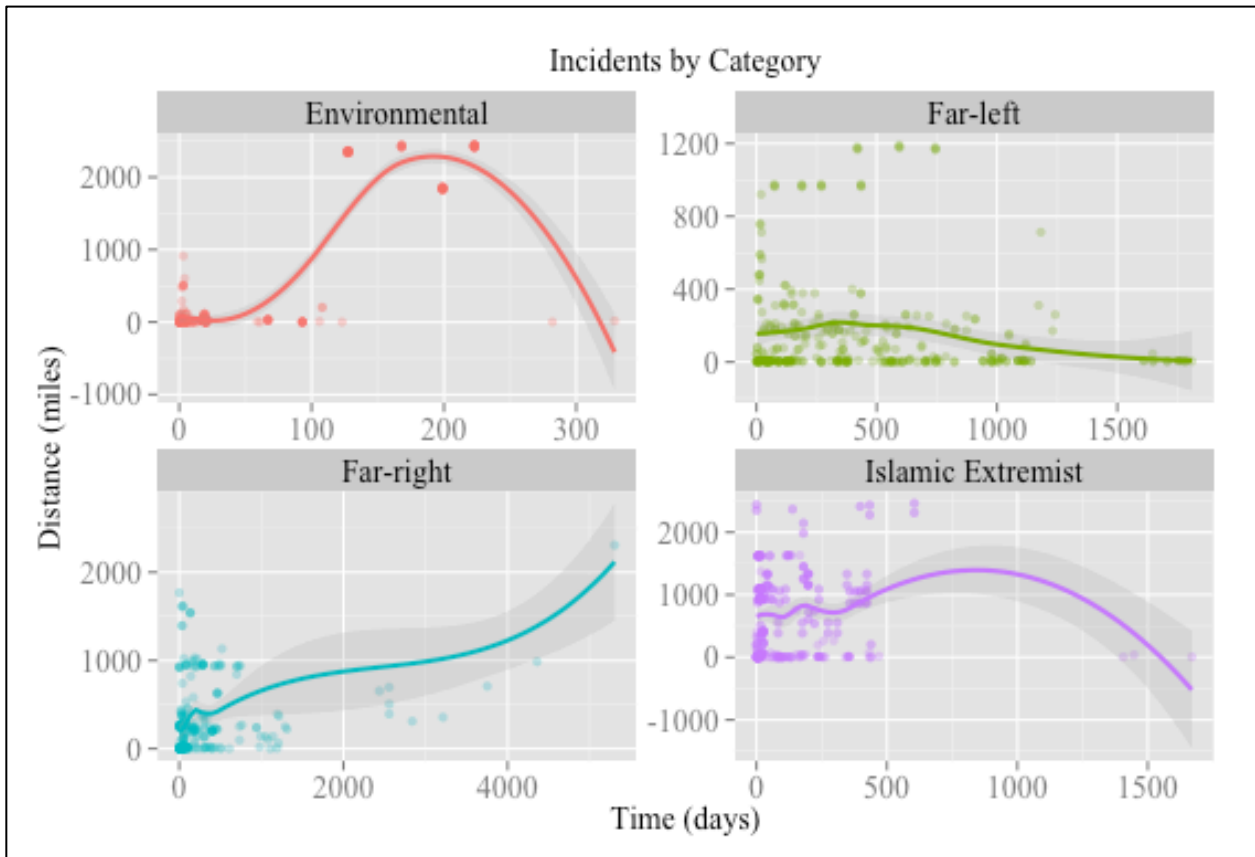
Figure 12. Time-Space Signature for All Incidents by Category

Through these initial assessments, it becomes clear that terrorist activities within each of these four classifications exhibit unique, or at least different, planning cycles. The general statements offer an introduction into how the signatures can be described. The individual terrorist categories and their signatures will be assessed in detail in the following sections.

Environmental Extremist

In recent history, environmental extremist movements have emerged in attempt to advance environmental protection beyond the current pace and scope; these movements often encourage and even employ criminal activity to send their message and achieve their goals (Michael 2013). The common thread between environmental extremist groups is a belief in biocentrism, a philosophy that removes human beings from the philosophical center of the world (Liddick 2006). This category of terrorism is recognized as its own group due to the diversity in political alignment; though environmental welfare movements are generally identified as being on the political left, there have been historical movements that have roots in fascist ideologies of the political Right (Michael, 2013).

Environmental movements generally target individuals and entities that are perceived to commit actions compromising the welfare of animals and the environment, as well as those with ties to the aforementioned companies. The goal of these organizations is to organize direct actions that inflict economic damage perceived offenders and ultimately cause changes in policy and society (Liddick 2006). Two well-known and active Environmental Extremist groups are Earth Liberation Front (ELF) and its sister organization Animal Liberation Front (ALF). These groups have conducted attacks on research facilities and laboratories, farming operations, construction companies, fast-food restaurants, and other institutions that are perceived as proponents of unsustainable environmental actions (Liddick 2006). The attacks, resulting in millions of dollars in damage, range from vandalism to arson and are intended to harass, intimidate, and cause economic damage to the target (United States et al. 2008). The prevalence and impact of these attacks, combined with the preference for arson as an attack technique has

established environmental extremists as the No. 1 domestic terror concern (United States et al. 2007).

The structure of environmental extremist groups has an inherent impact on their preparatory activities. ELF and ALF are both considered below ground organizations that have no official or formal leadership, membership, and central organization. Members of this organization gather in small autonomous cells consisting of two to five persons (Michael 2013). ELF and ALF members remain anonymous to the public and other members in order to protect their identity, avoid detection, and prolong their activities (Liddick 2006). Additionally, remaining autonomous allows for above ground organizations with similar agendas, including PETA and the Earth First! Foundation, to maintain plausible deniability in their relationship to these cells and their direct actions.

The planning cycle of Environmental Extremist groups generally involves target selection, planning, and attack. This approach can be best identified and examined through guides released to existing and potential members on the ideologies and strategies of a group, such as *The Alf Primer*. Though *The Alf Primer* is a document for ALF members, its content is applicable to all below ground environmental activist organizations, including ALF's brother organization ELF. *The Alf Primer* contains information on the history and ideologies of ALF as well as a guide for how to commit a direct action in support of ALF's mission. The primer outlines the planning of an attack in a series of steps. The first step of a direct action is target selection; in this step the ALF member selects an establishment that is perceived to be an animal abuser. The primer advises selecting a target that is outside of the attackers immediate area. The second step of a direct action is planning. This step includes visiting the site, studying the roads and environment, and conducting surveillance. A second visit is conducted following the

construction of a detailed scheme for the attack; during this visit to the target a simulation of the attack is performed in a run-through. Once the planning, preparation, and training are finalized, the attack is executed. The primer also lists preparation considerations, such as the use of a safe house, proper attire, and detection prevention. The document details how to commit specific attacks ranging from gluing locks and painting windows to arson and animal liberations.

Figure 13 below shows the signature for all Environmental Extremist incidents. The signature shows that activity towards the beginning of the planning cycle is at a close proximity to the target. The activity then becomes more remote as time before the attack decreases. Finally, directly prior to the attack the activity is concentrated near the target. The general pattern seems to support the idea that a plot may involve initial surveillance at the target location, followed by planning and preparation at a distant location, and ultimately the attack at the target location.
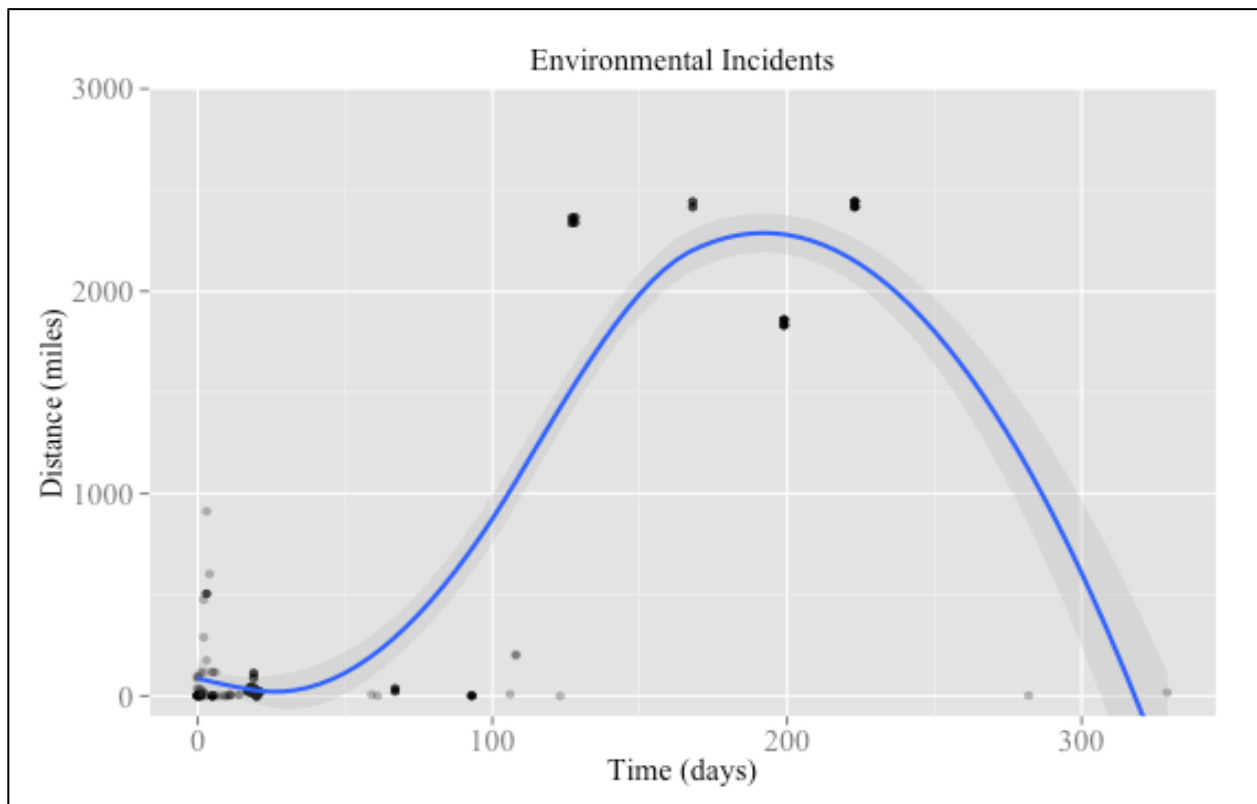

Figure 13. Time-Space Signature for Environmental Incidents

Figure 14 shows a data summary for the time values contained within the entire Environmental dataset. The data summary for the time attribute shows that the mean activity took place around two months prior to the attack (57.59 days), while the median activity took place around 19 days prior to the attack. The low median value indicates that environmental attacks involve a greater proportion of activity directly prior to the attack. It could also indicate that the types of attacks, such as vandalisms, assaults, and possibly even arson, carried out by environmental activists may not require lengthy and detailed planning.

Distribution of Environment Time Values	
	Time (days)
Min	0.00
1st Quartile	9.00
Median	19.00
Mean	57.59
3rd Quartile	93.00
Max	329.00

Figure 14. Distribution of Environmental Time Values

The histogram in Figure 15 below shows the distribution of the environmental time values. The histogram represents a right skewed distribution. The bottom half of values are very close in time to the time of the attack, indicating that activities increasingly occur directly prior to the incident and do not appear even distributed over time.
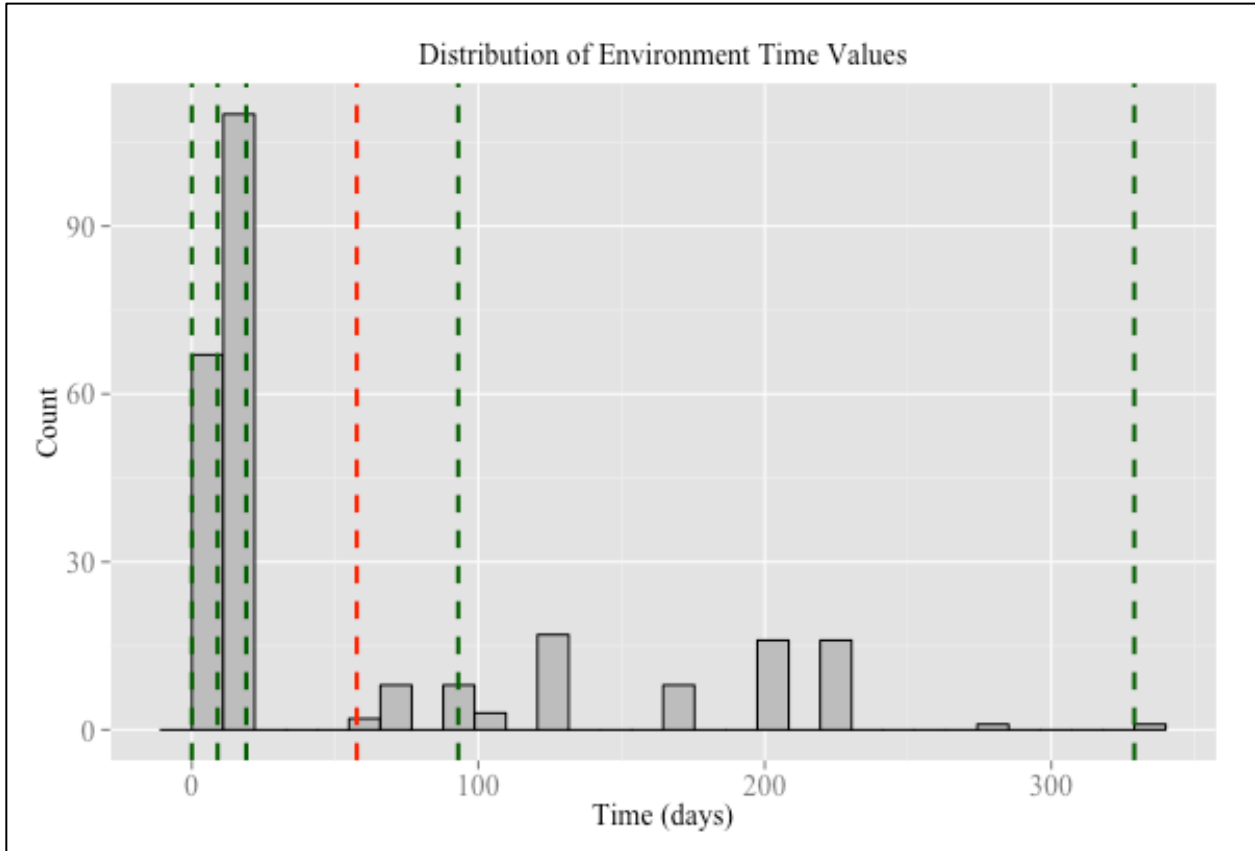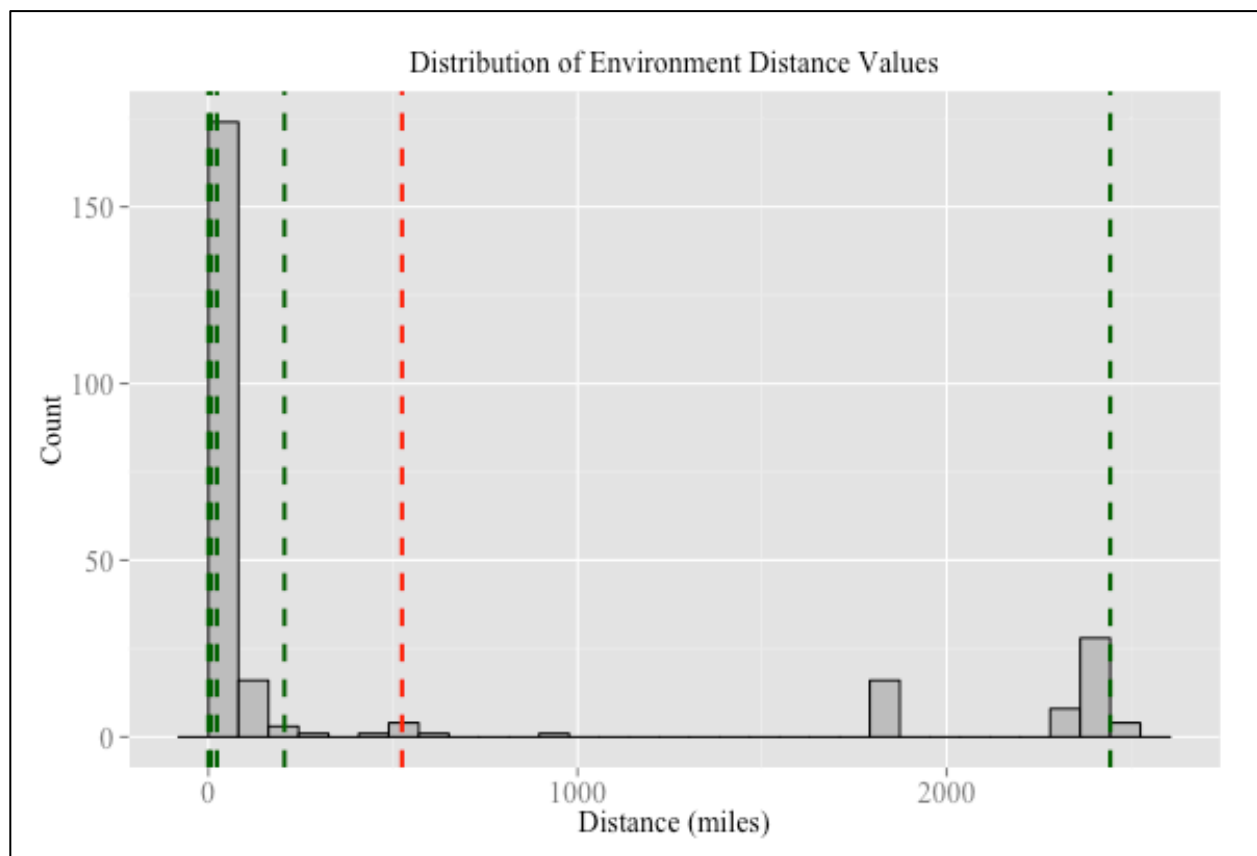
Figure 15. Histogram for Distribution of Environmental Time Values

The distance summary for the environmental dataset is shown in Figure 16. While the mean value is a large distance of 524.442 miles, likely influenced by a high max value of 2443.247, the median distance is only 23.165, indicating that the planning and preparation for environmental incidents are occurring at a very close proximity to the target. This low distance median value shows that environmental extremists are attacking targets near their planning areas. This could represent a high amount of activity near the location of the attack, such as surveillance, but it could also indicate that these terrorists may be attacking targets within their immediate area.

Distribution of Environment Distance Values	
	Time (days)
Min	0.00
1st Quartile	9.00
Median	19.00
Mean	57.59
3rd Quartile	93.00
Max	329.00

Figure 16. Distribution of Environmental Distance Values

The histogram in Figure 17 below shows the distribution of the environmental distance values described above. The histogram represents a right skewed distribution and illustrates that the majority of activities are occurring within a close proximity of the target.


Figure 17. Histogram for Distribution of Environmental Distance Values

Figure 18 shows a summary of the first recorded preparatory act in each of Incidents; the first record for each incident was determined by identifying the record with the highest number of days between the event and the attack. The table shows that the average attack planning began around three months (128 days) prior to the attack, the median falls very close to the mean at 108 days. The table also shows that the median distance of initial activity is 1.5 miles from the target, showing that a large portion of planning begins near the target, possibly in surveillance or target selection meetings. The mean value, however, is 406.64, largely influenced by the maximum value, and shows that there are incidents where planning begins remotely, at venues such as national meetings.

| Environmental Incidents Initial Act Summary		
	Time (days)	**Distance (miles)**
Min.	7.000	0.00
1st Qu.	61.000	0.00
Median	108.000	1.50
Average	128.385	406.64
3rd Qu.	223.000	198.99
Max.	329.000	2443.25

Figure 18. Distribution of Values for Initial Acts in Environmental Incidents

Figure 19 below shows the signatures for all of the Environmental Extremist Incidents. The plot shows the diversity in temporal length and spatial extent of environmental planning activities. While certain incidents involve a larger timeframe for planning, including three that involve over 200 days, the majorities involve less than 150 days for preparation. It is also noticeable that the incident planning cycles contain a number of different time- signature shapes. There are lines that appear to be constant in distance from the target over time, while others distances from the target appear to change noticeably over time throughout the planning cycle.
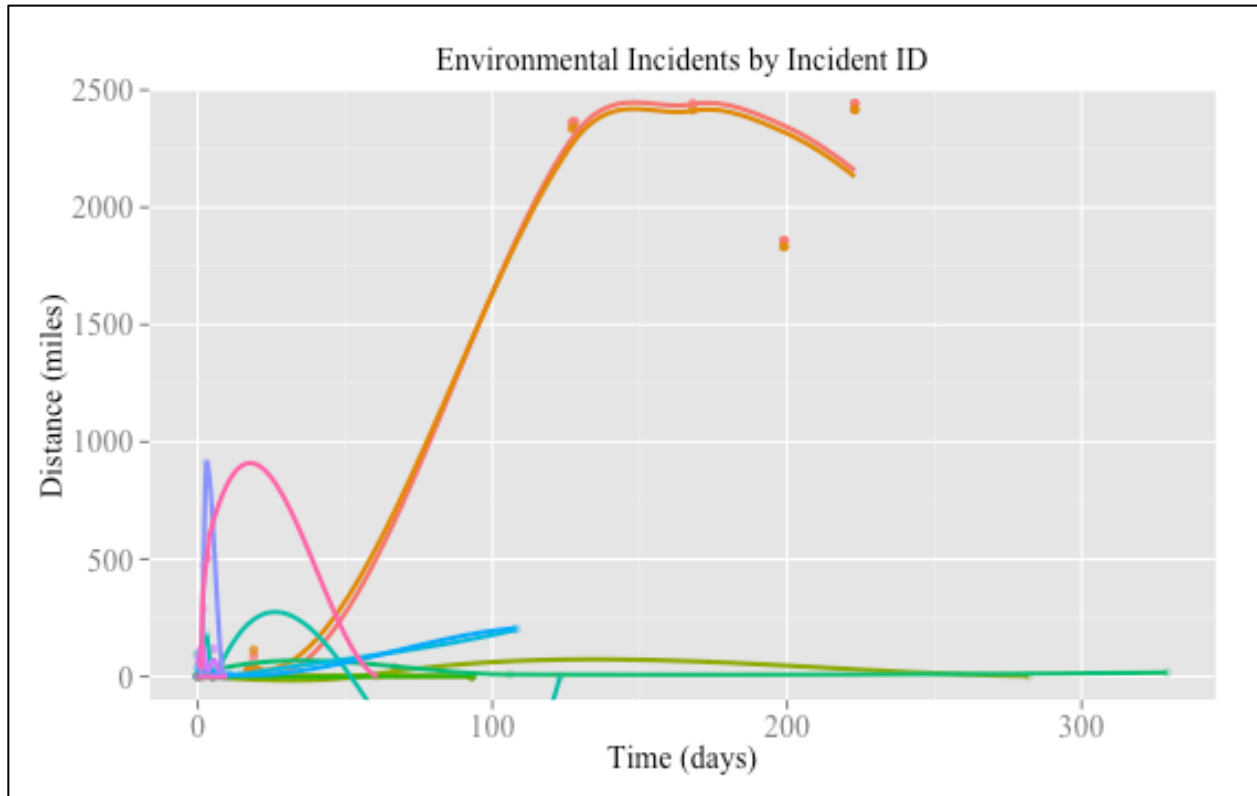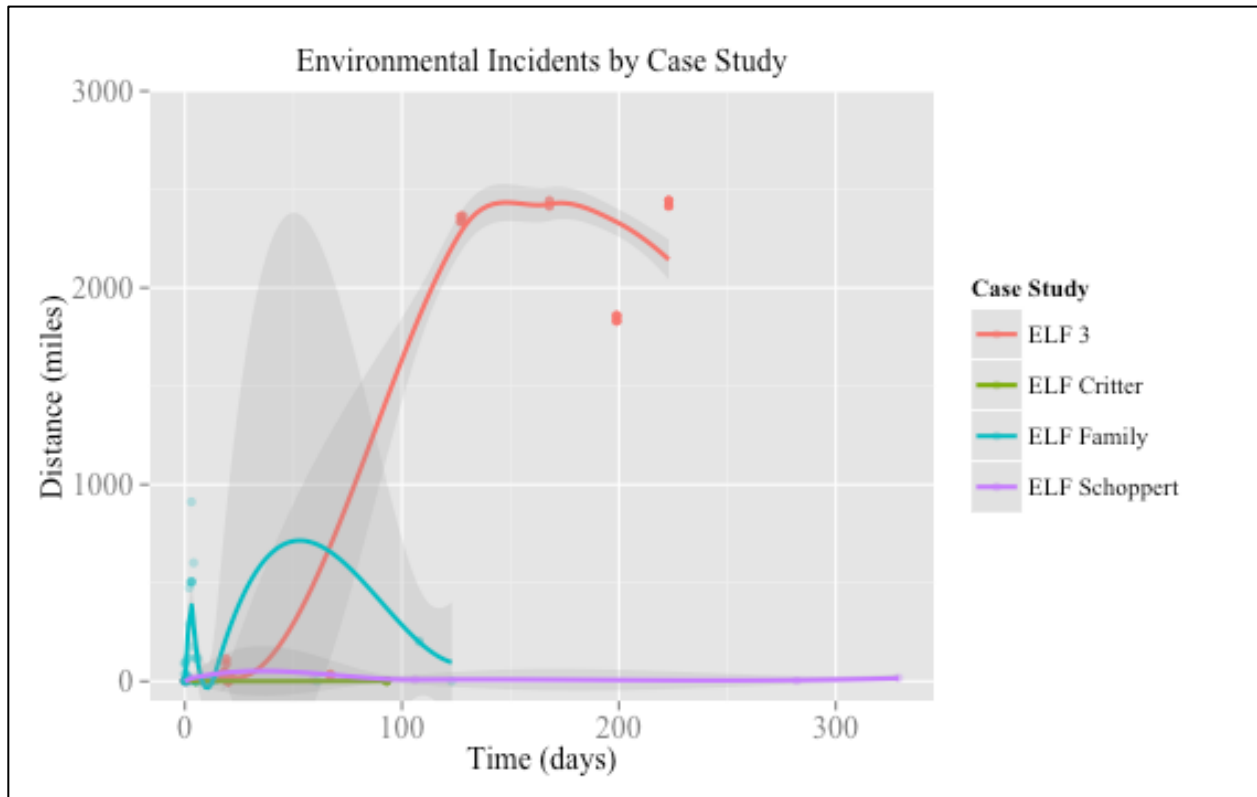
Figure 19. Time-Space Signatures for Environmental Incidents by Incident ID

