A Report on the Utility of the Automated Licence Plate Recognition System in British Columbia

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Introduction

With the high rate of auto theft in British Columbia and the general risk to the public from unlicenced, prohibited, or uninsured drivers, the RCMP, other municipal police forces, and the Insurance Corporation of British Columbia continue to develop and test a myriad of strategies to keep citizens safe. One such strategy is the deployment of Automated Licence Plate Recognition (ALPR) technology.

Over the last decade, British Columbia has had the reputation of being a world leader in auto thefts per capita. In 2003, 40,000 cars and trucks were stolen in British Columbia, with 30,000 of these stolen from within the Greater Vancouver Regional District (Schuurman, 2007). More specifically, until very recently, the city of Surrey, British Columbia, was known as the auto theft capital of the world (Schuurman, 2007). In 2005 alone, the city of Surrey experienced nearly 6,500 auto thefts (Schuurman, 2007). As part of a more general response to auto theft, in 2006, IMPACT (Integrated Municipal Provincial Auto Crime Team) began to examine the utility and feasibility of ALPR. The current study will discuss the results of the initial phase of the testing of this technology and its effectiveness in assisting police to respond to auto theft and other auto-related offences.

ALPR technology uses illumination to highlight a licence plate, allowing a camera to take a photograph of the car's licence plate. The plate image is then scanned by image-processing software which extracts the necessary data and compares the data against any number of police databases (Gordon and Wolf, 2007). ALPR software is a form of Optical Character Recognition which scans images and recognizes the characters present (Gordon and Wolf, 2007). Theoretically, ALPR can scan up to 3,600 plates per hour, either from a moving or stationary platform (Pughe, 2006). The technology can work in all lighting and weather conditions. ALPR was originally designed for use with parking lot security to regulate, for example, entry to the location or to record time of entry (Gordon and Wolf, 2007). However, current technology allows the licence plate to be compared with information stored on a variety of databases, such as stolen car hotlists or prohibited driver databases.

While currently in use in British Columbia to identify stolen vehicles and unlicenced, uninsured, and/or prohibited drivers, ALPR can also assist the police to identify persons of interest associated with other criminal activity. According to a recent article (Canada NewsWire, 2007), auto theft is associated with a wide range of criminal activity, including the offences of break and enter, armed robbery, and drug-related offences. In other words, offenders steal cars for use in the commission of additional offences. For example, drug offenders may steal from within cars, but may also steal the car to raise money to purchase drugs (Schuurman, 2007). Those engaged in break and enters may steal cars to transport the stolen property. Given this, ALPR may have the benefit of assisting the police to uncover other crimes in the course of investigating prohibited, unlicenced, or uninsured drivers. As such, ALPR has the capacity to deter criminal activity, assist in locating offenders, and recover stolen property.

The ability of ALPR to assist in these critical police functions is based on research suggesting that those who consistently violate traffic regulations often have a criminal history (Rose, 2000). For example, Chenery, Henshaw, and Pease (1999) found that one-third of people who illegally parked in disabled parking spots had a previous criminal record, nearly half (49 per cent) had a history of traffic violations, and one-fifth (21 per cent) were of immediate police interest or were known or suspected of having involvement with other criminal activities (18 per cent). In this study, registered keepers of vehicles who were of immediate interest to the police, who had a criminal record, whose vehicle had a history of traffic violations, whose vehicle had been used in the past for criminal activity, or who had a current vehicle illegality were all significantly more likely to be parked illegally than legally (Chenery, Henshaw, & Pease, 1999). This research suggests that ALPR can assist police beyond catching traffic violators by providing an additional tool to identify those individuals who are wanted by the police.

The literature on ALPR is, to date, fairly limited. Although the technology has been used in various countries across the world, very little research on its utility has been conducted. The following sections will review the history of use of ALPR, discuss the current research project, and consider the known benefits and limitations of the technology.

History of ALPR Use

The United Kingdom

The United Kingdom is at the forefront in the use of plate recognition technology. As a part of its intelligence network, there are 3,000 cameras across the United Kingdom, stationary (roadside) and mobile (mounted on police cars), scanning up to 5 million plates a day (Pughe, 2006). As of 2001, all 43 police forces in England and Wales were provided with vans equipped with automated number plate technology (ANPR[1]): ANPR cameras were mounted in vans, and police forces were provided with computers that were able to store ANPR information in real time (Pughe, 2006). The central ANPR system, i.e. the databases, is stored at the National ANPR

[1] This term is synonymous with ALPR and will be used interchangeably

Data Center (NADC) in London. NADC stores plate data and lists of suspect vehicles (Pughe, 2006). When a plate is photographed by an ANPR camera, a text file containing information on the car registration number, the time and date of the scan, and the GPS location of the camera is created. In addition, a JPEG image of the plate is produced, as well as a video image of the plate and a video of the vehicle occupants (Pughe, 2006). Approximately four seconds after a plate is read by the camera, the patrol officer is provided with information regarding the vehicle, such as whether the car was stolen, if it had been involved in another crime, or if it was uninsured (Pughe, 2006).

In 2002 to 2003, the United Kingdom evaluated the use of ANPR with nine police forces. The results of this initial study indicated that officer productivity increased primarily due to the officers not having to spend as much time *waiting* for hits after they typed in a plate. Instead, officers were able to spend more of their time *investigating* hits. This resulted in an increase in arrests to 100 per year, 10 times the national average (PA Consulting Group, 2003). In total, approximately one out of every 200 cars photographed by the ANPR cameras was stopped by an ANPR intercept team; equivalent to approximately one stop per hour. In nearly two-thirds (61 per cent) of these stops, the intercept team took some action (e.g. enforced an arrest). However, the data also highlighted the limited ability of the intercept teams to respond to the volume of hits they received. In effect, police were only able to respond to 13% of hits (PA Consulting Group, 2003).

