PSYCHOLOGICAL PROFILING

Analysing Spatial Patterns of Convicted Serial Arsonists

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CONTENTS

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

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ABSTRACT

Arson is a major problem nationwide, with local authorities investigating arson cases daily. To help combat this issue, a national study was conducted which focussed on the geographical distribution of arson offences in relation to the offender's home base. The purpose of the current study was to evaluate the utility of Canter and Larkin's (1993) circle theory and home range hypothesis for predicting geographical patterning of serial arson offences in New Zealand. This was achieved by examining offence locations of 45 serial arsonists convicted between 1988 and 2003. Each offender's offence sites and home base were plotted on a scaled street map, replicating Canter and Larkin's (1993) geometric technique for constructing the criminal range circle. An initial test showed that a majority of offenders committed their offences within a distinct offence region. It was also found that the breakdown of commuter- and marauder-type offenders was different from Canter and Larkin's (1993) study of UK serial rapists, suggesting that the marauder model is not universally applicable to account for all types of serial offending. However, the home range hypothesis was supported in this study. Additionally, there was support for the existence of a safety zone around the offender's home base as proposed by Brantingham and Brantingham (1981). Lastly, the current study supports the hypothesis that offenders travel short distances to commit their arsons. Overall, Canter and Larkin's (1993) circle theory and home range hypothesis successfully describe the geographical patterning of offences by serial arsonists in New Zealand. Although the marauder model is not universally applicable, it still offers potential benefits as part of an investigative tool for local authorities.

SECTION ONE

1. INTRODUCTION

Psychological profiling has become an extremely important investigative tool for all law enforcement personnel. It is a useful guide for any professional involved in the investigation or litigation of major serial crimes such as arson, rape and murder. The application of profiling will facilitate the conduct of criminal investigations and the successful resolution of cases. With possible benefits of increased apprehension rates for these types of serial offences, in particular arson, it is pertinent to test the utility of this investigative tool in the context of serial arson in New Zealand.

The thesis is presented in two sections, the first comprising four chapters and the second three. In chapter one, arson is defined and important terms provided. This includes the literature review, the purpose of which is to provide a general overview of the topic. The second chapter introduces psychological profiling, including history and myths, followed by the two main approaches to profiling, those of the Federal Bureau of Investigation (FBI) and those used in the United Kingdom.

The third chapter narrows the scope from psychological profiling to geographical profiling. This chapter looks more closely at profiling approaches used in the United Kingdom. In particular, this chapter presents concepts and approaches of geographical profiling and its use in the law enforcement community. Lastly, the fourth chapter

describes Canter and Larkin's (1993) circle theory of environmental range, focusing on the two proposed models of spatial patterning.

Section two of this thesis tests the hypothetical model of spatial patterning for serial offenders, as adapted from Canter and Larkin's (1993) circle theory. This part embodies the method, results, and discussion, in chapters five, six, and seven respectively. The last two chapters will offer some empirical validation to the circle theory. Finally, conclusions will be drawn regarding the potential usefulness and benefits of geographical profiling on serial arsonists within New Zealand.

1.1. Arson

Arson, as defined under section 294 of the New Zealand Crimes Act 1961, is wilfully setting fire to and/or damaging targeted property such as structures, buildings, aircraft, ships, wells, mines, and plantations by any means of ignition (Raea, 1985). The penalty for the act of arson is substantial: if found guilty the offender is liable for up to a maximum of 14 year's imprisonment (Raea, 1985).

More generally, arson has been defined as the wilful and malicious burning of any type of property (DeHann, 1991; Holmes & Holmes, 1996; Sapp, Huff, Gary, Icove, & Horbert, 1994). For criminological purposes this definition has three separate components (DeHann, 1991): first, burning of property. For a prosecution to proceed, the court must be shown that there is actual destruction of the target. Second, the burning of property must be shown to have an incendiary basis: all possible natural or accidental causes can

be ruled out. Third, it must be shown that there is specific malicious intent to destroy the property (DeHann, 1991).

Arson is a violent crime, not only towards property but also people (Sapp et al., 1994). A study by Hill et al. (1982) supports the depiction of arsonists as a mixture of both assault offenders and property offenders; although it was found that the majority of arsonists will align with property offenders. The impact of arson has direct, visible effects on the lives of innocent civilians (Geller, 1992). It is apparent that the use of fire can be a devastating weapon causing serious financial losses towards property, setting back society millions of dollars. In turn, the quality of life in the affected community by arson is diminished dramatically (Geller, 1992). But the biggest issue at hand is cost in human lives lost due to these violent acts (Holmes & Holmes, 1996). Arson is undoubtedly a major problem world wide (Geller, 1992)

The Fire Problem in the US

The United States has one of the most severe fire problems in the world per capita basis, although very similar trends can be seen in Canada (Geller, 1992). In 1989 a fire department in the United States responded to a fire every fifteen seconds, and almost 30 percent of these fires were regarded as suspicious or arson related. The fire problem in the United States alone continues to be a significantly costly public issue. For instance, human lives and injuries from fire far exceed other incidents such as traffic accidents (DeHann, 1991). Between 1983 and 1989, the U.S. had on average well over 2,000,000

fires, 5,800 civilian casualties, 28,500 civilian injuries, and property loss totalling 8 billion dollars (Geller, 1992).

No dollar amount can match the statistics of recorded loss of life and injury in the US. In terms of fire-property losses, the number of structure fires in 1971 was 996,600, but increased by 1980 to 1,065,000, with a capped direct loss of 5.54 billion dollars (DeHann, 1991). In addition, between 2 and 4 million acres of wild lands are destroyed by fires each year, which further causes an estimated $300 - $500 million in costs alone (DeHann, 1991).

The Arson Problem in the US

To appreciate the true effect of arson in the US it is necessary to look at the actual data. Arson is a leading cause of all residential fire deaths and property loss in the US (Icove, Schroeder, & Wherry, 1979). There are two federal agencies which deal with data concerning arson in the US: the National Fire Protection Association (NFPA), and the Federal Bureau of Investigation (FBI). The NFPA collects data regarding all structural, victim and statistical trends from all arson/suspicious related fires (Icove et al., 1979). The FBI on the other hand, as part of its annual Uniform Crime Reports (UCR), collects data and reports from local law enforcement agencies (Holmes & Holmes, 1996).

Researchers and policymakers frequently rely on these two agencies to gather basic information about the nature and severity of arson offences (Jackson, 1988). The NFPA estimates that during 1994, 548,500 fires were set intentionally. Economically, NFPA

estimated for the same year, arson fires caused around $3.6 billion dollars in damages (Icove et al., 1979). NFPA estimated 560 fire-fighters and civilians died with 3440 people suffering from injuries (Hall, 1996, cited in Icove, 1979).

In 1992, The US Department of Justice's Bureau of Statistics reported 20,000 arson incidents (Holmes & Holmes, 1996). In addition, arson data supplied from the US Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms (1992), found 567 incidents of arson, 52 people killed, and 254 injured. It is interesting to note from the number of arson incidents (567), only 53 offenders were convicted or pled guilty (Holmes & Holmes, 1996).

Clearance rates for the crime of arson are low: thus, arson trends based on arrest statistics will underestimate the true extent of the problem. The NFPA supports this, by suggesting that because arson is so difficult to solve and prosecute (Hart, 1990; Icove et al., 1979), it leads to extremely low conviction rates compared to other crimes (Icove et al., 1979; Munday, 2000). Another issue to consider is the under-reporting of arson figures between government agencies, such as the FBI's uniform crime reports and fire departments within the US. Thus, the reported data underestimate the true nature and cost of arson to society (Jackson, 1988).

Arson within the past five years has ranked within the top three leading causes of fires in countries such as Canada, Finland, Denmark, Great Britain, and New Zealand (Geller, 1992). In the United Kingdom alone, it was the leading cause of all major fires; for

Germany, it was the major cause of insurance loss (Geller, 1992). In the Netherlands, between 1986 and 1989 arson accounted for over 50 percent of all school fires, whilst in Japan between 1983 and 1987, 21 percent of all structure fire deaths were caused by incendiary suicides (Geller, 1992).

The Arson Problem in New Zealand

The true extent of the arson problem in New Zealand is far from known (Roberts, 1985), although, what information is available indicates an alarming upward trend (Roberts, 1985). Arson in New Zealand, as suggested by the New Zealand Fire Service, is increasing at a rate of about 12.5 percent every year (Raea, 1985). New Zealand showed very similar arson rates to those in the US. In 1987, the New Zealand arson rate was 44 per 100 000 people, whereas the arson rate for the US was 49.6 per 100 000 (Cropp, 1992).

Arson in New Zealand is reaching epidemic proportions, to the point where local authorities are investigating deliberately lit fires at a rate of four a day (Raea, 1985). Police investigated 1226 arson related cases in 1984, a rate which has increased by more than 50 percent from 1980 to 1984. In 1984, the New Zealand Fire Service (NZFS) attended 8500 property fires, of which 5.5 percent fell within the arson category (Raea, 1985). It is argued by some in the NZFS that these figures are too conservative, with actual figures looking more like 20 percent of all fires representing arson cases (Raea, 1985). Support for this is given by New Zealand Insurance, suggesting the figure for arson is something above 20 percent for all property fires (*Firefighter*, 1983). If this is

correct, then New Zealand is not far behind other countries in arson rates. The norm for Australia, the UK and US is between 25 to 35 percent of all property fires being the cause of arson (*Firefighter*, 1983).

The clearance rates for New Zealand are extremely low (Roberts, 1985). It would be naive to imply from NZFS statistics, that they represent the whole picture and extent of arson offending in New Zealand (Roberts, 1985). Rather, they identify what is reported to the police. Unfortunately, as with most other types of crimes, not all arson offences come to police notice (Roberts, 1985).

When looking at the conviction rates for arson in New Zealand, not all prosecuted cases involving arson actually lead to a conviction. For instance, as can be seen in Table 1, information supplied by the New Zealand Ministry of Justice on the number of prosecuted cases involving arson by outcome in 2002 showed a total of 229 arson prosecutions (Spier, 2004). Of these, 14 cases were proved in Youth Court, 6 cases were discharged without conviction, 75 cases were not proven, 6 cases were "other" (this includes cases where there was a stay of proceedings, cases where people were found to be under disability or was acquitted), and the remaining 128 cases resulted in arson convictions (Spier, 2004). (Refer to Appendix A, for further notes on the breakdown of convicted, youth court, discharge, not proven, and other).

Table 1: Number of prosecuted cases involving arson by outcome, between 1988 and 2002

Year	Convicted[1]	Youth Court proved[2]	Discharge without conviction[3]	Not proved[4]	Other[5]	Total
1988	122	21	0	66	5	214
1989	150	26	2	80	8	266
1990	114	8	2	35	4	163
1991	109	12	0	35	2	158
1992	117	7	2	34	0	160
1993	125	23	0	37	4	189
1994	135	23	1	65	3	227
1995	132	11	3	74	5	225
1996	136	19	2	61	6	224
1997	139	18	4	69	5	235
1998	174	17	1	59	7	258
1999	130	9	3	68	3	213
2000	124	33	4	68	1	230
2001	151	22	3	70	6	252
2002	128	14	6	75	6	229

Source: Research and Evaluation Unit, Ministry of Justice, 2004.

Motives for Arson

What is a Motive?

A motive, as it relates to arson, is simply the reason why someone would deliberately burn property, or has a co-offender burn it for them. Motive is the inner drive or impulse that leads to the fire setting behaviours (Icove & Estepp, 1987).

Historical Background

The study and research of fire setting motives appear to date back as far as 1951, when two researchers, Lewis and Yarnell (1951, cited in O'Connor, 1985) conducted the largest study at the time of fire setting. They examined 1500 arson records, and attempted to

categorize offender motives (Ritchie & Huff, 2001). In the years leading up to 1970, Vreeland and Waller (1979, cited in O'Connor, 1985), further refined this type of classification scheme by focusing their research on matching fire setter behaviours to fire setting motives (O'Connor et al., 1985). Other studies have focused on hospitalized patients, with small sample sizes (Ritchie & Huff, 2001). Recent studies have placed more emphasis on the methodology of arson and crime scene analysis (Ritchie & Huff, 2001).

It is suggested by the FBI that local authorities need to determine the motive for arson in order to narrow down the investigation to minimize the list of potential offenders. The unknown offender's motive does not necessarily establish the crime of arson, nor is it an element of the offence, rather the development of a motive may lead to the identification of the unknown offender (Icove et al., 1979).

The Arson Classification System

The National Centre for the Analysis of Violent Crime (NCAVC) with its extensive knowledge of arson literature, arson cases, and interviews of incarcerated arsonists across the US, has produced the following motive classification system. This has proved extremely effective in identifying various characteristics of the offender (Douglas, Burgess, & Ressler, 1997). Douglas et al. (1997) divide arsonists into six distinct categories of motivated arson: revenge, excitement, vandalism, profit, crime concealment, and extremist. These will be reviewed briefly.

Revenge Motivated Arson

A revenge-motivated arsonist sets fires with the purpose of gaining revenge for a real or imagined injury (DeHann, 1991; Holmes & Holmes, 1996). The fire is set in retaliation for some type of injustice perceived by the offender (Douglas et al., 1997). This attack may focus on targets such as government facilities, gangs and businesses (Geller, 1992; Holmes & Holmes, 1996).

A study conducted by NCAVC on serial arsonists found that revenge is the most common motive for this type of offender, with a striking 41 percent of serial arsonists falling into this category (*Interfire, 2002*). A study by Ritchie & Huff (2001) further supports the revenge motive, suggesting it was the prominent motive in over 37 percent of cases. A study by Inciardi (1970, cited in Pettiway, 1987) found that of offenders who were released from New York State Prisons on parole, 76 percent of the arsonists were motivated by revenge.

Excitement Motivated Arson

This type of arsonist, as suggested by Douglas et al. (1997) is an offender who is stimulated to set fires because they crave excitement; the end product is satisfaction from their fire-setting activities. These arsonists usually watch the fire from a safe place, either from a long distance to reduce the likelihood of being detected, or they blend in with bystanders to observe the fire (Douglas et al., 1997; Holmes & Holmes, 1996; Rider,

1980). When offenders do leave the scene once the fire has started, they usually return later to the crime scene and check the damage (Douglas et al., 1997).

There are four subtypes of arsonists in this category: the thrill seekers, attention seekers, recognition seekers, and sexually perverted arsonists. The thrill seekers are usually adolescents who enjoy the turmoil gained by fire setting. Attention seekers are arsonists who are excited by the idea that everyone is looking for them. Third, the individual is out to seek recognition. This category is one of the most disturbing and worrying because a number of them are fire-fighters (Munday, 2000). The phenomenon of the fire fighter-arsonist is well known: every year we read about fire fighters being arrested for arson (Holt, 1994). Lastly, the sexually perverted offender gains sexual satisfaction from setting fires.

Vandalism Motivated Arson

This type of arson is caused by malicious and mischievous motivation on the part of the offender, resulting in wilful damage to property (Douglas et al., 1997). The two subtypes of this vandalism-motivated arson category are wilfully/malicious mischief and group pressure. Targeted properties are those such as educational facilities, schools, residential property such as abandoned houses, and vegetation. The major difference between the vandalism motivated arsonist and the previous two motivated categories, is that these arsons are instigated by the leader of the group. The group of fires-setters will typically work spontaneous and impulsively during their fire-setting.

Profit Motivated Arson

Arson for profit is a commercial crime, the sole purpose of which is to achieve some type of material gain (Douglas et al., 1997; Geller, 1992). This arsonist tends to be less passionate or emotionally driven compared to the other categories. Sometimes the arsonist is paid-otherwise known as a "hired torch"- by a business owner who may look to collect insurance on the property (Holmes & Holmes, 1996; Levin & Vreeland, 1978; McGehan, 1976). The property targeted by these arsonists includes residential, business, cars and boats. Douglas et al. (1997) suggests that the motivation for this type of arsonist includes insurance fraud, fraud to dissolve a property, liquidating property, destroying unprofitable inventory, creating employment, parcel clearance, and eliminating competition.

Crime Concealment Motivated Arson

This type of arson is committed to conceal another crime; it is a secondary activity in order to cover up a primary act (DeHann, 1991; Douglas et al., 1997; Holt, 1994). This type of arsonist will destroy forensic evidence or mislead authorities from the original crime committed, and possibly, in the case of a homicide, impede an investigation by preventing identification of a victim (Holmes & Holmes, 1996). For example, in some cases documented by the NCAVC on filicide by fire, children have already been stabbed, strangled, or shot to death prior to the arson. The killer, usually a parent, may have repositioned the bodies or staged the scene so that the children look as though they have died in the sleep. A fire is then set to conceal the murdered children (Huff, 1993).

Extremist Motivated Arson

The last of the major categories for the classification of motives as suggested by Douglas et al., (1997) are the extremist-motivated arsonists, otherwise viewed as terrorists or social protest arsonists. These arsonists commit their crimes as a means to further a religious, social, or political cause. The Political extremists in particular will tend to attack symbolic economic or political targets, such as government buildings. However, terrorists may also target civilians to meet their demands or increase terror (White, 1996). These types of arsonists are extremely unpredictable and highly capable of causing substantial damage.

From here, we have presented a brief discussion on the motive classification system as suggested by Douglas et al.'s (1997) *Crime Classification Manual.* Now it is important that we move onto another classification system, one which categorizes arsonists into three distinct types; serial, mass and spree.

Three Types of Arson

One of the most common typological differentiations is made between serial, mass, and spree arsons as can be seen in Table 2. In defining the essential features of each of these three arson types, we will briefly review them in regards to the characteristics proposed by Douglas et al.'s (1997) *Crime Classification Manual.*

Table 2. Classification by style and type.

Style	Single	Double	Triple	Mass	Spree	Serial
Number of Victims	1	2	3	4+	2+	3+
Number of Events	1	1	1	1	1	3+
Number of Locations	1	1	1	1	2+	3+
Cool-Off Period	N/A	N/A	N/A	N/A	No	Yes

Adapted from Douglas et al., (1986) (p.408)

Serial Arson

This type of arson has been subject to more research and attention then any other form of fire setting to date. As suggested by Lewis & Yarnell (1951, cited in Douglas, 1997), repeat arsonists that set fires are referred to as serial fire setters. These repeated fire setters become increasingly destructive and life threatening towards entire communities. They alarm local residents, and overtax limited resources of local law enforcement agencies (Douglas et al., 1997; Icove & Horbert, 1990).

Serial arsonists are involved in a minimum of three separate fire setting episodes, with emotional cooling-off periods between each fire (Douglas et al., 1997; Higgins, 1990; Holt, 1994). These cooling-off periods may last for days, weeks, or even years. The unpredictable gaps between each of the incidents together with the apparently random selection of property, makes the serial arsonist a serious type of offender (Higgins, 1990).

The typical offender fitting the description for this category will generally live within one mile of the scene. Their mode of transport is often by foot, as they are usually familiar with the local surroundings, and could easily justify their presence at a crime scene (Douglas et al., 1997; Higgins, 1990).

It must be noted that a serial arson act does not have a distinct motive for fire setting, but rather is viewed as offenders who display certain patterns of fire setting. Most frequently serial arsonists fall into the revenge, excitement, and extremist-motivated categories (Douglas et al., 1997).

Mass Arson

Mass arson involves one offender who sets three or more fires during a limited time, at the same location (Douglas et al., 1997). There is no cooling-off period between each of the arson attacks. An example would be an offender who sets fires to each floor of a government building.

Spree Arson

The spree arsonist sets three or more fires at separate locations, but all within the one event, i.e. arsons committed within a 24 hour time frame. Again, there is no cooling-off period between each of the arson attacks (Douglas et al., 1997). An example of this is a spree arsonist roaming city streets, setting fires all night in conjunction with the "Hell's Night" of Halloween (Douglas et al., 1997).

Problems with Classifications and Typologies

While it is evident that the application of classification systems and typologies are utilized in profiling, many issues arise from the use of these categories. First, samples used in the studies may be biased, as samples are derived from selected populations such as apprehended or convicted arsonists (Geller, 1992). Secondly, classification systems segregate arsonists in two artificial groups, arsonists either fitting the motivated or motiveless category (Geller, 1992). This could hold implications in categorizing offenders as they could potentially be in the wrong segregated group. For example a pyromaniac fire setter is classified in the motiveless group, when in fact these offenders should be in the motive group (Geller, 1992).

Summary

Chapter one has provided the definition of arson as defined under section 294 of the New Zealand Crimes Act 1961, it also identified the arson problem in New Zealand and on the international scene, namely in the US. Following this a basic outline of motive classifications and criminal typologies as relating to arson was presented. This began with a brief background on motives, and then described in detail the six motives for arson offenders: revenge, excitement, vandalism, profit, crime concealment, and extremist motivated arson as suggested in the *Crime Classification Manual*. From here a brief section was presented on offending types: serial, mass, and spree. Lastly, we discussed various problems associated with the arson classification and typologies.

The arson-motive classification system plays an important role in criminal profiling investigations, as it provides professionals with a concise summary of distinctive characteristics of an offence. As suggested by the FBI if we can determine the motive for the arsons it will narrow down the investigation thus minimize the list of potential offenders. This further supports the common assumption of psychological profiling that the nature of the crime scene reflects the personality of the offender, as with behaviour reflecting personality (Ault & Resse, 1980). This method of analysis will help determine the recognizable personal traits and behavioural characteristics displayed by the offender. As a result, the six arson-motive classifications have proven effective in identifying unknown arson offenders.

1.2. Psychological Profiling

History of Profiling

There are many myths about psychological profiling (Grubin, 1995). The origins of profiling are unknown and uncertain, although there are reports of similar procedures used as early as the 1800's within the discipline of criminal anthropology. One of the world's first recorded uses of criminal profiling of a serial offender occurred in 1888, when London CIB asked Dr Bond for assistance to identify the likely characteristics of the serial killer "Jack the Ripper" (Rumbelow, 1988, cited in Kocsis, 1997).

Definition of Psychological Profiling

Psychological profiling is a relatively new phenomenon (Turco, 1990), although it is not a radically new technique as the common myth would imply (Kocsis & Davis, 1997). Psychological profiling has many different names including: psychological criminal profiling (Teten, 1989), offender profiling (Canter, 1989), criminal investigative analysis (Grubin, 1995), specific profile analysis (Davies, 1997), forensic psychology (Wrightsman, 2001), criminal personality profiling (Pinizzotto, 1984), criminal profiling (Boon & Davies, 1993), crime scene behavioural analysis (Rossi, 1982), sociopsychological profiling (Holmes & Holmes 1996), and investigative profiling (Annon, 1995). Given the range of terminologies and different approaches used, it is not surprising that it is difficult to have one definition to account for all the many different techniques used in profiling.

However, despite the lack of an accepted definition to embrace the many different techniques employed, the core underlying concept remains the same (Jackson & Berkerian, 1997). By studying the individual's behaviour that is exhibited in a crime scene, we are able to make inferences about the likely perpetrator (Jackson & Berkerian, 1997). Various authors describe it as an application to assist the legal system (Wrightsman, 2001), an educated attempt to give information about a suspect (Geberth, 1981), a concise sketch outlining the observable characteristics of an individual (Vorpagel, 1982), and a collection of leads (Geberth, 1981; Rossi, 1982).

Only Suitable to Some Cases

Profiling is effective in cases where the unknown offender has clearly displayed signs of psychopathology (Ault & Resse, 1980; Geberth, 1981; Holmes & Holmes, 1996). It is suggested that the crime scene behaviour reflects the pathology of the offender's personality (Holmes & Holmes, 1996). Crimes most appropriate for psychological profiling are those such as sadistic torture in sexual assaults, evisceration, motive-less fire setting, mutilation murder, rape, satanic and ritualistic crimes, paedophilia and post-mortem slashing and cutting (Geberth, 1981; Holmes & Holmes, 1996; McCann, 1992).

First Case of Psychological Profiling

The first practitioner in modern times to implement offender profiling in a serial case was Dr Brussel, a psychiatrist based in New York. He was regarded as the true pioneer of offender profiling (Teten, 1989). During the 1950's, New York City was in the middle of

a massive manhunt, in search for an offender who was setting off bombs. Over an eight year period, 32 bombs were set off by the "mad bomber" (Pinizzotto, 1984). Local authorities at the time had no substantive leads; therefore, police requested assistance from Dr Brussel. Drawing on his psychiatric experience he developed a detailed personality profile which would identify certain characteristics of the unknown "mad bomber". In the profile, he determined that the unknown offender would be single, male, between the ages of 40 and 50, come from an Eastern European background, reside with his sister or relative in Connecticut, have a negative relationship with the father, and finally be dressed in a double breasted suit, fully buttoned (Pinizzotto, 1984).

Within the year of the profile, the "mad bomber" George Metesky was apprehended and charged for the bombings. As predicted by Dr Brussels, George Metesky was Slavic by birth, was in his early 50's, single, residing with his sisters in Connecticut, and wore a double-breasted suit with all the buttons done up (Pinizzotto, 1984). The case of George Metesky demonstrated an accurate profile, particularly on major aspects of this case.

Although, the Metesky case proved successful in the investigation, other high profiled cases have failed to reach the same results and are not always so accurate, such as the "Granny" killings in Australia and the "Boston Strangler" in the US. In fact, recently developed profiles such as the serial sniper in Maryland US, have been more misleading and inaccurate than anything else. It is stressed that because of the potential disadvantages and implications of using profiles, it is regarded by professionals as an investigative tool only to assist, not as the answer or remedy to the problem at hand.

Three Approaches to Criminal Profiling

The technique of profiling is used extensively by investigators from the FBI, consultants in the mental health sector, and police in the United Kingdom. There are three main distinct approaches to criminal profiling: diagnostic evaluations, criminal investigative analysis, and investigative psychology (Kocsis & Davis, 1997). Advances in profiling have been mainly developed within the US and UK. We will briefly look at the basic concepts and developments on profiling as approached by the US and the UK.

Diagnostic Evaluation – UK Approach

Diagnostic evaluation is regarded as the oldest and most classical approach to psychological profiling. It is regarded by some as the precursor of criminal personality profiling (Wilson, Lincoln, & Kocsis, 1997). This approach does not have a unified discipline, nor does it follow any prescribed method or set procedures. Such profiles are developed by consultants with clinical experience; thus the approach relies on the understanding of personality theories and mental disorders (Kocsis & Davis, 1997). The profiles can be regarded as idiographic, and the construction of a profile is individually focused, emphasizing the psychopathology and personality (Wilson et al., 1997).

