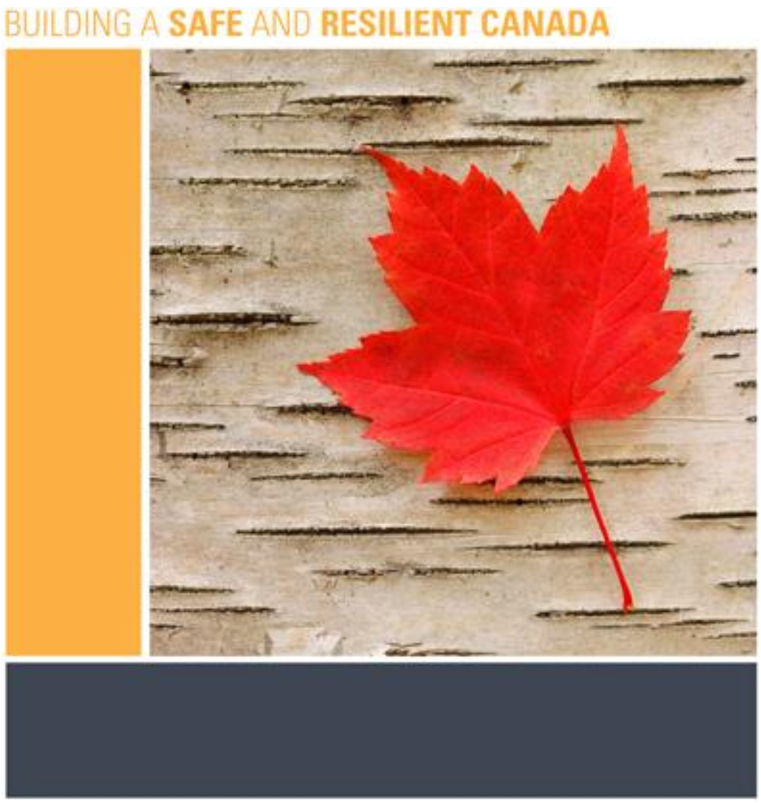

Public Safety Canada
Estimating the Size of the Canadian Illicit Meth and MDMA Markets: A Multi-Method Approach

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Estimating the Size of the Canadian Illicit Meth and MDMA Markets: A Multi-Method Approach

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Executive Summary

This study addresses the lack of reliable estimates on the scope of amphetamine-type stimulants (ATS: amphetamine, methamphetamine, ecstasy/MDMA) production in Canada. Such a study allows for a thorough assessment of Canada's role in global ATS production and exportation. Using a multi-method approach, this research derives more accurate estimates of:

- the total number of ATS users in Canada than currently exists, including an estimate of the quantity of ATS consumed domestically;
- the total number of actors active on the supply side of ATS markets than currently exists;
- the total production volume of ATS in Canada than currently exists, including an estimate of the number of active ATS labs; and,
- the total amount of ATS exported from Canada.

This report begins with a literature review of patterns in ATS use and production within and beyond Canada. Drawing from this past research, a series of methods and data sources that will allow the production of an estimate of the size of these populations for the present study are laid out. The remainder of the report presents the results from the various estimation methods that were applied to assess the size of various segments of the ATS market in Canada. The conclusion provides the main highlights and recommendations from the overall study.

The review of the literature on trafficking and production found that there is too much uncertainty in regards to the existing data to truly assess the role of Canada in the global ATS trade. There are no established estimates of the size of production and the amount of ATS lab seizures remains low. While Canada ranked 6th in the world in the amount of methamphetamine seized in 2007 with 1.54 metric tons, the figure for the previous years was as low as 60kg. Finally, the review found that two methods for estimating the size of the ATS market in Canada (multiplier methods and capture-recapture methods) have shown more promise in obtaining reliable estimates of illegal populations, including drug dealers and producers.

To derive these estimates, existing survey, arrest, and seizure data were used. Procedures used included multiplier methods, synthetic estimation methods, capture-recapture methods, and economic modeling methods. When possible, two methods were used to estimate a segment of the market. In most analyses, the diverse methods yielded consistent results, but much more research is required to provide further validation of this study's results. Working with small and sparse data increases the levels of uncertainty that already exist in these estimation exercises. This report should be approached as a first step in developing standard methods that academics and policy makers can use to make systematic assessments of the ATS and other illicit drug markets in Canada and beyond. Our efforts should therefore be viewed as an exploration that lays the groundwork for a Canada-wide study with a strong emphasis on collecting fieldwork data.

Assessments of the demand-side of the ATS market, based on synthetic estimation techniques, suggest that there are roughly 52,000 meth users and 270,000 ecstasy users in Canada. This estimate is based on a low count of data which combines the general population that is twelve years and older, the homeless population, and the inmate population. This total count of 320,000

likely underestimates the population of ATS consumers. Adjustments for 50% underreporting (high count) suggest a much larger total population of about 480,000 users (77,788 meth users and 402,677 ecstasy users).

The assessment of the supply-side of this market relied on arrest data. The market is predominately male, but no more so than other illegal drug markets and crime settings in general. The population estimates suggest that steep increase occurred between 1999 and 2009 in Quebec, echoing what has been found through other indicators in Canada. One limit in our analysis was that we were unable to provide a valid estimate of importers, exporters, and producers. These populations are small, captured offenders have a higher likelihood of being incarcerated for longer time periods (and thus be unavailable for recapture), and simply not enough offenders get re-arrested in Quebec for these methods to be usable.

The populations of meth and ecstasy dealers were estimated using both capture-recapture and multiplier estimates. Based on arrest data from Quebec, the capture-recapture estimate resulted in 3,458 meth dealers and 4,561 ecstasy dealers in Quebec. This allowed us to infer Canadian populations of 14,303 meth dealers and 16 980 ecstasy dealers. Results from the multiplier procedure for Canada that was based on a user:dealer ratio provided some validation at the higher end for meth and lower end for ecstasy—the population of meth dealers was estimated from a low of 3,457 to a high of 11,113 dealers, while the population of ecstasy dealers was estimated from a low of 17,897 to a high of 57,525 dealers. Once again, the substantial range that emerges from the multiplier procedure calls for considerable caution and additional verification with different data sources from a variety of regions.

Estimates of the population of labs and producers were derived using diverse methods. The number of ATS labs was estimated using an economic model. This estimate ranged from a low of 560 labs to a high of 1,400 ATS labs in Canada. Such information was subsequently carried over to estimate the number of producers in the country. A ratio of 3.5 producers per lab was established, resulting in an estimated low of 1,960 ATS producers if 560 labs were in operation to a high of 4,900 producers if 1,400 labs were in operation in Canada.

Both ATS production and consumption were estimated in order to arrive at a final estimate of how much meth could be reasonably exported from Canada. Such an analysis would lend some substance to persistent claims and debate regarding Canada’s pivotal position in the international ATS trade. Using the results from the economic model as a starting point, overall production was estimated at 2,297 kg if the lower-end 560 labs scenario was accurate and 5,743 kg if the higher-end 1,400 labs scenario was accurate. Such results must be approached with caution since the estimates are based on a single cook per lab in a given year—it may very well be the case that ATS labs produce multiple batches and will likely yield much larger quantities than we estimate. Adjusting these estimates to two ‘cooks’ per lab resulted in a low-end estimate of 4,594 kg and high-end estimate of 11,485 kg of meth in Canada. Depending on the scenario, Canadian producers would export between 38% and 75% of domestic ATS production.

Using a multiplier method to derive a quantity per user ratio, meth consumption for Canada was estimated between 678 kg and 847 kg. Ecstasy consumption was estimated between 1,643 and

2,054 kg. Combining meth and ecstasy resulted in a total ATS consumption range of 2,321 to 2,902 kg in Canada.

Based on mid-point estimates for consumption and seizure data, an excess of 1,733 kg to 8,624 kg of Canadian ATS was estimated for annual exportation. This would suggest that 38% (if 1733 kg of production) or 75% (if 8624 kg of production) of ATS produced in Canada is exported. Information was also added regarding the quantity of Canadian produced ATS overseas to produce an estimate of any ATS unaccounted for by Canadian users or law enforcement agencies around the world. This suggested that an excess of 288 to 7,179 kg of ATS was available for consumption overseas after domestic and international seizures and consumption were subtracted from overall production.

The estimates produced for the purpose of this report suggest that Canada produces as little as 0.6% of the world's supply or as much as 4.6%. Canada would not be considered as a major ATS producer under most standards. Based on the estimates produced in this report, Canada is no more and no less of a player today than it was five years ago.

Five specific recommendations could improve these estimates over the long term:

- establish a more concerted effort to monitor national trends in synthetic drug markets, especially on the supply side;
- monitor trends in domestic illegal ATS precursor importation;
- monitor trends in Canadian produced synthetic drugs in other countries;
- adopt wastewater analysis as a method to estimate the quantity of ATS used in large Canadian cities; and
- make use of capture-recapture methods for the purpose of estimating the size of illegal markets a priority for Canada as a whole.

Introduction

The publication of the 2009 World Drug Report created a media frenzy of the wrong kind for Canada as it has been identified as one of the world's lead producers of amphetamine-type stimulants (ATS) such as crystal methamphetamines and ecstasy. Yet, the proposition that Canada is a primary ATS producer and exporter may be premature. For one thing, the data requirements to assess with any degree of certainty the quantity of illegal drugs produced in a single country are onerous – imagine the problem of doing it for multiple countries. For another, little data has been provided to support this claim, and the little available data provided is itself subject to a variety of interpretations that are worth considering. While it is wise to make an effort to identify emerging patterns before they become heavy trends, recent history has shown that caution should be exercised when trying to understand patterns in global drug production (e.g. Bouchard 2008; Kilmer and Pacula 2009), especially when relying (almost) solely on seizure data.

This study addresses the lack of reliable estimates on the scope of amphetamine-type stimulants (ATS: amphetamine, methamphetamine, ecstasy/MDMA) production in Canada. Such a study allows for a thorough assessment of Canada's role in global ATS production and exportation. Using a multi-method approach, this research aims to derive more accurate estimates of the:

- total number of ATS users in Canada than currently exists, including an estimate of the quantity of ATS consumed domestically;
- total number of actors active on the supply side of ATS markets than currently exists;
- total production volume of ATS in Canada than currently exists, including an estimate of the number of active ATS labs; and
- total amount of ATS exported from Canada.

The final report begins with a literature review of patterns of ATS use and production within and beyond Canada. Drawing from such past research, we layout a series of methods and data sources that will allow us to estimate the size of these populations for the present study. The remainder of the report presents the results from the various estimation methods that were applied to assess the size of various segments of the ATS market in Canada. The conclusion provides the main highlights and recommendations from the overall study.

Literature Review

Patterns in ATS Use in Canada

The first step when thinking about illicit markets is to assess their size – in terms of the number of producers, suppliers, and drug users. While estimates for the former two categories may be harder to come by, there are some data available on the prevalence of ATS and MDMA use. Such data are available through various surveys of specific populations. Surveys are a suitable starting point to think about the size of the market to the extent that: a) such surveys are valid indicators of the populations they aim to estimate; and b) there is a survey that can successfully capture all segments of the user population. But there are validity issues to any type of survey, and even combining all existing surveys may not capture all elements of the population – especially the elusive population of heavy users.

A review of the most recent data available on ATS and MDMA use in Canada has been conducted by Bouchard et al (2010). The results are briefly summarized here for the purpose of this report. Results were based around three subpopulations: a) general; b) student; and c) "at-risk" populations (defined as those shown to have higher rates of ATS use than other populations; e.g., street population, rave participants, and Lesbian/Gay/Bisexual/ Transgender/Questioning). National population surveys were relied upon to examine rates in the first subpopulation. For students, both general (e.g. Health Behaviour in School-Ages Children Study (HBSC)) and province-specific surveys (e.g., Ontario Drug Use and Health Survey (OSDUHS)) were examined. Finally, published reports of important longitudinal studies in Canada were reviewed to provide results for at-risk populations. Results show that levels of use remain low in the student and especially in the general populations, and are generally on the decline. ATS use is higher in specific at-risk populations.

General Population

Using a random sample of nearly 13,000 Canadians age 15 and older in 2009, the Canadian Alcohol and Drug Use Monitoring Survey found past year prevalence rates of 0.1% for methamphetamine, 0.4% for "speed" and 0.9% for ecstasy (CADUMS 2009). These numbers are comparable to the 2004 Canadian Addiction Survey (CAS) (Adlaf, Begin, and Sawka 2005) which found that 0.8% had used speed and 1.1% had used ecstasy at least once in the past year. However, all the rates are down from the CADUMS survey conducted in 2008, which showed that 0.1% of respondents had used meth, 1.1% had used speed, and 1.4% had used ecstasy (CADUMS, 2008). Overall, however, the different surveys suggest a relatively stable trend in ATS use in Canada in the general population.

Student Population

Table 1 presents annual prevalence rates for student populations in most provinces. The data was extracted from a few major surveys around the country, including the OSDUHS which has been conducted for more than two decades. Rates of meth and crystal meth use among adolescent students is generally low compared to cannabis use (under 2.5% used meth in the past year, see Table 1), although it is higher than rates found for the general population. Over the course of the past decade, rates of meth and crystal meth use have been decreasing. In all regions, ecstasy is the most heavily used ATS, ranging between 7.2% (past year) in Newfoundland and Labrador and 3.2% in Ontario at the most recent measurements. Most regions have witnessed modest increases in ecstasy use over the past decade. Estimates of amphetamine use range from 2% to 5.3% (using both past year and lifetime measures). The most substantial changes over the past decade are in amphetamine use. Interestingly, there are few substantial gender differences in ATS use.

At-risk populations

Despite a variety of recall periods, the findings of studies examining ATS use among at-risk populations report much higher overall rates than student or general population studies (Table 2). Non-Aboriginal street youth appear to have the highest rates, though the ATS use of aboriginal street youth is not far off. Interestingly, street-based drug injectors have substantially lower ATS use rates than other street populations, though this could be a product of the sampling strategy that focussed on injectors who are more likely to use substances other than ATS. The rates of use among the lesbian, gay, bisexual, transsexual and questioning (LGBTQ) population appear to be higher than the general population but lower than the street population. The Sex Now (SN) survey (Trussler 2007) shows that crystal meth consumption has been declining since the early 2000s among gay men. Rave attendees appear to have the highest rates of ATS use. A recent survey of inpatient youth in northern BC showed that methamphetamine was the primary drug of choice in 35% of treatment admissions for drug addiction (Callaghan et al. 2007).

Table 1: Adolescent student ATS use in Canada (from Bouchard, Gallupe, and Descormiers 2010)

Region	Substance	Source	Grade level	Prevalence % (year)	Male %	Female %	Trend (total)
Alberta[a]	Meth (speed)	TAYES	7-12	0.5 (2008)	0.5	0.4	5.3% used "club drugs" in 2002 (AADAC, 2003)
	E	TAYES	7-12	3.7 (2008)	3.7	3.8	
	Crystal meth	TAYES	7-12	0.4 (2008)	0.6	0.3	
BC[b]	Amphet	BCAHS	7-12	2 (2008)			2003-2008: 4% to 2%
Manitoba[a]	E	AFM	7-12	4 (2007)	3.5	4.4	2003-2007: 2% to 4%
	Crystal meth	AFM	7-12	0.5 (2007)	0.5	0.5	2003-2007: 3% to 0.5%
New Brunswick[a]	Meth	NBSDUS	7, 9,10,12	2.5 (2007)			
	E	NBSDUS	7, 9,10,12	4.4 (2007)			2002-2007: 4.0% to 4.4%
	Amphet	NBSDUS	7, 9,10,12	2.4 (2007)			2002-2007: 10.9% to 2.4%
Nova Scotia[a]	Meth	NSSDUS	7, 9,10,12	1.6 (2007)			
	E	NSSDUS	7, 9,10,12	6.9 (2007)			2002-2007: 4.5% to 6.9%
	Amphet	NSSDUS	7, 9,10,12	3.6 (2007)			2002-2007: 9.5% to 3.6%
Ontario[a]	Speed	OSDUHS[c]	7-12	1.4 (2009)	1.8	1.0	1999-2009[d]: 5.0% to 1.4%
	E	OSDUHS[c]	7-12	3.2 (2009)	3.1	3.2	2000-2009[d]: 6.0% to 3.2%
	Crystal meth	OSDUHS[c]	7-12	0.5 (2009)	0.6	0.5	1999-2009[d]: 1.4% to 0.5%
Newfoundland and Labrador[a]	Meth	NLSDUS	7, 9,10,12	2.4 (2007)			
	E	NLSDUS	7, 9,10,12	7.2 (2007)			2003-2007: 2% to 7.2%
	Amphet	NLSDUS	7, 9,10,12	3.2 (2007)			
Canada[b,e]	E	HBSC	9, 10	5.5 (2006)	5.0	5.9	1998-2000: Boys – no change; Girls – 3% to 5.9%
	Amphet	HBSC	9, 10	5.3 (2006)	4.0	6.5	1998-2006: Gr 10 boys – 9% to 4.0%; Gr 10 girls – 9.0% to 6.5% (King, Boyce, and King, 1999)

HBSC = Health Behaviour in School-Aged Children study (Boyce, King, and Roche, 2008); OSDUHS = Ontario Drug Use and Health Survey (Adlaf, Begin, and Sawka 2005); TAYES = The Alberta Youth Experience Survey (AHSAMH 2009); BCAHS = BC Adolescent Health Survey (Smith et al., 2009)
AFM = Addictions Foundation of Manitoba (Friesen, Lemaire, and Patton, 2008); NBSDUS = New Brunswick Student Drug Use Survey (New Brunswick 2007); NSSDUS = Nova Scotia Student Drug Use Survey (Poulin and McDonald, 2007); NLSDUS = Newfoundland and Labrador Student Drug Use Survey (Ryan and Poulin, 2007); [a]Past year use; [b]Life time use; [c]OSDUHS categories consist of a) "speed", b) ecstasy, and c) crystal methamphetamine; [d]Prevalence rates peaked around the late 1990s. Longer term trends using a restricted sample show that current prevalence rates are very similar to pre-peak rates; [e]Calculated from the values published in Boyce, King, and Roche (2008).