Figure 20 below shows each incident plotted individually. This display does not show easily convey relativity between incidents however it more clearly shows the shape of each signature; in doing so this figure shows the diversity between environmental extremist planning cycles. Incidents 53340, 53366, and 53409 show little change in distance from the target over time and are represented by stable lines. Incidents 50239, 50333, 53385, and 53450 show initial activity close to the target followed by activity at an increased distance from the target, and finally, activity near the target. Incidents 6720 and 6722 are concave down graphs showing activity at a decreasing distance from the target over time. In general there seems to be a gradual curve that approaches the attack; the planning cycles seem to begin at a close distance to the target before moving a greater distance away and ultimately returning to the target.
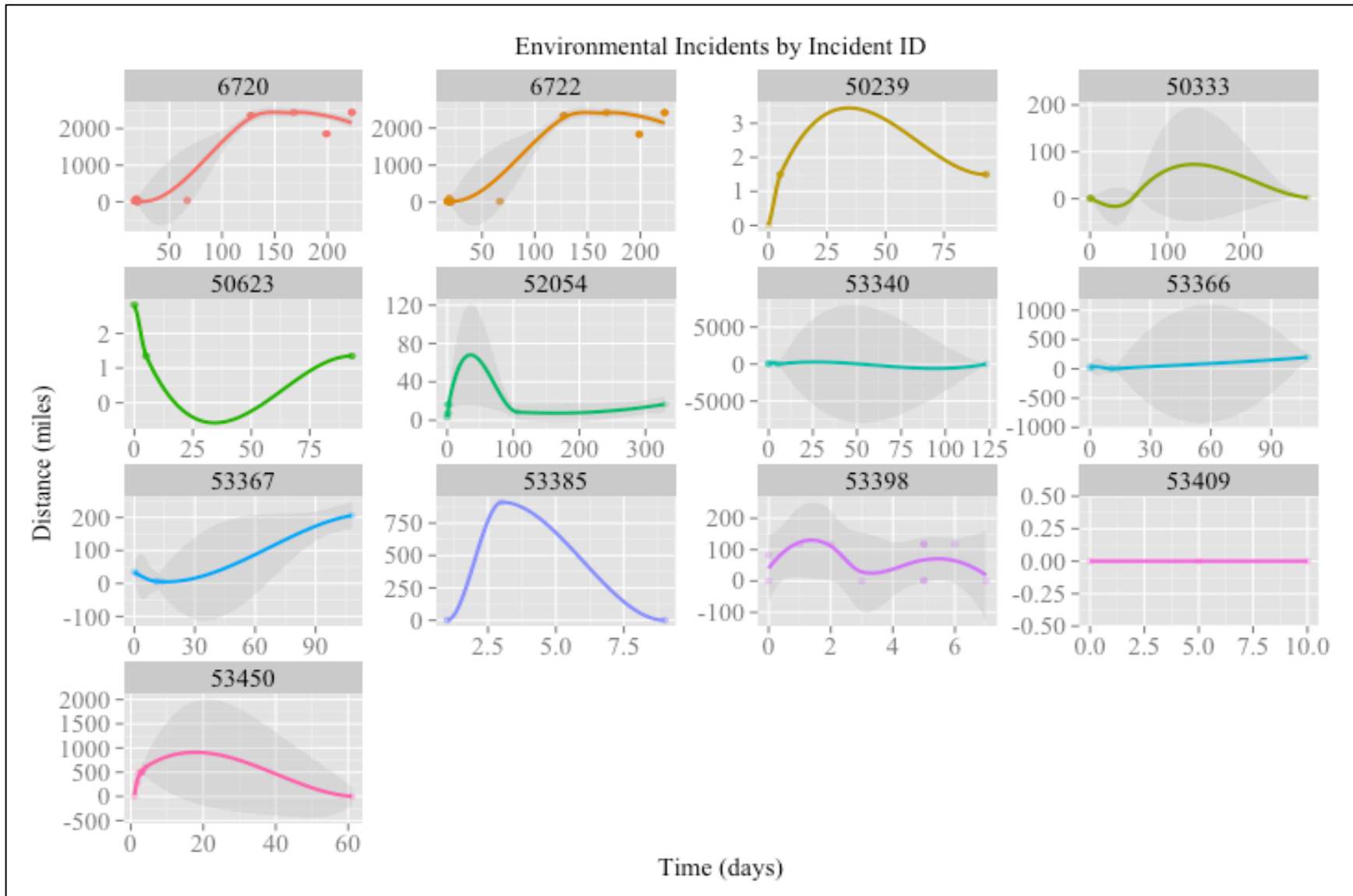
Figure 20. Time-Space Signatures for Environmental Incidents by Incident ID

Figure 21 below shows the Environmental Incidents by Case Study. In this graph various incidents are grouped if the same actors commit them. The graph largely exhibits characteristics described above, including variety in temporal and spatial extents of planning activities. ELF Critter and ELF Schoppert do not appear to have any activity at a distance remote from their target while ELF Family and ELF 3 engage in activity at great distances away from their target.
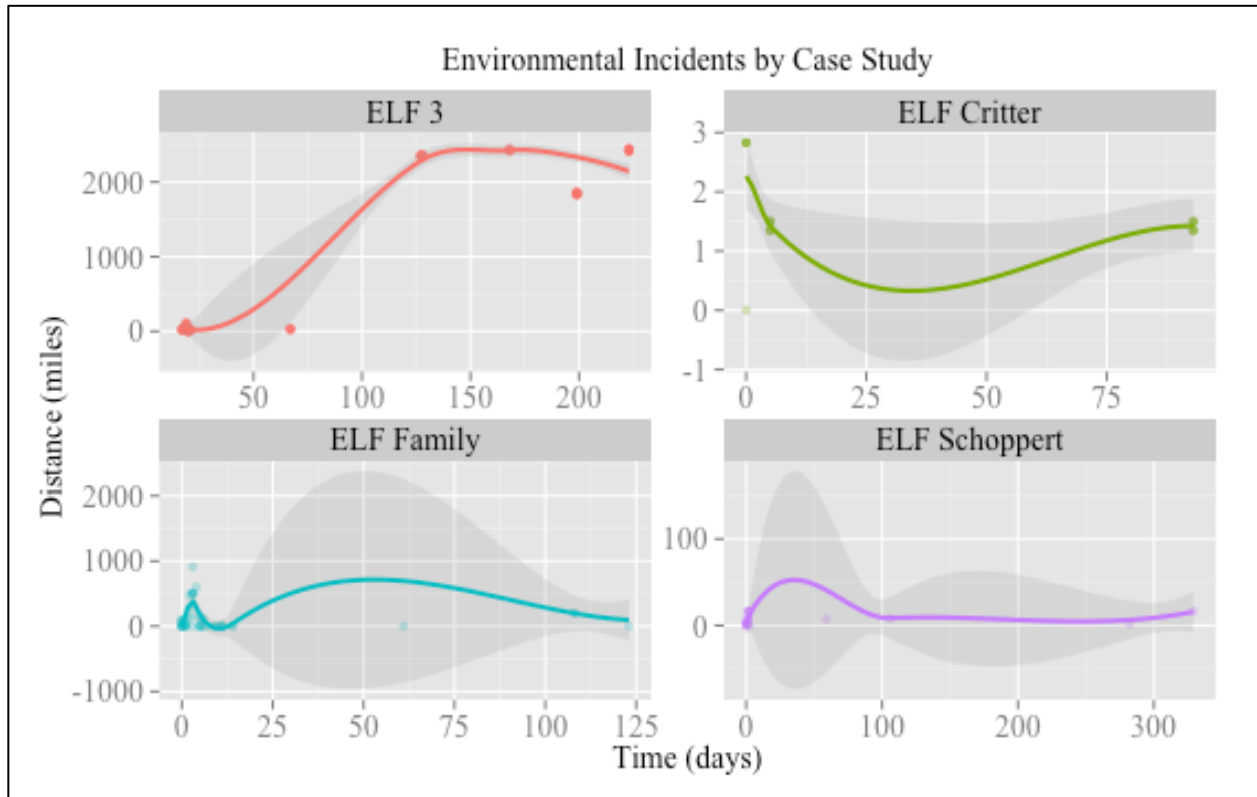

Figure 21. Time-Space Signatures for Environmental Incidents by Case Study

Figure 22 below shows the same signatures as shown above in Figure 21, however, the curves are plotted individually. With the exception of the ELF Critter case study, all of the incidents appear to approach the target as the time to the attack decreases. Theses graphs also show activity at a remote distance from the target prior to approaching the target for the attack. In this visualization, the ELF Family and ELF Schoppert planning cycles appear to exhibit

similar patterns, however the relative scale differences, shown in Figure 21 above, indicates the actual differences.
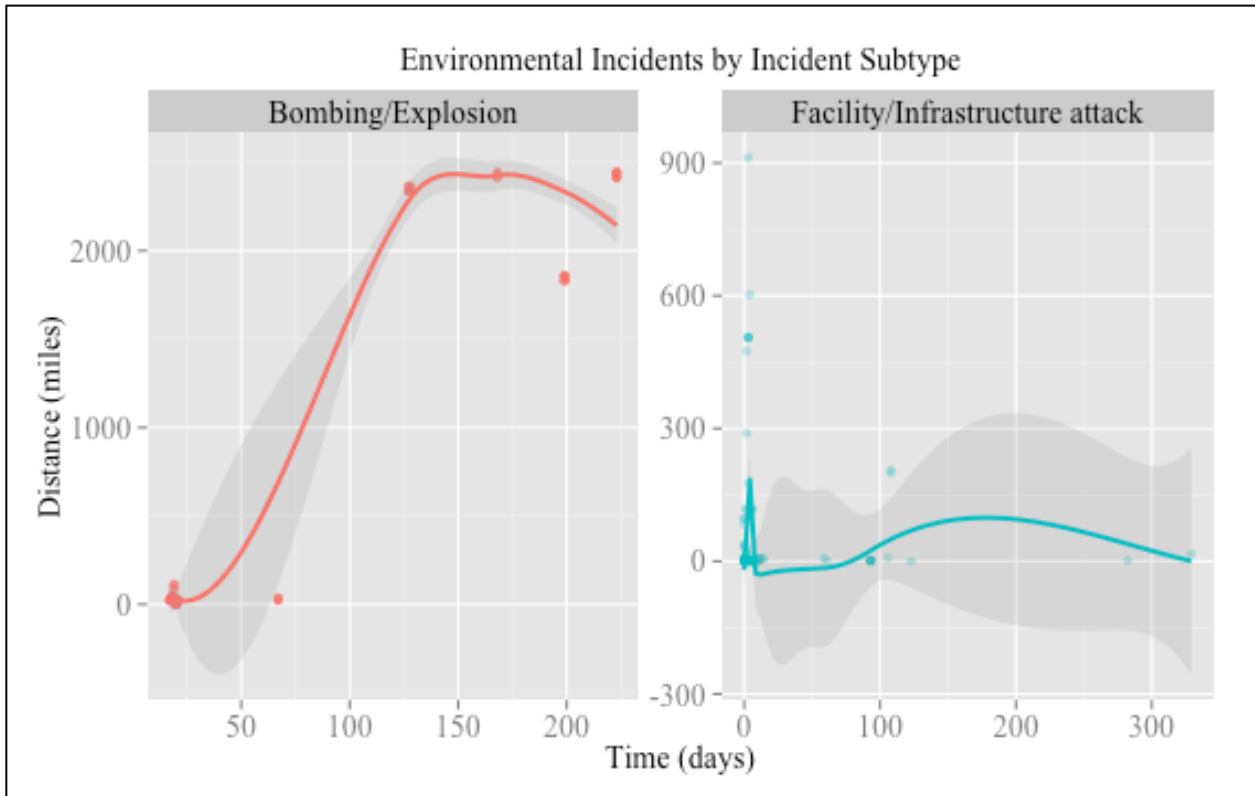

Figure 22. Time-Space Signatures for Environmental Incidents by Case Study

The planning cycles for various environmental Incident Subtypes are shown in Figure 23. Represented on this graph are bombing/explosions and facility/infrastructure attack. Instructions for attacks such as these are described in manuals such as *The Alf Primer*, other attacks described in the manual, such as vandalism and assaults, are likely not included due to their lack of planning efforts. The figure shows that while the bombing/explosion attacks involved remote planning activities, the facility/infrastructure attacks seem to involve planning activity close to the target. There doesn't appear to be a substantial difference in temporal scales between the various Incident Subtypes.
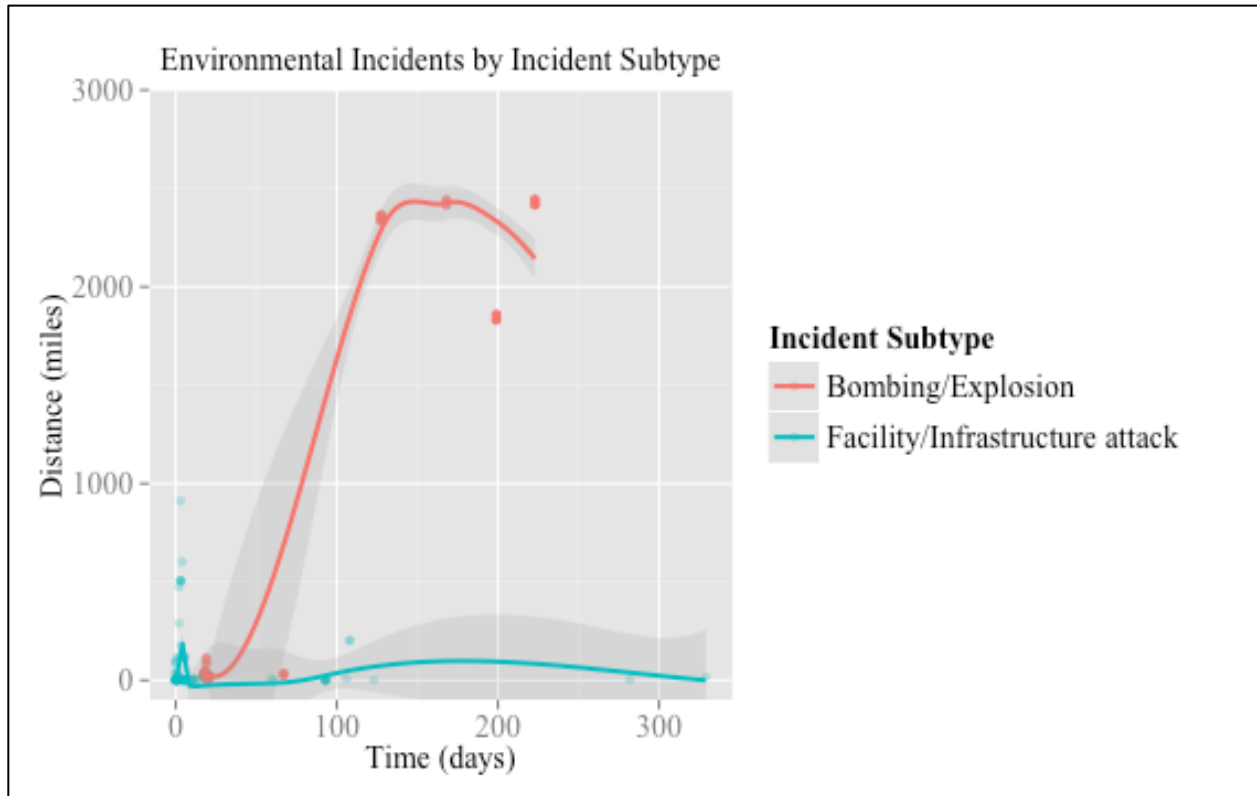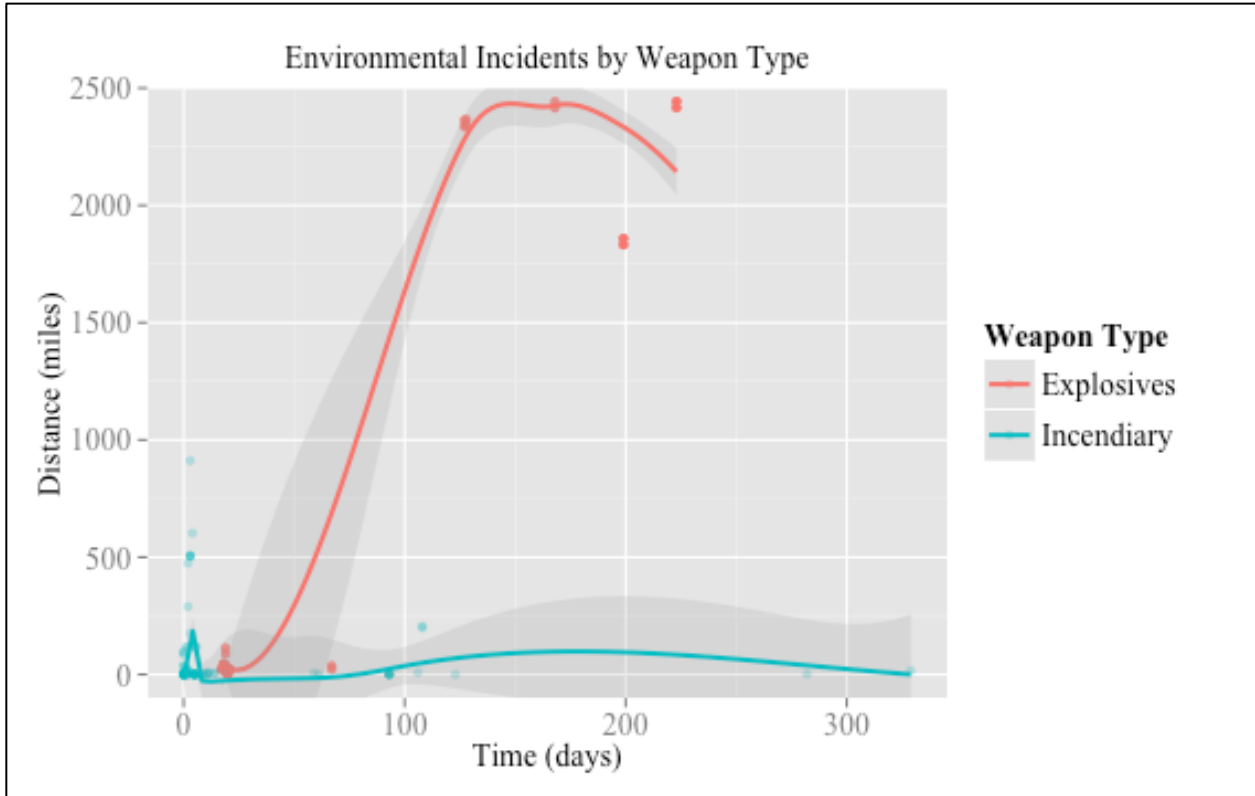
Figure 23. Time-Space Signatures for Environmental Incidents by Incident Subtype

The planning cycles for environmental incidents based on their incident subtype are shown on individual plots below in Figure 24. The graph shows the same patterns and trends as Figure 23 above. While the bombing/explosions are planned and prepared for remotely, the facility/infrastructure attacks are planned and prepared for in close proximity to the target. Figure 24 also helps to show the inconsistent pattern in planning activity directly prior to the attack.
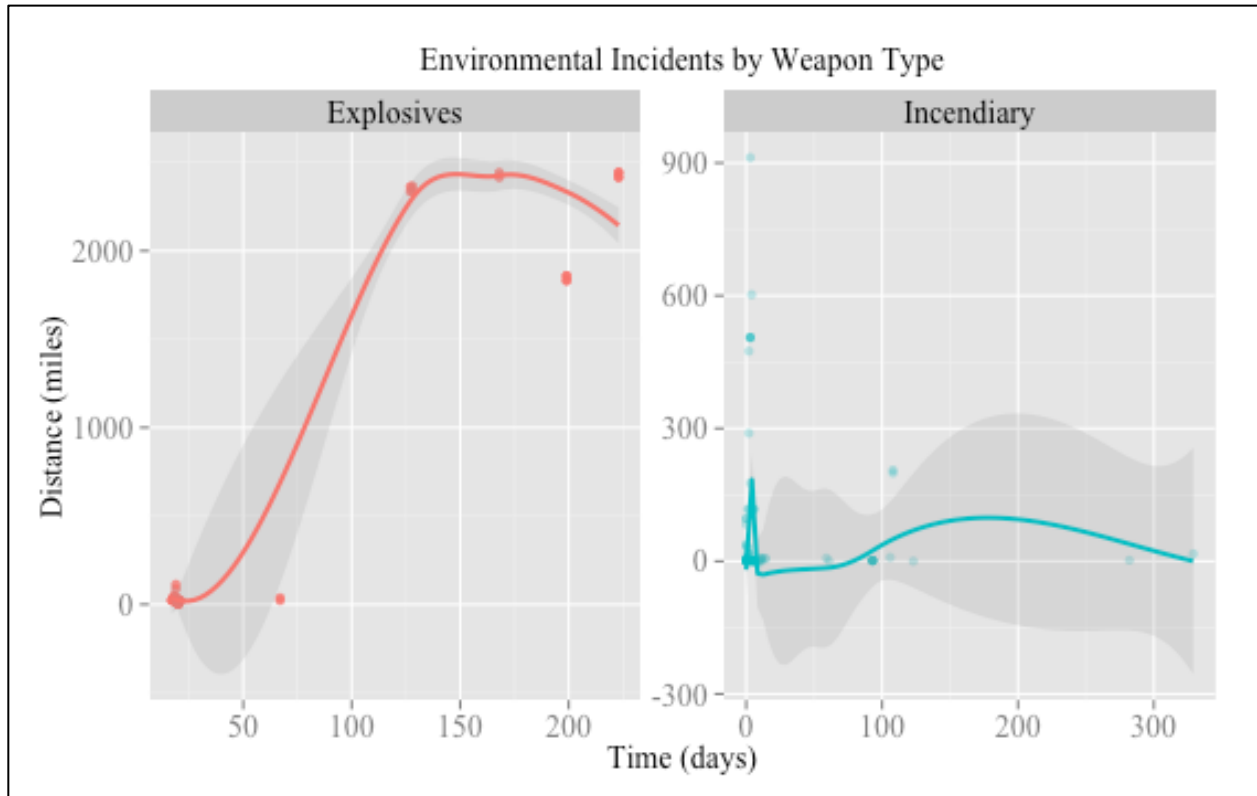
Figure 24. Time-Space Signatures for Environmental Incidents by Incident Subtype

The signatures for environmental terrorists by the weapon type used in the attack are shown in Figure 25 below. This graph is the same as Figure 24 above, showing the planning cycles based on Incident Subtype. This is due to the fact that the bombing/explosion attacks used explosives as their weapon type while facility/infrastructure attacks used incendiary weapon types. The patterns and observations are the same as observed through Figure 23 and Figure 24. Though it is logical, it is interesting to note how directly the weapon type is connected to the incident subtype.
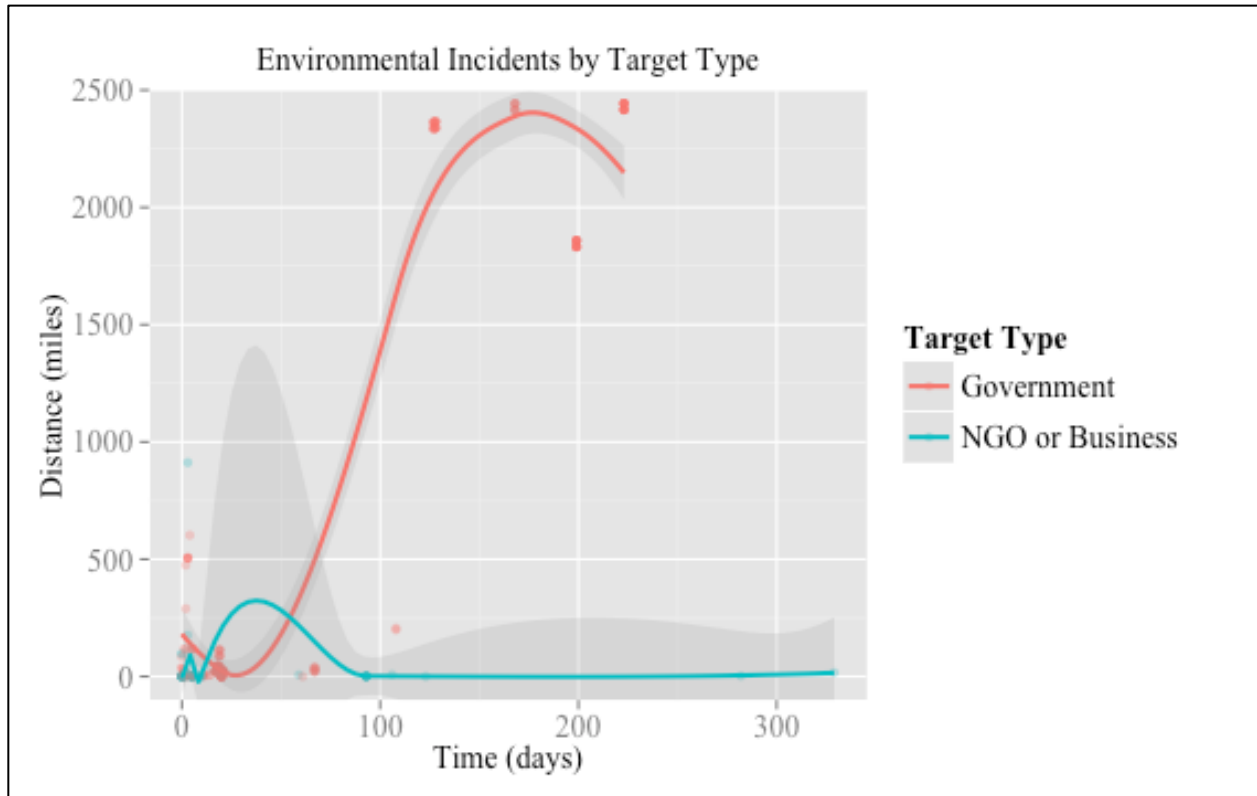
Figure 25. Time-Space Signatures for Environmental Incidents by Weapon Type

Figure 26 below, showing the signatures for environmental incidents by weapon type, represents the same curves as Figure 25 above, indicating the correlation between weapon type and incident subtype.
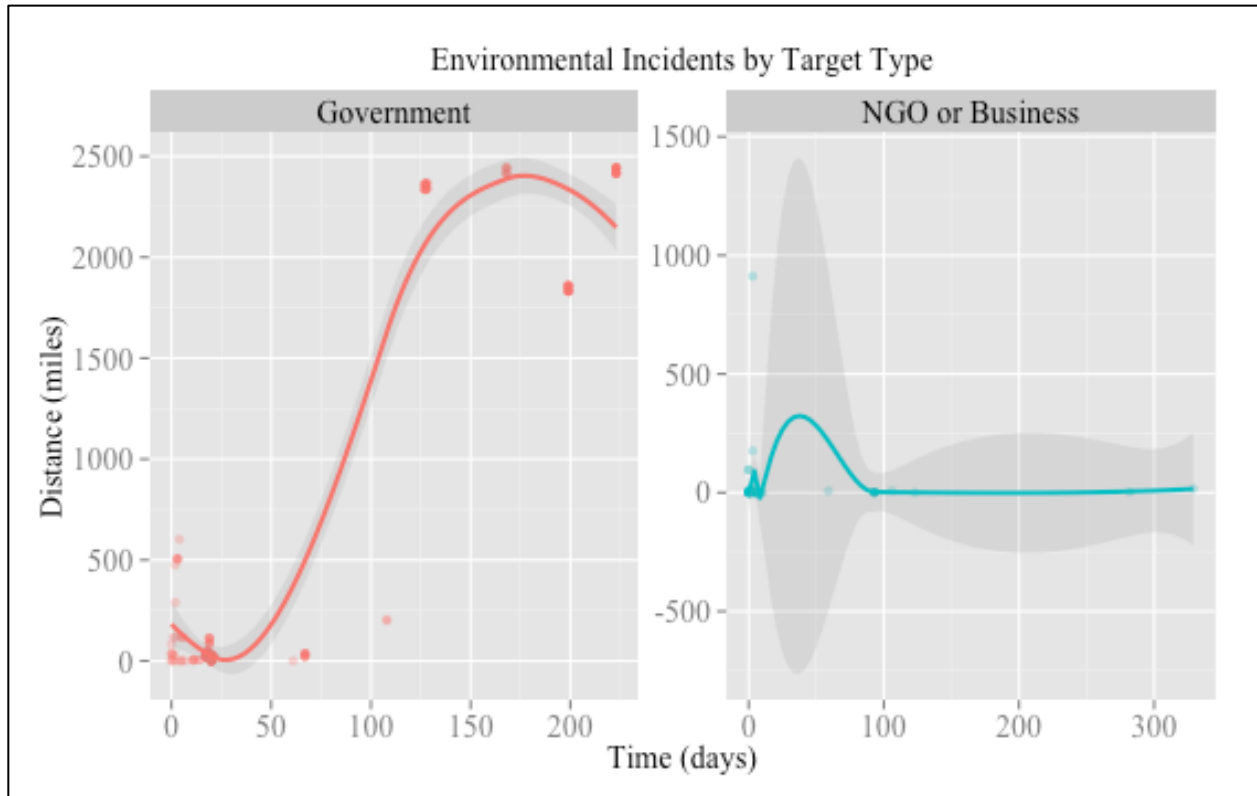
Figure 26. Time-Space Signatures for Environmental Incidents by Weapon Type

Figure 27 below shows the environmental incidents by target type. The temporal and spatial patterns observed in the figure below are almost the same as the patterns observed in Figure 26 above. It shows that the attack of the government target involved planning beginning at a distant location before approaching the target while the planning for the attack on the NGO or business target involved planning at a short distance from the target.

Figure 27. Time-Space Signatures for Environmental Incidents by Target Type

Figure 28 below shows the environmental incidents by target type. There are slight differences between the curves for the figures showing the incidents by weapon type and incident subtype; however, the graphs appear to show the same general patterns. While the Government targets were attacked with explosives, the NGO or business targets were attacked with incendiary devices.