The advantage of using diagnostic evaluations is that they are the easiest to conduct. The disadvantage is that most mental health professionals have minimal experience in criminal investigations (Dietz, 1985, cited in Kocsis, 1997). Unfortunately, this lack of

experience in the criminal domain may negatively impact the accuracy of the diagnostic evaluation (Douglas & Olshaker, 1996).

Criminal Investigative Analysis – FBI Approach

The second approach to criminal profiling was founded by the FBI's Behavioural Science Unit, at Quantico, Virginia. This approach emerged in the 1970's when there was a surge of public interest and concern regarding bizarre and apparently random violent crimes within the US (Wilson et al., 1997). The FBI became increasingly aware that principles from the behavioural sciences supported the application of psychological profiling for investigative purposes (Jackson & Berkerian, 1997). It was recognized that investigators of violent crimes required more specific advice on some cases, particularly if there was no forensic evidence at the crime scene. FBI agents view profiling as an educated attempt, based on the behavioural sciences, to provide law enforcement agencies with a detailed description of the probable characteristics of the unknown offender (Gebert, 1981).

The advantage of using criminal investigative analysis is that it caters to the specific requirements of the investigator. The disadvantages are that the FBI approach does not take into account cultural considerations: research and development of classification manuals were drawn exclusively from the US. Thus they may not be relevant for non-US locations. Second, the extensive use of statistics and probabilities to construct the profiles ends up focussing less on the individual, in turn placing more emphasis on the personality type of the offender. Douglas (1996) has further supported this by emphasizing in his acclaimed book *Mind hunter* that the work of profilers is far from scientific (Douglas &

Olshaker, 1996). Examples of non-scientific procedures used by the FBI and its profilers are those of intuitions, and educated attempts to construct profiles of unknown offenders. This contrasts with the UK approach, which is more systematic and analytical which has resulted in some theoretical development. Thus, relies heavily on theoretical constructs such as the circle theory in developing its profiles.

However, because of its popularity and depiction in popular media, the approach to profiling by the FBI is a main force behind the application and development of profiling in the US. The approaches suggested by the FBI such as the dichotomous organized/disorganized classifications, typologies, and behavioural analysis have been adopted by other countries and used in their psychological profiling units (Jackson & Berkerian, 1997). For example, Canada and the Netherlands have modelled the FBI approach to psychological profiling (Jackson & Berkerian, 1997).

Investigative Psychology – UK

Investigative psychology is the most recent approach to criminal profiling. Offender profiling in Great Britain has been developed and researched primarily by university institutions and clinical consultants. Advancement in profiling and research has been developed from the work of Professor Canter and colleagues (Wilson & Soothill, 1996) at the Offender Profiling Research Unit at Surrey University (Boon & Davies, 1993). Canter's first involvement in profiling was in London, 1987, when he made a significant contribution to the "Railway Murder" case, in which John Duffy was later apprehended (Wilson & Soothill, 1996).

The development of the circle theory and home range hypothesis are important contributions by Canter. A major premise for Canter is that the time and place of any offence are important factors when profiling an offender. From this, Canter suggests that "mental maps" can be identified from the offences, which can ultimately assist in locating the area of where an offender resides (Wilson & Soothill, 1996).

The advantage of this approach is the precise and specific details that contribute to the development of criminal profiles. Canter (1996, p.25) noted that "As part of the general increase in the quality of police activities, the systematic study of criminal behaviour is playing an ever increasing role". However, the research literature in this area is relatively scarce, because it is a fairly new approach to profiling (Kocsis & Davis, 1997). Further, its theories have yet to be further tested outside the UK. Geographical profiling still needs to be replicated in more countries (Wilson et al., 1997).

Issues Concerning the Approaches

The three distinct approaches-diagnostic evaluation, criminal investigative analysis, and investigative psychology-each have their own advantages and disadvantages. However, the main issue which needs to be addressed is the utility and generality of the work conducted overseas. Criminal profiling originated overseas and in turn all research and literature regarding profiling has come from the two major developers of this new discipline, the United States and United Kingdom (Kocsis & Davis, 1997). Principles and theories suggested from foreign countries are derived from foreign demographics, and thus they may not be applicable in New Zealand.

Summary

This chapter briefly discussed the history of profiling. We then went on to discuss crimes for which psychological profiling is appropriate: those crimes where the offender has displayed signs of psychopathology. This leads to one of the main premises of the FBI, which is that crime scene characteristics reflect the pathology of the offender's personality. From here we discussed the first case of psychological profiling as conducted by Dr Brussels on the New York City "mad bomber" case. Then we briefly reviewed the three different approaches to psychological profiling: diagnostic evaluation, criminal investigative analysis, and investigative psychology as conducted in the US and UK.

In sum, it was identified that the UK approach popularised by Canter and colleagues places more emphasis on the spatial activity of the offender, thus focusing on the offence locations when profiling an unknown offender. In US approach, primarily instigated by the FBI, the emphasis falls more on the crime scene characteristics as a means of predicting the personality of the unknown offender.

1.3. Geographical Profiling

What is Geographical Profiling?

The study of spatial patterning of offences has a long history, with early work conducted by Guerry (1833, cited in Brantingham, 1981) in the early nineteenth century in France. Other work conducted by Tobias (1972, cited in Brantingham, 1981) looked at important features of the distribution of sex offenders in London and Manchester. Within the last ten years, there has been a new renaissance of interest in the spatial patterning of criminal activities (Brantingham & Brantingham, 1981). In an attempt to investigate spatial patterns of offenders, investigative approaches such as geographical profiling need to be employed to help establish the link between the offence site and the offender's home base, thereby helping police identify the offending individual.

In essence, geographical profiling is a strategic information management system, which is employed to ease complex and difficult investigations (Rossmo, 1995a, cited in Rossmo, 1997). It was designed to help alleviate the issue of information overload in serial investigations such as murder, rape, kidnapping, sexual assaults, sexual homicide, arsons, bombings and bank robbery, and to decrease the considerable resources required for complex investigations. Often, thousands of tips and clues will be received and thousands of suspects will be developed. This volume of information places high demands on local authorities. In an attempt to identify the probable area of the offender, local authorities can effectively manage information supplied in huge cases. This will

maximize the utility of geographical profiling, and lead to the successful resolution of unsolved cases (Holmes & Holmes, 1996).

Much of the material presented in this chapter is provided by Rossmo and colleagues, whose research and work have made a major contribution to investigative psychology in particular geographical profiling. Rossmo (1997) has presented local authorities with a plan that allows geography and topography to take part in the profiling process. In addition, other major works such as Brantingham and Brantingham (1981), Baker (2000), Holmes (1996) have been discussed in this section.

Principles of Geographical Profiling

The first assumption of geographical profiling is that the offender's home base is a pivotal point from where they commit their offences. According to Brantingham and Brantingham's (1981) spatial model of criminal behaviour, the area of criminal activity can be encompassed by a circle; thus, the offender's home will be at the centre of the circle. Based on this premise the radius of the circle will be the offender's maximum journey to offend from their residential base (Barker, 2000). The findings clearly show that offenders tend to commit their offences within a few kilometres of their place of residence (Philips, 1980, cited in Barker, 2000).

Furthermore, a study by Baker and Donnelly (1986, cited in Barker, 2000) found that 70 percent of all crimes within neighbourhoods were committed by local residents. Two explanations help account for this. First, the offender's familiarity with their residential

area would influence their knowledge of target opportunities (Barker, 2000). Second, pathways and routes near the crime site will usually be the same pathways and routes used by the offender during their non-criminal activities.

The second assumption is the nearness principle. According to this principle, an offender will select targets that require the least effort (Rossmo, 1996). For example, if an offender is faced with different pathways to complete their criminal activity, the offender will choose the one which represents the least effort. However, the offender will also take into account other factors such as: risk of recognition, victim availability, transportation routes, familiarity of the area, attractive routes, actual geographical distances, and physical barriers. Although the nearness principle seems quite simple, its use in geographical profiling is fairly complicated (Rossmo, 1996).

The third geographical principle is mental maps, otherwise known as "behavioural activity zones". This principle suggests that all offenders form some type of "cognitive image" of their local areas which they are familiar with (Rossmo, 1996). These mental maps or images may represent the locations of homes, workplaces, recreation centres, and shopping centres (Holmes & Holmes, 1996). Lynch (1960, cited in Golledge, 1987) proposes a five-element classification system, which identifies the fundamental components of mental maps: paths, edges, districts, nodes, and landmarks.

Geographical profiling has both an objective and subjective component, as described by Newton and Newton (1985, cited in Rossmo, 1996). The subjective component revolves

around the interpretation and reconstruction of the offender's "mental map". The profilers involved in the investigation will attempt to make inferences about the cognitions of the offender: how they operate around their local areas. The objective component uses geographic techniques to analyze and interpret distinctive patterns of offences (Rossmo, 1997).

The main objective technique employed is a computerized process called Criminal Geographic Targeting (CGT). This program is a useful strategy for information management in serial crimes, whereby it focuses on the spatial characteristics of a series of offences. It uses all available information of a series of crimes to identify the likely areas where the offender may reside or work (Rossmo, 1996). Once all the information is encoded into the computer program, it will produce a three-dimensional probability surface, which is similar to a relief map of a mountain range, otherwise termed "jeopardy surface". The height of each point will represent the relative likelihood of the unknown offender's home of residence or workplace (Rossmo, 1997). Following from this is the development of a "geo-profile", sometimes described as the "fingerprint" of the offender's cognitive map. By this, the three dimensional distribution of offences is superimposed on a scaled street map. A range of colours is usually superimposed, which will represent varying probabilities of the likely offender's home or work: the darker the colours the more concentrated the offence sites (Rossmo, 1996).

The Brantingham and Brantingham (1981) Model

The most often cited research in the field of spatial relations and victim selection is that conducted by Brantingham and Brantingham (1981). They developed one of the most comprehensive theoretical models of spatial organization. The model has testable hypotheses which focus on the location of the offender's crimes in relation to their residential address (Fritzon, 2001). One concept is familiarity; this factor helps determine where they commit their crimes. The model proposes that the selection of a target will occur within an awareness zone in which they feel safe; this is determined by the familiarity of their area (Fritzon, 2001; Rossmo, 1996).

In addition, there is an area within the awareness zone where offenders will not commit their crimes, generally because the risk of identification is too high (Brantingham & Brantingham, 1981). This is regarded as the "safety zone" or "buffer zone", representing an area around the offender's home (Fritzon, 2001; Rossmo, 1996).

The Profiling Process

The preparation of a geographical profile is a complex process, and usually involves the following:

1. Examining files, reports, witness statements, autopsy, and psychological profiles
2. Area photographs, and inspection of the crime scene
3. Visits to the crime site

4. Neighbourhood demographics, such as characteristics of the populations that reside around the crime site, sex ratios, racial composition, age breakdown, socio-economic status, and crime rates.
5. Studying arterial roads and highways, zoning, land use and rapid transit stations, bus stops, physical and psychological boundaries.
6. Final report

Elements beyond offence locations and times of day which need to be considered in the development of a geographical profile include: crime location type, target backcloth, and hunting typology. We will briefly discuss each of these.

Crime Location Type

From the literature on the geography of crime, the crime site is regarded as a single location. The designation of a site is fully dependent on the type of offence and the offender's distinctive mode of operation (MO). Various violent crimes have several locations, these locations having different meanings for the offender (Newton & Swoope, 1987, cited in Rossmo, 1997). For example, in a homicide case, there may be different locations or sites, such as victim encounter (first contact with the victim), attack site (first attack of the victim), murder or crime site (actual crime), and last dumping the body at a site.

While these four actions could potentially occur in one place, sometimes they can occur in several different locations (Rossmo, 1997). These four different crime location types can have up to eight possible crime location sets.

Target Backcloth

Target backcloth is spatial opportunity; it is governed by the geographic and temporal target distributions of suitability as perceived by the offender. The target backcloth is influenced by natural and physical environments, affecting where people reside. Housing is determined by physical topography, highway systems, boundaries, city limits and zoning regulations. The availability of crime targets across physical landscapes may vary according to the neighbourhood, suburb, or city. Brantingham & Brantingham suggest that target backcloth is important in gaining insight into the geometric arrangement of crime sites (Rossmo, 1997).Target location and availability play key roles in identifying where offences occur. For example, if a warehouse is a preferred target for an arsonist, the availability and distribution of warehouses will be geographically determined primarily by city zoning.

Hunting Typology

It is suggested that offenders use various "hunting styles" in order to attack their targets. This in some respects affects the spatial distribution of the offender's crime sites, further implying that any attempt to predict the unknown offender's residence, one must consider the offender's particular hunting style (Rossmo, 1997). The hunting process can be

broken down into two components: first, identifying a suitable target, and second, the method of attack (Rossmo, 1997). According to Rossmo (1997), there are four victim search methods: the hunter, the poacher, the troller, and the trapper.

1. The hunter is defined as an offender who searches for targets from their home base within their city or area. Their searches are conducted through areas of awareness that hold suitable targets for these offenders.
2. The poacher is an offender who searches for a target by travelling outside their awareness area or city limits, typically commuting or travelling beyond their home.
3. The troller is an offender who will encounter a target by opportunity.
4. The trapper is an offender who creates a situation that allows them to encounter their targets. This may be achieved through placing want-ads, or taking in boarders. Black widows and custodial killers are examples of trappers.

In addition, there are three victim attack methods: the raptor, the stalker, and the ambusher.

1. The raptor is an immediate attack on a target.
2. The stalker is an offender who first follows and watches their target, then follows through with the attack.
3. The ambusher is an offender who attacks at a particular location like a home of residence or workplace. It is an attack on the target that has been drawn into their "web".

Investigative Strategies using Geographical Profiling

Through the application of geographical profiling various investigative strategies can be employed in a more effective manner. We will briefly look at a few:

Suspect Prioritization

Geographical profiling can assist in determining suspects and prioritizing tips during complex investigations. For example, the unsolved "Green River Killer" case in Seattle, Washington, involved the killing of 49 prostitutes. Police had only enough resources to investigate 12,000 names of the possible 18,000 supplied from their suspect files (Montgomery, 1993, cited in Rossmo, 1997). In addition, detectives had gathered 8000 items of evidence from the crime scenes, and a TV documentary generated 3,500 tips (Rossmo, 1997). In cases like these where information overload is an issue, the use of an information management system such as geographical profiling could reduce the investigative difficulties involved.

Patrol Saturation and Static Stakeouts

Geographical profiling can assist with the establishment of direct patrolling efforts and stakeouts on identified high risk areas. This is most successful in cases where the offences committed occur during specific time periods. For example, in a serial killer case in Kentucky, local authorities anticipated the next movements of the likely killer

through geographic analysis. Hence, they set up road blocks to question motorists around the area at the time. The approach gathered 2000 names.

Neighbourhood Canvasses

Optimizing and assisting in door to door canvassing in city areas, and grid searches in rural areas are another area where geographical profiling can assist. Information requests can be mailed out to identified target areas which are established through prioritization of postal walks. For example, Richard Chase, known in the US as the "Vampire Killer", was caught by means of canvassing a targeted area determined by analysis of his crime locations. It was predicted in the profile that he would be residing near a car stolen from one of his previous victims (Biondi & Hecox, 1992, cited in Rossmo, 1997).

DNA Testing – Blooding

The Narborough Murder Enquiry was a sexual case in Britain in which the police conducted a large-scale DNA test. The test involved all un-alibi male residents within the area aged between 17 and 34 (Wambaugh, 1989, cited in Rossmo, 1997). About 4000 men from Narborough, Littlethorpe and Enderly were DNA tested. Obviously high resources and lab costs were required. The application of a geographical profile as a systematic strategy would prove beneficial and extremely effective in cases like these. It would effectively administer DNA testing to targeted locals prioritized by address or postal code, thus, reducing the mass screening procedure originally employed (Rossmo, 1997).

Trial Court Expert Evidence

Geographical profiling can assist in both investigation and criminal trial stages. Here the investigative approach analyzes distinctive patterns of unsolved crimes, spatial relationships between the locations of a crime series, and suspects' activity sites, hence determining the probability of their congruence. In a criminal trial, when combining the investigative approaches with other forensic findings such as DNA profiles, the investigator is able to use this available information as a means to increase the evidential strength (Rossmo, 1997).

Issues on Geographical Profiling

It is important that geographical profiling can be used only in cases with multiple offences; hence a serial offender is required for this approach to be feasible. If a profiler attempts to develop a geographical map of an offender with only a few offences, it will be difficult to determine distinctive patterns of offending.

Regardless of the sophistication of computer systems implementing geographical profiling such as CGT, it cannot possibly account for the multitude of details in any serial investigation. Computer systems can only cast a net over the probable area identified by the systematic use of the information available. There will be cases where the offender will be missed (House, 1997). Vital information may not make it to the computer system; thus, some percentage of offenders may not fit the proposed profile (House, 1997). The development of computer profiling programs is an important investigative advance, but

we are still years away from widespread availability of such programs. Profiling is still more an art than a science, so it is useful and practical only when human elements are involved.

Summary

In this chapter we briefly discussed the history of geographical profiling as described by the early works in France by Guerry (1833), and research in London by Tobias (1972). From here we defined geographical profiling as a strategic information management system which is used in serial investigations such as murder, rape, and arson. Following this we discussed three major principles in geographical profiling: first, the offender's home base is a pivotal point from where they commit their offences as suggested by Brantingham and Brantingham (1981). Second, the nearness principle suggests that offenders will select targets which require the least amount of effort. Last, the mental map of the offender represents the locations of the offender's home, workplace, recreation centres. We then briefly looked at the subjective and objective components of geographical profiling with an example of the main quantitative technique, Criminal Geographic Targeting (CGT).

From here we discussed one of the most comprehensive theoretical models of spatial organization as suggested by Brantingham and Brantingham (1981). Concepts of familiarity and the safety zone of the offender were referred to. Following this was the overview of the geographical profiling process, which preceded an exploration of other elements beyond the process in which the crime location type, target backcloth, and

hunting typology were reviewed. Then we briefly discussed investigative strategies using geographical profiling such as suspect prioritization, patrol saturation and static stakeouts, neighbourhood canvasses, DNA testing – blooding, and trial court expert evidence. Last we discussed a few issues regarding geographical profiling.

1.4. The Circle Theory

Studies on Spatial Activity of Criminals

Research conducted on offenders' geographical behaviour has shown that offenders do not travel very far from their home base to commit their crimes (Canter & Gregory, 1994). A study by Shaw and McKay (1942, cited in Canter, 1993) found that there are limited areas where the offender would commit offences. These areas were identified as areas where they lived (Canter & Larkin, 1993).

The starting point for a theory on offence selection is the hypothesis that the offence site relates to a home base or residential address of the offender. The hypothesis is based on the assumption that offenders will have a fixed home base (fixed abode) to operate from (Canter & Larkin, 1993).

Based on various studies of spatial patterning of offenders, it is suggested that the mental representation of places that an offender develops are determined by their residential address. This proposition of "domocentric" experiences is a good starting point for a conceptual framework to account for criminal activity (Kocsis & Irwin, 1997). The validity of "domocentricity" is supported by Amir's (1971) study, which found that rapists operate from a fixed point such as a home base when committing their crimes (Canter & Larkin, 1993; Kocsis & Irwin, 1997). Amir (1971) draws attention to psychological processes that determine the criminal's spatial behaviour patterns.

Another pioneering effort was that of White (1932, cited in Pyle, 1974), who conducted a study on 481 cases of crime against people and property in Indianapolis. White (1932) identified distances from the offender's residence to their offence locations. The study had two important findings. First, crimes against people were committed extremely close to the offender's home (mean distance of 0.84 miles). Second, crimes against property were committed at considerable distances from the offender's residence (mean distance of 1.72 miles) (Pyle, 1974). Nearly four decades later, Reiss (1965, cited in Pyle, 1974), conducted a study using data from the Seattle Police Department on 19,327 persons arrested in Seattle. The findings were similar to those of White (1932), whereby property offenders were more likely to move out of their neighbourhoods to commit their crimes, in contrast to those committing crimes against people.

An explanation for increased distances travelled away from the offender's residential address to commit property offences is the desire to remain anonymous, to reduce the risks of identification during their offending (Pyle, 1974).

Capone and Nicholas' (1975, cited in Canter, 1993) studies on robbery provide further support about the criminal range of offenders. It is suggested that the offender's goal in robbery is primarily personal gain. The robber will operate in areas which have the greatest profits involved, and thus will travel the minimum distance to commit their crimes. Therefore, they will be looking to identify the target areas with the greatest opportunities for success, with minimal effort required (Canter & Larkin, 1993).

Furthermore, Capone and Nicholas (1975) found that there were different distances travelled by armed and non-armed robbers. Armed bank robberies showed a greater mean distance from their home base to the crime scene than the non-armed low-risk robberies.

In studies on centrography LeBeau (1987a, cited in Canter & Larkin, 1993) found some evidence that rapists have similar geographical behaviour patterns to those of burglars. The sample came from rape offences committed in San Diego between 1971 and 1975. The results showed that offenders operated from a residential base to commit their crimes. This further supports the assumption that geographical behaviour patterns of rapists are located around their residential base (Canter & Larkin, 1993).

The literature on spatial behaviour indicates that there are two important features that must be considered when developing a theory of offender spatial behaviour. First, the "home range", which is defined as an area well known and familiar to the offender, is the surrounding area where the offenders will operate from. Second, there is the "criminal range" which is a region that includes all offence sites of the offender (Canter & Gregory, 1994). Canter and Larkin's (1993) study helps address the relationship between the offender's home range and criminal range. We will now discuss these concepts of criminal range and home range with respect to the hypotheses proposed by Canter and Larkin (1993).

Two Hypothetical Models of Spatial Patterning

From various studies conducted on spatial patterning of offences, it is reasonable to assume there is a fixed base or home base for those who carry out series of criminal activities. Evidence suggests that an area where the offences are committed will have some relationship to the fixed base or residential address of the offender. Canter and Larkin's (1993) circle theory of environmental range tests various models for the relationship between the offender's criminal range and their home base. The two hypothetical models of offender movement characterize the relationship between the fixed base and the area of the offence locations (Canter & Larkin, 1993). This is similar to the model developed by Brantingham and Brantingham (1981), who suggest two divisions of offender activity: the awareness and buffer zones. The assumption about the criminal domain is that it is circular (Canter & Larkin, 1993).

The circle theory looks at the construction of two competing models which describe the spatial distribution of offences by a serial offender. The two hypothetical models of spatial behaviours are the commuter and the marauder models. Although the Commuter and Marauder models can be applied to almost any form of serial offending, the original study was conducted on 45 rapists in the South East cities of England.

The Commuter Hypothesis

The first model of Canter and Larkin's (1993) Circle Theory is the commuter hypothesis. This model describes the geographical pattern of an offender who travels away from their

home base into another area to commit their offences. Central to this hypothesis is that there will be no clear relationships between the location of the criminal range and the offender's home base. The criminal range of the offender is defined by taking the two furthest offence locations and using these two points as the diameter of the criminal range of the circle. This circle identifies an approximate range of where the offender will do their criminal activities. For the home range, it is the region where the offender does their non-criminal activities such as shopping, socializing, and working. Thus, as can be seen in Figure 1, there is no overlapping between the criminal range and the home range of the offender (Canter & Larkin, 1993). This hypothesis does not imply that the criminal range is unfamiliar to the offender, but rather that "it is an appreciable distance from the area in which he habitually operates as a non-offender" (Canter and Larkin, 1993, p. 65).

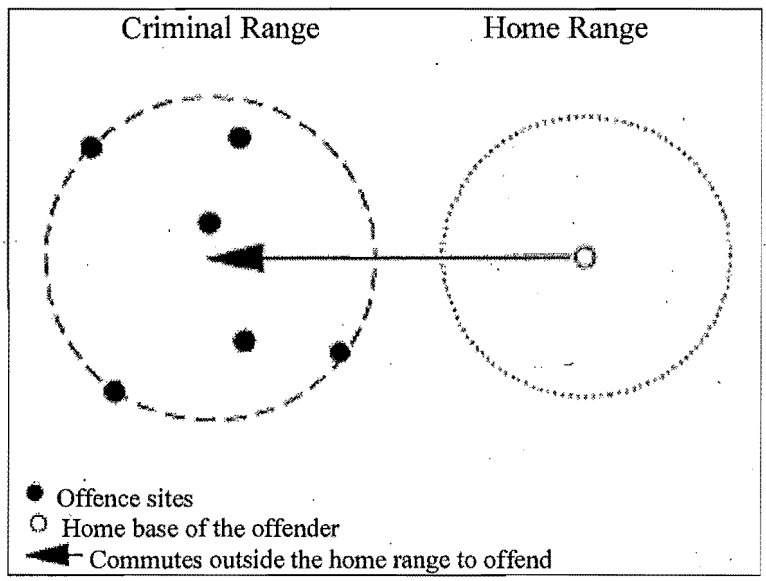

Figure 1. The commuter model of spatial behaviour (Adapted from Canter and Larkin, 1993).

According to Davis (1997), there are many reasons why some offenders commit their crimes further away from their residential address than other offenders. These reasons may involve factors such as offenders having different locations for home, work, and family; having a transient lifestyle and committing their offences while on holiday; or simply travelling further to select a certain type of target. Other factors that might predict commuter-type behaviour would be forced change from their normal attacking areas because of police activities such as patrol saturation in targeted neighbourhoods, or increased media publicity (Davies, 1997; Holmes & Holmes, 1996).

The Marauder Hypothesis

The second model of the circle theory is the marauder model. According to this model, the offender's home base is a focus for all their offence locations (Canter, 2000). In other words, the home base acts as a spatial reference point for each offence committed (Kocsis & Irwin, 1997). It is proposed that the offender moves out from his home base to commit crimes and then returns once the offence is completed. This hypothesis relates directly to the research conducted by Brantingham and Brantingham (1981), who suggested the home base of the offender was a focus for all their offence locations (Kocsis & Irwin, 1997). The marauder model suggests a closer relationship between the offence locations and the offender's home (Canter & Larkin, 1993). It is observed that the offender operates from a home base which is located within the boundaries of the proposed criminal range, thus, as seen in Figure 2, producing an overlap between both the offender's home range and criminal range (Canter & Larkin, 1993).