Table 2: ATS use among at-risk populations in Canada (from Bouchard, Gallupe, and Descormiers 2010)

Population	Region	Substance	Source	Prevalence % (year)	Trend (total)
Street youth	Canada	E	E-SYS[a]	5.1 (2003)	1999-2003: 1.2% to 5.1%
	Canada	Crystal meth	E-SYS[a]	9.5 (2005)	1999-2005: 2.3% to 9.5%
	Vancouver	Crystal meth	MASY[b]	67 (2003)	
	BC	Amphet	MSIYS[b,c]	50 (2000)	
	BC	E	MSIYS2[d]	25 (2006)	
	BC	Crystal meth	MSIYS2[d]	14 (2006)	
	BC	Amphet	MSIYS2[d]	11 (2006)	
Aboriginal street youth	BC	E	MSIYS2[d]	22 (2006)	
	BC	Crystal meth	MSIYS2[d]	12 (2006)	
	BC	Amphet	MSIYS2[d]	8 (2006)	
Street injectors	Vancouver	Crystal meth	VIDUS[e]	6.7 (2004)	1997-2004: 2.5% to 6.7%
LGBTQ	Vancouver	Crystal meth	MASY[b]	24 (2003)	
	Vancouver/ Victoria	E	MASY[b]	26.7[f] (2003)	
	Vancouver/ Victoria	Crystal meth	MASY[b]	26.7[f] (2003)	
	BC	Crystal meth	SN[g]	6 (2007)	2002-2007: 11% to 6%
Ravers	Montreal	Amphet	SUCRP[d]	64.9 (2002-3)	
	Montreal	E	SUCRP[d]	53.2 (2002-3)	

E-SYS = Enhanced Surveillance of Canadian Street Youth (PHAC, 2006, 2009)
MASY = Methamphetamine Study of Youth (Lampinen, McGhee, and Martin, 2006; Martin, Lampinen, and McGhee, 2006)
VIDUS = Vancouver Injection Drug Users Study (Fairbairn et al., 2007)
MSIYS = Marginalized and Street-Involved Youth Survey, 2000 (Murphy et al., 2001)
MSIYS2 = Marginalized and Street-Involved Youth Survey, 2006 (Smith et al., 2007)
LGBTQ = Lesbian/Gay/Bisexual/ Transgender/Questioning
SN = Sex Now (Trussler 2007)
SUCRP = Substance Use in a Canadian Rave Population (Gross et al., 2002)
[a]Past three months use
[b]Lifetime use
[c]Calculated from the values published in Murphy et al. (2001)
[d]Past month use
[e]Past six months use
[f]Small sample (n=4 reporting ecstasy and crystal meth use)
[g]Past year use

Although these surveys of at-risk populations are informative on the extent of consumption for specific subgroups of at-risk individuals, it is much harder to make inferences about prevalence from these numbers. Not only is it sometimes impossible to determine the boundaries from one population to the next or the extent of overlap between them, but the problem of the denominator is even greater – how many users over how many individuals susceptible to using? Such is the logic of capture-recapture estimates: given the patterns found in the known population (numerator), how many total users should be found (denominator)?

Note that an important missing sub-population is the criminal population. Surveys like the Arrestee Drug Abuse Monitoring (ADAM) program were found to be extremely important in estimating illicit drug use prevalence and incidence among heavy users in countries where it has been implemented (Bennett and Holloway 2007). In constant operation for over 10 years now, the Drug Use Monitoring in Australia (DUMA) program is perhaps the best example of the group (Gaffney, Jones, Sweeney and Payne 2010). Because they are conducted quarterly (instead of annually), such programs are key to detecting trends and changes in drug markets, including the emergence of new drugs. A group of researchers led by Dr. Chris Wilkins at Massey University recently received a grant to implement the program in New Zealand. Canada, unfortunately, does not currently have a similar program. However, it is a recommendation of this report that the implementation of such a program be seriously considered, given the demonstrated benefits of such programs in other jurisdictions. An important complement to such surveys is to rely on capture-recapture estimates of arrest data.

Estimating the quantity of ATS consumed from general population surveys: The Kilmer and Pacula (2009) study

Kilmer and Pacula (2009) provide a method to estimate the quantity of ATS consumed globally. This report is interesting on a number of levels, including the fact that a separate estimate was produced for Canada (though only for ecstasy). A review of their methods illustrates some of the data requirements for estimation exercises, and it also provides a useful ballpark figure to compare with the estimates derived later for the purpose of this project. Table 3 reproduce Kilmer and Pacula's estimates for ecstasy in Canada in 2004.

Table 3 Estimating the quantity of ecstasy consumed from general population surveys, Canada, 2004 (from Kilmer and Pacula 2009)

	Ecstasy 2004
Past year ecstasy users from CAS 2004	244,526 users
Correction for under reporting (20%/50%)	Low (20%): 305,658 High (50%): 489,052
Mean tablets consumed/year	Low: 30 tablets/year High: 139 tablets/year
Low tablets * low user estimate	9,169,738 tablets
High tablets * high user estimate	67,978,328 tablets

The estimated range is wide: from 9 million to 68 million ecstasy tablets consumed in Canada in 2004. The mid-range estimate would be 38 million tablets, but the authors were not comfortable in recommending settling for mid-range for any of their estimates. Note that the RCMP typically seize over 1 million ecstasy units annually (1.5 million units in 2008, see UNODC 2010) and that an unknown quantity of domestic production is destined for market overseas. The estimated range implies that whether the consumption estimate is closer to the low or high end estimate (which are lower bounds of the total production which includes exports), the seizure rate achieved by law enforcement agencies would at most be anywhere between 1% and 10%.

Two additional observations should be made on this estimate and its assumptions for the purpose of this report:

1. <u>The authors rely on a demand-side estimate based strictly on a general population survey on drug use.</u> Instead of chasing for separate estimates for different sub-population of ATS users, the authors chose the past year's general population estimate and then made corrections for under-reporting. The size of under-reporting is unknown for ATS markets, but better known for the cannabis (20%) and cocaine (50%) markets where the bulk of prevalence research has been undertaken in the US. The authors reasoned that the rate of use for a recreational drug like ecstasy would fall somewhere in between those two rates. The alternative is, of course, to add multiple, separate estimates for populations not covered in the general population survey (as do the synthetic estimation methods proposed in this paper) and refrain from relying on such corrections. The trade-off is the effort incurred in finding reliable, mutually exclusive estimates for different sub-populations of ATS users. Should these be obtained, a comparison of both strategies would provide more information on the suitability of this method and its assumptions.

2. <u>The authors derive one parameter of the mean number of tablets consumed per user per year that is meant to capture the variety of ecstasy users and their intensity of use.</u> The authors assume that this parameter provides some middle ground to take into account those who use very infrequently and may simply experiment with 1-2 tablets per year (the majority of users in the

general population) and the minority of heavy users who most likely use a lot more tablets than the range of consumption proposed. The authors are prudent in proposing two estimates, one with the lowest estimate found in the literature (30 tablets), and one with the highest (139 tablets). The truth may lie somewhere in between. UNODC (2009), for example used 5.45 grams/year/user, which translates into a middle figure of 73 pills (at 75 mg of MDMA/pill).

This strategy of using one parameter over many proved sound in other contexts. Bouchard (2008), for example, showed that his estimate of cannabis consumption in Quebec derived from a careful breakdown of category of users and their individual consumption rates could have been summarized by the use of a simple 100 gram/past year user parameter, a similar parameter to what has been found for US consumption (Childress 1994). The problem with measuring ATS consumption is, of course, that much less is known about what that parameter might be, given that much less is known about the size of the ATS market than others. A primary goal of this project is to make progress towards that end.

A New Method to Estimate Illicit Drug Use from Wastewater Analysis

A recent article by Metcalfe et al. (2010) describes a novel method to estimate the size of illegal drug markets in specific cities from wastewater analysis. Because illegal drugs are eliminated through urine and excrement in the way any food or liquids are, it becomes possible to estimate how many doses of various substances have been eliminated by the specific population served by a water treatment plant. In the words of the authors:

> Drug consumption can be estimated from data on the concentrations of the target compounds in untreated wastewater, the flow rates into municipal wastewater treatment plants (WWTPs), the population served by the WWTP, human excretion rates for the target compounds in urine, and estimates of the drug dose.

The authors do not identify by name the three cities where they conducted the analysis outside of the “eastern Canada” locations, but they were careful in choosing three cities with very different populations: 1.6 M (city 1), 500 000 (city 2), and 75 000 (city 3). Drug dosage estimates were provided for three substances of interest for the purpose of this report (amphetamine, methamphetamine, ecstasy), but also for cocaine which we will use as a benchmark for comparisons.

Table 4 presents the dosage estimates for those, with an estimation of the prevalence of users for the communities served by the wastewater facilities. Three observations can be made from the results. First, cocaine is much more prevalent than the other drugs, within similar proportions as it is in general population surveys. Second, it is much easier to detect drug presence in the largest city than others, which also reflects the higher prevalence of hard drug use in urban centers. The numbers derived from this method may apply more to large cities than other regions, although a) the same can be said of general population surveys, and b) meth use is common in many rural areas in the US (Weisheit and White 2009; Reding 2009; Armstrong and Armstrong 2009; Sexton, Carlson, Leukefeld, and Booth 2006). Third, drug concentrations expectedly vary per day of the week, making it important for such analyses to be undertaken in both weekdays and weekends. Assuming that Montreal is the city under analysis in this study (the population size suggests this is the case), the ratio of cocaine to meth use found (2.5 – 5.5) can be tested against other demand-side estimates provided in the current study.

Table 4: Summary of wastewater based estimates for four illegal drugs in three eastern Canadian cities (source: Metcalfe et al. 2010)[1]

	Large city (1.6M)	Mid-Large city (500K)	Small city (75K)	Three cities combined
Methamphetamine				
Dose/day/1000 pop (median)	4.2 – 10.1	≤ 1.0	≤ 1.0	4.5
	-	-	**% prevalence**	0.45%
Ecstasy				
Dose/day/1000 pop (median)	≤ 1.0	≤ 1.0	≤ 1.0	0.4
			% prevalence	0.04%
Amphetamine				
Dose/day/1000 pop (median)	≤ 1.0 – 4.0	≤ 2.0	≤ 2.0	1.8
			% prevalence	0.18%
Cocaine				
Dose/day/1000 pop (median)	10.5 (Tuesday) - 56.7 (Friday)	10.5 (weekday) - 44.0 (weekend)	8.1 (weekday) – 9.0 (weekend)	15.7
			% prevalence	1.57%

Note. Combined estimates (last column) taken directly from the text. The majority of other estimates are our approximations based on Figure 3 (p. 184) of the article.

Patterns in ATS Production in Canada and the US

Few studies focus primarily on ATS production, even less have a Canadian focus. This section begins with a review of the small set of studies focusing on meth cooks and their methods in North America. The second section examines in more details what is known about patterns and trends in ATS production in both Canada and the US.

Meth Cooks and their Methods

One of the only studies interviewing meth cooks, the work of Sexton et al. (2006) is informative, as they recruited through snowball sampling 10 meth cookers active in Kentucky or Arkansas. All were white, and the mean age of the group was 38 years of age – slightly older and more likely to be single than a sample of meth users recruited in the same region within the context of the study. All of them would qualify as small-time producers running “addiction-based labs”, all

[1] There are some indications in this study that suggest that the large city under analysis is Montreal, although the authors never confirm this. We also suspect, based on the sizes reported, that the other cites are Hamilton and Peterborough. The Montreal estimates are important for our purposes because they inform us that the use of cocaine compared to meth is 2.5 to 5.5 times higher in Montreal. Such a comparison may be confirmed with arrest data on each of these drug markets.

producing through the Birch method, which is the method that proved the most efficient at rapidly producing quality meth (Man et al. 2009; Weisheit and White 2009). The Birch method uses ephedrine or pseudoephedrine and anhydrous ammonia as its main ingredients. It has also been reported as the main production method elsewhere, including Canada. However, the RCMP (2009) notes that a relative shortage in the availability of pseudoephedrine in 2009 may have caused a shift back to the 'traditional' P2P-based methods, which is based on a different precursor - phenyl-2-propanone (Man et al. 2009). In fact, the meth industry in general appears to be very sensitive to changes in precursor availability and control, something discussed further below.

Sexton et al.'s study of cooks also helps illustrate a few other interesting patterns about meth production. First, meth is perceived as a very "white" drug to do, and to produce. These perceptions were confirmed at the macro level by studies on the geography of meth production in the US (Armstrong and Armstrong 2009; Weisheit and Wells 2010). Examining community characteristics that are most likely to be associated with meth production, both find that communities with a majority of White residents were most likely to have higher lab seizure rates. This is noteworthy because racial heterogeneity is usually a positive predictor of the presence of illegal drug markets. This illustrates the "rural feel" for meth production in the US, a phenomenon that has been captured in non-fiction books as well (see Reding 2009). Second, the study illustrates the simplicity of meth production ("Dumb old country boy can do it" Sexton et al. 2006: p. 859), but also the dependence of producers on the availability of the raw materials for production, including anhydrous ammonia, the possession of which is restricted to authorized farmers. The cooks' addiction, limited financial means, but also availability of raw materials appeared to limit their production to little more than what they need for their own consumption. This creates a situation where a) the ATS market may fluctuate more than would otherwise be expected in markets for other illegal drugs, and b) criminal organizations with good precursor-related connections overseas have a definite competitive advantage over these small producers as they would be least affected by local changes in precursor laws. Finally, this study illustrates that meth production is mainly learned from person to person, as opposed to being learned from impersonal sources like books or the Internet. The reason is simple: the hazards of meth cooking are quite high. The slightest mistake may prove fatal. As observed by Weisheit and White (2009), the necessity of initial peer-to-peer mentorship may explain why there is so much variation in meth seizure rates from one county to the next in the US - a community where first-hand cooking knowledge has not been integrated may never see a meth lab at all.

Patterns and Trends in ATS Production

Drawing on a new method for estimating production from the number of users, the 2009 UN World Drug Report estimated worldwide meth/amphetamine production between 230 and 640 metric tons (mt). The range for ecstasy is 63-128 mt. Using the same approach with minor variations in the assumptions in 2010, the estimate for meth/amphetamine was 197-614 mt, and for ecstasy 53-132 mt. An important underlying assumption behind the new method is that a valid estimate of the total number of users and of the mean quantity consumed annually by an average user exists (12g and 5.5g, respectively in 2009 vs. 10.9g and 5.1g in 2010). These estimates allow for the calculation of a seizure rate. For example, a total of 53 mt of meth/amphetamine has been seized in 2007, producing a global seizure rate between 7 and 19%

for that year. The seizure rate for ecstasy is found to be between 6 and 12%. T hese figures loosely match the detection rates (11%) found in a recent study drawing on capture-recapture methods to estimate the size of cannabis production in Quebec, Canada (Bouchard 2008).

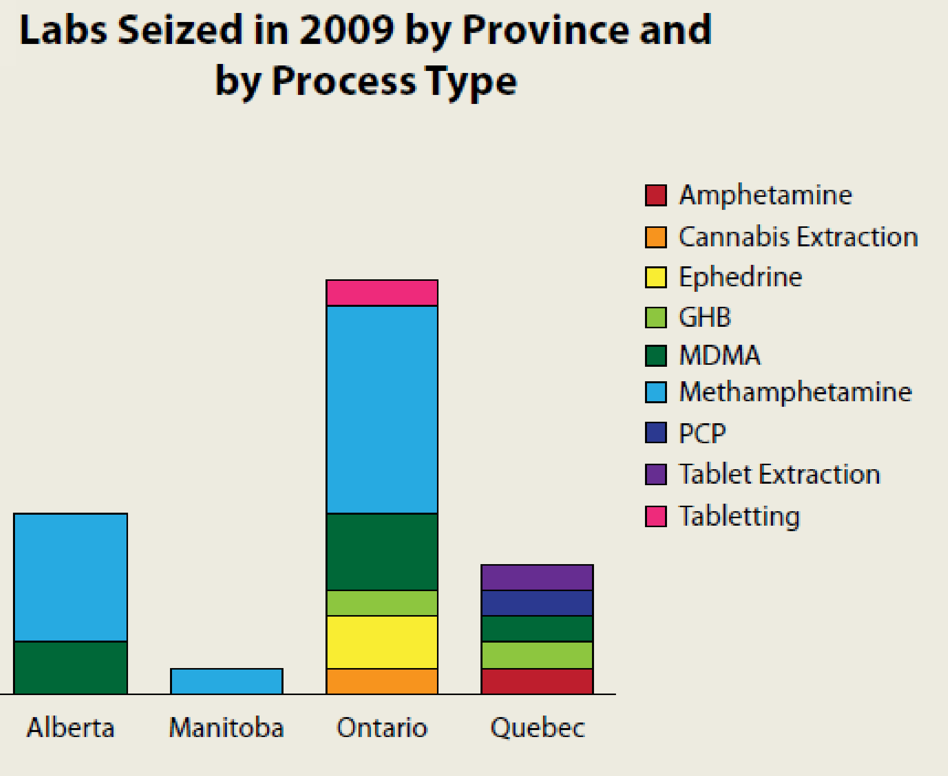
The 2009 World Drug Report is important for our purposes because in the report Canada was as alleged to be a major exporter of methamphetamine and ecstasy to countries like the USA, Japan, and Australia (see also RCMP, 2007; for similar concerns over Southeast Asia, see McKetin et al. 2008). The claims also included estimates of the proportion of meth and ecstasy produced domestically versus the proportion exported overseas, as well as mentions of the participation of organized crime groups (e.g., Asian-based, and biker gangs).