The results also indicated that the police could expect a substantial increase in the amount and value of goods they recovered. On an annual basis, on average, a constable using ANPR technology could expect to encounter: the recovery of 11 stolen vehicles (equivalent to approximately 68,000 pounds); three instances involving the recovery of other stolen goods (equivalent to approximately 23,000 pounds total); seven instances of drug seizures (equivalent to approximately 3,300 pounds total); two seizures of weapons and/or firearms; and five instances of recovery of other stolen property (PA Consulting Group, 2003).

This initial study also provided the Home Office with descriptions of the quantity of vehicles on the road violating insurance or other traffic regulations, the number of vehicles used in the commission of other criminal offences, and the number of vehicles owned or operated by persons of interest (PA Consulting Group, 2003).

A second evaluation was conducted between June 2003 and June 2004 with 24 police forces (PA Consulting Group, 2004). The results of this evaluation also demonstrated that the ANPR technology contributed to a substantial increase in arrests (Pughe, 2006). Over this one year period, 180,543 vehicles were stopped by intercept teams resulting in 13,499 arrests. In effect, arrests were made in nearly

8% of the vehicle stops. One-quarter of the arrests were for disqualified, uninsured, or prohibited drivers. A further 16.8% of arrests were made for theft or burglary offences, 10.3% for theft of or from a vehicle, and 8.2% for drug offences. In total, over 1,000 stolen vehicles were recovered over this period (PA Consulting, 2004). The results of this study were similar to the first study; ANPR was beneficial to police forces by providing better efficiency in the deployment of officers, however, workload concerns continued to exist, again suggesting a need for policy outlining a response priority scheme.

Currently, ANPR technology continues to be used across the United Kingdom. For instance, the Hampshire Constabulary uses ANPR to prevent and detect terrorism, serious crime, volume crime, and fatal and serious injury road traffic accidents (Hampshire Constabulary, 2007). The Metropolitan Police Service operates four ANPR units who work across London. There are deployment teams who are used to assist in targeting hot spots for vehicle and other crime. In 2005 and 2006, these units made, an average, 200 arrests per month (Metropolitan Police Service, no date).

The United States

Over the past several years, the United States has also introduced plate recognition technology, primarily in the form of "red light cameras" (Jenkins, 2007). In 2007, 150 American cities utilized this technology to catch those who drove through red lights. These offenders have a photograph taken of their plate by the ALPR cameras and receive a ticket in the mail. This technology will also be used, in several jurisdictions, to catch drivers who violate speed limits (Jenkins, 2007).

The US has also used plate recognition technology at border crossings with Mexico and Canada to track auto theft (Canadian Press NewsWire, 2006). More recently, ALPR has been used to track potential terrorists. A recent study of ALPR technology in the state of Ohio emphasized the recovery of two stolen trailers demonstrating the technology's potential utility for homeland security (McClellan, 2004).

The state of Ohio studied the effectiveness of ALPR technology over a four month period in 2004, using $61,000 in federal funding. Over the four month period, beginning in August 2004, the state highway patrol apprehended 23 criminal suspects and recovered 24 stolen vehicles valued at US $220,000 (McClellan, 2004). These results were 50% higher than results during the same time period one year previous. It is important to note that the ALPR technology used in this study was only linked to databases on stolen vehicles and wanted persons and, therefore, did not provide information on unlicenced, uninsured, or prohibited drivers.

Canada

ALPR technology in Canada has only recently been implemented for use with traffic and other criminal violations. ALPR has the potential to allow Canadian police forces to engage in proactive policing. By driving through traffic corridors in cities across Canada, police can use ALPR technology linked to criminal justice and insurance databases to identify those drivers who, for instance, have outstanding warrants, are prohibited from driving, or are driving uninsured vehicles. As previously discussed, the technology also offers police a potentially useful tool for identifying and recovering stolen vehicles.

ALPR technology has been used in Toronto for toll-collection purposes. The Highway 407 Express Toll Route was introduced in 1997. It allows drivers to use the express route for a toll fee that is recorded electronically. Nearly one-third (30 per cent) of the tolls are tracked through licence plate recognition technology allowing for faster movement of traffic as the need to stop and physically pay the toll is eliminated (Commission for Integrated Transport, no date).

Still, there are several issues that must be considered prior to the widespread use of ALPR technology in Canada. The United Kingdom established a central data warehouse in London containing information from insurance, criminal justice, and other agencies that is linked with the ALPR technology in police cruisers. The cost of warehousing this data, in addition to the cost of buying, installing, and maintaining ALPR technology, must be weighed against the costs recovered through the use of this system, including reductions in criminal activity, recovery of stolen goods, and increases in positive public perceptions of the police (Schuurman, 2007). Additional staffing costs may also be incurred, whether in the form of additional police on the roads utilizing this technology or the hiring of additional staff to assist in confirming hits, updating the databases, and/or conducting further searches of licence plates. One way to offset these resource increases may be to, wherever possible, use civilian volunteers.

ALPR was introduced in British Columbia as part of a pilot study in 2006. Schuurman (2007) recently produced an analysis of the use of this technology in parking lots in Surrey, British Columbia. Using information obtained through the Canadian Police Information Centre (CPIC) and the Motor Vehicle Branch (MVB), lists of vehicles of interest[2] were populated on a daily basis and uploaded to the patrol car's onboard computer. To collect the data for this initial study, one unmarked patrol vehicle drove through 31 Surrey parking lots scanning the licence plates of parked cars over the period of one week. Scanned plate images were compared to the CPIC and MVB databases.

[2] The Hot Lists were for unlicenced vehicles, uninsured drivers, prohibited drivers, and stolen vehicles.