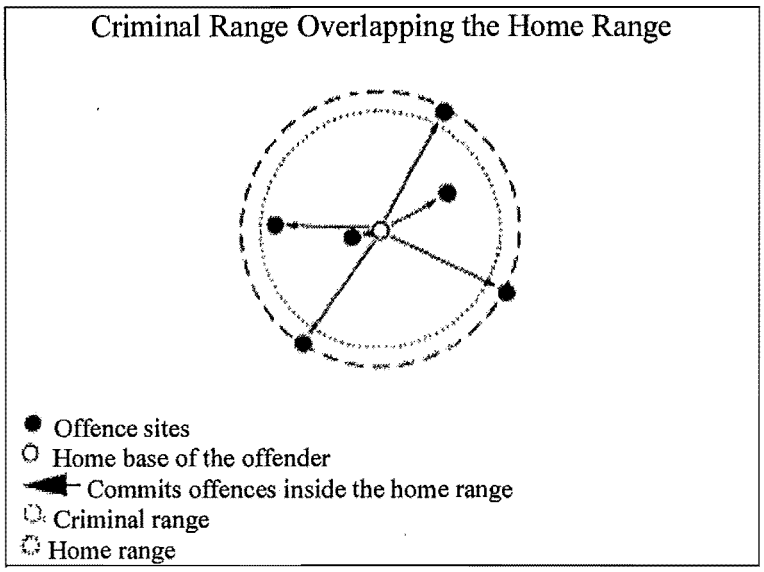

Figure 2. The marauder model of spatial behaviour (Adapted from Canter and Larkin, 1993)

There are two precise geographical aspects which can be derived from the marauder model:

1. The two offences that are furthest from each other will define the diameter of the circle.
2. The home base of the offender will be within this proposed circle.

Testing the Hypotheses

To test the marauder and commuter hypotheses, Canter and Larkin (1993) assessed whether the region covered by the offences also included the home base. In order to define the area of offences, the offenders' two furthest offences from each other were identified, and the distance between these two points were measured. This, in turn, would be the diameter of the proposed circle for that offender (Canter & Larkin, 1993). The circle drawn based on these two points is likely to include all the individual's offence

locations within it. In Canter and Larkin's (1993) study, 91% of the offenders had all their offences located within the constructed circular region, this suggesting that the offenders operate within a distinct offence region (Canter & Larkin, 1993). Figure 3 gives an example of offence sites outside the constructed circular region as defined by the two furthest offence locations.

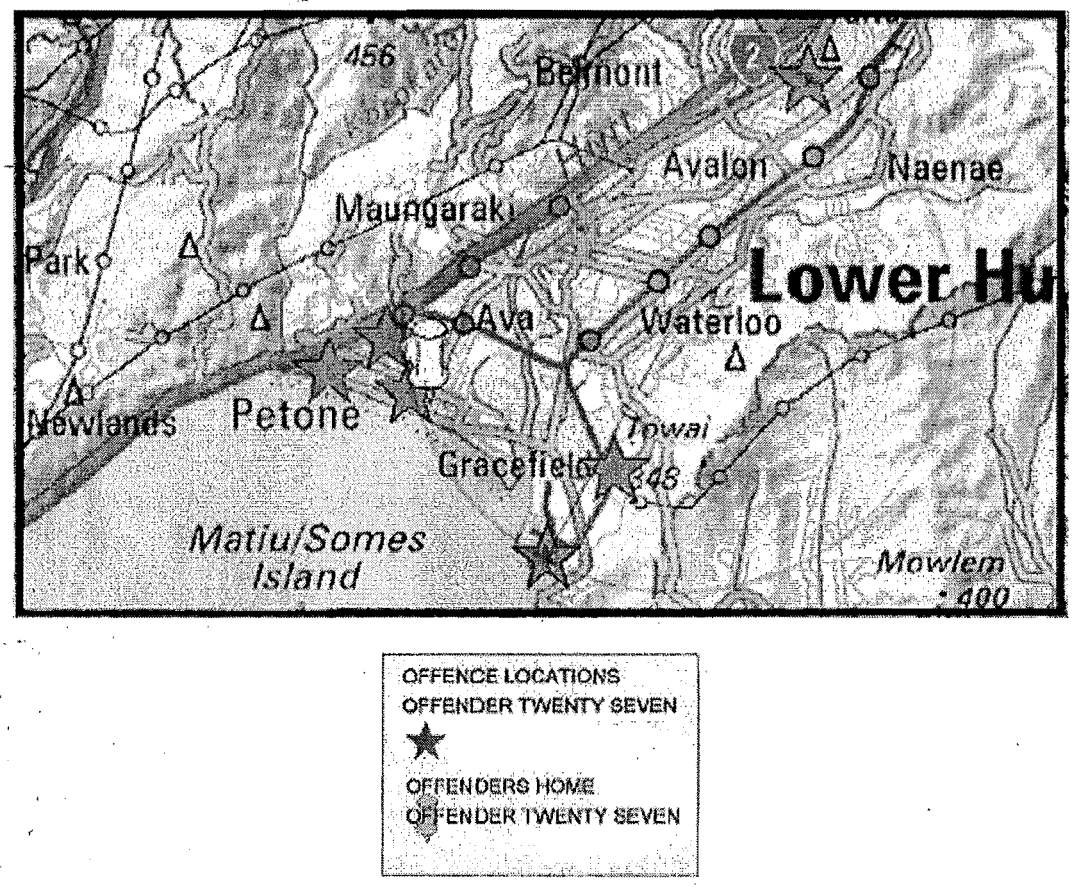

Figure 3. Offence sites outside the offenders constructed criminal range circle

Canter and Larkin (1993) found that 39 (87%) of these offenders lived within the proposed circle, indicating that they were marauder type offenders. Furthermore, the average minimum distance, which was assessed by identifying the first closest offence

site to the home base for each of the marauder offenders was 1.53 miles, matched with the constant term of 0.61 miles (identified from the regression equation of $Y = 0.84x + 0.61$). From these results it suggests that criminal's "safety areas" had an average radius of 0.61miles around the offender's residential base. Thus, the study offered strong evidence for a proposed minimum distance that an offender is willing to travel (Canter & Larkin, 1993).

In replicating Canter and Larkin's (1993) study, Kocsis and Irwin (1997) tested the utility of the circle theory by assessing the spatial behaviour patterns of rape, arson and burglary offences in New South Wales, Australia. From their study, it was found that in 71 percent of rape and 82 percent of arson cases the offender's home base was located within the proposed circle area (Fritzon, 2001).

The Home Range Hypothesis

Canter and Larkin (1993) formulated an additional hypothesis regarding the marauder offenders; the home range hypothesis, which applies only to those offenders who fit the criteria for the marauder type offenders. Those offenders which did not fit the marauder model, such as the commuter type offenders were excluded from this final analysis. We will briefly present the home range hypothesis:

It was proposed that if criminals are offending within a defined circle region, and that their home base is within this proposed area, it might be possible to make some further generalizations about the relative location of their home base within the defined area

(Kocsis & Irwin, 1997). For instance, if the offender's home base is at the centre of the circle, then those offences which are committed further away from each other are most likely to be further from the home base in relation to those offences which are nearer to each other (Canter & Larkin, 1993). This type of relationship would be consistent if the offence locations were distributed around the home base.

The procedure developed for the home range hypothesis concerns the relationships between two variables, namely, the distance between the two furthest offence sites (X) and the distance between the furthest offence site and the offender's home base (Y). If the home base is situated at the centre of the proposed circle then the distance from the home base to the furthest offence location would be half of the maximum distance of those two furthest offences; hence it would be exactly 0.5 (Kocsis & Irwin, 1997).

Thus, a regression of maximum distance between offence sites (X) on a maximum distance from the offender's home (Y) will have a slope between 0.50 and 1.00. A slope close to 1.0 would imply that the home base is eccentrically placed within the proposed criminal range circle. The closer the gradient slope is to 0.5, the closer the home base is to the centre of the circle.

Canter and Larkin (1993) found from the regression analyses on the home range hypothesis, that serial rapists produced a highly significant, positive correlation ($r = 0.93$, $p < 0.001$) between the two furthest offence locations and the furthest offence from the offender's home base. The regression equation was $Y = 0.84x + 0.61$, with the observed

gradient being 0.84. This would indicate that a rapist's residential base would be located within the proposed criminal range circle, but unlikely to be close to the centre of the circle.

Summary

The study conducted by Canter and Larkin (1993) found precise relationships between the distances that serial rapists travel between their crimes and the distances they travel from their home base. Combining purely geographical information such as this, it is possible to develop a data base system that could potentially narrow the area of the likely residence of a marauder offender (Canter, 1995). Police could assign priorities to an extensive list of suspects in all serial investigations (Canter and Gregory, 1994). Therefore, this type of research on models of criminal behaviour around the home base may prove as an effective tool in serial crime investigations.

The Current Study

The primary objective of this thesis is to offer an evaluation of Canter and Larkin's (1993) circle theory of environmental range. The theory proposed by Canter and Larkin (1993) tested only one form of serial crime, namely rape. The present thesis therefore will determine the generality of the circle theory and home range hypothesis by assessing its efficacy in relation to a different type of serial crime, namely arson. The study will be able to determine whether Canter and Larkin's (1993) theory of spatial patterning of serial rapists can be applied and yield the similar results in the case of serial arsonists.

A second objective of this thesis is to determine the utility of Canter and Larkin's (1993) circle theory within the New Zealand environment. The theory proposed was tested in only one geographical location, namely cities in England. It is suggested that the circle theory may function differently across particular geographical environments. For example, it is suggested by studies in environmental psychology that variations in people's cognitive maps are dependant on the spatial environment that they came from (Gilfford, 1987, cited in Kocsis, 1997). Theoretical models developed in countries such as England will not necessarily apply to the New Zealand context.

It was demonstrated by Canter and Larkin (1993) that at least one version of the circle theory, namely, the marauder hypothesis proves to be a viable model for offender behaviour in serial rapists within England (Kocsis & Irwin, 1997). The efficacy of the circle theory would be further supported if it could be shown to be applicable to other geographical locations such as New Zealand.

The Five Hypotheses of the Study

In an attempt to evaluate the utility and generality of Canter and Larkin's (1993) circle theory and home range hypothesis, this study will look at five core hypotheses which will help assess the purpose of the study: First hypothesis; that all offences are committed within the constructed criminal range circle. Second, the majority of offenders in this study behave in a manner consistent with Canter and Larkin's (1993) marauder model. Third, that the offence patterns of the marauder offenders will be consistent with Canter and Larkin's (1993) home range hypothesis. Fourth, that there is safety zones around the

offender's home base. Finally, that offender's in the study travel short distances (a few kilometres) to commit their offences.

To test Canter and Larkin's (1993) hypothesis, information was obtained concerning the geographical locations of offences committed by serial arsonists in New Zealand between 1988 and 2003. Data was derived from two archival sources, the New Zealand Police and the New Zealand Fire Service. The most recent 45 multiple arson offenders were chosen as the sample. Thus, the sample size was similar to that of Canter and Larkin's (1993) study on serial rapists.

SECTION TWO

2. METHOD

The purpose of the present study was to determine the utility of Canter and Larkin's (1993) circle theory and home range hypothesis for psychological profiling. This study determined whether Canter and Larkin's (1993) theory of spatial patterning of convicted serial rapists in England can be applied to convicted serial arsonists within New Zealand.

Because this thesis was based on official records of serial arsons in New Zealand, co-operation with the New Zealand Police and New Zealand Fire Service was essential. Approval from the New Zealand Police was necessary when accessing selected information in national police files for the data collection and data editing phases of the study (refer to Appendix B). In addition, approval was granted by the New Zealand Fire Service for the data analysis phase to produce the 45 offender maps as required.

2.1. Participants

Data were obtained from two archival sources, namely criminal records from the New Zealand Police and the New Zealand Fire Service. The data extracted from national files relates to the information gained from the offender at the time of each offence. In each instance, the offender's address at the time of the arsons was recorded, as well as each offence site. The study used the same sample size as did Canter and Larkin (1993). Thus,

45 convicted serial arson offenders were selected from criminal records for inclusion in the study, as described below.

2.2 Selection

We selected the 45 most recent serial arson offenders for inclusion in the study. Participants were required to be 14 years or older at the time of their first arson offence. In addition, each offender must have committed a minimum of three arson offences; and must have had no regular prior contact with the targets before committing the offence. The offenders had to reside at a fixed home base for at least a minimum of two arson offences. Eight offenders who were identified as having a no-fixed abode (no fixed home base) were excluded from the study. The offences had to be investigated crimes for which the offender had been charged with arson. Offenders were ineligible and excluded from the study if it was known that they were acting as a "hired torch" for another person who had selected the target.

All participants were required to have committed their multiple arson offences within the specified international criteria that define serial offences. That is, successive offences had to have been committed on separate days (24 hour period), and no more than 52 weeks apart. The first wave of serial offences at their first home base was used for the study, i.e. if an offender committed multiple offences before and after two years in prison, then the first phase of serial offences was used for that offender. Serial offending was determined by the offence dates and times as identified on their records. If the offender had committed spree or mass offences, the first offence identified on that day was identified

and used for the study, with the remaining offences excluded from the study. The mass and spree offences were excluded from the study because this study was only emphasizing the serial arsons that were committed by the 45 offenders. Thus, offences in this study had to conform to the standards set by the international criteria that define serial offending. The majority of the offenders in this sample (72%) were serial only offenders.

It is worth noting that some information regarding the offenders may have been unavailable for use; in particular, files may be destroyed as a general procedure after five years, the police usually only hold records in the office for up to five years. In addition, if the damage to property by the arsonist was less then $20,000 the file will also be destroyed after five years. Information was unavailable for these destroyed files and could not be used for the data entry phase of the thesis.

2.3 Data Entry Phase: New Zealand Police

A spreadsheet including all convicted arsonists (first time and multiple offenders) between 1988 and 2003 was received from the Modius Operandi (MO) section at the Police National Headquarters. Once this information was obtained, the screening process then followed, identifying the most recent 45 multiple offenders with arson offences. Those offenders who had been convicted of more than three arson offences within the specified international criteria for serial offending were identified and selected for the study. From here, a Query History Persons (QHP) and a Query History Details (QHD) were conducted at the Christchurch Central Police Station. These queries identified the

offence dates and the period of each arson offence. The information supplied was true and correct as of June 2003.

Once the 45 offenders had been identified, contact was made with various police stations within the 12 Police Districts, in order to access information in national police files of the identified offenders. The police files from each of the 45 offenders supplied pertinent forensic information such as the gender, ethnicity, age, police districts where the serial arsons had been committed, arson charges, sentencing imposed on the offender, occupation, previous criminal convictions, marital status, accomplices involved, total number of arsons, all other offences, and the type of arsons committed. All these variables were recorded.

2.4 Data Editing Phase: Southern Communications Centre

Once the offender's home base and all offence locations were identified (i.e. street names and numbers) for each of the 45 offenders, the next step was to find the exact location or grid point co-ordinates (Easting and Northing) of these places, as a requirement for the New Zealand Fire Service to construct the offender maps. The computerized geographic information system at the police station was used to identify the 214 grid point co-ordinates for the offender's offence and home base locations. Once the grid point co-ordinates were encoded, the next step was to measure the distances from the home base to each of the offences by straight-line measurements that were later converted into travelling kilometres.

2.5 Procedure: New Zealand Fire Service

Four steps were required to test the circle theory and home range hypothesis:

STEP 1 - Data Analyses - New Zealand Fire Service

For each offender, a separate map was produced indicating the locations of all their offence sites, and home base at the time of the committed offences. This information was displayed on an A3 size map which was superimposed onto a scaled street map produced by the New Zealand Fire Service (refer to Appendix C). House numbers for each of the offence sites and home base were not indicated on the produced street maps. In some cases (for example walkways in wildlife reserves), the offence locations were plotted at the midpoint of the target pathway or street. This process was repeated on a different map for each of the 45 offenders.

STEP 2 – Constructing the Criminal Range Circle

After all offence sites were recorded and plotted on the offender maps, the next step was to determine the criminal range. This was achieved by measuring the distance between the two furthest offence sites (X) using a standard ruler. In replicating the procedure proposed by Canter and Larkin (1993) a circle was then be drawn using this distance as the diameter of the circle. The centre of this circle is at the midpoint between those two most distance offences. According to Canter and Larkin's (1993) circle theory, this represented the criminal range of the offender.

STEP 3 – Visual Inspection of the Offender Maps

The next step was to inspect each of the maps and give an appraisal on two specific features:

1. How many offence sites from each offender were contained within the proposed criminal range circle?
2. Was the offender's home base inside this proposed criminal range circle?

For each data set, the number of offence sites and home locations both inside and outside the criminal range circle was recorded. For those cases where the offender's home base or offence sites fell on the proposed criminal range circle (the circumference of the circle), they were counted as being within the circle. Then, each offender was categorized as a "commuter" or "marauder". A commuter offender is one who has their home base outside the constructed criminal range circle, in contrast to the marauder offender who has their home base within the proposed criminal range circle. Thus, to make these determinations for the commuter and marauder categories, visual inspection of the offender maps confirmed that those offenders whose home base was outside the circle, and they were identified as the commuters. Those offenders who had their home base inside the circle were identified as the marauders. Only the offender maps that displayed offence patterns consistent with the marauder pattern were used for the next step. Maps displaying patterns of the commuter model were not further analyzed.

STEP 4 – Testing the Home Range Hypothesis

Once the marauder offenders were visually identified in Step 3, the maps were then used to test the home range hypothesis as proposed by Canter and Larkin (1993). This required measuring the distance from the home base to the furthest offence site (Y). The distance between the X and Y points identified was measured in a straight line millimetres on a standard ruler, and then was converted to kilometres using the scale on each offender map. These X and Y values were then used to conduct a regression analysis. All statistical tests used the .05 significance level.

3. RESULTS

Results are presented in four sections. The first section gives participant demographic information, extracted from the New Zealand Police files. Next, a binomial test is reported that compares the breakdown of offenders depending on whether all their offence sites were located within the circle. In addition, a second binomial test was administered which compared the breakdown of marauder and commuter offenders. Third, two sets of regression analyses that test the home range hypothesis are presented. The first analysis includes all the offenders; the second analysis excludes three potential outliners. Finally, criminal mobility is assessed using distributions of straight-line distances.

3.1. Participant Demographic Information

The dates and locations of the offences and the offender's home base for each of the 45 offenders were provided by the New Zealand Police.

After further analysis of the data, it was found that one offender was a professional "hired torch". Therefore, this offender was excluded from the study. The final sample of arson offenders thus comprised 44 offenders. Table 3 shows the gender of the convicted arsonists: 39 were males, and five were females.

Table 3.

Gender of convicted serial arsonists, 1988 to 2003

Gender	1988-1989	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	Total
Male	3	4	5	5	3	9	3	7	39
Female	2	0	0	2	1	0	0	0	5
Total	5	4	5	7	4	9	3	7	44

Source: New Zealand Police Files

In Table 4, offenders were classified from the records as 38 Caucasian and 6 Maori offenders:

Table 4.

Ethnicity of convicted serial arsonists, 1988 to 2003

Ethnicity	1988-1989	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	Total
Caucasian	5	2	4	7	4	8	2	6	38
Maori	0	2	1	0	0	1	1	1	6
Total	5	4	5	7	4	9	3	7	44

Source: New Zealand Police Files

At the time of their apprehension as illustrated in Table 5 the mean age for the entire sample was 25 years, the minimum age was 14 years and the maximum age was 52 years.

Table 5.

Mean age of arsonists

Mean Age of Convicted Serial Arsonists (N = 44)	
Mean	25
Std.Dev.	9.10405
Median	22
Min	14
Max	52
Range	38

Source: New Zealand Police Files

Table 6 shows a breakdown of the sample by age range. The largest numbers of offenders (13) was in the range 20 to 24.

Table 6.

Age of convicted serial arsonists, 1988 to 2003

Age	1988-1989	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	Total
14-16	2	0	0	1	1	2	1	1	8
17-19	0	1	2	1	0	1	0	1	6
20-24	1	2	1	2	0	3	0	4	13
25-29	1	0	0	2	1	1	0	0	5
30-34	1	0	2	0	2	0	0	0	5
35-39	0	1	0	0	0	1	0	1	3
40+	0	0	0	1	0	1	2	0	4
Total	5	4	5	7	4	9	3	7	44

Source: New Zealand Police Files

The 12 Police Districts where offences were committed ranged from the Northern to Southern Districts of New Zealand. Table 7 shows that twelve arsonists committed their offences in Wellington, ten offended in Christchurch, five in Central, three in North Shore, Auckland City, Waikato, Eastern, two in Counties Manukau, and one in Northern, Bay of Plenty, Tasman, and Southern. One offender committed arsons in the police districts of both Auckland City and Waikato. The district with the most offenders was Wellington with a total of 12 offenders committing their offences within this district.

Table 7.

Districts where serial arsons had been committed, 1988 to 2003

POLICE DISTRICTS	1988-1989	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	Total
Northern						1			1
North Shore/Waitakere	1				1	1			3
Auckland City		1	1	1					3
Counties/Manukau		1					1		2
Waikato	1		1		1				3
Bay of Plenty						1			1
Eastern	1		1		1				3
Central						4	1		5
Wellington	1		1	4	1	1	1	3	12
Tasman			1						1
Canterbury	1	2	1	1		1		4	10
Southern				1					1
Total	5	4	6	7	4	9	3	7	45

Source: New Zealand Police Files

Sentence data are given in Table 8. It shows that the most serious sentence imposed on the offenders was imprisonment, with 25 in this category. Most offenders were sentenced in 1998 and 1999, with 9 offenders being prosecuted over that 2-year period.

Table 8.

Most serious sentence imposed on convicted serial arsonists, 1988 to 2003

Most Serious Sentence	1988-1989	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	Total
Corrective Training						1			1
Supervision	1			1					2
Cumlatv.Imprisonment			1			1			2
Supervision SWO	1			1			1	1	4
Imp. Suspend				2	1				3
Non Resident Pd				1		1			2
Discde = Dis Crt Jury Tr/ B/A								2	2
Discde = Remand on Bail								2	2
Comit.118 CJ. ACT	1								1
Imprisonment (Months)	2	4	4	2	3	6	2	2	25
Total	5	4	5	7	4	9	3	7	44

Source: New Zealand Police Files

Table 9 shows that the 44 offenders in this study had committed a cumulative total of 214 arson offences. The mean arson series comprised of 4.86 offences, with a minimum of 2 and a maximum of 14. Note that for the recidivist serial arsonists, only the first episode of serial offending (or first serial phase of offending) was used in this study.

Table 9.

Cumulative number of arsons for the 44 offenders (N = 214)

All Arsons	Arson Convictions
Mean	4.863636
Standard Deviation	2.914207
Median	4
Min	2
Max	14
Range	12
Total Arson Convictions	214

Source: New Zealand Police Files

Table 10 reports the breakdown of the 44 offender's arson and non-arson offences (all offences such as burglary, kidnapping and extortion as identified in their criminal history). It shows that the 44 offenders had committed a cumulative total of 1537 offences. The offenders had a mean of 34.93 convictions. The minimum convictions by an offender was 3, the maximum convictions by an offender was 344.

Table 10.

Cumulative number of arson and non-arsons for the 44 offenders (N = 1537)

All Criminal Charges	All Criminal Charges
Mean	34.931818
Standard Deviation	52.089546
Median	24
Min	3
Max	344
Range	341
Total Criminal Charges: All arson and non-arson offences	1537

Source: New Zealand Police Files

Offenders were classified according to the types as proposed by Douglas et al. (1986). The results from Table 11 show that thirty-two offenders were identified as serial offenders, nine were serial and spree, two were serial and mass, and one was a serial, spree and mass offender.

Table 11.

Type of arsons committed by convicted serial arsonists (N = 44)

Type	Number	Percent
Serial Only	32	72.73%
Serial and Spree	9	20.45%
Serial and Mass	2	4.55%
Serial, Spree and Mass	1	2.27%
Total	44	100%

Source: New Zealand Police Files

3.2. Binomial Test

All Offences within the Criminal Range Circle

An initial test of the circle theory was to calculate how many offenders committed all their offences within the proposed criminal range circles. The criminal range was defined by a circle, with a diameter that was the distance between the two furthest offences. Testing this part of the circle hypotheses found that 37 of the 44 offenders had circles, which encompassed all of their offence locations. That is, 84% of the offenders had all their crimes located within Canter and Larkin's (1993) proposed criminal range circle. A sign test (binomial test data) against the null hypothesis that offence sites are equally likely to be outside the circle as inside the circle was statistically significant (p <.05).

The binomial test demonstrated that offenders operate within the circle or distinct offence region, as can be seen in Table 12.

Table 12.

Binomial test: Number of offence sites located within the criminal range circle:
Marked tests are significant at $p < .05000$

	No. of	Percent	Z	p-level
Offences located within and outside the circular region – criminal range circle	44	84.09091	4.371914	0.000012

Categorizing the Commuter and Marauder Offenders

When the home base was considered, the second test was to calculate how often the offender's home base fell within the proposed criminal range circle. Visual examination of the 44 offender maps confirmed that the offender's home base fell within the criminal range in 22 out of the 44 occasions. (Again, one offender was excluded from the analysis on the grounds that the offender was a professional "hired torch").

A sign test (binomial test data), against the null hypothesis that homes are equally likely to be outside the criminal range as inside the criminal range was not statistically significant ($p > 0.05$). Neither model was predominant for arson, Table 13 shows that the sample equally comprised of marauder and commuter offenders.

Table 13.

Binomial test: Number of homes within the criminal range circle:

Marked tests are significant at $p < .05000$

	No. of	Percent	Z	p-level
Marauder & Commuter participants	44	50.00000	-0.150756	0.880168

A Chi-Square test was conducted to determine whether the percentage breakdown of marauder and commuter offenders was different in our serial arsonist sample compared with Canter and Larkin's (1993) study of serial rapists. Results are shown in Table 14. This indicates that marauder offenders predominated in the UK serial rapist sample, compared to the New Zealand serial arsonists. The χ^2 value for this 2 x 2 table is χ^2 (df = 1) = 13.87, $p < .05$.

Table 14.

Contingency table of observed (and expected) frequencies of the NZ and UK study with the two different types of offenders: Marauder and Commuters

	Type of Offender		
	Marauder	Commuter	Total
NZ study	22 (30.16)	22 (13.84)	44 (49.44%)
UK study	39 (30.84)	6 (14.16)	45 (50.56%)
Total	61	28	89 (100%)

(Expected frequencies in brackets)

3.3. Regression Analyses

Testing the Home Range Hypothesis

The home range hypothesis only applies to those cases that were consistent with the marauder model. Table 15 shows that the number of valid observations for the regression analyses is 22.

Table 15.
Home range analyses for the marauder offenders only: X = distance measured between the two furthest offence locations. Y = distance measured from the home base to the furthest offence location.

	Valid N	Mean	95% Confidence	95% confidence	Median	Mode	Frequency	Minimum	Maximum	Std.Dev.
X	22	8.941364	1.537419	16.34531	2.695000	Multiple	1	0.040000	64.06000	16.69905
Y	22	8.012727	1.086471	14.93898	1.975000	Multiple	2	0.020000	59.66000	15.62166

The first prediction of the home range hypothesis is that the distance between the offender's home base and the furthest offence (Y) is positively and highly correlated with the distance between the two furthest offences (X). Figure 4 shows a scatterplot of the distance between the home base and the furthest offence, and the distance between the two furthest offences.

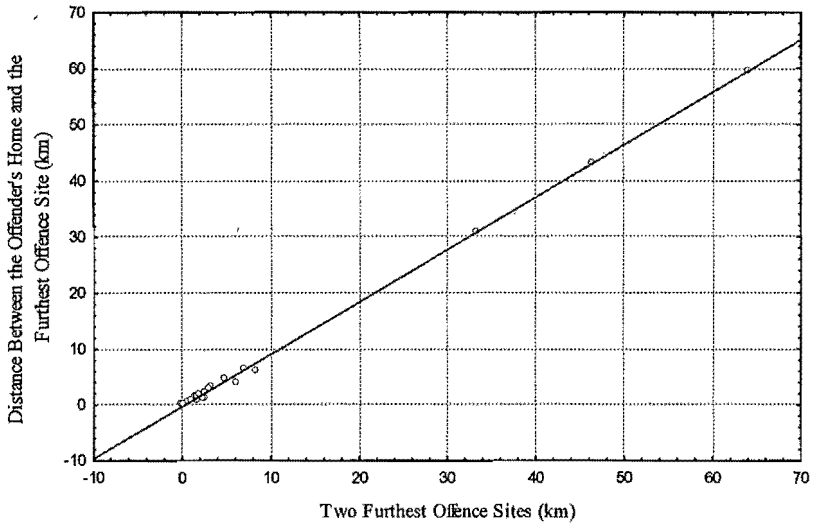

Figure 4. Scatterplot of the criminal range: relationship between distance of the two furthest offence sites and distance between the offender's home and furthest offence site. The line is the best-fitting regression line. N = 22; $p < 0.001$. The regression equation is $Y = 0.3463 + 0.9349x$.

The Pearson correlation of 0.99 can be seen in table 16, this coefficient is significantly greater than zero ($p < .001$). The corresponding regression equation for the marauder offenders was $Y = 0.3463 + 0.9349x$

Table 16.

Regression summary for dependent variable: Y (all marauders) R= .99934689 R^2= .99869421 Adjusted R^2= .99862892 $F(1,20)$=15296. p

	Beta	Std.Err.	B	Std.Err.	$t(20)$	p-level
Intercept			-0.346294	0.140630	-2.4625	0.023001
X	0.999347	0.008080	0.934871	0.007559	123.6787	0.000000

Note that there are three apparent outliners in Figure 4. The regression analyses then repeated but with these outliners excluded, to test the robustness of the results.

Table 17 shows the number of valid observations for the second regression analyses of 19 offenders.

Table 17.

Home range analyses for the marauder offenders only – excluding the three outliners

	Valid	Mean	95% Confidence	95% Confidence	Median	Mode	Freq	Minimum	Maximum	Std.Dev.
X	19	2.784211	1.658397	3.910024	2.420000	Multiple	1	0.040000	8.390000	2.335788
Y	19	2.239474	1.315622	3.163326	1.500000	Multiple	2	0.020000	6.500000	1.916767

Figure 5 shows the relationship between the X and Y variables with the three outliners excluded.

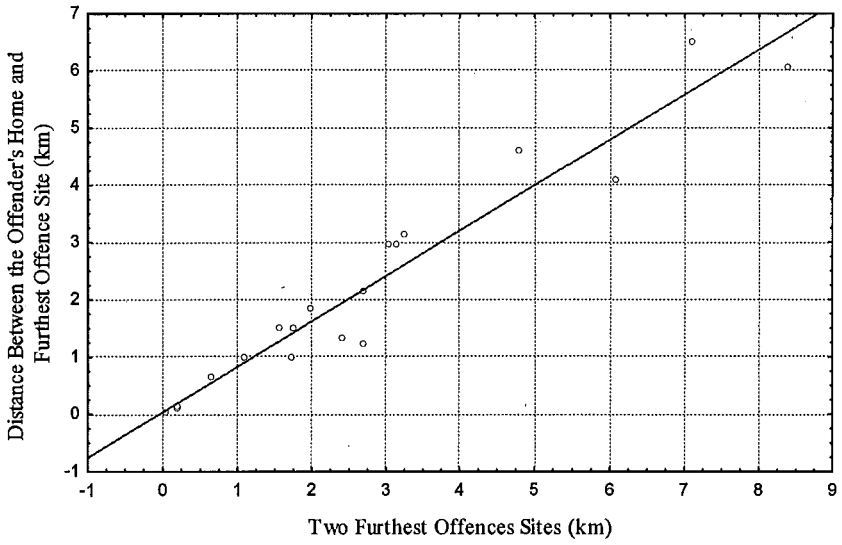

Figure 5. Scatterplot of the criminal range (three outliners excluded): relationship between distance of the two furthest offence sites and distance between the offender's home and the furthest offence site. The line is the best-fitting regression line. N = 19; $p < 0.001$. The regression equation is $Y = 0.036 + 0.7914x$

Table 18 shows the revised Pearson correlation at 0.96. This coefficient is significantly greater than zero ($p < .001$). The regression equation for the marauder offenders was: $Y =$

0.036 + 0.7914*x. Note that the regression slope has decreased somewhat when the outliners were excluded.

Table 18.

Regression summary for dependent variable: Y (excluding three marauders) R= .96442400 R^2= .93011365 Adjusted R^2= .92600269 $F(1,17)$=226.25 p

	Beta	Std.Err.	B	Std.Err.	t(17)	p-level
Intercept			0.036010	0.189125	0.19040	0.851250
X	0.964424	0.064117	0.791414	0.052615	15.04168	0.000000

The second prediction was that the regression equation of X and Y will have a gradient slope between 0.50 and 1.00. In terms of the gradient of the regression line, the value does lie between 0.50 and 1.00, as would be expected with the home range hypothesis. The home range proposes that if the home base was at the centre of the constructed criminal range circle then the gradient slope would be 0.50; if the home base was on the circumference of the circle then the gradient slope would be 1.00. The gradient, at 0.79, does indicate a location within the criminal range circle, but suggests that the home base is not close to the centre of the criminal range circle but tends to be roughly half way between the centre and the circumference of the circle.

3.4. Safety Zone

Testing the Safety Zones

The third prediction is that there will be a safety zone or "buffer zone" around the home base. This would be established by a constant term in the regression that is positive but

less than the average minimum distance of offence sites from the home base. The average minimum distance of offences from the home base for these offenders was 0.507km.The constant term of 0.036km when matched against the average minimum distance of offence sites shows that the constant term is well below the average minimum distance of offences. Therefore, there is strong evidence for a minimum distance that an arsonist is willing to travel to commit their offences from their home base. This supports Brantingham and Brantingham's (1981) proposed existence of a safety zone or "buffer zone" around the marauding offender's residential base.

3.5. Criminal Mobility Research

Travelling Distances to Commit Offences

Examination of New Zealand Police records established that the offenders (N = 44) in the study did have a home base at the time of their offences, and in every serial episode except one case (one offender, committing arsons in two police districts), their home address was in the same police district as their offence locations. Figure 6 shows the distribution of distances for each offence location (N = 212), using straight-line distances between the offence site and the offenders home base.

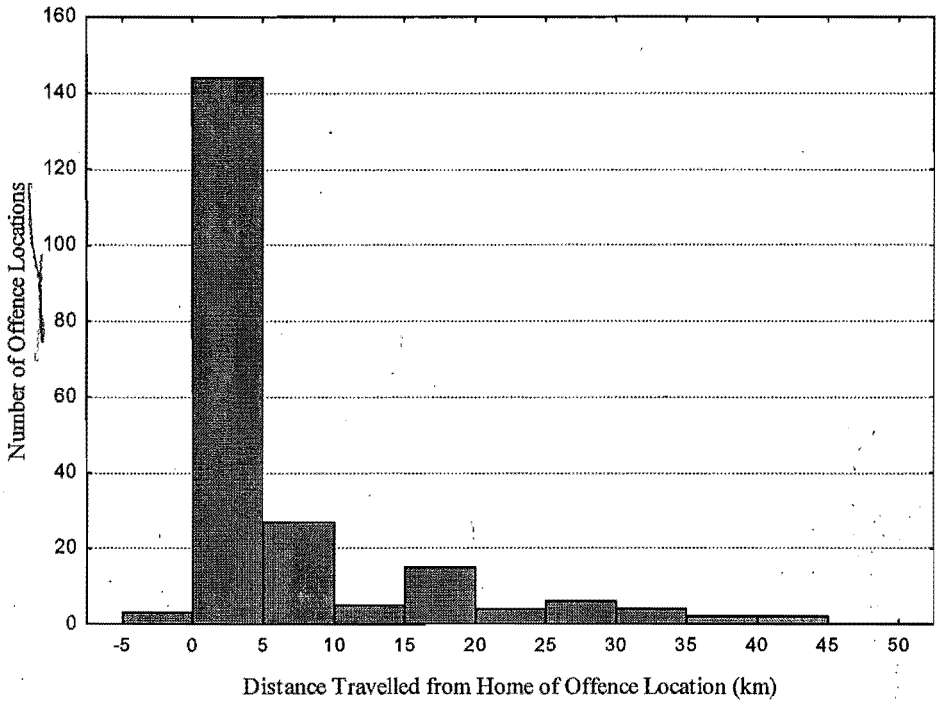

Figure 6. Straight-line distances between offences and home locations. N = 212 offences

Note that the distribution is positively skewed. The graph shows that 82% of the offenders commit their offences within five kilometres of their homes. Furthermore, as can be seen in the graph, the greater the distance travelled from home to their crimes the decrease in the number of offences committed. In other words, the majority of offenders start fires relatively close to their home base and less as they travel further away from their home.

A decision was taken to exclude the two offences of one offender from the analysis, first, because the offender committed offences in two police districts, which is uncharacteristic of the sample. Second, the offender appeared to have travelled between 63.56 and 66.01

kilometres from the home base to the offence sites. These were uncharacteristic of distances travelled by the other offenders in the sample.

Table 19 shows the mean travelling distances from the home base to the offence sites at 6.08 kilometres, with a standard deviation of 9.14 kilometres. The minimum distance travelled was 0.00 kilometres and the maximum was 43.36 kilometres.

Table 19.

Straight-line distances: Criminal mobility research excluding two offences from one offender

	Valid N	Mean	95% Confidence	95% Confidence	Median	Mode	Frequency	Minimum	Maximum	Std.Dev.
Distances	212	6.081226	4.843437	7.319016	2.335000	Multiple	6	0.00	43.36000	9.142576

4. DISCUSSION

The purpose of the current study was to evaluate the utility of Canter and Larkin's (1993) circle theory and home range hypothesis. Testing the circle theory and home range hypothesis led to five hypotheses, which assisted in determining the utility of this theory based on a sample of convicted serial arsonists within New Zealand. The circle theory was assessed by constructing a circle on a map by taking the two furthest offence locations, thus representing a geometrical approximation of the criminal range of the serial arsonist. The home range hypothesis was tested using the marauder offenders from the circle theory.

The Five Hypotheses

The current study focused on five main hypotheses that helped to assess the evaluation of the circle theory. The first hypothesis was that all offences were committed within the constructed criminal range circle. Second, it was hypothesized that a majority of offenders in this study would behave in a manner consistent with the marauder model. Third, that the offence patterns for the marauder offenders would be consistent with Canter and Larkin's (1993) home range hypothesis. Fourth, that there were safety zones or buffer zones around the offender's home base. Finally, that offender's in the study would travel short distances (a few kilometres) to commit their crimes.

4.1. Circle Theory and Home Range Hypothesis

Canter and Larkin's (1993) geometrical technique for constructing the criminal range circle using the two furthest offence sites was applied to this study. It was found that the proposed circle did encompass most of the offences, specifically, 84% of the offenders had all their arsons located within the circular region. The construction of the circle in order to identify a distinct offence region was hence supported. However, it must be noted that this figure was slightly lower than that of Canter and Larkin's (1993) finding of 91%. The difference between this study and Canter and Larkin's (1993) findings could be attributed to the differences in geographical structure of the environment such as rural and urban areas between New Zealand and the greater London and South East areas of England.

Second, Canter and Larkin (1993) found from their study that the marauder version of the circle theory was more predominant than the commuter version. That is, most of the offenders (rapists) in their study displayed the marauder pattern of behaviour. The initial test of the second hypothesis was to identify how often the offenders' homes fell within the criminal range circle. Examination of the offender maps produced the most noticeable finding that the percentage of cases observed (50%) was not consistent with the marauder pattern of serial offending as proposed by Canter and Larkin's (1993) circle theory of (87%). The results showed that the percentage breakdown of marauder and commuter offenders was significantly different compared to that of Canter and Larkin's (1993) study of serial rapists.

Therefore, the findings suggest that the marauder version, as part of the circle theory is not universally applicable to account for all types of serial offending. It is hence suggested that the commuter and marauder models differ across serial crimes, such as rape and arson. The present sample showed that arsonists are just as likely to commute to commit their offences outside their home range as to commit their offences within their home range.

A possible reason for the observed differences in the offence patterns between the two studies is that the arsonists were more likely to target property outside their home range. That is, the offenders were likely to travel outside their local areas to select their desired targets, whilst fulfilling the desire to remain anonymous. A majority of offenders in the study were identified as vandalism-motivated arsonists, whose malicious and mischievous motivation led to targeting specific types of property, such as schools and vegetation areas. Therefore, the study found that the present sample of New Zealand arsonists was not consistent with Canter and Larkin's (1993) marauder pattern of serial offending, as the former were more likely to commute outside their home range to select their ideal targets. On the other hand, rapists in Canter and Larkin's (1993) study were highly likely to commit offences within their home range because they reside in densely populated urban areas, areas that are highly concentrated and readily available for offending.

The assessment of the home range hypothesis in the present study determined whether the distance between the offender's home base and the most remote offence site was

positively correlated with the distance between the two most widely separated offences. A finding similar to that of Canter and Larkin's (1993) study would support the hypothesis.

A regression analysis was conducted to test the utility of Canter and Larkin's (1993) home range hypothesis. It was demonstrated that the distance between the offender's home base and the most remote offence site was positively correlated with the distance between the two most widely separated offences; thus, a positive relationship of 0.96 was found. This finding was similar to the correlation of 0.93 found in Canter and Larkin (1993). Therefore, the offence patterns for the marauder offenders in this current study were consistent with the home range hypothesis. The findings hence provide support for Canter and Larkin's (1993) home range hypothesis.

In addition, after testing the home range hypothesis, the present study suggests that the marauding offender's home base is not eccentrically placed at the centre of the proposed criminal range circle. However, a gradient slope of 0.79 does suggest the home base may lie roughly halfway between the centre and the circumference of the circle.

The finding from the regression analyses may reflect the developmental stages of the offender's criminal careers, whereby arsonists will travel from their home base depending on their criminal developmental stages as suggested by Canter and Larkin (1993). For example, an offender with a well-developed criminal career could have the propensity to

travel further to commit their offences, in contrast to an inexperienced offender who will travel shorter distances to commit their crimes.

Overall, Canter and Larkin's (1993) circle theory and home range hypothesis is supported by the results found from the sample of serial arsonists in New Zealand.

Brantingham and Brantingham (1981) proposed a safety zone around the offender's home base. This theory of spatial organization suggests that there is an area around the offender's home base where they will not commit offences, due to the risk of identification and the lack of desirable targets (Brantingham & Brantingham, 1984). Canter and Larkin (1993) found that the average minimum distance of offences from the home base was well above the constant term (as identified from the regression equation), thus providing strong support for a safety zone as suggested by Brantingham and Brantingham (1981).

As for the present study the average minimum distance of offence sites from the home base was above the constant term (as identified in this regression equation), thus providing strong evidence of the existence of a safety zone around the arsonists home base. As with the finding from Canter and Larkin's (1993) study, this study supports the proposed theoretical model of a safety zone around the offenders' home base as suggested by Brantingham and Brantingham (1981).

Previous research on criminal mobility has shown that criminals do not travel very far (i.e. a few kilometres) from their home base to commit their offences. The study of arsonists

by Fritzon (2001) found that the mean distance travelled from home to their offences was 2.06 km. In particular, the study conducted by White (1932, cited in Fritzon, 2001) found that offenders committed their offences with a mean of 2.67 km from their home.

The current results showed that the distance travelled by the offenders was 6.08km, this showing that the sample of arsonists travelled relatively short distances to commit their arsons. The results showed that 82% of all the offences occurred within 5km of the offender's home base. Thus, a vast majority of arsonists start fires relatively close to their homes. The present study hence, supports the final hypothesis that offenders travel short distances (i.e. a few kilometres) to commit their arsons.

A possible reason for the slightly longer distances to offend than previous studies such as Fritzon (2001) and White (1932) is that this study is based on offences in small townships and rural areas, in contrast to the urban areas and bigger larger cities in the studies (Barker, 2000). For example, White's (1932) study focused on property offenders in large cities like Indianapolis. Thus, the opportunities to commit offences in White's (1932) study were more concentrated and readily available, consequently, the offenders would only need to travel minimal distances to commit their crimes.

4.2. Limitations of the Research

Some limitations were exposed in the course of this research, such as lost and destroyed files, approximating offence sites, and using only convicted serial arsonists. These must

be considered when evaluating the utility of Canter and Larkin's (1993) circle theory and the home range hypothesis.

Some of the New Zealand Police offender files were lost and therefore could not be included in the study. Furthermore, some offender files were destroyed because the file had been stored for more than five years at the local police station and the damage to property or target was worth less then $20,000. However, if the targeted property was valued at more than $20,000 it would be stored in archives. Thus, small time arsonists who targeted property worth less than $20,000 could have been overlooked in this study, as the police files would have only dated back to 1999. Thus, this study may be reflective of only those arsonists who set fire to expensive targets above $20,000. If the offender files of those targeting less valuable property had been available for extraction, this could have provided a more accurate or reflective sample of convicted serial arsonists within New Zealand.

A further limitation in the study was that some of the offence data, such as the street numbers or exact location of the burnt target were not identified in the police files. These offence locations were determined by identifying the road of the target and using the centre of the road as the offence site for that offender. In addition, some offence locations were not identified on the geographical information systems, so additional information, such as nearby off-streets, monuments and sub-divisions, were used to predict the likely offence site.

A final limitation of the study was that the sample consisted only of offenders who had been apprehended and convicted for arson by the courts. Therefore, convicted serial arsonists in this study may not be representative of all arson offenders, since they may have represented only a small percentage of all those who commit arson offences. This prevents broad generalizations to all arsonists. Therefore, the spatial patterning identified in this study might well be characteristic of only those serial arsonists who are likely to be apprehended and convicted for arson.

4.3. Directions for Future Research

Canter and Larkin's (1993) circle theory is primarily based on two offence sites, which are used to develop the criminal range of a serial offender. The effectiveness of the circle theory to establish the offence region of an offender may be improved if other pertinent features from the offence data were to be taken into account. Features such as topographical and geographical characteristics could be beneficial when constructing the circle, such as taking into account urban structures, arterial roads, highways, zoning, land use and rapid transit stations and bus stops. Physical and psychological boundaries and natural barriers such as coastlines may also be useful when determining the true distinct offence region of the arson offender. In addition, offender characteristics may be useful when constructing the circle. Applying the FBI approach as suggested by Douglas et al., (1997) such as the arson classification system (revenge, excitement, vandalism, profit, crime concealment and extremist) to the spatial patterning of these offenders may further assist in the construction of the circle.

4.4. Conclusion

The current study has tested a number of hypotheses to evaluate Canter and Larkin's (1993) circle theory and home range hypothesis. The circle theory and the home range hypothesis are supported by this study. The study found that the commuter and marauder offence patterns using the circle theory do differ across serial crimes such as rapes in England and arsons in New Zealand. The differences between the commuter and marauder findings of the present study and Canter and Larkin's (1993) study, require further research in order to determine any effects that the environment has on the two models.

Further refinements of the proposed criminal range circle can be achieved by taking into account more details of the topography and geography of the offence locations, and also offender classification systems, such as the six arson motivation types as suggested by Douglas et al. (1997). The present study has important practical implications for police and local authorities, such that the application enhances the effectiveness of investigative strategies such as suspect prioritization. In studying the spatial behaviours of offenders as one part of the profiling process, local authorities will be in a better position to predict the likelihood of offender's home base.

It must be stressed that the practical use of the circle theory and home range hypothesis for psychological profiling will only be successful when combined with other investigative tools. The use of this investigative tool will be beneficial to local authorities

such as the New Zealand Police and New Zealand Fire Service, as it will facilitate the conduct of an inquiry, and help lead to the successful resolution of arson cases.

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6. APPENDICES

APPENDIX A

MINISTRY OF JUSTICE

Table 1: Number of prosecuted cases involving arson, by outcome, 1988 to 2002

Notes:

1. Convicted in the District or High Court.

2. Proved case against a young person in the Youth Court.

3. Discharged without conviction under s19 of the Criminal Justice Act 1985 or s106 of Sentencing Act 2002.

4. Cases that were withdrawn, dismissed, discharged, not proceeded with, or acquitted.

5. Includes cases where there was a stay of proceedings, and cases where the person was found to be under disability or was acquitted on account of insanity, and an order was made under section 115 of the Criminal Justice Act 1985.

6. Source: Research and Evaluation Unit, Ministry of Justice.

APPENDIX B

NEW ZEALAND POLICE APPROVAL LETTER

POLICE
Nga Pirihimana O Aotearoa

SM 6255

13 June 2003

Mr Paul Williams
O/C : Records Section
CHRISTCHURCH

MICHAEL EDWARDS, MASTERS STUDENT, UNIVERSITY OF CANTERBURY

Mr EDWARDS is to be allowed access to information in Police files to assist him with the completion of his thesis.

Can you please prepare a confidentiality report and have Mr EDWARDS sign it.

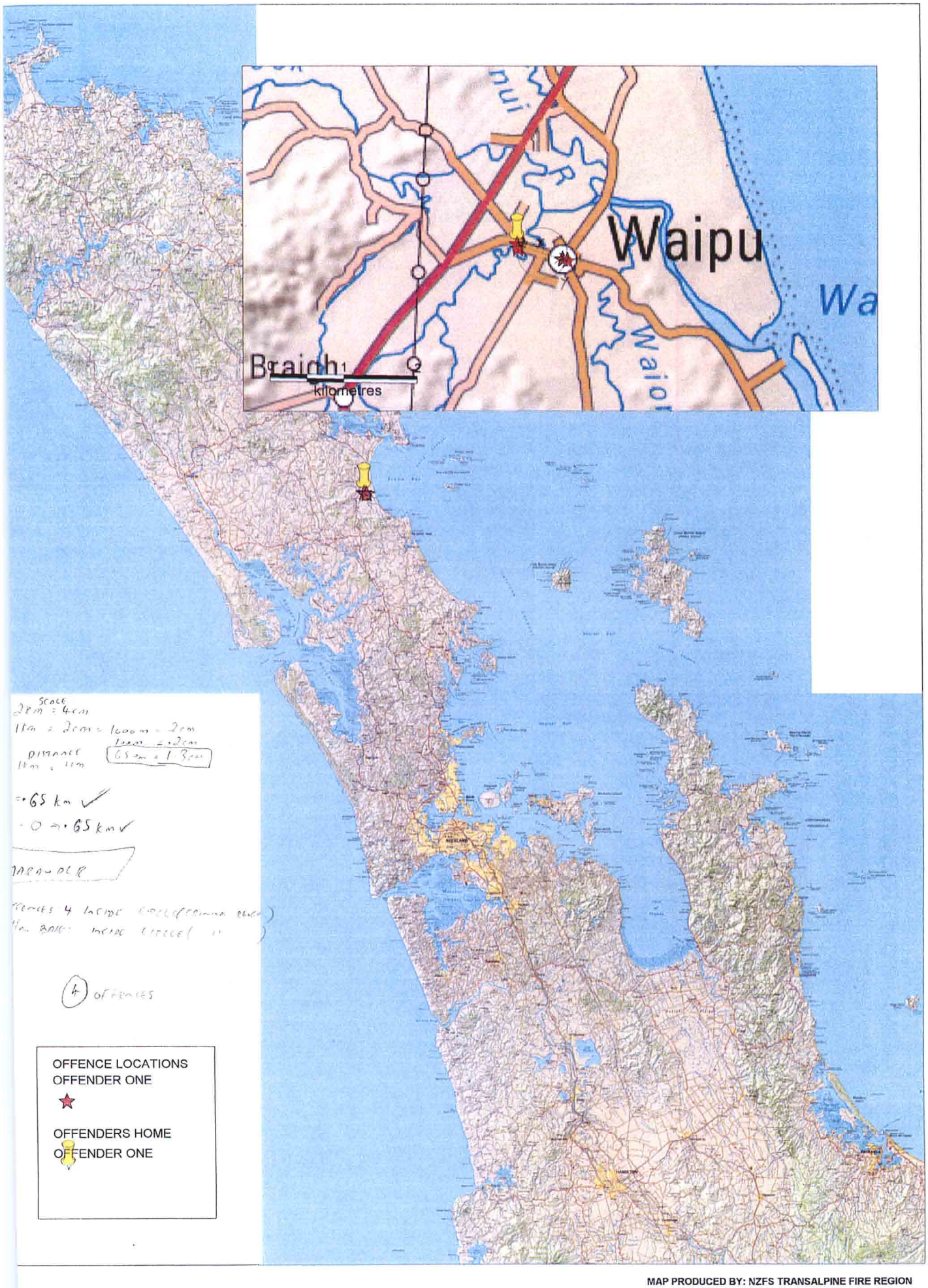
Inspector A McGregor
for District Commander
Canterbury

APPENDIX C

45 OFFENDER MAPS

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

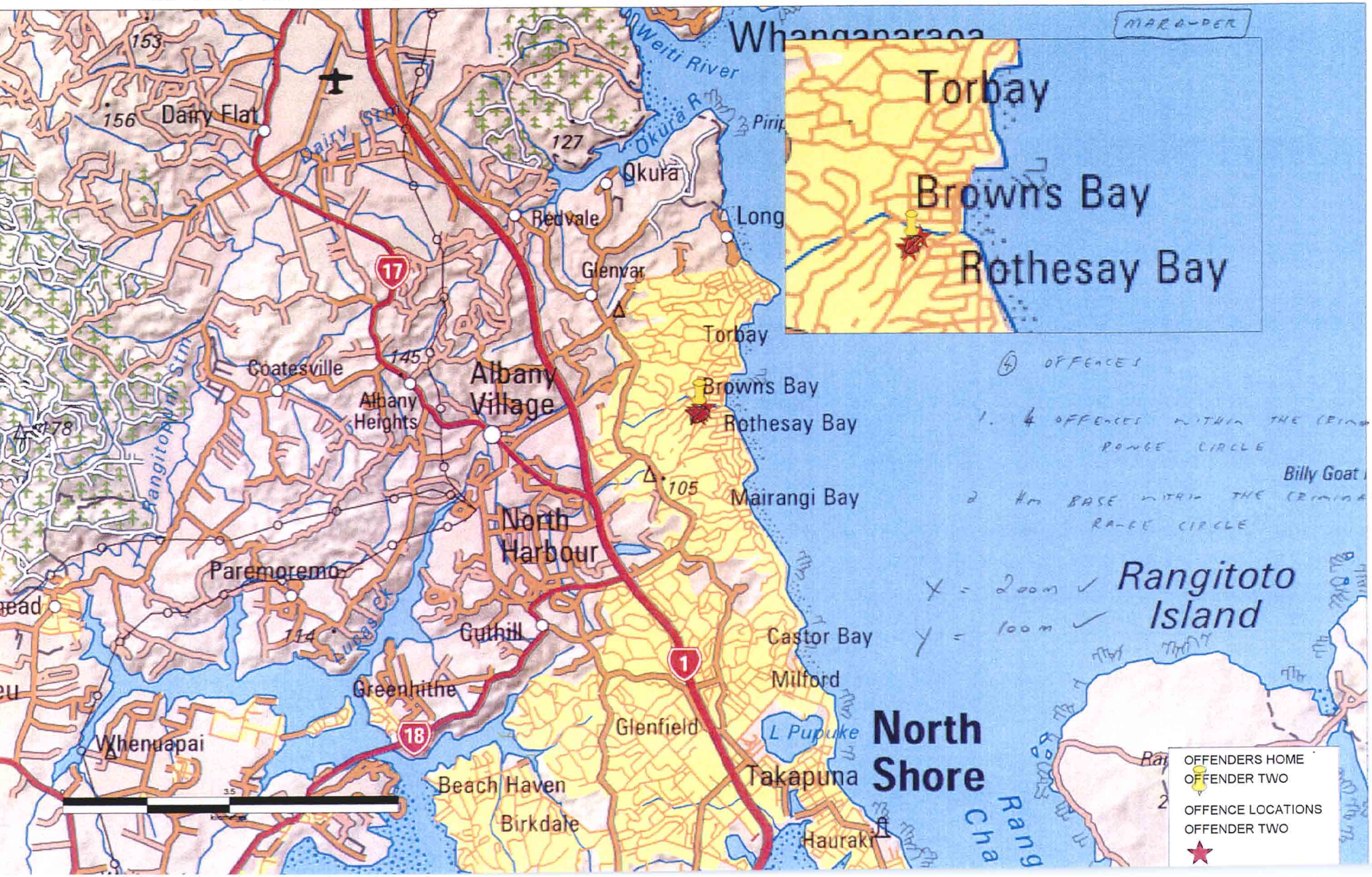
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER ONE'S HOME



MAP PRODUCED BY: NZFS TRANSALPINE FIRE REGION

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWO'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THREE'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FOUR'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FIVE'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

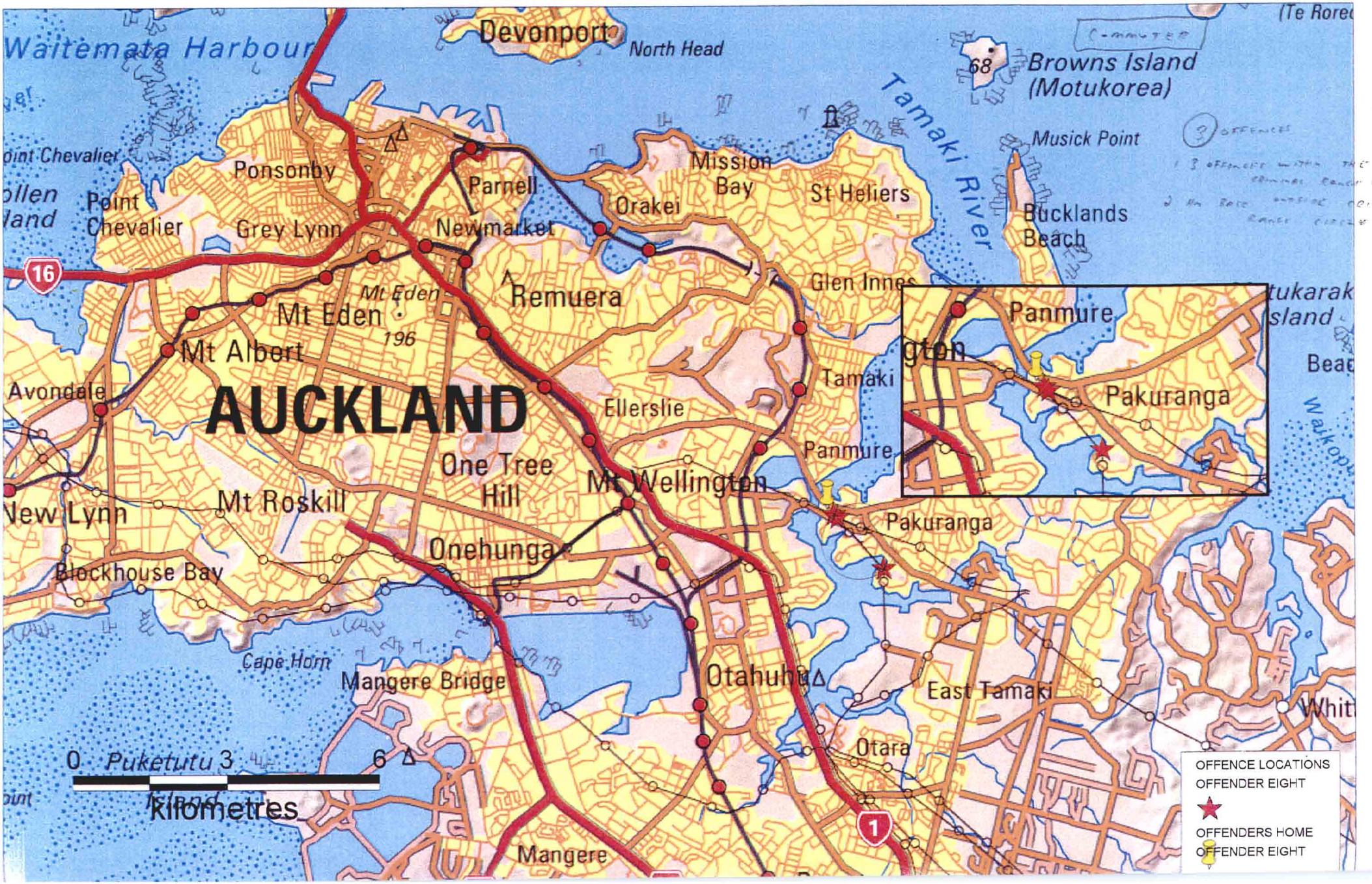
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER SIX'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER SEVEN'S HOME

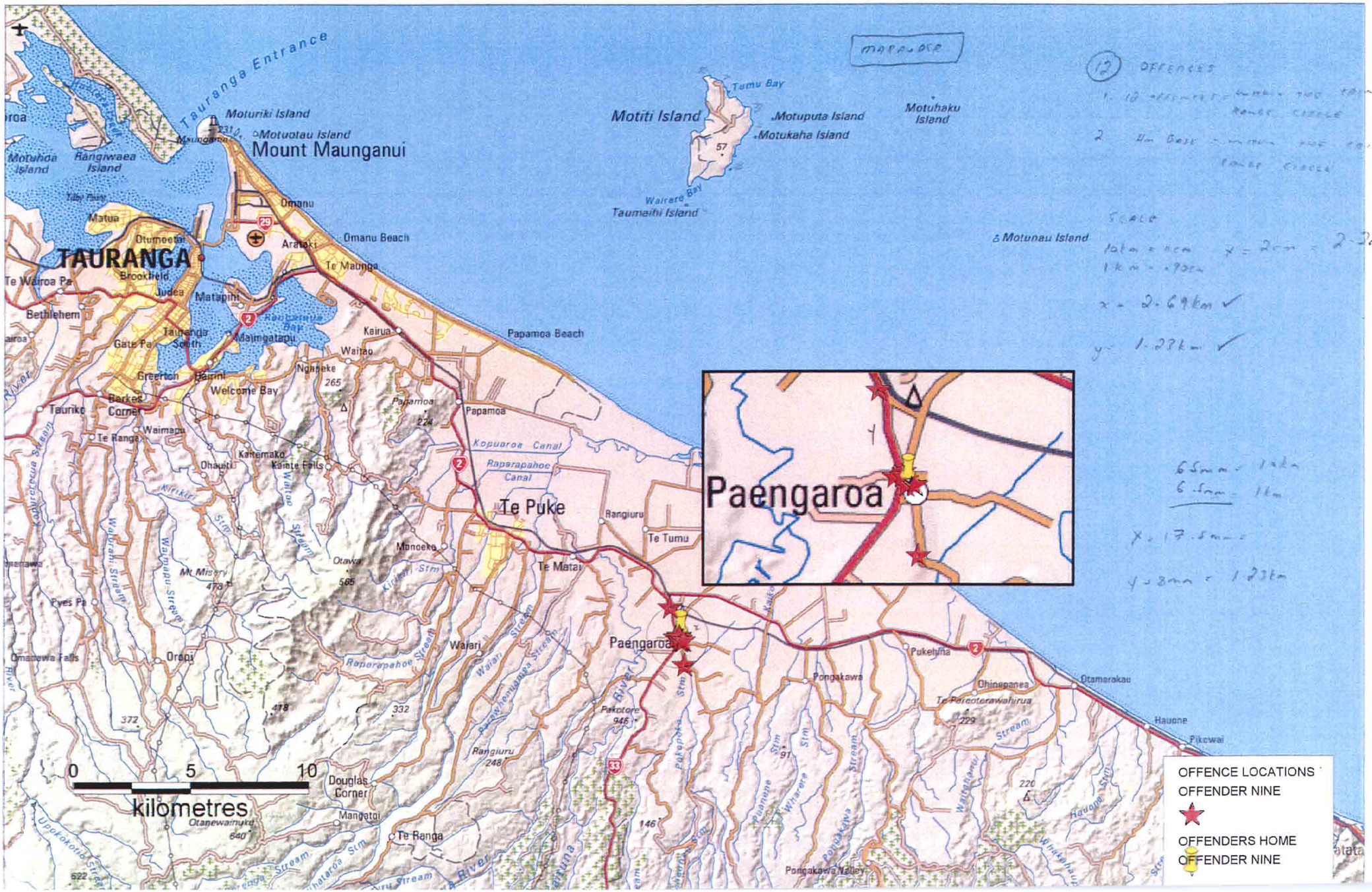
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER EIGHT'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER NINE'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

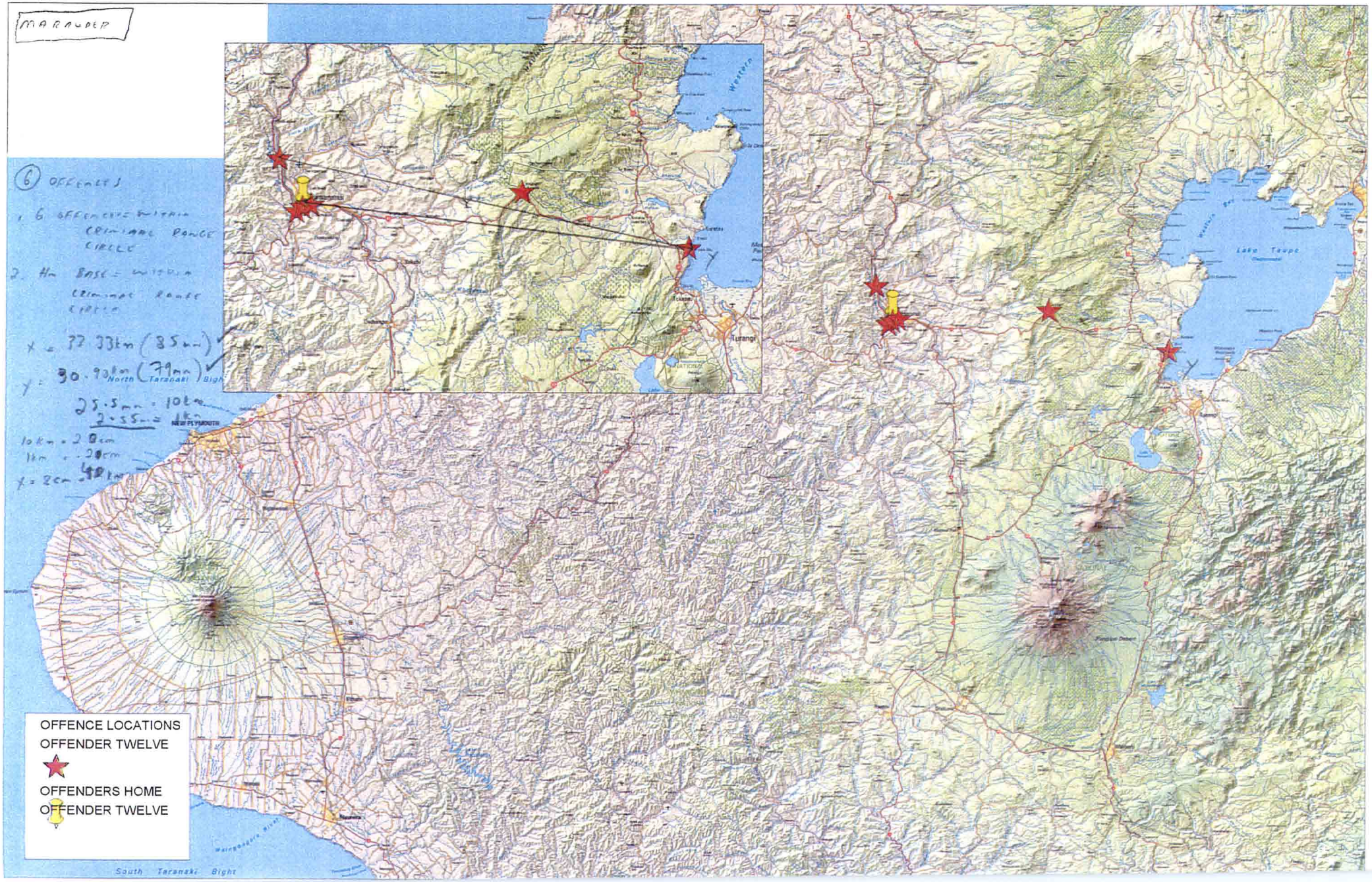
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TEN'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER ELEVEN'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

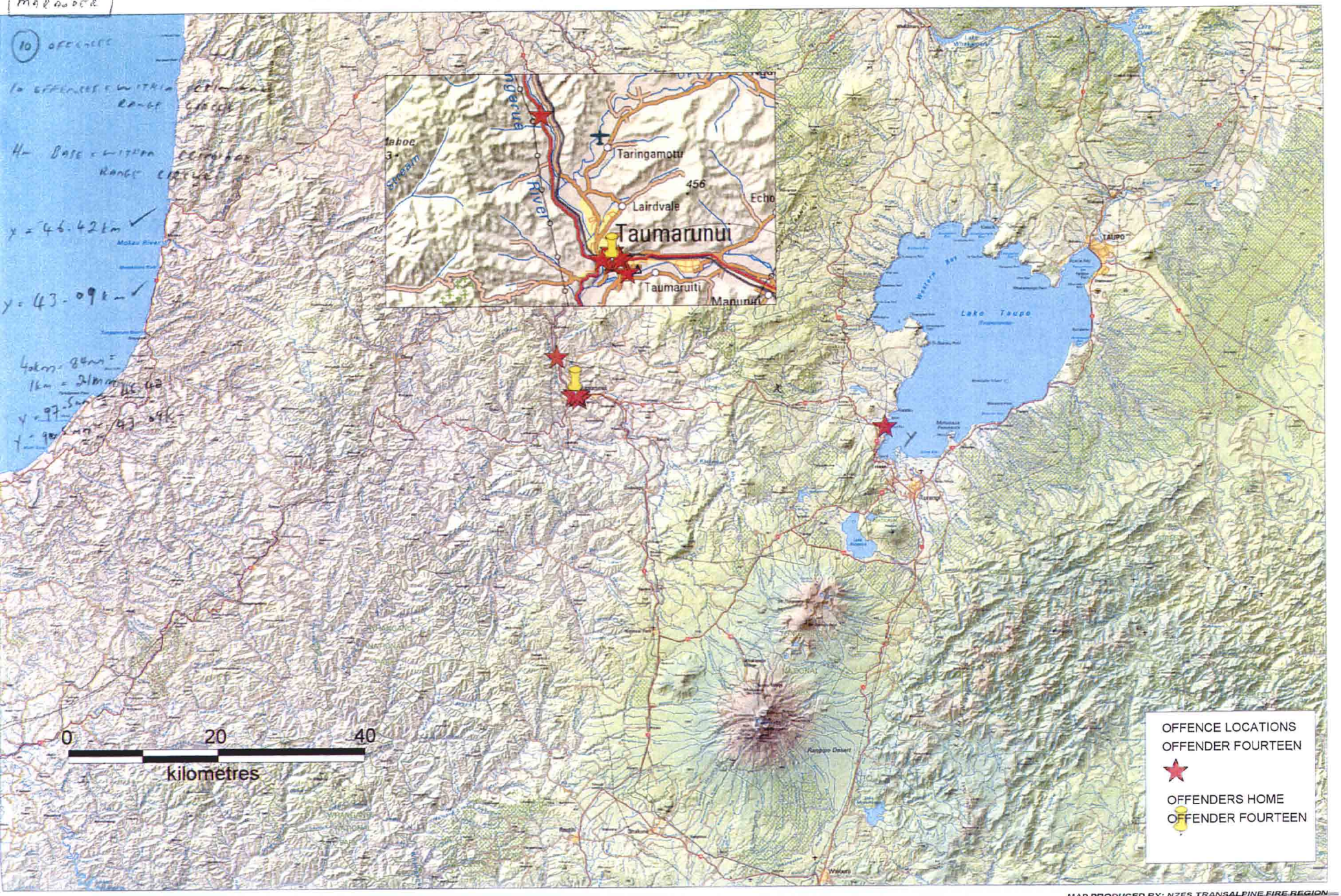
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWELVE'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTEEN'S HOME

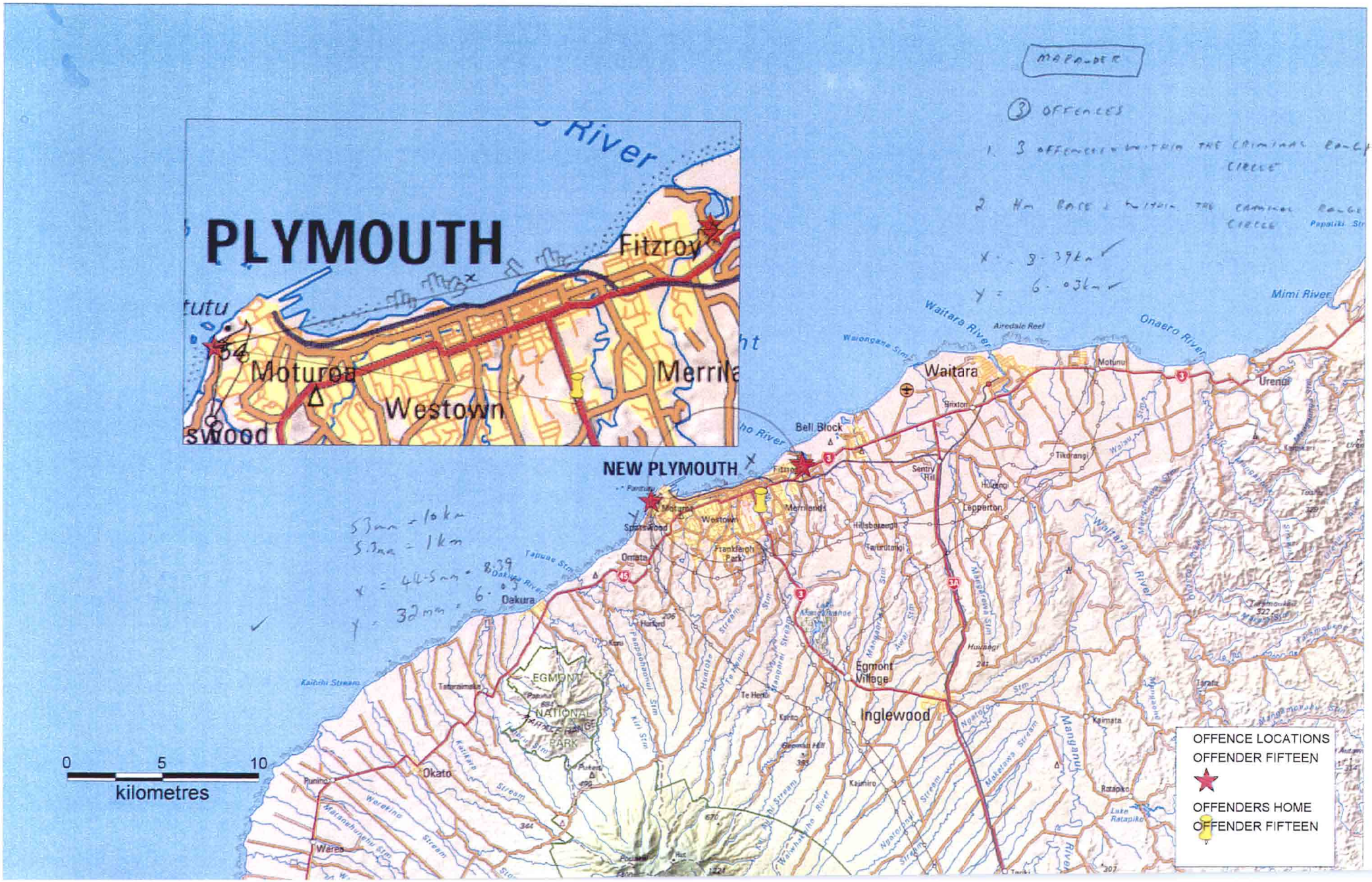
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FOURTEENS HOME



MAP PRODUCED BY: NZFS TRANSALPINE FIRE REGION

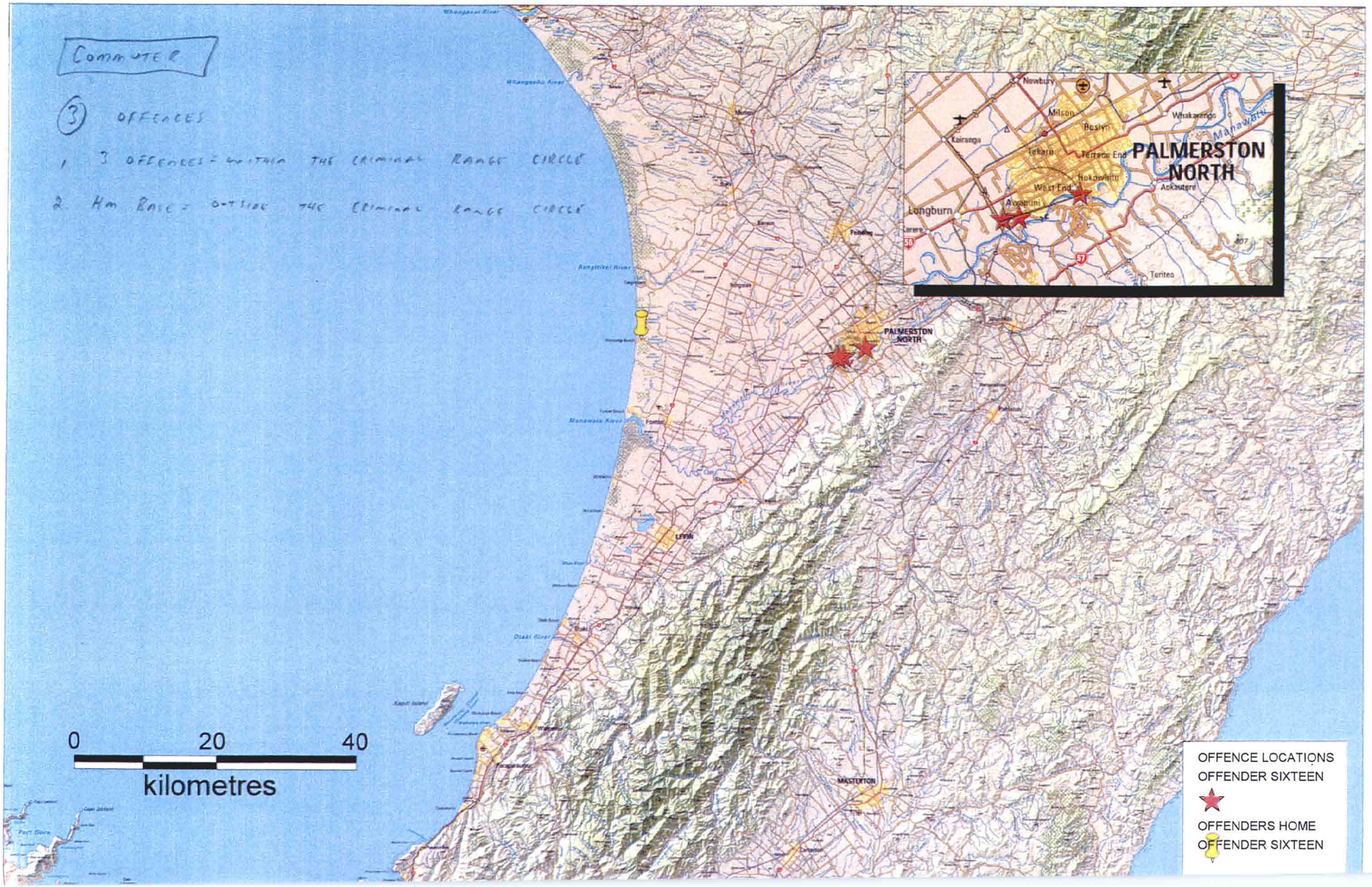
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FIFTEENS HOME



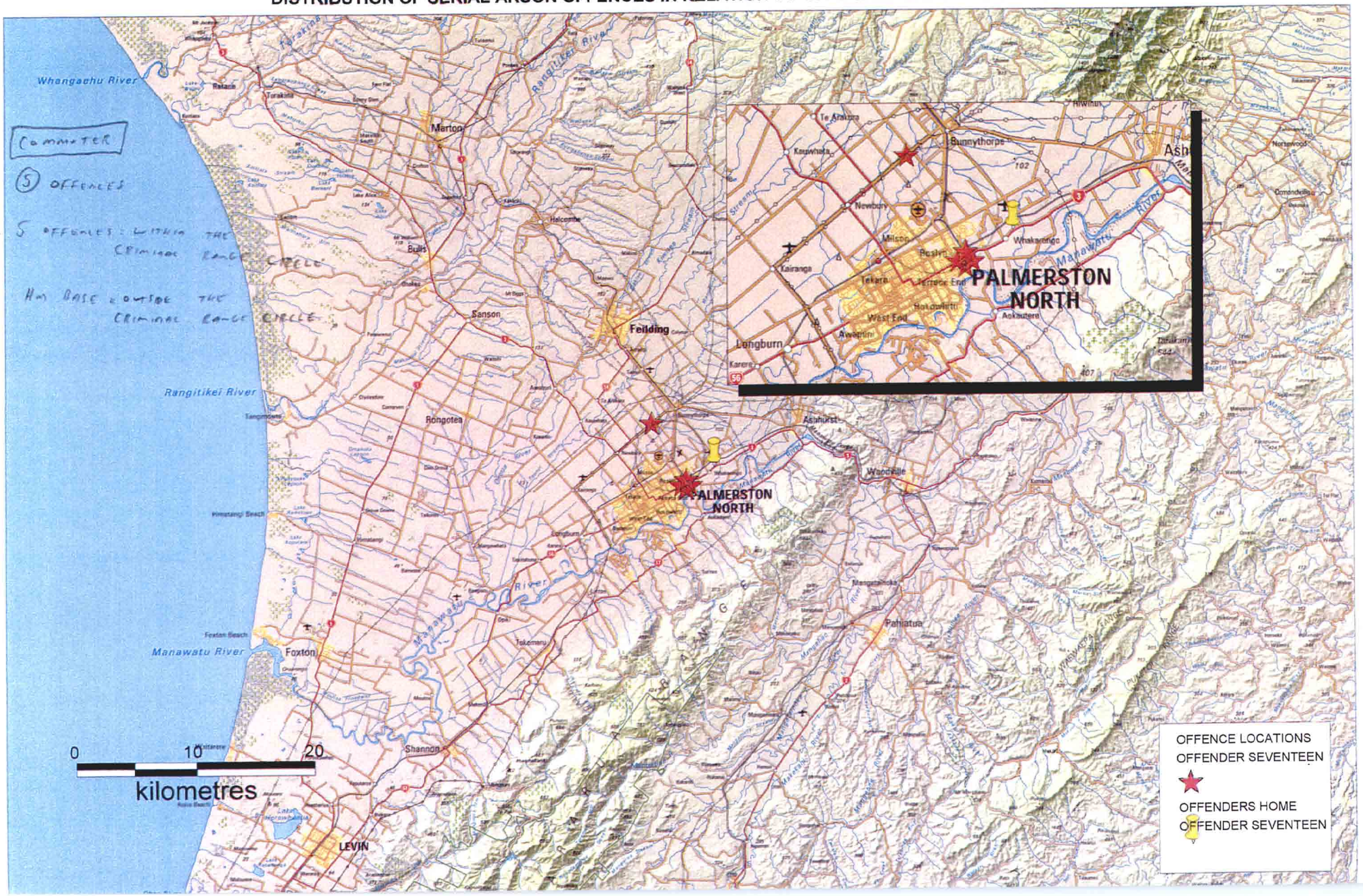
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER SIXTEENS HOME



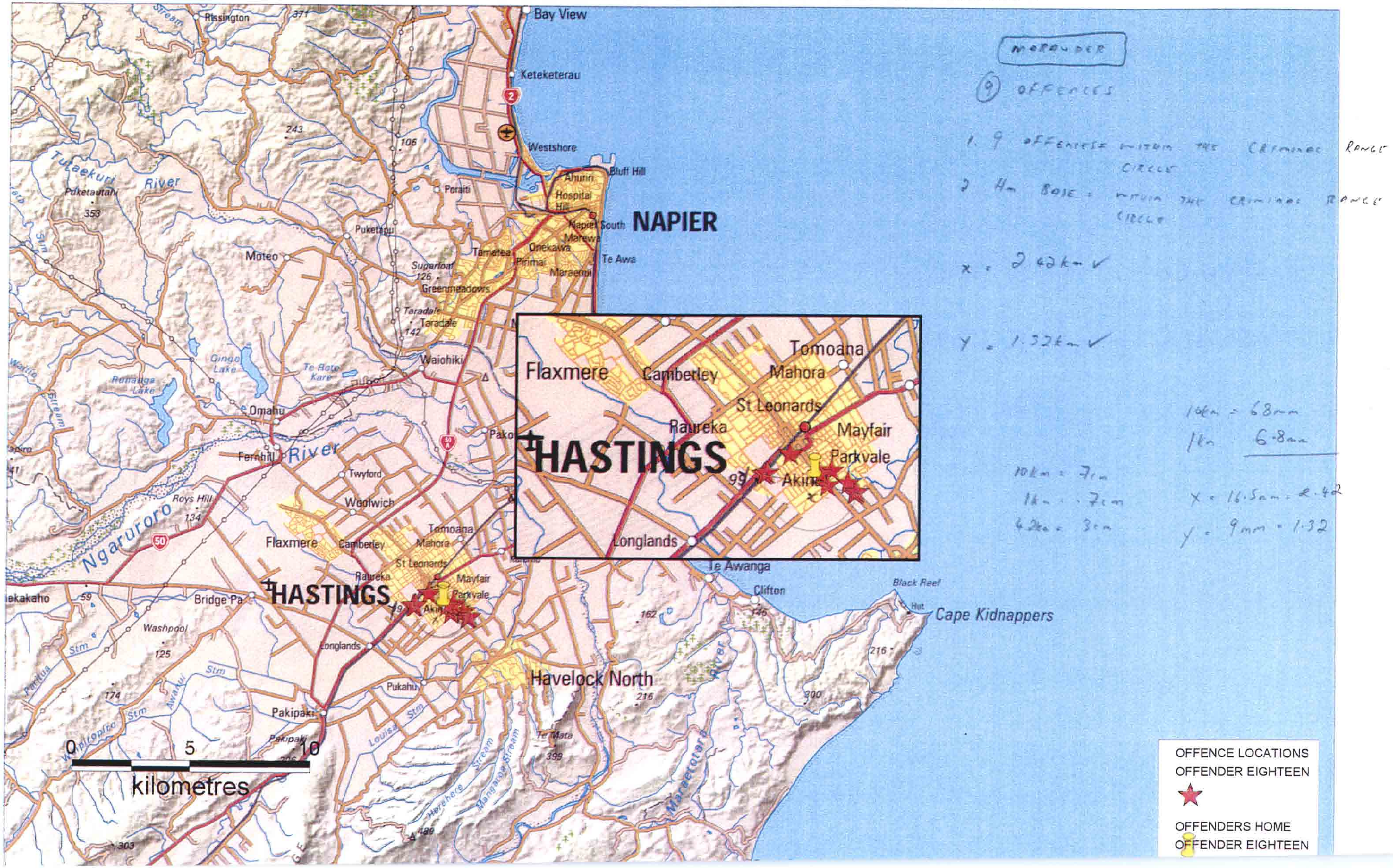
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER SEVENTEENS HOME



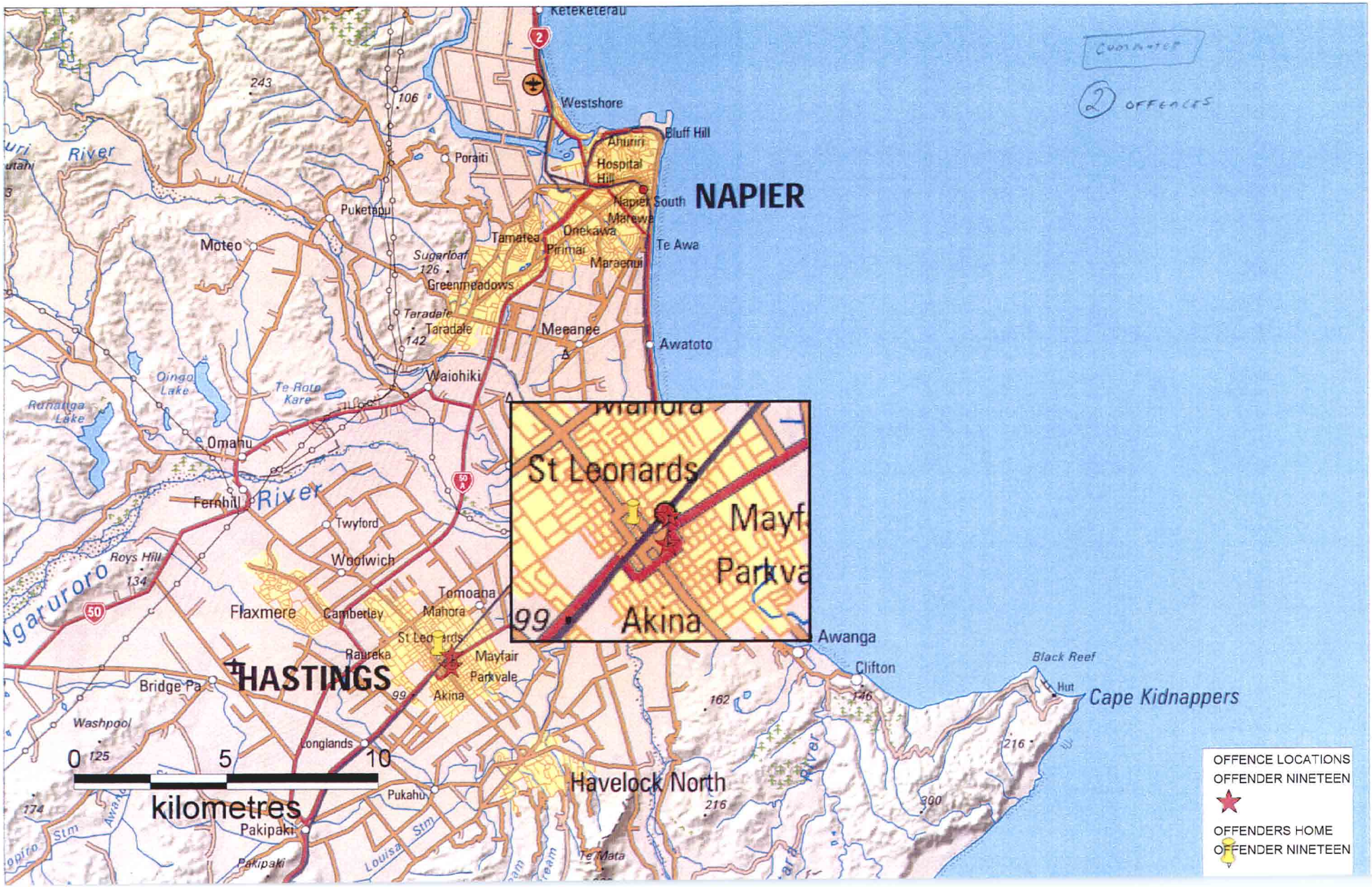
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER EIGHTEENS HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER NINETEENS HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY'S HOME

MARAUDER

(9) OFFENCES

19 OFFENCES WITHIN THE CRIMINAL RANGER CIRCLE

24m BASE : WITHIN THE CRIMINAL RANGER CIRCLE

10km = 67.5mm
1km = 6.75mm
x = 20.5mm = 3.03km
y = 20mm = 2.96km

x = 3.03km ✓

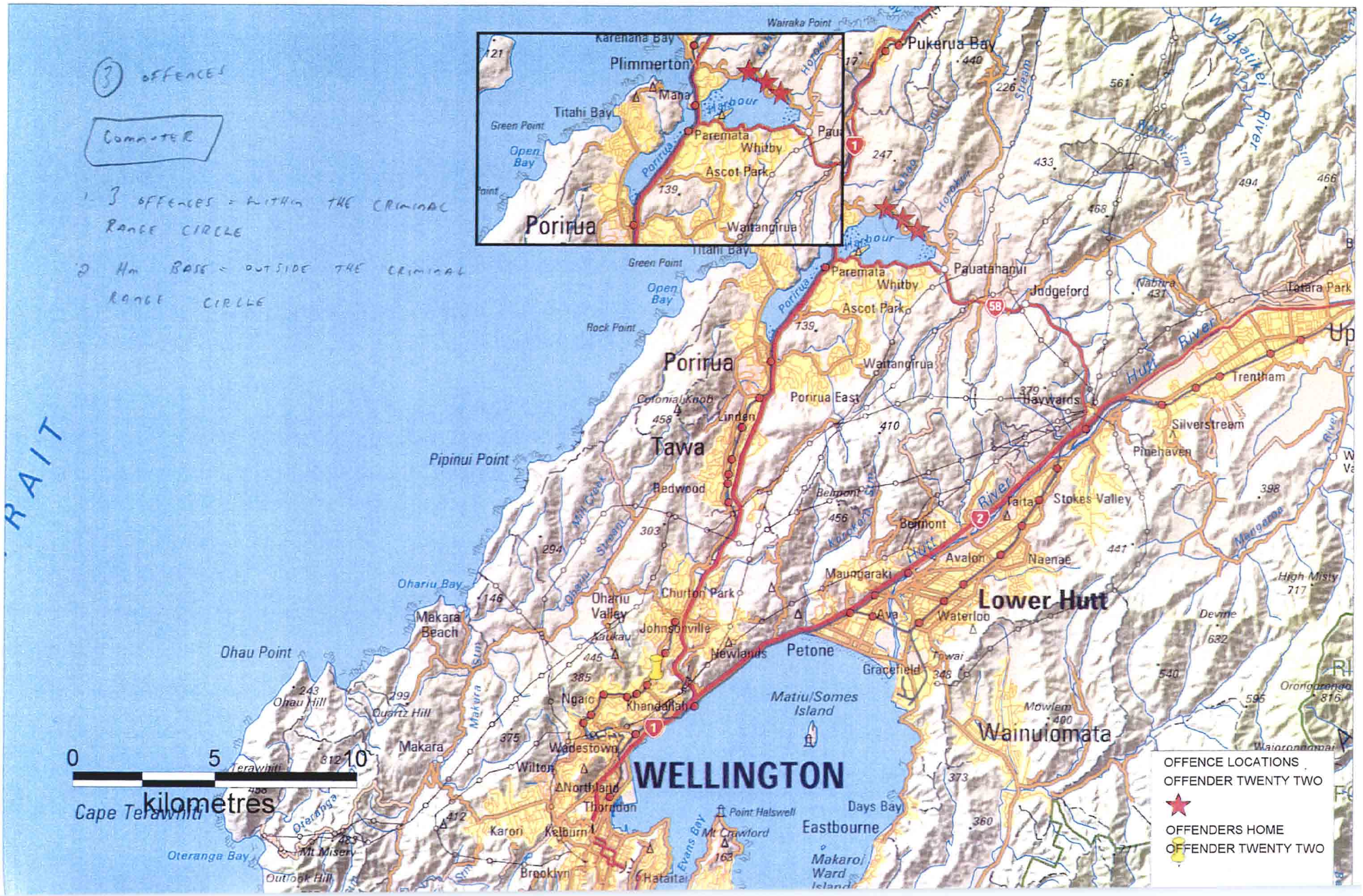
y = 2.96km ✓

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY ONE'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY TWO'S HOME

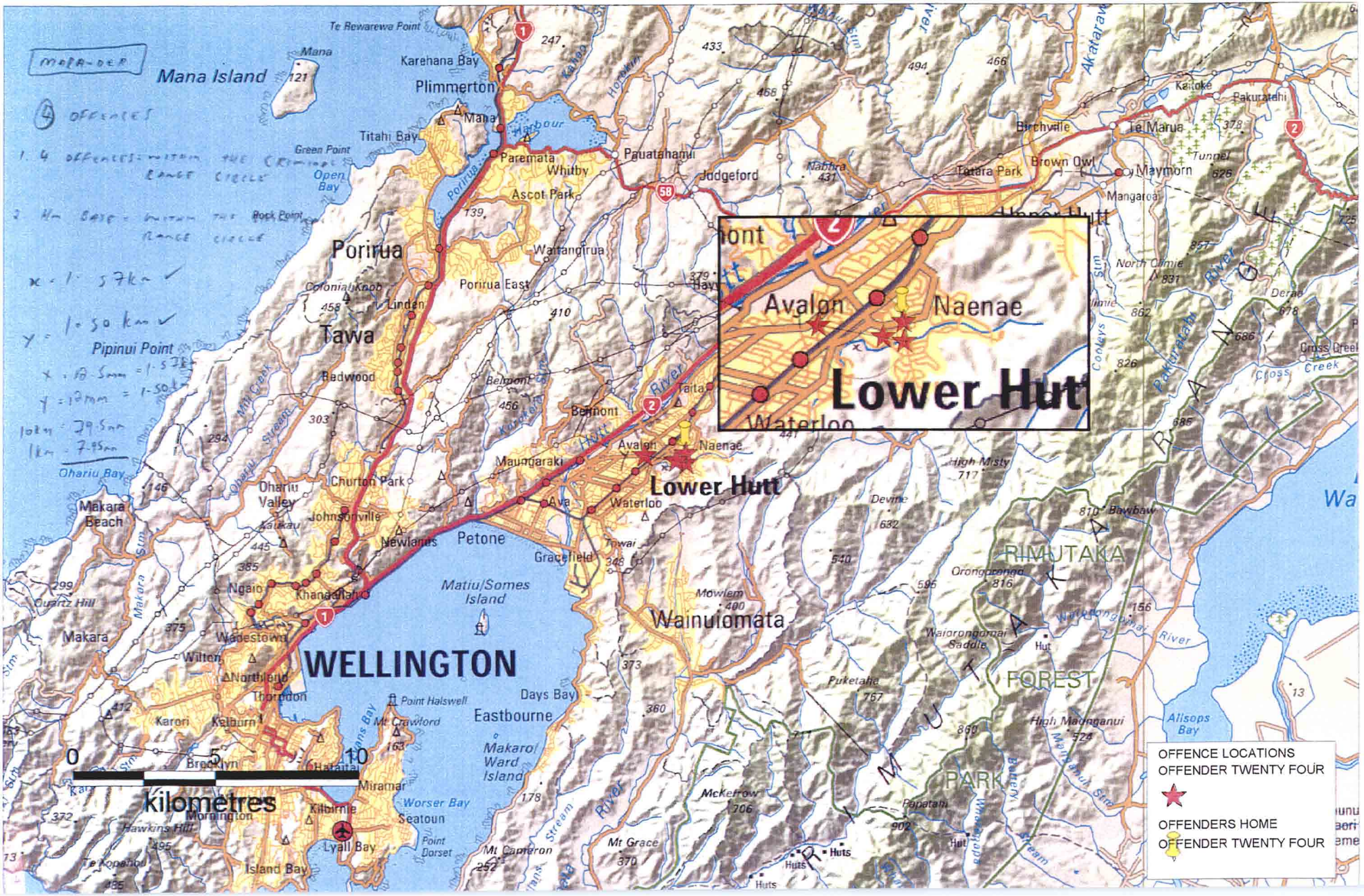


ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY THREE'S HOME

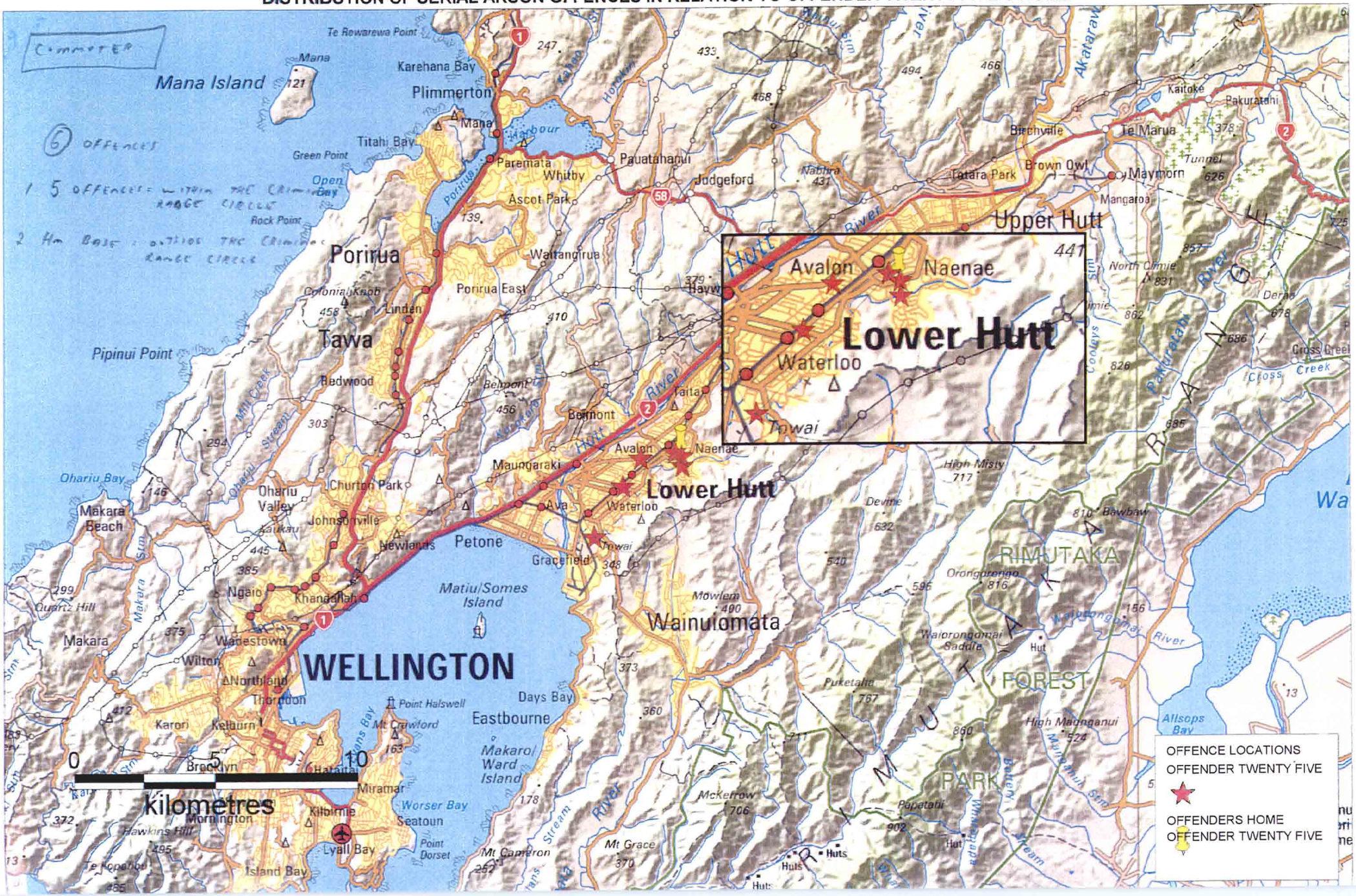
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY FOUR'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY FIVE'S HOME

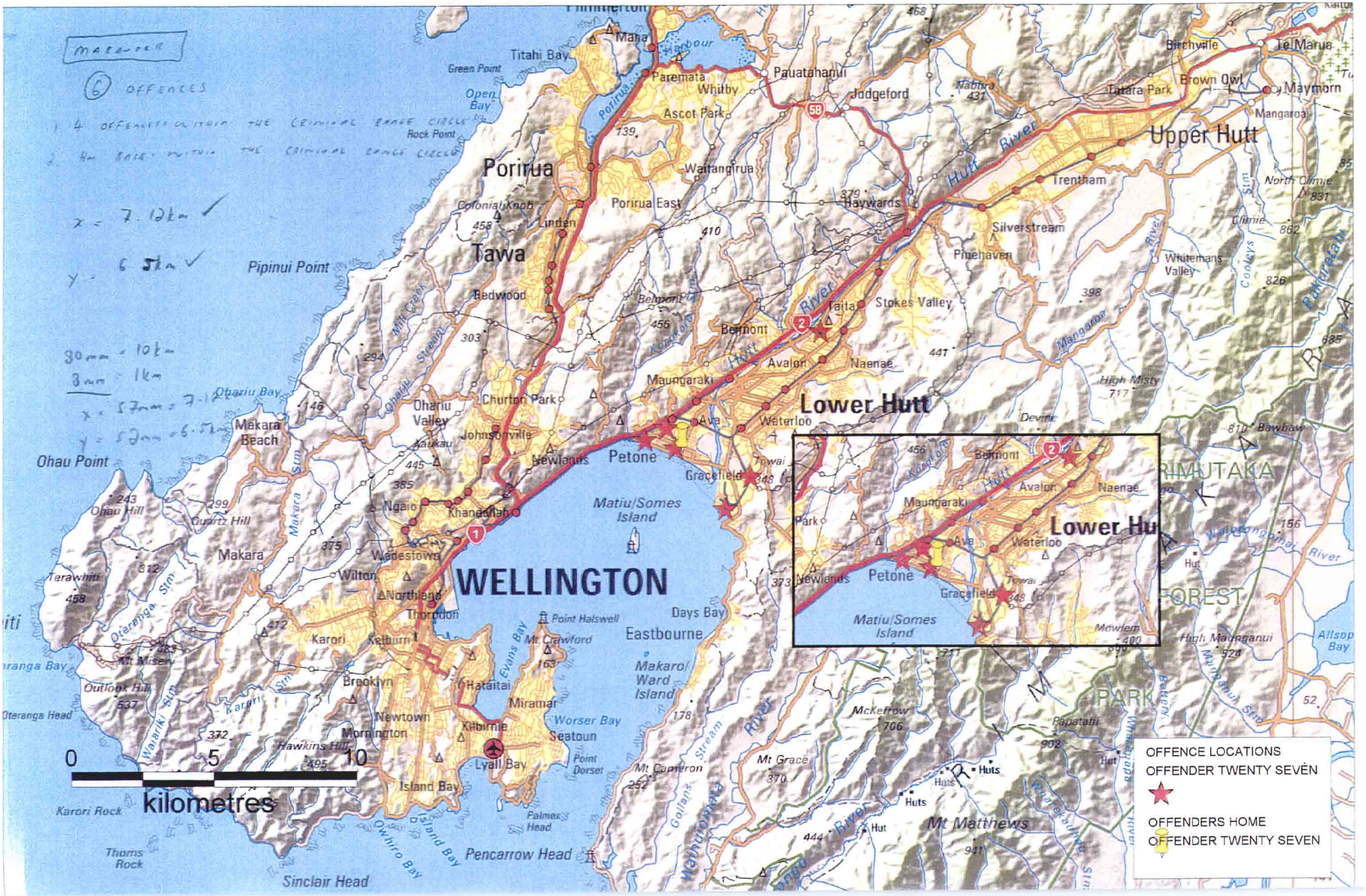


ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY SIX'S HOME

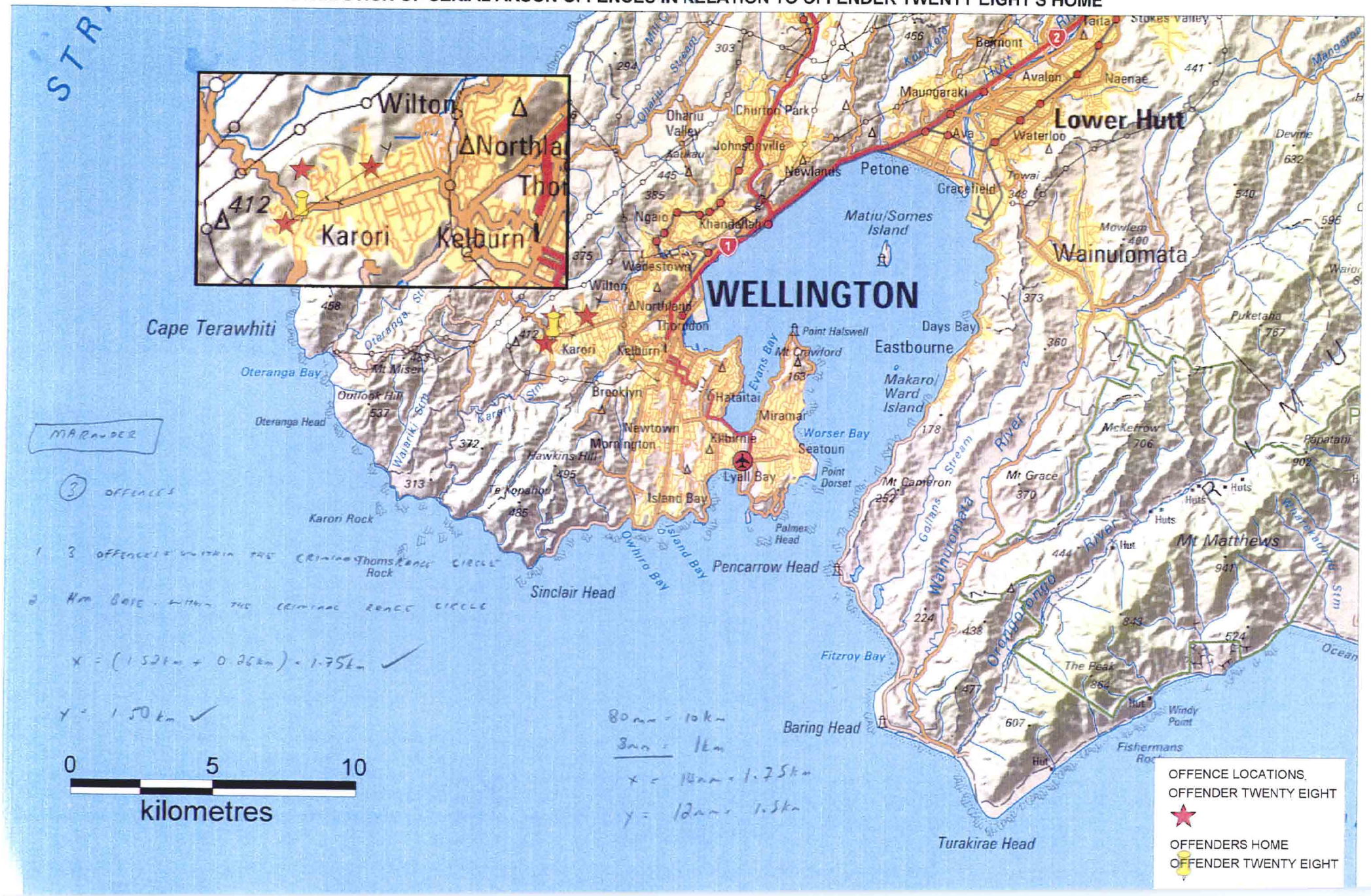
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY SEVEN'S HOME



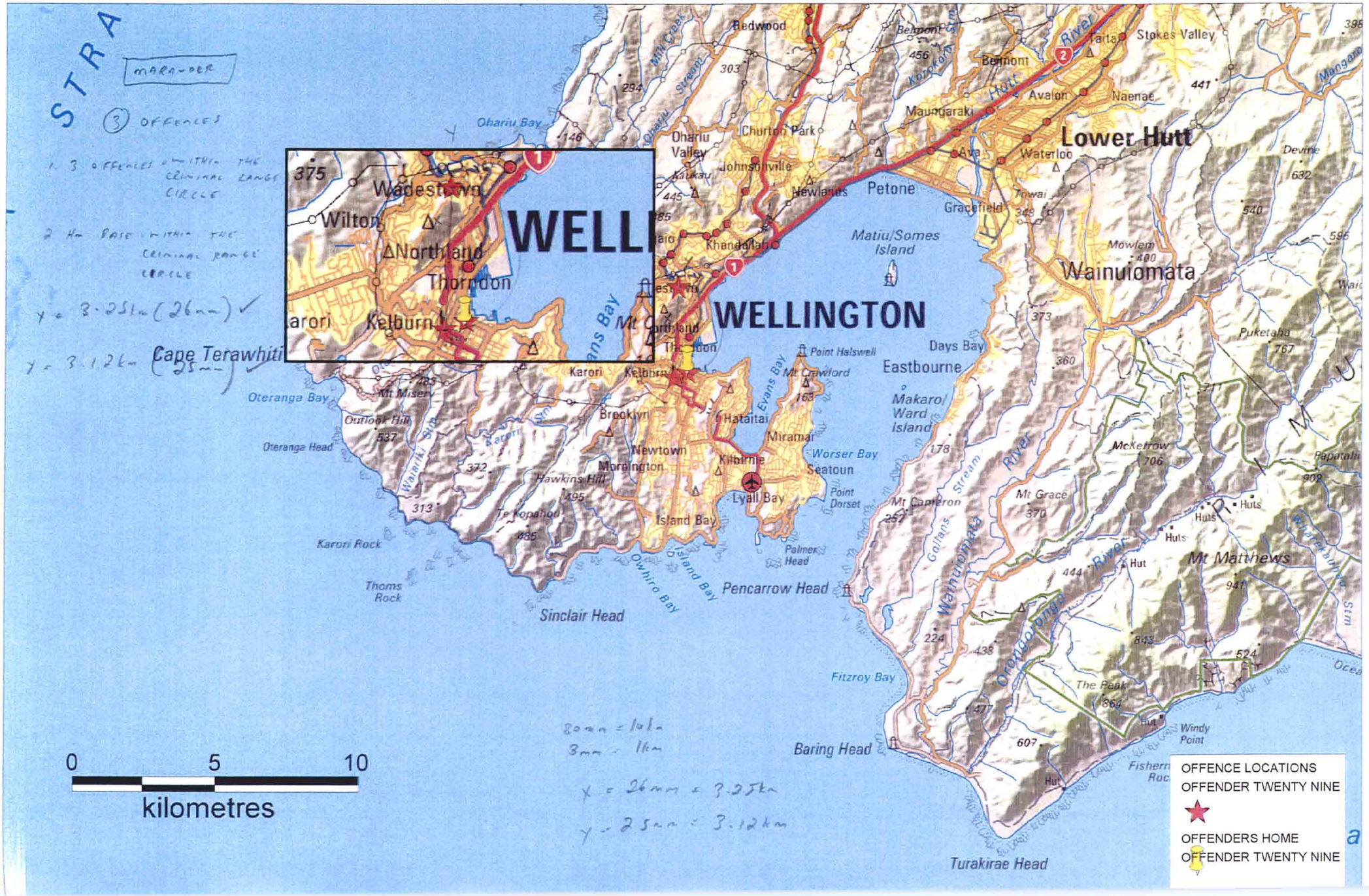
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY EIGHT'S HOME



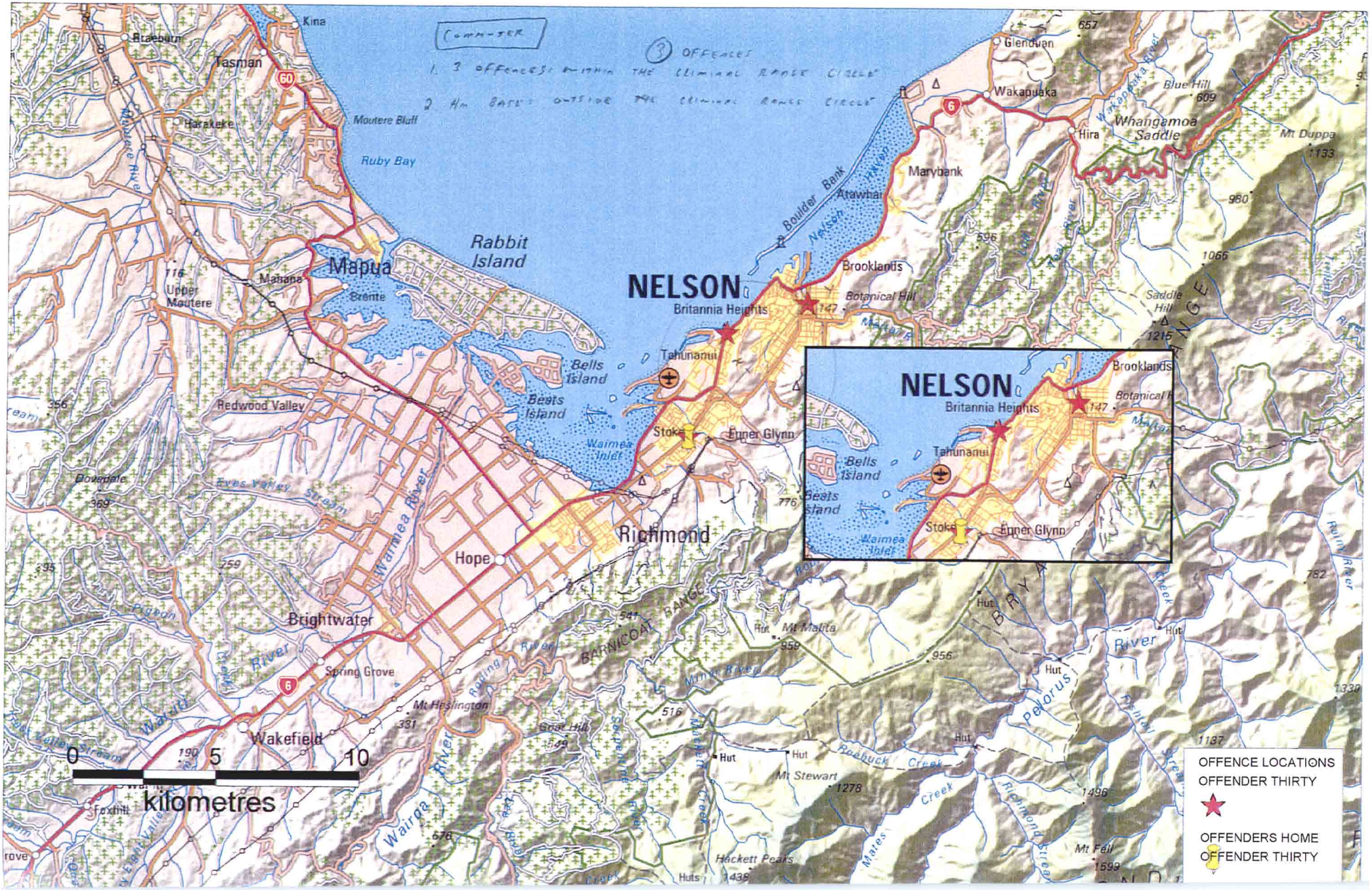
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER TWENTY NINE'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

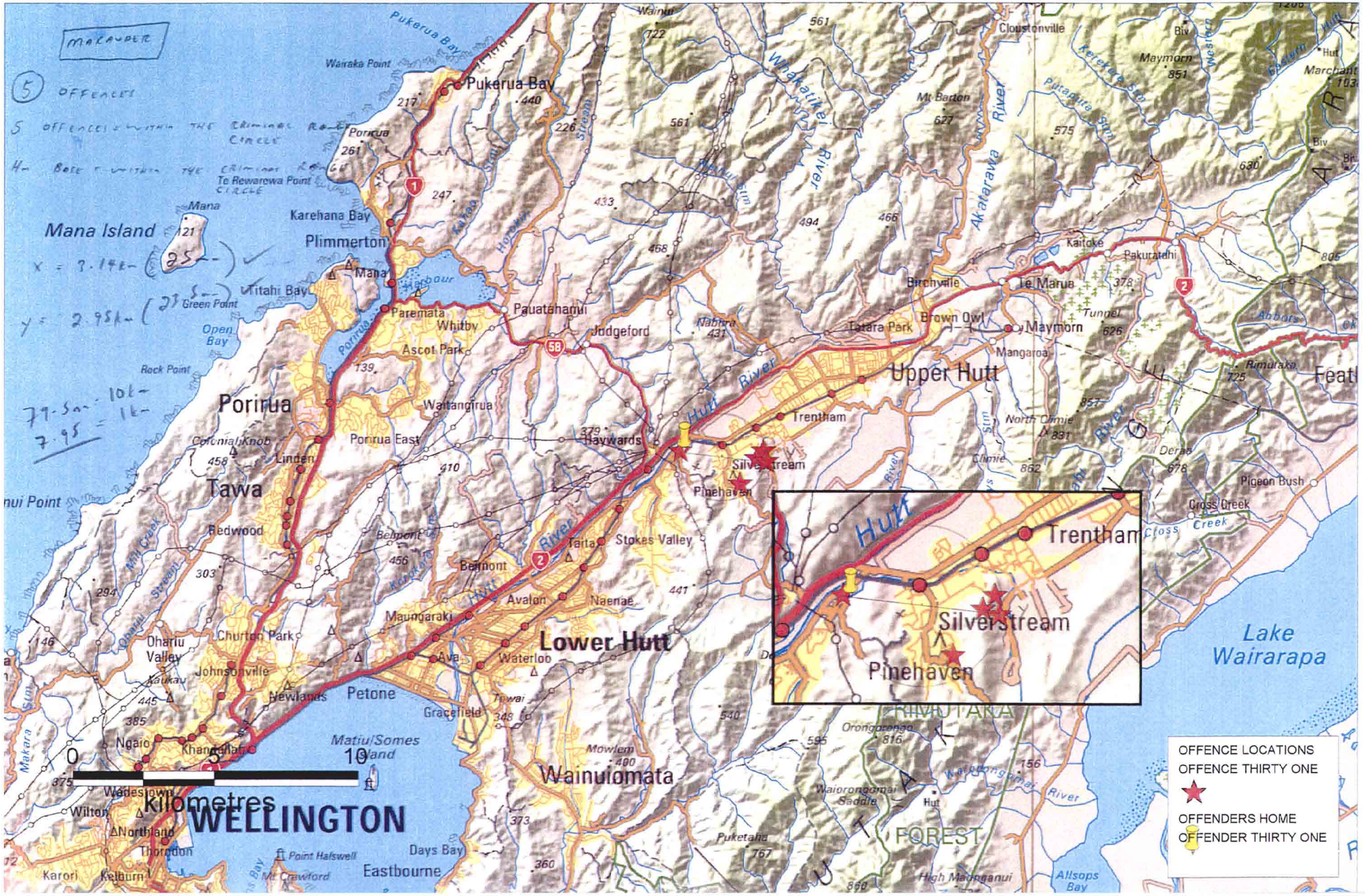
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

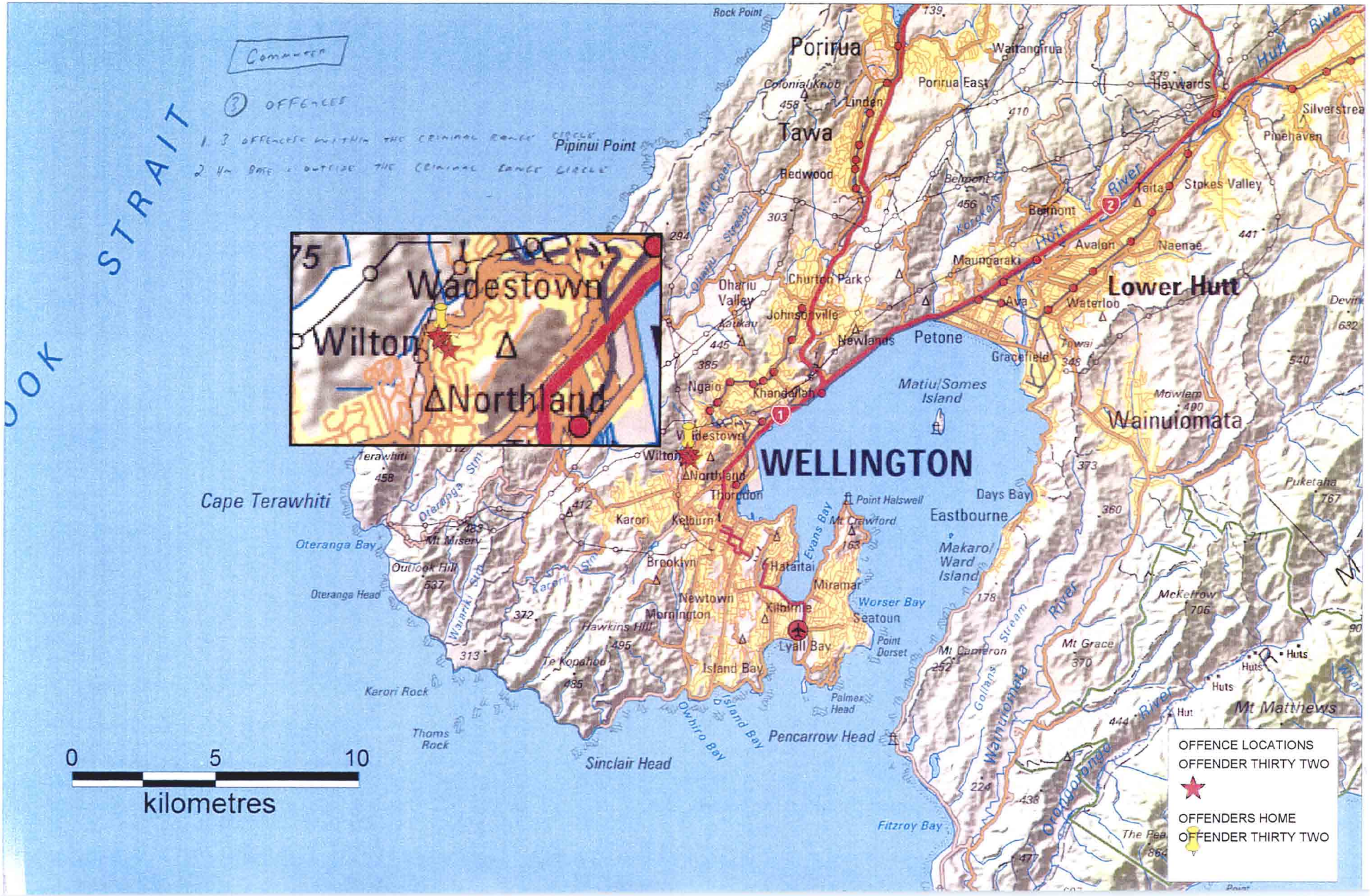
ARPEST - 2000 - 2001

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY ONE'S HOME



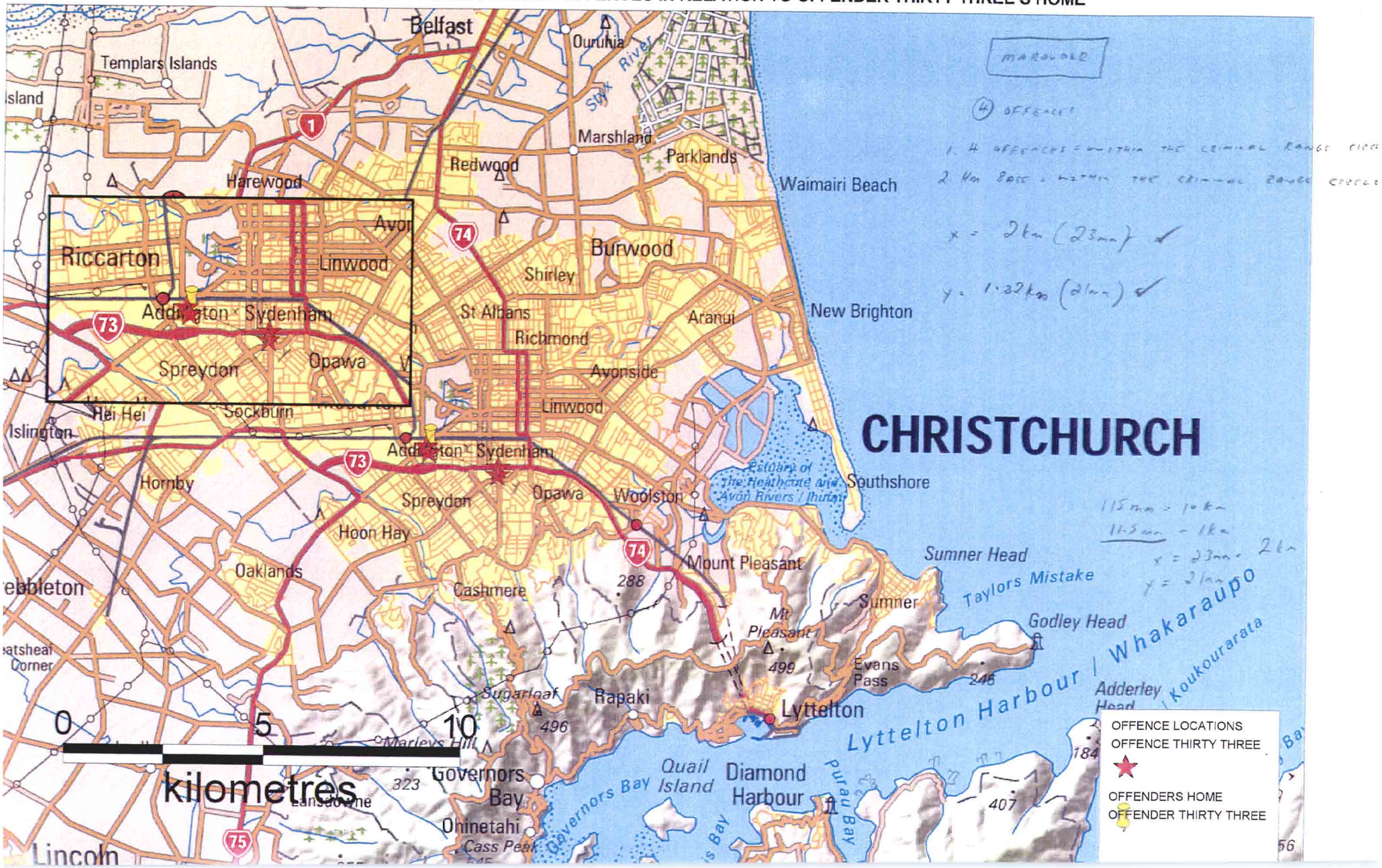
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY TWO'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY THREE'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

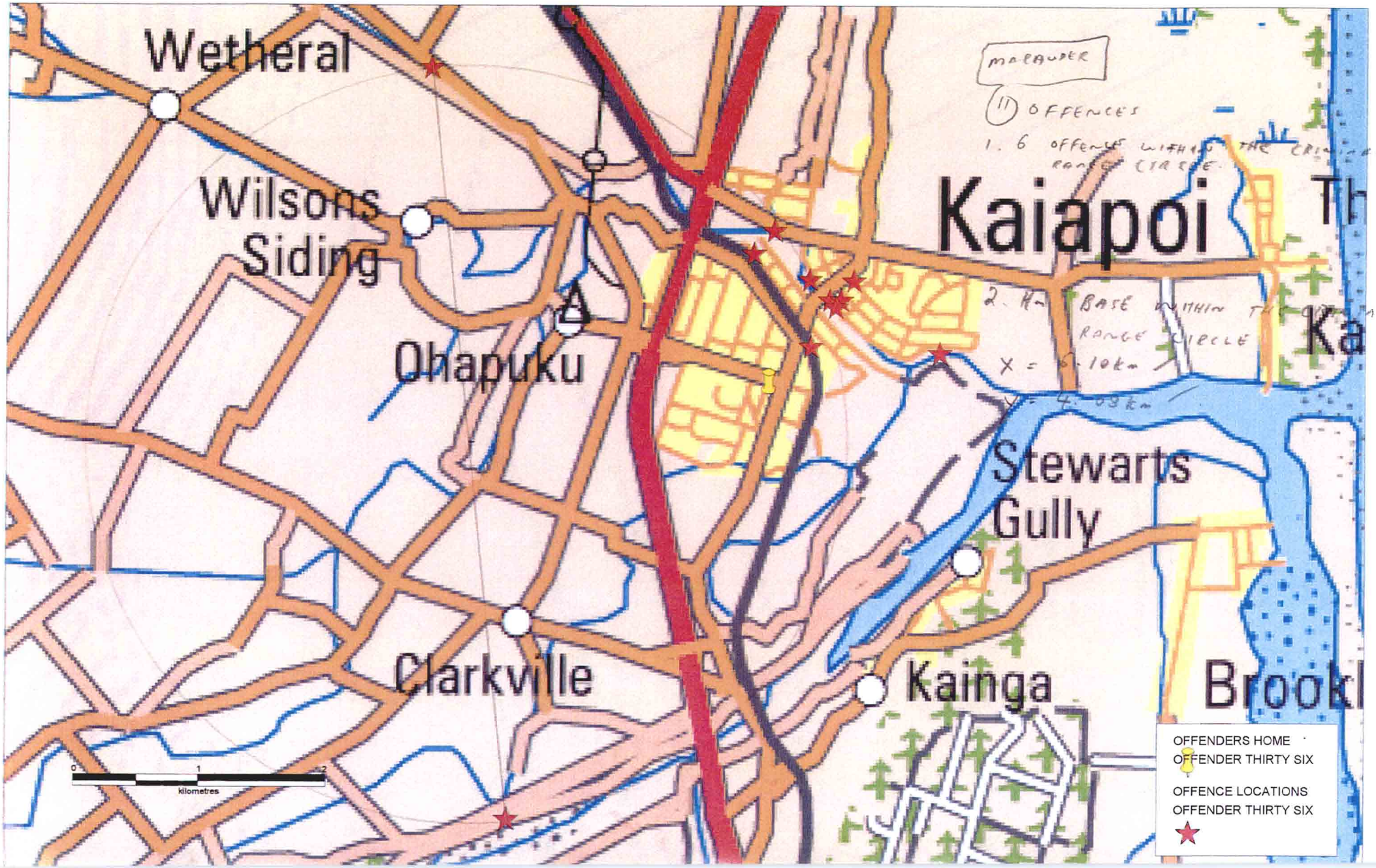
DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY FOUR'S HOME

ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY FIVE'S HOME

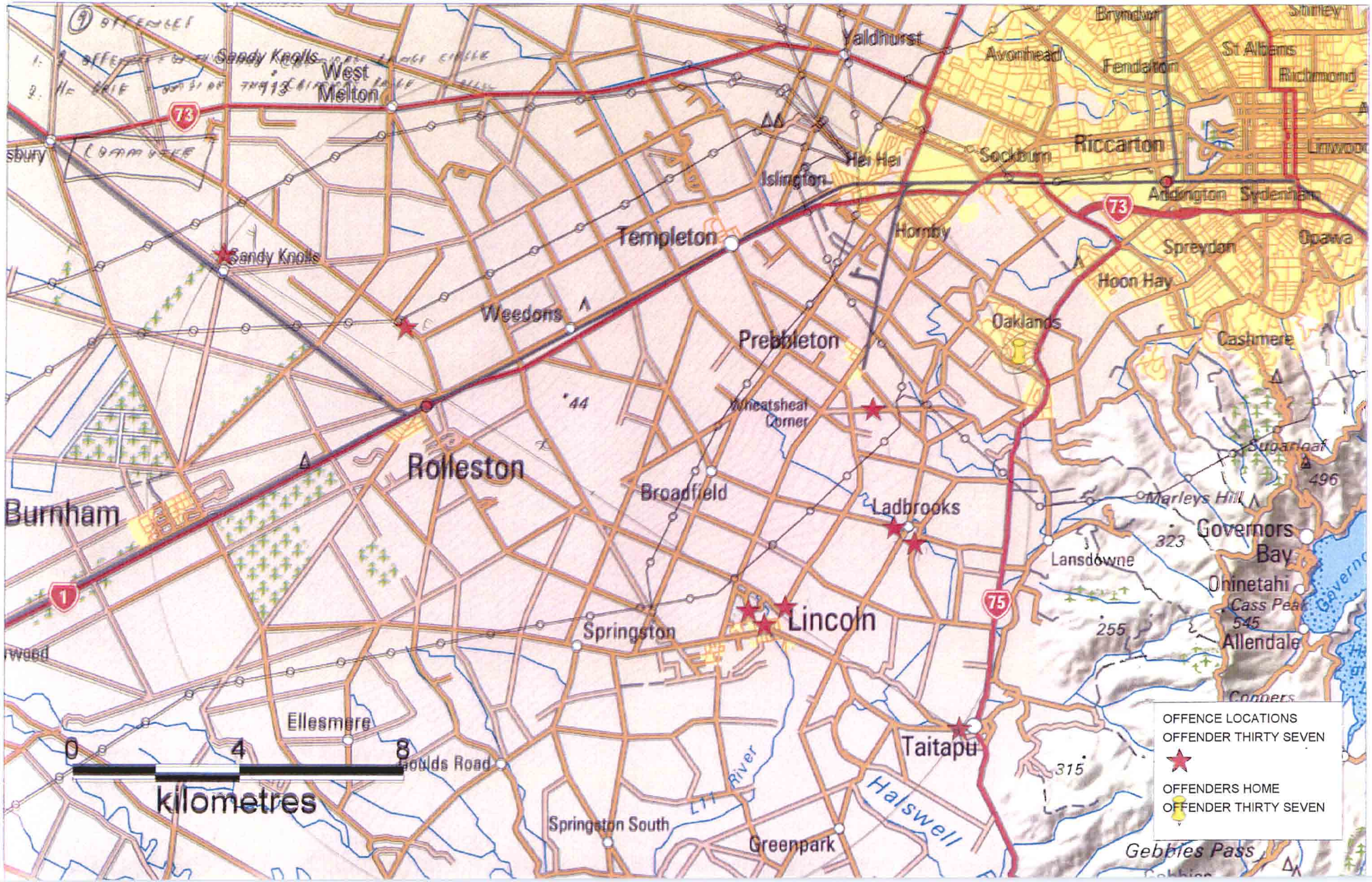
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY SIX'S HOME



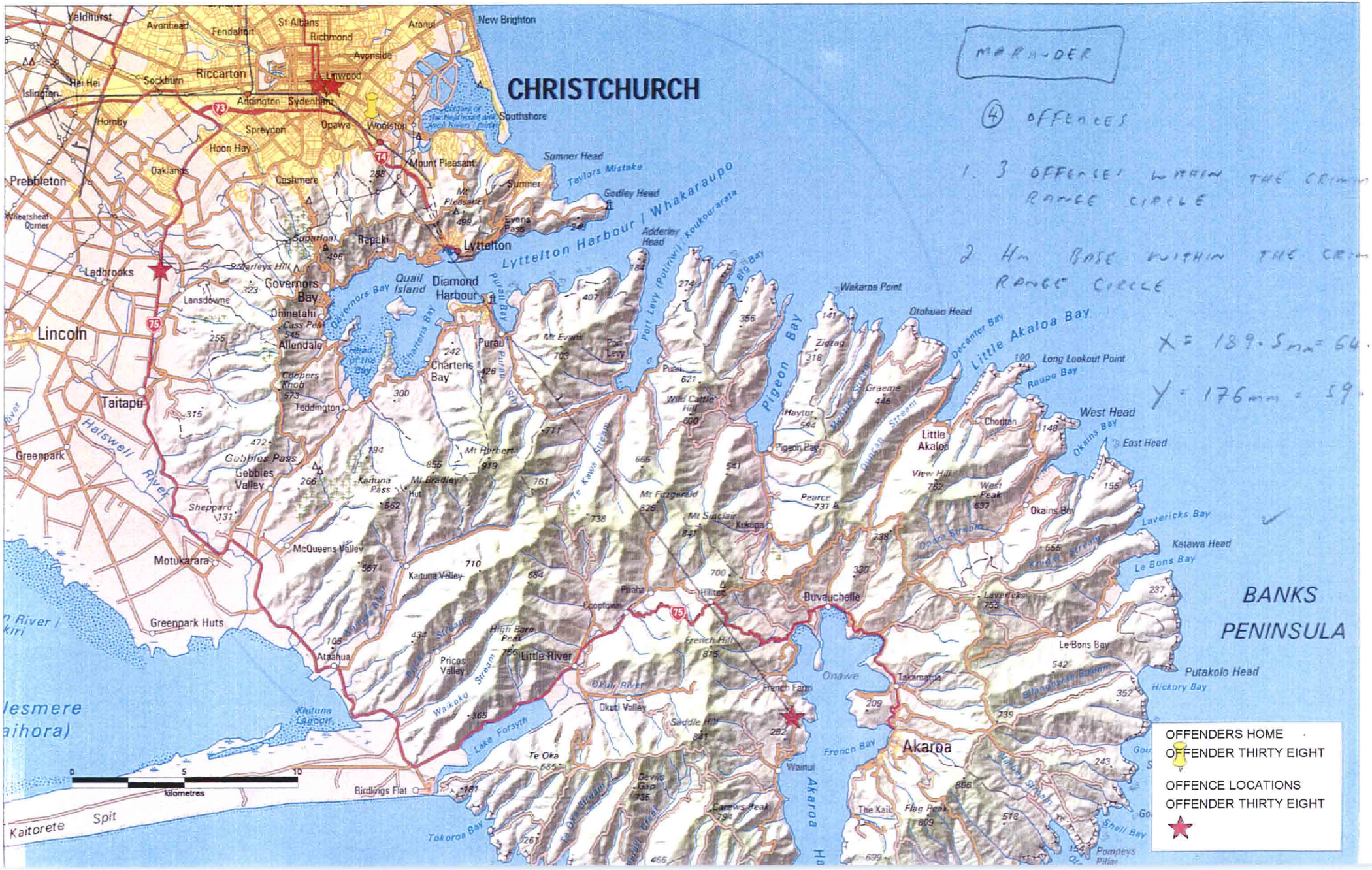
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY SEVEN'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY EIGHT'S HOME

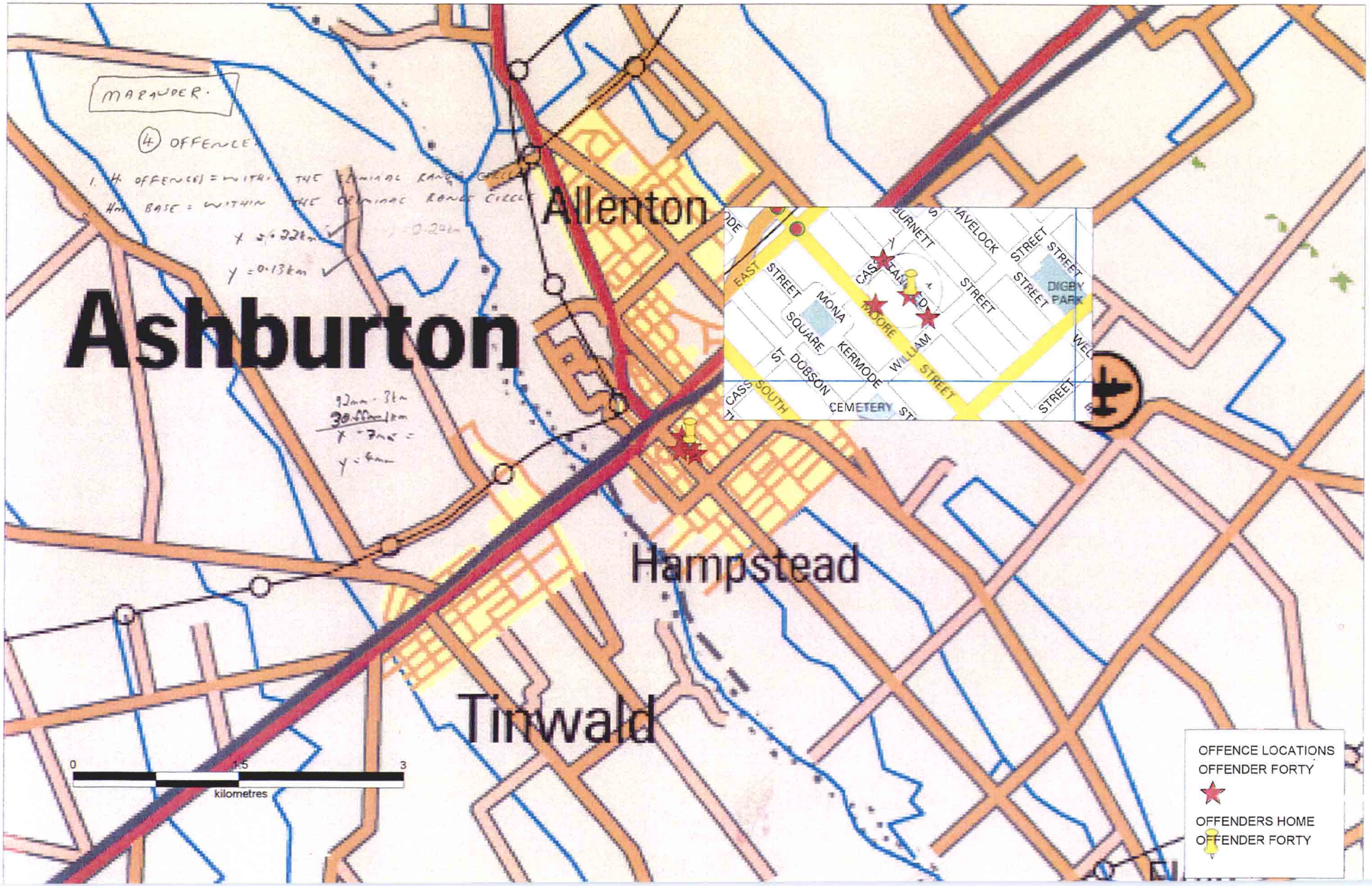


ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER THIRTY NINE'S HOME

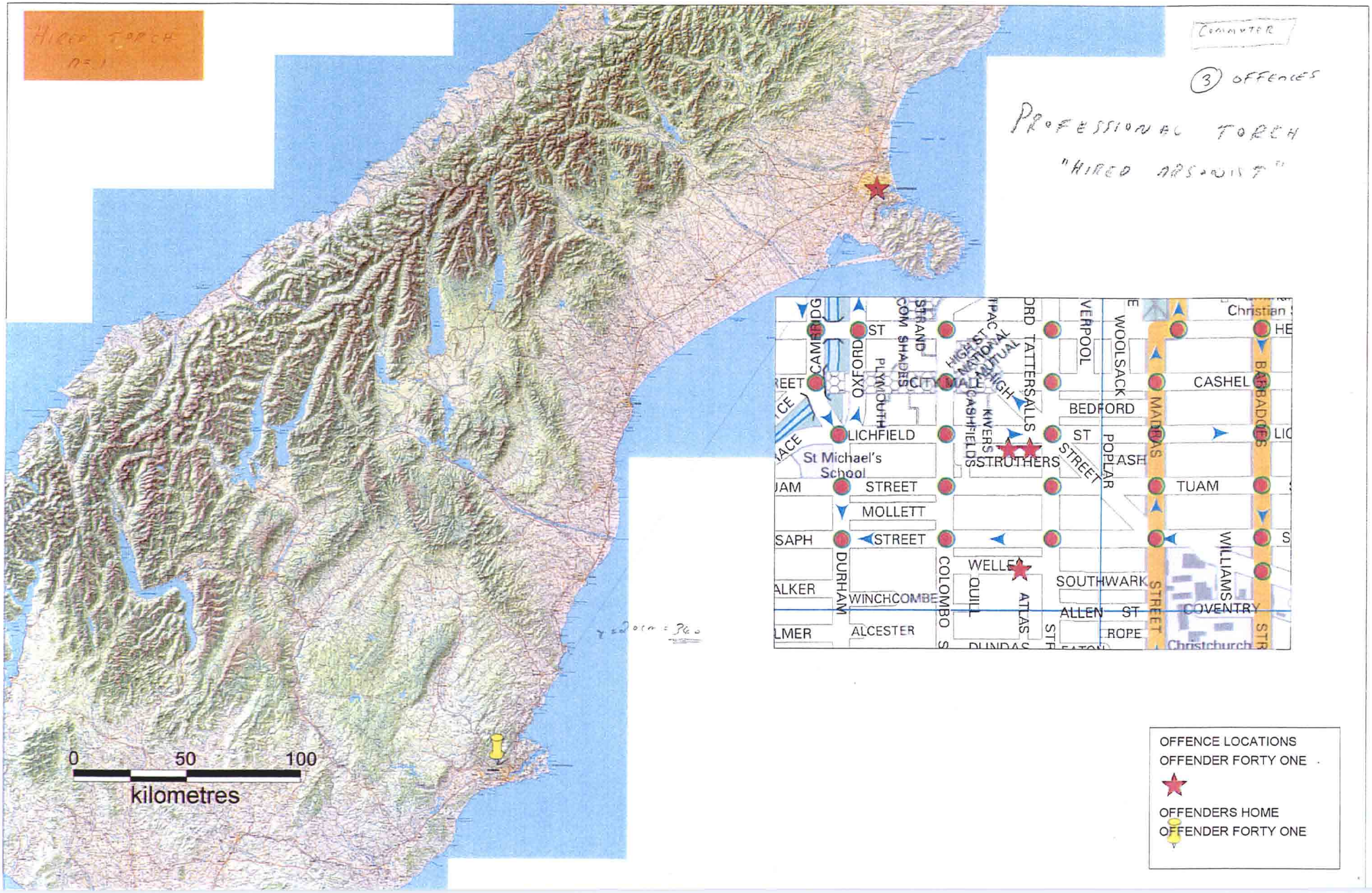
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY ONE'S HOME

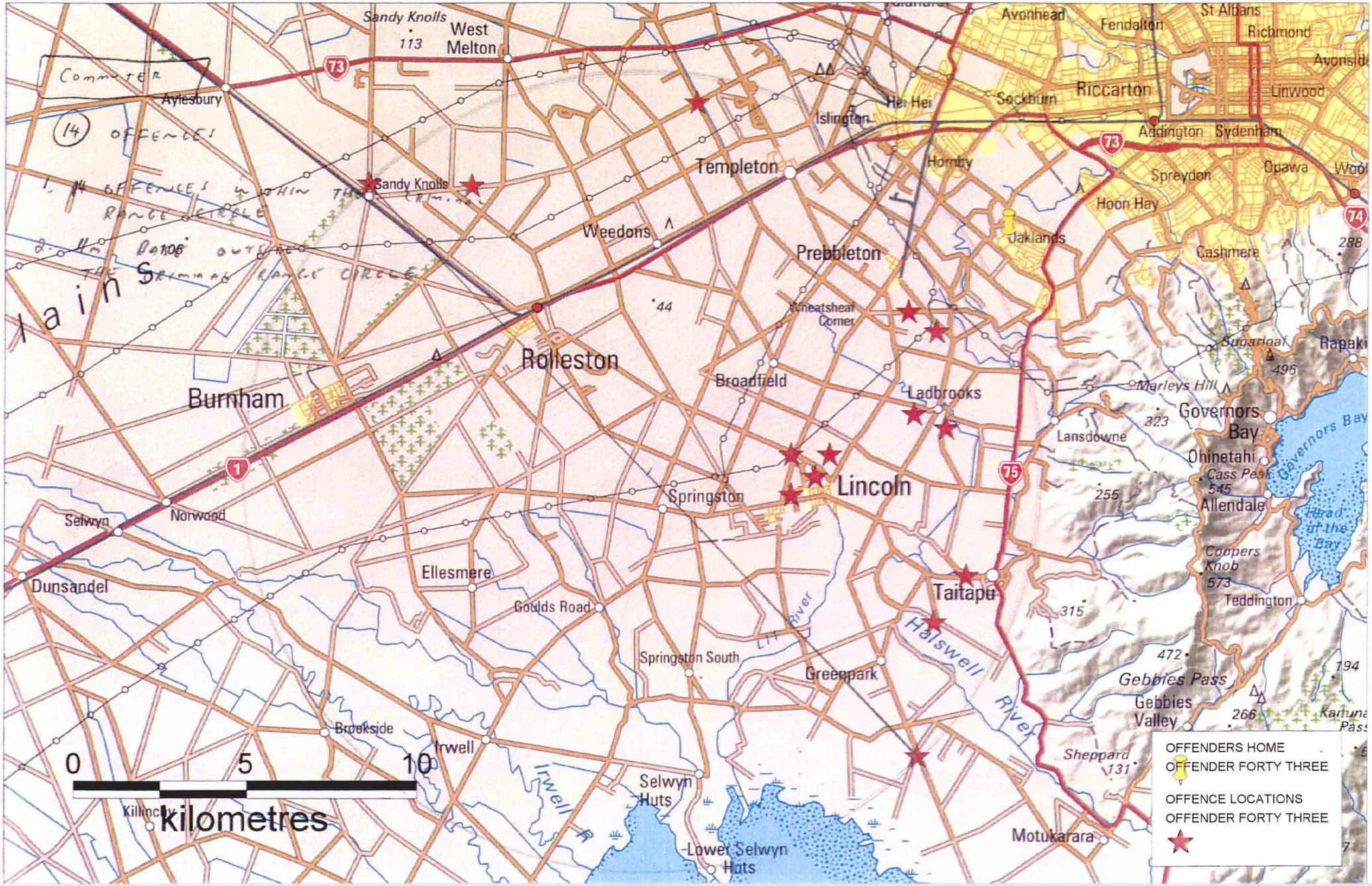


ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY TWO'S HOME

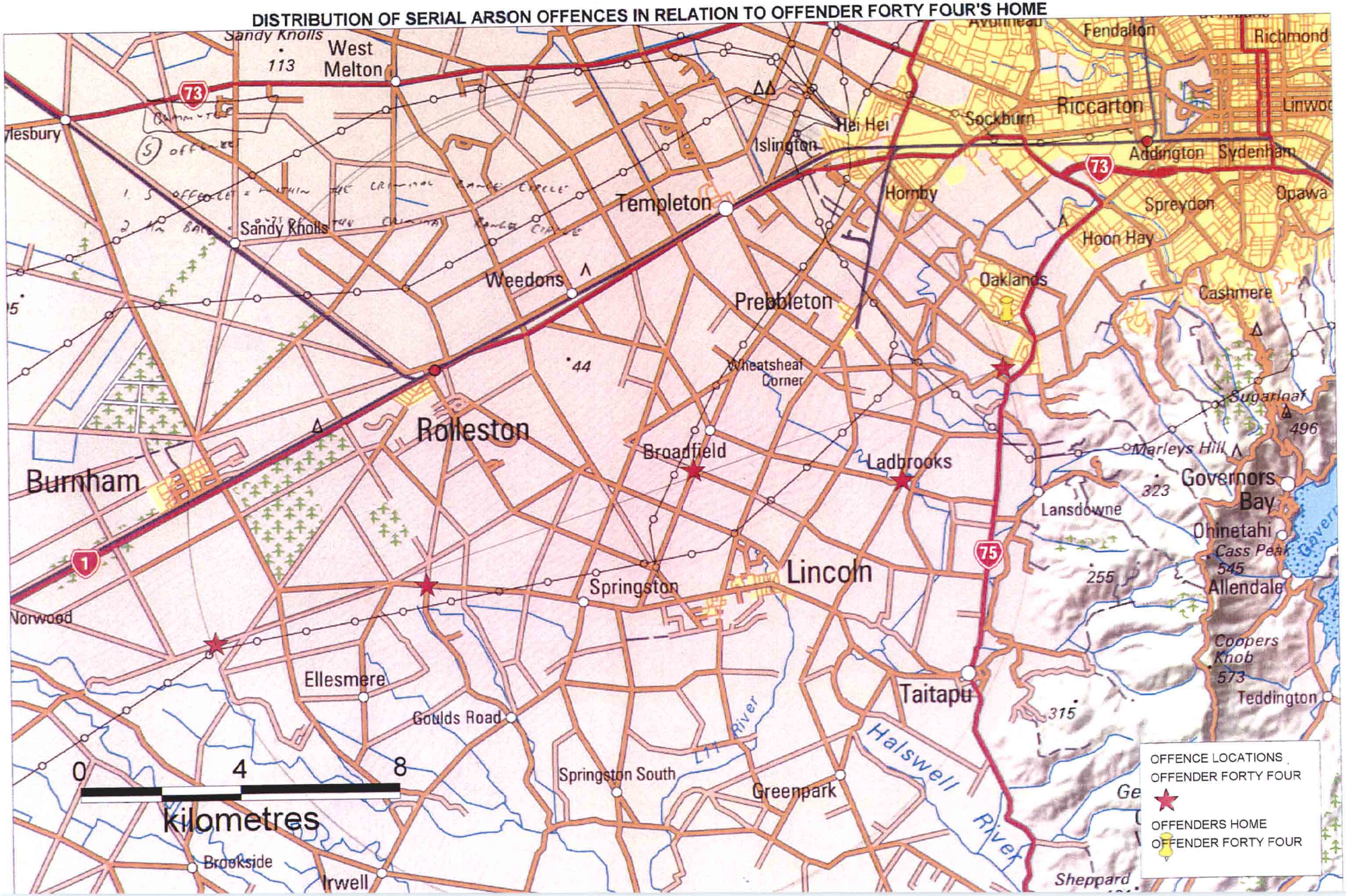
ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY THREE'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY FOUR'S HOME



ANALYSING SPATIAL PATTERNS OF CONVICTED SERIAL ARSONISTS

DISTRIBUTION OF SERIAL ARSON OFFENCES IN RELATION TO OFFENDER FORTY FIVE'S HOME