Given the clandestine nature of the ATS markets, no definite production figures exist. The number of ATS trafficking cases in Canada declined from 9,000 in 2005 to 4,000 in 2007. The amount of meth labs detected in Canada annually remains relatively low compared to the US (17 vs. 5,700 in 2007; 7 vs. 7,225 in 2008), but it is their larger size that seems to pose the greatest problem. While only 14 of the 5700 US labs qualified as "large" in 2007, a majority of the 17 Canadian based labs that were detected could be classified as such (UNODC 2009). But "large" is much larger in some contexts than others. Cunningham et al. (2009), for example, report that large-scale labs in the US produce 5-7 kg during a cook, compared to 70-90 kg for large Mexican labs. The Canadian superlabs do not appear to be different than those found in the US. According to the numbers provided in Diplock, Kirkland, Malm, and Plecas (2005) for BC, 17 of the 33 labs detected between 2003 and 2005 could qualify as superlabs (more than 5kg/cook). Seizure data for ecstasy, however, show that just as many labs were detected in the US and in Canada in 2007 (12 labs), although the US authorities seized 4 times the quantity of ecstasy seized in Canada (UNODC 2010). MDMA (ecstasy) is also the only drug seized in larger quantities along the Northern US border (Canada) compared to the Southwest border (Mexico). In 2009, 303 kg of MDMA was seized entering the US from Canada, compared to 10 kg for methamphetamine (US Department of Justice 2010).

Figure 1 illustrates the distribution of ATS lab seizures in Canada in 2009 where a total of 45 labs were detected. The Figure suggests that 1) BC now shares with Ontario the distinction of being a major ATS producing province; 2) meth dominates the number of seizures, followed by MDMA; 3) only a small number of labs were detected in Quebec, but as much as 5 process types/substances are represented including the only "tablet extraction", "PCP", and "amphetamine" labs. Such diversity is intriguing, as it may reflect a capacity of Quebec producers to adapt to local demand, and provide a variety of locally synthesized products. But the numbers are too small to make much of those interpretations, small enough to suggest a potentially large number of undetected labs[2].

[22] One reason is because Quebec arrest data indicates much larger MDMA and methamphetamine markets than the lab seizure data suggests.

FIGURE 1.



Source: RCMP (2009)

Another piece of the puzzle is the reverse trends between the US and Canada: while the number of seized laboratories has been steadily declining in the US since 2003, the numbers have risen in Canada, and also in Mexico (UNODC 2009; Brouwer et al. 2006). According to a recent evaluation by Cunningham et al. (2009), two trends emerge: a) the trends between all 3 countries are interrelated; and b) the trends are affected by precursor regulations implemented in each country. According to Cunningham et al. (2009), the 1995 ephedrine and 1997 pseudoephedrine US regulations seemed to have created incentives for US producers to import their precursors from Canada. When Canada followed through with regulations of their own in January and June 2003, producers increasingly turned to Mexico for chemicals. Note that Mexico recently adopted similar regulations in 2007 (Cunningham et al. 2009) – the effects of which on the US and Canada remain to be seen.

Overall, seizure and detection data suggests that Canada is among the largest ATS producing nations (UNODC 2008; 2009; 2010; RCMP 2007). For example, Canada ranked sixth in the world in meth/amphetamine seizures with 1.54 mt seized (UNODC 2009, p 136) and fourth in ecstasy seizures (p 142) with 985 kg seized in total. Bouchard et al. (2010) suggested that these numbers should be used and interpreted with extreme caution. For example, the 1.54 mt seized in 2007 represented a 2,500% increase from the preceding year where only 60kg were seized by the police. The publication of the 2010 World Drug Report showed that such caution was warranted: 2008 meth seizures fell to 371 kg in Canada, placing the country in 18th place that year. Ecstasy seizures dropped to 491 kg in 2008, following a worldwide decreasing trend. This reminds us of the volatility of seizure data from one year to the next, especially for smaller markets like ATS. One very large seizure may greatly influence the absolute numbers. Seizure rates, like drug-related offense rates in general, are also dependent on police priorities and funding. Trends should be monitored further before they can be used to assess the size of the market or police detection rates.

Methods to Estimate the Size of Illegal Markets

Estimating the size of an illegal market is a complex task. As shown in previous work undertaken by the main researcher of the current proposal and his colleagues (e.g. Bouchard and Tremblay 2005; Bouchard 2007; 2008; Kalacska and Bouchard 2011; Tremblay, Bouchard and Petit 2009), it requires the combination of numerous data sets, steps and assumptions. It also requires the use of proper methodologies in a stepwise approach where any small error at any one step can completely derail the whole procedure. These challenges point towards the use of: a) methods which have been shown to be valid in illegal market settings in prior work; and b) a triangulation of methods wherever possible in order to achieve the most valid estimates possible.

For this study, seven separate estimates are proposed: four for different sub-populations of individuals (users, dealers, producers, labs) and three for quantities of ATS (used, produced, exported). For the majority of the estimates, a minimum of two different methods among the following will be used: multiplier methods, synthetic estimation methods, capture-recapture methods, and economic modeling methods. It is impossible, given the short time frame to produce this study and limited fieldwork data, to provide reliable estimates for all of these populations and quantities. Our efforts should therefore be viewed as an exploratoration that lays the groundwork for a Canada-wide study with a strong emphasis on collecting fieldwork data. Table 5 summarizes the work to be undertaken for each estimate. More details on the data sources and each of the methods are presented below.

Table 5: Summary of estimates to be provided, the methods required, and an example study using these methods among the research team

Type of estimate	Method 1	Method 2	Reference
1. Number of ATS users	Synthetic estimation (multiple survey results)	Multiplier methods (overdose data/wasterwater analysis)	1. Bouchard and Tremblay (2005) 2. Bouchard (2008)
2. Number of ATS dealers	Capture-recapture methods plus inference (arrest data)	Multiplier methods (dealer per user ratio)	1. Bouchard and Tremblay (2005)
3. Number of ATS producers[a]	Multiplier method I (arrest ratio)	Multiplier method II (producer per lab ratio)	1. Bouchard (2007)
4. Number of ATS labs	Economic modeling	Multiplier methods (detected to undetected ratio - domestic)	1. Bouchard (2007; 2008) 2. Easton (2004)
5. Quantity of ATS production	Using (4), method proposed in Bouchard et al. (2010): $TPV_{\text{Meth/MDMA}} = \sum_{i=1}^{N}(c_i * kg_i * p_i)$ where *TPV* denotes total production volume, ∑ is the summation operator, *c* is the count of clandestine production facilities of size *i* (*i* = 1 through *N*) at risk of detection, *kg* represents the total weight in kilograms of product generated by clandestine production facilities of size *i*, and *p* represents a purity weight ranging from 0.0 to 1.0.		1. Bouchard and Tremblay (2005) 2. Bouchard (2008) 3. Bouchard, Gallupe, Descormiers (2010)
6. Quantity of ATS consumed	Multiplier methods 1 (quantity per user ratio – method 1 for estimate 1 above)	Multiplier methods 2 (quantity per user ratio – method 2 for estimate 1 above)	Bouchard (2008)
7. Quantity of ATS exported	(5) minus (6) above		Bouchard (2008)

a. Initially, we intended on estimating the size of the producer population through capture-recapture methods. This proved not to be feasible because no producer was actually re-arrested for production during the period under study.

Multiplier Methods

One form of multiplier method will be used for each of the estimates to be provided in this study. Within this family are grouped all methods using a ratio from an observed part of the population to make inferences on the unobserved part of the population. For example, multiplier methods have been used to estimate the size of the heroin using populations from a ratio of overdoses per user (Degenhardt, Rendle, Hall, Gilmour and Law 2004; Law, Degenhardt and McKetin 2006). As in Brecht and Wickens (1993), it can be formulated as:

$$(1)\ N = d/p;$$

where N is the total population of users, *d* is the number of overdose deaths, and *p* is the probability of dying from ATS use during a year.

Knowing, for example, that one out of 300 ATS users die of overdose during a given year, we could estimate a prevalence of 10,000 ATS users knowing that 30 overdoses occurred over the course of a year (30/0.003 = 10,000). Because it is dependent on many factors including the lethality of a drug, variations in purity, location or methods of use, the rate of overdose per user varies per type of drug, and even per region for a similar drug. Multipliers of 100 and 125 have been shown to provide suitable estimates of heroin use in Australia a few years ago (Degenhardt et al., 2004). There are currently no established multipliers for meth or ecstasy, but we know that they should be substantially higher than the one used for a more lethal drug like heroin.

In the current study we propose to explore the possibility of establishing a suitable overdose ratio for the ATS market by a) comparing the lethality of ATS to other drugs where overdose ratios are more established (such as heroin), and b) comparing the overdose to ATS user ratios where reliable estimates of ATS users have been provided through other methods (e.g. as in Chiang et al., 2007; Hser, 1993).[3] This work will lead to estimate 1 in Table 5 above.

These methods are also useful for supply side estimates, for example to estimate the size of drug production from a quantity of drugs seized with some assumption about the risk of detection (1%, 5%, 10% or 20%). The problem is of course that it is not adequately known what the detection rates actually are (they have to be estimated through other methods) and these rates are likely to vary from one year to the next (especially if the rates are driven by a particularly large seizure). Hence, the amount of uncertainty is thus larger than for other methods. Triangulation with other methods, as proposed in this study, is important. A detected to undetected ratio will be used as a secondary method for estimate 3 and 4 (Table 5).

Other studies have used variations in the multiplier methods that could be useful in estimating the number of drug dealers (Bouchard and Tremblay 2005; MacCoun and Reuter 2001). The

[3] A recent article by Gable (2004) reviewed a number of studies that examined the lethality of drugs. The study found that the safety ratio (lethal dose/effective dose) for heroin was 6 – the smallest among all legal and illegal drugs examined, meaning that the risks of overdoses were much higher for heroin than for other drugs. The safety ratio for crystal meth was 10 (+150mg/15mg) – comparable to alcohol, higher than heroin, but lower than ecstasy which was 16 (2g/125mg). From this, we can safely assume from the safety ratios that the proper multiplier for meth and ecstasy will be higher than for heroin (125) but how much higher will be determined during the course of this study.

ratio of interest here is the number of users per dealer. This ratio can be obtained from surveillance investigations (Lacoste and Tremblay 1999), but also from surveying drug dealers directly in prison settings. After corrections to take into account variations in productivity per dealer, these ratios were found to be around 7 to 10 users per dealer for crack, heroin, and cocaine (Bouchard and Tremblay 2005). These ratios typically take into account the heterogeneity of the dealing populations involved (e.g., a mix of part-time and full-time dealers), something that should also be found in the ATS markets (e.g., rave party dealing). Assuming one has a valid estimate of the number of ATS users and a users-per-dealer ratio, the number of ATS dealers can be estimated using such a method (N dealers = users/users-per-dealer). These will be used for estimate 2 and 3 above (Table 5).

Capture-recapture Methods

Capture-recapture methods have been proven to provide reliable estimates of hidden populations, including illegal populations (Bouchard 2007; Bouchard et al. 2010). Not unlike other estimation methods presented here, it relies on a pattern found in the observed part of the population to make an inference on the unobserved part. The major difference is that the inference follows a mathematical distribution, usually variations of the Poisson distribution. Such distributions have been shown to reproduce quite well the distribution of rare events, such as the distribution of arrests and re-arrests in an illegal population, or the distribution of entry and re-entry into treatment for drug using populations. These methods are relatively easy to implement, and importantly, they do not require any new data collection exercises. Capture-recapture estimates have a long history of use in biological and ecological research. In criminology, such estimates are derived from existing lists of individuals arrested for a specific offence (e.g., ATS dealing).

There are many variations in the capture-recapture family of models, all with slightly different assumptions about the population of interest and how it behaves prior to, and after capture. One particular model (Zelterman's truncated Poisson estimator – Zelterman 1988) proved to be robust in a number of contexts, especially for the estimation of illegal populations where the assumptions of the Poisson distribution[4] may be violated (Bouchard 2007; Bouchard and Tremblay 2005; Choi and Comiskey 2003; Smit, Toet and van der Heijden 1997; Bohning and Kuhnert 2004). One reason why Zelterman's estimator proved to be robust with such populations is simple: its logic is based on the idea that the projected rate of capture for those individuals not yet captured more closely resembles the rate found for those individuals captured only once or twice. In others words, offenders who have been arrested only once during a year are more likely to 'resemble' those who have not been arrested than offenders arrested many times. Zelterman's estimator is given by:

(2) $Z = N / (1- e(-2*n2/n1));$

[4] The assumptions are as follows: 1) the population under study must be closed (no entries and exits); 2) the population has to be homogenous (same capture rate for everyone); 3) the probability for an individual to be observed and re-observed must be held constant during the observation period.

where Z is the total population, N is the total number of individuals arrested, n1 is the number of individuals arrested once, and n2 is the number of individuals arrested twice in a given time period.

As shown elsewhere (Bouchard and Tremblay 2005; Bouchard 2007; Bouchard et al. 2010), Zelterman's model produces robust estimates in almost any context, with many different types of capture distributions. The model is much simpler than most other models. It also requires only one database (which can be crucial for difficult to track populations), while many other models require the linkage of many databases to construct a capture distribution. Zelterman's estimator is also robust to many different types of data, and it is conservative by nature.

Zelterman Regression

A recent study by Bohning and van der Heijden (2009) provides an interesting extension to Zelterman's estimator for use in a standard regression. The authors noticed Zelterman's compatibility with standard logistic regression, notably its reliance on a binary outcome, and proceeded to extend the estimator for use with covariates in a logistic regression, a procedure that can be labelled as "Zelterman regression". The authors published a STATA program in supplementary materials provided with the article that has been adapted for use with the present data. Note that running the procedure without covariates is equivalent to using equation 2 presented above. An added benefit to using the program is the calculation of confidence intervals for every estimate provided, including the no covariate estimate. The addition of covariates to the estimation procedures is meant to account for the problem of unobserved heterogeneity in the no covariate estimates. However, to the extent that the covariates are not significantly related to the probability of re-recapture, the estimates won't be affected. In other words, the more parsimonious model is either assumed to perform well because of the absence of unobserved heterogeneity in the sample, or the covariates added are simply not solving the problem of unobserved heterogeneity. The latter issue is a real possibility with official arrest data which typically do not contain detailed information on offenders arrested. Below the models without covariates are compared to models with age at first arrest and gender as the main covariates.

In this project, arrest data and capture-recapture methods are drawn on to estimate the number of ATS users (i.e., those users at risk of being arrested – mostly those found among the criminally active population), and the number of ATS dealers in Quebec, from which the number of dealers in Canada will be inferred (estimate 2, Table 5).

Economic Modeling Methods

Easton (2004) drew from economic principles to estimate the number of cannabis cultivation sites in British Columbia. The method proposed here for estimating the number of ATS labs follows the same general outline as that used in the estimation of marijuana grow operations in British Columbia (Easton 2004). With the appropriate characterization of the meth industry a similar technique can be applied to estimate the size of the activity. The basic outline consists of the recognition that these are businesses and consequently are subject to many of the same pressures as faced by legitimate enterprises. For example, among other constraints illegal producers must make a rate of return that is at least as great as that which is received by other legitimate activities; additional risk from both competitors and from law enforcement must be compensated by a higher rate of return; and, producers have to pay people who work for the business a competitive wage whether in goods in kind or in cash.

It is possible to identify the rate of return (ρ) of the operation as simply the value of sales (Q) times the price (P) less costs (C) relative to total cost:

$$(3)\quad \rho=(PxQ-C)/C$$

But ATS lab operations also face operating risks not faced by legitimate businesses: they run the risk of losing their product from raids by the authorities or other criminals. This is not the same kind of business risk faced by legitimate operators who may also lose their product due to fire and flood and so forth. Illegal operators are not able to insure their equipment or product and that raises the risk. To model this risk, assume that the producer faces a probability, π, of losing his production. This means that the expected value of the production that is being brought to market is reduced by that risk to $(1-\pi)xPxQ$.