Over the course of this study, 21,876 licence plates were scanned. Of these, nearly all (97.7 per cent) of the scans accurately captured the car's licence plate. Schuurman's (2007) results indicated that 1.6% of scanned plates resulted in a 'hit'. In fact, there were, on average, four hits every hour (Schuurman, 2007). Nearly three-quarters (72 per cent) of the hits occurred between 3pm and 7pm, and over two-thirds (69.8 per cent) of hits were for unlicenced drivers. The remaining hits were for unlicenced (i.e. uninsured) vehicles (23.9 per cent), prohibited drivers (4.8 per cent), and stolen cars (1.4 per cent).

Schuurman (2007) concluded that the deployment of ALPR technology exclusively to parking lots would not be the most efficient use of the system, especially to locate and recover stolen vehicles. It was concluded that using the technology in a stationary format along major intersections or installing it in mobile units that patrolled the jurisdiction's main roads would likely be more effective for identifying stolen vehicles.

Given that there is limited information available to date on the use of ALPR technology, research must be conducted to determine the extent to which such technology is useful to Canadian police forces. Such research can be used to inform deployment strategies; for example, in determining whether it is more beneficial to have police equipped with ALPR technology drive their usual patrol routes or travel exclusively within known "hot spots" (Schuurman, 2007). The current study intends to provide some initial data regarding the use of ALPR technology in British Columbia, Canada.

Current Study

The current study involved the first of a two-phase test of the ALPR technology. In this first phase, baseline data was collected to test the utility of the ALPR technology. The data in this phase was analyzed to determine the quantity, quality, and location of "hits". This first phase was designed to examine how best to deploy the ALPR technology. The second phase, which is currently underway, involves a live test of the technology and its effect on police and police resources.

Methodology

Phase One: Baseline Data Collection

In order to collect baseline data, the study employed four unmarked police vehicles equipped with ALPR technology.[3] These four vehicles were on the road nearly 24 hours a day for 21 days, traveling along designated traffic corridors in Surrey,

[3] For a detailed account of the operation of the ALPR technology, see Schuurman, 2007.

British Columbia (see Appendix A). In total, 12 corridors were selected from within Surrey based on their traffic patterns. These 12 corridors represent the main routes used both within, and in and out of Surrey. This methodology allowed for a baseline count of the quantity and quality of "hits" along those particular routes. In this phase, ALPR cars did not stop any vehicles based on a "hit", but simply collected data on the location, date, time, and nature of hit.

In each police vehicle, a research assistant was assigned to record specific information which was subsequently coded into a database for analysis. This methodology allowed for a check on the accuracy of the ALPR technology by having the research assistant record the plate number captured by the technology against the actual plate number (see Appendix B for the research assistant coding sheet).

The results presented in this report exclusively encompass this initial period of data collection. The data was analyzed to assess the quantity, quality, and location of the hits.

Results

The ALPR technology was deployed in four roving unmarked RCMP vehicles between October 10th and October 31st, 2006. The data from 19 of these days, October 12th through October 31st was used in the current analysis.[4] These four cars were on the road 7 days a week, for approximately 22 hours a day. Each day the four cars were assigned a specific corridor that they would drive for the entire week.

Number of Plates Read

In total, 177,985 plates were read by the four ALPR-enabled vehicles. Over the 11 driving hours per shift per car, the vast majority of plates were read during the day (7am to 7pm). On average 2,682 plates were read during the day or approximately 244 plates per hour. During the evening, an average of 703 plates was read or approximately 64 plates per hour. In effect, the ALPR technology read nearly four times (3.8) as many plates during a day shift as when operational at night.

Overall, approximately 1,642 plates were read by car per shift or, on average, 149 plates per hour. These numbers are substantially less than previous estimates of ALPR capability which have been stated as upward of 3,000 plates per hour. The reason for the lower rates may have to do with the way roads are designed in Surrey. ALPR technology has the capacity to photograph those vehicles that are on either side of the police car or those cars in front or behind the police cruiser. However, the cameras can only take pictures of cars that are in the lanes directly

[4] The data from the first two days of the study were not included in the current analysis as they produced unexplainably high levels of hit rates for stolen autos.

beside the cruiser. In other words, on three lane roads, if the police car was driving in the middle lane, it could take pictures of the cars on the two outside lanes; however, it could not photograph any cars in the on-coming traffic lanes. Moreover, in Surrey, many roads are only two lanes and the on-coming traffic lanes are separated by a median. In these cars, the ALPR-enabled vehicles could only collect data from one lane of traffic, typically the right lane and no data from on-coming traffic.

"Hit" Results

Of the approximately 178,000 plates read during Phase I, nearly 4,000 hits were recorded. The total number of plate hits for each of the four ALPR-enabled vehicles was fairly evenly distributed ranging from a low of 900 total hits to a high of 1,007 hits (see Table 1).

Table 1: Total Number of Licence Plate Hits

ALPR-Enabled Vehicle	**Total Number of Plate Hits**
1	994
2	972
3	900
4	1,007
Total	**3,873**

When analysing just those plates correctly read by the ALPR system, the proportion of the total number of photos taken, the proportion of hits by traffic corridors, and difference between the proportions are presented in Table 2. The three traffic corridors with the highest volume of photos taken were 128th Street, 64th Avenue, and 152nd Street which accounted for 40.1% of all photos taken. These corridors, however, only resulted in 30.9% of the total number of hits. The corridor with the greatest negative difference between the proportion of photos taken the number of hits was Fraser Highway (-4.5 per cent). Fraser Highway accounted for the lowest proportion of hits, but had the sixth highest volume of total photos. In other words, Fraser Highway was not the most efficient location to deploy ALPR.

