

# **“Catch and Release”: Predicting Encounter and Victim Release Location Choice in Serial Rape**

**by**

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## **Abstract**

Much research on the geographic decision-making of sexual predators has found that offenders do not travel very far from their home base to commit crimes. Although this aspect of geographic profiling has been well documented, of equal importance is the understanding of why offenders choose certain locations to commit their crimes. This information is not only significant to rape investigations, but it is especially important for geographic profiling and its further development as an investigative tool. Using data from a sample of 361 crime events committed by 72 serial sex offenders, Generalized Estimating Equations are used to predict both the encounter and victim release sites. Results indicate that temporal factors, offender hunting behaviour, and modus operandi strategies are key considerations, but their importance varies depending on whether the location is in a residential land use area, private site, inside location, or a site that is familiar to the offender.

**Keywords:** serial rape; geographic profiling; target locations; temporal factors; offender hunting behaviour; offender modus operandi

*I dedicate this thesis to my loving and  
supportive family: Mom, Dad, and Jason, and  
to my love, Codey.*

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# 1. Introduction

From July 2004 until August 2005, a serial rapist was aggressively hunting for, and sexually attacking, young women in Manhattan, New York, and throughout New Jersey, thereby threatening the safety of all females throughout the region. The first attack in Manhattan took place in September 2004 when a young woman, while walking to work, was grabbed by a man talking on his cell phone who then attempted to force her into his parked vehicle. After vigorously struggling with the attacker and receiving many blows to the head, the woman was knocked unconscious on the street and woke up to find the man and his vehicle gone. The woman also found a cell phone that was left behind that did not belong to her. An investigator into this incident was able to identify only the "SIM" card of the phone, and it belonged to a prostitute who was working in Elizabeth, New Jersey, who had been a rape victim a few months prior.

In July 2004, the prostitute had arranged a sexual encounter with two men who decided to drive the woman to an isolated area and rape her at knifepoint. After the sexual assault, the men proceeded to rob her of both her clothes and her cell phone, and left her nude and helpless. Although the prostitute could not identify the previously found cell phone as being hers to investigators, she did claim ownership of the "SIM" card. A couple of months later, in September 2004, just 13 days before the failed attack on the woman in Manhattan, a female was walking home from a church service in Newark, New Jersey, when she was grabbed by the suspect and forced into his vehicle. From here, the attacker drove the victim to an isolated area and sexually assaulted her for the first time. The suspect then drove her to several different locations where he forced her to engage in more sexual activity. One of these locations included a residence unbeknown to the victim, where the rapist drove into the garage and collected various supplies including a rope. From the garage, the suspect brought the victim to another isolated site where he tried to murder her. After no success, the man drove the woman to her final destination and released her there.

In October 2004, a female victim was walking down a Manhattan street early in the morning when she was grabbed by her neck and forced into the backseat of her attacker's vehicle. The suspect drove the victim to a secluded area where he sexually assaulted and robbed her. After the sexual assault had been committed, the suspect drove the woman to another secluded area of Elizabeth, New Jersey, where she was released from his capture. Similarly, in January 2005, a woman was attacked in Newark, New Jersey, and she was sexually assaulted twice, in two different isolated locations.

The suspect struck twice more, in both May and June of 2005, once in New Jersey, and once in Manhattan, and both victims were driven to isolated areas where they were sexually assaulted. The latter victim, who was encountered and attacked in Manhattan, was later released in Elizabeth, New Jersey. Finally, the last sexual assault that was officially brought to law enforcement officials' attention was in August 2005 in Jersey City, New Jersey. To attack the victim, the offender changed his modus operandi after following the media coverage of his crimes, and impersonated a police detective who demanded that the woman cooperate with his requests. The suspect drove the victim to an isolated park where she was sexually assaulted, and then transported her to another location where she was subsequently released. After enlisting the help of the Federal Bureau of Investigation and identifying Elmo Rivadeneira from the original owner of the abandoned cell phone (i.e., Rivadeneira's ex-girlfriend) found on the street in Manhattan during his attempted abduction in September 2004, law enforcement officials finally arrested him in September 2006 outside of his home in Kearny, New Jersey (Savino, 2011).

From the description of each official crime event within Rivadeneira's series, it is clear that there was more than one geographic crime site associated with each offence. In particular, the location of the sexual assault always differed from the site where the offender and victim first came into direct contact with one another. Additional movement was seen in some of the events as Rivadeneira transported his victims from the crime site to another location to release them from his capture. However, not all of Rivadeneira's victims were able to identify the exact crime site location, apart from describing it as an isolated or secluded area, which was problematic for investigators as not all of the information about each offence was known. As such, it was seen that the two locations that were always known to police investigating these sexual assault cases

were the encounter and victim release sites, as the victims were able to accurately recall the location where they came into contact with Rivadeneira, as well as where they were after being released by him.

From this information, several questions remain unanswered: why did Rivadeneira choose these specific locations to hunt for his victims, commit the sexual assaults, and subsequently release them? How is Rivadeneira familiar with these locations in both Manhattan and New Jersey, and what does this tell us about his routine activities? Why did the offender deem it necessary to transport the victim from one location to another throughout the crime-commission process? Could the geographical mapping of these locations possibly lead investigators to the perpetrator's doorstep? And, could the information garnered from the first few victims about the offender and the crime sites (e.g., encounter, attack, crime, and victim release sites) chosen assist the police in predicting where future crime locations might be? Substituting other offenders for Rivadeneira, these detrimental questions are applicable to any serial rape case, and need to be answered in order to aid law enforcement officials in their investigations, especially in cases where there is a stranger victim-offender relationship, as was the case between Rivadeneira and his victims.

To date, much research has been conducted on offenders' journey to crime, and it has generally found that offenders – especially sex offenders – do not travel very far from their home base to commit crimes (Canter & Gregory, 1994; Canter & Larkin, 1993; LeBeau, 1987a,b; Rossmo, 2000; Warren, Reboussin, & Hazelwood, 1995). Although the spatial behaviour of rapists and their journey to crime have been well documented, it is of equal importance to investigations, especially geographic profiling, to understand the choices made by offenders in regards to the type of places they select to commit their crimes. In particular, it is of both academic and practical significance to research sexual offenders' spatial behaviour in relation to other factors affecting their choice of crime site location to better understand the mechanisms driving this behaviour, and how this information can be used in criminal investigations.

It is often recognized that crimes involving stranger victims are the most difficult for law enforcement officials to solve because there is no direct link leading investigators to the suspect. Furthermore, these investigations are complicated by other factors

including information overload (Rossmo, 2000) and a lack of resources (Beauregard, Proulx, Rossmo, Leclerc, & Allaire, 2007). Thus, increased knowledge of those factors influencing rapists' choice of crime site location in conjunction with investigative tools such as geographic profiling (Rossmo, 2000), will surely aid law enforcement officials in solving stranger-victim sexual crimes.

The current research is a first of its kind to recognize the dynamic nature of rape offences, and integrate such factors that strongly influence where crime sites are likely to be into predictive models, as identified by the journey to crime literature. As such, this exploratory study hopes to identify the best predictors of the environmental aspects (i.e., residential land use area, private site, inside location, and familiarity of the site to the offender) of where future encounter and victim release sites of sexual crimes within a series will be. In doing so, the primary goal of this study is to be of practical use to law enforcement officials who are investigating cases of stranger-victim sexual assaults and are in desperate need to prevent future incidents from occurring by identifying where potential crime sites will be. To be able to identify future crime sites within an offender's series, in combination with other investigative strategies such as geographic profiling, law enforcement officials can use their limited resources more efficiently by implementing a variety of situational crime prevention strategies in those areas thought to be targeted by the offender. However, to better appreciate the rationale underlying this research and the important, but often neglected, role that the environment plays in the crime-commission process, an understanding of how offenders make decisions related to their criminal behaviour, as well as how they move about in their environments, is required. As such, three crucial theoretical frameworks to this research are discussed: rational choice, routine activities, and the geometric theory of crime.

## **2. Theoretical Perspectives**

### **2.1. Rational Choice**

In discussing offenders' ability to select certain locations to commit their crimes, there is an underlying assumption of choice, whether rational or otherwise, inherent in this act. The rational choice perspective was originally proposed in an attempt to improve the utilization of findings from criminological research to better inform policy (Cornish & Clarke, 1986). Proponents of the rational choice perspective assume that offenders display some degree of rationality when committing their crimes. In general, offenders, whether consciously or not, weigh the potential rewards versus costs of engaging in deviant behaviour. If potential rewards outweigh the potential costs as perceived by the offender, he will likely engage in the deviant behaviour (Cornish & Clarke, 1986). However, rational choice theorists note that few criminals choose to commit crimes on a purely rational basis (Akers & Sellers, 2009). Instead, decision-making based on partial rationality is more plausible since offenders are usually constrained by a lack of information, ability, moral values, effort, and time (Akers & Sellers, 2009; Cornish & Clarke, 1986; Rossmo, 2000). "It is assumed, in other words, that crime is purposive behaviour designed to meet the offender's commonplace needs for such things as money, status, sex, and excitement, and that meeting these needs involves the making of (sometimes quite rudimentary) decisions and choices, constrained as these are by limits of time and ability and the availability of relevant information" (Clarke & Felson, 1993, p. 6). From this definition it is clear that serial rapists, like other types of offenders, display a degree of rationality in order to achieve their desired rewards for committing a crime, but these decision-making processes vary depending on the type of offence and the situational context.

When studying criminal behaviour using the rational choice approach, it is important to focus on, and differentiate between, specific types of crimes (e.g., rape, robbery, burglary, shoplifting, or car theft). According to Cornish and Clarke (1986), there

are different situational factors present for each type of crime, and these differences require offenders to change their decision-making and interpret the information being received accordingly. For example, the situational context of a rape event, and the decisions that need to be made by the offender when committing this type of crime, will be considerably different than those needing to be made by an offender engaging in residential burglary. Not differentiating between crime types and acknowledging their inherent differences may impede law enforcement officials' ability to intervene in these types of offences (Cornish & Clarke, 1986). Because rational choice proponents emphasize the situational context of crime, the underlying rationale of this theory is that it should be applied to individual crime events, rather than individual offenders, to better understand offender decision-making (Cornish & Clarke, 1986).

Cornish and Clarke (1986) make the argument that there is a fundamental difference between criminal events and criminal involvement. The decision-making processes required when contemplating whether or not to commit a specific crime (i.e., an individual event) involve only a short time frame, and are premised on the immediate information available to the offender about the circumstances and situations at the time. For example, an offender's decision of whether or not to commit a rape in a residential land use area will largely depend on specific circumstances of that event, such as level of guardianship, offence timing, or type of vehicle used, to name a few. Alternatively, criminal involvement refers to the decision-making processes that offenders undergo when initially deciding to become involved in committing crime, to continue in the crime-commission process, and to desist (Cornish & Clarke, 1986). Decision-making, in this context, requires a multi-stage process that extends over a longer period of time, and will require the offender to consider a wide range of information that may or may not be directly related to the offence(s) in question (Cornish & Clarke, 1986). For example, in the pre-crime stage, a rapist may have had a difficult upbringing or had been having pervasive deviant fantasies for an extended period of time that led him to consider raping another individual. After sexually victimizing women and becoming more specialized in certain aspects of the offence (e.g., hunting for individuals in particular locations where he has been successful in finding suitable victims and avoiding detection in the past), the offender may continue to rape due to his perception of the rewards of engaging in such behaviour (e.g., sexual gratification and/or perceived power



over the victim). In this instance, the decision-making of the offender has extended over a long period of time, and factors such as the time of day or day of the week are not as relevant when deciding whether or not to commit a rape more generally. As such, when considering criminal involvement, an examination of the different stages of the criminal event (i.e., pre-crime, crime, and post-crime periods) is required.

Because each stage of the criminal event involves different decision-making on behalf of the offender, it is important to examine each phase to better understand the crime event as a whole. In the context of a sexual assault, this would include the offender's search for a suitable victim, the rape, and the release of the victim, as well as strategies for evading detection. This sequence of events highlights the need to examine the modus operandi of the offender; that is, the series of actions and behaviours that the offender engages in throughout the commission of the crime in order to achieve his desired goal (Leclerc, Proulx, Lussier, & Allaire, 2009). Thus, in sexual offences, rational decision-making on the part of the offender is clearly evidenced by the different behaviours that he adopts throughout the stages of the crime to secure a victim, choose an appropriate crime site location, and ensure that the rape is successful. Cornish (1993) notes that an offender's learning is another aspect of rational choice theory that cannot be overlooked. Over time and through experience in criminal activities, offenders' decision-making improves (Rossmo, 2000) as individuals learn successful strategies through interaction with others, and they adapt their behaviour accordingly in future crimes. However, modus operandi strategies are contingent, in part, on the situational context of the crime, thereby reinforcing the importance of contextual factors when analyzing the offender's decision-making.

As previously mentioned, a sexual crime event cannot be viewed in a vacuum; rather, the strategies used by the offender to both hunt for a suitable victim and commit the rape need to be regarded as a dynamic process that largely depend on both the situational context of the crime as well as the environment. Beauregard, Rossmo, and Proulx (2007) examined the hunting process of serial sex offenders from a rational choice perspective and confirmed just this. Because rapists have the ability to choose certain strategies at different stages of the crime and adapt their behaviour depending on the situational and environmental context (e.g., deciding in advance that the crime site location will be in a public space, but subsequently altering this decision as the

offence unfolds based on the time of day and number of onlookers nearby), it is clear that these offenders display some degree of rationality. However, in order to stress the role that the environment plays in not only deciding when a crime event is to take place, but also the location(s) where it is to occur, the routine activities framework needs to be considered.

## **2.2. Routine Activities**

In keeping with the criminal event perspective, the routine activities approach focuses less on macro explanations, or structural circumstances, of why crime events occur, and more on the micro reasons that facilitate their occurrences. First introduced by Cohen and Felson (1979), the routine activities approach states that in order for a direct-contact predatory violation (i.e., an offence where the offender comes into direct contact with his victim in an attempt to do harm) to take place, there must be a convergence in time and space of three elements: a motivated offender who is able to engage and participate in his motivations, a victim/ target who the offender deems as being suitable (e.g., due to his/her size, perception of strength, or vulnerability), and a lack of a capable guardian who would be able to interfere, or prevent the offence from taking place. Cohen and Felson also note that the absence of any one of these factors may result in the offence not coming to fruition. Conversely, Cohen and Felson argue that crime may increase when suitable victims come into contact with motivated offenders in the absence of capable guardians simply due to individuals' routine activities, rather than a surge in offenders' motivations to commit deviant acts. In other words, when trying to better understand crime patterns or the rate at which crimes, such as sexual assaults, occur, the most important factor to examine is the routine activities of the parties involved. Depending on the individuals' routine activities, and attendant fluctuations, more or less opportunities for offending are created as there is a convergence of the two people in time and space, regardless of the amount of motivated offenders and suitable victims initially available. Although prior research conducted before 1979 took into account the importance of space in explaining crime patterns, seldom did researchers examine the utility of time.

As noted by Cohen and Felson (1979), prior researchers studying crime rates recognized the importance of space in their analyses. However, past researchers have failed to study crime rates from a criminal event perspective, in that each offence is an event, and that in order to exist, it needs to take place at a specific location in both *space* and *time*, while also involving certain offenders and victims/ targets (Cohen & Felson, 1979). Unlike proponents of the rational choice perspective who are concerned with the question of 'why' offenders commit crime, routine activities theorists already presume that offenders are motivated, and instead concentrate on those spatial-temporal social conditions that encourage this motivation to come to fruition, and result in criminal activity (Cohen & Felson, 1979). An important point to be made here is that the routine activities associated with criminal behaviour are not independent of those required for individuals' survival (e.g., work, school, home, and leisure, to name a few); rather, they are interdependent, in that criminal activity usually occurs while offenders are engaged in their legitimate routine activities (Cohen & Felson, 1979).

As individuals are engaged in their routine legal activities, they are constantly coming in and out of contact with potential offenders or suitable victims. As a result, individuals are at an increased risk of being victimized, offending, or conversely, preventing an offence from taking place by providing guardianship, as they move about through their environment (Cohen & Felson, 1979). Because individuals' routine activities are located in a number of different locations such as their home, workplace, and places of leisure, there is a great possibility that they will be victims of crime in these locations as well. Thus, the routine activities of both the offender and the victim have a direct influence on the kinds of locations chosen for crimes to take place. For example, a sexual offender, while engaged in his occupation of being a parcel deliverer in a residential neighbourhood, may encounter a victim who he views as being suitable, walking home alone from school. As there is no presence of a capable guardian who could protect the victim or otherwise interfere in the offence, the offender may act on his motivations to commit the crime by immediately attacking the victim. As both parties are physically present in this land use area while engaging in their routine activities, this location now serves as the site, or one of the sites if the victim is transported, of the crime. Keeping this in mind, Rossmo (2000) notes that "current and past routine daily activities of the rapist are important, as is the influence of prior crime 'successes'" (p.