At the same time we need to recognize that the rate of return faced by the producer must be augmented by the risk he bears. This means that the rate of return, ρ, should be augmented by the risk so that the correct measure of the return is $\rho+\pi$. This leads to an equation that permits identification of the size of the ATS production industry in Canada:

$$(4)\quad \rho+\pi = [(1-\pi)xPxQ-C]/C$$

The reason that this equation permits identification of the size of the industry is that the probability of being busted, π, can be calculated as B/T where B is the number of ATS lab "busts", and T is the total number of labs. "B" is known from police data. "T" is to be calculated. We know the general rate of return to small businesses, ρ, as it has been the same for the past fifty years or so: 10%. For various reasons outlined below, it is possible that the rate of return for ATS labs is larger. We use a figure of 50% in estimates below in illustrating different estimate scenarios. We know the value of production for the average lab operation from police busts across the province. We can calculate the cost of operating an ATS lab. In terms of equation 4 above, we know the values of all the variables, ρ, P, Q, and C, and we know the number of "busts", B. Eq. 4 can be solved for T, the total number of ATS labs:

$$(5)\quad T= Bx[1+(PxQ/C)]/[(PxQ/C)-(1+\rho)]$$

Because this method is applicable only to "businesses", it will solely be used to estimate the number of ATS labs in Canada (estimate 4, Table 5).

Composite Synthetic Estimation Methods

It is difficult or impossible to find an appropriate data source that can cover the full range of possible ATS user populations. Illegal drug users can be found among prisoner populations, but also among otherwise law-abiding citizens, as well as adolescent, and homeless populations

(Bouchard et al. 2010). Although we treat them as a separate category for the purpose of this study, synthetic estimation techniques could be considered as within the family of multiplier methods. Following Rhodes' (1993) lead, the synthetic estimation in this study consists of estimating the size of the ATS using populations in as many different sub-populations as can be found: school students, general adult populations, individuals involved with the criminal justice system, and the homeless. The idea is to derive estimates for each sub-population and then combine them into one. Bouchard (2008) provided a version of this method for the cannabis market in Quebec where he combined separate survey estimates for high school and adult populations. The challenge, however, is much different for other drugs as standard survey methods do not provide a valid estimate of the total number of users involved (Bouchard and Tremblay 2005).

To derive synthetic estimates of the ATS user population, the following equation was used (Wickens 1993):

(6) $\hat{N} = \Sigma i P_c(i) N_t(i)$

where,

$\hat{N}$ = predicted number of users
Σi = summation of the various i subpopulations
$P_c(i)$ = proportion of users within population i
$N_t(i)$ = number of individuals within target population i

Methods to Estimate Quantities of Drugs

The methods described above can be combined to estimate *quantities* of drugs (consumed, produced, exported) as opposed to simply estimating *individuals* (whether users or sellers). For example, once a valid estimate of the number of ATS users is provided, it becomes possible to estimate the quantity of drugs they consume using the mean quantity consumed annually by an average user. Based on past research on users, UNODC (2010) uses quantities of 10.9g for meth and 5.1g for ecstasy to estimate the quantity of ATS consumed worldwide. A similar strategy will be used in this study to estimate the quantity of ATS consumed domestically (estimate 6, Table 5).

Importantly, a similar logic (although slightly more complex) can be applied to estimate production. For example, Bouchard (2007; 2008) proposed the following equation to estimate the number of cannabis cultivation sites:

(7) $S = \sum (Z_i/c_i)\lambda_{i,n}$

where S is the annual number of cultivation sites at risk of detection, Z is the prevalence of growers of type i, c is the number of co-offenders working on a median size plot of type i, and λ represents the proportion of seizures for type i and of sizes n.

Bouchard (2008) then started from this prevalence of sites estimate to derive an estimate for the size of production, in metric tons of cannabis produced. Because fieldwork data showed that plant yield decreases as a function of size (larger sites grow less productive plants, overall), the yield per plant for a type of cultivation site has been calculated by regressing plant yield (in ounces) on the number of plants grown in fieldwork data. The equation can be written as:

$$(8) \qquad TPV_{\text{cannabis}} = \text{S*(Adj. mean size*oz/plant*crops/year)}$$

The adjusted mean size simply reflects the mean number of plants seized by the police minus plant attrition (for any harvests, not all plants will produce). The equation produces an estimate in ounces which can be transformed into metric tons. Using equation 7, Bouchard (2008) estimated cannabis production at 300 metric tons for Quebec in 2002.

The same strategy will be applied to estimate the total production of meth and MDMA. As first presented in Bouchard et al. (2010), total production volume for ATS can be expressed as:

$$(9) \qquad TPV_{\text{Meth/MDMA}} = \sum_{i=1}^{N} (c_i * kg_i * p_i)\,;$$

where, *TPV* denotes total production volume (which could be restated in metric tons), ∑ is the summation operator, *c* is the count of clandestine production facilities of size *i* (*i* = 1 through *N*) at risk of detection, *kg* represents the total weight in kilograms of product generated by clandestine production facilities of size *i*, and *p* represents a purity weight ranging from 0.0 to 1.0. The indicator *i* is needed to reflect varying production volumes and purity[5] across the different facility sizes (which would be coded using an ordinal scale). This work will lead to estimate 5 in Table 5.

Finally, once we have a valid estimate of domestic *consumption* and of domestic *production*, it becomes possible to estimate the quantity of ATS potentially exported to other countries. For example, Bouchard (2008) estimated that 56% of Quebec's cannabis production was potentially exported after having subtracted from his 300 metric ton production estimate the quantity of cannabis consumed in Quebec (100 metric tons) and the quantity of cannabis seized by law enforcement agencies (31 metric tons). The final estimate 7 (Table 5) will be similar in nature, but for ATS markets in Canada.

Data Sources

The main analyses are based on arrest data that were obtained for Quebec. In addition, information obtained from a content analysis of existing literature on ATS cooks and their methods (Chiu et al. 2011; Diplock et al. 2005; Sexton et al. 2006; Weisheit and White 2009; see also Reding's 2009 *Methland*) and a survey of the Internet and extant literature on the economics of ATS production was also conducted in order to supplement the analyses that will be conducted throughout the report.

[5] Purity data was unavailable and therefore, the purity parameter is held at 1.0 for the purpose of this report.

Arrest Data

The main data requirement for capture-recapture estimates is a complete list of arrested individuals for specific offenses for an extended period. In addition, each re-arrest for an individual can be recognized and coded as such. We obtained access to official arrest data for all crimes committed by adults in Quebec from 1999-2009.[6] These data are recorded by law-enforcement agencies across the province and compiled by crime event in the *Module d'Information Policières* (MIP). Information on all arrestees is included for each event. While their identities have been concealed for confidentiality reasons, each individual that has been arrested over this period is tagged with a unique identification number that allows us to track his/her re-arrest in subsequent periods. With such a lengthy period of arrest records, we will be able to draw repeated samples and arrive at more stable estimates.

Whereas estimating most crimes with such data is generally a straightforward procedure, certain adjustments were necessary in the case of arrests linked with synthetic drugs markets. Table 6 presents the number of arrests from 1999 to 2009. Before 2006, all crimes that are of interest for the present project were categorized under a generic 'Other Drugs' label. As of 2006, the possession, traffic, import/export, and production of methamphetamine and ecstasy were included as specific crimes. Table 6, however, illustrates that even though the crimes were explicitly registered as official crimes, the coding of such events did not follow suit in any systematic way until a couple of years after. In order to adjust for these coding limits, we included all arrests for 'Other Drugs' to the ecstasy and methamphetamine related arrests. Without these additional arrests, this data set would be significantly reduced and largely irrelevant for the market estimations designed for this research.

[6] Access conditions with the Quebec Provincial Police required that youths (under 18 years of age) who were arrested for such crimes be excluded from this data set.

Table 6: Arrests for Main Crimes Related to Methamphetamine, Ecstasy, and 'Other Drugs' Markets, Quebec, 1999-2009

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	**Total**
Meth.	*Possession*	0	0	0	0	0	0	0	0	3	176	302	**481**
	Possession/Traffic	0	0	0	0	0	0	0	0	2	41	114	**157**
	Traffic	0	0	0	0	0	0	0	1	0	28	100	**129**
	Import/Export	0	0	0	0	0	0	0	0	0	1	2	**3**
	Production	0	0	0	0	0	0	0	0	0	0	1	**1**
Ecstasy	*Possession*	0	0	0	0	0	0	0	0	0	23	73	**96**
	Possession/Traffic	0	0	0	0	0	0	0	0	0	3	32	**35**
	Traffic	0	0	0	0	0	0	0	0	0	0	26	**26**
	Import/Export	0	0	0	0	0	0	0	0	0	0	2	**2**
	Production	0	0	0	0	0	0	0	0	0	0	1	**1**
Other Drugs	*Possession*	331	489	396	400	577	640	909	1,093	1,403	1,432	1,019	**8,680**
	Possession/Traffic	132	180	138	167	181	239	399	488	573	585	452	**3,534**
	Traffic	213	549	141	157	143	183	262	383	424	365	278	**3,098**
	Import/Export	11	14	10	10	12	14	15	19	22	10	12	**149**
	Production	0	0	0	0	0	0	0	0	0	15	34	**49**
	Total	**687**	**1,232**	**685**	**734**	**913**	**1,076**	**1,585**	**1,984**	**2,427**	**2,670**	**2,448**	**16,441**
	+ 3 Additional Crimes	**771**	**1,369**	**814**	**862**	**1,067**	**1,331**	**2,014**	**2,576**	**3,011**	**3,394**	**3,052**	**20,261**

Because the project aims to estimate the size of the ecstasy and methamphetamine markets as opposed to all 'other drugs' (which include LSD, various prescription pills), the most detailed estimates have been developed for the years 2008 and 2009 where drug specific data were available.

Overall, our data set is comprised initially of 16,441 events in which individuals were arrested for methamphetamine, ecstasy, and 'other drugs' possession, traffic, importation/exportation, and production as a main crime. If we expand beyond the main crime in any event and include three additional crimes[7], the number of arrests increases to 20,261 events (see last row in Table 6). The addition of these three additional crimes that may be possibly linked to an event is consistent across all years, with an increase of 7.5% to 8.9% of arrests per year for the entire period. We will be using mostly the latter set of data for the estimates.

Results

The organization of the results follows the structure of Table 5.

[7] For example, an individual could be arrested for homicide as a main crime, conspiracy as a second crime, cocaine trafficking as a third crime, and methamphetamine possession as a fourth crime.

Estimating the Number of ATS Users in Canada

Method 1 - Synthetic Estimation

First we draw from synthetic estimation methods (eq. 5 above) to estimate the number of ATS users in Canada. To do so, we combine estimates from 4 populations in 2009: general (15 years and older), adolescents (12-14 year olds), homeless, and incarcerated populations.

An estimation of ATS prevalence in the general population of individuals age 15 and over in 2009 was found in the CADUMS survey (CADUMS 2009). The ecstasy prevalence rate was reported at 0.9% and the meth prevalence was reported at 0.1%. Census data from 2006 showed that the population of individuals aged 15 and over was 26,033,060 (Statistics Canada, 2011a). Multiplying the population by the proportion of users in the general population (ecstasy = 0.009; meth = 0.001) resulted in estimated user populations of 234,298 for ecstasy and 26,033 for meth.

To derive estimates for the youth general population (students under age 15—ages 15+ were covered by CADUMS), we used the ATS estimates reported in Atlantic Canada (Poulin and Elliott 2007), Ontario (Paglia-Boak, Mann, Adlaf and Rehm 2009), and Alberta (AHSAMH 2009) to be representative of eastern, central, and western Canada, respectively. An overall ecstasy and meth prevalence rate for 12 (grade 7s), 13 (grade 8s), and 14 year olds (grade 9s) was derived by pooling the number of users and the sample size from each report. It is assumed that there is no ATS use among youth under the age of 12. Multiplying the pooled prevalence rates by census age counts (Statistics Canada 2011b) resulted in an estimated 24,967 ecstasy users and 11,404 meth users in Canada between the ages of 12 and 14. The estimated Canada-wide youth prevalence rates, census counts, and estimated number of youth ATS users are reported in Table 7.

Finding estimates of the size of the homeless population was not straightforward. Radford, King, and Warren (1989) estimated that there were approximately 150,000 street youths in Canada. However, newer figures are desired. Many estimates are specific to certain regions (e.g., GVRSCH 2010) that are not ideal for our purposes. We therefore chose to use the estimate of 150,000 homeless individuals (adult and youth) in Canada as reported in Laird (2007) citing statistics from 2005 found by the National Homelessness Initiative.[8] We assume that the ATS prevalence is the same for all homeless populations as it is for street-involved youth. Using prevalence rates for ecstasy of 5.1% (2003 estimate, reported in PHAC, 2006) and 9.5% for meth (2005 estimate—reported in PHAC 2009), we estimate that there are 7,650 homeless ecstasy users and 14,250 homeless meth users.

[8] www.homelessness.gc.ca - According to Laird, this federal initiative was closed in 2007 and the website no longer exists.

Table 7: Estimated Youth ATS Prevalence Rates, Canada, 2009

	Ecstasy (%)	Meth (%)	Census count	Estimated ecstasy #	Estimated meth #
12 year olds	0.59	0.58	41,3660	2,453	2,387
13 year olds	0.65	0.02	42,3340	2,758	103
14 year olds	4.6	2.1	43,2600	19,756	8,914
Total				24,967	11,404

The final population to be estimated was the incarcerated population. According to Brochu et al. (2001), "half of the offenders used illicit drugs at least once in the 6 months prior to their arrest" (p. 21). Since they do not report ATS prevalence, we estimate this by assuming that the ratio of ATS use to any drug use is the same in the prison population as it is in the general population (as reported in CADUMS):

(9) $P_a/P_d=G_a/G_d$

therefore,

(10) $P_a=(G_a/G_d)P_d$

where,

P_a=Prison ATS use (to be estimated)
P_d=Prison drug use (any drug) (50.0% - Brochu et al., 2001)
G_a=General population ATS use (ecstasy=0.9%; meth=0.1% - CADUMS 2009)
G_d=General population drug use (any drug) (11.4% - CADUMS 2009)

This resulted in prisoner ATS prevalence rates of 3.95% for ecstasy and 0.44% for meth.

The overall prisoner population was based on average daily counts. For adults, the average number of incarcerated offenders was 37,234 in 2008 (Statistics Canada 2011c) while for youths it was 1,719 (Statistics Canada 2011d) for a total daily average of 38,953. Using daily counts instead of yearly admissions makes sense since many prisoners enter and leave (and occasionally re-enter) prison in the course of a given year. Taking yearly prison admission numbers as the population not eligible to be counted in the general population surveys would therefore overestimate the population of incarcerated ATS users. The daily count is more likely to accurately represent the user population not found in general population surveys since it would indicate the number of individuals not eligible for general population surveys on any given day. Multiplying the prevalence rates by the daily average count results in estimated prisoner ATS user populations of 1,537 for ecstasy and 171 for meth.

Summing the estimated ATS user subpopulations results in an expected total Canadian population of 268,452 ecstasy users and 51,858 meth users. There is not likely to be any overlap among the populations. Street youth will not be found in general population surveys. The use of daily average counts of prisoners eliminates any concern regarding overlap with either the street or general populations since this is the population that is not eligible for inclusion in either street or general population surveys on any given day. A population that is not explicitly included below because of the risk of partial overlap with all of those categories is the ATS using population of non-incarcerated offenders. Because of this omission, we believe those estimates to be conservative. In other words, we would be surprised if the true populations were significantly below these, but not if they were higher.

Table 8 provides a summary of the estimated subpopulation numbers of ATS users as well as estimates assuming underreporting rates of 20% and 50%. It is difficult to determine which of the three estimates provided is closest to the mark. In such cases, it might be preferable to not decide on one, and instead work with a range of estimates which reflect the uncertain nature of such estimation exercises.

Table 8: Prevalence of ecstasy and meth users in Canada, synthetic estimates at 0%, 20%, and 50% underreporting

	0%[a]	**20%**[a]	**50%**[a]
Ecstasy:			
General population - age 15+	234,298	281,157	351,446
General population - age 12-14	24,967	29,960	37,450
Street population	7,650	9,180	11,475
Incarcerated	1,537	1,845	2,306
Total	268,452	322,142	402,677
Meth:			
General population - age 15+	26,033	31,240	39,050
General population - age 12-14	11,404	13,685	17,106
Street population	14,250	17,100	21,375
Incarcerated	171	205	257
Total	51,858	62,230	77,788
Ecstasy plus meth	320,310	384,372	480,465

[a]Percentage underreporting.