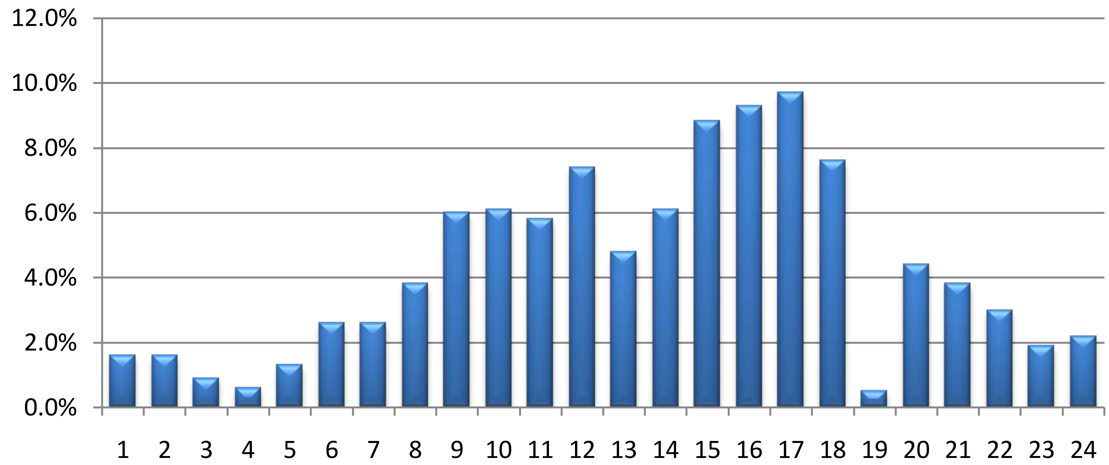
Although it may appear from Table 2 that the most efficient traffic corridors were 108th Avenue and 104th Avenue as they had the highest proportional difference between the number of photos taken and their contribution to the total proportion of hits (+6.5% and +5.4% respectively), it must be kept in mind that these corridors contributed some of the lowest volume on photos taken (1.9% and 3.2% respectively) of all corridors. In effect, as the four ALPR-enabled vehicles, for the most part, travelled on their designated corridors for the same amount of time, it appears that success is fundamentally dependent on volume rather than proportional differences between photos taken and hits discovered. In effect, those corridors with the highest proportion of hits were the most efficient regardless of the number of photos taken. In other words, although 108th Avenue and 104th Avenue yielded the best hit rates, which will be discussed in greater detail below (see Table 3), the fact that they scanned among the lowest number of plates (1.9 per cent and 3.2 per cent, respectively) suggests that it would be more efficient to employ ALPR technology on roads with greater volume of traffic as this will result in more hits per hour.

Table 2: Distribution of Hits along Traffic Corridors

Traffic Corridor	% of Photos Taken (n = 177,985)	% of Total Hits (n = 3,571)	% Difference
128th Street	13.2%	11.1%	**-2.1%**
64th Avenue	14.1%	10.5%	**-3.6%**
152nd Street	12.8%	9.3%	**-3.5%**
72nd Avenue	8.0%	8.7%	**+0.7%**
104th Avenue	3.2%	8.6%	**+5.4%**
108th Avenue	1.9%	8.4%	**+6.5%**
Highway 10	10.6%	8.2%	**-2.4%**
King George Highway	11.0%	7.8%	**-3.2%**
88th Avenue	4.9%	7.6%	**+2.7%**
176th Avenue	2.6%	7.3%	**+4.7%**
Scott Road	8.1%	6.9%	**-1.2%**
Fraser Highway	9.9%	5.4%	**-4.5%**

Figure 1 displays the distribution of hits across time of day. Hits were more or less evenly distributed across the 24 hours of the day with the highest percentage occurring at 4pm (9.3 per cent) and 5pm (9.7 per cent), and the least number of hits (0.3 per cent) occurring at 7am. In fact, the majority of hits (53.5 per cent) occurred between noon and 7pm. The fact that 7pm had the lowest number of hits is likely because this is when day shift comes off duty and night shift begins. As such, ALPR-enabled vehicles are not on their designed corridors for much of the 7pm – 8pm hour.

Figure 1: Distribution of Licence Plate Hits over 24-Hours



In this phase of the project, 1.5% of all plates read resulted in a hit. In terms of distribution, this equalled, on average, 3.6 hits per hour during a day shift and one hit per hour during a night shift. In effect, ALPR-enabled vehicles, on average, had 39 hits during their day shift and 11 hits during their night shift.

An analysis of hit rates, or the number of cars that have to be photographed before getting a hit, suggested that there was not a statistically significant difference by type of shift. The average hit rate for the day shift was one hit per 67.9 cars photographed and was 65.6 for the night shift. The average hit rates for the specific traffic corridors are presented in Table 3.

Table 3: Average Hit Rate per Traffic Corridor

Traffic Corridor	Average Hit Rate
Highway 10	106.97
88th Avenue	80.70
64th Avenue	75.04
176th Avenue	70.01
King George Highway	69.17
152nd Street	66.44
Fraser Highway	64.20
128th Street	61.39
104th Avenue	53.13
Scott Road	52.48
108th Street	51.27
72nd Avenue	50.98
Total	**66.67**

As mentioned above, based exclusively on hit rates by corridor, it would appear that the most efficient corridors were 72nd Avenue, 108th Street, Scott Road, and 104th Avenue, while the least efficient were Highway 10, 88th Avenue, and 64th Avenue. Again, these findings must be considered in light of the traffic flows of these corridors, construction patterns, and the nature of the roads themselves (whether medians impeded the reading of on-coming traffic plates or whether the roads were 1, 2, or 3 lanes).

Again, hit rates should not be used exclusively to assess efficiency as a low hit rate on corridors with low traffic volume is still inefficient. For example, if two corridors had the same hit rate of 50 (meaning that for every 50 cars photographed, one would result in a hit), it would be more efficient to deploy the ALPR-enabled vehicle to the corridor with the higher volume of traffic as that corridor would produce the hit quicker and, therefore, produce more hits per shift. As such, hit rates combined with traffic volume must be considered when determining where to deploy the ALPR technology.