113) when investigating cases of serial sexual assault and their crime locations. If the rapist, while traveling along his daily route as a parcel deliverer, was successful in the past in finding young women alone in particular locations (e.g., the same neighbourhood bus stop), it is likely that he will search for victims in this same area on a regular basis. In order to grasp a more detailed understanding of the ways in which individuals move throughout their environment while engaging in their routine activities, and how this influences the types of locations chosen by offenders to commit their crimes, the geometric theory of crime is discussed.

### **2.3. Geometric Theory of Crime**

Unlike mainstream criminological theories that focus on psychological, biological, and sociological reasons for criminality of the offender, the geometric theory of crime emphasizes the spatial characteristics and geographic patterns that criminals follow to search for and select victims; thus, the focus is placed on the offenders' environment and the influences it has on their deviant behaviour (Andresen, 2010; Brantingham & Brantingham, 1981b). The geometric theory of crime is closely related to routine activities theory in that it is not concerned with offenders' motivation for committing crimes, but rather a better understanding of the opportunities available to these individuals within the urban environment (Andresen, 2010). However, once these opportunities are acknowledged by the offender, a series of rational choices are then made to not only find a suitable victim or target, but also determine the geographical locations of the crime (Rossmo, 2000).

Because humans are not stationary beings, they are able to control their movements throughout the environment in terms of where they are going and at what time of day (Andresen, 2010). Thus, because individuals make different choices about their movements, the environment is never consistent; rather, it is a dynamic process in what is referred to as the environmental backcloth. Once individuals enter into an environment, they are restricted by the pathways that they can take due to both the physical structures (e.g., location of buildings and sidewalks or roadways) and its social characteristics (e.g., spaces occupied by individuals who are perceived as being dangerous or abnormal). To further understand the role of environmental factors in

criminal offending, it is important to highlight four geographic elements: nodes, pathways, districts, and edges.

Within environmental criminology, nodes are described as places where individuals engage in activities such as home, work, or shopping, and they travel between these places via pathways, whether it be roads, sidewalks, bicycle paths, or railways. Districts are seen as spatial areas that share common features and distinguishing characteristics “such that any differences within the district must be smaller than the differences that exist between districts” (Andresen, 2010, pp. 22-23). Edges are those places that characterize the perimeter of a district and delineate where one district ends and another one begins. Criminal activity thrives on the edges of districts because these are the areas where offenders are least likely to be noticed by locals or others who are familiar with, and inhabit, the space (Andresen, 2010; Felson, 2006). It is from these four geographic elements that the concepts of activity and awareness space are constructed.

Individuals’ activity nodes can be conceptually viewed as points on a map (Andresen, 2010). These nodes, as well as the pathways that individuals use to get from one point to another, make up their ‘activity space’. Because people spend most of their time at these places (e.g., work, home, recreational activities), they become more familiar with the individual nodes, the areas surrounding these nodes, and the people who occupy them. These elements are considered an individual’s ‘awareness space’. Rossmo (2000) notes, however, that certain locations (e.g., tourist attractions or well-known buildings) can be included in one’s awareness space without that person actually having to frequent these locations on a regular basis (i.e., being a part of his/her activity space). Since individuals spend the majority of their time within their awareness space, these are the areas where they are most likely to be victimized (Andresen, 2010).

Similarly, offenders have awareness spaces that are constructed from the locations where they spend most of their time. It is within offenders’ awareness spaces that they are likely to encounter potential victims while engaging in both criminal and non-criminal activities. Because criminals are the most familiar with the space surrounding their activity nodes, they are likely to know specific locations within their awareness space that are associated with ‘good’ victims (Brantingham & Brantingham,

1981b). For example, a rapist who targets prostitutes may know particular streets on his way home from work where he is sure to find this type of victim. Thus, it is within this public space that these targeted victims are likely to be encountered and/or attacked by the offender. By drawing upon the geometric theory of crime, law enforcement officials and researchers alike are able to use information about the encounter, attack, crime, and victim release sites of sexual offences to re-construct the offender's awareness space and thus his most probable area of residence or work.

Geographic profiling (see chapter three), an application of the geometric theory of crime, highlights the relevance of 'distance decay' (Andresen, 2010). Distance decay refers to the time, effort, and money that are needed by the offender to overcome distance limitations (Brantingham & Brantingham, 1981b). For instance, offenders tend to search for potential targets or victims in areas that are close to their homes or other activity nodes since it requires minimal effort (Andresen, 2010; Brantingham & Brantingham, 1981b). As the distance traveled from offenders' home base locations increases, the number of crimes they commit decreases substantially since people, in general, are unlikely to expel more effort to achieve their goal than is necessary. This concept is abundant in the journey to crime literature and is known as the nearness principle or principle of least effort (Zipf, 1949). When offenders lack time, effort, or money, they are likely to remain close to their home base and thus acquire more information about the area surrounding this location (Brantingham & Brantingham, 1981b). In doing so, offenders become more confident in their ability to commit crimes undetected as they have greater knowledge about the environment in which they are operating, and thus a basis from which they can make informed, conscious decisions about their behaviour.

Although most crimes are committed within offenders' awareness spaces, or comfort zones, they are less likely to commit crimes in the area *directly* surrounding their homes, in what Brantingham and Brantingham (1981b) termed a 'buffer zone'. Criminals are generally deterred from offending so close to their home base as they perceive an increased risk of being detected by police (Rossmo, 2000). Rossmo (2000) notes, however, that this concept applies mostly to predatory crimes such as rape, as other offences, like domestic assaults or child abuse, often take place within the home. The mere existence of a buffer zone, paired with the notion that the amount of distance

traveled by offenders inversely affects the number of crimes they commit, suggests that there are elements of rational decision-making at work when predators spatially move throughout their environment in search of suitable victims or targets. Taken together, from a theoretical standpoint, this knowledge adds to the validity of geographic profiling as being a very useful tool for locating the home bases of serial violent offenders such as rapists.

## **3. Literature Review**

### **3.1. Geographic Profiling and Serial Rape**

As noted previously, offenders tend to search for crime targets and commit crimes in locations not far from where they spend the majority of their time and along the routes between these locations (Brantingham & Brantingham, 1981a,b). This line of theorizing has paved the way for several criminal investigative techniques, one of the most notable being geographic profiling. Geographic profiling is a criminal investigative tool that was developed by Kim Rossmo during his doctoral dissertation on target patterns of serial murderers. It analyzes the geographic locations of a series of connected crime sites to try to predict the most likely location of the offender's residence (Rossmo, 2000). This technique is most commonly used in serial crimes such as rape, murder, arson, robbery, and bombing, but it can also be applied to a single criminal event that encompasses several locations or has "other significant geographic characteristics" (Rossmo, 2000, p.1). Originally based on Brantingham and Brantingham's (1993) crime pattern theory, which predicts where crime site locations are likely to be based on the offender's home base or other significant activity node, geographic profiling differs in that it predicts the home base of the offender from his crime site locations (Rossmo, 2000). Although geographic profiling does not pinpoint the exact location of the offender, its main purpose is to give investigators the most optimal starting point when trying to narrow down suspects (Rossmo, 2000). In addition to this purpose, this technique can also be used in cases of stranger crime to prioritize tips, conduct address searches of police databases for those residences close to crime sites, increase police patrol and surveillance efforts of targeted areas, mobilize neighbourhood searches, prioritize deoxyribonucleic acid (DNA) samples for testing, conduct searches of the Department of Motor Vehicles for vehicles seen at the offence locations, prioritize certain postal/zip codes, find offender hide-out locations, and be a starting point for



information request mail-outs to obtain community information (Rossmo, 2000; for additional examples, see Rossmo, 2004).

Geographic profiling is especially useful to those investigations that are suffering from information overload, and thus need assistance in prioritizing suspects. In such circumstances, the assistance that geographic profiling provides to law enforcement officials is clearly exemplified by a prior case of a serial sex offender who was active in suburban Toronto. Three hundred and twelve suspects emerged during the time of this crime series, and although investigators had physical DNA evidence from one of the rapes, their lack of monetary resources restricted the number of laboratory tests that could be conducted (Rossmo, 2004). As such, it would not have been feasible to conduct DNA tests of all of the suspects implicated in this investigation, and the use of a geographic profile to rank these individuals (e.g., in terms of familiarity with crime site locations), and subsequently test the DNA of the most probable ones, would have been an efficient approach.

When investigators employ geographic profiling and obtain an idea of where the suspect's home might be, based on the crime site locations, it becomes possible for them to focus their efforts on those individuals who either reside in or are familiar with the area. Similarly, the prioritization of suspects allows investigators to allocate their resources more efficiently by increasing patrol officers in neighborhoods where the offender is thought to reside (Rossmo, 2000). In doing so, the main goal of this technique is to identify and apprehend suspects faster, thereby preventing future crimes from taking place. Although the theoretical underpinnings and purposes of geographic profiling have been made clear, it is necessary to consider both the objective and subjective elements of constructing this type of profile.

### **3.1.1. *Components of a Geographic Profile***

Geographic profiling is composed of both quantitative (objective) and qualitative (subjective) aspects (Rossmo, 2000). The objective aspect focuses on a series of geostatistical techniques and other quantitative measures, such as the criminal geographic targeting (CGT) model. The CGT model has been translated into a computerized geographic profiling system where "crime site coordinates are analyzed

with a patented criminal hunting algorithm that produces a probability surface showing likelihood of offender residence within the hunting area” (Rossmo, 2000, p. 197). Once the crime site coordinates are analyzed, a three-dimensional illustration of the likelihood of the location of the offender’s residence is produced, and is known as a jeopardy surface (Rossmo, 2000). A jeopardy surface is a virtual map where each point is given a probability, and is represented visually with peaks, valleys, and their corresponding colours (e.g., red represents the highest peaks and thus the most probable area of offender residence with 96-100% confidence, while dark green represents the valleys and thus the lowest probability of offender residence with 0-5% confidence; Rossmo, 2000). However, when a jeopardy surface is produced and it remains flat (i.e., no peaks or valleys), this indicates that there is no optimal search area and a geographic profile may not provide investigators with additional information that would be greater than chance alone. Nonetheless, once a jeopardy surface is produced and thus the *most likely* locations of the offender’s residence presented, a two-dimensional view of these locations is constructed with corresponding street maps, and this is known as a geoprofile (Rossmo, 2000). Once street maps are displayed alongside the probability surface, law enforcement officials can prioritize certain blocks or streets that show the highest probability values of offender residence, and search in order of decreasing probabilities until the offender is found (Rossmo, 2000; for examples of jeopardy surface maps, as well as geoprofiles, refer to Rossmo, 2000).

The qualitative (subjective) aspect of geographic profiling refers to the investigator’s reconstruction and interpretation of the offender’s mental map (Homant & Kennedy, 1998 as cited in Rossmo, 2000). Once a jeopardy surface and geoprofile are produced, and probabilities given, it is the responsibility of investigators to determine how offenders move about in their environments in search of suitable victims/ targets based upon the principles of rational choice, routine activities, and the geometry of crime theories (Rossmo, 2000). However, Rossmo (2000) states that there are additional factors that investigators must consider when constructing and interpreting a geographic profile. The most important of these considerations is an examination of the crime locations. Rossmo (2000) notes that offence locations and temporal elements are crucial to a geographic profile, as well as “the number and types of crime sites, their parsing, and the crime location set” (p. 213). Investigators also need to consider the offender

type, how many there are, as well as the hunting style used, as these hunting methods directly influence the encounter and victim release locations in serial rape cases (Rossmo, 2000). Target backcloth is important to note as well, as the people who inhabit certain locations will dictate where crime locations are likely to be. For example, if the target backcloth is sparse (e.g., prostitutes and drug addicted individuals in the Downtown Eastside of Vancouver, British Columbia), the offender's choice of victims will be affected, and thus the types of crime sites chosen (Rossmo, 2000). When considering the target backcloth of crime site locations, investigators need to keep in mind that the individuals who occupy these spaces can vary depending on such temporal elements as the time of day, day of the week, and season of the year (Rossmo, 2000). It is also true that the target backcloth is influenced by the type of neighbourhood, area of the city, or at a more aggregate level, the city itself (Rossmo, 2000).

Investigators must also consider the physical landscape of the environment, paying particular attention to arterial roads and highways, bus stops, and rapid transit stations (Rossmo, 2000). Rossmo (2000) notes that offenders are constrained in how they travel by the layout of roads and highways. As such, there are only certain pathways that offenders can follow, and it is likely that they will choose the major arterial routes, freeways, or highways. In cases where offenders do not have access to vehicles, they are likely to use public transportation such as buses or trains, or use jogging or bike paths; therefore, these pathways must be taken into consideration when interpreting a geographic profile (Rossmo, 2000). Physical and psychological boundaries must be noted as well. Just as offenders are constrained by physical barriers such as roads, rivers, oceans, lakes, and ravines, psychological boundaries exist too (Rossmo, 2000). For example, it is unlikely that offenders will search for victims or targets in areas where they do not belong, or will be noticeably different (e.g., due to race, sex, or socio-economic status), from other individuals who inhabit those spaces. By doing so, they are at an increased risk of exposing themselves to others nearby, which could ultimately lead to their quicker apprehension by police. In addition, zoning and land use are important considerations, especially when considered from a routine activities perspective. Rossmo (2000) notes that a consideration of the type of land zone and/or land use of a particular crime site(s) will provide investigators with clues as to why the offender was in a certain location. This information is particularly important for

investigators when interpreting a geoprofile, as they can refer to the peak areas and ask themselves whether or not they are in a commercial or residential land use zone, and thus determine if the anchor point is likely to be the offender's place of work or his residence (Rossmo, 2000). Other possible anchor points may include residences of family members or friends, previous residences, and the possibility that there are two or more offenders who live in separate locations (Rossmo, 2000). When a geoprofile has more than one peak area, this is indicative of the possibility that the offender is operating from more than one activity node (Rossmo, 2000). Therefore, to determine what these peak areas in the geoprofile represent, a consideration of what the land is used for is necessary.

Investigators should also consider neighbourhood demographics when predatory crimes take place in a residential land use area, as certain offenders (e.g., sex offenders) may prefer victims of a particular race or ethnicity, thereby affecting the types of neighbourhoods where they search for their victims. The victim's routine activities, particularly in the time period before the offence took place, are important as well, as they can help investigators piece together the offender's victim-search method. For example, if the victim was encountered as she was leaving the bar district, this could indicate that the offender purposefully travels to these areas in search for vulnerable victims. Lastly, Rossmo (2000) warns that crime events that deviate from a noticeable pattern in a crime series should be carefully considered by investigators, as it may provide them with additional information about the offender. In keeping with this, investigators should always be aware of the possibility of spatial displacement. Common reasons for this change in offender behaviour include media coverage of an offender's crimes, or increased police presence in certain locations known to be connected to a crime series, which causes the offender to hunt for victims and commit crimes in areas that deviate from his previous pattern.

### **3.1.2. *Investigative Considerations of Geographic Profiling***

Despite the various factors that must be considered when constructing and interpreting a geographic profile, this investigative tool will be of little use to law enforcement officials unless it is accurate. To produce an accurate profile, Rossmo (2004) advises that the following three steps be taken by police in an investigation. First,

the offender must be included in the investigators' suspect pool, meaning that the search parameters must not be too stringent to exclude possible suspects. Second, those individuals within the suspect pool should first be prioritized and the list of suspects searched as efficiently as possible. Lastly, each suspect, beginning with those who have the highest probabilities, should be evaluated to determine his likelihood of actually committing the offence (e.g., is it geographically possible that this suspect could have committed the rape during this time period?). Beginning with the first step, investigators can never truly know whether or not the real perpetrator lies within their list of suspects. If the perpetrator does not, all geographic profiling efforts beyond this point are hopeless and may result in the misuse of limited police resources. Even graver of a consequence is the fact that an invalid profile can result in a longer time to suspect apprehension, which potentially results in more victims due to investigators' interpretation of misspecified information. As geographic profiling is only one of many investigative tools at the disposal of law enforcement officials, it should not be used on its own due to the aforementioned dangers, but alongside other police efforts, such as psychological profiling, to better assist detectives in solving major crimes (Rossmo, 2000). This integrated approach, as Rossmo (2004) notes, provides investigators with the most optimal suspect search strategy.