Method 2 - Multiplier Method

To estimate the ATS user population, we also used the following equation (Brecht and Wickens 1993):

N=d/p

where,

N=estimated number of ATS users
d=meth deaths (from coroner's reports B.C.)
p=probability of death due to meth

No ecstasy-related deaths were found in coroner reports and, therefore, the equation above is only applied to meth. Accessing published coroner reports from B.C. (BCCS 2005), there were five deaths caused by meth in 2003 and three deaths in 2004. The probability of death due to meth was more complicated to derive. Darke, Kaye, McKetin and Duflou (2008) state that: "In the case of heroin, it is estimated that the proportion of overdoses that results in death is 2 – 4% (Darke, Mattick and Degenhardt 2003). To date, there are no comparable data on methamphetamine toxicity, but one Australian study has been conducted on non-fatal cocaine overdose (Kaye & Darke, 2004). This found that 13% of regular cocaine users had overdosed on cocaine, and 7% had done so in the preceding 12 months. Given the psychopharmacological similarities between these two psychostimulants, similar rates might be expected for methamphetamine. Indeed, given the wider availability of methamphetamine, rates may well be higher." Based on the above quote, if we assume that 7% of meth users overdose in any particular year and that 2% of overdoses are fatal, the probability of death due to meth in a given year is 0.02(0.07)=0.0014. In other words, the meth multiplier would be 714, that is, 1 overdose death per 714 meth users per year. In comparison, recall that a multiplier of 125 was shown to provide valid estimates of heroin users in Australia (Degenhardt et al. 2004). If the 714 multiplier is valid, this would mean that heroin is 5 to 6 times more lethal than methamphetamine.

Using the 714 multiplier (or 0.0014 death rate), the following meth population in B.C. is obtained:

$$N_{\text{meth } 2003} = 5/0.0014 = 3{,}571.43$$

$$N_{\text{meth } 2004} = 3/0.0014 = 2{,}142.86$$

Based on the 51-77 000 range found in Table 4, these estimates would imply that BC had between 4% and 7% of all meth users in 2003, which is an improbably low proportion. One possibility is that the meth overdose measure (meth as cause) is too stringent. If we use the number of deaths in which meth was present and not necessarily the main cause (n=15 in 2003; n=33 in 2004 – BCCS 2005), the following estimates are derived:

$N_{meth\ 2003} = 15/0.0014 = 10{,}714.29$

$N_{meth\ 2004} = 33/0.0014 = 23{,}571.43$

These new estimates would imply that BC had between 12% and 45% of Canadian meth users, which may be closer to reality (which is partly a result of the large range provided). Overall, we do not feel confident enough in the multiplier method to recommend using any of the estimates provided above. Much more work is needed to determine whether any of the assumptions used in the process are reasonable. An added disadvantage of this method is that no estimates could be derived for ecstasy.

Method 3 – Alternative Method from Wastewater Analysis

Given the uncertainty with the estimates provided by the multiplier method, we also tested whether the prevalence rates provided by Metcalfe et al.'s (2010) testing of waste water could be used to derive valid estimations of the Canadian ATS population. Multiplying the ATS user proportions reported by Metcalfe et al. (meth=0.0045; ecstasy=0.0004) by the 12-59 Canadian metropolitan population (17,509,680 individuals from 12 to 59 years old in cities with population in excess of 10,000 – Statistics Canada, 2011e) results in an estimated 78,794 meth users and 7,004 ecstasy users in metropolitan areas in Canada. Both estimates are beyond the range found with method 1. The estimated number of ecstasy users is likely too low, which is consistent with Metcalfe et al.'s lack of confidence in the estimate. The prevalence of meth users is outside of the 50-77,000 range estimated earlier at 78 794, but not too much outside of it to be implausible. Because we cannot reach a wastewater estimate for ecstasy, for consistency we will also refrain from using the wastewater meth estimate for that drug.

To summarize, we are most confident in the estimates provided from summing up mutually exclusive prevalence estimates for the four populations presented in Table 8. The wastewater estimate provides some validity to the range of estimates for methamphetamines, especially the high estimate of 77,788. We will use the ranges found in Table 8 where appropriate in analyses presented below.

Capture-recapture Results

Before providing specific estimates for ATS participants active on supplying the drug, it is worth describing the arrest data in greater detail. An analysis of arrest data for Quebec shows that separate records for ecstasy and meth offences were only provided for years 2008 and 2009. We will, therefore, focus on those two years for the majority of analyses presented below. When appropriate for comparison purposes, we provide estimates for "any synthetic drugs" for the 1999-2007 periods. We start by presenting the arrest distributions for all synthetic drug offenders for 2008-2009 and then breaking it down by types of offences (possession, selling – including possession with intent to sell, importation/exportation, and production). These distributions are the basic ingredients needed for the capture-recapture analysis. Prior to discussing the results, a discussion of certain features of the data are in order.

First, distributions overlap – many individuals arrested for selling are charged with possession as well. They were included in both distributions for the purpose of capture-recapture estimation as they were effectively at risk of being arrested for both offences. Offence specific distributions, however, strictly include arrests for the same type of crime (an offender arrested on a possession charge at t1, and on a selling charge at t2 will only show up as a re-arrested offender in the all offender distribution).

Second, to be included, re-arrests had to be separated from the previous arrest by at least 5 full days. This procedure deleted many consecutive day arrests that were inevitably related. While it is certainly possible that many close range arrests of over 5 days are also related, we felt that such a threshold also allowed for a bona fide recapture process to take place – e.g., an offender is arrested on a Sunday, incarcerated 24 hours, released, goes back to selling the following Friday, and is arrested again on a similar charge. Not being able to know for certain from the data, we established the threshold at 5 days (Gallupe, Bouchard and Caulkins 2011 used a similar approach). A total of 1.4% arrest/lines were deleted in 2008 and 2009 in applying this criterion. Most were deleted because multiple entries of the same capture were found on the same day. These procedures may have some internal logic (separate deals, separate labs, etc), but they refer to the same "capture" for our purposes, so they have to be counted as one.

Third, age and gender are included as variables in every analysis below, though they do not always appear in regression models because they are rarely statistically significant. Age and gender are nonetheless interesting covariates to examine with arrest data, especially as the goal is to estimate the size of populations. For example, a significant effect of age in regression models would indicate that older or younger offenders are at greater risks of re-arrest, something which would have practical criminal justice implications.

Finally, arrest year is another important control variable because the timing of the first arrest affects the likelihood of a second arrest: by default, an individual arrested for the first time in late 2009 has a much smaller likelihood of re-arrest than an individual first arrested in early 2008. This is a particularity of this research design where the capture-recapture estimates are derived from a list that accumulates over time, something that is not necessarily commonplace in biology where such methods first originated. Controlling for arrest year partially offsets the effect of this bias by explicitly introducing the information that an individual arrested in a certain year may have lower probabilities of being arrested because of a smaller observation period, which is the case for 2009 arrestees in this sample.

Tables 9 to 13 present the arrest distribution for all synthetic drug offenders for 2008-2009. Three key observations can be made in regard to these results. First, age and gender vary little overall, with a mean of approximately 25 years of age and 86% male proportions, but it is worth noting that: a) slightly more females are generally found in the meth market (16% vs. 14%), b) ecstasy offenders are generally younger (24.7 sv 26.5), c) individuals charged with possession (Table 10) are generally younger than supply side offenders, especially those involved in import/export or production (Tables 12-13). These results are not unexpected. Second, the proportion of offenders re-arrested varies for the meth and ecstasy markets. Many more meth offenders are re-arrested than what we found for ecstasy—this is perhaps linked to the younger age of ecstasy users and dealers, and their (likely) lesser involvement in criminal activities. More extensive comparative profiles of participants to those two markets would be needed to verify these hypotheses.

Tables 12 and 13 show that no offender was re-arrested for import/export or production in 2008-2009. We extended the period to include 11 years of data (1999-2009) and found that a single offender had been re-arrested for the full time period. Such a situation makes capture-recapture methods inoperative. Recall that production was not recorded as a separate offense until 2008. Those offences were rare, and they were subsumed in the import/export category.

Taken as a whole, synthetic drug production/importation/exportation rose steadily between 1999 and 2009, from 16 charges in 1999 to a high of 68 in 2009. A total of 48 of the 68 charges were for production, a 2.4 production-to-importation/exportation ratio. This ratio was 0.95 (18/19) in 2008, which is either an early sign of a turnaround in the industry (e.g. increased reliance on domestic production - import substitution) or simply an early sign of a switch in law enforcement priorities (or both, as we have seen in the cannabis cultivation industry—see Bouchard 2007; Bouchard and Dion 2009). The fact that arrest data does not distinguish between charges for importation and exportation prevents us from being able to make any assumptions about market trends, at least using this data.

Table 9: Age at start of window period, gender, and arrest distribution for meth, ecstasy, and other synthetic drug offenders, any charges, 2008-2009

		Meth	Ecstasy	Other synthetic[9]	All synthetic
Mean age 2008 (std)		27.4 (10.5)	24.7 (8.8)	26.5 (10.4)	26.5 (10.4)
Male %		83.7	86.8	86.1	85.6
Arrests:		**n**	**N**	**N**	**n**
	1	951	420	4,466	5,431
	2	51	5	237	351
	3	3		29	51
	4			6	9
	5			4	5
	6				1
	Total	1,005	425	4,472	5,848

[9] Other synthetic drugs include GHB, PCP, LSD, among others.We suspect that for many of the cases classified under the "other synthetic" category are simply unknown at time of recording, and may include ecstasy and methamphetamine.

Table 10: Age at start of window period, gender, and arrest distribution for meth, ecstasy, and other synthetic drug offenders, at least one possession charges, 2008-2009

		Meth	Ecstasy	Other synthetic	All synthetic
Mean age 2008 (std)		26.1 (9.3)	24.6 (9.1)	25.6 (10.0)	25.6 (9.9)
Male %		85.8	83.3	86.3	86.0
Arrests:		**N**	**N**	**N**	**N**
	1	596	231	2,752	3,417
	2	22	2	97	156
	3			7	13
	4				1
	5				1
	Total	618	233	2,856	3,588

Table 11: Age at start of window period, gender, and arrest distribution for meth, ecstasy, and other synthetic drug offenders, at least one selling charge, 2008-2009

		Meth	Ecstasy	Other synthetic	All synthetic
Mean age 2008 (std)		28.9 (11.9)	24.7 (8.5)	27.7 (10.9)	27.7 (11.0)
Male %		81.1	90.6	85.9	85.3
Arrests:		**n**	**N**	**N**	**N**
	1	396	189	1,881	2,298
	2	17	2	88	123
	3			6	12
	4			7	7
	5			1	1
	Total	413	191	1,983	2,443

Table 12: Age at start of window period, gender, and arrest distribution for meth, ecstasy, and other synthetic drug offenders, at least one import/export charge, 2008-2009

		Meth	Ecstasy	Other synthetic	All synthetic
Mean age 2008 (std)		N = 6	N = 4	N = 29	29.0 (10.3)
Male %					84.6
Arrests:		**n**	**N**	**N**	**N**
	1				39
	Total				39

Note: we do not trust substance specific classification for import/export, thus we only provide statistics for any synthetic drug import/export

Table 13: Age at start of window period, gender, and arrest distribution for meth, ecstasy, and other synthetic drug offenders, at least one production charge, 2008-2009

		Meth	Ecstasy	Other synthetic	All synthetic
Mean age 2008 (std)		N = 4	N = 3	N = 63	29.6 (10.4)
Male %					87.9
Arrests:		**n**	**N**	**N**	**N**
	1				66
	Total				66

Note: We do not trust substance specific classification for production, thus we only provide statistics for any synthetic drug production.

An examination of the full time period (1999-2009) shows a steady increase in synthetic drug-related arrests. The increase was most spectacular between 2005 and 2008 as the number of offenders arrested more than doubled. This trend in Quebec is consistent with trends observed elsewhere (McKetin et al. 2008; UNODC 2009).

Table 14 presents the capture-recapture estimates for all synthetic drug offenders and then breaks it down by type of offense (possession and selling, Tables 15-16). No estimates could be provided for importation/exportation and production because not enough offenders were re-arrested for those offences.

Table 14: Capture-recapture regression (Zelterman) estimates for meth, ecstasy, other synthetic drugs, and any synthetic drugs - All offences, 2008-2009 (best model in bold)

		AIC	G^2	P	$\hat{N}$	95% CI
Meth						
	Null	405.11			9,882	7,182-12,582
	Year	**396.67**	**10.43**	**.00**	**11,711**	**7,690-15,732**
Ecstasy						
	Null	**56.37**			**18,063**	**2,234-33,893**
Other synthetic						
	Null	1,880.11			47,092	41,123-53,061
	Year + Age	**1,857.89**	**26.23**	**.00**	**52,713**	**44,474-60,952**
Any synthetic						
	Null	2,649.05			48,230	43,17-53,243
	Year	**2,607.57**	**43.49**	**.00**	**54,666**	**47,528-61,804**
	Best annual estimates[a]	**2008-2009**	**2005-2007**	**2002-2004**	**1999-2001**	
	Meth	5,856	-	-	-	
	Ecstasy	9,032	-	-	-	
	Other synthetic	26,357	-	-	-	
	Any synthetic	27,333	19,370	11,235	6,619	

Note. Regression models for 1999-2007 not shown, but available upon request
a. Moving average: the two year 2008-2009 estimates were divided by 2 to obtain annual estimates.

Unless otherwise noted, we always ran two separate models for each offense, and each market (meth, ecstasy, other synthetic, and any synthetic (which combines them all). The first model (Null) is the classic Zelterman (1988) estimator involving no covariates. The other model includes one or more covariates among "Year of first arrest", "Gender" or "Age", depending on whether one or more of them were significantly related to the probability of re-arrest for a specific offense/drug. We always started by running the full model with all covariates included, and then backward estimated models until only significant covariates are included. This means that for some offense/drug combinations, only the null model (no covariate, equivalent to Zelterman 1988) proved to be significant and is presented below.

For each set of estimates, Akaike's information criterion (AIC) indicates which model is a better fit to the data (the smaller the AIC, the better the fit). The logic of AIC will make it biased towards choosing the best fitting, most parsimonious model possible. In other words, it penalizes the addition of non significant variables to models. For each model with covariates, we report whether the model (G^2) is significant (p), the population estimate (N), and the 95%

confidence interval. The smaller the interval, the more confidence one can have in the N estimate, although the intervals are strictly based on statistical fit, it cannot be emphasized enough that there are no guarantees that they are more or less on target.

A few additional notes are in order before the results are examined more closely:

- Estimates will not vary much when covariates are not significant, as is most often the case below. This is because the covariates used do not correct for any unobserved heterogeneity in the data. In those situations, the simpler (Null) model is usually preferred.
- When a covariate is shown to be significant, it will generally increase the estimated size of the population. Although further tests are needed to better understand the model's behavior in different contexts, it appears to be a situation where the added information corrects an arrest rate that was assumed to be too high for a significant portion of the population.
- Estimates get extremely unstable in cases with smaller proportions of re-arrests. This is the case for some of the estimates provided for the ecstasy market where some of the confidence intervals cross zero (e.g. table 15), making the estimates invalid.
- We provide estimates for two years of data. As such, the estimates should be interpreted as representing a population that has been active at least for some time period during those two years. If the interest is in annual populations of offenders, an argument can be made for providing an annual 'moving average' estimate for a time period by dividing the size of the population by two (or three for a three-year period), as others have done (Bouchard 2007; Bouchard and Tremblay 2005). Although we only had two years of drug specific data, it proved suitable to the application of capture-recapture methods.
- Because arrest distributions overlap (see above), estimates for an offense category should not be added to another in order to assess the size of those populations. We believe the 'all offenders' estimates provide the best overall size estimate. The offense specific estimates are nonetheless meaningful – many sellers are at risk of being arrested strictly for possession, and it makes sense to have those sellers belong to both populations for the purpose of this study.

Starting with all offences, Table 14 shows that the population of synthetic drug offenders at risk of being arrested in Quebec is estimated to be around 55,000, with a relatively tight confidence interval of 47,500-62,000. The 55,000 model is estimated from a model where our control for "year of first arrest" was shown to be statistically significant (simply referred to as "year"), an expected result that simply means that offenders who are first arrested in 2008 have a higher likelihood of being re-arrested before the end of the window period (December 31, 2009). The better fit of the 'year' model is a common result for all capture-recapture analyses presented in this report.

Table 14 also shows that offenders involved in synthetic drugs other than methamphetamines and ecstasy are the most prevalent. The estimates suggest a prevalence of 12,000 for meth, 18,000 for ecstasy, and over 52 000 for other synthetic drugs (a population which offenders with charges for meth and ecstasy as well, something that is revealed by the only slightly higher 55,000 total population estimate). It is uncertain whether the recording practices of law enforcement agencies are consistent and that such a breakdown reflects true synthetic drug market patterns. We suspect that the specific substance cannot always be accurately identified at the time of recording and that many officers will file the arrest under the “other synthetic drug” category to err on the side of caution. Without a clear answer to this question, we work with the assumption that the breakdown is meaningful for the purpose of estimating the size of the meth and ecstasy markets in Quebec. This assumption should be tested in future work.

Our results also include annual estimates for four time periods (1999-2001, 2002-2004, 2005-2007, and 2008-2009) for “any synthetic drug offences”. [10] This exercise reveals what we already knew from the arrest data, namely that the synthetic drug market exploded during those years, from 6,000 to 27,000 offenders in a 10 year span.

Table 15 and 16 show the estimates for possession and selling offences, respectively. As expected, more offenders are at risk of being arrested for possession than for selling synthetic drugs, which is to be expected as: a) there are more users than dealers, at least 10 times more for most markets (Bouchard and Tremblay 2005); and b) it is easier to charge someone for possession than selling. A comparison shows that the population estimates for possession increased one period before (2002-2004) it increased for selling (2005-2007) at a much faster pace than the one for selling. The relatively linear increase for possession shows signs of stabilizing in 2008-2009, although more years of data would be needed to confirm a trend.