Figure 28. Time-Space Signatures for Environmental Incidents by Target Type

Far-Left

Far-Left terrorist organizations are categorized by their desire to initiate revolution through the overthrowing of capitalist systems or government control. Far-Left terrorists often propagate a class based or ethno-national agenda as a motivation for their political violence; their ideas are often rooted in Marxist or communist ideals (Hoffman 1998). The target of the violence is commonly an oppressive system, class, or government entity. Far-Left groups consider their actions to be beneficial to the poor or oppressed and herald themselves as supporters of the subjugated (Martin, 2011). Attacks from the Far-Left generally involved bombings and assaults on individuals, groups, or infrastructure that are important to the opposition. Examples of Far-Left groups include Puerto Rican independence groups, such as the Fuerzas Armadas de Liberación Nacional Puertorriqueña (FALN), African American separatist groups, including the New African Freedom Fighters, and American Marxist or communist groups, such as United Freedom Front (UFF).

Similar to other acts of terrorism, plots of Far-Left terrorism generally involve target selection, surveillance, procurement of supplies and funds, prior to the attack. Far-Left incidents of terrorism are suggested to be symbolic in nature. They are designed to call attention to a specific political call and avoid collateral damage to individuals that could become supporters. Their actions are called 'armed propaganda' due to their symbolic and educational intent (Hoffman 1993). Terrorist plots are designed to destroy existing structures or order in the name of the poor and downtrodden (Martin 2011).

Though the actions of Far-Left groups were prominent through the 80s and 90s, attacks from these groups have since decreased and are uncommon. Despite the infrequency of actions from the Far-Left in contemporary society, it is still valuable to study their actions as a

contribution to the understanding of terrorism as a whole. The majority of recorded Far-Left incidents within the ATS database include incidents of bombing, murder, and assault.

Figure 29 below shows the time-space signature for Far-Left terrorist planning cycles. The general trend shows a stable and flat line with a very gradual increase followed by a very gradual decrease. It appears that the actions occur with a close, but fluctuating, proximity to the target.
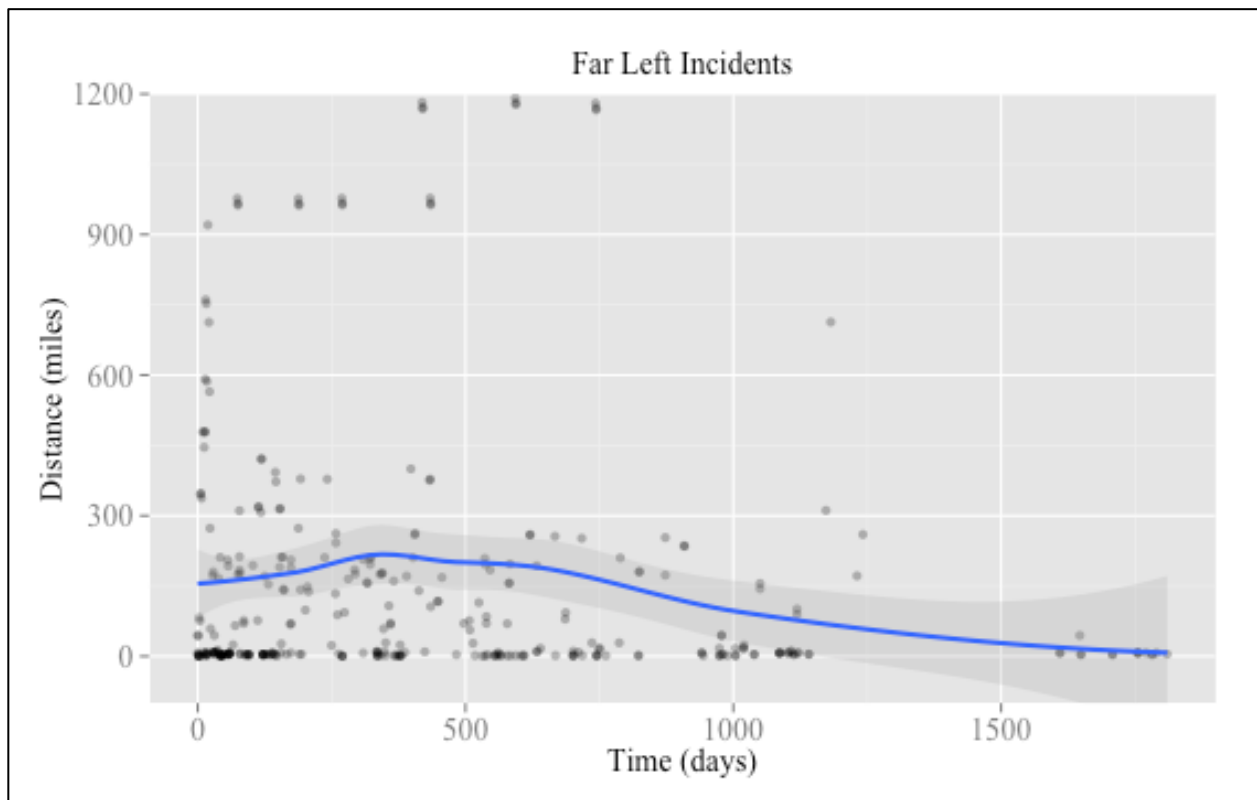

Figure 29. Time-Space Signatures for All Far Left Incidents

The table in Figure 30 below shows a summary for the temporal values in the Far-Left dataset. It shows that the far left median incident occurs almost a year from the attack at 335 days. The mean value for the time at which incidents occur is at 446.40 days. Both of these values are relatively large indicating that the planning cycles for Far-Left incidents involve long time periods.

Distribution of Far Left Time Values	
	Time (days)
Min	0.00
1st Quartile	92.00
Median	335.00
Mean	446.40
3rd Quartile	668.00
Max	1810.00

Figure 30. Distribution of Far Left Time Values

The histogram shown in Figure 31 illustrates the distribution of time values in the Far-Let Dataset. The distribution is skewed to the right, however the quintiles are spread throughout the dataset and less clustered towards the time of the attack. The distribution shows a relatively stable decline towards the right extreme indicating that the time values are generally present throughout the spectrum. Though there is a noticeably high presence of activity close to the time of the attack, the activities do seem to occur outside of time periods directly prior to the attack.
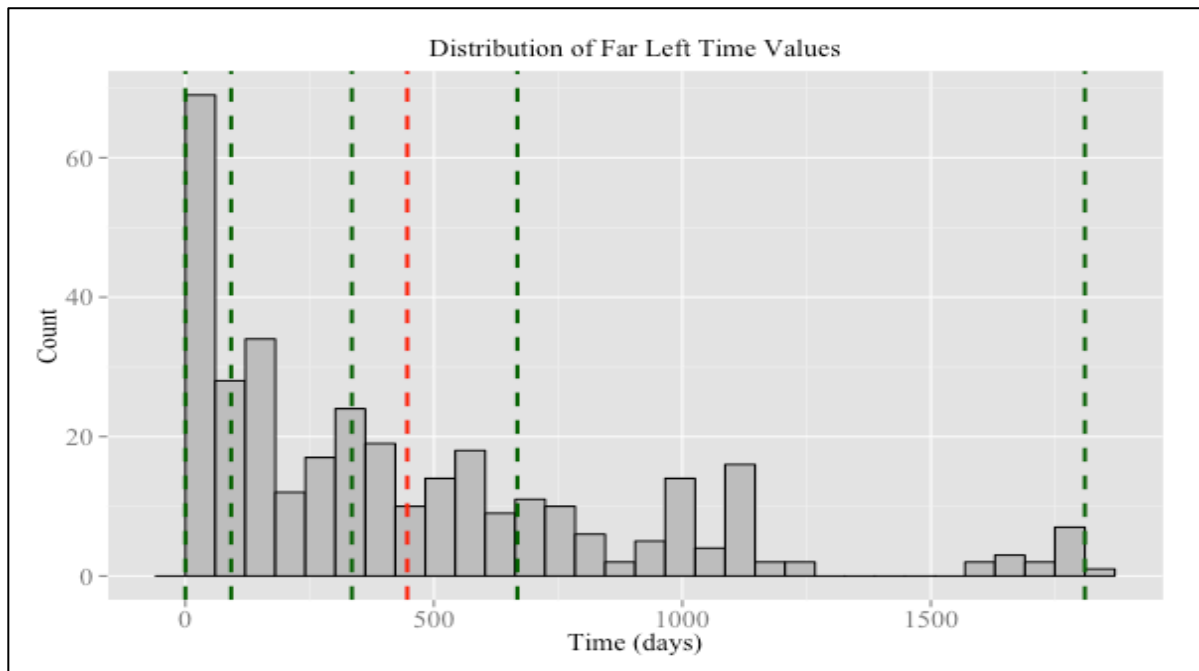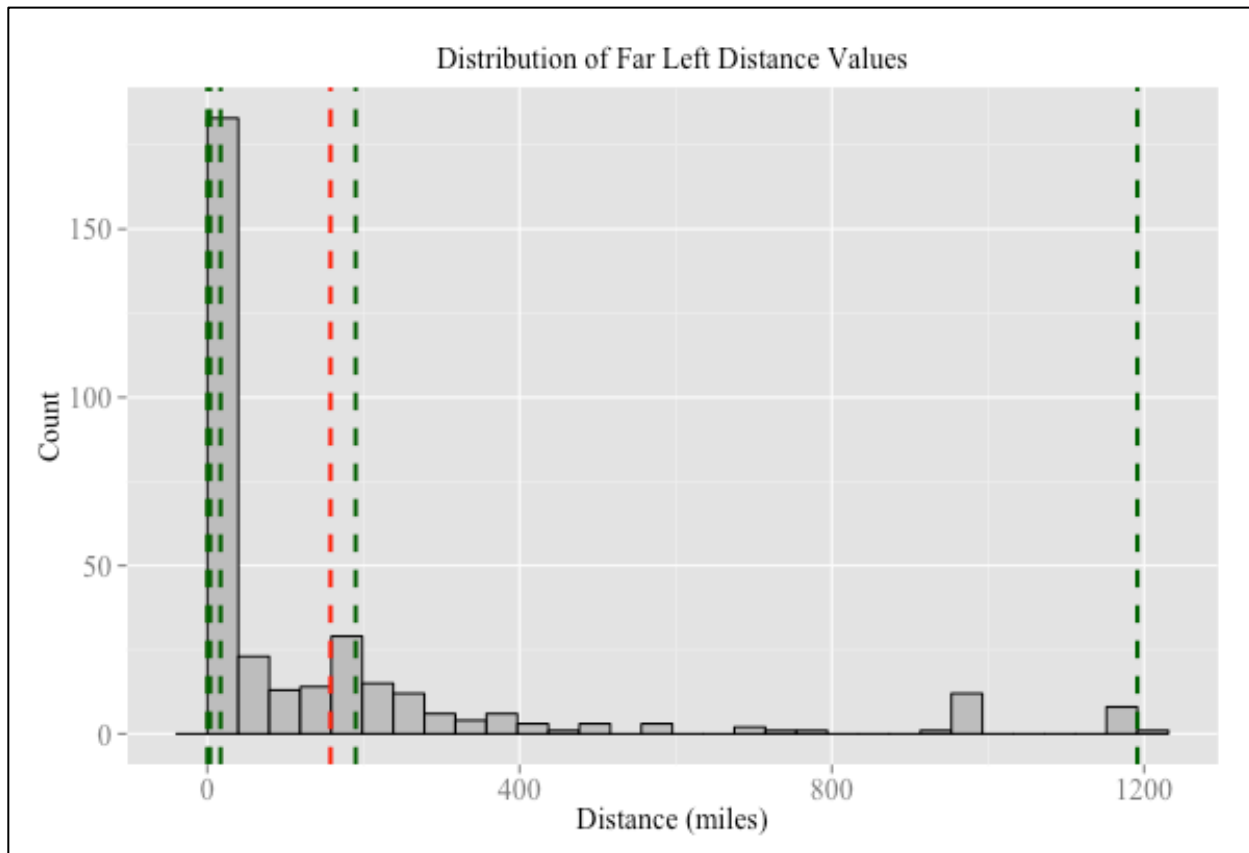

Figure 31. Histogram for Distribution of Far Left Time Values

The distribution of distance values in the Far-Left dataset is summarized in Table 32 below. The median distance for preparatory and planning activities is rather low at 16.974 indicating that a large portion of these activities occurs within a close proximity of the target. The mean value for distances between the target and the planning activity is larger, at 157.782 miles. The large difference between the median value of 16.974 and the mean of 157.782 indicates that the mean is influenced by the maximum value of 1191.450 and other large outlier values.

Distribution of Far Left Distance Values	
	Distance (miles)
Min	0.000
1st Quartile	3.692
Median	16.974
Mean	157.782
3rd Quartile	190.068
Max	1191.450

Figure 32. Distribution of Far Left Distance Values

The distribution curve for the Far Left distance values is shown below in Figure 33. The histogram shows a right skewed curve with the bottom half of values at a very close distance to the target. Additionally, the bottom third of values all fall within a relatively close distance of the target and the top quartile is spread over a large range of distance values. This distribution shows that the far left terrorist activities seem to be concentrated within a short distance of the target.

Figure 33. Histogram for Distribution of Far Left Distance Values

The Far-Left extent summary shown in Figure 34 below shows the summary statistics for the first recorded activities in each of the Far-Left incidents. These statistics give a description of where the terrorist plots begin in time and space relative to their target. The temporal summary shows that the bottom quarter of attacks begin just seven days before the attack, while the bottom half of incidents begin less than 94 days from the attack, and the bottom third begins less than 260 days from the attack. This indicates that while the attacks can require planning of more than three months, there are attacks that can be planned and carried out in less than one week. The distance summary shows that these attacks generally begin at a larger distance from the target. The minimum distance is 37 while the median is much higher at 687. This is a clear indication that these events generally begin their planning cycle remotely before they are executed.

| Far Left Incidents Initial Act Summary		
	Time (days)	**Distance (miles)**
Min.	3.15	37.000
1st Qu.	7.03	435.000
Median	93.45	687.000
Average	274.87	865.220
3rd Qu.	258.46	1242.000
Max.	1181.14	1810.000

Figure 34. Distribution of Values for Initial Acts in Far Left Incidents

The planning cycles for the Far-Left incidents are graphed below in Figure 35 based on their Incident ID. The high number of incidents, and their great variation in patterns and extents, makes this graph difficult to interpret. It is apparent that though there are incidents that have flat lines indicating limited spatial movement over time, many of the lines are show a fluctuation in time and space in the planning cycle, indicating considerable movement in both space and time.
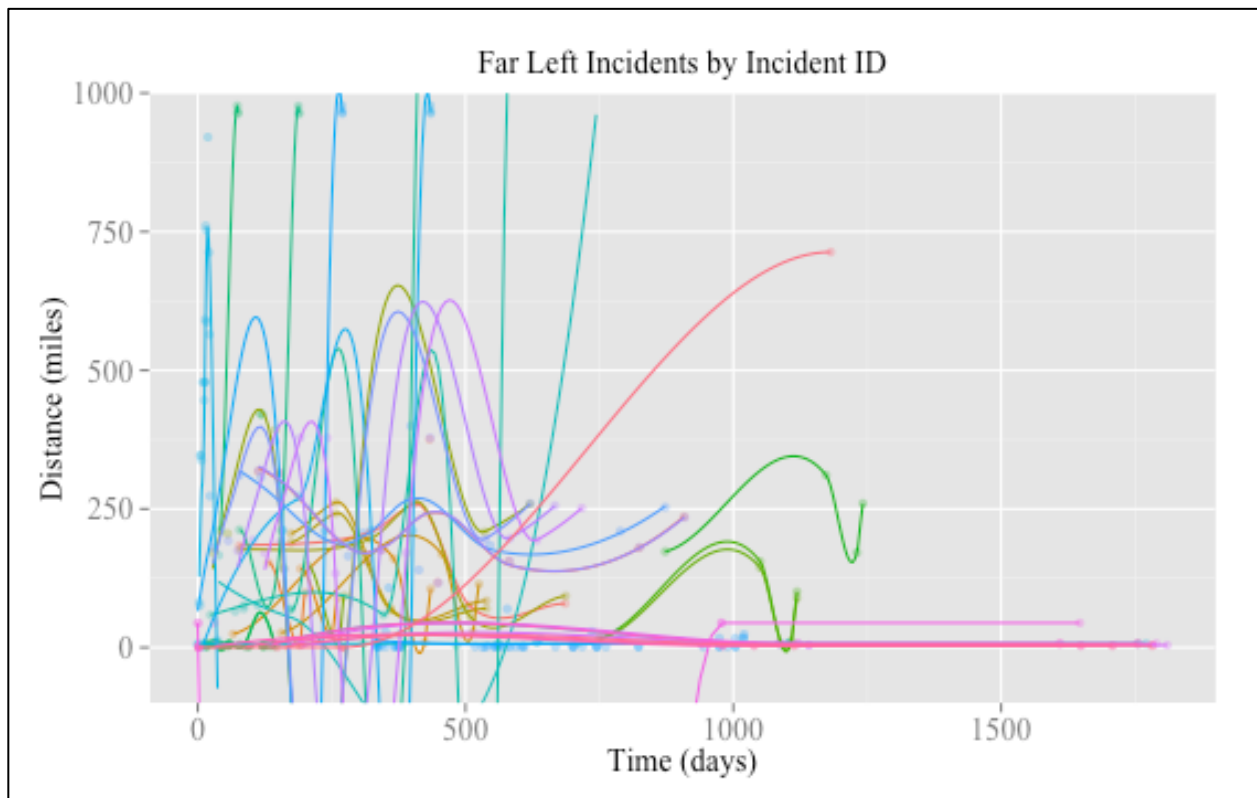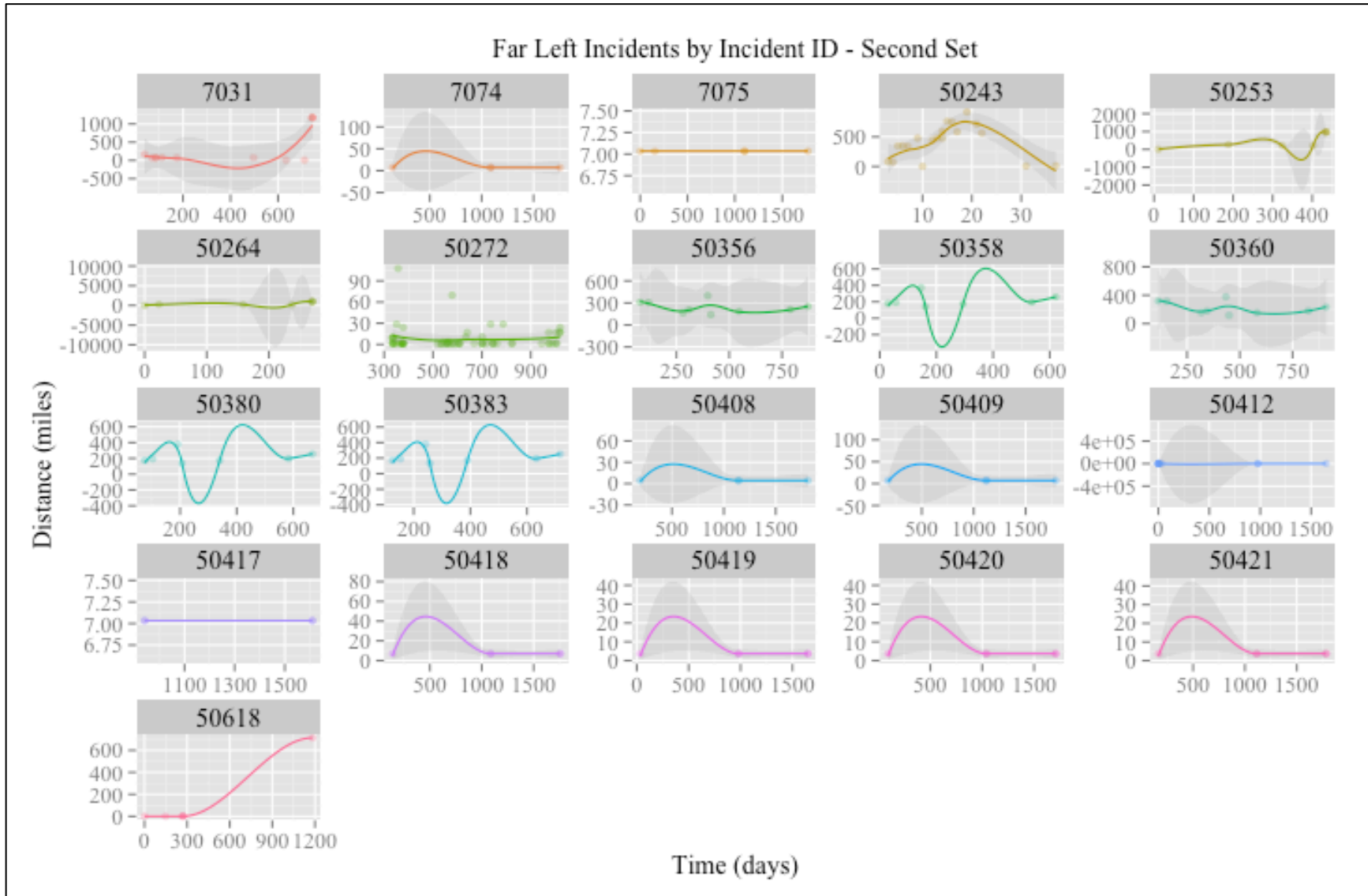

Figure 35. Time-Space Signatures for Far Left Incidents by Incident ID

The signatures for Far Left incidents are shown individually in Figure 36 and 37 below. This method of data presentation identifies that the majority of the incidents involved a retreat to a remote location after a visit to the approximate area of the target. There are around 13 of the 41 graphs where this trend is not clearly visible. This pattern is likely indicative of a surveillance or reconnaissance operation to obtain information about the target. The signatures also show movement between the target location and a more remote location in a number of graphs. This pattern seems to indicate that activities occur at a range of locations in relationship to the target.
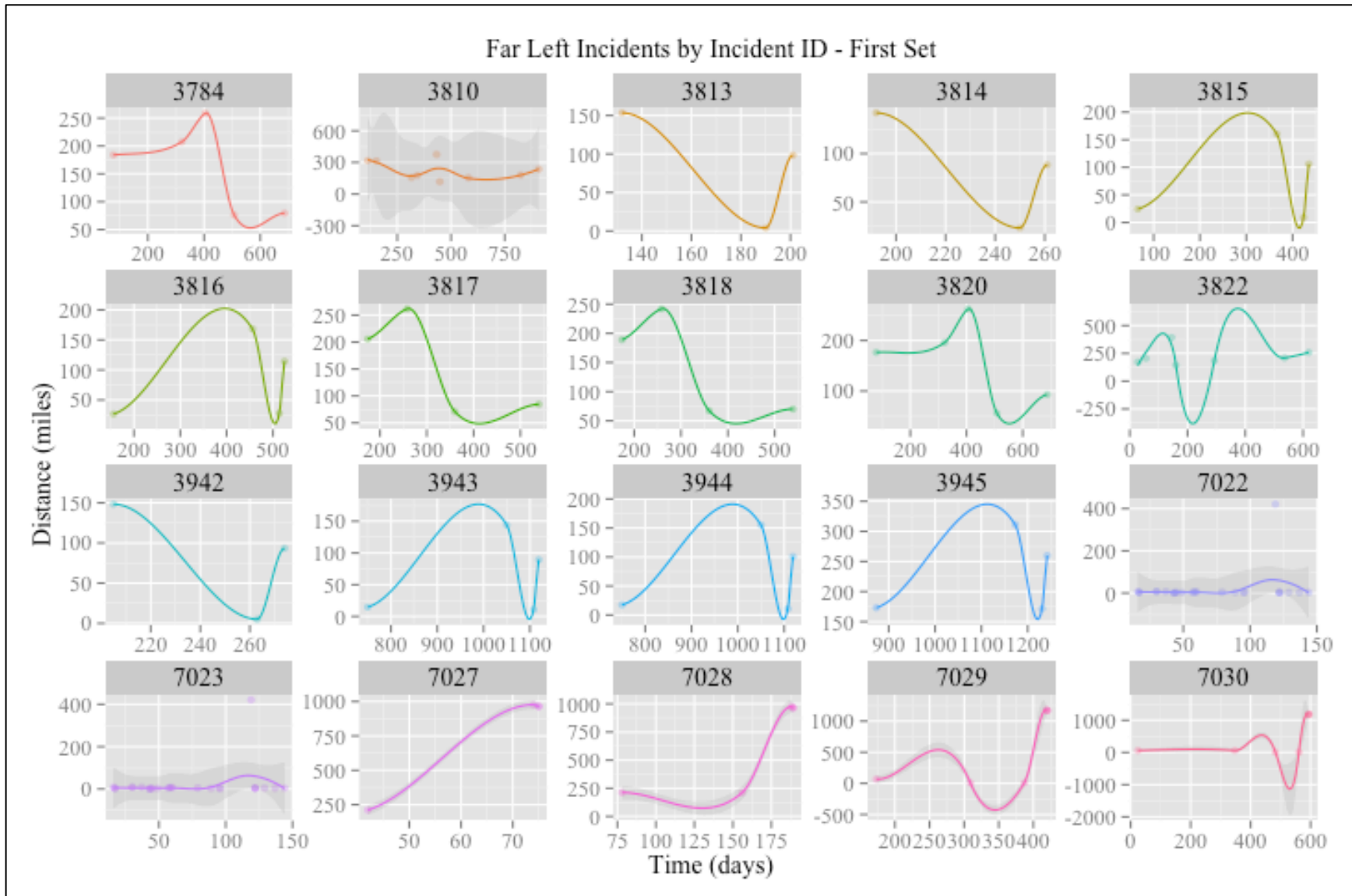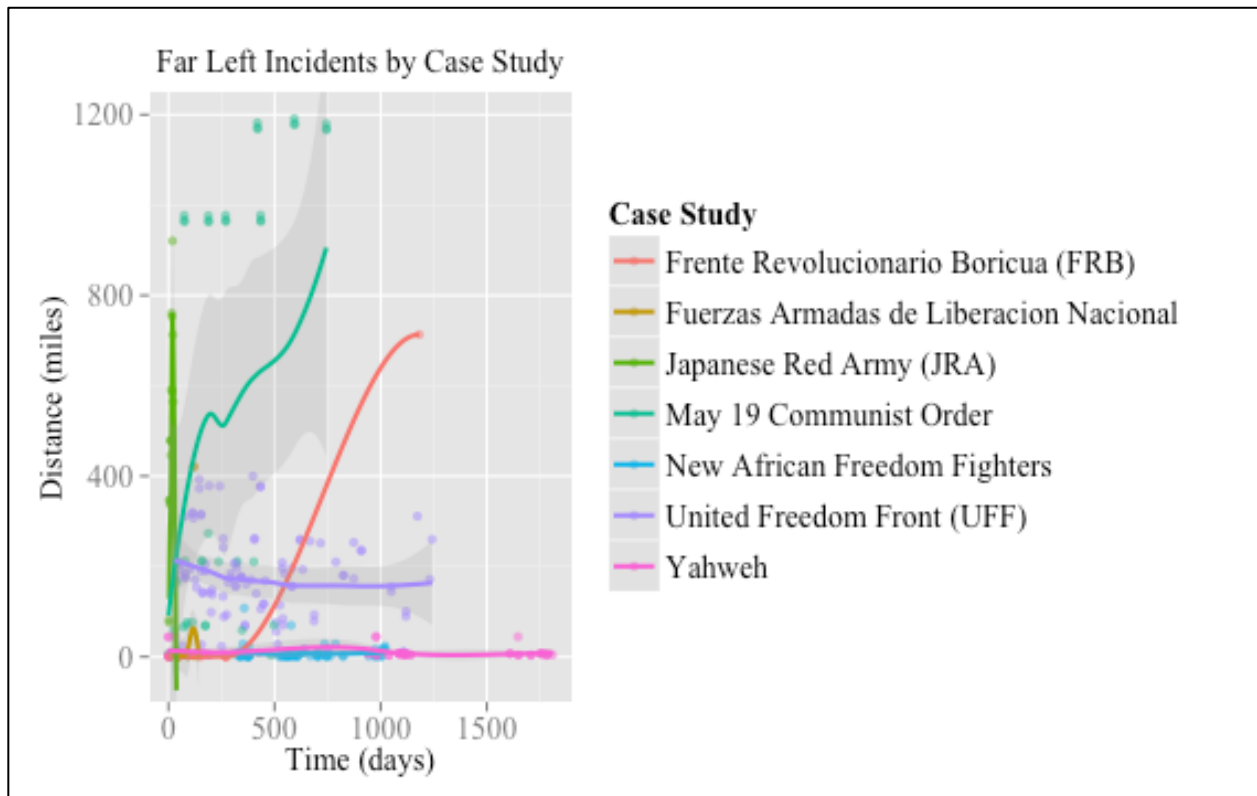
Figure 36. Time-Space Signatures for Far Left Incidents by Incident ID – First Set

Figure 37. Time-Space Signatures for Far Left Incidents by Incident ID – Second Set

The Far Left incidents are shown below in Figure 38 graphed according to their case study. The figure shows that the Japanese Red Army and the Fuerzas Armadas de Liberacion Nacional employ shorter planning and preparatory cycles, while the other five Far Left case studies involve planning and preparation activities beyond 500 days prior to the attack. Figure 38 also shows the difference in planning cycle movement. While the Yahweh group, New African Freedom Fighters, and Fuerzas Armadas de Liberacion Nacional remain at a close proximity to their target locations, other groups, including the Frente Revolucionario Boricua and the May 19 Communist Order facilitate planning and preparation activities at locations very remote from their target.