Although geographic profiling can be a very useful tool in some investigations, not all crime events warrant law enforcement officials to request a geographic profile. Rossmo (2000) explains that there is a typical sequence of events that law enforcement officials follow when investigating crimes, and a geographic profile is only one tool that is used when the other methods that come before it do not produce adequate information. For example, for a geographic profile to even be considered in an investigation, law enforcement officials first need to recognize the occurrence of a crime series (Rossmo, 2000). The second step involves the use of traditional investigative techniques (e.g., collecting evidence that the crimes occurred, piecing together how the crimes took place, searching for possible suspects through victim and witness interviews, and preparing a case against the offender for the prosecution; Dempsey & Forst, 2011), followed by the third step, case linkage analysis. Rossmo (2000) notes that this third step is the most vital to the geographic profile because the more crimes that can be accurately linked together, the better the geographic profile will be. As there is room for error at this stage

(i.e., some criminal events may be incorrectly considered as part of one's series, while the correct ones are not), it is important to note that the geographic profile will not be significantly affected provided that there is no spatial bias, and the majority of the true crime site locations are included in the analysis (Rossmo, 2000). As a general rule, ninety percent of the information provided to those who are constructing a geographic profile should be accurate in order to produce valid results (Rossmo, 2000). Until this point in the investigation, if more traditional investigative methods have proven to be successful, a criminal or geographic profile is not likely needed. However, if law enforcement officials still need guidance, they may request a criminal profile, geographic profile, or both. From here, new investigative strategies are used (Rossmo, 2000).

Although it is not necessary to request both a criminal and geographic profile in an investigation, both techniques complement one another. For example, Rossmo (2000) notes that in cases where there are very few crime site locations to extract information from, a criminal profile may be useful to give investigators some insight into the offender's personality, behaviour, and lifestyle. Conversely, Rossmo (2000) argues that a geographic profile can be a major aid to an offender profile, in that investigators can use the geographical profile to focus their suspect search to certain areas, and thus increase the efficacy of both methods. Despite the potential drawbacks of geographic profiling if used incorrectly, this technique, in conjunction with other investigative strategies, has resulted in the most efficient apprehension of suspects in a number of criminal cases. As such, researchers in recent years have recognized the success of this method and have tested its utility in both non-human and non-criminal populations.

### **3.1.3. Applications of Geographic Profiling**

Geographic profiling was originally designed to be used in serial violent crime investigations (Rossmo, 2000), but it has recently been applied to various non-criminal domains. Le Comber, Nicholls, Rossmo, and Racey (2006) applied the principles underlying geographic profiling, specifically the buffer zone and distance decay functions, to patterns of animal foraging of two species of pipistrelle bat in Aberdeenshire, Scotland. Findings indicated that the bats use of the model-produced search strategy allowed them to find their roost more efficiently as compared to if they had just engaged in a random search (Le Comber et al., 2006). Differences in foraging

patterns were noted between *P. pipistrellus* and *P. pygmaeus* as well, with the former bat species foraging over longer distances from the roost than the latter. As an exploratory study, this research proved to be a good example of how the principles underlying geographic profiling can be used effectively when applied to animal data.

Similarly, Raine, Rossmo, and Le Comber (2009) used geographic profiling principles to compare actual bumble-bee (i.e., *Bombus terrestris* L.) foraging patterns with those that were computer simulated. In doing so, Raine and colleagues sought to find out whether or not geographic profiling could locate the home base (i.e., nest entrance) based upon known patterns of flower visitation by foraging bees. Using geographic profiling techniques, Raine et al. also compared the differences in foraging patterns between the experimental and virtual bees due to changes in the densities of potential food sources (i.e., flowers). These researchers were also interested in knowing whether or not geographic profiling could be used, more generally, to differentiate between foraging patterns that would be observed from differing computer simulated foraging strategies, and if any of the computer simulated foraging patterns were representative of the spatial movements observed in real bumble-bees. Similar to Le Comber et al.'s (2006) findings, geographic profiling can be used to pinpoint the bumble-bees' anchor point (i.e., nest entrance) more efficiently than if they had engaged in a random search process (Raine et al., 2009). It was also demonstrated that geographic profiling can be used to distinguish the foraging patterns between both the experimental and virtual bees as it pertained to the differing flower densities, to differentiate between foraging patterns derived from computer simulated foraging strategies, as well as compare and contrast the foraging strategies of the hypothetical foraging algorithms with those of the experimental bees. From the findings of this research, Raine and colleagues (2009) speculated that our knowledge of the spatial patterns of animal foraging would greatly benefit from the use of geographic profiling techniques as it is applied to other, more diverse populations.

To further exemplify the use of geographic profiling in the biological realm, Martin, Rossmo, and Hammerschlag (2009) investigated white shark search and attack behaviour of Cape fur seals at Seal Island in False Bay, South Africa. Unlike the studies conducted by Le Comber et al. (2006) and Raine et al. (2009), which primarily focused on differences in foraging patterns, Martin and colleagues went one step further by

determining whether or not a relationship existed between shark attack locations and the distance from Seal Island, if an anchor point had any effect on the spatial behaviour of white sharks, and if these predators were random or strategic in their hunting locations (i.e., specifically targeting prey at entry-exit points, or along the routes that seals took from land to open water). From the shark attack locations, a clear pattern emerged that may indicate that sharks hunt for seals in an area that maximizes their chances of finding a suitable victim (i.e., seal), while minimizing the competition between other predators (Martin et al., 2009). In addition, a single peak on the geoprofile emerged, indicating that the spatial movement of sharks is both purposeful (i.e., non-random), and that sharks, despite being a highly mobile species, do hunt from one common anchor point (Martin et al., 2009). Interestingly, these researchers found that the size of the sharks dictated which ones dominated the most optimal hunting locations. Specifically, larger sharks have more access to these locations, and thus are more successful at hunting for prey than are smaller sharks. This phenomenon may be due to increased hunting experience and learning of those locations where the sharks have been successful in capturing their prey in the past (Goldman & Anderson, 1999; Martin et al., 2009). These explanations are similar to the crime site selection model proposed by Brantingham and Brantingham (1978; see section 3.2.1. below), which details how human predators select locations to hunt for their victims based on past successes of capturing suitable victims in these spaces. Interestingly, it appears as though the mechanisms underlying the hunt for victims and the selection of crime sites used by humans are the same as those used by predatory animals in their endeavors.

More recently, geographic profiling has stretched beyond its original mandate and has been innovatively used as a basis for understanding the geospatial patterns of terrorist cell behaviour (Rossmo & Harries, 2011), determining geographic patterns of illegal border crossings (Rossmo, Thurman, Jamieson, & Egan, 2008), and been used in epidemiological research as a tool for targeting the control of infectious disease (Le Comber, Rossmo, Hassan, Fuller, & Beier, 2011) and invasive species (Stevenson, Rossmo, Knell, & Le Comber, 2012). In applying this technique to areas of homeland security, Rossmo and Harries' (2011) findings indicated a strong geospatial structure underlying the terrorist cell behaviour in Ankara and Istanbul, Turkey. Unlike the relationship between a target location and the perpetrator's home base as is dictated by



crime pattern theory (i.e., an offender's home base is used to determine crime site locations), Rossmo and Harries (2011) noted the possibility of an inverse of this relationship as it is applied to terrorist cells (i.e., terrorists choose a target and from this location they begin to establish terrorist cells and subsequently residence locations). Despite either possibility being the case, the underlying role of geography and its influence on human behaviour must be considered. Because terrorist cell sites were found to be clustered together and a short distance away from their target(s), a geographic profile can provide intelligence agencies with an optimal search area to look for potential targets or other terrorist cells that are likely to be in close proximity to a known cell site (i.e., prevent the attack from happening while it is in its planning stages), or search for terrorist cells and other potential targets (e.g., landmarks, buildings, or government offices) that are likely to be in the vicinity of an already successful terrorist attack (Rossmo & Harries, 2011).

In keeping with applications of geographic profiling and threats to national security, Rossmo, Thurman, and colleagues (2008) used the principles underlying this technique to analyze illegal land entry events to better understand the physical and human geographic features that promote and inhibit individuals from crossing through the Del Rio sector of the Texas-Mexico border. It was found that illegal border crossings cluster in both space and time (Rossmo, Thurman et al., 2008), and several physical and human geographical features were significantly correlated with illegal and criminal entries into the United States (US). This examination of the spatial behaviour of illegal migrants, drug couriers, smugglers, and fugitives, to name a few, who wish to illegally and/ or criminally enter the US provides border patrol officials with insight into the most probable locations and times that these individuals are likely to enter the country.

Another application of geographic profiling was made by Le Comber and colleagues (2011) who sought to determine whether or not they could take disease case locations and use them to construct a geographic profile of where the infection sources lie. In applying this technique to the London cholera and Cairo malaria studies, both geoprofiles were efficient in locating the main sources of infection using data on the disease case locations (Le Comber et al., 2011). In fact, this method provided the most proficient results as compared to using other tools for analysing spatial data such as spatial mean, median, and centre of minimum distance (Le Comber et al., 2011).

Similarly, Stevenson and colleagues (2012) applied geographic profiling to cases of invasive species to determine where their source populations are located. As with Le Comber and colleagues' (2011) study, Stevenson et al. wished to see if geographic profiling would provide a more efficient search process than other measures used to analyse spatial data. As this study was exploratory in nature and there is a possibility that data in this area are scarce, the researchers also wanted to see if general parameter values could be substituted for different species or groups, or for species that populated different habitats, and if model variables differed over time periods (Stevenson et al., 2012). As was the case in prior studies, geographic profiling was shown to correctly determine the sites of the source populations of invasive species given their current locations. Important implications of this research point to the fact that these types of analyses can, and should be done in the early stages of invasions when intervention efforts are the most effective. In addition, it was found that general parameter values were able to be used in cases where data on individual species were lacking (Stevenson et al., 2012), which for the time being is extremely helpful until knowledge in this area improves.

Many of these applications of geographic profiling to biological, homeland and border security, and epidemiological domains prove the usefulness of this technique as a means of optimizing search processes and understanding geographic mobility patterns, thereby providing a more efficient use of scarce resources. Recognizing the unexpected, yet robust, utility of geographic profiling in these areas, and the information gleaned therein, there is clear potential for this technique to be applied to various circumstances. Furthermore, building upon previous studies, recommendations for future improvement to the method and/or its application can be made due to our evolving knowledge of geographic patterns of different populations. Rossmo (2012) specifically discusses some future directions of geographic profiling including the incorporation of areal data and analysis into the already used point pattern analysis (e.g., Johnson, 1999), a better understanding of the actual spatial dynamics of offenders' journey to crime (e.g., Rossmo, Lu, & Fang, 2011), and the move towards integrating both forensic and behavioural science. Despite the success of geographic profiling since its inception, the extent of its applications and further developments remains to be seen in both criminology and other disciplines.

### **3.2. Geographic Locations and Sexual Crime**

It is possible to better understand crimes as well as determine offenders' most likely area of residence based on the geographic locations of their crimes (Brantingham & Brantingham, 1981a). A single offence may occur in just one location, or there could be several different geographic sites associated with the crime (Rossmo, 2000). Geographic locations of a rape include the encounter, attack, rape, and victim release sites (Rossmo, 2000). Each of these locations is important to an investigation as it reveals vital information about the offender, such as modus operandi strategies and familiarity with an area, but it may also provide clues as to what occurred during the offence. However, not all of these geographic locations are known to the victim or investigators after a sexual assault takes place (e.g., the victim may have been blindfolded from the time she was attacked until she was released by the offender; therefore, the crime location may only be known by the rapist). Because of this possible lack of information, the most important locations for constructing a geographic profile of an offender in rape cases are the encounter and victim release sites, since these locations are always known by the police (Rossmo, 2000).

In addition to information that is known about the offender, it is also of importance to the geographic profile to consider what the offender did not do throughout the crime commission process (Rossmo, 2000). Such aspects of the offence that investigators need to address are locations connected to the crime or series, timing of the offence(s), site selection made by the offender, target backcloth, and offender hunting behaviour (Rossmo, 2000). For example, investigators might want to ask why particular crime sites were chosen and not others? How is the offender familiar with these locations? What might these locations tell us about the offender's routine activities? Why did the offender find these sites an attractive place to commit the crime? Although focusing on the offender's journey to crime is informative, it is also necessary to consider the environmental characteristics of crime site locations and the information that they can tell us about the offender and his decision-making.

### **3.2.1. Crime Site Selection**

Geographic profiling is developed from the crime site selection model proposed by Brantingham and Brantingham (1978), which describes motivated offenders and their spatial decision-making who seek to find victims positioned in time and space. The environment sends signals to the offender that describe its characteristics and he uses these cues to search for and locate potential targets or victims. As the offender becomes more experienced in committing crimes, he learns which cues emitted from the environment are indicative of 'good' victims or targets (Brantingham & Brantingham, 1978). These cues make up a template to which future victims or targets are compared, either consciously or subconsciously, and they are either rejected or accepted by the offender depending on how well they fit his criteria. This template, then, is used by the offender in all future offences and thus becomes relatively permanent and is constantly reinforced (Brantingham & Brantingham, 1978).

The principles underlying geographic profiling and the spatial behaviour of violent offenders have been areas of interest for many academics (for a review, see Beauregard, Proulx, & Rossmo, 2005). One of the most important of these principles is awareness space (Brantingham & Brantingham, 1981b). The influence of this concept on spatial decision-making has led to such developments as the circle theory of environmental range (Canter & Larkin, 1993), which states that a circle drawn from the diameter between the two farthest offence locations will likely encompass the offender's home base. This theory was constructed from two hypotheses that describe the relationship between a sexual offender's home base and his criminal range (i.e., the geographical area where the rapist commits his crimes): the *commuter* and the *marauder*. The *commuter* hypothesis proposes that the offender purposefully travels from his home base into another area to commit his crimes. Although the offender travels to another location to search for suitable victims, there is some relationship between this area and his residence (Canter & Larkin, 1993). Conversely, the *marauder* hypothesis states that the offender leaves his home base in search of suitable victims, commits his crimes, and then returns. The *marauder* typology assumes that the offender commits his crimes in areas within his awareness space, and the further the distance between the crime locations, the further the offender is travelling from his home (Canter & Larkin, 1993). According to Canter and Larkin (1993), this typology is closely related to

Brantingham and Brantingham's (1981b) crime site selection model where the offender's home base is significant for determining where the crime locations will be.

To test these models, Canter and Larkin (1993) plotted each offender's residence and crime event locations on forty-five maps and drew a diametric circle between the two farthest offence locations. It was found that for 91% of the sample, the circle drawn on each map contained all of the offence locations for that particular offender. Further support for these models was provided when 87% of the offenders' residences were located within the same circle as their offence locations. Thus, from these empirical findings, it appears as though serial rapists hunt for victims and commit the majority of their crimes in the area surrounding their homes and with which they are the most familiar, since it requires minimal effort.

Kocsis and Irwin (1997) examined the spatial patterns of serial rapists, serial arsonists, and serial burglars to further assess the usefulness of the circle theory of environmental range across offence types. It was found for the serial rapists and arsonists that their residential home base was located within their criminal range, thereby providing support for Canter and Larkin's (1993) *marauder* hypothesis. However, serial burglars proved to be both *commuters* and *marauders*. More specifically, Kocsis and Irwin noted that half of the burglars' residences were located within their criminal range, while the other half were not. These findings compliment prior work that has found that criminals tend to travel longer distances from their home base when offending against static versus mobile targets (White, 1932).

Although the importance of the environment in determining where crime will take place is readily apparent, environmental factors may differ considerably from one crime event to another. Thus, it is important to examine whether or not offenders remain consistent in their choice of crime site locations. Since serial rapists remain relatively stable in their modus operandi strategies (Sjöstedt, Långström, Sturidsson, & Grann, 2004) and their hunting behaviour (Rossmo, 2000), the question thus becomes how consistent are the locations of sexual assaults across a series? Lundrigan, Czarnomski, and Wilson (2010) investigated the crime patterns of serial sexual offenders in order to determine how consistent they were across their series in terms of the distances travelled to offend, and the crime site locations that they chose. It was found that serial

sexual offenders are consistent in the distances travelled from their home to commit their crimes, and that the crime locations were close to where they live, thereby providing additional support for the principles underlying geographic profiling and its utility in assisting serial rape investigations. Of particular importance to the current study is the finding that these sexual offenders were highly consistent in their choice of environmental factors relating to the crime location, such as land type, area type, and day of the week across their series (Lundrigan et al., 2010). Furthermore, the crime events committed by individual offenders were more consistent than those committed by other sexual offenders, which leads the current research to take into account the dependencies between offences.