The estimates for selling are especially important for our purposes as one of the objectives of this report is to estimate the size of the dealer population. The results suggest an annual population of 3,500 meth dealers in Quebec. Unfortunately, the small proportion of ecstasy dealers re-arrested did not produce a reliable estimate for that drug. The one actually produced suggest a larger number of dealers for that drug (4,500), something that would be consistent with patterns found on the demand side. An examination of the actual models show that age was a significant factor for the “other” and “any” synthetic drug markets. Where significant, the (positive) direction of the effect suggests that risks of re-arrests increase with age. For the only instance where gender is significant (Table 16, selling any synthetic drug), the direction of the effect suggests that risks of re-arrest are higher for females. Consequently, it means that most of the time, neither males nor females are specific targets of law enforcement agencies in the synthetic drug markets.

[10] Details of the estimates derived from 1999-2007 not presented in this final report are available upon request to the first author.

Table 15: Capture-recapture regression (Zelterman) estimates for meth, ecstasy, other synthetic drugs, and any synthetic drugs – Posession offences, 2008-2009 (best model in bold)

		AIC	G^2	P	$\hat{N}$	95% CI
Meth						
	Null	191.97			8,684	5,063-12,305
	Year	**183.86**	**10.11**	**.00**	**12,974**	**4,515-21,433**
Ecstasy						
	Null	**25.01**			**13,573**[a]	**-5,236-32,381**
Other synthetic						
	Null	848.38			41,959	33,625-50,292
	Year	**842.78**	**7.60**	**.01**	**45,664**	**34,909-56,419**
Any synthetic						
	Null	1,284.06			41,117	34,686-47,548
	Year	**1,275.93**	**10.12**	**.00**	**43,888**	**36,096-51,679**
	Best annual estimates[b]	**2008-2009**	**2005-2007**	**2002-2004**	**1999-2001**	
	Meth	6,487	-	-	-	
	Ecstasy	6,787	-	-	-	
	Other synthetic	22,832	-	-	-	
	Any synthetic	21,944	18,004	11,068	5,596	

Note. Regression models for 1999-2007 not shown, but available upon request

a. Invalid estimate, confidence interval crosses zero

b. Moving average: the two year 2008-2009 estimates were divided by 2 to obtain annual estimates.

As noted above, it was impossible to derive population estimates for importation/ exportation or production. We did have one offender arrested twice during period 1, which produced an estimate of 968 offenders at risk of being arrested for that time period (or 323 offenders annually, not shown). However, we cannot put any trust in that estimate, especially considering the confidence interval which crosses zero (lower bound equals -927, upper bound equals 2,864).

Table 16: Capture-recapture regression (Zelterman) estimates for meth, ecstasy, other synthetic drugs, and any synthetic drugs – Selling offences, 2008-2009 (best model in bold)

		AIC	G^2	*P*	$\hat{N}$	95% CI
Meth						
	Null	143.76			5020	2,640-7,399
	Year	**138.70**	**7.06**	**.01**	**6915**	**2,294-11,537**
Ecstasy						
	Null	**24.22**			**9121**[a]	**-3,518-21,759**
Other synthetic						
	Null	721.01			22200	17,578-26,822
	Year+Age	**712.94**	**12.06**	**.00**	**24938**	**18,761-31,116**
Any synthetic						
	Null	974.66			24,045	19,815-28,275
	Year+Age+Gender	**958.19**	**22.47**	**.00**	**28,483**	**21,979-34,987**
	Best annual[b] **estimates**	**2008-2009**	**2005-2007**	**2002-2004**	**1999-2001**	
	Meth	3,458	-	-	-	
	Ecstasy	4,561	-	-	-	
	Other synthetic	12,469	-	-	-	
	Any synthetic	14,242	11,944	4,848	4,281	

Note. Regression models for 1999-2007 not shown, but available upon request

a. Invalid estimate, confidence interval crosses zero

b. Moving average: the two year 2008-2009 estimates were divided by 2 to obtain annual estimates.

Estimating the Number of ATS Dealers

Method 1 – Capture-recapture Methods

No Canadian-wide data was available to estimate the size of the ATS dealing population in Canada. Although not ideal, the results for Quebec presented above are helpful in trying to provide a crude estimate of the number of sellers for Canada as a whole. In the spirit of synthetic estimation methods, we first have to find meaningful ATS-related data that is produced for both Quebec and Canada, an indicator that is likely to vary in similar ways. One candidate is simply the number of users as estimated by the general population survey. One reason why it is a suitable candidate is because the number of sellers is most likely to follow the number of users. The same cannot be said, for example, for the number of producers which may or may not follow trends in other market levels, depending on the intensity of the exportation activities.

Table 17 presents the estimates for the number of meth and ecstasy sellers, as estimated from the prevalence of sellers found in Quebec (Table 16). The inference method make a number of assumptions that may not always be tenable, including the assumption that patterns found in Quebec are representative of patterns found in the rest of the country and the key assumption that we start from reliable prevalence estimates.

Table 17: Inferring the prevalence of meth and ecstasy sellers in Canada from the number of sellers in Quebec, 2009

	Meth	**Ecstasy**
Seller prevalence – Quebec	3,458	4,561
User prevalence - Quebec - CADUMS	6,294	62,936
User prevalence - Canada – CADUMS	26,033	234,298
Inference - Seller prevalence – Canada	14,303	16,980

Table 17 suggests that, based on the general population survey indicators, the estimated population of meth and ecstasy dealers are 14 000, and 17 000, respectively. Are these estimates plausible? One way to probe these dealer estimates is to see how they compare to the user prevalence estimates of Table 8. For meth, we found a range of 52,000 to 78,000. A prevalence of 14,000 dealers implies a 3.7 to 5.6 user-to-dealer ratio, which is low, yet not implausible for non-cannabis markets (see Bouchard and Tremblay 2005). The user to dealer ratio derived for ecstasy is much larger, between 15 and 24 which appears high, but again, not implausible. No hard statements can be made about these estimates without finer research in the user-dealer dynamics for those markets in Canada. In the meantime, the numbers derived appear reasonable enough (that is, within the limits of a very large ball park) to proceed.

Method 2 – Multiplier Method

The second method used to estimate the number of dealers relies on the assumption of the reliability of two indicators: 1) the prevalence of ATS users, and 2) the user-to-dealer ratio. We estimated the first indicator above. The second indicator requires fieldwork data. Unfortunately, our attempts at interviews with insiders within the ATS markets in Quebec were unsuccessful. Therefore, we need to rely on data derived from other drug markets, as presented in Bouchard and Tremblay (2005). The good news is that those ratios vary relatively little by type of drug sold: 15 for cannabis, 11 for cocaine, 8 for crack, 7 for heroin. In the absence of ATS data, we use the full range above (7-15) to produce the estimates.

Table 18: Estimates of the number of meth and ecstasy sellers in Canada, multiplier method (user-to-dealer ratio), 2009

	Meth	Ecstasy
Prevalence of users - low (0% underreporting)	51,858	268,452
Prevalence of users – high (50% underreporting)	77,788	402,677
User to dealer ratio - low	7	7
User to dealer ratio - high	15	15
Low estimate: Users low/high User-dealer ratio	3,457	17,897
High estimate: Users high/low User-dealer ratio	11,113	57,525
Middle estimate	7,285	37,711

The range estimated for both substances is outside the one estimated with method 1 above. For meth, the estimated range of 3,457-11,113 is completely below the 14,000 estimated above. For ecstasy, the scenario is inversed: the 18,000-57,000 range is completely above the 17,000 estimated with method 1. Which one is most plausible? It is hard to know for certain, as even the user-dealer ratios were not derived from either market. Based on the above, the safest statement that can be made at this point is that the population of meth dealers is found within the 3500-14000 range and that the ecstasy dealer population is most likely to be found within the 17,000-57,000 range.

Number of ATS Labs

Despite our best efforts to locate ecstasy specific production data, the simple fact is that more data is available on meth labs than ecstasy labs. Given this situation, we settled on accumulating as much data as possible on meth production for the purpose of estimating the number of ATS labs more generally. Drug specific data on ATS seizures involves very small numbers, and some uncertainty in regards to actual drugs being produced. In their survey of synthetic drug production in BC, Diplock et al (2005) reported that 27 of the 33 files analyzed involved meth labs, five were ectasy labs, and one was a GHB lab. They note that 7 of the 27 meth labs were set up to produce ecstasy as well. The RCMP (2009) reported that, among the 45 synthetic drug lab seizures in 2008, 12 were ecstasy labs and 21 were meth labs. Given the results presented in Diplock et al. (2005), however, and the small number of labs involved in seizures annually, we are not confident enough in the distinction between the type of synthetic drug lab to produce drug specific estimates. With little data on ecstasy production available at the current time, we make the assumption that the cost structure of ecstasy production is comparable to what is derived for methamphetamine below.

Method 1 – Economic Modeling Method

The chemicals frequently used to manufacture methamphetamine include pseudoephedrine, anhydrous ammonia, and red phosphorus. However, there are many methods that can be used to reach the same production goal. Many of the ingredients have legal uses from cold remedies for pseudoephedrine to anhydrous ammonia for agricultural fertilizer or red phosphorus for matches. This makes it particularly important to identify the cost of the various methods to get a reliable fix on the number of labs. Thus far, we have not been able to find anything other than what could be termed generic statements about cost. Some 32 different chemicals can be involved in the process although all start with ephedrine or pseudoephedrine (Chiu, Leclerc and Townsley 2011). We have not been able to identify a price and quantity for each. This would require supplemental information from participants in this market or law-enforcement experts.

We are, however, able to derive a partial estimate of the cost structure of meth production. It takes about 10-20 milligrams of meth to have an effect in controlled conditions (Health Canada 2005). Often found in the literature is the assertion that there are roughly 110 doses per ounce or 3.88 doses per gram. If we take the smaller amount, we have about 10 doses to the gram. If meth retails for $25 per quarter gram and $100 per gram, then one dose is $10. If you have 110 doses per ounce and 28g/oz then each gram yields an average hit of 250 mg. Consequently, without access to street level data, it is difficult to conclude what the “average” dose taken really looks like and indeed heavy users need higher doses. A reasonable assumption would be that the total investment needed for a one-ounce production of meth is approximately $200, plus the cost of anhydrous ammonia and the labour cost of production, which should take the better part of a day (this is for a small lab since larger amounts are produced by labs and “super labs”). Assembling the materials is relatively time consuming, although not too difficult for professionals. The cooked product is diluted to become two to three ounces and sold for approximately $1500 an ounce, although of course this varies by region. Labour costs and risks are not included in the assessment. Appendix B details the costs of some of the ingredients as would be available to a pharmacist, for example. I t also provides an example method to extract meth drawing from those ingredients.

This report’s estimates are based solely on a survey of the internet rather than on police statistics. Clearly there are areas in which some police data may be available, but more importantly they illustrate the kind of information that would be usefully gathered by law enforcement to permit a better estimate of the number of illicit labs.

In Canada there were close to 50 synthetic drug labs busted in 2009. This is a small number and may well be too small to represent the population. However, to the extent that it reflects an industry that is growing, it may also be associated with a higher rate of return than what we might characterize as the "normal" rate of return which is about 10 percent for small business. In what follows we will assume that in Canada a reasonable return requires the investor to obtain a fifty percent return on his investment. This is likely to be a transitory assumption since a larger scale of operation will surely reduce the return.

The value of a gram of meth is assumed to be worth $100, which is consistent with the UNODC (2009) retail estimate. The wholesale price reported by UNODC is $22,086/kg. Following equation 5 with assumptions that the cost of producing an ounce of meth is $200 worth of materials, plus another $200 in wages for the producer and another $100 for rent and protection, yields an unrealistically small estimate of the number of labs in operation.

A more conservative approach to the economics of meth production leads to an estimate of the number of producers that is signficantly greater. In particular, if we believe that the cost of production is higher than the simple value of the ingredients since there is an apartment to be rented, risk attached to the purchase of the materials, and the possibility of permanent injury during the process of production, then combined with a higher rate of return required on the production process, this leads to an estimate of the number of ATS labs of about 1,400. The assumptions are that the value of production is $100 per gram, that a return of 50 percent is required, and that the cost of production is about $1,800 an ounce. With 50 busts a year, this would imply a detection rate of 3.6%, which would be 3 times lower than the rate for cannabis cultivation sites in Quebec (Bouchard 2007; 2008). Decreasing the cost assumption to $1,700 yields an estimate of 560 labs, for a detection rate of 9%, and another $100 decrease produces an estimate of 350 labs (14% detection rate). To refine this estimate and get a stronger sense of the number of labs we need data from the larger labs so that their economies of scale and cost of production can be more systematically developed. In the absence of better data on ATS labs in Canada, a 560-1,400 range appears to be plausible, especially given the amount of meth and ecstasy seized in 2007-2008 (UNODC 2009; 2010).

Table 19 illustrates how estimates are sensitive to a change in the cost parameter, which we make vary from $400 to $1800. This method also relies heavily on the number of labs detected – a significant change in the number of labs detected would produce a significant change in the prevalence estimate. Variations in costs across this range would lead to estimates of the number of labs (N) from a low of 64 to a high of 1400. The probability of discovery (π) also decreases radically (from 0.79 to 0.04) as the costs or estimated number of labs increases. Appendix C discusses some of the ways in which this method can be improved should more detailed data be available in future research endeavours.

Table 19: Variations in Lab Estimates in Accordance with Differential Cost Parameters

P	Q	C	R	B	N	π
2800	1	400	0.5	50	64	0.79
2800	1	500	0.5	50	68	0.73
2800	1	600	0.5	50	74	0.68
2800	1	700	0.5	50	80	0.63
2800	1	800	0.5	50	88	0.57
2800	1	900	0.5	50	97	0.52
2800	1	1,000	0.5	50	108	0.46
2800	1	1,100	0.5	50	122	0.41
2800	1	1,200	0.5	50	140	0.36
2800	1	1,300	0.5	50	165	0.30
2800	1	1,400	0.5	50	200	0.25
2800	1	1,500	0.5	50	255	0.20
2800	1	1,600	0.5	50	350	0.14
2800	1	1,700	0.5	50	560	0.09
2800	1	1,800	0.5	50	1,400	0.04

P= price per ounce;
Q = quantity in ounces;
C = assumed cost;
R = rate of return assumed (.5 is 50%);
B = number of discovered labs;
N = implied number of labs (raw);
π = probability of discovery

Estimating the Number of ATS Producers

No estimates can be derived through the capture-recapture method as no producer was re-arrested in Quebec in 2008-2009 when this offense started to be recorded. Here we rely on multiplier method estimates which are subject to even more uncertainty. Note that an estimate of the number of producers is unnecessary for estimating the quantity of ATS production, which relies on the ATS lab estimate.

Method 1 – Multiplier Method: Producer per lab ratio

A producer per lab ratio estimate starts with the ATS lab estimate and derives the number of producers based on the division of labour involved in a typical lab. For cannabis production, Bouchard (2008) suggested that, on average, four individuals are involved from start to finish. Synthetic drug production is likely to involve either as many people, or perhaps less (cannabis cultivation is generally perceived as more cumbersome and involves more steps requiring potential help from others, such as setting up the site, harvesting and trimming the plants). Sexton et al.'s (2006) small-time producers suggested a process involving at least two people, sometimes more if help is required to buy the ingredients. Chiu et al. (2011), who examined court cases of large-scale meth labs in Australia, do not report any numbers but mention four roles to be filled: operator/organizer, cook, worker (run errands, courier), and security. The more productive the lab, the higher the likelihood of finding different people taking on such roles.

In the absence of ATS specific division of labour data, we believe that a ratio of three to four producers per lab is reasonable. We use a ratio of 3.5 in the estimates presented below in table 20 below.

Table 20: A producer per lab estimate of the number of ATS producers in Canada

	Low estimate	**High estimate**
Number of labs	560	1,400
Number of producers per lab	3.5	3.5
Producer estimate	1,960	4,900

Table 20 suggests a population of 1960 to 4900 ATS producers in Canada. This estimate is, needless to say, highly speculative. We do not have data on the number of producers arrested annually in Canada. The data for Quebec (Table 13) shows that 66 individuals were arrested for synthetic drug production in 2008-2009, a mean of 33 arrests per year. Assuming that 25% of producers estimated in Table 20 are from Quebec (range: 490-1225), the risk of being arrested for synthetic drug production would be 2.7-6.7%. This range would be consistent with the one found through capture-recapture estimates of the number of cannabis growers in Quebec: 2-5% (Bouchard 2007).

Method 2 – Multiplier Method: Arrest ratio

The second method considered simply estimates the prevalence of producers through a hypothetical detected-to-undetected ratio, illustrated in Table 21 below. We know from Bouchard (2007) that the risks of being arrested for a cannabis producer ranges between 2 % and 5% per annum. If we assume that the risks for ATS producers may not vary too widely from those numbers, the estimates found in table 21 can be derived. These estimates are almost purely based on hypotheticals, so even more caution than usual should be applied. Because the substance specific arrest data has not been confirmed to be reliable, only one estimate for synthetic drugs as a whole is produced.