Figure 38. Time-Space Signatures for Far Left Incidents by Case Study
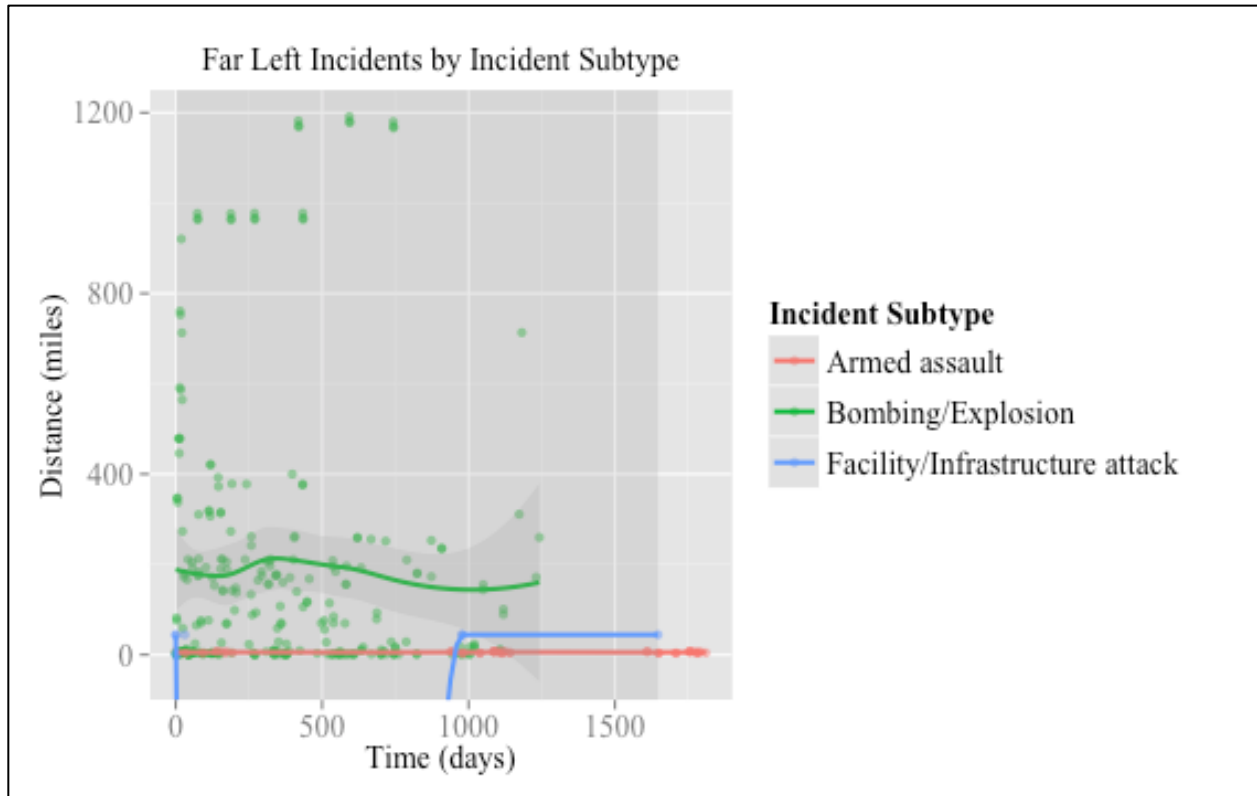
The Far Left incidents are graphed individually in Figure 39 below. The figure shows the diversity in space-time movement of actors within these case studies. While three of the case

studies exhibit a stable signature, two signatures appear to approach the target from an area

distant to the target.
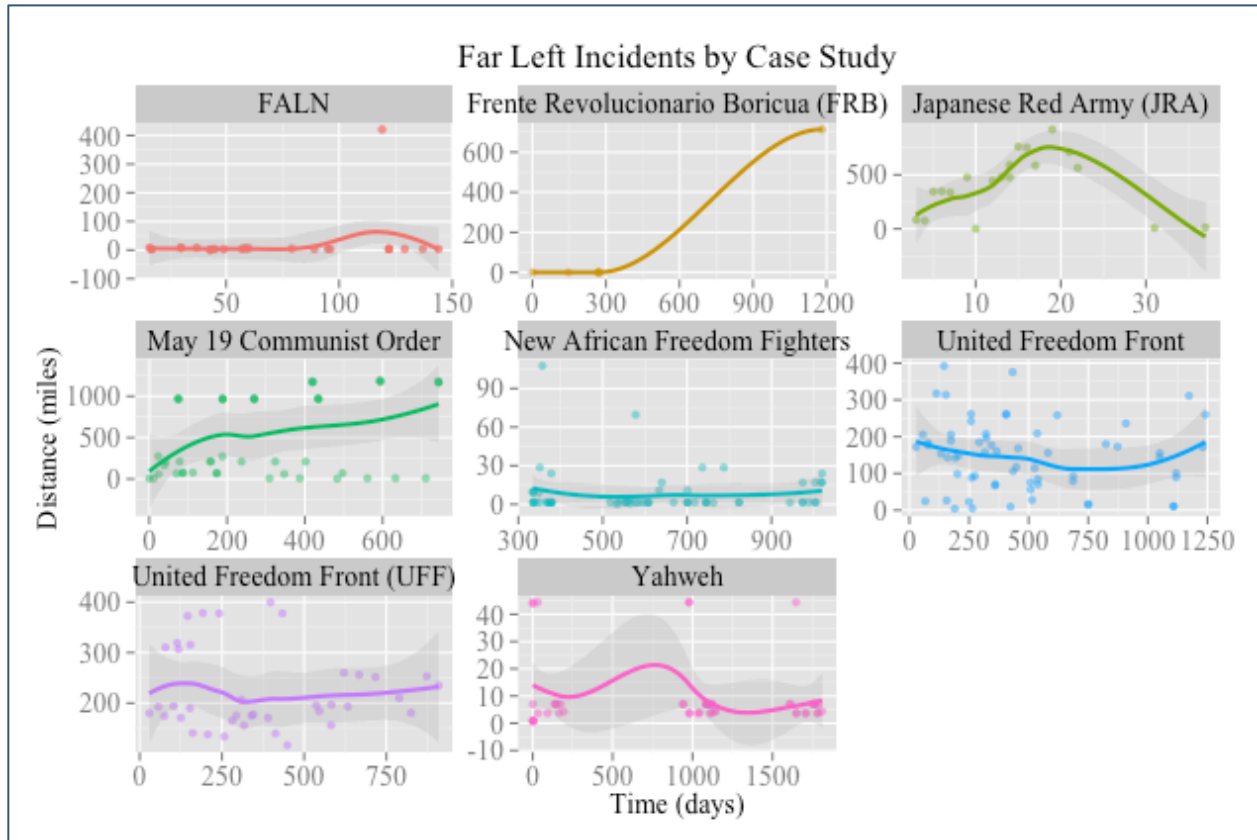
Figure 39. Time-Space Signatures for Far Left Incidents by Case Study

Figure 40 shows the Far Left incidents graphed by case study. The figure shows that the

various incident subtypes include incidents of similar lengths; all incident subtypes include

incidents with planning cycles of over 1000 days. Additionally, this figure shows that Far Right

planning for Facility/Infrastructure attacks and Armed Assault attacks occur near to the target

location throughout the planning cycle. Planning activities for Far Right Bombing/Explosion

attacks fluctuate greatly in their location relative to the target throughout the planning cycle.

Figure 40. Time-Space Signatures for Far Left Incidents by Incident Subtype

The Far Left incidents are shown in Figure 41 based on their relative incident subtype on individual plots below. This figure supports the same observations determined in Figure 40 above. While the Armed Assault and Facility/Infrastructure Attacks involve planning activities close to the target, the Bombing/Explosion attacks vary in their proximity to the target. All signature lines for the three incident subtypes do appear to be relatively flat and do not show distinctive change in position over time.
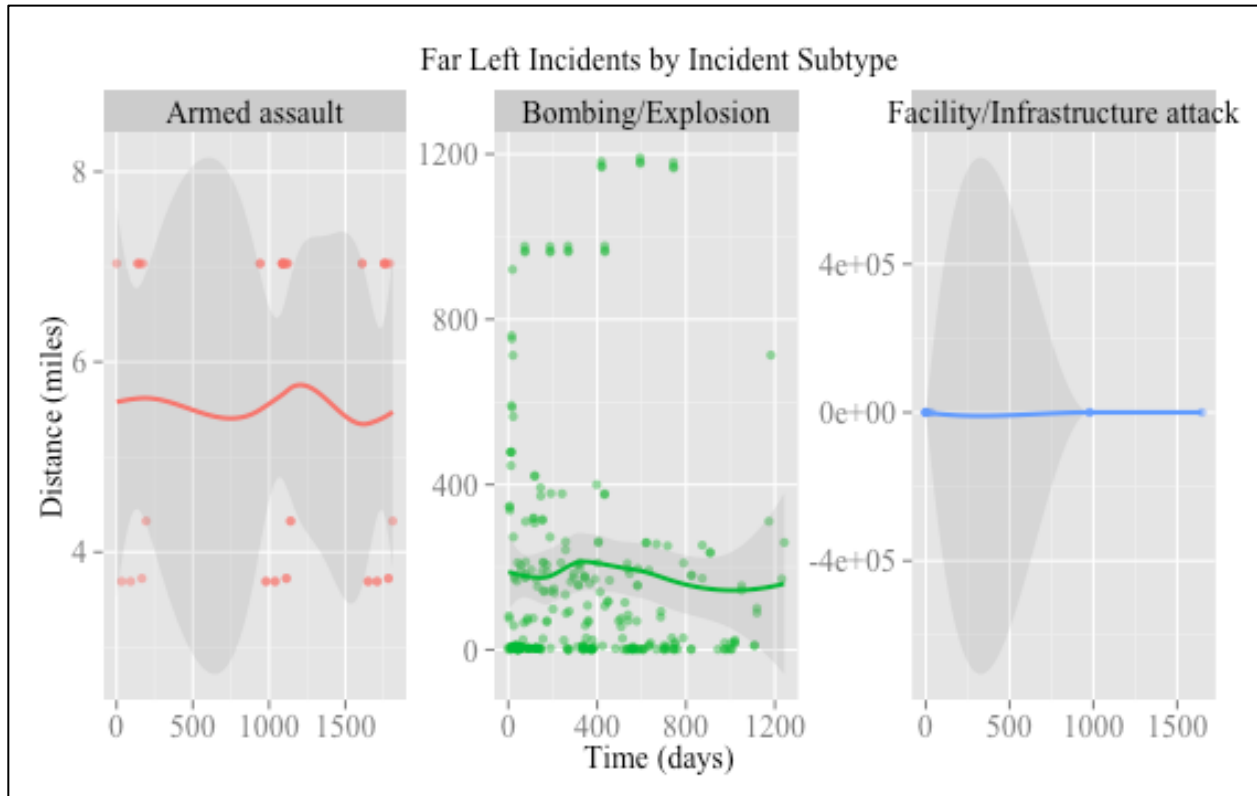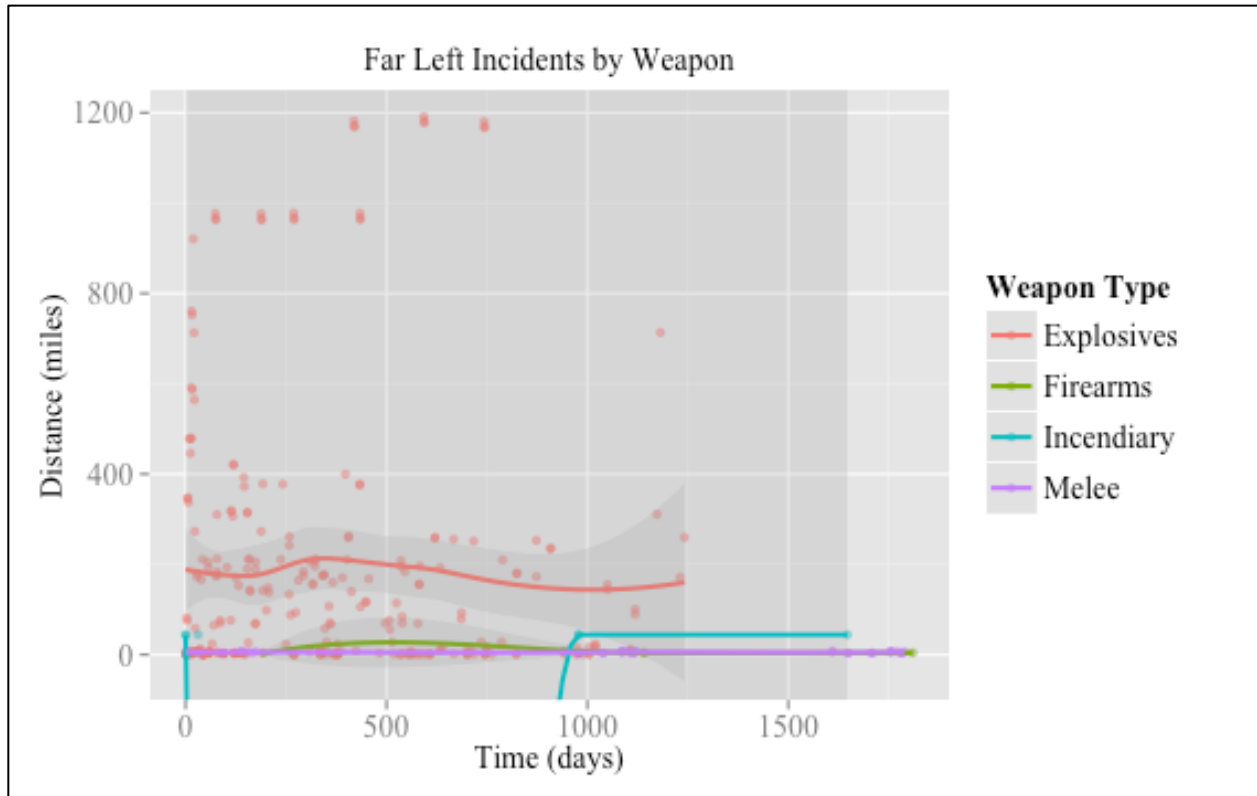
Figure 41. Time-Space Signatures for Far Left Incidents by Incident Subtype

Far Left incidents are shown graphed by their Weapon Type in Figure 42 below. The graph has noticeable similarities with Figures 40 and 41 above, as the weapon type is likely to correspond to the incident subtype. Incidents involving melee and firearms together represent the signature for Armed Assault in Figure 40. Additionally, Explosives correspond to the signature for Bombing/Explosion while Incendiary devices correspond to Facility/Infrastructure attacks. Planning and preparatory activities involving melee, firearms, and incendiary weapon types are close to the target. Planning and preparatory activities involving explosives seem to fluctuate in their spatial relationship to the target.

Figure 42. Time-Space Signatures for Far Left Incidents by Weapon Type

Figure 43 below shows the signatures plotted individually for Far Left incidents by weapon type. All signatures show a limited movement from the target over time, though the data points for the Explosives weapon type appear to be distributed irregularly.
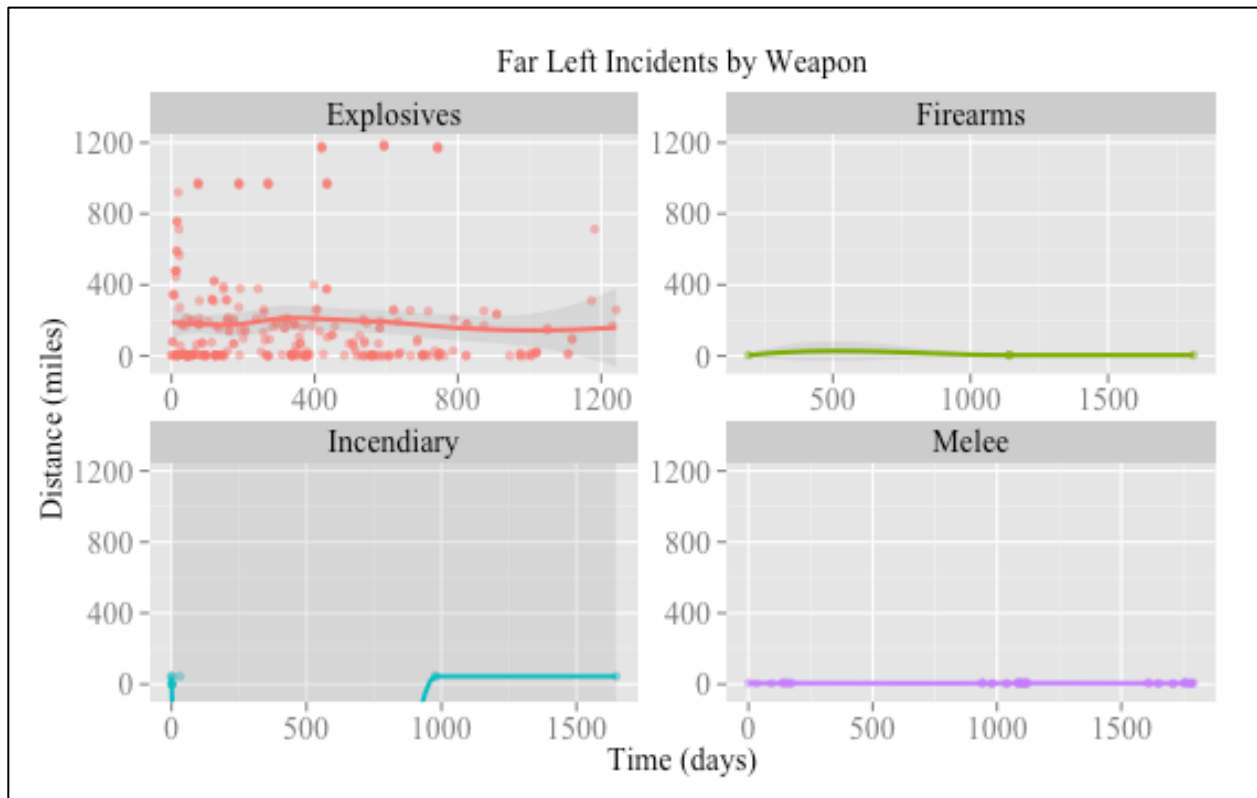
Figure 43. Time-Space Signatures for Far Left Incidents by Weapon Type

The Far Left incidents are graphed based on the target type involved in the attack in

Figure 44 below. There is visible variation in the patterns between time signatures. It appears as

if incidents targeting private property or citizens do not involve planning at locations remote

from the target; however, other target types seem to have signatures that fluctuate considerably

indicating movement in space throughout the planning cycle.
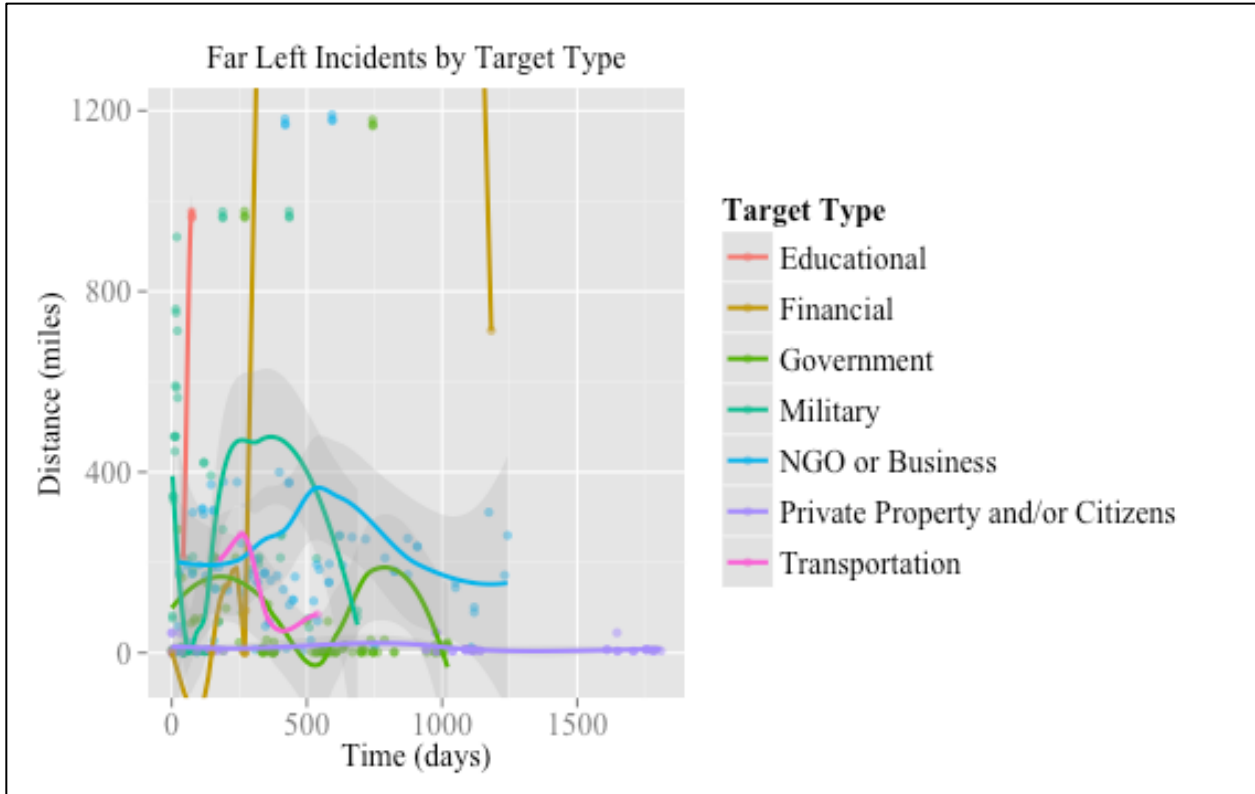
Figure 44. Time-Space Signatures for Far Left Incidents by Target Type

Far Left incidents are graphed individually based on their target type in Figure 45 below. All attacks on the various target types identified, with the exception of Educational targets, show a movement from the target location to a remote location and then a movement back to the target location. This fluctuating pattern seems to indicate that Far Left plots selecting these targets employ planning cycles that involve movement between the target and a more distant location.

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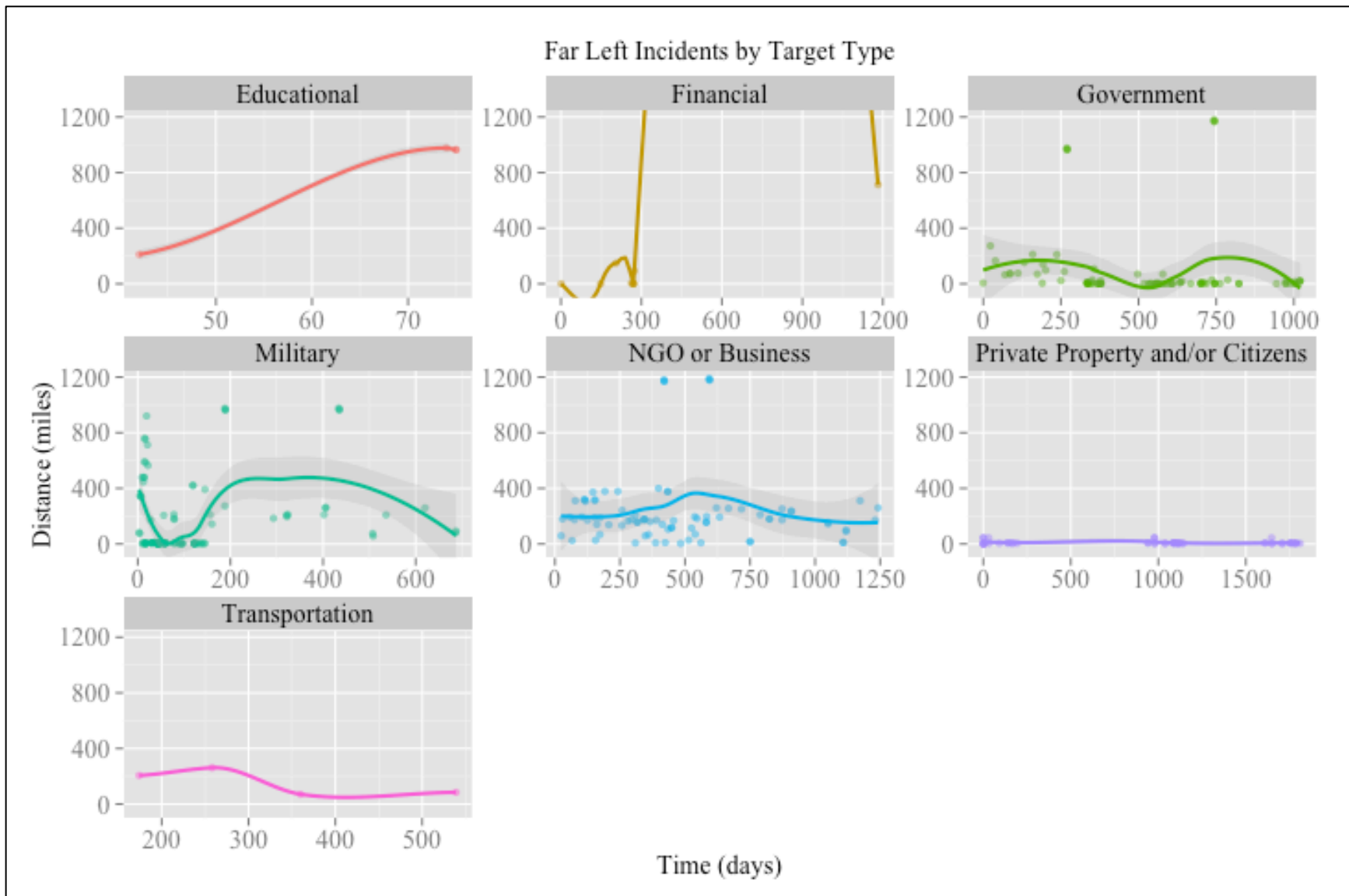
Figure 45. Time-Space Signatures for Far Left Incidents by Target Type

Far-Right

Far-Right terrorists encompass a collection of extremist groups that target specific communities. The communities targeted are often blamed for perceived shortcomings within society (Taylor, 2013). Far-Right groups are organized into two groups. The first group consists of actors who claim to represent the interest of the general public over the actions of others in society. These groups often have their ideologies characterized by value systems rooted in antigovernment and evangelical religious extremism. An example of this type of Far-Right group is the Army of God, a Christian extremist group that propagates a primarily anti-abortion agenda. The second set of organizations is known as 'hate groups;' these groups form their ideologies from their perceived ethno-national or religious superiority (Martin, 2011). Examples of 'hate groups' include the Aryan Nation and the Jewish Defense League (JDL).

Far-Right terrorist groups have varied levels of organization. While some Far-Right terrorists act as individuals in accordance with the opinions of a larger group, other terrorists work in rigidly structured and organized groups where commands are facilitated through an established hierarchy (Taylor, 2013). These groups often organized in compounds or retreats; the compounds encourage the development of radical ideologies and violent ambitions and can facilitate planning, training, and supply stockpiles (Taylor, 2013). In general Far-Right groups have been characterized as less organized and less consistent than Far-Left extremism (Martin, 2011). Despite their outward image, these groups still posses deliberate polices and plots intended to achieve desired goals within society; their actions are aimed at increasing awareness and providing the start of changes within society and government (Hoffman 1998). Though Far Right extremists are often stereotyped as individuals of limited accomplishment, they have possessed the capacity to carry out plots affecting communities throughout the United States.

Far Right The Army of God Manual provides an insight into planning cycles for Far-Right terrorist groups. The manual has a section titled 99 Ways to Stop Abortion. The section contains detailed directions for how to sabotage abortion clinics in various ways ranging from gluing locks to destroying facilities with propane gas. Various methods also include insights into how to avoid detection and how to increase awareness of the attack motivations. Bombings, murders, and assaults characterize the majority of the recorded incidents carried out by Far-Right groups. These instructions include insights into terrorist planning stages target selection, pre-attack planning, and attack execution.