### **3.3. Hunting Processes of Serial Rapists and the Environment**

From a geographic profiling perspective, understanding the spatial movements of serial rapists requires an examination of their hunting behaviour and target locations. Hunting behaviour refers to the actions employed by the offender to search for and attack victims, and encompasses several predatory typologies and combinations thereof (Rossmo, 2000). Target locations, however, refer to the geographic sites that are linked to a crime series (Rossmo, 2000). To facilitate the relationship between offender hunting behaviour and target locations, it is necessary to differentiate between hunting fields (Beauregard, Rossmo et al., 2007) and hunting grounds (Rossmo, 2000). An offender's hunting field refers to the type of area where he hunts for his victims, and may include searching through a family or occupation, ads in a newspaper, or a local visibility, to name a few (Beauregard, Rossmo et al., 2007). An offender's hunting grounds, however, include the geographical area, or territory, within which he searches for his victims (Rossmo, 2000). These hunting grounds include locations that Rossmo (2000) termed, 'fishing holes' or 'trap lines'. Fishing holes are locations that hold a high probability that the offender will find a potential victim (e.g., an elementary school for offenders attracted to children), and this victim may be followed to another location before he/she is attacked by the offender (Rossmo, 2000). A trap line is a "linear fishing hole" (Rossmo, 2000, p. 126) that encompasses an entire street or commercial strip (e.g., red light district). An offender's choice of victim type will largely dictate his hunting

grounds, and it is within this geographic area that he will engage in hunting behaviour to choose specific victims (Rossmo, 2000).

As an extension of the *commuter* and *marauder* models (Canter & Larkin, 1993), Rossmo (2000) introduced similar typologies that describe the geographic patterns of serial violent predators. Rossmo (2000) proposed the idea of the hunting process; that is, the offender's search for a suitable victim and the method he uses to attack his victims. An offender's victim search methods affect encounter sites, and his attack methods influence victim release sites (Rossmo, 2000). A combination of both the offender's search and attack strategies composes his hunting typology (Rossmo, 2000). Four victim search methods are proposed: *hunter*, *poacher*, *troller*, and *trapper*.

The *hunter* is an offender who leaves his home base, or place of residence, to search for a victim. *Hunters* search throughout their awareness spaces in places they believe to contain suitable victims or targets, and generally confine themselves to the city in which they live (Rossmo, 2006). As offenders need to come into contact with victims in the absence of capable guardians, *hunters* will be found in places that are busy as to guarantee the presence of potential victims, but not too busy as to risk interference from others (Rossmo, 2000). This is the most commonly used hunting style adopted by offenders. Conversely, the *poacher*, like the *commuter* (Canter & Larkin, 1993) who travels a great distance, is an offender who deliberately leaves an activity node, other than his place of residence, in search of finding a suitable victim, even travelling to other cities to do so (Rossmo, 2000).

Rossmo (2006) notes that it may be difficult for law enforcement officials to determine offenders' hunting styles in general, but this is especially true when it comes to differentiating between *hunters* and *poachers*. To help investigators make this distinction between the two styles, Rossmo (2006) puts forth potential indicators of offender poaching that should be analysed in conjunction with other factors, but also within the context of individual crime series. To begin, investigators should examine the offender's crime series to take note of his target area. Factors reflective of the *poacher* hunting style include whether or not the crimes are taking place within a small geographic area (e.g., a few square city blocks), considerations of the specificity of the victim/target type (e.g., is the offender targeting a specific population such as

prostitutes?), if the crimes are taking place in a non-residential area or a central business district (e.g., commercial land use zone), if the crimes occur in areas inconsistent with the offender's socio-economic status or social demographics (e.g., crimes are taking place in wealthy areas or in neighbourhoods where the majority of the residents are of a different race/ethnicity/age than the offender), the location of the crimes is in close proximity to a major highway or thoroughfare, thereby providing clues as to the possible routes taken by the offender when traveling between cities, and the possibility that other anchor points exist that would attract the offender to these specific locations (e.g., highway/freeway exit or a major bus stop).

In addition to examining the geographic characteristics of the target area, investigators must also consider the factors surrounding the offender and his crimes. Rossmo (2006) suggests that law enforcement officials need to determine if there is a possibility that, due to increased police patrol efforts in certain areas, spatial displacement has taken place. In this vein, it might be a possibility that investigators have targeted an area where the offender is thought to reside, and in efforts to evade detection, he has continued to commit crimes, but in other geographic locations. It is also important to consider the number of criminal events in the offender's series. Generally speaking, the more criminal events within a series, the more information can be gleaned about the offender. If there are less than five crimes within the series (Rossmo, 2006), it is possible to wrongly label an offender as being a *poacher* when no clear pattern yet exists. Conversely, when there is a sufficient number of offences within a series, travel patterns that show a clear directional trend are indicative of *poachers*. It would also be beneficial for investigators to examine local crime trends in order to see if the data suggest prior poaching or commuting within the area. In terms of the offender, the possibility that he is a career criminal should be considered [e.g., "a traveling bank robber, high-end burglar, [or] gypsy" (Rossmo, 2006, p. 549), to name a few]. Finally, it needs to be considered whether or not the offender is a *stalker* (see below) who may follow his victims, thereby not having complete control over where the crime site locations will be. It could also be that offenders are using a different strategy to hunt for their victims that is independent of any geographical considerations (e.g., reading names and addresses on luggage tags at airports; Rossmo, 2006). Despite the complexity in differentiating offenders according to the various hunting styles, the aforementioned



factors should assist investigators, given adequate information, in making these distinctions.

The *troller* is an opportunistic offender who, while engaging in his non-predatory, routine activities, comes into contact with a suitable victim and decides to attack her (Rossmo, 2000). Generally, *trollers* have fantasized about what they are going to do during the crime and how it will play out; thus, when offenders come into contact with a potential victim who satisfies their criteria associated with being a 'good' target, they are prepared and ready (Rossmo, 2000). The final hunting pattern is the *trapper*, who holds a position in an organization, or has an occupation that draws in potential victims (e.g., babysitter). Rather than leaving a home base in search of a suitable target, *trappers* try to lure potential victims into their homes, or other areas, where they have a great deal of control (Rossmo, 2000). These offenders 'trap' their victims in these locations by using subterfuge strategies such as posting want-ads, entertaining potential victims, or offering to host individuals in their home over a period of time (e.g., running a bed and breakfast).

In keeping with the hunting process of serial violent offenders, Rossmo (2000) proposes three attack methods: *raptor*, *ambusher*, and *stalker*. The most common attack method used by serial violent offenders is the *raptor* approach (Rossmo, 2000). Offenders who use this approach attack their victims quickly and efficiently once they have come into contact with them. *Ambushers* attack their victims once they enter locations where the offenders have the most power and control (Rossmo, 2000), such as in their homes or vehicles. Conversely, *stalkers* encounter their victims and follow them while waiting for the perfect moment to attack. Unlike the aforementioned typologies, the *stalker's* choice of attack, crime, and victim release locations are dependent on the victim's activities and her awareness space since the offender follows her while waiting for the opportune moment to attack (Rossmo, 2000). In detailing the hunting styles and attack methods of serial predators, certain hunting style and attack method combinations are more common than others. For instance, *hunters* often use the *raptor* attack, while *trappers* tend to *ambush* their victims (Rossmo, 2000). Although other combinations are uncommon, it is not to say that they do not occur. From the descriptions of the aforementioned typologies, it becomes clear that the environment plays a very important role in where crimes are likely to take place.

In an effort to address both the behavioural and geographic components of the hunting process of serial sex offenders, Beauregard, Proulx, and colleagues (2007) identified three hunting process scripts, as well as their related tracks. The coercive script contains the *home-intrusion rape track* and the *outdoor rape track*, where both utilize the *hunter/raptor* combination as proposed by Rossmo (2000). The *home-intrusion rape track* is utilized when an offender breaks into the victim's home and sexually assaults her while she is by herself, whereas sex offenders follow the *outdoor rape track* when they assault their victims in an outside location. Interestingly, the choice of which rape track to follow depends on the offender's rational calculation of the benefits versus costs inherent in each.

Beauregard, Proulx, et al. (2007) also found the manipulative script, which contains the *sophisticated rape track* and the *family-infiltrator rape track*. Those using the *sophisticated rape track* tend to use the *troller* victim search method and the *ambusher* attack (Rossmo, 2000) in their crimes, and will either wait for or make opportunities, or purposely travel to areas where suitable victims are likely to be. Because rapists utilizing this track invest a large amount of time and effort into planning and committing their crimes, and are in positions that allow them to insert themselves into and manipulate situations to their benefit, they are considered to be quite sophisticated offenders. The *family-infiltrator rape track* describes those offenders who adopt the *trapper/ambusher* search and attack methods (Rossmo, 2000) to hunt for victims by infiltrating families. These rapists use their occupation to become acquainted with potential victims and are skillful in bringing them to places that are familiar to the offenders only.

Lastly, the non-persuasive script was identified that contains the *direct action rape track*. Unlike the previous rape tracks that require some degree of planning and effort on behalf of the offender, the *direct action rape track* does not require any premeditation and hinges only on the presence of an opportunity to directly act on a victim. Not only do the aforementioned crime scripts and associated rape tracks highlight the important association between behavioural and geographic elements of a crime, thereby helping to validate Rossmo's (2000) typologies, but they also emphasize the important role that the environment plays in offenders' hunting processes.

Similarly, Beauregard, Rossmo, and colleagues (2007) further examined the dynamic relation between offender behaviour and geography by producing a nine phase descriptive model of the hunting process of serial sex offenders from the offenders' point of view. These nine phases include: (a) offender and victim routine activities; (b) choice of hunting ground; (c) victim selection; (d) method of approach; (e) attack location choice; (f) method to bring the victim to the crime site; (g) crime location choice; (h) method to commit the crime; and, (i) victim release location choice. This descriptive model emphasizes the fact that not all sex offenders display the same hunting behaviour, and there are elements of rational decision-making at play throughout each phase of the crime commission process (Beauregard, Rossmo et al., 2007). This decision-making will be influenced by the offender's modus operandi strategies, type of victim and his/her reaction to the offender (e.g., level of resistance), situational factors surrounding the crime, as well as the environment (Beauregard, Rossmo et al., 2007). Although there are few studies that have recognized the importance of geography to better understand sexual crime events, the aforementioned descriptive model is consistent with, and builds upon, prior work in this area, namely the hunting typologies posed by Rossmo (2000), and the crime site selection model as discussed by Brantingham and Brantingham (1978).

### **3.4. Aim of the Study**

Much research in the field of spatial decision-making has concentrated on distance to crime, but less focus has been on those factors that affect the types of environmental locations where crimes are likely to take place. As rapes are complex crimes largely influenced by contextual factors, environmental variables, and offender decision-making (Beauregard, Rebocho, & Rossmo, 2010), it is necessary to examine these factors when determining offenders' choice of crime site locations. Thus, the aim of the current study is to analyze temporal factors, offender hunting behaviour, and modus operandi strategies in a sample of 361 sexual crimes committed by 72 serial rapists, to determine their utility in predicting the type of location where victim encounter and release sites are likely to be. When examining serial rapes from a geographic profiling perspective, particular attention needs to be paid to these two sites since they are the most likely to be known by the police during the investigation (Rossmo, 2000).

## 4. Methods

### 4.1. Participants

Data on crime events were collected from a sample of sexual offenders who were incarcerated in a Correctional Service of Canada institution (where inmates serve a sentence of two years or more). The sample included any individual who had committed two or more sexual assaults or other sex-related crimes (e.g., sexual homicide) involving a victim of any age and of any gender who was a stranger to him (i.e., the victim and offender had no personal relationship prior to the date the offence was committed)<sup>1</sup>. Serial sex offenders were specifically targeted for the sample as they are more likely to face a variety of situations and, accordingly, are more likely to make a variety of choices during the decision-making process of each crime committed. Moreover, the stranger-victim element provides a further refinement to preserve a relative homogeneity in the situation faced by offenders; prior relationship between the offender and the victim arguably heavily influences the offenders' necessity and incentives to move the victim to a different location.

Among all sex offenders convicted of a sentence of two years or more in the province of Quebec, Canada, between 1995 and 2004, 92 offenders matched the definition criteria, and 72 participated in the research. Together, these 72 offenders committed an average of five sexual offences (ranging from 2 to 37 sexual assaults), for a total of 361 sexual assaults. Among the 20 excluded participants, only 9 actually refused to participate, the remaining 11 having been unavailable because of their mental state, discipline problems, or transfer to another institution. The majority of the

<sup>1</sup> Events that interrupt a series of offences, such as incarceration, do not preclude the inclusion of offences that occurred before or after the interruption in the series (Alston, 1994).

participants were white (91.3%;  $n = 63$ ), and the average age at the beginning of the crime series was 30.7 years ( $SD = 9.4$ ). Almost half (46.4%;  $n = 32$ ) of the offenders were married or in a relationship at the beginning of their series of crimes. Among the participants, 89.9% ( $n = 62$ ) had a prior criminal record before the onset of their series of sexual crimes. Despite their involvement in a series of sexual offences, the majority of the sample was involved in a wide array of other crimes. Participants with a prior criminal record had an average of 2.9 charges ( $SD = 6.3$ ; Median = 1.0) for violent sexual crimes, 1.0 charges ( $SD = 3.1$ ; Median = .0) for non-violent sexual crimes, 2.5 charges ( $SD = 4.4$ ; Median = 1.0) for violent non-sexual crimes, and 11.9 charges ( $SD = 19.6$ ; Median = 4.0) for non-sexual non-violent crimes. Offenders included in this study had sexually assaulted adult women ( $n = 33$ ), children ( $n = 17$ ), or both ( $n = 22$ ).

## **4.2. Procedures**

The procedure involved two main stages: a) in-depth semi-structured interviews conducted with all offenders to investigate each sexual crime, and b) content analysis of police investigation reports for all events involved. An instrument was developed from existing police questionnaires (i.e., ViCLAS in Canada and VICAP in the U.S.) to guide the nature of the questions. Data, especially on the crime, were collected from the police reports and coded in the instrument. The reliability of responses in this study was monitored by checking for and questioning inconsistencies. In case of any discrepancies between the offender's account and the police report, information from the police report was used. Interviews were conducted in a private office, isolated from correctional staff and other inmates. They lasted from 2 to 12 hours, depending on the number of crimes committed and the participants' verbosity. All participants signed a consent form and were promised complete anonymity and confidentiality, as well as a guarantee that the information they disclosed could not be used against them by Correctional Service of Canada.

## 4.3. Measures

### 4.3.1. *Dependent Variables*

The current study contains four dependent variables that measure the environmental aspects of each of the two most important locations for constructing a geographic profile in cases of serial rape: the victim encounter and release sites (Rossmo, 2000). Consistency in offenders' choice of environmental factors related to their crime sites has been found in previous studies (e.g., Lundrigan et al., 2010); therefore, it is assumed that offenders in the current study remain stable in their environmental selections across their series. The four environmental aspects to be estimated for each of the victim encounter and release sites are whether or not the location is in a residential land use area, private site, inside location, and familiar to the offender. Each of the dependent variables is a nominal-level measure that is dichotomized to isolate the category of interest. The first environmental dependent variable for both sites describes the potential land uses of the offender's target locations, and consists of non-residential versus residential areas (0 = *non-residential land use*<sup>2</sup>; 1 = *residential land use*). The second dependent variable measures whether or not the offence takes place in a public versus private site (0 = *public*; 1 = *private*). The third dependent variable refers to whether or not the offence location is outside versus inside (0 = *outside*; 1 = *inside*). The final dependent variable refers to whether or not the victim encounter and/or release site is familiar to the offender (0 = *site is not familiar to the offender*; 1 = *site is familiar to the offender*).

### 4.3.2. *Control Variable*

Age of the victim is used as a control variable in all eight models. The variable for the victim's age is an interval-level measure that is trichotomized [0 = *adults* (18 years and older); 1 = *pubescent adolescents* (12-17 years); and, 2 = *pre-pubescent children*

<sup>2</sup> Non-residential land use includes commercial, industrial, institutional, park, rural/agricultural, and wilderness/uninhabited areas.

(0-11 years)], to better reflect sex offenders' sexual preference for victims of varying developmental stages. It is important to control for the age of the victim because it differentiates child molesters from rapists.

#### **4.3.3. Temporal Factors**

Two temporal variables are included in the study that are relevant for determining the environmental aspects of the victim encounter and release sites: offence timing (0 = *weekend only*; 1 = *both week and weekend*; 2 = *week only*); and, the time of day when the offence takes place (0 = *day*; 1 = *night*).