Depending on whether one believes that 1% or 10% is the proper arrest rate, the population of producers in Quebec varies between 330 and 3,300. Based on demand side proportions, the Canadian estimate would likely be four times the Quebec estimates (1,320-13,200). It is an enormous range, wide enough to not warrant further interpretation/consideration at this point. The true rate could very well outside of that 1-10% range, there is simply no way to know for certain at this point. For the moment, more faith should be put in the producer per lab ratio estimate for Canada found in table 20: 1,960-4,900 producers, which may imply that arrest rates are at the lower end of the scale.

Table 21: Estimating the prevalence of ATS producers through hypothetical arrest rates, Quebec, 2008-2009

	Hypothetical yearly arrest risk			
	1%	2%	5%	10%
Mean annual number of synthetic drug producers arrested in 2008-2009	33	33	33	33
Estimated prevalence of synthetic drug producers	3,300	1,650	660	330

Quantity of ATS Production

Diplock et al. (Diplock et al. 2005, Table 3 and page 5) found that some 60 percent of the labs discovered by the police in BC were capable of producing more than 5 pounds of meth or ecstasy during a single cook. Of the 33 cases that were discovered, two were able to produce as much as 250 grams (nine ounces), four between 250-500 grams; two between 500 g and one kilogram; four between one and five kilograms; and twenty were able to produce five kilograms or more. These values are decisively different from the previous exercise which was based on values of one ounce or 28 grams of production.

Although we do not have a good read on the actual number of labs associated with what would be a very different cost structure as well as product pricing, we can hazard a guess about overall production if we assume that the crude distribution found in BC is similar to that in the rest of the country. In Table 22, the percentages are those found in BC of ATS labs of different capacities. This implies the number of labs of each size and the average number of grams of each "cook". This estimate also keeps the purity parameter constant: without reliable data on purity, it is assumed that ATS production refers to the weight of what will eventually be sold as ATS to drug users. The final column in Table 22 gives the total production of the single cook by each type of lab, with an estimated 2,297 kg from 560 labs, and 5,743 kg from 1,400 ATS labs.

The vast bulk of production occurs in the large labs. Of course, this is based on an assumption that the distribution of labs is the same as that discovered in BC, which is highly unlikely. The police are more likely to find larger operations than a myriad of smaller ones so it is likely that this is an overstatement of the total amount of production based on one cook. Yet, these estimates should not be taken as final counts, as they are likely to be too low. The estimated production is simply that of one "cook". Estimating the total quantity of ATS production in Canada requires information on the mean number of annual cooks per lab. This is information is not available at this time. Logistically, a small lab can potentially make four to six cooks a month. The limit, and it could be an important one, is in consistently finding the required material for another cook. Note as well that many of the 33 labs described by Diplock et al. (2005) in BC were inactive, suggesting that many labs may not necessarily produce at their potential or even near their potential. Indoor cannabis growers, for example, could produce up to eight crops a year, but rarely go beyond three or four (Bouchard 2008).

Table 22: Output Estimates of ATS labs based on one cook/lab

Production	%*	Number of Labs	Average cook (gr)	Total Kilograms
Implied output of 560 Labs				
50 - <250 g.	7	39.2	150	5.9
250 -<500 g.	13	72.8	375	27.3
500 g – 1 kg	7	39.2	750	29.4
1 - <5 kg	13	72.8	3,000	218.4
5 Kg+	60	336.0	6,000	2016
TOTAL ONE COOK/LAB PRODUCTION				2,297.0
Implied output of 1400 Labs				
Production	%*	Number of Labs	Average cook (gr)	Total Kilograms
50 - <250 g.	7	98	150	14.7
250 -<500 g.	13	182	375	68.3
500 g – 1 kg	7	98	750	73.5
1 - <5 kg	13	182	3,000	546.0
5 Kg+	60	840	6,000	5,040.0
TOTAL ONE COOK/LAB PRODUCTION				5,742.5

*Diplock et al. 2005. Calculations by the authors

Given the quantity of ATS consumed in Canada (a high estimate of close to 3 metric tons as shall be seen below) the quantity of Canadian produced ATS seized annually (2.5 mt in 2007, 0.8 mt in 2008), a ratio of two cooks per lab is minimally required for the low estimate to be realistic. Whether such a ratio should be three or more cooks per lab is unknown. We believe that a ratio of two cooks per lab is reasonably conservative given the current state of knowledge, leading to the final estimates produced in Table 23, below.

Table 23: Total ATS production in Canada, 2009

	Low estimate	**High estimate**
Total production based on one cook	2,297 kg	5,742.5 kg
Number of cooks per lab/year	2	2
Total ATS production	4,594 kg	11,485 kg

Table 23 suggests a range of 4.5 to 11.5 mt of ATS produced annually in Canada. Given such production, the seizure rate would have been 21.7-55.5% in 2007 with a record 2.5 mt of Canadian produced ATS seized, and 7.4-18.9% in 2008 where a more modest 850kg of ATS was seized. The seizure rate calculated by Bouchard (2008) for cannabis cultivation was 11%. Unless one believes that law enforcement agencies are that much better at detecting ATS than cannabis (the low number of seizures would indicate otherwise), the high estimate of 11.5 mt of ATS produced may be closer to reality. Again, any strong conclusion is unwarranted at this stage. Based on UNODC's (2010) estimate of worldwide ATS production of 250-746 metric tons, the 4.5 mt scenario would imply that Canada produces 0.6-1.8% of the total world amount.

Based on the 11.5 mt scenario, we would expect 1.5-4.6%, for a final range of 0.6 to 4.6%. Whether Canada deserves a 'major player' reputation based on those numbers is a matter of opinion, but under no plausible scenario can Canada be considered as a major producer in the global ATS market under most standards.

Quantity of Domestic ATS Consumption

Method 1: Quantity per user ratio I

Using Kilmer and Pacula's (2009) methods and assumptions, we provide estimates of the amount of ecstasy (Table 24-25) and meth (Table 26) consumed in Canada using the prevalence estimates derived above (Table 8). The estimated range for both substances is wide. For ecstasy, it is from 8 million to 56 million ecstasy tablets consumed in Canada in a given year. It is slightly lower than the one produced by Kilmer and Pacula (2009) for 2004, reflecting a slight decrease in ecstasy use noticeable in the general population survey. The mid-range estimate would be 32 million tablets. The RCMP typically seizes over 1 million ecstasy units annually (1.5 million units in 2008, according to UNODC 2010) and an unknown quantity of domestic production is destined for markets overseas. The estimated range implies that whether the consumption estimate is closer to the low or high end estimate (which are lower bounds of the total production which includes exports), the seizure rate achieved by law enforcement agencies would at most be anywhere between 1.8% and 19%.

Table 24: Estimating the quantity of ecstasy consumed in Canada in 2009 from the table per user ratio found in Kilmer and Pacula (2009)

	Ecstasy
Past year users (Table 8) above	268,452 users
Correction for under reporting (20%/50%)	Low (20%): 322,142 High (50%): 402,678
Mean tablets consumed/year (Kilmer and Pacula 2009)	Low: 30 tablets/year High: 139 tablets/year
Low tablets * low user estimate	8,053,560 tablets
High tablets * high user estimate	55,972,242 tablets

Table 25: Estimating the quantity of ecstasy consumed in Canada in 2009 from UNODC's (2010) gram per user ratio

	Ecstasy
Past year users (Table 8) above	268,452 users
Correction for under reporting (20%/50%)	Low (20%): 322,142 High (50%): 402,678
Mean amount of grams consumed/year (UNODC 2010)	5.1 grams
Low estimate – quantity	1,643 kg
High estimate – quantity	2,054 kg

When transformed back into kilograms at 75 mg/pill, the range found in Table 24 produces a wide range of 604 to 4,198 kg of ecstasy used in Canada. Relying on UNODC's 5.1 gram/user ratio, the range is brought down to 1,643-2,054 kg (Table 25), which is considered as the best estimate for the purpose of this report.

For meth, we had to modify Kilmer and Pacula's method because the available Canadian meth consumption data is not detailed enough. What we did for the lower bound is to use the mean amount of meth used per year per user as provided in the UNODC's World Drug Report 2010: 10.9 grams.

Table 26: Estimating the quantity of methamphetamine consumed in Canada in 2009 from UNODC's (2010) gram per user ratio

	Meth
Past year users (Table 8) above	51,858 users
Correction for under reporting (20%/50%)	Low (20%): 62,230 High (50%): 77,788
Mean amount of grams consumed/year (UNODC 2010)	10.9 grams
Low estimate – quantity	678 kg
High estimate – quantity	848 kg

According to Table 26, Canadians consumed anywhere from 678 to 847 kg of methamphetamines in 2009. Combined with ecstasy, this gives us a range of 2,321 to 2,902 kg of ATS consumed by Canadians in 2009.

Method 2: Quantity Per User Ratio II

We also estimated the number of meth users in Canada from the wastewater analysis method (Metcalfe et al. 2010). Because this estimate is so close to the high end estimate presented in Table 26 (859 kg vs 848 kg), we simply rely on the range produced in Table 26 for the purpose of estimating the quantity of ATS exported below.

Quantity of ATS Exported

The previous estimates allow us to assess the quantity of meth that is possibly exported from Canada. As before, we offer two different scenarios (one low and one high estimate). Neither scenario may be discarded at this point. Indeed, the true estimate could possibly even higher than what is estimated here. It is not likely, however, that ATS production is lower than the low estimate found in Table 27 (see below).

Drawing from mid-point estimates for consumption and seizure data, Table 27 suggests that Canada would have had an excess of 1,733 kg to 8,624 kg of ATS available for exportation annually. Table 27 also adds information about the quantity of Canadian produced ATS overseas to produce an estimate of any ATS unaccounted for by Canadian users or law enforcement agencies around the world. This serves as an indicator of whether the potential exportation estimates are potentially too low (in the event that such an estimate produces a negative number). The exercise suggests that an excess of 288 to 7179 kg of ATS was available for consumption overseas after domestic and international seizures and consumption have been taken into account.

Table 27: Estimating potential ATS exports from Canada to any other country, 2009

	Low estimate	High estimate
Quantity of ATS produced	4,594 kg	11,485 kg
Minus:		
- Total meth consumption (mid-point estimate from Table 26)	763 kg	763 kg
- Total ecstasy consumption (mid-point estimate from Table 25)	1,849 kg	1,849 kg
- Total meth seizures in Canada (mid-point estimate for 2007-2008, from RCMP, 2009)	141 kg	141 kg
- Total ecstasy seizures in Canada (mid-point estimate for 2007-2008, from RCMP, 2009)	108 kg	108 kg
=		
Total ATS potentially exported to other countries	1,733 kg	8,624 kg
Quantity of ATS seized overseas (Mid-point estimate for 2007-2008	1,445 kg	1,445 kg
=		
Total ATS potentially exported + not seized by law enforcement agencies	288 kg	7,179 kg
Seizure rate	36.9%	14.8%

Discussion and Conclusion

The publication of the 2009 World Drug Report created a media frenzy of the wrong kind for Canada in that the country was identified as one of the world's leading producers of amphetamine-type stimulants (ATS) such as crystal methamphetamines and ecstasy. The report led to Kirby and MacDonald's (2009) article in *Maclean's* magazine which dubbed Canada as "Colombia North", as well as the "new global drug lord" (Glenny 2009) for its role as a "leading producer and exporter of illegal synthetic drugs". Concerns regarding the role of Canada in the global synthetic drug trade mainly emerged from two types of numbers. First, it was reported that the majority of amphetamine-type stimulants (ATS) seized in two countries (Australia and Japan) were initially produced in Canada. Second, a relatively large amount of amphetamine

(1.54 metric tons) and ecstasy (985 kg) was seized in 2007 within Canadian borders, numbers which put Canada among the leading nations in the world.

Is Canada really one of the world's leading synthetic drug producers? Answering this question requires that reliable estimates of the size of the ATS market in Canada be produced, something that is simply not available. Although the estimates produced in this study are tentative, it nonetheless offers a good starting point to consider Canada's role in ATS production worldwide.

The current study addressed the lack of reliable estimates on the scope of the ATS market in Canada. Drawing on a variety of methods, we estimated the size of four sub-populations of individuals/units (ATS users, dealers, producers, labs), as well as three separate "quantity" estimates (domestic consumption, domestic production, quantity exported). Such estimates allow us to assess Canada's role in the global ATS market. This will be particularly valuable in terms of establishing a baseline for assessing the effectiveness of regulatory and enforcement efforts.

Our review of the literature on trafficking and production found that there is too much uncertainty in regard to the existing data to truly assess the role of Canada in the global ATS trade. There are no established estimates of the size of production and the number of ATS lab seizures remains low. While Canada ranked 6th in the world in the amount of meth/amphetamine seized in 2007 with 1.54 metric tons, the figure for the previous years was as low as 60kg. Finally, the review found that two methods for estimating the size of the ATS market in Canada (multiplier methods and capture-recapture methods) have shown more promise in obtaining reliable estimates of illegal populations, including drug dealers and producers.

To derive these estimates, we used existing survey, arrest, and seizure data. Procedures used included multiplier methods, synthetic estimation methods, capture-recapture methods, and economic modeling methods. Table 28 presents a summary of estimates for segments of the meth and ecstasy markets in Quebec, BC, or Canada.

In most analyses, the diverse methods that were applied yielded consistent results, but much more research is required to provide further validation of this study's results. This report should be approached as a first step in developing standard methods that academics and policy makers can use to make systematic assessments of the ATS and other illicit drug markets in Canada and beyond. Our efforts should therefore be viewed as an exploration that lays the groundwork for a Canada-wide study with a strong emphasis on collecting fieldwork data. The present experience suggests that some methods (e.g., capture-recapture) are more accurate tools than others (e.g., multiplier estimates) for estimating illegal markets.

Assessments of the demand-side of the ATS market, based on synthetic estimation techniques, suggest that there are roughly 52,000 meth users and 270,000 ecstasy users in Canada. This estimate is based on a low count of data which combines the general population that is twelve years and older, the homeless population, and the inmate population. This total count of 320 000 likely underestimates the population of ATS consumers. Adjustments for 50% underreporting (high count) suggest a much larger total population of about 480,000 users (77,788 meth users and 402,677 ecstasy users).

Table 28: Summary Estimates

	Meth Estimates	Ecstasy Estimates
Users		
- Synthetic estimation	Low: 51,858 (Canada) High: 77,788 (Canada)	Low: 268,452 (Canada) High: 402,677 (Canada)
Dealers		
- Capture-recapture	3,458 (Que.) 14,303 (Canada)	4,561 (Que.) 16,980 (Canada)
- Multiplier (dealer : user)	Low: 3,457 (Canada) High: 11,113 (Canada)	Low: 17,897 (Canada) High: 57,525 (Canada)
	ATS Estimates	
Labs		
- Economic model	Low: 560 (Canada) High: 1,400 (Canada)	
Producers		
- Multiplier (3.5 producers per lab)		
- if 560 labs		
- if 1400 labs	1,960 (Canada) 4,900 (Canada)	
Total Consumption	Low: 2,321 kg (Canada) High: 2,902 kg(Canada)	
Total Production	Low: 4,594 kg(Canada) High: 11,485 kg (Canada)	
Total Potential Exportation (after seizures taken into account)	Low: 1,733 kg (Canada) - 38% is potentially exported High: 8,624 kg (Canada) - 75% is potentially exported	

Our assessment of the supply-side of this market relied on arrest data. The market is predominately male, but no more so than other illegal drug markets and crime settings in general. The population estimates suggest that steep increase occurred between 1999 and 2009 in Quebec, echoing what has been found through other indicators in Canada. One limit in our analysis was that we were unable to provide a valid estimate of importers, exporters, and producers. These populations are small, captured offenders have a higher likelihood of being incarcerated for longer time periods (and thus be unavailable for recapture), and simply not enough offenders get re-arrested for these methods to be usable.

The populations of meth and ecstasy dealers were estimated using both capture-recapture and multiplier estimates. Based on arrest data from Quebec, the capture-recapture estimate resulted in 3,458 meth dealers and 4,561 ecstasy dealers in Quebec. This allowed us to infer Canadian populations of 14,303 meth dealers and 16,980 ecstasy dealers. Results from the multiplier procedure for Canada that was based on a user:dealer ratio provided some validation at the higher end for meth and lower end for ecstasy—the population of meth dealers was estimated from a low of 3,457 to a high of 11,113 dealers, while the population of ecstasy dealers was estimated from a low of 17,897 to a high of 57,525 dealers. Once again, the substantial range that emerges from the multiplier procedure calls for considerable caution and additional verification with different data sources on a variety of regions.

Estimates of the population of labs and producers were also derived using diverse methods. While capture-recapture estimates proved to be amongst the more effective in this report, we were unable to provide such an estimate for the number of producers since arrests were too few in our data for this segment of the market. The number of ATS labs was estimated using an economic model. This estimate ranged from a low of 560 labs to a high of 1,400 ATS labs in Canada. Such information was subsequently carried over to assess the number of producers in the country. A ratio of 3.5 producers per lab was established, resulting in estimated low of 1,960 ATS producers if 560 labs were in operation to a high of 4,900 producers if 1400 labs were in operation in Canada.