Figure 46 below shows the signature for all Far Right records. The figure shows a gradually decreasing signature that approaches the date and location attack. It appears that there is a decrease in distance between the target and the preparatory act as the attack approaches in time.
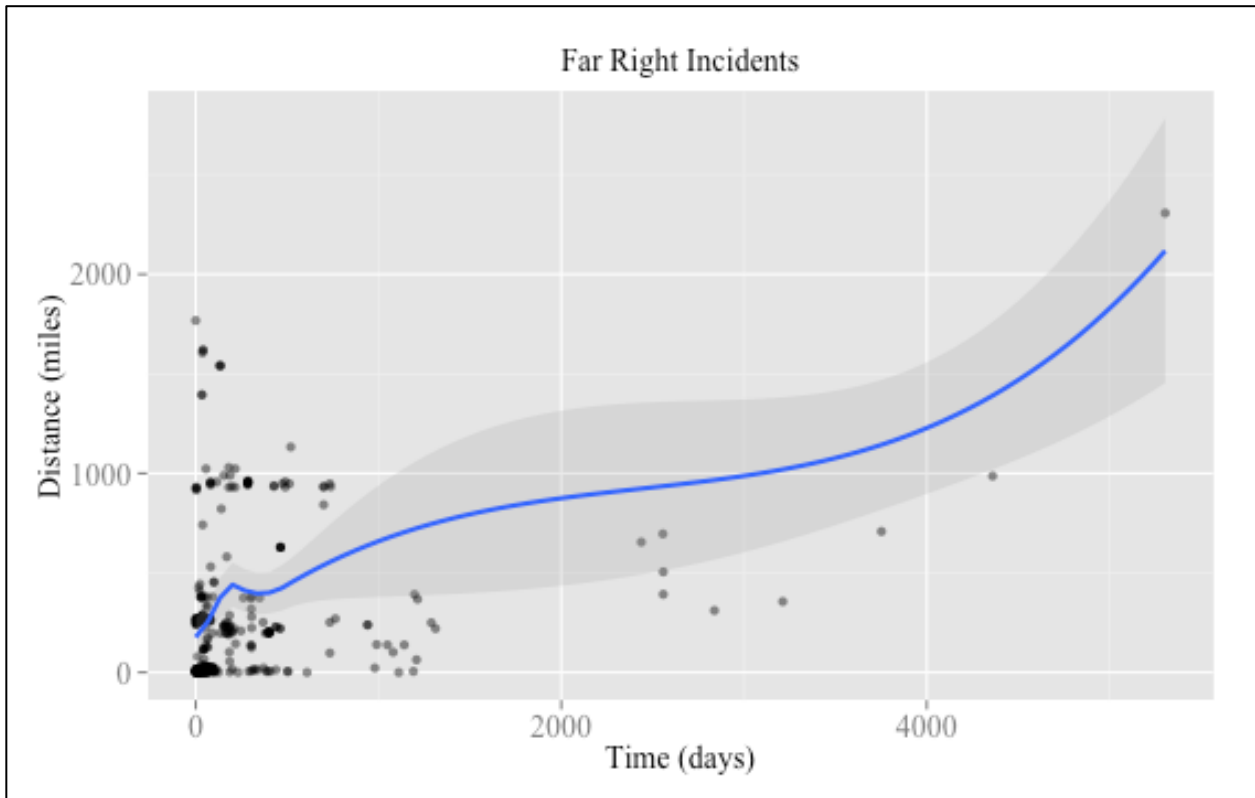
Figure 46. Time-Space Signature for Far Right Incidents

The Distribution of Far Right Time Values for the entire Far Right dataset are shown below in Figure 47. The bottom third of the data occur within 296 days of the attack, indicating that the majority of activities occur within a year of the attack. The median value is 77, showing that the bottom half of activities occur within less than 3 months of the attack. The mean value of 281.20 days is much greater than the median value and indicates that the distribution is skewed to the right due to a much higher max value and other outliers.

Distribution of Far Right Time Values	
	Time (days)
Min	0.00
1st Quartile	27.50
Median	77.00
Mean	281.20
3rd Quartile	296.00
Max	5304.00

Figure 47. Distribution of Far Right Time Values

The Distribution of the Far Right Time values described above is shown in the histogram in Figure 48. This figure shows that the data exhibits a right skewed distribution. It shows that a majority of the preparatory activities of Far Right terrorist groups occur near to the time of the attack.
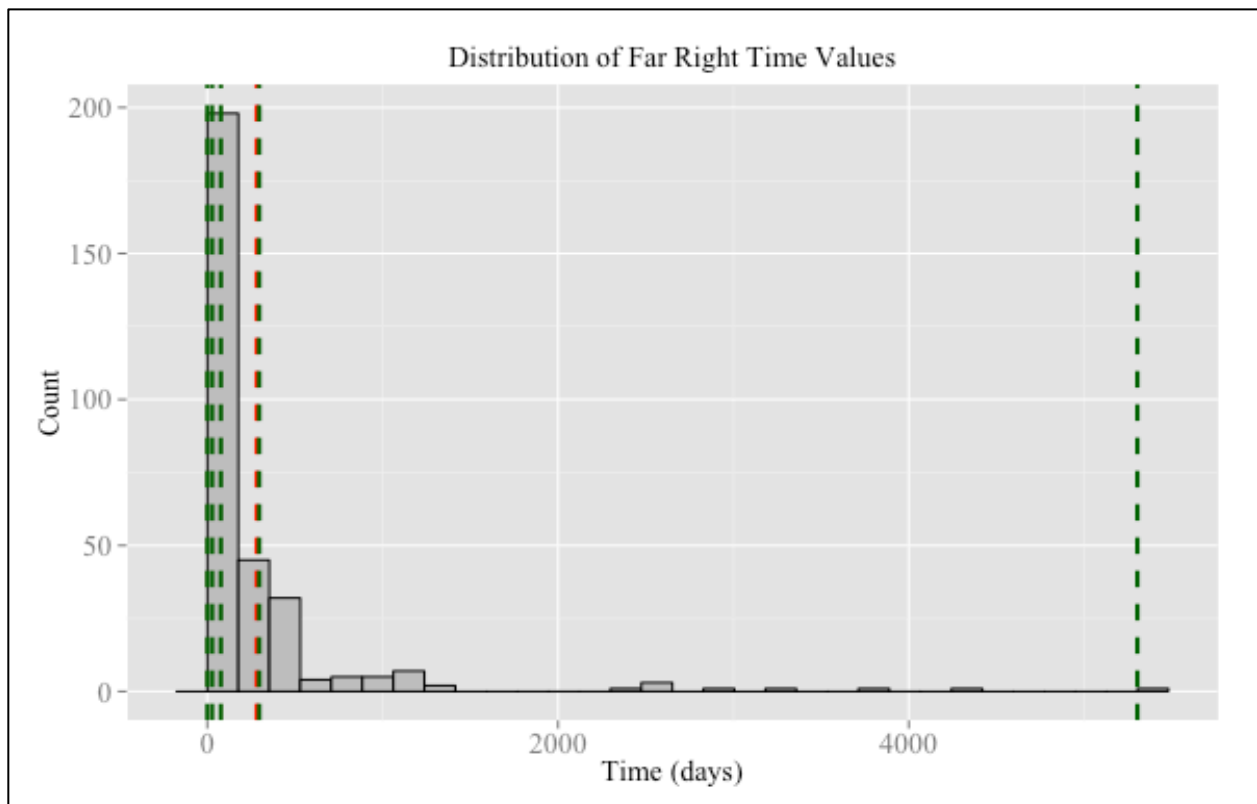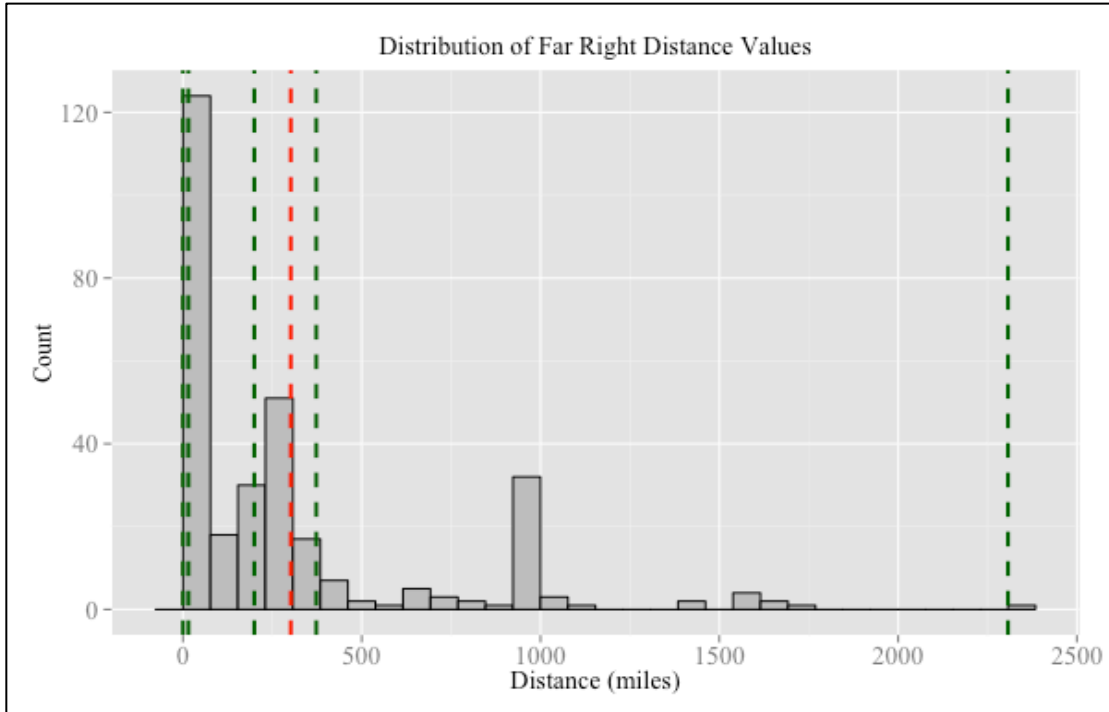

Figure 48. Histogram for Distribution of Far Right Time Values

The distance values for the Far Right dataset are summarized in Figure 49 below. The distance values are spread more evenly within the first three quartiles of the dataset, while the fourth quartile appears to contain the high maximum values and other outliers. This distribution shows that the preparatory attacks are occurring at a range of distances from the target location.

Distribution of Far Left Distance Values	
	Distance (miles)
Min	0.000
1st Quartile	15.570
Median	199.520
Mean	301.580
3rd Quartile	372.800
Max	2307.360

Figure 49. Distribution of Far Left Distance Values

Figure 50 below shows a histogram representing the distribution of Far Right distance values. The histogram shows that the values are even spread within the first three quartiles, while the third quartile occupies a much higher range. This right-skewed distribution indicates that planning activities for Far Right groups generally occur within 400 miles of the target though they have been recorded at much greater distances. Additionally, it shows that there is a fairly even distribution of activities between 0 and around 400 miles from the target.

Figure 50. Histogram for Distribution of Far Right Distance Values

A statistical summary of the first preparatory action for each of the Far Right incidents is shown below in Figure 51. It appears that planning for Far Right incidents occurs far in advance of the attack at a location remote from the target. This is through the median incident, which begins 318.70 days before the attack at a location 472.500 miles away. This idea is also supported through profile of the top third of attacks, which begin at least 214.47 days before the attack and at a distance of 204.500 miles from the attack.

Far Right Incidents Initial Act Summary		
	Time (days)	**Distance (miles)**
Min.	2.80	55.000
1st Qu.	214.47	204.500
Median	318.70	472.500
Average	500.26	985.429
3rd Qu.	758.62	1232.750
Max.	2307.36	5304.000

Figure 51. Distribution of Values for Initial Act in Far Right Incidents

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The Far Right incidents are shown below in the Figure 52. It is difficult to discern any individual pattern due to the number of incidents and diversity in signatures. It does appear that there is fluctuation in spatial location over time with a number of the incidents, though there are also incidents that are more stable and imply less movement in relationship to the target. It is also noticeable that a considerable amount of activity occurs at large distances away from the target.
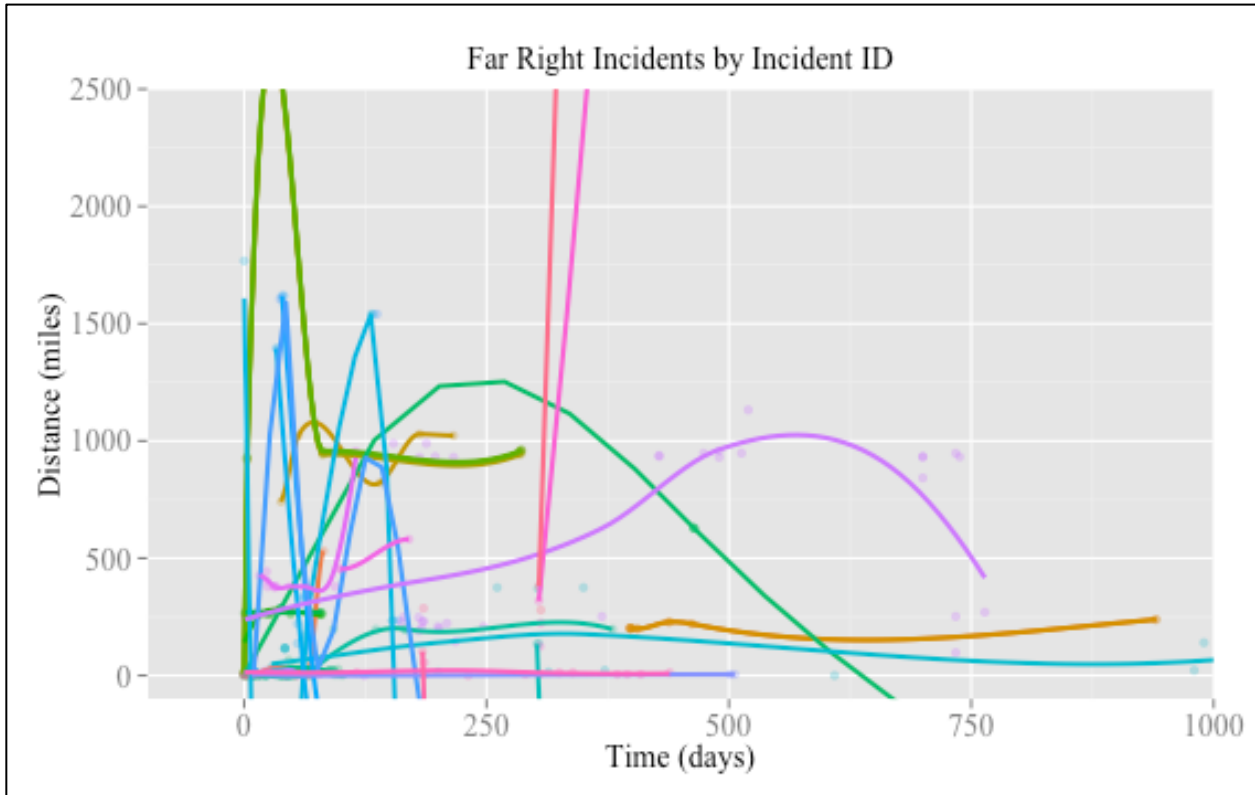
Figure 52. Time-Space Signatures for Far Right Incidents by Incident ID

Figure 53 and Figure 54 below show the Far Right incidents graphed individually. The incidents have been divided into two groups and graphed between two figures due to the larger number of incidents. There are around 14 signatures that display the trend of visiting the site and subsequently moving to a more distant location before approaching the site again. There are also some U shaped curves, these are however incidents that are contain signatures that delve into the negative area of the quadrant and are therefore would be more likely represented by straight lines

along the axis. The general trend of visiting the target, or an area with closer proximity to the target, and relocating to further plan the attack seems to be on display in incidents such as Incident 7351 and 50282.
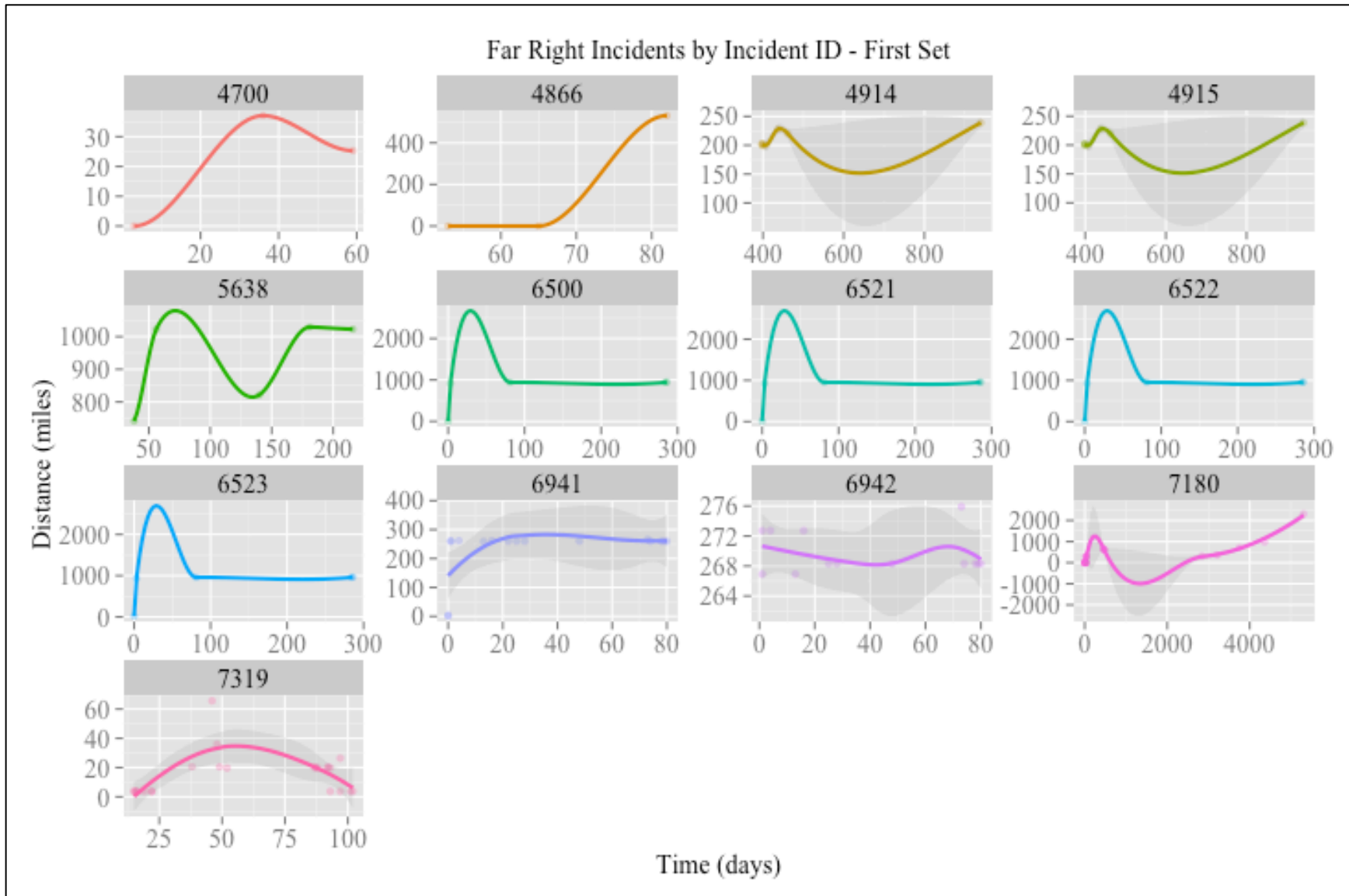
Figure 53. Time-Space Signatures for Far Right Incidents by Incident ID – First Set
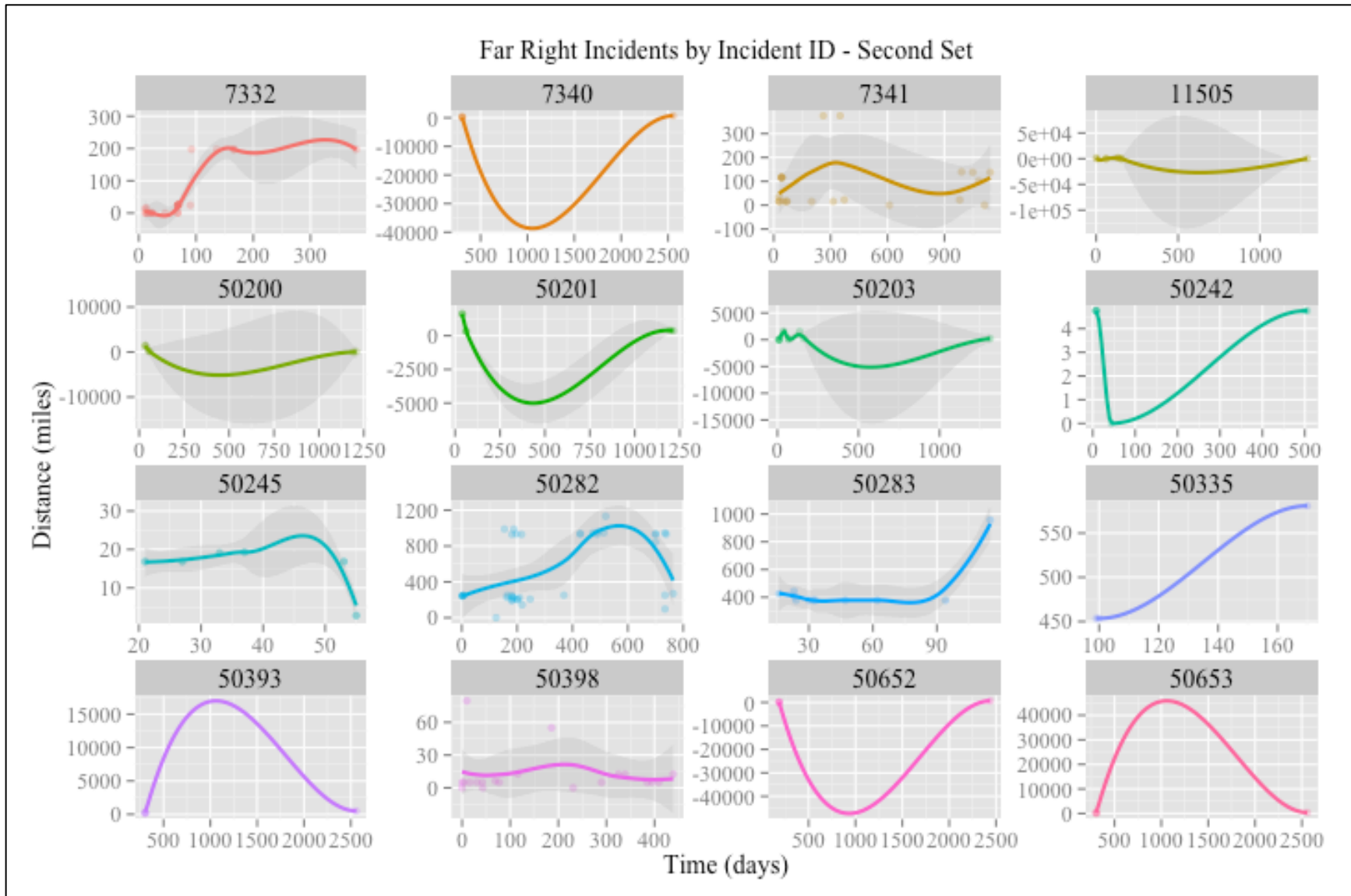
Figure 54. Time-Space Signatures for Far Right Incidents by Incident ID – Second Set

The Far Right incidents are shown in Figure 55 based on their case study. It appears from the graph that a number of categories employ initial planning activities near the target site followed by subsequent activities at a further distant from the target. Following a retreat from the target area, the target is approached once more for planning and preparatory activities. This is shown through a rise and successive fall in the signature. Though this pattern is exhibited by a number of categories, there are also signatures that display different patterns. It is noted that Far Right groups often organize in compounds or retreats; changes in location are often required for the facilitation of meetings which in many cases can be linked to the location of a compound (Taylor, Holbrook, and Currie 2013).
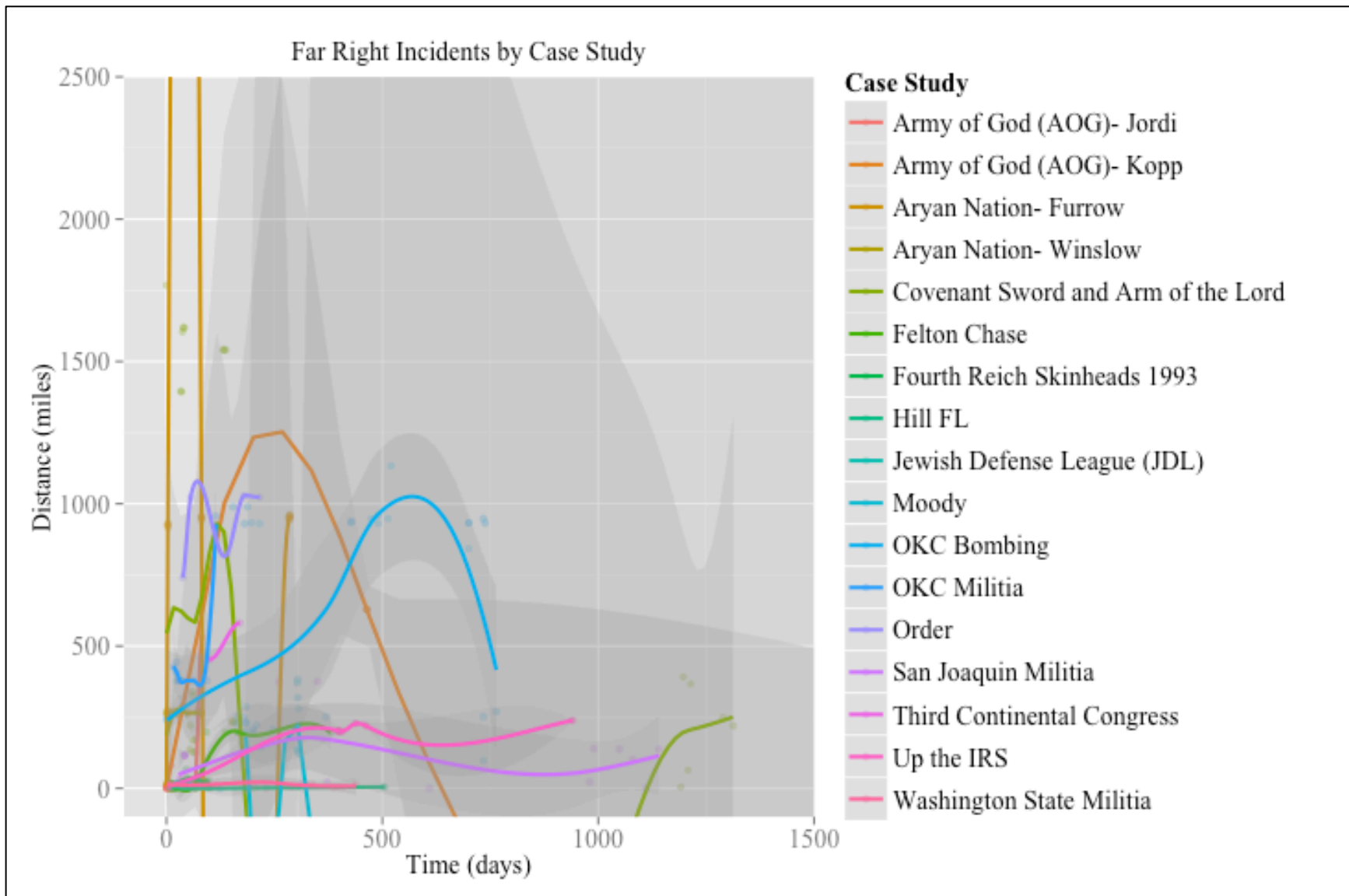
Figure 55. Time-Space Signatures for Far Right Incidents by Case Study

Figure 56 below shows the Far Right incidents graphed by category in individual plots. There are five signatures that show little increase or decrease between distances from the target over the course of the planning cycle. There are also categories that exhibit approach the target, travel to greater distances, and ultimately travel back to the target for activities during their planning cycle.
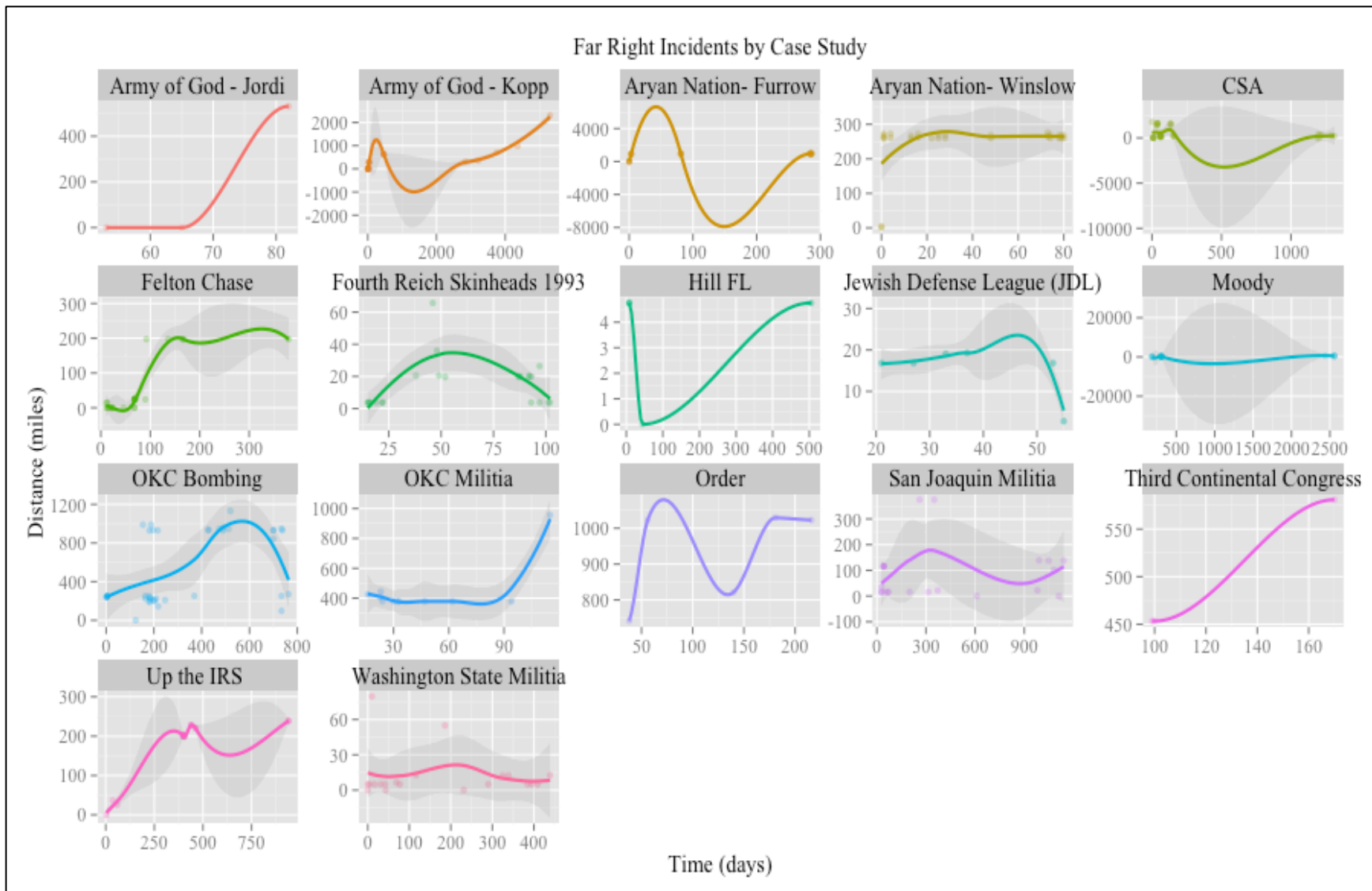
Figure 56. Time-Space Signatures for Far Right Incidents by Case Study

The Far Right incidents are graphed based on their incident subtype in Figure 57. In this figure it appears that Armed Assaults and Bombings/Explosions involve planning near the target throughout the planning cycle while Facility/Infrastructure attacks employ planning activities at the target location, followed by planning at a remote location, and subsequently planning and preparation near the target directly prior to the attack.
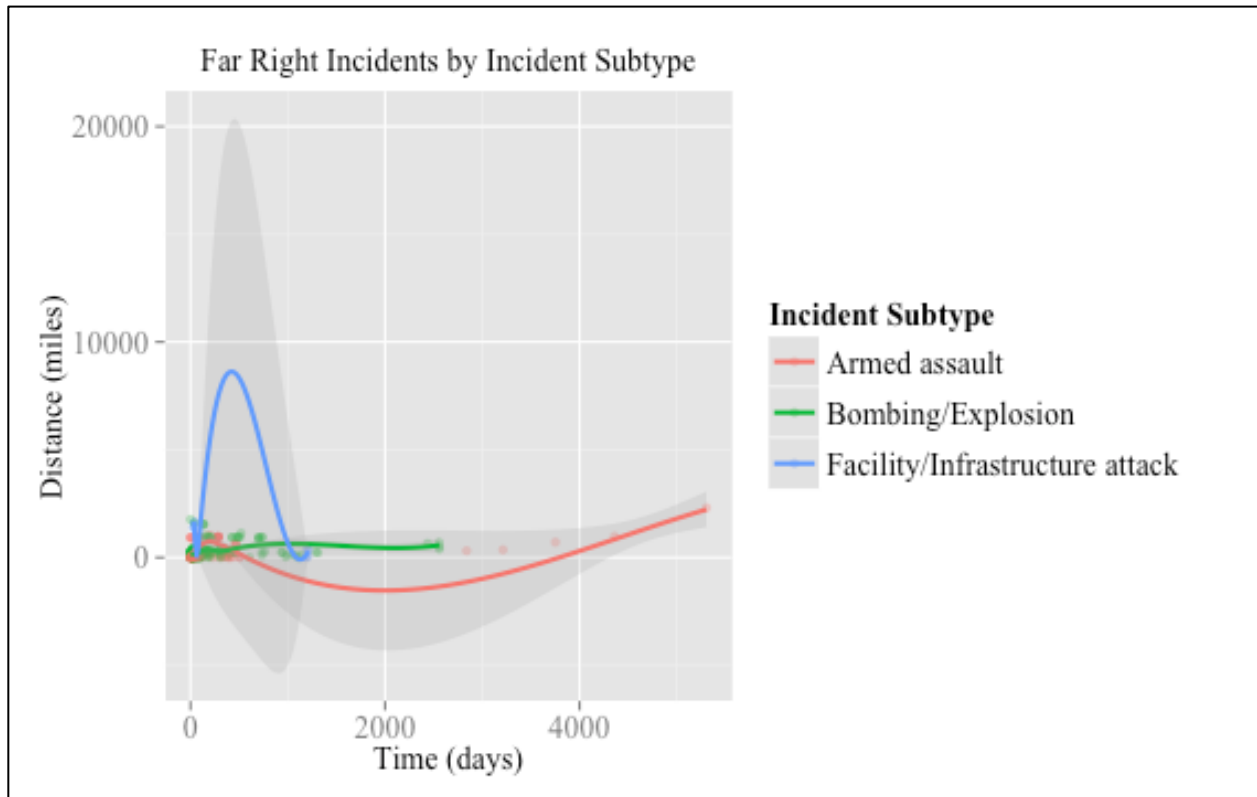

Figure 57. Time-Space Signatures for Far Right Incidents by Incident Subtype

Figure 58 below shows the Far Right incidents graphed by incident subtype in individual plots. In this figure, the signatures are shown in greater detail. The planning cycle for Far Right incidents involving armed assaults seem to approach the target from distance, and subsequently retreat back to a more distant location before approaching the target for the attack. Bombing/Explosion incidents exhibited a gradual decline in distance towards the target over time with some minor fluctuations. Facility/Infrastructure attacks show a trend where planning

activities are first conducted near the target, then remotely from the target, and eventually near the target prior to the attack.
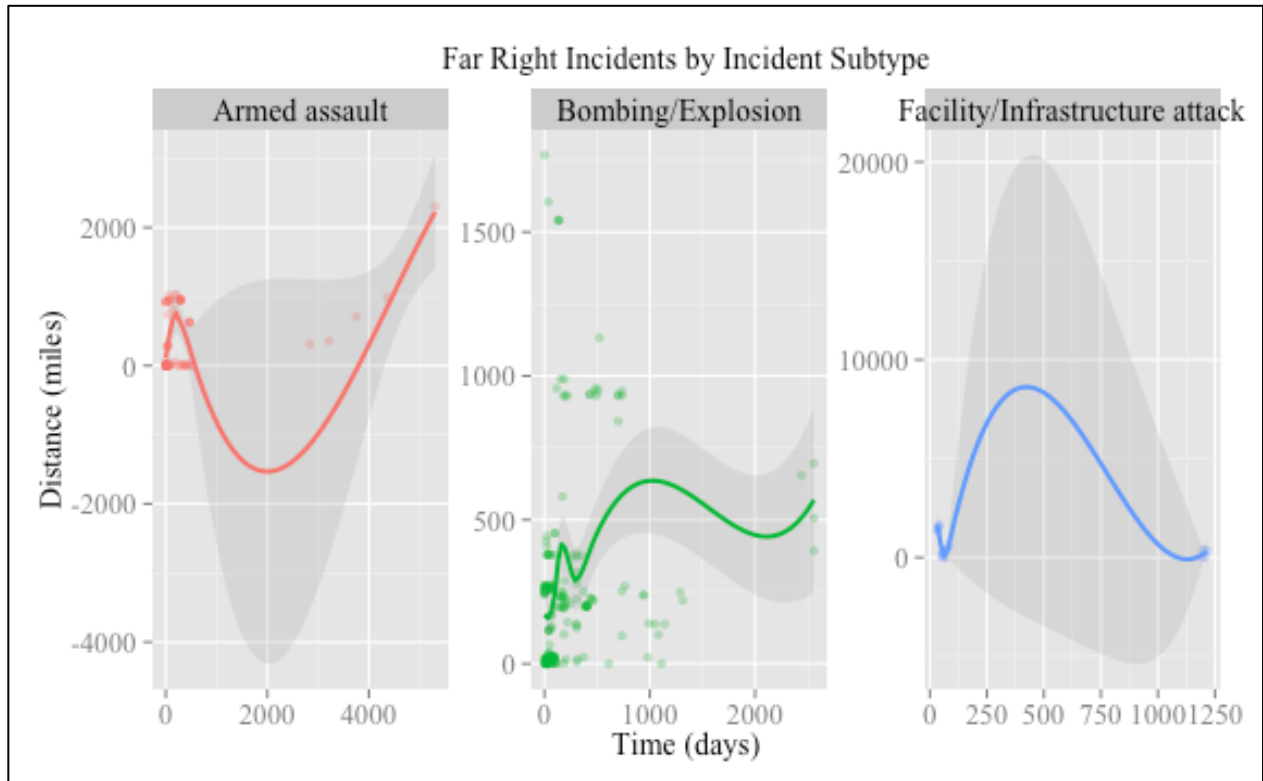
Figure 58. Time-Space Signatures for Far Right Incidents by Incident Subtype

The Far Right incidents are plotted by Weapon Type in Figure 59 below. The signature for Far Right incidents involving Explosives is logically identical to the signature for Far Right incidents of the Bombing/Explosion incident subtype while the Firearms weapon type signature is identical to the Armed Assault incident subtype signature. The signature for the Incendiary weapon type signature bears similarities to the Facility/Infrastructure attack incident subtype signature, however the curve appears to show the opposite relationship, with the curve below the x-axis into the negative space.
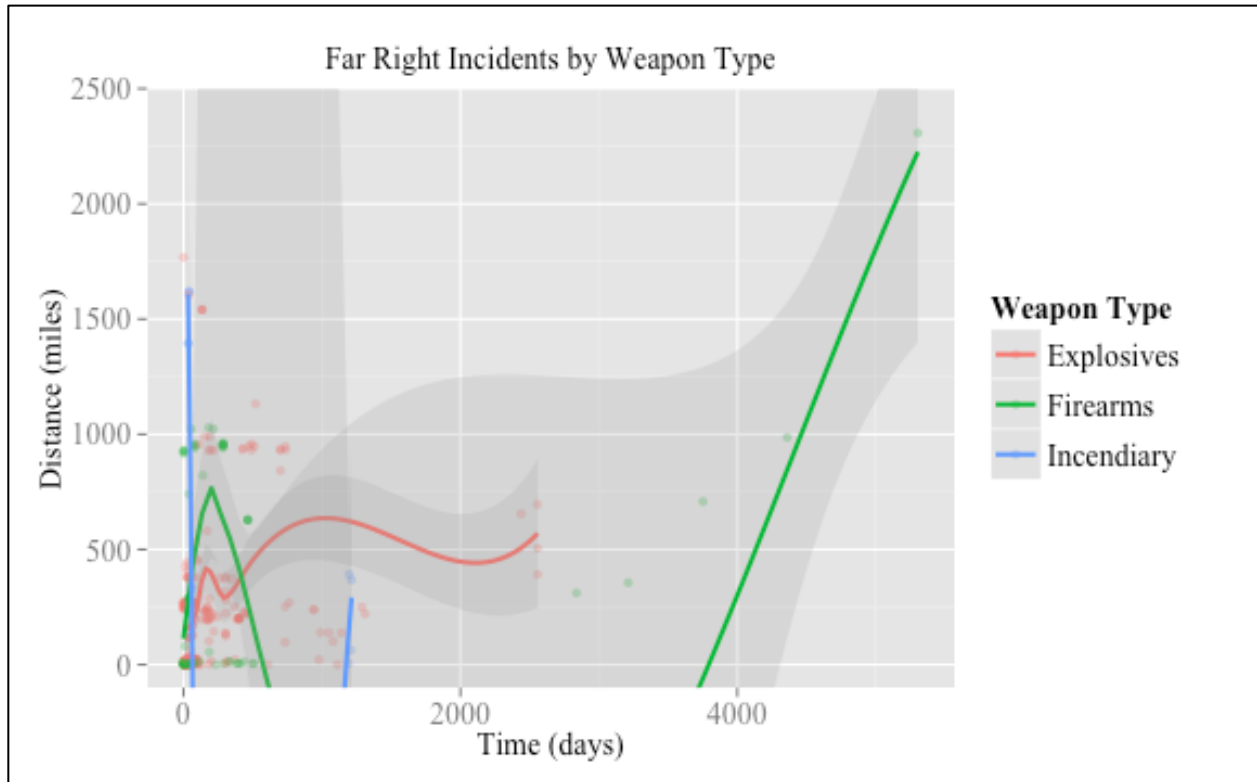
Figure 59. Time-Space Signatures for Far Right Incidents by Weapon Type

The Far Right incidents are individually graphed based on weapon type in Figure 60. The Far Right incidents involving explosive weapon types present the most clear and observable signature. This signature shows activity occurring at a decreased, yet slightly fluctuating, distance from the target as the attack gradually approaches.
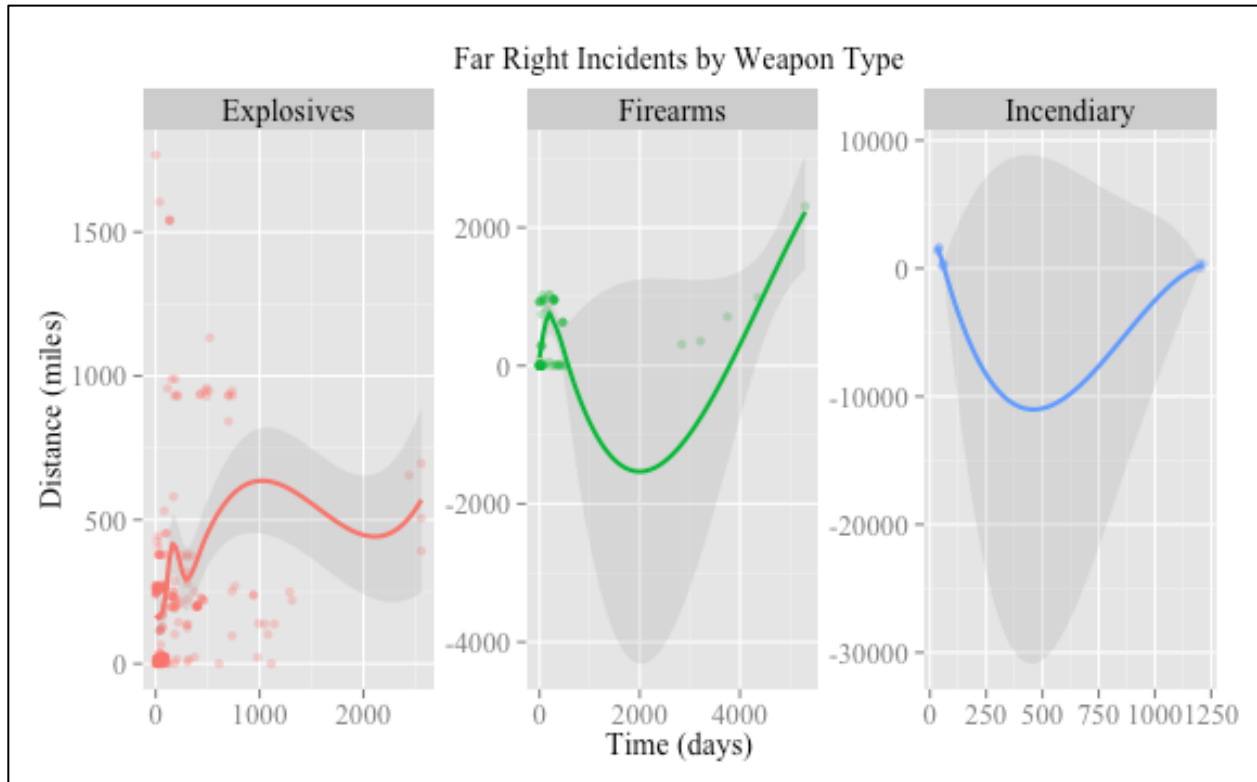
Figure 60. Time-Space Signatures for Far Right Incidents by Weapon Type

The Far Right Incidents are graphed based on the target type in Figure 61. The figure shows the variance in planning cycles based on the target type. There is not a clear pattern shared between the signatures of incidents involving various target types. There are no signatures with stable movement in relationship to the target over time; instead there seems to be a considerable amount of fluctuation in the location of planning activities based on target type.
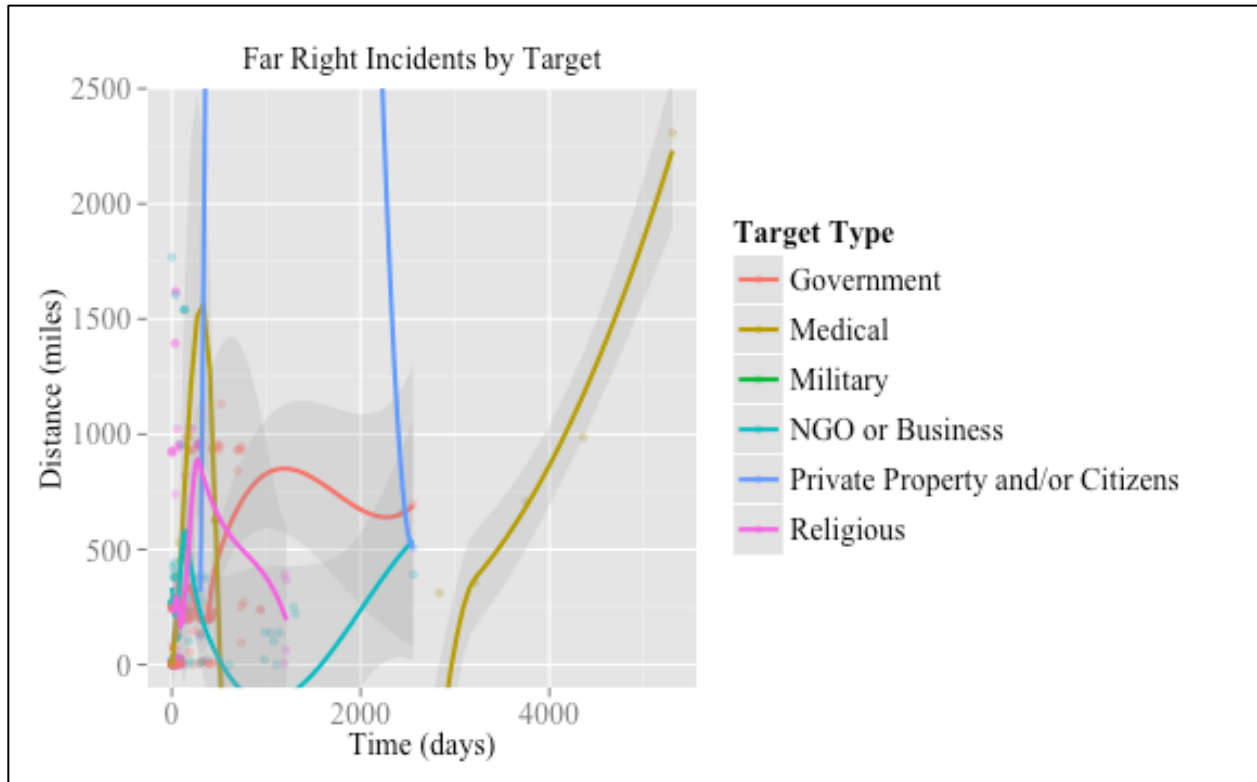
Figure 61. Time-Space Signatures for Far Right Incidents by Target Type

The Far Right incidents are graphed in individual plots based on the target type in Figure 62. The government target type signature bears similarities to the Explosives weapon type signature and naturally the bombing/explosion incident subtype signature. All but one signature at some point during their planning cycle include an identifiable pattern of approaching the target, retreating from the target, and approaching the target again for preparation prior to the attack.
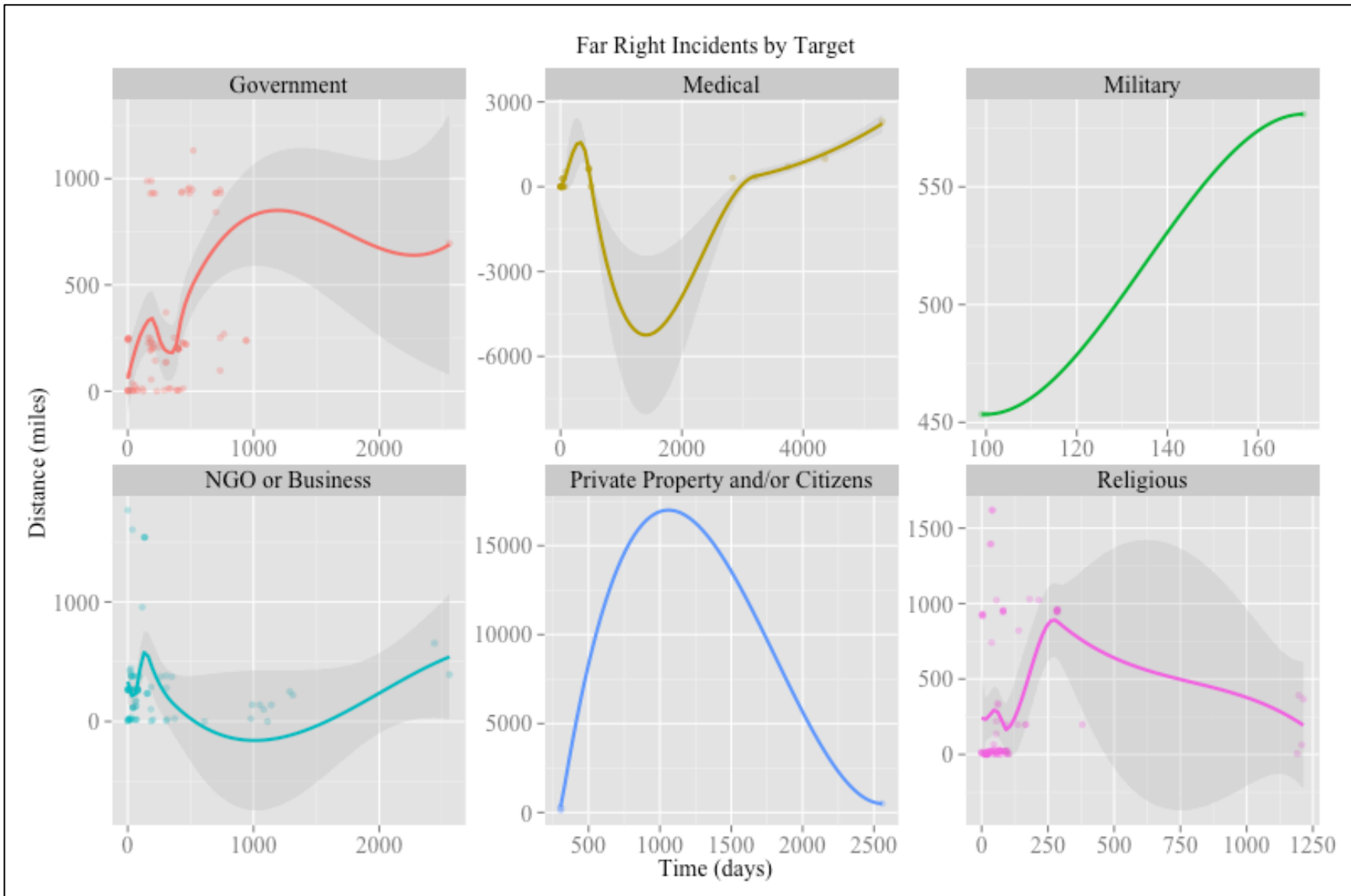
Figure 62. Time-Space Signatures for Far Right Incidents by Target Type

Islamic Extremist

Islamic extremists are terrorist actors that are motivated by their religion to seek social and political change. Much of the rational for acts of Islamic terrorism is rooted in the idea that Islam is not just a religious movement, but also a political one, and that society and politics should function in accordance with Islam (Thackrah, 1987). Islamic extremists have derived their hostility towards the U.S. government and its population in particular from a number of factors. These factors range from foreign policy and international involvement, such as the U.S. occupation of Saudi Arabia and its holy places, to distaste of modern, secular ways of life (Hewitt, 2003).

Islamic extremist organizations, such as al Qaeda, have expansive infrastructure throughout the world, including 'sleeper cells' within the United States that can be engaged in specific attacks (Hewitt, 2003). Their operations are known to involve principles of military organization. Insights into Islamic extremist terrorism techniques were discovered after an al Qaeda training manual was obtained during a police raid of a house in Manchester, England. The manual contains information on military organization and operation techniques. The guide provides information on how to effectively gather information, avoid detection, establish safe houses, and conduct acts of terrorism, such as kidnapping, assassinating, and bombing (Hewitt, 2003).

Islamic extremist groups, such as al Qaeda, often have expansive networks that traverse international boarders, therefore the planning cycle has been hard to discern. Cells can be located across political boundaries and planning can last months or even years. It has been noted that Islamic extremist actors have been able to live and work in areas for long periods of time without detection while planning and training for attacks (Taylor, 2013). The ability for Islamic terrorists

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to avoid detection and live normal seeming lifestyles is vital to their success; techniques for preventing suspicion have been discovered in the al Qaeda training manual.

The signature for all Islamic Extremist records is shown in Figure 63 below. The signature shows a great variation in planning even locations occurring 500 days before the attack with three outlier events at greater than 1000 days before the attack. Signature shows that planning events occurring at the longest time before the attack are very close to the target. Preparatory events then occur at a greater distance from the target before moving to closer distances from the target. There is also slight fluctuation in the distance between the preparatory events and the target towards the end of the planning cycle.
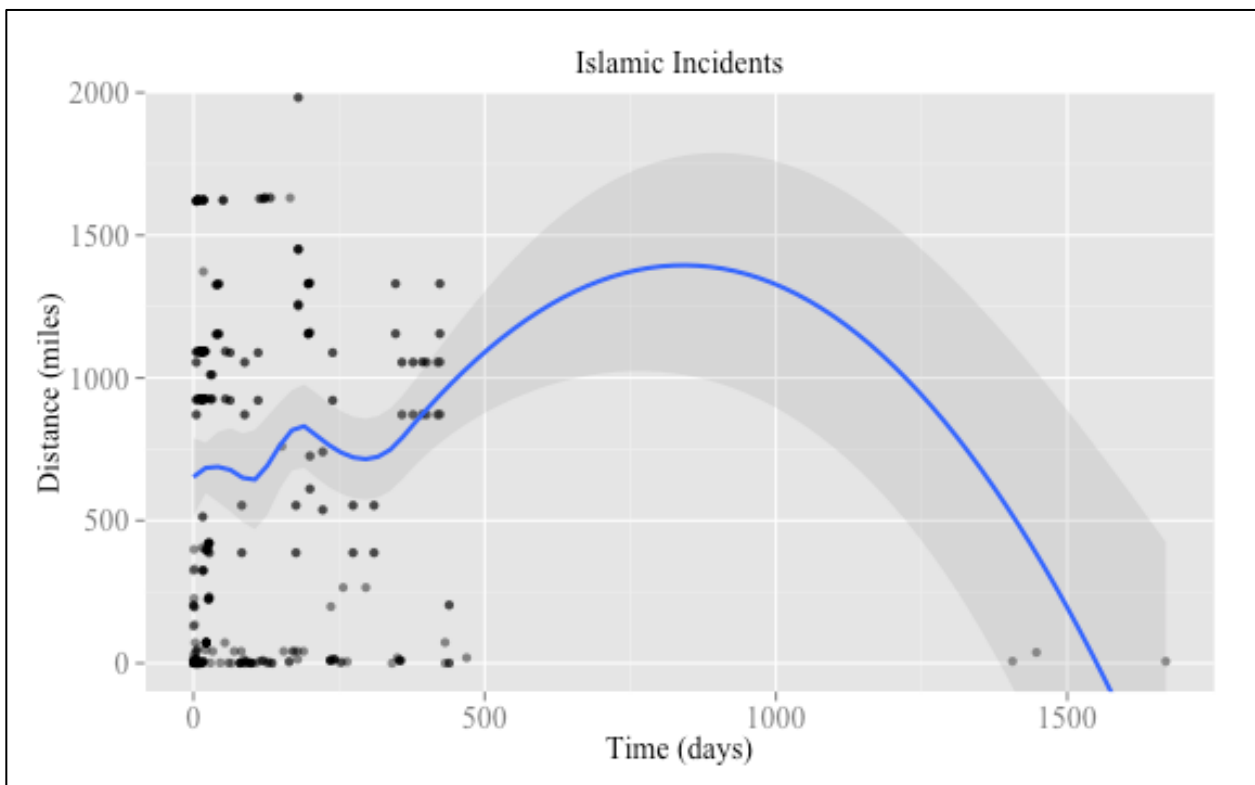
Figure 63. Time-Space Signature for Islamic Extremist Incidents

Figure 64 contains figures that represent the distribution of the time values for Islamic Incidents. The distribution shows that the lower third of values occur within around 200 days of

the attack while the upper third of values are stretched between around 200 days from the attack all the way to around 1700 days from the attack. The median value of 44 shows that the lower half of planning events occur within less than two months from the attack.

Distribution of Islamic Time Values	
	Time (days)
Min	0.00
1st Quartile	14.00
Median	44.00
Mean	133.80
3rd Quartile	198.50
Max	1669.00

Figure 64. Distribution of Islamic Extremist Time Values

Figure 65 below shows the distribution of Islamic extremist incident time values in a histogram. The values are represented as a right skewed distribution. The histogram shows that the preparatory events are concentrated towards time periods closer to the date of the attack while preparatory events a long time before the attack are far less frequent.
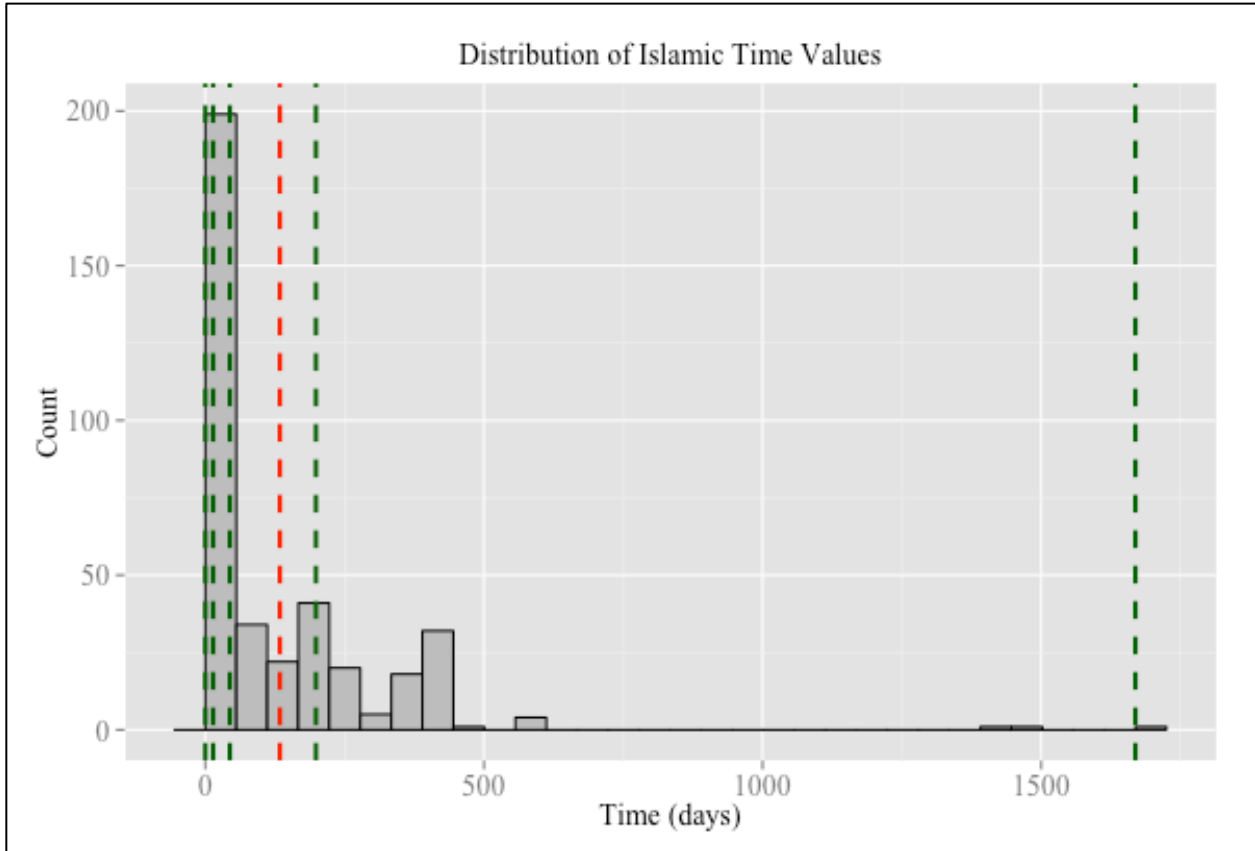
Figure 65. Histogram of the Distribution of Islamic Extremist Time Values

Figure 66 shows the distribution of distance values within the Islamic extremist dataset. There is a concentration of events with close distances from the target as the lower quartile is set at 41.630; however, second quartile of values seem to occupy a large range, as the median value is 871.340. There are a considerable amount of incidents at a great distance from the target as the upper half of the values range from between 871.340 to 2461.790 miles from the target.

Distribution of Islamic Distance Values	
	Distance (miles)
Min	0.000
1st Quartile	41.630
Median	871.340
Mean	744.920
3rd Quartile	1092.850
Max	2461.790

Figure 66. Distribution of Islamic Extremist Distance Values

The Distribution if Islamic Extremist distance values is summarized in Figure 67. This figure illustrates the irregular distribution of distance values. The histogram resembles an Edge Peak distribution as it has a large peak at the left tail, however, due to its multiple peaks it could also resemble a bimodal distribution. The histogram shows that there is a cluster of preparatory events occurring at a close proximity to the target, but also a cluster of preparatory events occurring at a greater distance from the target.
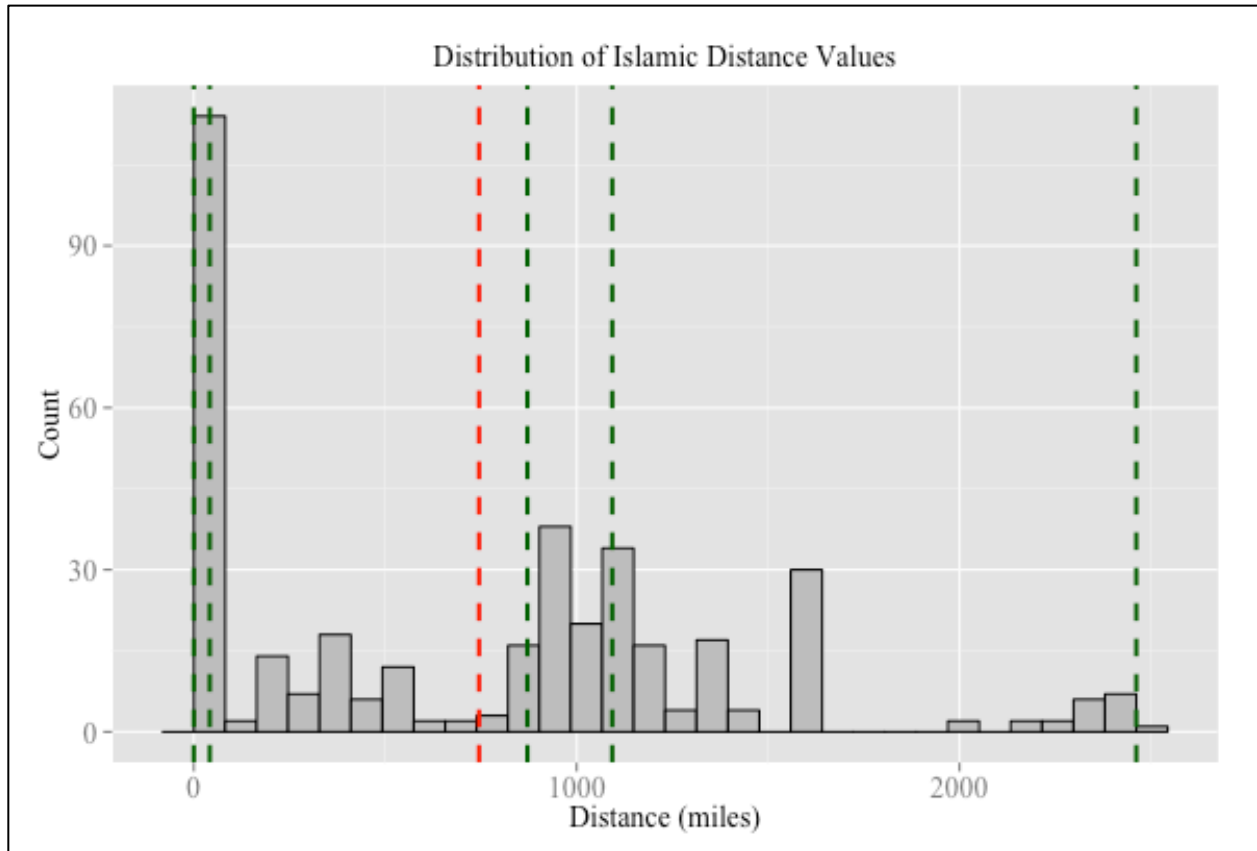
Figure 67. Histogram of the Distribution of Islamic Extremist Distance Values

Figure 68 below shows a statistical summary of the first act in each incidents planning cycle. Planning cycles for Islamic incidents range greatly, varying from 15 days prior the attack to over four years prior the attack. Initial Planning for the lower half of incidents occurs in under a 354 days, or around one year, from the attack while the upper half extends between around 354 days to over four years. Initial planning for Islamic extremist attacks begins at a range of locations. Planning for the lower quarter of attacks begins within 42 miles of the target, while the upper half begins at over 712 miles from the target.

Islamic Incidents Initial Act Summary		
	Time (days)	**Distance (miles)**
Min.	15.00	0.660
1st Qu.	91.00	9.565
Median	354.00	41.631
Mean	431.37	712.647
3rd Qu.	605.00	1411.931
Max.	1669.00	2461.788

Figure 68. Distribution of Values for Initial Act in Islamic Extremist Incidents

The Islamic Incidents are graphed by Incident ID in Figure 69 below. The graph reveals that the incidents generally begin at around 500 days prior to the attack or less. The graph shows that there are several incidents that contain stable movement in relationship to the target, while other incidents contain peaks in their signatures and thus fluctuate in terms of their distance from the target over time.
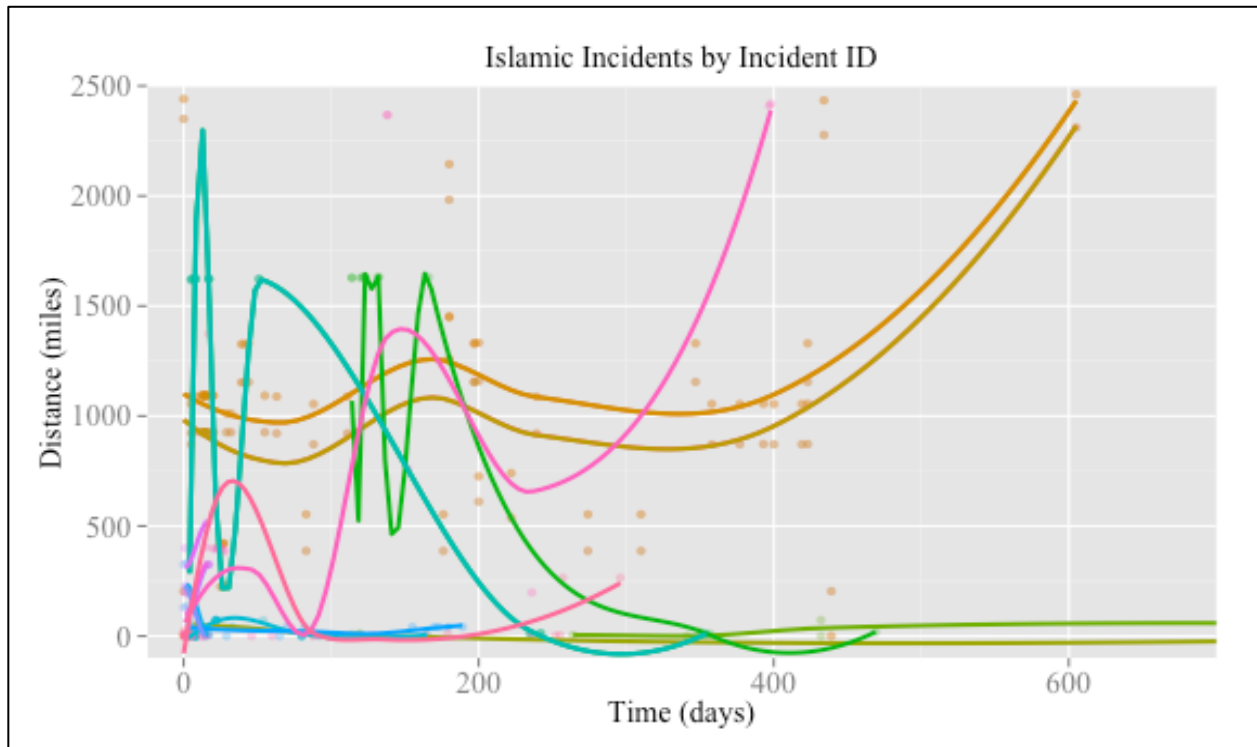
Figure 69. Time-Space Signatures for Islamic Extremist Incidents by Incident ID

The Islamic Incidents are displayed in individual plots based on their Incident ID in Figure 70 below. Once again it becomes apparent that there are a number of incidents with very flat signatures, indicating little movement in space during the planning cycle. Incidents 9600-9623, 9845, and 50406, have signatures that show initial activity close to the target followed by activity at a more remote location, and subsequently activity near or at the target location. These incidents, as well as other incidents within this category, show peaks within the signatures indicating that approaches towards the target are followed by withdrawals to distant locations.
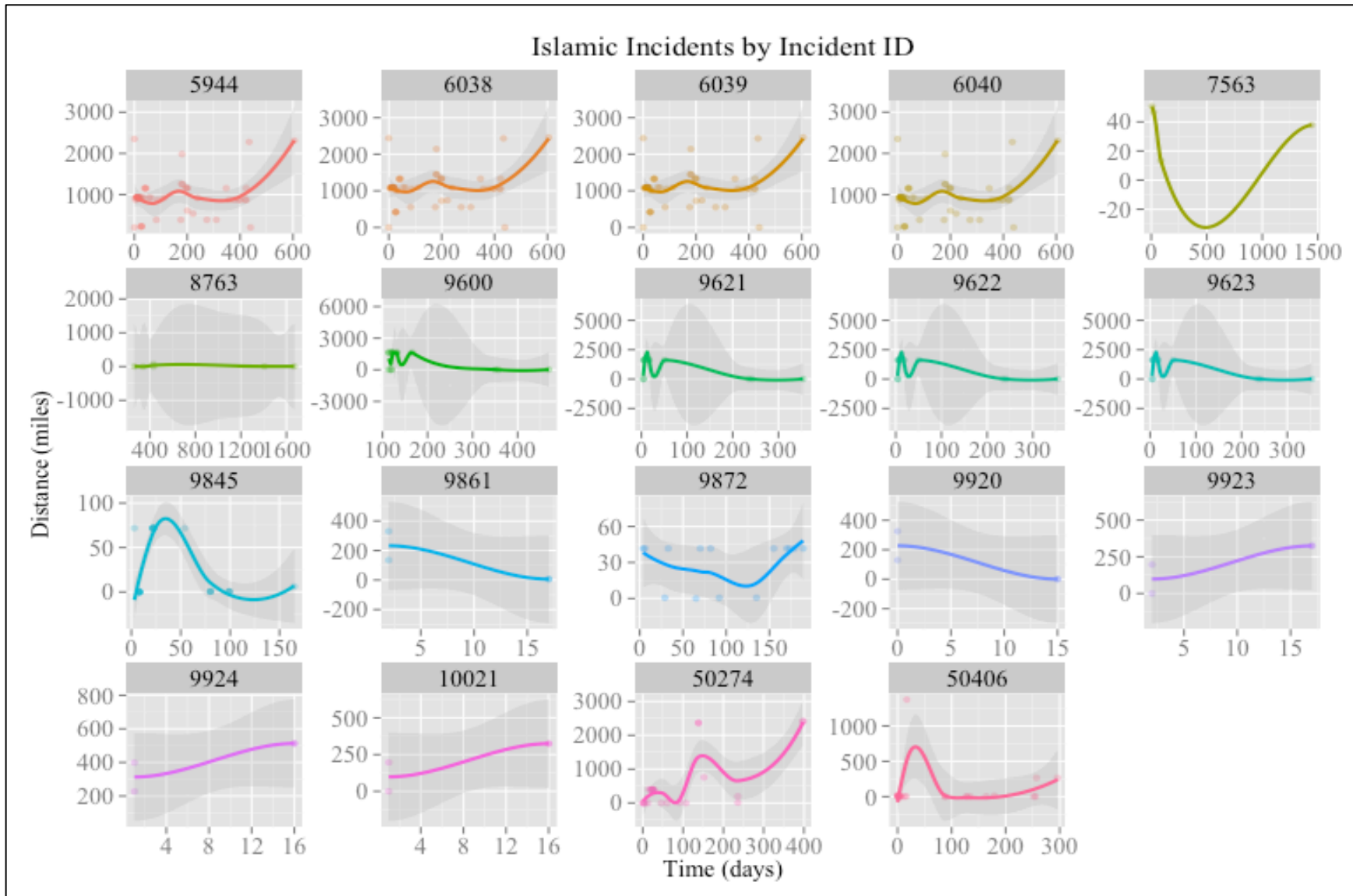
Figure 70. Time-Space Signatures for Islamic Extremist Incidents by Incident ID

When the Islamic Extremist incidents are plotted based on their associated case study, as shown in Figure 71, the patterns identified are similar to the patterns observed in Figure 70. Although there are case studies that do not involve planning at locations remote from the target, there are also case studies that fluctuate greatly in their spatial relationship to the target.
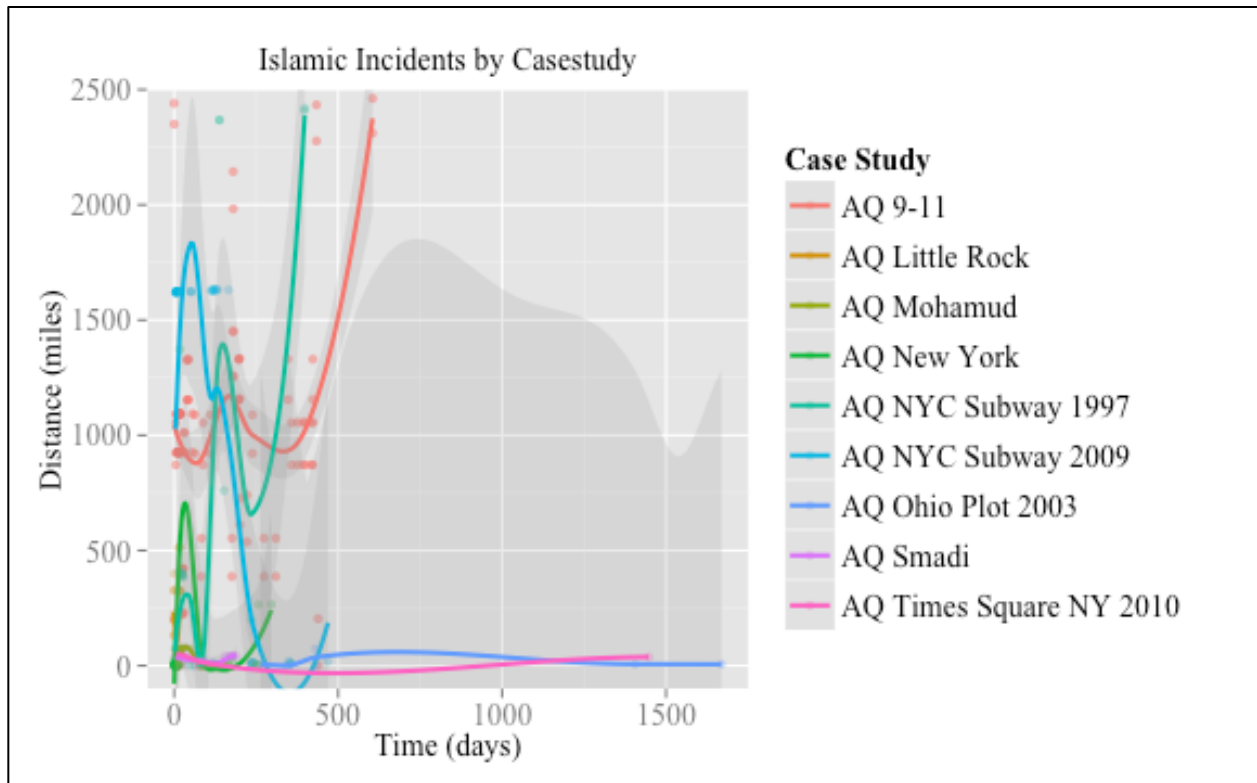
Figure 71. Time-Space Signatures for Islamic Extremist Incidents by Case Study

The Islamic extremist incidents are shown in Figure 72 in individual plots based on their associated case study. Case Studies such as the AQ Ohio Plot 2003, AQ Smadi, and AQ Little rock, show little movement through space over their planning cycle. Incidents such as these could be the result of actors planning or even residing within a close proximity to their target. Other incidents, such as AQ 9-11, AQ NYC Subway 2009, and AQ New York involve preparatory activates at varying locations. These planning cycles employ surveillance and plot testing at the target site and meeting and preparation at remote locations.
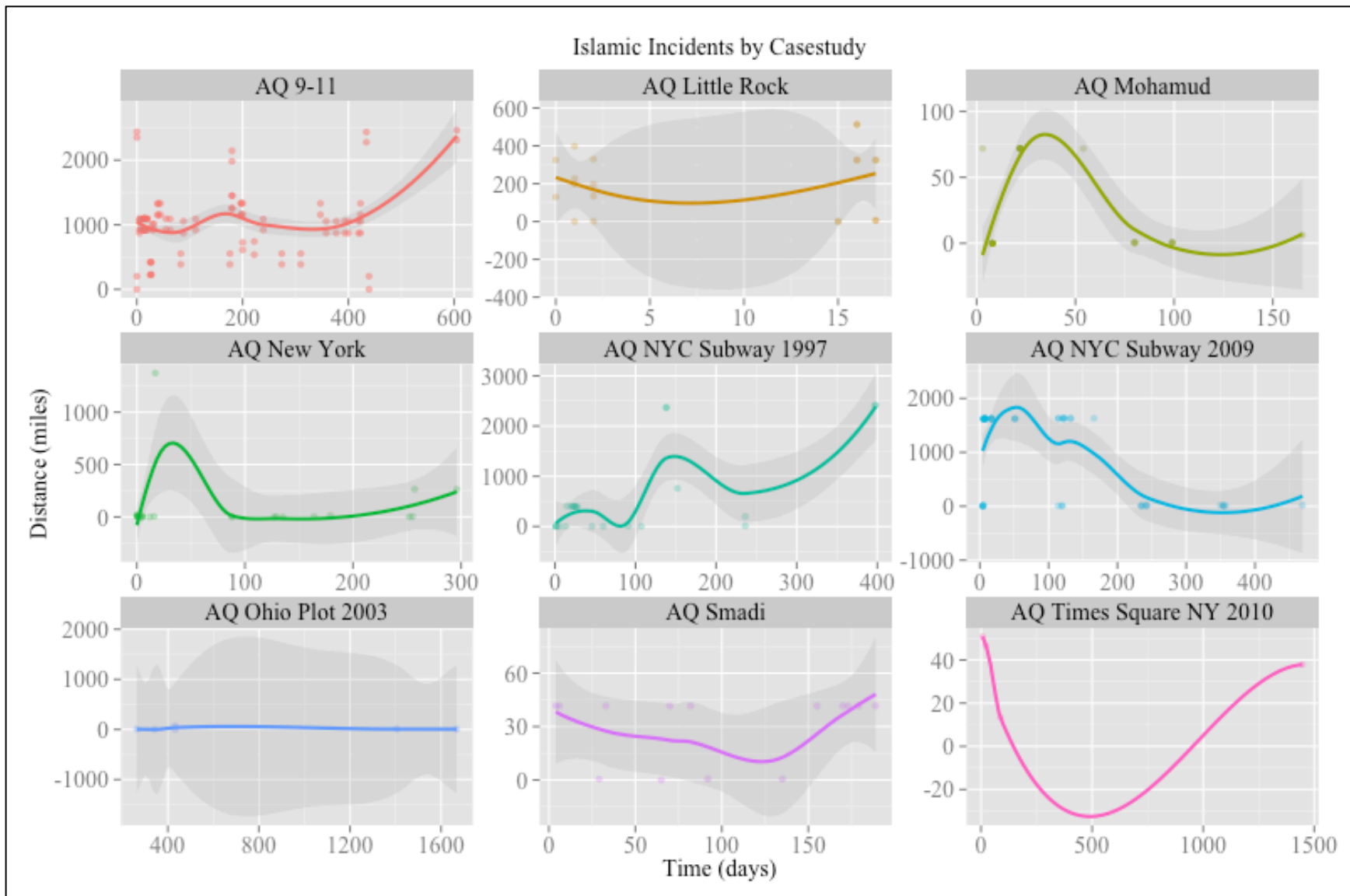
Figure 72. Time-Space Signatures for Islamic Extremist Incidents by Case Study

The time space signatures for Islamic Incidents by incident subtype, shown in Figure 73, reveals that planning events for Hijacking, Facility/Infrastructure Attack, and Bombing/Explosion, incident subtypes occur in fluctuating distances from the target, while Armed Assaults occur relatively close in space and time to the actual attack. The planning events involved in hijacking incidents seem to cluster at large distances from the target while those planning events for Bombing/Explosion occur at relatively closer distances to the target.
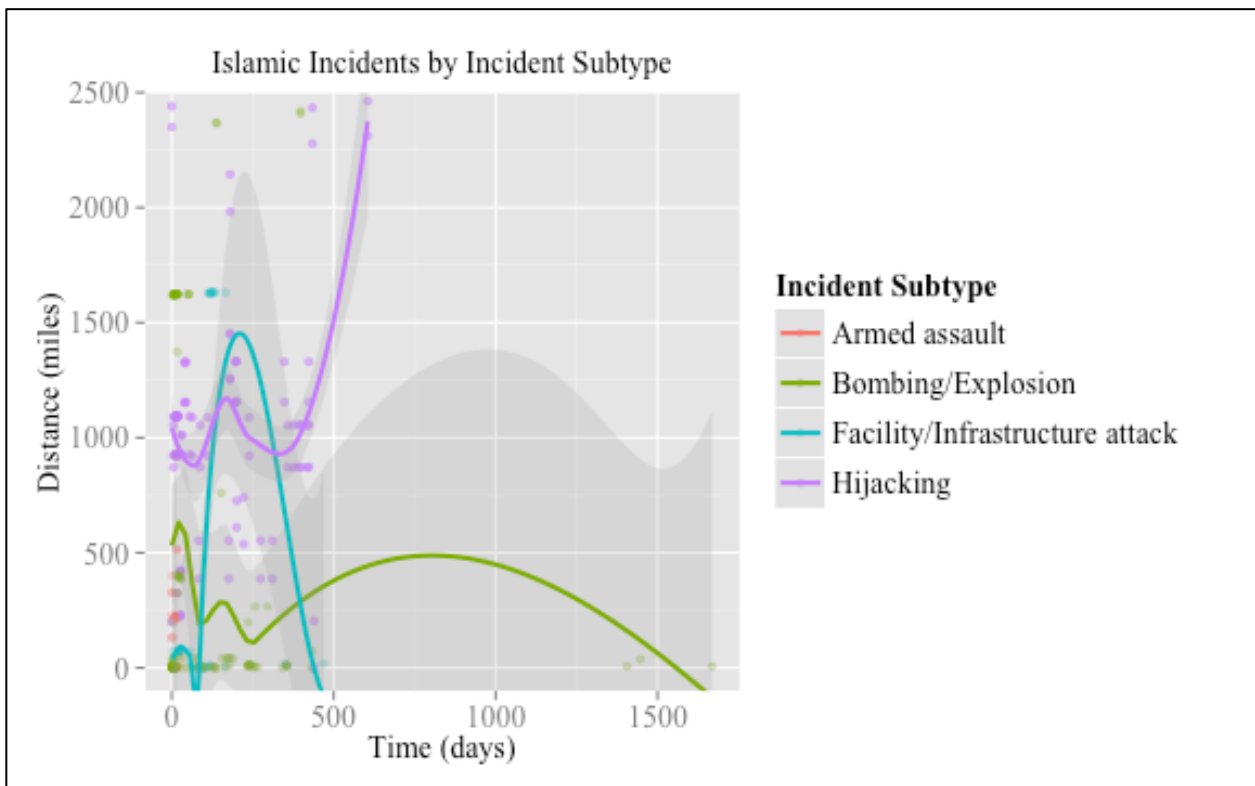
Figure 73. Time-Space Signatures for Islamic Extremist Incidents by Incident Subtype

When plotted on individual plots, shown in Figure 74, the Incident Subtypes of Islamic Incidents exhibit fairly unique signatures. The Armed Assault planning events do not fluctuate in relationship to the target. The Bombing/Explosion preparatory events seem to occur at areas near to the target, while the Hijacking preparatory events occur at areas distant from the target. The

preparatory events for Facility/Infrastructure attacks are clustered near the target but also incorporate planning in areas distant from the target.
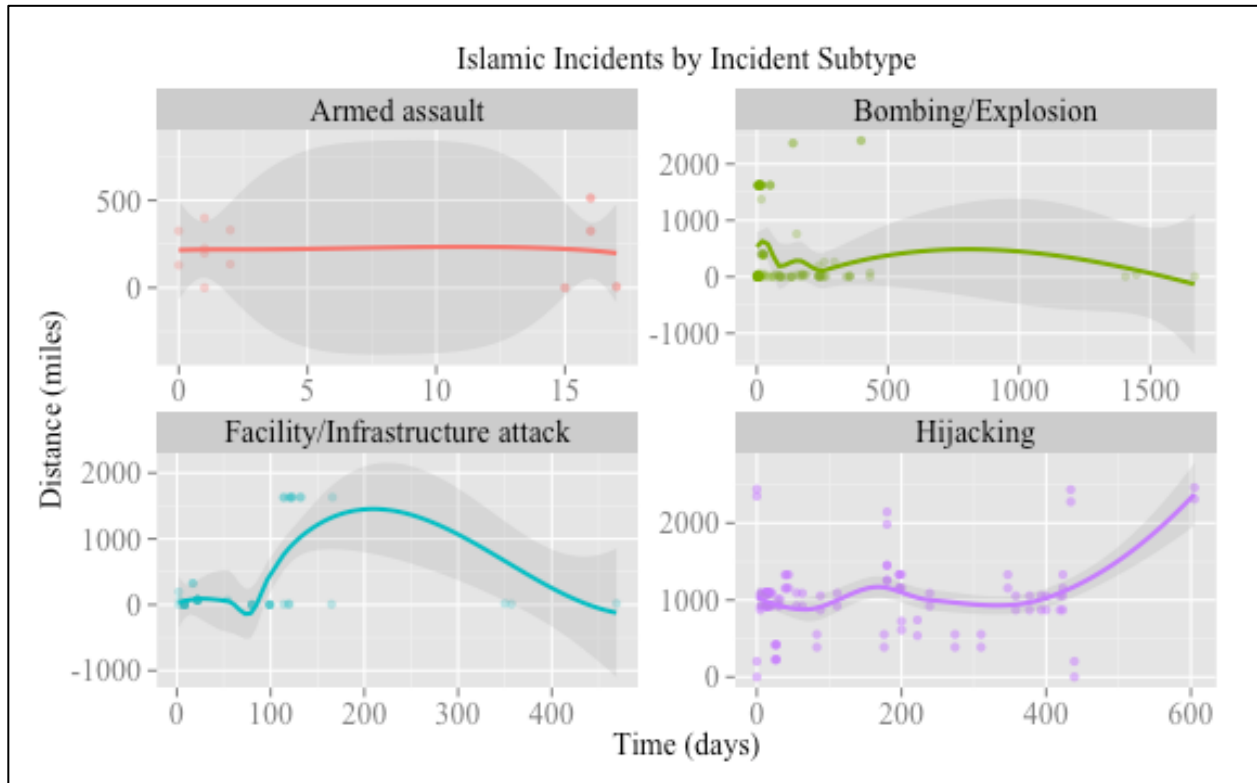
Figure 74. Time-Space Signatures for Islamic Extremist Incidents by Incident Subtype

As in previous analysis, there are clear connections that can be made between the Incident Subtype and the Weapon Type. Figure 75 shows that preparatory events involving melee compose of the same events that compose the Hijacking signature in Figure 73. These events also occur at distances very remote from the target. In this case, the plot that ultimately relied on melee was the AQ 9-11 plot involving the hijacking of commercial airlines. Logically, the signature for the Explosives weapon type is identical to the signature for Bombing/Explosion incident subtype and the signature for Firearm weapon type is identical to the Armed Assault incident subtype.

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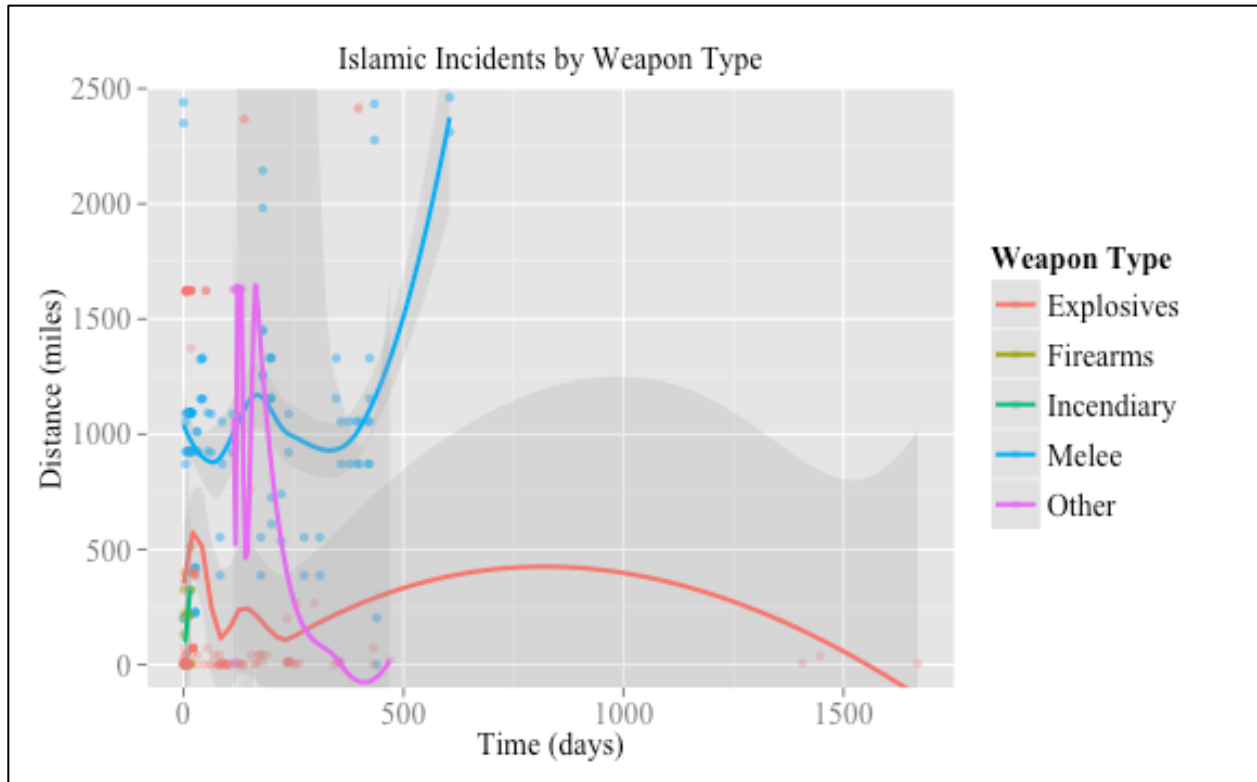
Figure 75. Time-Space Signatures for Islamic Extremist Incidents by Weapon Type

The Islamic Incidents are graphed individually based on the weapon type involved in the attack in Figure 76 below. While plots involving Explosives seem to employ a long planning cycle, plots involving other weapon types involve planning within shorter time frames from the attack. The Time-Space Signatures also show that there is fluctuation in the location of planning activities with regard to the target location in all weapon types except for Firearms.

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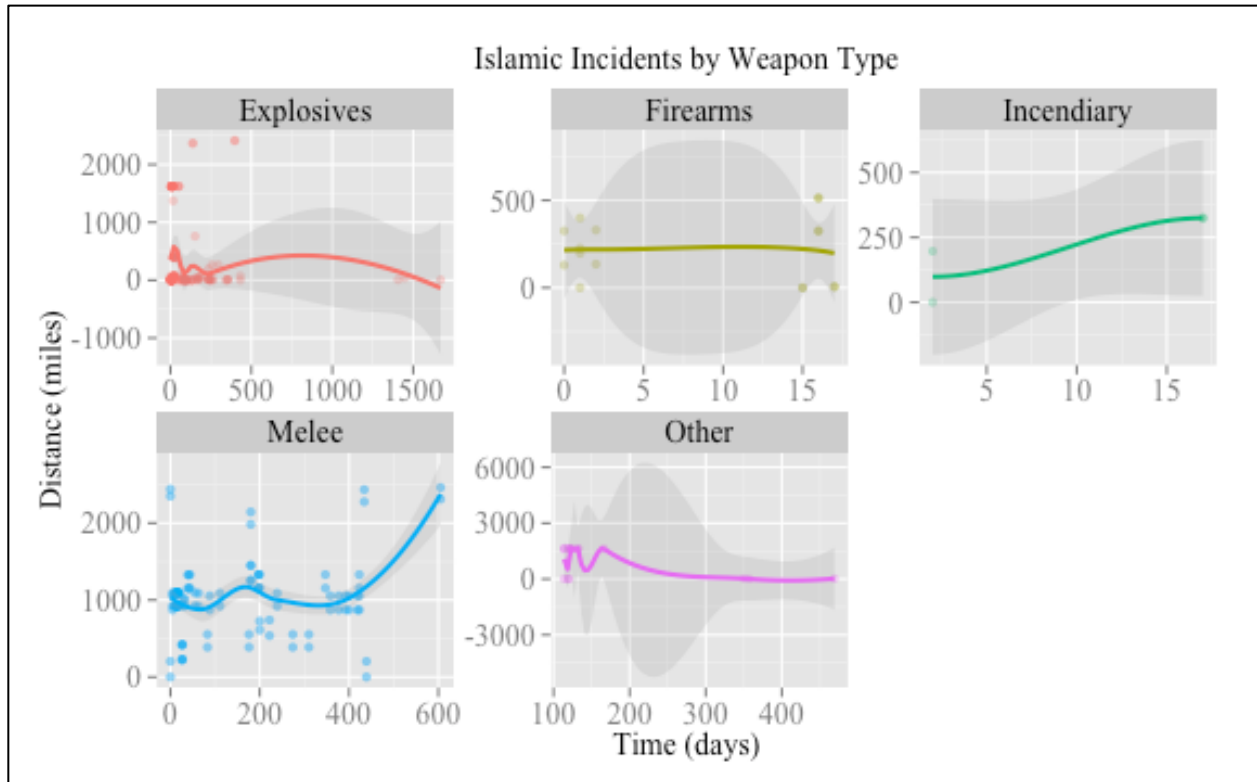
Figure 76. Time-Space Signatures for Islamic Extremist Incidents by Weapon Type

The Islamic incidents are graphed based on the target type below in Figure 77. While Islamic extremists with plots targeting certain target types, such as NGO or Businesses, employ preparatory acts near the target, other targets, such as Transportation and Financial entities, have involved planning at more varied distances from the target. In this case the transportation signature is a product of the AQ 9-11 plot and is thus tied to the Hijacking incident subtype and melee weapon type.
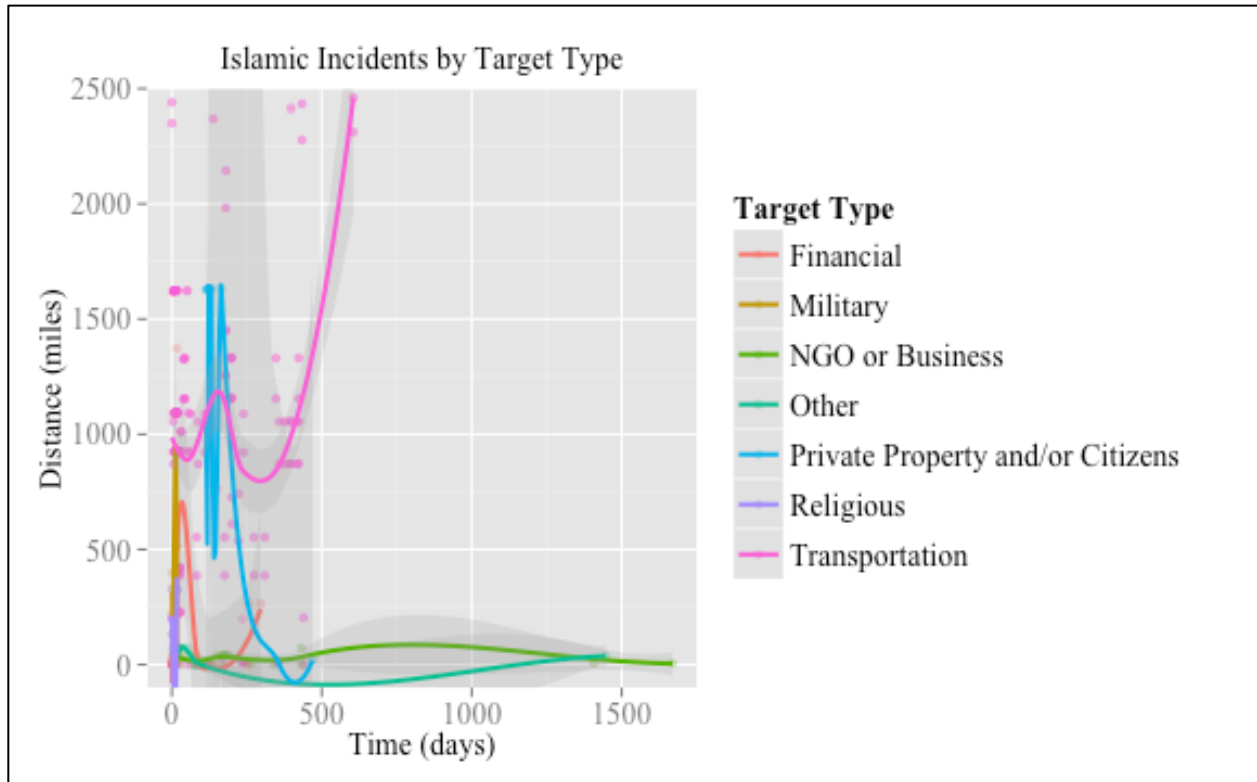
Figure 77. Time-Space Signatures for Islamic Extremist Incidents by Target Type

The Islamic Incidents are plotted on individual graphs in Figure 78 below based on the target type involved. From this display it becomes apparent that all target types involve movement through space prior to the attack. It is also noticeable that attacks on these targets require preparatory acts near the target followed by planning and preparation faraway from the target.
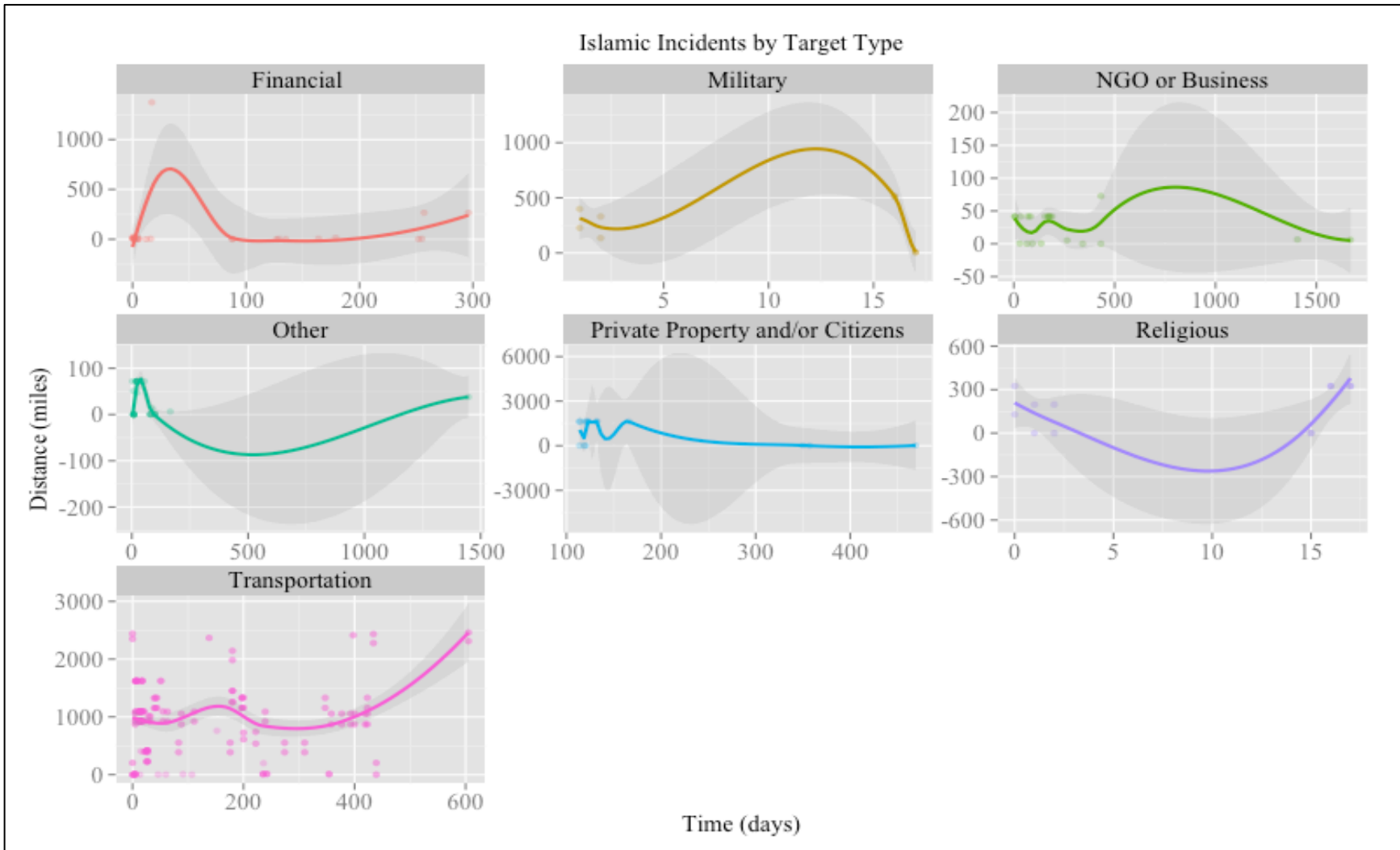
Figure 78. Time-Space Signatures for Islamic Extremist Incidents by Target Type

V. Conclusion

Currently, the use of informants within terrorist organizations is one of the most common methods used to thwart terrorist operations (Hewitt 2003); however, police work and intelligence analysis techniques have been successfully used to assess suspicious activity and incidents of crime in order to make arrests and prevent terrorist attacks (United States et al. 2011). Information describing patterns in terrorist planning activities can be useful for detecting and ultimately preventing terrorist activity. Despite the variety of terrorist actors, the planning cycles employed by terrorists are theorized to involve a pattern of preparatory activities. The common theory is that terrorists select a target, visit and survey the target in order to obtain relative information and intelligence, plan the attack and acquire materials, test the plan, and ultimately commence the attack at the target location (Stratfor 2012; NYS Office of Counter Terrorism 2014; United States et al 2005). Generalizations describing where terrorists are in relation to their target throughout their plot can aid investigations into terrorist activity.

The methodology created for this study, involving the construction of time space signatures for the analysis of terrorist planning cycle, proved to be very useful. The signatures are an effective way of visualizing any changes in the location of preparatory activities over the lifecycle of a terrorist plot. This methodology successfully accomplishes the goal of visualizing where terrorist actors are in relationship to their target during planning and preparation activities.

There is an enormous amount of diversity in the ideologies and motivations of terrorist groups (Hewitt 2003); this diversity inherently influences the tactics used and the targets selected. It is clear that the four different categories of terrorists, including Environmental extremist, Far Left, Far Right, and Islamic extremist, exhibit unique patterns in the movement of their preparatory activities in relationship to the target throughout their planning cycle. This

observation is of no coincidence, as the four categories each select different target types and employ different methods in their attacks. The signatures for these four groups show that Environmental extremist plots involve planning near their targets with the exception of limited outlier planning events at a great distance from their targets. Similarly, Far Left activists consistently carry out planning and preparation activities near to their target. Both Far Right and Islamic Extremist planning and preparation activity seems to vary and fluctuate greatly with regard to their distance from the target. These groups seem to travel to more distant areas as well as areas of a close proximity to the target. These observations are best seen in Figure 11 and Figure 12 in the results section.

Environmental incidents of terrorism appear to vary in their planning cycles, making it difficult to identify a key pattern. There are incidents where planning is consistently conducted near the target as well as incidents where planning activity is conducted further away from the target. It is observed that the majority of Environmental planning activities occur close to the target. Though *The Alf Primer* suggests leaving your immediate area to conduct actions, it appears that most planning, including material procurement and meetings, is conducted near the target. Within the environmental category it was clear that the bombing/explosion incidents involved planning at remote distances while the facility/infrastructure attacks involved planning near the target.

Planning for Far Left terrorist incidents seemed to occur near the target location throughout the planning cycle. The trend for the entire dataset indicates that planning activity occurs at a close and constant distance from the target, however at the incident level, plots seemed to involve movement between the target location and a more remote locations, shown by the fluctuating signature curves. The case study analysis shows four of the various organizations,

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including the Fuerzas Armadas de Liberacion Nacional, New African Freedom Fighters, UFF, and Yahweh, plan within a close and constant distance from their target while the JRA, May 19 Communist Order, and FRB fluctuate more in their distance from the target over time. There was great variation in the relationship between preparatory incidents and their target location when the incidents were plotted by target type.

The planning activities of Far Right terrorists show a less consistent pattern in their relationship to the target. A larger amount of planning activities occur at further distances from the target than in plots of both the Environment and Far Left groups, indicating that these groups are meeting, planning, and preparing for their attacks from more distant locations. Additionally, when represented based on Incident, the vast majority of events show fluctuation in location relative to the target, indicating more movement during the planning cycle. This indicates that these croups are approaching the target for planning but also conducting planning from more distant areas. An assessment of Far Right terrorist planning based on case studies confirmed this observation, as there is movement shown within almost all the signatures.

Similar to the planning activities of Far Right terrorists, Islamic extremist terrorist planning activities occupy a range of locations with varying distances from the target. Plotting the signatures based on Incident ID and Case Study supports this statement as it shows movement between the target and more remote locations. The movement occurs in wavelike patterns where the target is visited or approached followed by a subsequent retreat before approaching once again.

Plotting the incidents based on Incident ID proved to be the most useful, as it shows the movement of actors through the organization of a single attack. Additionally, the trends identified by graphing incidents by weapon type, incident subtype, and target type generally

showed similar patterns to those observed during analysis of the incidents based on incident ID. This is due to the fact that the weapon, subtype, and target attributes are generally constant within each Incident; therefore the lines appear to be similar.

Although it is difficult to generalize the patterns of terrorist planning cycles, due to the variety of attack types even within terrorist categories there are trends that can be observed. The noticeable trend of movement between target and distant locations is visible for numerous incidents. This observation supports the idea that intelligence gathering, reconnaissance activity, and test runs are important steps in terrorist planning and occur near the target while meetings, procurement, and training can occur at more remote locations. This study also shows that while terrorist plots share theoretical steps during planning efforts, there is are distinct differences between planning cycles among the various terrorist group types.

Future Research Direction

Continued research into patterns within terrorist planning cycles is important. The methodology constructed for this analysis provides an insight into movement of terrorists during their planning cycles that can be implemented to supplement future analysis.

There are a number of improvements that could be made to the dataset. One of the more significant improvements would be improving the accuracy of the location coordinates for the preparatory activities and thus the distance measurement between the preparatory activity and the attack location. In a number of records the exact location is unknown. Consequently, the coordinates for the location are gathered from the centroid of the smallest location level known, normally the city name. The measurement error is not a factor when the distance between the locations are great, however when the distance between the two locations is short, such as two adjoining cities, the amount of error in the measurement is directly related to the diameter or size of area within the city limits. A methodology for this analysis needs to be created to reduce error between the centroid measurements. Additionally, there are inherent shortcomings that result from extracting terrorist planning cycles data from court case reports, such as activity that was not discovered in the investigation and thus not included in the incident report. The source of error regarding unreported activity can only be resolved at the investigation and court case level.

The time-space signature methodology can also be implemented in further exploratory studies. For example, the analysis can be used to determine spatial and temporal patterns in the relationship between antecedent event type and the target.

This analysis investigated a large amount of incidents simultaneously. The signatures for each incident could be investigated individually in conjunction with a description or explanation for the movement. This would provide further information about why movement between

locations is or is not occurring, and would elaborate on trends discovered in this exploratory

analysis.

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VII. Appendix

Appendix A.

Incident Variables		
Variable #	Variable Level	Variable Description
1	CATEGORY	Category of organization
2	CASESTUDY_ID	Links a CASESTUDY record to a court case
3	CASESTUDY	Name of data collection pertaining to one or more terrorism incidents that have the same group of persons involved
4	INC_ID	Incident ID
5	INC_DESC	Description of Incident
6	INC_LAT	Latitude Location of Incident
7	INC_LON	Longitude Location of Incident
8	INC_YEAR	Year of Incident
9	INC_DATE	Date of Incident
10	INC_TYPE	Type of Incident
11	INC_SUBTYPE	Subtype of Incident
12	ANT_ID	Antecedent ID
13	ANT_DESC	Description of Antecedent Act
14	ANT_LAT	Latitude Location of Antecedent Act
15	ANT_LON	Longitude Location of Antecedent Act
16	ANT_YEAR	Year of Antecedent Incident
17	ANT_DATE	Date of Antecedent Incident
18	ANT_TYPE	Type of Antecedent Incident
19	ANT_SUBTYPE	Subtype of Antecedent Incident
20	INC_TO_ANT_DIST	Distance from Incident to Antecedent Incident
21	INC_TO_ANT_DIST_ADJ	Distance from Incident to Antecedent Incident Adjusted
22	INC_TO_ANT_DAYS	Time between Incident and Antecedent Incident
23	APPR_INC_TO_ANT_DAYS	Time between Incident and Antecedent Incident in Days
24	WEAPON	Weapon Classification
25	WEAPON_TYPE	Weapon Type
26	TARGET	Target
27	TARGET_TYPE	Target Type
28	TARGET_SUBTYPE	Target Subtype