#### **4.3.4. Hunting Behaviour**

The study includes the victim search and attack method typologies embodied by serial violent predators as put forth by Rossmo (2000). Victim search methods, or hunting styles, refer to how rapists search for suitable victims in the environment, which is very important in determining the encounter location (Rossmo, 2000). The hunting style variable is a nominal-level measure used in both the victim encounter and release site models, and consists of four hunting patterns (0 = *trapper*; 1 = *poacher*; 2 = *troller*; 3 = *hunter*). Attack methods refer to how rapists attack their victims and bring them to the crime site location. These methods are influential in determining the location of the release site (Rossmo, 2000). The attack methods variable is a nominal-level measure used in the victim release site model only, and includes three attack methods (0 = *ambusher*; 1 = *stalker*; 2 = *raptor*).

#### 4.3.5. *Modus Operandi Strategies*

Both victim encounter and release site models include dichotomous (0 = yes; 1 = no) modus operandi variables, namely structured premeditation<sup>3</sup> of the offence, offender searches in specific places for victims, and the use of a vehicle to commit the crime. Offender-victim relationship (0 = *offender and victim are strangers*; 1 = *offender and victim have already seen/talked to each other*) is also investigated. The current sample of cases only involves crimes where the offender and victim had no personal relationship prior to the date the offence was committed. However, it is also the case that the offender and the victim, despite not having had a personal relationship, may have seen and/or briefly spoken with one another prior to the time the attack took place (e.g., the offender and the victim met in a bar, then he followed her home and sexually assaulted her). Although the offender and the victim may have had a brief encounter before the assault took place, this interaction is not characteristic of having a personal relationship. Additionally, the victim encounter site model includes selection of the victim<sup>4</sup> (0 = yes; 1 = no) and the type of victim selection displayed by the offender (0 = *non-random/patterned*; 1 = *random/non-patterned*). These latter variables are removed from the victim release site model because it is thought that they are more theoretically relevant for predicting victim encounter locations. In addition to the aforementioned predictors present in the victim release site model, the offender approach variable (0 = *surprise attack*; 1 = *other, which includes a confidence approach or blitz assault*) is also included in this model. Table 1 presents the frequencies of the variables used in this study.

<sup>3</sup> Premeditation is a modus operandi variable that has been used throughout the literature concerning victim/target selection and the decision-making processes of offenders (e.g., Beauregard et al., 2010). Premeditation refers to a thought process which manifests itself by preparation and planning. A sexual crime is premeditated when it is planned by the offender prior to its commission. The premeditation is *structured* when its level of planning is elaborate and involves specific components such as the victim's identity, specific victim characteristics, locations at which the crime will be committed, strategies to commit the crime, et cetera.

<sup>4</sup> Selection of the victim refers to the offender choosing a victim not at random. In other words, the offender purposefully selected a victim independent of the situation. Non-selection of the victim refers to the offender selecting the victim completely at random arising out of an opportunity to do so. In this case, the victim could have been anyone.



**Table 1. Descriptive Statistics of Dependent and Independent Variables**

Variable	Categories	N (%)	Variable	Categories	N (%)
<b>DEPENDENT VARIABLES</b>					
<b>VICTIM ENCOUNTER SITE</b>			<b>VICTIM RELEASE SITE</b>		
Residential land use	Non-residential	138 (38.2%)	Residential land use	Non-residential	114 (31.6%)
	Residential	223 (61.8%)		Residential	247 (68.4%)
Private site	Public	245 (67.9%)	Private site	Public	180 (49.9%)
	Private	116 (32.1%)		Private	181 (50.1%)
Inside location	Outside	183 (50.7%)	Inside location	Outside	162 (44.9%)
	Inside	178 (49.3%)		Inside	199 (55.1%)
Site familiar to offender	Unfamiliar	78 (21.6%)	Site familiar to offender	Unfamiliar	119 (33.0%)
	Familiar	283 (78.4%)		Familiar	242 (67.0%)
<b>INDEPENDENT VARIABLES</b>					
<b>CONTROL VARIABLE</b>			<b>MODUS OPERANDI STRATEGIES</b>		
Age of vic (in years)	Adult (18+)	164 (45.4%)	Offender looks in specific places for vics	Yes	257 (71.2%)
	Pub (12-17)	107 (29.6%)		No	104 (28.8%)
	Pre-pub (0-11)	90 (24.9%)			
<b>TEMPORAL VARIABLES</b>			Structured premeditation	Yes	164 (45.4%)
Offence timing	Weekend only	66 (18.3%)		No	197 (54.6%)
	Mixed	48 (13.3%)	Selection of vic before encounter	Yes	273 (75.6%)
	Week only	247 (68.4%)		No	88 (24.4%)
Time of day	Day	217 (60.1%)	Offender-vic relationship	Stranger	239 (66.2%)
	Night	144 (39.9%)		Already seen/ talked to	122 (33.8%)
<b>HUNTING BEHAVIOUR</b>			Offender approach	Surprise attack	87 (24.1%)
Hunting styles	Trapper	75 (20.8%)		Other	274 (75.9%)
	Poacher	20 (5.5%)	Type of vic selection	Non-random/ patterned	181 (50.1%)
	Troller	68 (18.8%)		Random/ non-patterned	180 (49.9%)
	Hunter	198 (54.8%)	Type of vehicle used to commit the crime	Vehicle	76 (21.1%)
Attack methods	Ambusher	179 (49.6%)		No vehicle	285 (78.9%)
	Stalker	29 (8.0%)			
	Raptor	153 (42.4%)			

Note. Some words are abbreviated due to space constraints; full names of variables are provided in-text.

## 4.4. Statistical Analyses

Using Statistical Analysis System 9.2 (SAS 9.2) software for Windows, the GENMOD procedure is employed to perform eight separate Generalized Estimating Equations (GEEs). The GEE technique allows for data that have correlated responses to be modeled as a generalized linear model (Liang & Zeger, 1986). GEEs differ from other methods used to model generalized linear models because they account for the correlation between observations, thereby increasing the efficiency of the results (Liang & Zeger, 1986). Correlated data are most commonly encountered in studies involving longitudinal or clustered data, where information is taken from individuals over time or events that share a common characteristic or circumstance, leading them to have some degree of correlation (Johnston & Stokes, 1997).

The current data consist of a series of sexual crimes committed by serial rapists. Because each offender committed at least two sexually-related crimes, it is possible that correlations exist between crimes that were perpetrated by the same offender. In other words, crimes that were committed by the same offender are more alike, due to similar hunting behaviour and modus operandi strategies, for example, than those events perpetrated by another rapist (see Lundrigan et al., 2010). As a result, it cannot be assumed that independence exists between each observation, and the current models need to take this dependence into account.

Due to the nature of correlated data, treating observations as though they were independent of one another, as is one of the assumptions of regression, has potentially negative consequences. First, without taking into account the correlations, the resulting regression parameters can mislead researchers and allow them to draw incorrect conclusions because of underestimated standard errors (Johnston & Stokes, 1997). Second, it is likely that the models will have inefficient estimators, meaning that there will be “more mean square error in regression parameter estimators than necessary” (Johnston & Stokes, 1997, p. 881). Thus, in order to draw the correct conclusions from the results, researchers must not only acknowledge that the data are correlated, but they need to decide how the data are associated and specify the most appropriate correlation structure.

Although the correlation structure must be specified, the correct structure is not usually known to the researcher and therefore needs to be estimated (Johnston & Stokes, 1997). This estimation takes place through an iterative process that utilizes “the current value of the parameter vector  $\beta$  to compute appropriate functions of the Pearson residual” (Johnston & Stokes, 1997, p. 882). Although many different types of working correlation matrices exist (see Liang & Zeger, 1986), GEEs are relatively robust to the specification of the correlation structure (Pan & Connett, 2002). Thus, parameter estimates are relatively unchanged as analysts substitute one correlation matrix for another. In the present study, three working correlation matrices are analyzed for both the victim encounter and release site models in order to identify the best structure for the data<sup>5</sup>. Based on the comparisons of the quasi-likelihood under the independence model criterion (QIC) between the three correlation matrices for all eight models, the structure with the lowest QIC value is chosen for each<sup>6</sup>. Due to the binary nature of the dependent variables for all eight GEEs, the binomial distribution and logit link function are specified.

<sup>5</sup> Correlation matrices that are appropriate for these data include the independent, exchangeable, and unstructured types. The independent structure assumes that all cases are independent of one another (Liang & Zeger, 1986). Conversely, the exchangeable structure assumes that the correlation that exists between observations is the same across all of the cases (Liang & Zeger, 1986). The unstructured matrix does not make any assumptions about the correlations between observations; rather, the correlations are unpredictable and there is no systematic pattern (Field, 2009).

<sup>6</sup> The QIC (Pan, 2001) goodness of fit statistic is similar to Akaike's (1974) Akaike information criterion (AIC) used in maximum likelihood estimation. Because GEEs are not likelihood-based, the AIC measure of goodness of fit is not available; thus, QIC must be used (Pan, 2001).

## 5. Results

### 5.1. Generalized Estimating Equations

To test the role of temporal, hunting behaviour, and modus operandi variables in predicting the environmental aspects of victim encounter and release sites of rapes, the GEE technique is used (Liang & Zeger, 1986). Eight separate regression models are tested for main effects. Tables 2 and 3 display the results of the GEE analyses for the victim encounter and release sites taking place in residential land use areas, private sites, inside locations, and sites that are familiar to the offender. The independent correlation structure is used in each of the eight GEE analyses measuring the environmental aspects of the victim encounter and release sites. This correlation matrix is chosen because the QIC value of each model using the independent matrix is closest to zero. Although the cases in these models are theoretically correlated with one another, the finding that the independent correlation structure is the best fit to the model suggests that there is not much intraclass correlation between observations<sup>7</sup>. Thus, it is concluded that the efficiency of the parameter estimates is not improved by accounting for the dependency between crimes perpetrated by the same rapist.

#### 5.1.1. *Victim Encounter Site*

Temporal, hunting behaviour and modus operandi variables are significant predictors of the characteristics of both the victim encounter and release sites, although the importance of these factors differs among locations. Referring to Table 2, the control

<sup>7</sup> Because the independent correlation structure is the best fit to the data, the assumption of independence of observations has not been violated. Thus, it is possible to analyze these data using logistic regression. The results of the logistic regression analyses are presented in Appendix A.

variable used in the analyses, age of the victim, is a significant predictor of whether or not the encounter site takes place indoors. Sexual crimes that involve either adult ( $\beta = 3.25$ ;  $p < .001$ ) or pubescent ( $\beta = 2.69$ ;  $p < .001$ ) victims are more likely to take place inside than if they involve pre-pubescent children. In terms of whether or not the encounter site is familiar to the offender, the age of the victim also proves to be significant. In sexual crimes involving adult victims ( $\beta = -1.86$ ;  $p < .05$ ), the encounter site is less likely to be familiar to the rapist than those events committed against pre-pubescent children.

With regard to temporal factors, the sole significant predictor, time of day of the offence, is important to the residential land use model only. Crimes that are committed during the day ( $\beta = -0.86$ ;  $p < .05$ ) are less likely to occur in residential land use areas than those taking place at night.

Offender hunting behaviour is significantly related to whether or not the victim encounter site will be in a residential land use area, private site, or inside location. When examining offender hunting styles, crimes involving rapists who adopt the *troller* typology ( $\beta = -1.61$ ;  $p < .05$ ) are less likely to be located in residential land use areas than those crimes perpetrated by *hunters*. Alternatively, crimes perpetrated by *trappers* ( $\beta = 2.20$ ;  $p < .05$ ) are more likely to take place in private sites than those crimes committed by *hunters*. Similar to the private site model, crimes perpetrated by *trappers* ( $\beta = 2.20$ ;  $p < .05$ ) are also more likely to take place inside than those committed by *hunters*.

Modus operandi strategies proved to be especially important for predicting whether or not the encounter site takes place in a residential land use area, private location, and inside area, but not for the site familiarity model. As for the residential land use model, crimes that are structurally premeditated by the offender ( $\beta = 1.38$ ;  $p < .01$ ) are more likely to take place in residential areas than if they are not structurally premeditated. Similarly, sexual crimes that are structurally premeditated by the offender ( $\beta = 1.47$ ;  $p < .05$ ) are more likely to take place in a private site than those that are not structurally premeditated. Finally, crimes that are structurally premeditated by the rapist ( $\beta = 1.84$ ;  $p < .05$ ) are also more likely to take place inside than those crimes that are not.

The relationship between the offender and the victim is also a significant predictor of the type of location where the encounter is likely to take place. Sexual crimes where the rapist and victim have had no previous contact with one another prior to the date of the offence ( $\beta = -1.80$ ;  $p < .01$ ) are less likely to occur in a private site than those events where the offender and victim have seen and/or spoken with each other. Likewise, if the victim and offender are characterized as being strangers ( $\beta = -1.64$ ;  $p < .01$ ), the encounter sites of sexual crimes are less likely to be inside than if they had previously seen and/or spoken with one another. In terms of victim selection, if rapists have selected their victims ( $\beta = -2.06$ ;  $p < .01$ ), crimes are less likely to take place indoors than those events where the offenders have not. The type of victim selection that the offender uses is also a significant predictor of the type of land use where the encounter occurs. If the victim is not selected at random and the target selection choice is patterned ( $\beta = -1.77$ ;  $p < .001$ ), the encounter site is less likely to take place in residential areas than if the victim selection is random and non-patterned.

**Table 2. Generalized Estimating Equation Models<sup>a</sup> Predicting Residential Land Use, Private Site, Inside Location, and Familiarity of the Victim Encounter Site to the Offender (n = 72)**

	Residential Land Use		Private Site		Inside Location		Site Familiar to Offender	
	$\beta$	t	$\beta$	t	$\beta$	t	$\beta$	t
Age of the vic (Pre-pubescent)								
Adult	0.17	0.30	1.21	1.76	3.25***	4.16	-1.86*	-1.96
Pubescent	-0.35	-0.67	0.58	0.69	2.69***	3.40	-1.23	-1.14
<b>Temporal Factors</b>								
Offence timing (Week)								
Weekend	-0.52	-0.85	-0.18	-0.30	-0.57	-0.92	0.20	0.36
Mixed	-0.56	-0.67	0.57	0.56	-0.16	-0.19	1.99	1.30
Time of day (Night)	-0.86*	-1.99	-1.34	-1.73	-0.42	-0.61	0.69	0.99
<b>Hunting Behaviour</b>								
Hunting style (Hunter)								
Trapper	0.32	0.36	2.20*	2.34	2.20*	2.51	1.80	1.72
Poacher	-1.23	-1.76	-0.32	-0.35	-0.47	-0.81	0.49	0.58
Troller	-1.61*	-2.40	0.04	0.05	-0.06	-0.12	2.04	1.59
<b>Modus Operandi Strategies</b>								
Structured premeditation (No)	1.38**	2.88	1.47*	2.43	1.84*	2.37	-0.95	-1.37
Offender-vic relationship (Already seen/ talked to)	-0.62	-1.15	-1.80**	-2.78	-1.64**	-2.64	1.01	1.37
Selection of vic before encounter (No)	0.47	0.81	-1.12	-1.37	-2.06**	-3.05	2.00	1.58
Type of vic selection (Random/ non-patterned)	-1.77***	-3.37	0.11	0.12	0.05	0.06	-0.49	-0.55
Offender looks in specific places for vics (No)	-0.67	-1.40	0.26	0.52	0.31	0.67	0.06	0.11
Type of vehicle used to commit the crime (No)	-0.04	-0.06	0.96	1.23	-0.19	-0.29	-0.65	-0.84
Constant	2.40*	2.42	-0.59	-0.49	-0.72	-0.57	0.24	0.13

<sup>a</sup> The specified working correlation structure is independent.

Note. Some words are abbreviated due to space constraints; full names of variables are provided in-text; the reference category for each independent variable is provided in parentheses; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

### 5.1.2. Victim Release Site

As shown in Table 3, age of the victim is significantly related to whether or not the victim release site takes place in a residential land use area and inside location. As to the victim's age, adult ( $\beta = -1.56$ ;  $p < .05$ ) and pubescent ( $\beta = -1.55$ ;  $p < .05$ ) victims are less likely to be released in residential areas than victims who are pre-pubescent. In terms of inside versus outside locations, victim release sites are more likely to be indoors when crimes involve adult victims ( $\beta = 2.00$ ;  $p < .05$ ), as compared to pre-pubescent children.