Both ATS production and consumption were estimated in order to arrive at a final estimate of how much meth could be reasonably exported from Canada. Such an analysis would lend some substance to persistent claims and debate regarding Canada's pivotal position in the international ATS trade. Using the results from the economic model as a starting point, overall production was estimated at 2,297 kg if the lower-end 560 labs scenario was accurate and 5,743 kg if the higher-end 1,400 labs scenario was accurate. Such results must be approached with caution since the estimates are based on a single cook per lab in a given year—it may very well be the case that ATS labs produce multiple batches and will likely yield much larger quantities than we estimate. Adjusting these estimates to two 'cooks' per lab resulted in low-end estimate of 4,594 kg and high-end estimate of 11,485 kg of meth in Canada.

Using a multiplier method to derive a quantity per user ratio, meth consumption for Canada was estimated between 678 kg and 847 kg. Ecstasy production was estimated between 1643 and 2054 kg. Combining meth and ecstasy resulted in a total ATS consumption range of 2321 to 2902 kg in Canada.

Based on mid-point estimates for consumption and seizure data, we estimated an excess of 1733 kg to 8624 kg of ATS available in Canada for annual exportation. This would suggest that 38% (if 1733 kg of production) or 75% (if 8624 kg of production) of ATS produced in Canada is exported. Information was also added regarding the quantity of Canadian produced ATS overseas to produce an estimate of any ATS unaccounted for by Canadian users or law enforcement agencies around the world. The exercise suggests that an excess of 288 to 7,179 kg of Canadian ATS was available for consumption overseas after domestic and international seizures and consumption were subtracted from overall production.

Does this make Canada a key player in the international ATS trade? The estimates produced for the purpose of this report suggest that Canada produces as little as 0.6% of the world's supply according to the low estimate scenario or as much as 4.6% according to the high estimate scenario. Whether Canada deserves a 'major player' reputation based on those numbers is a matter of opinion, but Canada would not be considered as a major producer in the global ATS market under most standards. ATS, like cannabis, can be produced virtually anywhere in the world. Based on the estimates produced in this report, Canada is no more and no less of a global player today than it was five years ago.

Recommendations

Based on the research conducted, five specific recommendations are offered:

1) A more concerted effort to monitor national trends in synthetic drug markets, especially on the supply side

One of the clear conclusions of this study concerns how little is available in terms of data to study synthetic drug markets in Canada. Drug specific data on arrestees or drug-related overdoses are not publicly available, even at the aggregate level. The lack of data is especially salient on the supply side, where only one study of patterns in drug production was found (Diplock et al. 2005)—a study published six years ago and for one province only. Estimating the size of an illicit market necessarily requires that assumptions be made since we cannot establish exact numbers of participants or amounts. This leads to much uncertainty in the estimates. While this is a problem for any attempt to quantify illicit markets, it is more so for ATS since relatively little is known in comparison with other markets such as cannabis. For this reason, we recommend that greater efforts be taken to collect the data necessary to obtain a more concrete estimate of the size of the ATS market. Arrestee monitoring programs such as the Drug Use Monitoring in Australia program (Gaffney et al. 2010) would be a highly valuable step in this direction. Indeed, data on drug purity and prices should be centralized in such a program. Furthermore, research projects that involve interviews with ATS-related offenders at all levels of the trade should be a priority. Without those, it will be extremely difficult to go beyond the crude estimates and wide confidence intervals provided in this report.

2) Monitor trends in domestic illegal ATS precursor importation

One of the limitations of this study is the lack of attention to precursor importation as a potential source of alternative data on trends in ATS markets. Only anecdotal evidence is available on seizures of precursors in law enforcement reports. Seizures of ephedrine at Canadian borders and within the country should be as systematically reported as seizures for drugs in finished form.

3) Monitor trends in Canadian produced synthetic drugs in other countries

The claim that Canada was a key player in worldwide ATS production was made after unusually large seizures in Australia and Japan made the headlines in 2007. No other year was as spectacular as 2007 in terms of Canadian produced ATS seizures. Nonetheless, systematic reporting of seizures overseas would help challenge estimates of potential exports such as the one produced for the purpose of this report.

4) Adopt wastewater analysis as a method to estimate the quantity of ATS consumed in large Canadian cities

Metcalfe et al.'s (2010) wasterwater analysis method provides an interesting alternative to estimate the quantity of synthetic drugs consumed in Canadian cities. While more work is needed to validate the estimates derived from such methods, the potential for estimating the size of ATS and other illegal drug markets is enormous.

5) Make greater use of capture-recapture methods for the purpose of estimating the size of illegal markets

As shown in this report with the introduction of a capture-recapture regression model developed by Bohning and van der Heijden (2009), the methods for estimating the size of illegal populations are improving and becoming more useful. The issue is one of data availability. We were fortunate to count on arrest data provided by the Sûreté du Quebec for the purpose of this project, but requests for obtaining similar data in BC were not successful. This is unfortunate because BC is the province for which the most data is available and has been identified as the main province for Canadian ATS production. The use of capture-recapture methods could become a routine occurrence in law enforcement agencies around the country as an intelligence and performance management tool. Although collaborations with the academic community might necessary at first, the methods are simple enough to be transferred to research analysts working within such agencies.

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Appendix A: Regression Tables with Significant Covariates

Table A1 shows the output for regression models (all offences) in which significant covariates were found. In the model with only gender as a covariate and in the model with both age and gender, it is found that females are less likely to be rearrested. There is no relationship between age and rearrest. Table A2 shows that females are less likely to be rearrested for a selling offence.

Table A1: All-offence models with significant covariates

	B	**95% CI**	**SE**	***P***
2005-2007				
Gender model				
Gender	-0.408	-0.746 to -0.071	0.172	0.018
Constant	-2.697	-2.801 to -2.592	0.053	0.000
AIC	3115.62			
G^2	6.216			
$\hat{N}$ (95% CI)	58,109	(52,282 to 63,935)		
Age + gender model				
Gender	-0.403	-0.741 to -0.066	0.172	0.019
Age	-0.003	-0.013 to 0.007	0.005	0.549
Constant	-2.618	-2.895 to -2.340	0.142	0.000
AIC	3,117.26			
G^2	6.578			
$\hat{N}$ (95% CI)	58,161	(52,319 to 64,003)		

Table A2: Selling model with significant covariate

	B	**95% CI**	**SE**	***P***
2005-2007				
Gender model				
Gender	-0.792	-1.477 to -0.108	0.349	0.023
Constant	-2.969	-3.146 to -2.791	0.091	0.000
AIC	1,112.39			
G^2	6.418			
$\hat{N}$ (95% CI)	35,832	(28,433 to 43,231)		

Appendix B: Extracting Methamphetamine: Ingredients, Costs, and Risks

The Costs of the Critical Ingredients

One reasonable assumption is that there are two types of methamphetamine environments. The first described above refers to a small operation in which the participants have access to small amounts of the critical ingredients. The second is what we might call industrial production. Consider first what more careful consideration of the cost of the ingredients may look like.

Table 20 describes a list of ingredients obtained from a pharmacist on the kinds of prices that are available without any particular effort. While it is undoubtedly the case that most pharmacists are highly ethical and legal, it is likely that for those few who are not, the same prices apply for them as well.

What is immediately apparent is that on a small scale it is relatively easy to obtain the necessary ingredients and, on a larger scale, the cost of the underlying ingredients may be small. The set of processes needed for a stovetop operation are specified in sequence and then a description of the cost of the critical materials is described in Table 20.

The small scale processing yields roughly one ounce of methamphetamine

This is a distillation of several how to instructions found on the Internet. They all seem consistent and offer an accurate sense of the costs. The receipe listed below is drawn directly from http://sbillinghurst.wordpress.com/2009/08/13/pseudoephedrine-acetate/ (April 20, 2011) which in turn refers to Skinner, Harry F., "Methamphetamine Synthesis Via Hydriotic Acid/Red Phosphorous Reduction Of Ephedrine," *Forensic Science International*, Vol 48, 1990, pp. 123-134. Another example of a method to extract meth from available materials include receipes at

http://www.amphetamines.com/methamphetamine-faq/index.html. These are illustrative.

<u>- Materials:</u>
1. A bottle of tincture iodine containing iodine, sodium iodide, alcohol, and water
2. Sinustop Herbal Decongestant/Sudafed tablets containing crystaline pseudoephedrine HCl each mixed with some herbal ingrediants or ephedrine obtained through some other method.
3. Road flares and large boxes of matches
4. Bottle of drain cleaner containing H2SO4
5. Bottle white distilled vinegar
6. Red devil lye containing sodium hydroxide
7. Spray can of brake cleaner containing trichloroethylene or trichloroethane

<u>- Procedure:</u>
A. Purifying pseudoephedrine:
1. Take the decongestant capsules, empty their contents into a small funnel with a coffee filter. Pour cold water through the filter, and collect the liquid in a small jar.
2. Add lye to the collected liquid. You should immediately smell the odor of ephedrine.

3. Put the resultant solution in another small jar, and add brake cleaner, then close the lid and shake vigorously. Let stand so that the layers separate.
4. Using a turkey baster, suck up the bottom brake cleaner layer out of the jar and put it into a small bowl.
5. Add vinegar and heat the resultant mixure over low heat in a frying pan with water – thus, a water bath. Do not use a gas stove, since the brake cleaner vapors will produce toxic phosgene if there is contact with a flame. Instead use a hot plate or electric stove at low heat only.
6. Heat the bowl in the water bath until no more liquid is left. At the bottom will be a solid layer of a pseudoephedrine acetate.

B. Preparing the red phosphorus:

1. Scrape the red phosphorus off of the caps of the flares and store for later use. You should get about 0.1g per flare. Alternatively, scrape the striking surface off of wooden matchboxes

C. Preparing the iodine/HI solution:

1. Pour the entire bottle of the iodine tincture into a small ceramic bowl. Heat on the above type water bath until no more alcohol is left. Let cool, put in a small polyethylene jar and add H2SO4 drain cleaner. Add liquid in the end of an eye dropper. This converts the sodium iodide to HI. You now have a solution of iodine and HI. 2. Add the red phosphorus and heat bottle in a water bath until the purple iodine colour goes away.

D. The reaction:

1. Add the pseudoephedrine acetate to the solution of HI/I and phosphorus, and heat on a water bath for 24 hours.

E: Extraction:

1. Cool the reaction solution and lye. Take the solution and perform steps A3-A6. 2. You will end up with methamphetamine acetate that you can scrape from the bowl.

From the table, the most difficult ingredient to get in quantity is that of Pseudoephedrine and Ephedrine powder.

Table A3: Ingredients from the Pharmacy*

Product	Difficulty to obtain	Price to purchase legally	To purchase Illegally
Ephedrine powder	Available from chemical wholesalers. Must order verbally from chemical wholesaler, must sign "End Use Declaration", must keep usage records for narcotic inspector. Usually can receive within a week.	From chemical wholesaler $23/25g, $72/100g	Na
Pseudoephedrine powder	Available from chemical wholesalers. Must order verbally from chemical wholesaler, must sign "End Use Declaration", must keep usage records for narcotic inspector. Usually can receive within a week.	From chemical wholesaler $19/25g, $71/100g	Can legally purchase at most 3.5 g per day: 15 Claritin D tablets. Restrictions per month.
Red Phosphorus	Only from a chemical wholesaler.	$143.59/100g	50% of striking strip on a matchbox.
Tincture Iodine 2%	Easy to obtain over-the-counter, or from chemical wholesaler		
Ephedrine tabs	Cannot be purchased OTC	na	Na
Pseudoephedrine tabs	Can be purchased OTC at pharmacy (pharmacies are to be aware of frequent and/or large volume purchases of these products)	Sudafed Nasal Cold 120mg x 20 tabs $9.39 retail, Eltor 120mg x 12 tabs $5.19 retail	

There are risks associated with the "cooking" of methamphetamine. Unlike growing marijuana indoors, where the issues are primarily associated with the improper use of electricity and mold colonization, the process by which meth is produced is inherently dangerous as it involves heating and manipulating volitile chemicals. The table below illustrates some of the potential hazards associated with the simple cooking process described above. There are a host of hazardous chemicals in other processes that will also produce meth. These should be considered illustrative of the risks.

These are not the only risks. New methods emerge in response to the crackdown on pseudoephedrine since 2003 in Canada. (The so called "shake and bake" technique raises the risks associated with small scale production as the mixture produced in a large pop bottle can explode when exposed to oxygen.)

Table A4: Primary Risks Associated with the Laboratory Process Described Above

Anhydrous ammonia:	A colourless gas with a pungent, suffocating odor. Inhalation causes edema of the repiratory tract and asphyxia. Contact with vapors damages eyes and mucous membranes.
Red phosphorus:	May explode as a result of contact or friction. Ignites if heated above 260°C. Vapor from ignited phosphorus severely irritates the nose, throat, lungs, and eyes.
Hypophosphorous acid:	Extremely dangerous substitute for red phosphorus. If overheated, deadly phosphine gas released. Poses a serious fire and explosion hazard.
Hydriodic acid:	A corrosive acid with vapors that are irritating to the respiratory system, eyes, and skin.
Iodine crystals:	Give off vapor that is irritating to respiratory system and eyes. Solid form irritates the eyes and may burn skin. If ingested, causes severe internal damage.
Source: DEA Office of Diversion Control.	
www.justice.gov/ndic/pubs7/7341/7341p.pdf	

Appendix C: Refining the Economic Model in the Context of Added Law Enforcement

There are two additional pieces of information that can be usefully explored in this context. The first is to relate the rate at which labs are discovered to the intensity of the police effort. The second relates to a more careful characterization of the costs of the ingredients of the meth labs themselves.

The difficulty with the evaluation of the prevalence of methamphetamine operations using the current model and data is that we are dealing with very small numbers. The question about how to apply the model going forward is one of integrating new data as they become available. In this case there are two themes. The first is that of enforcement. How many resources are being devoted to the exposure and busting of meth labs? The second is the underlying number of labs that are out there. The questions are clearly related to each other. Consequently we need to take account of the possibility of changes in the level of enforcement and apprehension.

To imagine that there is a functional relationship between the number of identified methamphetamine operations, B, and the actual number of meth operations, T, the number of law enforcement officers, L, actually engaged in targeting or otherwise identifying meth operations, the security, S, mounted by the meth operations themselves, and other random events that bring meth operations to light, X. The coefficients, b_i, reflect the strength with which each variable impacts the discovery of meth labs. More total labs, higher T, presumably lead to a greater number of discoveries of labs. Consequently, b_1 is positive. The same is true for increases in the amount of law enforcement resources dedicated to the discovery of labs so that b_2 is also assumed positive. A higher level of security for meth labs reduces the number of labs discovered and so b_3 is assumed to be negative. The variables X are other random effects striking the discovery of meth labs not specifically identified. This we can write as equation 6:

(6) $B= b_0+b_1T+b_2 L+b_3 S+ X$

We know from the discussion earlier that the total number of operations can be estimated from the formula:

(5) $T= Bx[1+(PxQ/C)]/[(PxQ/C)-(1+\rho)]$

But in the case in which there is a relationship between the energy put toward finding meth labs, then we need to account for the increase in resources devoted to the activity.
We have two choices. We can solve for the total number of meth labs as a function of the number of busts directly, but if there are differences in the rate of enforcement, security and so forth, this will not give a very useful picture since it implicitly assumes that the rate of enforcement is constant.

Although the information requirements are greater, we can account for increased enforcement by estimating equations (5) and (6) simultaneously. This is something that should be considered in the context of the small number of meth labs currently discovered. If they are in fact more prevalent than the low rate of discovery would suggest, contrast that with some 2,000 or more marijuana growing operations found each year in British Columbia alone, then correcting for the level of enforcement is likely to be relevant if we want an accurate characterization of the number of methamphetamine labs in the general population.

What data are relevant for assessing the number of meth labs?

(1) Of those that are discovered, how large are they? Are they used once or twice or are they used more frequently? Is output in ounces or pounds? What are the constraints on the process? Is it because it cannot be produced or because it cannot be retailed?
(2) What chemical process is used to produce methamphetamine? There are many possible ways, but if one route is more common, it suggests what raw materials are easiest to get.
(3) What is the price of the meth products over time and by region? In that absence of other data, this is the most valuable kind of information. The price of the product will fluctuate and be associated with various events such as large scale law enforcement pushes, border events, bad weather and so forth. It will give a sense of how well the market is working and whether it is an integrated market or a series of local markets.
(4) What are the costs of manufacture? We have discussed preliminary views of the costs, but there is no substitute for on the ground data. Among the important issues are:

- The cost of lab equipment;
- The cost of the laboratory setting such as a house, back cottage, apartment and so forth.
- Is the lab setting rented or owned?
- How long is an average tenure after the lab is in operation?
- Are there unsuccessful labs? What proportion fail?
- How long does the process take from purchase of inputs to final sale of output?

(5) Group Dynamics

- Who finances the operation?
- How large is the group producing the product?
- How do they split the take? For example, in BC with marijuana for some time organized crime split the product 50/50 with the producer and would offer cash if in kind consumption was not desired. Is the ratio of the product produced shared with the various producers or are they paid a wage?

(6) What are the dimensions that change with the scale of the operation? For example, in marijuana growing operations, the key feature is the number of lights since that is the constraint on the amount of energy getting to the plants. What distinguishes an industrial operation from a top of the stove one ounce of production operation?