Still, the collection of baseline hit rates was extremely important for measuring the future success of ALPR. While the number of hits uncovered by the technology, and the ability of police to develop better methods to more effectively and efficiently respond to hits, are important measures of success, the ability to compare hit rates over time is vital. A significant reduction in hit rates over time would suggest that the program has had the effect of deterring or preventing auto-related offences which, in the long run, should be the goal of any police program or strategy.[5]

To determine the extent to which the ALPR cameras were accurately reading licence plates, student researchers in each of the four vehicles recorded the actual licence plate of each vehicle as well as the image of the licence plate recorded by the camera. In total, nearly all (92 per cent) of the plates were read correctly. The rates of correct readings did not differ across the four patrol cars (see Table 4).

Table 4: Percent of Plates Read Correctly per Car

Car Number	Per cent Read Correctly
1	92.3%
2	91.5%
3	93.0%
4	91.7%
Total	**92.1%**

[5] While ALPR could result in offence displacement or offending drivers avoiding those jurisdictions employing the technology, the widespread implementation of ALPR would eliminate this as a possible explanation for a reduction in hit rates over time.

For the most part, camera misreads were evenly distributed among the four types of hits that the ALPR-enabled vehicles were able to search for. However, there was a statistically significant difference for one type of hit. Uninsured vehicles were significantly more likely to have their plates incorrectly read (see Table 5). In effect, 26 per cent of the time uninsured vehicle plates were misread compared to approximately 1.5% of the time for the other types of hits.[6] One possible explanation for this difference is that those who drive uninsured vehicles do something to the plate in order to avoid detection, such as by covering a portion of the plate with dirt or some other substance.

Table 5: Proportion of Misreads by Nature of Hit

Category of Nature of Hit	Per cent Read Correctly
Uninsured Vehicle	73.6%
Prohibited Driver	98.8%
Unlicenced Driver	98.6%
Stolen Vehicle	98.2%
Total	**92.1%**

During day shifts, a total of 245 plates were read incorrectly; 85% of which were uninsured vehicles. Similarly, during night shifts, a total of 57 plates were read incorrectly; 88% were uninsured vehicles. In effect, when uninsured vehicles were excluded from the analysis, approximately 99% of plates were read correctly during both day and night shifts. The remainder of the analysis in this report will only include those 3,571 that were read correctly by the ALPR system.

Nature of Hits

The nature of the hit for all hits was recorded. The four types of hits that were collected in this phase of the project were: (1) unlicenced driver; (2) uninsured vehicle; (3) prohibited driver; (4) stolen vehicle. The four ALPR-enabled vehicles did not significantly differ in the rates of categories hit (see Table 6). Overall, more than two-thirds (70 per cent) of all hits were for unlicenced drivers. One-fifth of hits were for uninsured vehicles, while only 8% were for prohibited drivers and less than one per cent were for stolen vehicles.

[6] Chi-square analysis was significant at $p < .001$

Table 6: Nature of Hit by ALPR-Enabled Vehicle

Car	Uninsured	Prohibited	Unlicenced	Stolen
1	22.1%	7.3%	69.5%	1.1%
2	21.8%	8.3%	68.8%	1.1%
3	18.4%	8.8%	72.3%	0.5%
4	18.9%	9.3%	70.8%	1.0%
Total	**20.3%**	**8.4%**	**70.3%**	**0.9%**

There were no statistically significant differences between the type of hit and day or night shift. In other words, the proportion of hits was very similar across hit types and shift. For example, unlicenced drivers made up 71.6% of all hits during the day shifts and 66.3% of all hits for the night shifts. Similarly, 19.9% of all day shift hits and 21.6% of all night shift hits were for uninsured drivers. In effect, this analysis suggests that the difference between day shift and night shift was volume of cars and hits, rather than the nature of hits. There was, however, one anomaly to this conclusion. Prohibited drivers were significantly more likely than unlicenced or uninsured drivers to be hit during the night. Overall, one-third of all prohibited driver hits came during the night shift compared to one-quarter of uninsured drivers and less than one-quarter of unlicenced drivers.[7]

When considering the nature of hits to the corridor that the police patrolled, for the most part, a similar pattern emerged. In effect, the total distribution presented in Table 6 replicated itself in each traffic corridor. In other words, when considering each corridor, we would expect that approximately 70% of all hits in that corridor would be for unlicenced drivers. The range of this type of hit by corridor was 62.2% on Scott Road to 75.4% on King George Highway and 88th Avenue (see Table 7). Similarly, the range of uninsured vehicles was 14.7% on 72nd Avenue to 26.8% on Scott Road (see Table 7). This finding indicated again that the main difference between corridors was not the nature of hits, but volume of hits.

[7] Chi-square analyses were significant at the level of $p < .01$.

Table 7: Nature of Hits by Traffic Corridors

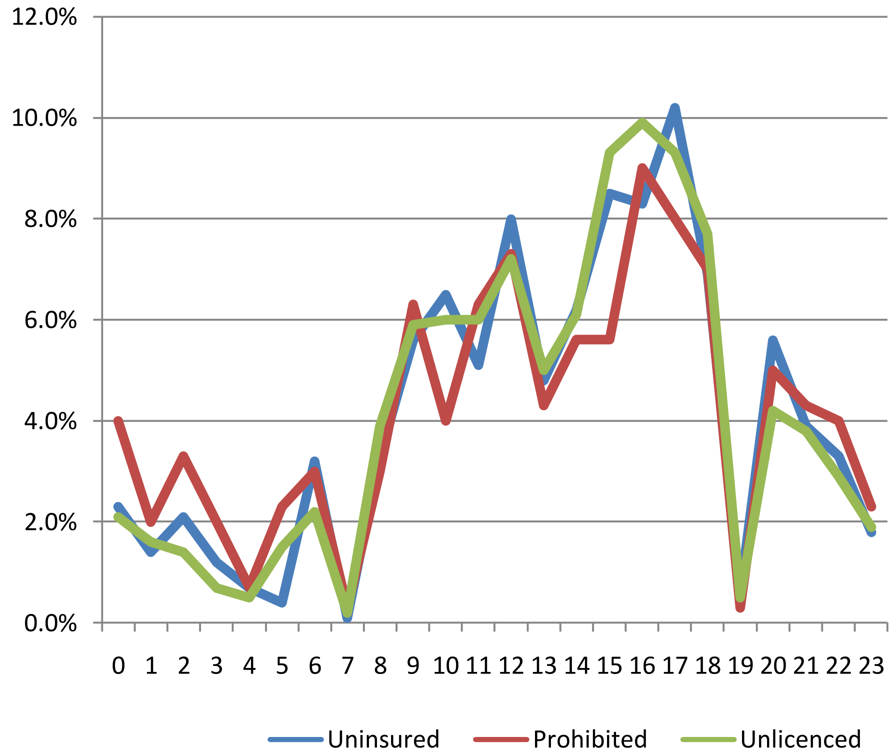
Traffic Corridor	Uninsured	Prohibited	Unlicenced	Stolen Vehicle
Scott Road	26.8%	9.4%	62.2%	1.6%
Highway 10	24.3%	9.2%	65.1%	1.4%
King George Highway	15.4%	8.1%	75.4%	1.1%
Fraser Highway	15.9%	7.4%	75.1%	1.6%
64th Avenue	24.2%	7.5%	67.2%	1.1%
72nd Avenue	14.7%	8.3%	76.0%	1.0%
152nd Avenue	21.0%	8.3%	70.4%	0.3%
128th Street	16.2%	10.2%	72.6%	1.0%
88th Avenue	19.3%	4.5%	75.4%	0.8%
104th Avenue	22.7%	8.1%	68.2%	0.9%
176th Avenue	18.3%	9.2%	72.1%	0.4%
108th Street	23.8%	10.0%	65.9%	0.3%
Total	**20.3%**	**8.4%**	**70.3%**	**0.9%**

A within group analysis suggested that, for the most part, the distribution of hit types was not significantly different by traffic corridors. The only findings of note were that 64th Avenue, 104th Avenue, and 108th Street combined for nearly one-third (32.7 per cent) all of hits for uninsured vehicles. Similarly, nearly one-quarter (23.3 per cent) of all hits for prohibited drivers were on 128th Street (13 per cent) and 108th Street (10.3 per cent).

The distribution of nature of hit by time more closely followed the overall distribution of hit types suggesting that, for example approximately 70% of all hits for any given time of day would be for unlicenced vehicles. As indicated by Figure 2, there were also no significant differences when considering when hits were detected by the nature of hits.[8] Again, what changed over time was the volume of hits, not the distribution of hit types.

[8] As there were so few stolen vehicles, this hit type was not included in the analysis.

Figure 2: Distribution of Hit Types by Time



Similarly, there were no significant differences with respect to the date of the month and the nature of hit or any substantial violations to the overall distribution pattern when examining the data from each individual day of data collection.

In sum, the analysis into the nature, location, and time of hit suggested that efficiency is exclusively a function of volume. For the most part, distribution of hit types and the effects of time and location on this distribution were not significant. Rather, those traffic corridors with the greatest volume of cars provided the best opportunity to get the greatest number of hits.

Characteristics of Drivers Associated to Hits

Driver data was also collected from a number of sources on the demographic and criminal justice characteristics of a sample of drivers.[9] Once a car registered a hit, the registered owner of the vehicle was run through CPIC (the Canadian Police Information Centre).[10] The information collected from the CPIC request included

[9] Due to the amount of time it took to run and obtain CPIC information on all hits, CPIC data collection only occurred for the first 7 days of this phase of the project.

[10] It should be noted that, as mentioned above, vehicles were not stopped during this phase of the project; therefore, it was unknown whether the registered owner of the vehicle was, in fact, the person driving the vehicle at the time the ALPR hit occurred.

age, gender, prior traffic violations, presence of a criminal record, history of violence, and the presence of outstanding charges (see Table 8). In total, information was collected for 1,082 drivers. As indicated by Table 8, the distribution of hit types for this sample closely resembled the overall distribution of hits.[11]

Table 8: Driver Characteristics

	Unlicenced (64%)	**Uninsured (28%)**	**Prohibited (7%)**
Average Age	42	42	34
% Male	69%	71%	85%
% with a prior speeding infraction	29%	35%	61%
% with "other" traffic violations	35%	34%	77%
% with criminal record	14%	14%	33%
% with history of violence	12%	12%	24%
% with outstanding charges	6%	5%	17%

In general, the registered owners of the vehicle tended to be middle aged (X = 42) and male. However, on average, prohibited drivers were six years younger (X = 34) than uninsured and unlicenced drivers.

Given that they were prohibited drivers, it was also not unexpected that nearly two-thirds (61 per cent) of this group had a prior speeding infraction on their records. This was a significant difference from unlicenced drivers (29 per cent) and uninsured drivers (35 per cent). Similarly, slightly more than three-quarters (77 per cent) of prohibited drivers had at least one other traffic violation on their record. By comparison, approximately one-third of drivers were flagged for being unlicenced or uninsured. In fact, prohibited drivers were slightly more than two times more likely to have a criminal record than drivers from the other two hit categories (33 per cent compared to 14 per cent). Moreover, nearly one-quarter (24 per cent) of prohibited drivers had a history of violence on their record, twice as many as those who were uninsured or unlicenced (see Table 8). In providing support to the notion

[11] Due to the fact that drivers were not stopped during this phase of the project, the information on stolen vehicles was not included in this analysis because CPIC data on the car would only provide information on the victim of the stolen vehicle as opposed to the perpetrator.

that ALPR can assist the police in identifying people of interest to the police, nearly one-fifth of hits for a prohibited driver (17 per cent) resulted in identifying an individual with outstanding charges. While the rates were lower for unlicenced (6 per cent) and uninsured (5 per cent) drivers, it does appear that identifying offenders of these hit types will bring serious offenders to the attention of the police.

Discussion

ALPR technology was operational nearly 24 hours a day, approximately 11 hours per shift. During the day, approximately four times as many plates were read than at night. Given that ALPR technology is said to be operational in low-light situations, it is possible that this result can be attributed to the different volume of cars on the roads during day and night shifts. Although ALPR technology has been promoted as being capable of reading in excess of 3,000 plates per hour, the current results suggest that this capability is significantly overstated in actual road tests. The results from this phase of the project indicated that, on average, during a typical 11-hour day shift, the ALPR technology could be expected to read approximately 244 plates per hour. Again, the technology may have the capacity to read more plates, but traffic volume and the design of Surrey streets may impede this read rate.

Perhaps the most important conclusion reached from this study is that the utility of ALPR depends on volume. The initial analysis of parking lot data produced by Schuurman (2007) suggested that parking lot deployment was dependent upon the number of vehicles in parking lots and, for the most part, the same conclusions applied to this road test of the technology. In both cases, the more cars scanned, the greater the number of raw hits. Importantly, the nature of hits was basically uniform for all of the assigned traffic corridors and the proportions held when considered by time of day or day of month. In effect, it was all about the number of hits, and, for the most part, the frequency of hits exceeded what a typical patrol unit could respond to during a shift.

As a consequence, the fact that officers could expect several hits per hour requires the design of a response priority scheme and increase patrol units to manage the increased workload. However, considering the results of this phase of the project, in order to maximize efficiency, police forces operating ALPR technology may want to focus on high volume traffic corridors during the day shift. Given this, it may be possible, as suggested above, to train volunteers who can assist the police in filtering through database hits, substantiating which calls are valid and which must receive priority attention to lessen the burden on patrol officers.

Schuurman's (2007) results also suggested that the use of ALPR technology in parking lots was not the best use of the system in terms of detecting stolen cars.

Unfortunately, these statistics were not improved in the current analysis. Despite the promise that ALPR technology holds for catching stolen vehicles, the current study results also indicated that stolen vehicles represented a very small proportion (approximately one per cent) of all licence plate hits. However, this result should not have been unexpected. There are two main reasons why ALPR, as currently operated in Surrey, was not effective in locating stolen vehicles. First, the hit list that the ALPR-enabled vehicle searched against was 24 hours old. Second, ALPR requires a meeting in time and space between the police cruiser and the stolen vehicle. In other words, for a stolen vehicle to be detected by an ALPR-enabled vehicle, the stolen car had to be on the road in Surrey, along one of the four traffic corridors assigned for that day, at least 24 hours after the car had been stolen, and at the exact location where a moving ALPR-enabled vehicle could photograph its licence plate. The likelihood of this scenario occurring is extremely low. Rather, until such time as ALPR-enabled vehicles have access to real-time data and there are many more ALPR-enabled police cruisers on the road at the same time, it may be more beneficial to use stationary cameras along a large number of intersections, if the objective is to identify stolen vehicles as this will, at least, remove the variable of a roving ALPR which likely reduces success.

An important consideration raised by this research has to do with prioritizing responses and the allocation of scarce resources. If patrol officers are faced with a significant increase in the number of hits as a result ALPR deployment, detachments must design response schemes to prioritize which hits officers respond to. Similarly, in order to respond to the increased number of serious hits, additional officers may be required. Whether or not and how detachments increase their patrol units is an important consideration prior to the implementation of ALPR.

In addition to an increase in the number of offenders identified and the ability to uncover other offences, ALPR also has the capability to deter potential offenders. To increase the deterrent effect of ALPR, consideration should be given to the use of advertising campaigns. A large advertising campaign can inform the public about the nature and use of this technology which may result in the public being less willing to violate traffic regulations.

Study Limitations

There are several limitations to this current study. Firstly, in this stage of the research project, officers did not actually make any traffic stops as a result of a hit. Given this, it was unknown exactly what proportion of hits would have resulted in the officer taken any further action. Further, while cars may have resulted in a hit, it is possible that the person who was *actually* driving the vehicle was, in fact, not violating any traffic regulations. A prohibited or unlicenced driver may have allowed a person with a valid licence to drive their car. Therefore, while the accuracy of plate *readings* tended to exceed 90 per cent, the potential for arrest was unknown. Additionally, the current study only took place along several main corridors within and leading in and out of Surrey. While unlikely, it is possible that alternative routes would have produced different results.

Future Research

Phase Two: Deployment Test

Phase Two of the study, currently underway, involves the live deployment of the ALPR technology. In consultation with the Integrated Municipal Provincial Auto Crime Team (IMPACT), the principle investigators will use data from Phase One to determine the most effective and efficient deployment of the ALPR technology.

Based on the research conducted in the United Kingdom, the ALPR technology will likely provide more hits than the police can respond to. After a period of time, the research team will review the collected data from this phase of the project to make further recommendations on ALPR deployment and response priority schemes.

Conclusion

The ALPR technology offers several benefits to police forces. Most importantly, ALPR has the ability to quickly and efficiently scan a large number of licence plates without any officer intervention, such as having an officer physically type in a licence plate to scan (Schuurman, 2007). ALPR also offers an objectivity that may benefit police. Given that officers cannot check all the licence plates they encounter while on shift, they are compelled to make a series of decisions concerning which plates to search. While officers currently employ a set of indicators, identified through experience, with which to select those plates that appear more suspicious, it is highly plausible that through this process, officers may miss plates that are, in fact, untoward. The ability of ALPR to scan a large number of plates allows for more plates to be scanned faster and more efficiently. The use of ALPR technology might also result in safer police driving as officers would no longer have the added distraction of turning away from the road periodically to manually type in licence plates of interest (Schuurman, 2007).

Research with ALPR has shown several benefits, namely, increased police efficiency. With an increased number of "hits", or successful matching between a scanned plate image and a database of interest, police are better able to identify more persons of interest. This increases the potential for the recovery of stolen goods as well as convictions. The technology also allows the police to identify uninsured vehicles, prohibited drivers, and unlicenced drivers much more quickly than previous police strategies.

There are, however, some limitations inherent in the use of such advanced technology. With the potential for an increased number of hits, officers could become overwhelmed by the increase in the number of problematic cars to respond to. Research in the United Kingdom suggested that in responding to the sheer number of hits identified through ALPR, an officer's workload substantially increased, impeding their ability to efficiently respond not only to ALPR hits, but to other calls for service (Schuurman, 2007). As a consequence, police must develop strategies that enable officers to prioritize their responses. However, as the profile of crime is different in jurisdictions, detachment-specific schemes may need to be developed. In other words, depending on the geographic location of hotspots, the number of officers on patrol, and the specific needs of the community, priority schemes may need to be individualized. Moreover, to better respond to priority hits, police forces may find it necessary to increase the number of officers on the road which, given current fiscal realities in many detachments in Canada, may not be feasible.

While advances in technology allow for the successful use of systems, such as licence plate recognition, it also provides new methods with which to avoid being screened by such technology. For instance, Gordon and Wolf (2007) reported that since the advent of ALPR, some companies have begun to sell products to thwart the technology. They noted that one company sells a clear spray (US $30 per can) that the manufacturers claim can make licence plates invisible when read by a camera. In effect, as the police develop new technologies, there will be those who develop the means to defeat these techniques.

In the past, recognition software has produced extremely low successful recognition rates (Gordon and Wolf, 2007). Yet, more recently, research suggested that the ALPR technology reads plates correctly 95% of the time (Pughe, 2006). However, in the event that a plate is not read correctly and the officer deems the plate suspicious, it is important that officers to retain the ability to investigate the plate more fully and to follow their instincts when observing a suspicious vehicle.

The efficiency of ALPR technology is entirely dependent upon the successful coordination of agencies. Without the provision of data by which to compare scanned plates, ALPR cannot possibly identify plates of interest. Information can either be provided in real time, e.g. lists are updated as cars or plates are reported stolen or it can be updated every 24 hours (Gordon and Wolf, 2007). Either way, those using ALPR technology must have access to data that details information about stolen plates or cars, vehicles that have been involved in other criminal activity, drivers that have been prohibited or have lost their licence, or drivers who are uninsured.

Much of the work involved in implementing ALPR technology involves building these initial relationships between agencies. Again, without the successful coordination between police forces and agencies, such as insurance companies, other criminal justice agencies, and the motor vehicle branch, ALPR technology simply will not succeed.

Lastly, privacy concerns are also a limitation to the use of ALPR technology. Concerned citizens may accuse police or the government of using the technology to track law-abiding citizens, invading their right to privacy (Gordon and Wolf, 2007). Citizens may equate the use of ALPR technology to “fishing expeditions”, where police simply scan all plates until they get a hit, as opposed to specifically searching out particular plates based on prior intelligence. Concerns in Canada already exist regarding the use of Closed Circuit Television (CCTV) systems in public (Schuurman, 2007). Deisman (2003) identified that there are limits to the extent that police in Canada can engage in continuous and non-selective monitoring of citizens. Schuurman (2007) also noted that the Canadian Charter of Rights and Freedoms states that privacy rights of citizens are breached by indiscriminate video surveillance without cause. Essentially, more research needs to be conducted in order to determine how ALPR technology can be balanced with respect to citizens right for privacy and civil rights.

Citizens may also have concerns with respect to the maintenance of data in warehouses. Citizens may fear the potential for breaches in security. In addition, there may be concerns regarding who has access to this data (Gordon and Wolf, 2007). It is, therefore, extremely important that considerable thought is given to the safe storage of data and strict regulations regarding who has access to the databases. In responding to concerns of privacy, policies may be put in place that regulate the deleting of collected data on a daily, weekly, monthly, or yearly basis.

In conclusion, although further research is needed to determine the extent to which ALPR increases the rate of arrest and has a deterrent effect, the results of this study suggest that ALPR technology offers several substantial benefits to the police. Until the completion of Phase II of this project, however, it is difficult to assess the impact of ALPR on police resources and workloads, and thus make any firm conclusions on its general utility. Still, ALPR does have a specific utility as its strategic deployment will assist police departments to more effectively respond to a variety of auto and driving-related offences. The overriding benefit of ALPR is that it brings a far larger number of offenders to the attention of the police, rather than the few offenders the police are able to find during their routine activities. How to adequately respond to this situation will require careful thinking and planning on the part of the police.

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Appendix A: Traffic Corridors

Scott Road - #10 Highway to King George Sky Train
Highway #10 – Scott Road to 200th Street
King George Highway – King George Sky Train to #10 Highway
Fraser Highway – 200th Street to King George Road
64th Avenue – 200th Street to Scott Road
88th Avenue – 200th Street to Scott Road
104th Avenue – 172nd Street to Scott Road
176th Street - #10 Highway to 104th Avenue
128th Street - #10 Highway to 104th Avenue
152nd Street - #10 Highway to 108th Avenue
108th Avenue – 152nd Street to Scott Road
72nd Avenue – 152nd Street to Scott Road

Appendix B: Coding Form

Date	Time	Location	Direction of Target	Direction of PC	Nature of Hit	Read Licence Plate	Actual Licence Plate