Regarding temporal factors, victims of sexual assaults are more likely to be released in residential areas when these crimes occur during both the week and the weekend ( $\beta = 3.33$ ;  $p < .01$ ), as opposed to those that take place during the week only. It is also seen that victims are more likely to be released in sites that are familiar to the offender if the rape takes place during the weekend ( $\beta = 1.48$ ;  $p < .05$ ) rather than during the week only. Table 3 shows that victims are less likely to be released in residential land use areas when the crime takes place during the day ( $\beta = -1.99$ ;  $p < .01$ ), as compared to if it were to happen during the night. Likewise, in crimes committed during the day ( $\beta = -2.88$ ;  $p < .001$ ), victims are less likely to be released in private locations than those sexual crimes committed at night. Lastly, the victim release site is more likely to be in a site familiar to the offender if the crime takes place during the day ( $\beta = 2.40$ ;  $p < .001$ ).

Offender hunting behaviour also proves to be significant in the residential land use, inside location, and offender site familiarity models; however, the attack methods appear to be more influential than the type of hunting style adopted by the rapist. As to hunting styles, victims are more likely to be released indoors if the rapist adopts the *trapper* typology ( $\beta = 2.56$ ;  $p < .01$ ) than if he were classified as a *hunter*. In terms of attack methods, the victim release site is less likely to be in a residential land use area ( $\beta = -1.83$ ;  $p < .05$ ) or inside location ( $\beta = -3.20$ ;  $p < .01$ ) if rapists use the *stalker* attack to commit the crime than if the *raptor* attack is used. In predicting whether or not the victim release site is familiar to the offender, rapists who use the *stalker* attack ( $\beta = 1.84$ ;  $p < .01$ ) are more familiar with the site than those who use the *raptor* attack. Likewise, the victim release site is more likely to take place in a location that is familiar to the offender if the *ambusher* attack method ( $\beta = 1.31$ ;  $p < .05$ ) is used rather than the *raptor* attack.

Results for the modus operandi strategies indicate that victims are more likely to be released in an inside location if the crime is structurally premeditated by the offender ( $\beta = 3.07$ ;  $p < .001$ ). If the rapist and victim have a stranger relationship ( $\beta = -2.13$ ;  $p < .01$ ), the victim release site is less likely to be in a private location than if they had previously seen and/or spoken with one another. Lastly, victims of sexual assault, where the rapist uses a vehicle to commit the crime, are less likely to be released in a private site ( $\beta = -1.58$ ;  $p < .05$ ) or inside location ( $\beta = -1.94$ ;  $p < .01$ ) than those crimes where no vehicle is used.



**Table 3. Generalized Estimating Equation Models<sup>a</sup> Predicting Residential Land Use, Private Site, Inside Location, and Familiarity of the Victim Release Site to the Offender (n = 72)**

	Residential Land Use		Private Site		Inside Location		Site Familiar to Offender	
	$\beta$	t	$\beta$	t	$\beta$	t	$\beta$	t
Age of the vic (Pre-pubescent)								
Adult	-1.56*	-2.08	0.13	0.19	2.00*	2.41	-0.72	-1.00
Pubescent	-1.55*	-2.08	0.05	0.07	1.19	1.46	-0.29	-0.34
<b>Temporal Factors</b>								
Offence timing (Week)								
Weekend	0.20	0.30	0.54	0.88	0.60	1.04	1.48*	2.21
Mixed	3.33**	2.75	1.46	1.59	-1.58	-1.94	1.08	0.98
Time of day (Night)	-1.99**	-3.23	-2.88***	-4.08	-0.30	-0.38	2.40***	3.96
<b>Hunting Behaviour</b>								
Hunting style (Hunter)								
Trapper	0.18	0.17	0.95	0.97	2.56**	2.85	0.97	1.08
Poacher	-0.47	-0.56	-0.19	-0.21	-0.07	-0.09	1.45	1.79
Troller	-0.56	-0.83	0.75	0.91	1.38	1.95	0.89	1.06
Attack method (Raptor)								
Ambusher	-0.59	-0.88	-1.05	-1.40	-0.58	-0.80	1.31*	2.09
Stalker	-1.83*	-2.35	-1.37	-1.50	-3.20**	-2.93	1.84**	2.74
<b>Modus Operandi Strategies</b>								
Structured premeditation (No)	0.71	1.05	0.87	1.53	3.07***	3.96	-0.15	-0.26
Offender-vic relationship (Already seen/ talked to)	-1.01	-1.46	-2.13**	-2.71	-0.99	-1.65	0.92	1.16
Offender approach (Other)	0.55	0.79	-0.45	-0.72	0.41	0.58	-0.99	-1.63
Offender looks in specific places for vics (No)	0.21	0.38	0.96	1.90	0.00	0.01	-0.60	-1.44
Type of vehicle used to commit the crime (No)	-0.59	-0.81	-1.58*	-2.22	-1.94**	-2.64	0.79	1.35
Constant	3.83**	2.65	2.42	1.72	-1.26	-0.97	-1.54	-1.20

<sup>a</sup> The specified working correlation structure is independent.

Note. Some words are abbreviated due to space constraints; full names of variables are provided in-text; the reference category for each independent variable is provided in parentheses; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

## 5.2. Logistic Regression

As previously mentioned, findings from the GEE models indicate that the independent correlation structure is the best fit to the data. Because these models treat the crime events as though they are independent of one another, it is possible to model these data using logistic regression analyses due to the binary nature of the dependent variables. Since the use of the GEE technique and corresponding findings were the foci

of this research, the results from the logistic regression analyses are located in Appendices A and B.

When evaluating model fit of the logistic regression models to determine validity, overall fit is tested using Receiver Operating Characteristic (ROC) analysis, which gives a measure of the area under the curve (AUC). It is seen that victim age, temporal factors, offender hunting behaviour, and modus operandi strategies are moderate predictors of the four encounter site models: residential land use ( $AUC = .78$ ; 95% CI: .73 - .83), private site ( $AUC = .88$ ; 95% CI: .85 - .92), inside location ( $AUC = .85$ ; 95% CI: .81 - .89), and familiarity of the site to the offender ( $AUC = .84$ ; 95% CI: .78 - .89). Similarly, these variables moderately predict the four victim release sites: residential land use ( $AUC = .82$ ; 95% CI: .78 - .87), private site ( $AUC = .87$ ; 95% CI: .83 - .91), inside location ( $AUC = .86$ ; 95% CI: .83 - .90), and familiarity of the site to the offender ( $AUC = .88$ ; 95% CI: .84 - .93). As the AUC for all eight models is above 0.70, with seven of the eight models being above 0.80, this suggests that the models represent a fair to good level of predictive accuracy (Swets, 1988).

As seen in Appendix A, the second test for evaluating model fit includes the Omnibus Tests of Model Coefficients, which proves to be highly significant in each of the four models measuring the environmental aspects of the encounter site: residential land use area ( $X^2 = 82.19$ ;  $p < .001$ ), private site ( $X^2 = 151.72$ ;  $p < .001$ ), inside location ( $X^2 = 161.75$ ;  $p < .001$ ), and familiarity of the site to the offender ( $X^2 = 92.71$ ;  $p < .001$ ). For the victim release site (see Appendix B), the Omnibus Tests of Model Coefficients is also highly significant for the residential land use area ( $X^2 = 110.12$ ;  $p < .001$ ), private site ( $X^2 = 178.42$ ;  $p < .001$ ), inside location ( $X^2 = 165.83$ ;  $p < .001$ ), and familiarity of the site to the offender ( $X^2 = 183.74$ ;  $p < .001$ ) models. These significant results suggest that the models, including all factors, are better at predicting each of the outcome variables than the intercept only models.

Lastly, the overall classification percentage of each of the models for both the encounter and victim release sites is presented in Appendices A and B. For the encounter site, the overall classification percentage for each of the residential land use (74.2%), private site (80.9%), inside location (77.0%), and familiarity of the site to the offender (84.2%) models surpasses the expected hit rate, which indicates good model

fit. Likewise, for the victim release site, the overall classification percentage for each of the residential land use (78.4%), private site (80.6%), inside location (77.6%), and familiarity of the site to the offender (88.4%) models is greater than that which would be expected, which indicates that they are accurately predicting the observed data.

An overall comparison of the parameter estimates between the GEE models and those of the logistic regression analyses reveals that all of the statistically significant findings in the former models remained significant in the latter analyses as well. Furthermore, the direction of the significant findings is consistent between both sets of results. The only difference in findings between the two techniques is that some additional independent variables prove to be significant in the logistic regression results that are not significant when tested using GEEs. Because the GEE technique produces more conservative standard errors of the parameter estimates, it is more difficult for variables to test significant. Thus, GEEs are a more stringent approach to use in order to reduce the risk of committing a Type I error. These variations in findings between the GEE and logistic regression models are detailed below.

### **5.2.1. Victim Encounter Site**

From the logistic regression models of the four environmental aspects of the encounter site (see Appendix A), victim age proves to be a significant predictor of whether or not a crime event will take place in a site that is private and familiar to the offender. As to the victim's age, adult victims ( $OR = 3.35; p < .05$ ) are more likely to be encountered in a private site than are pre-pubescent children. Conversely, pubescent victims ( $OR = .29; p < .05$ ) are less likely to be encountered in sites that are familiar to the offender as compared to pre-pubescent victims.

In terms of temporal variables, for crime events that take place during the day ( $OR = .26; p < .001$ ), victims are less likely to be encountered in private sites than those events taking place at night. Conversely, in crime events occurring during the day ( $OR = 1.99; p < .05$ ), victims are more likely to be encountered in sites that are familiar to the offender than those crime events occurring at night.

Differences in findings between the GEE and logistic regression techniques are present for offender hunting behaviour variables as well. Offenders who use the *poacher*

( $OR = .29$ ;  $p < .05$ ) hunting style are less likely to encounter their victims in residential land use areas than are those who are *hunters*. It is also seen that offenders who are *trappers* ( $OR = 6.05$ ;  $p < .05$ ) and *trollers* ( $OR = 7.67$ ;  $p < .001$ ) are more likely to encounter their victims in a site that is familiar to them than those who are *hunters*.

In terms of modus operandi strategies, several factors, in addition to those identified by using GEEs, are significantly related to the environmental aspects of where the encounter site is likely to be. First, victims of crime events that are structurally premeditated ( $OR = .39$ ;  $p < .05$ ) are less likely to be encountered in sites that are familiar to the offender than are those crime events that are not structurally premeditated. Second, the relationship between the victim and offender is also a significant predictor of where the encounter site is likely to be. Stranger victims ( $OR = 2.75$ ;  $p < .05$ ) are more likely to be encountered in sites that are familiar to the offender than are those where the victim and offender have already seen and/or spoken with one another. Findings also indicate that victims who are selected by the offender are less likely to be encountered in private sites ( $OR = .33$ ;  $p < .05$ ), but more likely to be encountered in sites familiar to the offender ( $OR = 7.42$ ;  $p < .001$ ), than are those who are not selected. It is also seen that offenders who look in specific places for victims ( $OR = .51$ ;  $p < .05$ ) are less likely to encounter their victims in residential land use areas than are those who do not look in specific places. Lastly, offenders who use a vehicle to commit their crimes ( $OR = 2.62$ ;  $p < .05$ ) are more likely to encounter their victims in private sites than are those who do not use a vehicle.

### **5.2.2. Victim Release Site**

In addition to those significant relationships already identified by the GEE technique between the victim's age and the environmental locations chosen for the victim release site, findings from the logistic regression (see Appendix B) deem pubescent victims ( $OR = 3.30$ ;  $p < .01$ ) as being more likely to be released in an inside location than pre-pubescent victims.

In terms of temporal factors, victims of crime events that take place during both the week and the weekend are more likely to be released in a private site ( $OR = 4.32$ ;  $p$

< .05), but less likely in an inside location ( $OR = .21$ ;  $p < .05$ ), than victims of those events taking place during the week only.

Statistically significant relationships are identified between the victim release outcome variables and offender hunting behaviour typologies that are not significant in the GEE results. First, victims of crime events where the offender is a *poacher* ( $OR = 4.24$ ;  $p < .05$ ) are more likely to be released in sites that are familiar to the offender than victims of crime events where the offender uses the *hunter* typology. Second, *trollers* ( $OR = 3.99$ ;  $p < .01$ ) are more likely to release their victims in inside locations than are *hunters*. Finally, *ambushers* ( $OR = .35$ ;  $p < .05$ ) and *stalkers* ( $OR = .26$ ;  $p < .05$ ) are less likely to release their victims in private sites as compared to *raptors*.

With regards to offender modus operandi strategies, victims of structurally premeditated crime events are more likely to be released in residential land use areas ( $OR = 2.03$ ;  $p < .05$ ) and private sites ( $OR = 2.40$ ;  $p < .05$ ) than victims of crime events that are not structurally premeditated. Findings also indicate that stranger victims are less likely to be released in residential land use areas ( $OR = .37$ ;  $p < .05$ ) and inside locations ( $OR = .37$ ;  $p < .05$ ) than are victims who have already seen and/or spoken with one another. In terms of offender approach, victims of crime events where the offender uses a surprise attack ( $OR = .37$ ;  $p < .05$ ) are less likely to be released in sites that are familiar to the offender than if a blitz assault or confidence approach are used. Finally, victims are more likely to be released in private sites ( $OR = 2.62$ ;  $p < .01$ ) if the offender looks in specific places for his victims than if he did not.

## 6. Discussion

Rapes are complex crimes that require an examination of offender modus operandi, temporal factors, and the environment to gain a better perspective on how offenders select their crime sites. Based on the author's knowledge, this is the first study to incorporate these factors in trying to predict the type of crime sites where victims are likely to be encountered and released. Findings from the current study indicate that temporal factors, hunting behaviour, and modus operandi variables are all important to the victim encounter and release sites, but the significance of these factors varies depending on whether or not the location is in a residential land use area, private site, inside location, and familiar to the offender. A summary of the findings is presented in Table 4.

**Table 4. Summary of Significant Findings for Residential Land Use, Private Site, Inside Location, and Familiarity of the Site to the Offender for both the Encounter and Victim Release Sites**

	Residential Land Use	Private Site	Inside Location	Site Familiar to Offender
<b>VICTIM ENCOUNTER SITE</b>				
<b>Age of the Victim</b>			<ul style="list-style-type: none"> <li>Adult and pubescent victims are more likely to be encountered indoors</li> </ul>	<ul style="list-style-type: none"> <li>Adult victims are less likely to be encountered in sites familiar to the offender</li> </ul>
<b>Temporal Factors</b>	<ul style="list-style-type: none"> <li>Victims are less likely to be encountered in residential areas if the crime takes place during the day</li> </ul>			
<b>Hunting Behaviour</b>	<ul style="list-style-type: none"> <li>Victims are less likely to be encountered in residential areas if the rapist is a <i>troller</i></li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be encountered in private sites if the rapist is a <i>trapper</i></li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be encountered indoors if the rapist is a <i>trapper</i></li> </ul>	
<b>Modus Operandi Strategies</b>	<ul style="list-style-type: none"> <li>Victims are more likely to be encountered in residential areas if the crime is structurally premeditated</li> <li>Victims who are not selected at random/the target selection choice is patterned are less likely to be encountered in residential areas</li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be encountered in private sites if the crime is structurally premeditated</li> <li>Victims are less likely to be encountered in private sites if the offender is a stranger</li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be encountered indoors if the crime is structurally premeditated</li> <li>Victims are less likely to be encountered indoors if the offender is a stranger</li> <li>Victims are less likely to be encountered indoors if they were selected by the rapist</li> </ul>	

VICTIM RELEASE SITE			
<b>Age of the Victim</b>	<ul style="list-style-type: none"> <li>Adult and pubescent victims are less likely to be released in residential areas</li> </ul>		<ul style="list-style-type: none"> <li>Adult victims are more likely to be released indoors</li> </ul>
<b>Temporal Factors</b>	<ul style="list-style-type: none"> <li>Victims are more likely to be released in residential areas if the crime takes place during both the week and the weekend</li> <li>Victims are less likely to be released in residential areas if the crime takes place during the day</li> </ul>	<ul style="list-style-type: none"> <li>Victims are less likely to be released in private sites if the crime takes place during the day</li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be released in sites familiar to the offender if the crime takes place during the weekend</li> <li>Victims are more likely to be released in sites familiar to the offender if the crime takes place during the day</li> </ul>
<b>Hunting Behaviour</b>	<ul style="list-style-type: none"> <li>Victims are less likely to be released in residential areas if the rapist uses the <i>stalker</i> attack</li> </ul>		<ul style="list-style-type: none"> <li>Victims are more likely to be released indoors if the rapist is a <i>trapper</i></li> <li>Victims are less likely to be released indoors if the rapist uses the <i>stalker</i> attack</li> <li>Rapists who use the <i>stalker</i> or <i>ambusher</i> attack are more likely to be familiar with the victim release site</li> </ul>
<b>Modus Operandi Strategies</b>		<ul style="list-style-type: none"> <li>Victims are less likely to be released in private sites if the offender is a stranger</li> <li>Rapists who use a vehicle to commit the crime are less likely to release their victims in private sites</li> </ul>	<ul style="list-style-type: none"> <li>Victims are more likely to be released indoors if the crime is structurally premeditated</li> <li>Rapists who use a vehicle to commit the crime are less likely to release their victims indoors</li> </ul>

## 6.1. Victim Encounter Locations

The victim's age proved to significantly affect whether or not the victim encounter site is classified as an inside location and if it is familiar to the offender. Crimes involving adults or pubescent children are more likely to take place in an inside location than those events involving pre-pubescent victims. This finding is consistent with the routine activities and lifestyles of individuals who are going through these developmental stages. For example, due to the routine activities of both adults and pubescent children who spend the majority of their time at work or in school (i.e., an inside location), it would be expected that victims in these age groups would encounter potential rapists indoors, as opposed to pre-pubescent children who spend an appreciable amount of time outside (e.g., playing outdoors with friends). Generally speaking, adults are more mobile and independent than both pubescent and pre-pubescent children. As such, adults tend to travel to more indoor locations and spend a large majority of their time there. As noted by Bernasco and Nieuwbeerta (2005), offenders are likely to choose an area in which to commit their crimes based on their perception of finding suitable targets in that location.

This perception, however, is influenced by the number of targets the offender deems as being suitable (i.e., those targets being compared to the offender's crime template and matching his criteria; Brantingham & Brantingham, 1978), and the likelihood that they will be found in this location. As such, offenders in the current sample travel to particular inside locations where they know they are likely to encounter many adult or pubescent victims who they deem as being suitable.

It is also the case that adult stranger victims are less likely than younger victims to be encountered in sites familiar to the offender. Since adults are generally more mobile than pubescent or pre-pubescent children, they are likely to be encountered in a variety of locations that may not be familiar to the offender. For example, offenders may take different routes or navigate throughout unfamiliar areas as a result of traveling to or from activity nodes. Because of their age, adults are likely to be found, more than pre-pubescents, for example, at locations used for a variety of functions. Thus, it is plausible that adults are to be encountered at locations that are unfamiliar to the offender. In contrast, for example, if offenders were specifically targeting children, they may hunt in areas where they know children are likely to be found (e.g., schools, playgrounds, and parks). As such, offenders may travel throughout their environment, in places both familiar and unfamiliar, and encounter potential adult victims.

Consistent with the *home-intrusion rape track* proposed by Beauregard, Proulx, and colleagues (2007), and the *intrusion track* noted by Deslauriers-Varin and Beauregard (2010), crimes that are committed during the day are less likely to occur in residential land use areas than those taking place at night. From a routine activities perspective, individuals are more likely to be at their residence during the night rather than during the day because of such activities as going to work or school. As a result, it may be that offenders who encounter their victims in residential land use areas are hunting at night and using the aforementioned hunting scripts to search for victims.

It is also seen that crimes involving serial rapists who adopt the *troller* typology are less likely to be located in residential land use areas than those perpetrated by *hunters*. This finding coincides with Rossmo's (2000) description of the *troller*, who while engaged in his routine activities, is suddenly presented with an opportunity to offend and is prepared to do so. Because people engage in their routine activities at activity nodes



located in a variety of land use areas, it is plausible that offenders will encounter potential victims in places other than residential zones. For example, it is likely that *trollers* who work and spend an appreciable amount of time in commercial land use areas will encounter potential victims who frequent these spaces. Moreover, there is an increased sense of guardianship in residential areas, as people protect their own personal property and the contents within it, while also watching over the property of nearby residents when they are away from their homes. Because of this, *trollers* may be more reluctant to act on offending opportunities presented to them in these areas as they may fear the increased potential risk of detection inherent in these spaces. For example, a *troller* may see a young child playing outside of a home, but because the offender perceives an increase in risk of being detected in these areas (i.e., he may be seen by guardians inside the home or residents nearby), he is unlikely to encounter victims here.

Also consistent with the *trapper* typology as proposed by Rossmo (2000) is the finding that the victim encounter site of crimes perpetrated by these offenders is more likely to be in a private site and inside location than those committed by *hunters*. As *trappers* are offenders who tend to target victims by bringing them to locations where they feel the most comfortable and in control, such as their homes or places of work (Rossmo, 2000), it is plausible that the crime sites will be in private areas and inside locations where they are unlikely to be disturbed by others. Moreover, it may also be that offenders embodying this victim search method are using the *home-invited track* (Deslauriers-Varin & Beauregard, 2010), where they search for vulnerable victims, such as single mothers with children, and gain their trust by offering them help or services (e.g., babysitter). In doing so, the offenders infiltrate the home (i.e., a private space; Smallbone, Marshall, & Wortley, 2008) and wait for an opportunity to attack. Similarly, Beauregard, Rossmo, et al. (2007) found that 16% of their sample's choice of hunting field was through families, most often single mothers. These offenders noted that it was effortless to seek out these types of victims, especially in neighbourhoods characterized as being poor (Beauregard, Rossmo et al., 2007). This finding further emphasizes the importance of considering the target backcloth when trying to understand offenders' choice of crime site locations (Rossmo, 2000), as these individuals are purposefully

traveling to neighbourhoods of a certain socio-economic status where they can easily infiltrate the homes of young, vulnerable victims.

In terms of offender modus operandi strategies, victims are more likely to be encountered in residential land use areas, private sites, and inside locations when the crime is structurally premeditated. These findings suggest that offenders purposefully hunt for victims in these locations because they know that they will find victims who satisfy their criteria. As noted in the *home-intrusion rape track* proposed by Beauregard, Proulx, and colleagues (2007), offenders following this script enter a private, inside location that is unfamiliar to them (e.g., the victim's residence). Thus, crimes taking place in private or inside locations require more premeditation on the offenders' behalf as they are entering a space that is removed from the public domain. Because the offender does not belong in these locations, it requires more effort and planning on his part to enter these spaces unlawfully, and be able to successfully commit the crime in areas where he is considered to be an outsider. This finding is corroborated by Beauregard, Rossmo, and colleagues (2007) who found that 13% of their sample of serial sex offenders hunted for their victims in private or semi-private places. More specifically, these offenders preferred the victim's home, which was usually an apartment (i.e., private space), as they found it to be the most thrilling. By purposefully searching for victims in apartment buildings, a degree of structural premeditation is implied.

As to the relationship between the offender and the victim, the encounter site in sexual crimes involving stranger victims is less likely to occur in a private site and inside location than those events where the offender and victim are not strangers. This finding is consistent with prior studies that have found that non-stranger rapes are more likely to take place in the victim's home (Warr, 1988). More specifically, McDermott (1979) notes, "most victims of non-strangers were raped in their own homes. Compared with stranger-to-stranger victims, victims of non-strangers were raped more than twice as often in their homes and less than one-half as often in open, public locations such as streets or parks" (p. 51). These findings disprove the public belief that rapes primarily take place in public sites (Warr, 1988). Although this is true in some instances, the type of location where the crime takes place largely depends on the offender-victim relationship. This result lends support to crime prevention strategies such as educational programs for parents on how to recognize inappropriate adult behaviour around their children (e.g., constant attempts

by an adult to be alone with a child), and how to properly and effectively supervise their children (Wortley & Smallbone, 2006).

With regard to victim selection, where rapists have selected their victims, the encounter site is less likely to take place in an inside location than crime events where the offenders have not. Consistent with the *outdoors script*, offenders who follow both the *coercive* and *noncoercive tracks* (Deslauriers-Varin & Beauregard, 2010) spend a considerable amount of time selecting their victims. Rapists utilizing the *coercive track* select a victim in an outside location and wait for an opportunity to attack. Once the attack has taken place, the offender brings the victim to another outdoor location to commit the sexual assault. Alternatively, rapists who follow the *noncoercive track* approach their victims outdoors and make considerable efforts to gain their trust, thereby creating the opportunity for them to bring the victim indoors to commit the crime (Deslauriers-Varin & Beauregard, 2010). Although sexual offenders using the *outdoors script* are at a higher risk of being apprehended due to potential witnesses and capable guardians, it is clear that these offenders view the benefits of their actions as outweighing the potential costs, implying some degree of rational choice.

As shown in the GEE analysis of the victim encounter site, crimes that involve victims who are not selected at random or there is a patterning to offenders' choices are less likely to take place in residential areas. This finding is consistent with Warren and colleagues' (1995) observation that serial rapists do not randomly select geographic locations when committing offences; rather, there is a patterning to their crimes. As mentioned in Brantingham and Brantingham's (1978) crime site selection model, it may be that serial rapists repeatedly search for victims in the same land use areas where they have found suitable victims and were successful in committing crimes in the past. Furthermore, consistency and patterning in serial rapists' choice of land uses has been found in previous literature (e.g., Lundrigan et al., 2010).

## **6.2. Victim Release Locations**

The victim release location for crimes involving adult victims is more likely to take place in an inside location than those involving pre-pubescent children. As noted by

Warr (1988), the same spaces that would be attractive to burglars are also attractive to some rapists. Thus, some sexual offenders appear to take note of the same environmental cues that locations emit as do burglars, despite the fact that their targets differ considerably (e.g., mobile versus static). Rossmo (2000) gives the example of a serial rapist who was interviewed by police about his crimes, and confessed to choosing residences by seeking out driveways that had oil spots on them. To him, this suggested that the resident had left in a vehicle, and if he spotted a woman in the house, he assumed that the man was not home. The rapist interpreted these environmental cues as being a good home to enter, and thus the woman inside a good victim. Additionally, Cohen and Felson (1979) contend that residences with single occupants are likely to have higher burglary rates because there is a lack of a capable guardian to protect the home when the owner leaves. As an extension of this argument, Warr states that these residences will also have higher rates of rape. As such, since experienced rapists tend to commit their crimes in their victims' homes because there is a lesser chance of interference from others (Rossmo, 2000; Warr, 1988), the encounter, attack, rape, and victim release site all take place in one location. Because adults are more likely to live on their own than are pubescent or pre-pubescent children, it is clear that these victims are more likely to be released indoors, as the victim's residence offers some protection to the offender.

Findings also indicate that adult and pubescent victims are less likely to be released in residential areas as compared to pre-pubescent children. In an examination of the literature on the relationship between modus operandi strategies and offenders' journey to crime, child molesters, like other offenders, commit crimes in the areas close to their homes (Ouimet & Proulx, 1994 as cited in Beauregard, 2005). However, unlike other sexual offenders (i.e., rapists) who target adult or pubescent victims, offenders who prefer children tend to hunt for their victims in the areas surrounding their homes, and commit their crimes within them (Beauregard, 2005), which generally speaking, are located in residential land use areas. This strategy is preferred by child molesters for two reasons. First, children may feel more comfortable engaging in sexual activities within a home as compared to an outdoor location such as a park, thereby allowing the child molester to achieve greater sexual gratification due to victim compliance (Beauregard, 2005). Second, the normalcy of the home location may contribute to the offender's ability

to manipulate his victim into secrecy about the sexual offending (Leclerc, Proulx, & McKibben, 2005), thus providing the offender with more rewards (e.g., continued access to the victim or sexual gratification) as opposed to costs (e.g., increased risk of detection due to the lack of a buffer zone) of offending so close to his home base. As the criminal act is likely to take place in the offender's home with pre-pubescent victims, it is not surprising, then, that they are more likely to be released from this location as well.

With regard to the victim release site, crime events that take place during both the week and the weekend are more likely to occur in residential land use areas than those that happen during the week only. It is hypothesized that victims can be released in residential areas during both the week and the weekend since offenders are likely to hunt, or come across opportunities to offend, during any day of the week. This finding is congruent with Brantingham and Brantingham's (1981b) research on temporal patterns and daily rhythms of activity. The environmental backcloth is a very dynamic process because it constantly changes with individuals entering and exiting spaces during different times of the day. Thus, offenders may release their victims in residential areas during the days when they are less likely to be noticed by others nearby. For example, offenders may release victims during the week when most people are likely to be at work. However, Rossmo (2000) notes that sexual assaults take place mainly on the weekend. Since most people traditionally work during the week, offenders adopting this work schedule have time to hunt for victims and commit crimes within their awareness spaces on the weekend; thus, if the encounter, attack, crime, and victim release sites are in one location (e.g., the victim's or offender's home), the victim will be released in a residential neighbourhood.

It is also seen that the victim release site of crimes taking place during the day is less likely to be in a residential land use area and private site than those events that occur during the night. Similar to what Brantingham and Brantingham (1984) note about geographic and temporal distributions of crime targets or victims, the environment, and thus the availability of victims, changes according to the time of day. Because most people are awake and active during the day, releasing the victim in a residential area during this time may be risky for the offender since there is a greater possibility that he will be seen. To avoid apprehension, rapists may be more inclined to release victims during the night. However, it may also be that the encounter, attack, rape, and victim

release sites are in one location, such as the victim's home. As stated by Beauregard, Proulx, et al. (2007) in their description of the *home-intrusion rape track*, offenders break into the victim's home and sexually assault her while she is alone. Since victims are more likely to be home at night, it is plausible that sexual assaults, and thus the victim release sites, are likely to take place during this time.

With regard to temporal factors, victims are more likely to be released in sites that are familiar to the offender if the rape takes place during the day and on the weekend. Because the offender faces an increased risk of being apprehended during daylight hours and on the weekend when people are more visible and mobile throughout the environment, sexual offenders will try to minimize their risk by releasing victims in areas where they know it will be safe for them to do so. For example, offenders may release victims in a parking lot that they know to be vacant in the mornings during the weekend. To release victims in areas in which they are not familiar is inherently more risky, as they themselves or their vehicle could be seen by onlookers. Based on these results, investigators can be confident in the fact that the victim release site for rapes taking place during these days and times is part of the offender's awareness space; thus, law enforcement officials can begin to narrow down suspects who are familiar with this location.

As to hunting behaviour, victims tend to be released indoors if the rapist adopts the *trapper* hunting style. Conversely, rapists using the *stalker* attack method are less inclined to release their victims in this type of location. Consistent with Rossmo's (2000) typologies, *trappers* lure victims into areas where they have the most control (e.g., their homes or workplaces), and these locations are considered to be indoor spaces. However, *stalkers* are more opportunistic in that their crimes depend on the victim's activities and offenders need to wait for the perfect time to attack. Thus, the victim release site has the potential of being in a variety of locations not determined by the offender. This is also suggested by Canter (1994), in that inside rapes are usually perpetrated by offenders who have premeditated their crimes (i.e., *trappers*) and have prior criminal histories. Outside rapes, however, tend to be less planned and more spontaneous and opportunistic in nature (i.e., *stalkers*).

It is also the case that rapists who use the *ambusher* attack method to secure their victims are more familiar with the victim release site than those who use the *raptor* attack. This finding is in line with Rossmo's (2000) victim attack method typology as *ambushers* attack their victims after they have entered a location that is familiar to, and controlled by, themselves. Thus, this lends support to the fact that geographic sites associated with the crime event are influenced more by the offender's activity space than the victim's (Beauregard, Rebocho et al., 2010). However, offenders who use the *stalker* attack are less likely to release their victims in residential areas, but more likely to release them in sites that they are familiar with, than those using the *raptor* attack. From a theoretical perspective, *stalkers* attack their victims as they move about in their environment. Thus, one hypothesis to explain this is if victims are being attacked at activity nodes other than their home, it is likely that the crime and victim release sites will be in the immediate area as well; however, this may depend upon the offender's mode of transportation and his ability to move the victim to another location. Interestingly, as the findings indicate that *stalkers* release their victims in sites that they are familiar with, this may point to the fact that these individuals are transporting their victims from the attack location, which is likely to be familiar to the victim only, to another location in which they know in order to reduce their risk of detection.

Offenders who structurally premeditate their crimes tend to release their victims in an inside location. As rapists who premeditate their crimes are more common than those who do not (Rossmo, 2000), many offenders select their victims by window peeping or following women on their way home, which suggests some degree of planning on behalf of the perpetrator. As such, the victim attack, crime, and release locations tend to be at the victim's residence, which in many cases is classified as an inside location. However, findings also indicate that crimes involving rapists and victims who have a stranger relationship are less likely to have the victim release site be in a private location. Indeed, rapists following the non-persuasive script, in particular the *direct action track*, act directly upon their victim to contact them, transport them to the crime site, and subsequently commit the rape (Beauregard, Proulx et al., 2007). As noted by Beauregard (2010), offenders following this track tend to choose indoor public places (e.g., bars) as their crime sites. Thus, the current finding lends support to the *direct action track* because these rapists tend not to have prior contact with their victims,

thereby requiring offenders to act directly upon them, whilst targeting public places to do so.

Lastly, victims of sexual assault, where the rapist uses a vehicle to commit the crime, are less likely to be released in a private site or inside location than those victims where the offender does not use a vehicle. As Beauregard and Leclerc (2007) note, sex offenders do not usually use vehicles throughout the commission of their crimes for several reasons, including lack of a driver's license or car, or the rape takes place in an inside location, thereby not necessitating the use of a vehicle. However, in crimes where rapists do utilize a vehicle, they may do so because it helps them to search for victims, provides them with a private site to rape the victim, and/or a means to move the victim from one location to another (e.g., moving her from the rape site to the release site) (Beauregard & Leclerc, 2007). By using a vehicle as the rape site and/or to move the victim from one geographic location to another, the rapist may release the victim in a variety of land use or public spaces. For example, Michaud and Hazelwood (1998) reported that some rapists used vehicles to transport the victim from the attack site to a cemetery to commit the crime because they did not think that law enforcement officials were present in these locations.



## 7. Conclusion

The current study aims to better inform law enforcement officials investigating serial rape cases as well as to add to the existing knowledge surrounding geographic profiling. It is found that temporal factors, offender hunting behaviour, and modus operandi variables are necessary to examine when predicting the environmental aspects of where victim encounter and release sites are likely to be. These results compliment prior studies that have examined the environmental aspects of sexual crimes (e.g., Canter & Larkin, 1993; Lundrigan et al., 2010). Law enforcement officials can learn from the current findings and apply them to subsequent rapes within a series by recognizing the timing of the offence, the type of hunting pattern and attack method used in prior sexual crimes committed by the same offender, and modus operandi strategies, to determine the type of location where the rapist is likely to offend next. Rossmo (2004) notes that law enforcement officials 'benefit' from serial crime in that there are "more pieces to the puzzle, presenting an opportunity to detect underlying patterns" (p. 122). The serial nature of some sexual crimes provides law enforcement officials with more information about the offender's crime commission process, thereby allowing more factors to play into the prediction of future encounter and victim release locations, thus improving its accuracy. At the risk of being speculative, in the case of Elmo Rivadeneira, findings from the current research may have aided law enforcement officials at the time to detect particular patterns in this rapist's offending, such as the time of day that he attacked women (e.g., early morning hours), the type of attack strategy he used (e.g., *raptor* attack), and his modus operandi (e.g., use of a parked vehicle to transport the victim), which would have allowed them to predict the type of environmental location where he would encounter and release his future victims. It remains unknown whether or not this information, if it were available during the time of Rivadeneira's crimes, could have prevented some of these women from being victimized.

The current findings are also important for geographic profiling. Because offences against stranger victims are the most difficult for law enforcement officials to

solve (Beauregard, Proulx et al., 2007; Rossmo, 2000), recognizing those temporal variables, offender typologies, and modus operandi strategies that are significantly related to crimes committed in residential areas, private sites, inside locations, and sites familiar to the offender, can provide law enforcement officials with valuable information. Since criminals do not travel very far from their homes to commit their crimes (Canter & Gregory, 1994; Canter & Larkin, 1993; LeBeau, 1987a,b; Rossmo, 2000; Warren et al., 1995), sexual offences that occur in particular locations may reduce the list of suspects since police can focus on those who spend a significant amount of time in the areas nearby. To illustrate this point, Rivadeneira encountered and released his victims in cities and suburbs throughout eastern New Jersey and Manhattan, New York. After his identity was revealed, Rivadeneira was found to be living in Kearny, New Jersey, not far from the known geographical sites associated with his crimes, which were all located within the New York metropolitan area. Once case linkages had been made by police and a geographic profile had been constructed from the crime sites, law enforcement officials may have been better able to narrow down their suspect pool and perhaps focus on Rivadeneira, since he lived relatively close to all of the known locations associated with the rapes. Furthermore, the ability to identify the hunting typologies of serial rapists who commit their crimes in the four types of locations examined in the current study can help law enforcement officials reconstruct offenders' awareness spaces (e.g., rapists who fit the *hunter* typology operate from their home base, and therefore are likely to commit their crimes in areas close by), thereby providing clues as to where their anchor points may be. Although the results are informative for geographic profiling purposes, the significant variables identified in this study are helpful for other investigative strategies as well.

The current study is unique in that it focuses on serial rapes and not on the offender; thus, implications for situational crime prevention and policy are put forth that can be applied to a variety of crime series perpetrated by different offenders. As defined by Clarke (1983), "situational crime prevention can be characterized as comprising measures (1) directed at highly specific forms of crime (2) that involve the management, design, or manipulation of the immediate environment in as systematic and permanent way as possible (3) so as to reduce the opportunities for crime and increase its risks as perceived by a wide range of offenders" (p. 225). Such measures may include defensible

space architecture, such as housing designs that allow residents to more easily guard and engage in surveillance efforts over the public spaces surrounding their residences, as well as community crime prevention initiatives, including programs like Block Watch, or other patrol efforts (Clarke, 1983). Situational crime prevention can be regarded as effective if investigators and academics alike view the occurrence of crime from a theoretical framework emphasizing the role of the situation and opportunity, rather than offenders and their reasons for engaging in deviant activities. In fact, Clarke (1983) notes that focusing on etiological theories and corresponding prevention strategies may have a limited effect since there is only so much that can be done to prevent correlates of criminality such as abuse within the family (for a review, see Haapasalo & Pokela, 1999), or mental illness (Ellis, Beaver, & Wright, 2009). As such, the ability to manipulate environments as to control, or predict human behaviour, may make situational crime prevention more effective in preventing crime than what was previously thought. From its inception, situational crime prevention has generally focused on non-sexual crimes (e.g., robbery, vandalism, and theft), and less on sexual offences (Murray, 2008). However, there has been a recent interest in studying sexual crimes from a situational perspective and the results are promising for situational crime prevention approaches (Murray, 2008). Consequently, the following strategies should be implemented and publicized generally, but more specifically when sexual assaults are known to be taking place in certain areas.

As proposed by Rossmo (1997), increased police patrol and static police stakeouts in residential areas known to be targeted by rapists would likely deter offenders from searching for and releasing victims in these locations. Since serial rapes take place in residential areas during the week and weekend, as well as predominantly during the night, women in the area can be warned against walking alone during these hours and to be more aware of their surroundings. When walking alone at night, women should also remain in well-lit areas so that there is a possibility that they will be noticed by onlookers in the event of an attack. Similarly, individuals who live in residential areas should participate in neighborhood programs such as Block Watch, in order to look for abnormal activity and provide safe places to go for both adults and children if they are in danger. Although widely cited in the situational crime prevention literature, these “natural” surveillance techniques have been criticized as not being overly effective (e.g.,

Clarke, 1995; Mayhew, 1979). Despite this, the implementation of these strategies will hopefully reduce the opportunities available for serial rapists to victimize innocent individuals within their own community.

For encounter and victim release locations that take place in private and inside locations, it is recommended that individuals close their curtains in the evenings and at night when it becomes much easier for others to see who lives in the home and observe their behaviour from outside. From an environmental criminology perspective, it is important for individuals, and women and children in particular, to be cautious of the environmental cues that they give away that could make them more susceptible to becoming victims of sexual crimes. Increasing surveillance efforts of both private and inside locations (e.g., residences), as well as semi-private (e.g., yard) and public (e.g., sidewalk and road) areas by means of cameras and videos positioned at entry points, may add an extra layer of guardianship over these sites, thereby acting as a stronger deterrent to offenders. For example, many alarm system companies now offer increased protection over dwellings by installing video cameras outside of front and back doors so that residents can view trespassers on their property from inside their homes. Similarly, closed circuit television (CCTV) may reduce opportunities to offend in other inside locations, apart from offender or victim residences, that are known to be frequented by sexual offenders, such as schools, churches, and shopping malls, to name a few.

Although situational crime prevention does have utility in reducing the opportunities for crime, investigators must be aware of the possibility of displacement that can result from these strategies, and thus complicate matters when linking crimes in serial cases. Because situational variables are highly influential in determining the time and place of crimes, changes in the environment may cause offenders to engage in spatial, temporal, or target displacement, and even motivate them to change their modus operandi strategies or engage in other forms of crime (Repetto, 1976 as cited in Clarke, 1995). Examples of displacement may be seen in a sexual assault investigation if police patrols saturate a targeted area at certain times of the day, and subsequent crimes see a change in patterning of location (i.e., spatial displacement) and timing (i.e., temporal displacement). Likewise, if media accounts broadcast unique information about an offender's modus operandi, subsequent victims may experience an abrupt change in his behaviour (e.g., Elmo Rivadeneira's change in victim approach from a blitz assault to a

con approach by impersonating a police detective after seeing reports of his crimes in the news). Additionally, in attempts to distract law enforcement officials so that they look to other suspects, a sexual offender may, for the first time in his series, burglarize the victim's home after committing the rape (e.g., changes in forms of crime) or hunt for older or younger victims (e.g., target displacement). Although the issue of displacement has been the root cause of criticism directed toward the situational crime prevention approach (Clarke, 1995), research studies and evaluation efforts have proven that it is not as much of an issue as critics have made it to be. In particular, Cornish and Clarke (1987) note that when displacement is suspected, it is often assumed that offenders will simply engage in other criminal behaviours to fulfill their needs. However, this is not always the case as offenders may instead seek out legitimate opportunities to meet their goals due to a lack of effort, or increased risk, of finding alternative victims or locations in which to offend (e.g., in the case of a rapist who seeks sexual gratification, he may go to a bar to try and seduce a woman into having sex with him rather than attacking one for this purpose). Alternatively, Cornish and Clarke (1987) note that offenders may desist from offending altogether as a result of situational crime prevention strategies, and displacement will therefore not be an issue. These alternatives to displacement are plausible when situational crime prevention strategies are put forth, and add support to their utility in decreasing crime. Despite these alternative possibilities, implications for criminal investigations mandate that law enforcement officials at least be aware of the aforementioned forms of displacement when sudden changes in offending patterns emerge, as well as when linking cases to criminal series more generally.

Although informative and interesting, this research does have limitations. The small sample size restricted the kinds of statistical analyses performed. Due to the small number of crimes present in some of the clusters, multilevel modeling could not be used which would have allowed for conclusions to be made about the rapists rather than the sexual crimes only. Due to the distribution of the sample, several variables that had strong theoretical relevance could not be included in the research. Although efforts were made to overcome this limitation, there is no way of knowing how the inclusion of these variables may affect the results. Moreover, the sample included crimes committed by incarcerated sex offenders only; therefore, it is possible that other factors exist that are better able to predict the environmental factors of victim encounter and release sites

among those who have not been apprehended. Lastly, the crimes analyzed in this study are restricted to the province of Quebec only, and it may be that differences in the geography and environmental designs of other regions affect where crimes are likely to take place. However, despite these limitations, the current findings are both theoretically and practically relevant for researchers and law enforcement officials alike.

Future studies should attempt to use larger samples in order to attribute findings to the offenders. Furthermore, it would be beneficial for researchers to consider how other situational and modus operandi variables, such as the season and weather during the commission of the crime, the estimated distance between the offender's home base and crime locations, the time interval of the crime (i.e., the time from victim encounter to the time of victim release), if the victim encounter, attack, and release site took place in one location, and whether or not the offender broke into the victim's home, influence where the victim encounter and release sites are likely to take place. Future research should also take into account the victim's specific activity at the time of encounter and the importance that this has on crime site selection, as well as whether or not the number of crimes in a sex offender's series affects site prediction. Findings from this research would undoubtedly contribute to the existing, albeit limited, knowledge of serial sex offenders' spatial patterns and selection of target locations.

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## **Appendices**

## Appendix A. Logistic Regression Analysis of Victim Encounter Site

**Table 1. Logistic Regression Models Predicting Residential Land Use, Private Site, Inside Location, and Familiarity of the Victim Encounter Site to the Offender ( $n = 72$ )**

	Residential Land Use		Private Site		Inside Location		Site Familiar to Offender	
	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald
Age of the vic (Pre-pubescent)								
Adult	1.18	.18	3.35*	6.22	25.68***	36.81	.16**	9.05
Pubescent	.70	.95	1.79	1.81	14.77***	28.15	.29*	4.15
<b>Temporal Factors</b>								
Offence timing (Week)								
Weekend	.59	2.19	.84	.17	.57	1.83	1.22	.19
Mixed	.57	1.31	1.76	1.13	.85	.09	7.35	2.99
Time of day (Night)	.42**	8.81	.26***	12.61	.66	1.81	1.99*	3.95
<b>Hunting Behaviour</b>								
Hunting style (Hunter)								
Trapper	1.38	.42	9.05***	16.28	9.00***	15.16	6.05*	5.63
Poacher	.29*	5.01	.73	.18	.62	.69	1.64	.66
Troller	.20***	14.28	1.04	.01	.94	.02	7.67***	10.69
<b>Modus Operandi Strategies</b>								
Structured premeditation (No)	3.97***	18.79	4.33***	16.44	6.31***	27.97	.39*	6.49
Offender-vic relationship (Already seen/ talked to)	.54	2.30	.17***	16.34	.20***	13.41	2.75*	4.25
Selection of vic before encounter (No)	1.60	1.67	.33*	5.51	.13***	24.33	7.42***	14.37
Type of vic selection (Random/ non-patterned)	.17***	26.02	1.12	.07	1.05	.01	.61	1.17
Offender looks in specific places for vics (No)	.51*	4.35	1.29	.52	1.36	.80	1.06	.02
Type of vehicle used to commit the crime (No)	.96	.01	2.62*	5.96	.82	.28	.52	3.04
Constant	11.07***	10.86	.56	.49	.49	.84	1.27	.06
<b>AUC</b>		.78		.88		.85		.84
<b>Omnibus <math>\chi^2</math></b>		82.19***		151.72***		161.75***		92.71***
<b>Overall Classification %</b>		74.2		80.9		77.0		84.2

Note. Some words are abbreviated due to space constraints; full names of variables are provided in-text; AUC = area under the curve; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

## Appendix B. Logistic Regression Analysis of Victim Release Site

**Table 2. Logistic Regression Models Predicting Residential Land Use, Private Site, Inside Location, and Familiarity of the Victim Release Site to the Offender ( $n = 72$ )**

	Residential Land Use		Private Site		Inside Location		Site Familiar to Offender	
	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald	Exp( $\beta$ )	Wald
Age of the vic (Pre-pubescent)								
Adult	.21***	12.19	1.14	.08	7.41***	17.40	.49	1.85
Pubescent	.21***	13.13	1.05	.02	3.30**	7.51	.75	.31
<b>Temporal Factors</b>								
Offence timing (Week)								
Weekend	1.22	.26	1.72	1.74	1.82	1.74	4.39**	7.59
Mixed	27.83**	9.17	4.32*	6.42	.21*	6.63	2.95	1.76
Time of day (Night)	.14***	35.14	.06***	56.91	.74	.99	11.04***	44.43
<b>Hunting Behaviour</b>								
Hunting style (Hunter)								
Trapper	1.19	.09	2.58	3.07	12.87***	19.03	2.65	1.90
Poacher	.62	.68	.83	.09	.93	.02	4.24*	4.79
Troller	.57	1.65	2.11	2.65	3.99**	9.06	2.43	2.84
Attack method (Raptor)								
Ambusher	.55	2.65	.35*	5.93	.56	1.93	3.72**	9.68
Stalker	.16**	11.22	.26*	5.24	.04***	23.87	6.29**	10.13
<b>Modus Operandi Strategies</b>								
Structured premeditation (No)	2.03*	4.31	2.40*	6.15	21.53***	44.51	.86	.16
Offender-vic relationship (Already seen/ talked to)	.37*	4.83	.12***	19.85	.37*	4.83	2.51	3.24
Offender approach (Other)	1.74	2.14	.64	1.17	1.51	1.22	.37*	5.61
Offender looks in specific places for vics (No)	1.24	.38	2.62**	7.55	1.00	.00	.55	2.41
Type of vehicle used to commit the crime (No)	.55	2.70	.21***	12.91	.14***	17.26	2.20	3.56
Constant	46.16***	23.16	11.24**	9.46	.28	2.93	.22	2.99
<b>AUC</b>		.82		.87		.86		.88
<b>Omnibus <math>\chi^2</math></b>		110.12***		178.42***		165.83***		183.74***
<b>Overall Classification %</b>		78.4		80.6		77.6		88.4

Note. Some words are abbreviated due to space constraints; full names of variables are provided in-text; AUC = area under the curve; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .