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Canada

Cannabis Performance Metrics for Policy Consideration

What Do We Need to Measure?

by Anton Maslov, Austin Lawrence and Matthew Ferguson

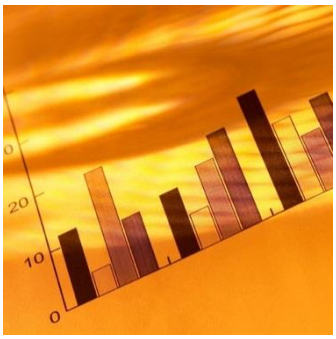
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Abstract

Cannabis and its byproducts are the most widely used illegal narcotic substances in the world. Canada has one of the highest prevalence rates of cannabis use in the world; over forty per cent of Canadians have used cannabis as a drug during their lifetimes, and between 10.2% (Health Canada, 2012) and 12.2% (Rotermann and Langlois, 2015) per cent used it in 2010. Its production and consumption is illegal under the *Criminal Code of Canada* as of February 2016, with the exception of some medical use. However, the federal government has indicated its intent to legalize the use of cannabis for non-medical purposes. When there is discussion regarding whether or not cannabis policy regimes are having their intended effect, or changes in cannabis regimes are being considered, it is important to empirically measure such changes and effects through performance metrics. Performance metrics are instances where the impact of cannabis on various aspects of society is measured using empirical data. This paper highlights the importance of collecting empirical evidence on 45 such metrics when it comes to evaluating possible changes to cannabis policy regimes in Canada. Of the 45 types of metrics identified in this paper, Canada currently collects data to calculate about seven, some partial information on a further 17, and little to no data on the remaining 21 metrics. The meaning, objective, and, where possible, operationalization of each metric is discussed in detail.

Author's Note

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Introduction

Cannabis and its byproducts[1] are the most widely used illegal narcotic substances in the world. According to rough estimates, in 2011, worldwide there were 125 million users and suppliers of cannabis products (Caulkins et al, 2012). Canada has one of the highest prevalence rates of cannabis use in the world. Over 40% of Canadians have used cannabis during their lifetime and between 10.2% and12.2% have used it in the year preceding the survey, 2011(Health Canada, 2012; Rotermann and Langlois, 2015).

In general, policy on cannabis use may be divided into regimes that exist on three dimensions. The three primary axes for policy regimes are: 1) intended use – recreational, medical, or spiritual; 2) user population – youth or adults; and, 3) severity of enforcement – illegal and enforced, illegal and unenforced, administratively regulated or decriminalized, and legalized (Caulkins et al, 2012).

Cannabis is still prohibited by criminal law in the majority of countries throughout the world, for all intended uses and user populations. From 2013 to 2015, four states in the United States (U.S.): Alaska, Colorado, Oregon and Washington, as well as the District of Columbia, legalized both the medical and recreational cultivation and use of cannabis. Numerous other states are adopting legislation to decriminalize the medical use, and the possession for recreational use, of cannabis products. Uruguay is the only country that has fully legalized the medical and recreational use of cannabis at a national level. In the Netherlands, the use of cannabis is decriminalized at the level of retail distribution and consumption, while in Portugal the use of all drugs is an administrative (rather than criminal) offence. In Jamaica, some types of possession have been decriminalized, along with some household production, and spiritual use being largely legalized. Canada currently has a legalized industrial hemp regime and medical cannabis regime,[2] with other uses being illegal.

When there is discussion on whether or not cannabis policy regimes are having their intended effect, or changes in cannabis regimes are being considered, the sides of the policy debate cite different types of evidence to support their point of view. For example, one group may argue that cannabis usage rates, volume of cannabis consumed, and the price of cannabis need to be properly measured to understand the size of the consumer market. They may argue that cannabis use patterns among various sub-groups of the population, such as youth, homeless persons, or ethnic and religious groups need to be better understood prior to any changes in policy. Such an understanding could help identify vulnerable populations and strategize the need for early

[1] The terms "cannabis" and "marijuana" are used interchangeably throughout this report. Unless otherwise specified, both of the terms refer to the plants *Cannabis sativa*, *Cannabis indica*, *Cannabis ruderalis*, or their hybrids. In this paper the term refers to the parts of these plants, usually the flowering buds or resinous concentrates, which are used as a drug.

[2] The growth and production of fiber products from low-THC cannabis plants, called "hemp," was legalized as a domestic industry in Canada in March, 1998, and the use of psychoactive marijuana for medical purposes was legalized in July, 2001.

interventions, should they become necessary. Another example could be that of health care-related issues when it comes to a change in cannabis policy. Proper measures of cannabis-related admissions to emergency rooms and toxicology departments, cases related to adverse impacts of cannabis on physical and mental health, and long-term effects of cannabis consumption and its impact on individuals and the society overall are examples of what might be required in order to determine the overall impact of cannabis policy on the health of the population.

These examples are instances of cannabis policy performance metrics. In other words, performance metrics are instances where the impact of cannabis on various aspects of society is measured using empirical data. The authors of this study initially looked to the State of Colorado for the initial identification of metrics that need to be measured when it comes to cannabis. In January 2015, Jack K. Reed of the Colorado Department of Public Safety made a presentation on the state's information and data needs to assess changes in cannabis policy (Reed, 2015). The presentation identified three areas in which performance metrics needed to be further elaborated: juveniles; public safety; and public health. The specific performance metrics identified in Reed's presentation were used as a starting point for this paper. Other metrics were identified and added by the authors and their colleagues at Public Safety Canada as the project moved forward.

Previous work by Public Safety Canada has specified in detail where performance metrics have been lacking when it comes to Public Safety issues and drug policy, in areas such as crime (Lawrence, 2012) and impaired driving (CSFS, 2014). Other research indicates that performance metrics related to economic issues are also critical contributors to understanding the policy impacts of different illicit substances regimes (Boucher et al., 2013; Caulkins et al., 2012; Maslov and Boucher, 2014).

Objective

The objective of this project is to itemize and discuss the main performance metrics suggested for the assessment of cannabis policy regimes. The intent is to discuss the various performance metrics that currently exist, as well as others that may need to be considered in advance, and upon implementation of, a new cannabis policy regime in Canada.

Approach and Methodology

This project involved a thorough literature review and an examination of the performance metrics that could be applied to cannabis regimes. The literature that was considered for examination consisted of academic published material, documents originating from governments and law enforcement agencies in Canada and internationally, and grey literature such as newspaper articles, online magazines, and non-academic discussion pieces in Organisation for Economic Co-operation and Development (OECD) countries.

Once the literature was gathered, sorted and analyzed, a short discussion of the performance metric for which the literature was available followed suit. Concurrently, an attempt was made to discuss the availability and quality of data that was available in Canada to assess a particular performance metric. Where data or proxy measures were not available for a particular metric, the

authors offered a discussion of the importance to collect the data directly, as well as possible methods to do so.

For the purposes of this report, the cannabis performance metrics that were collected were classified into four categories: 1) public safety; 2) public health; 3) economics; and 4) children and youth. It is acknowledged that many of the metrics discussed throughout this paper could be classified in more than one category. For example, the metric of the relationship of cannabis to other drugs could be both a matter of public safety and public health. Likewise, the metric of cannabis and organized crime or money laundering could be classified into both the public safety and economics groups. Fundamentally, it does not matter how the metric is classified or in which category it was made to fit. The ultimate objective of this project is to discuss the metrics themselves and the significance of properly measuring them.

The list of metrics outlined in this paper is by no means exhaustive. Rather, these metrics should be viewed as a starting point for the identifications and discussion of metrics that need to be measured when discussing how well the cannabis regime is meeting its objectives, as well as how any anticipated impacts due to policy changes are performing when it comes to a certain aspect of the cannabis regime. A summary list of the metrics discussed in this paper is provided in Table 1 in the Appendix. It must also be mentioned that while the authors made every effort to include and discuss as many metrics as the time and availability of literature allowed them, omissions of some metrics are possible. New metrics will continue to be identified and introduced in various forms in academic, government, police, or mass media publications and it is simply impossible to capture all of them in one paper. Therefore, it is hoped that this paper will serve as a starting point for discussion, with more metrics and ideas identified as the conversation proceeds.

Public Safety

Usage Trends

Usage trends are a basic performance metric that policy makers require understanding on how prevalent the usage of cannabis is in the population and how much of the substance is being consumed. Amongst other reasons, such information is required to better understand if policy is encouraging or discouraging people from using cannabis, to understand if problematic forms of use are increasing, declining or becoming concentrated amongst particular users, or to analyze economic questions such as identifying how much tax would, or should, be raised under different scenarios, or to do things like estimate the size of the grey or black markets for cannabis under a legalized regime.

Two separate surveys measure the prevalence of the use of cannabis among the Canadian population: the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) currently named the Canadian Tobacco, Alcohol and Drugs Survey (CTADS), and the Canadian Community Health Survey (CCHS). CTADS estimated the prevalence of past year (i.e., in the year preceding the survey) consumption of cannabis among Canadians 15 years of age and older at 10.2%, and lifetime at 41.5% (Health Canada, 2012). The results further indicate that there was a slight decrease in past year prevalence of consumption since 2004, when it was measured at 14.1%, as well as in lifetime prevalence of consumption which was 44.5% in the same year. In 2012, males (47.9%) were more likely than females (35.5%) to have used cannabis in their lifetime, as well as

in the year preceding the survey (13.7% versus 7%). Provincially, British Columbia (48.7%), followed by Alberta (44.3%) reported the highest proportion of lifetime prevalence of use of cannabis, while New Brunswick (36.4%) reported the lowest. British Columbia also reported the highest proportion of prevalence of use in the year preceding the survey (13.8%) and New Brunswick reported the lowest (8.5%).

The CCHS divided the results between one-time and repeat users. For single incident users, the survey estimated past year consumption among Canadians 15 years of age or older at 12.2%, and lifetime at 43% (Rotermann and Langlois, 2015). For repeat users, the prevalence of consumption in the year preceding the survey was estimated at 11.8%, and lifetime at 33.5%. The results also indicate no significant changes in past year or lifetime prevalence of consumption since 2002. Male one-time users reported lifetime prevalence of consumption at 49.4%, while male repeat users at 33.5%. Female one-time users reported lifetime prevalence of consumption at 35.8%, while female repeat users at 25.9%. When it comes to prevalence of use in the year preceding the survey, the percentages are 16.1% for one-time male users (15.3% for repeat male users) and 8.3% for one-time female users (7.8% for repeat female users). Provincially, Nova Scotia (15.7%), followed by British Columbia (14.3%) reported the highest proportion of prevalence of use of cannabis in the year preceding the survey, while Saskatchewan (9.9%) reported the lowest.

The CCHS further asked a question on the frequency of cannabis use among Canadians 15 years of age and older in the year preceding the survey. The percentages are: 0.7% used cannabis only once in the year preceding the survey (0.8% for males, 0.6% for females); 4.4% used less than once a month (5.2% for males, 3.6% for females); 2.1% used one to three times a month (3% for males, 1.3% for females); 3.2% used at least once a week (4.6% for males, 1.7% for females); and 1.8% used cannabis daily (2.4% for males, 1.2% for females) (Rotermann and Langlois, 2015).

Other demographic findings from the CCHS include higher prevalence of cannabis use in the year preceding the survey among non-immigrant population (14.7% versus 4.6% among immigrants) and population center (12.7% in urban areas versus 9.6% among rural) (Rotermann and Langlois, 2015). Interestingly, household income had no significant difference on the prevalence of use of cannabis in the year preceding the survey.

The CTADS and the CCHS both provide necessary data on prevalence of use of cannabis and usage patterns among various demographic groups in Canada. However, knowing how many times and how often people use cannabis provides only a start in understanding the overall cannabis usage trends. In Canada, the critical data-gaps concerns the quantity of cannabis consumed. Prevalence of use by itself is only a proxy measure for consumption; overall consumption should be measured in terms of the quantity of cannabis consumed. Boucher et al. (2013) highlighted the need to measure the amount of cannabis consumed in Canada when they examined fluctuations in the price of cannabis in Canada. Without knowing how much cannabis is consumed in Canada, the authors argued, research possibilities are very limited (see the section on economic metrics below). Questions regarding frequency of cannabis usage in the population must be asked at the same time as questions about consumption amounts, otherwise it is not possible to accurately estimate overall volumes of consumption at the population and per capita levels. It is recommended that, as a starting point, a question on the amount of cannabis consumed by users be added to surveys like CTADS and CCHS.

Usage trends, both in terms of prevalence of use and the amount of cannabis consumed, need to be continuously monitored regardless of any changes to cannabis policy. It is extremely important to continue to monitor the usage of substances, licit or illicit, as it would inform on the direction policy should take, and concomitant amendments to laws, programs or regulations to meet policy objectives that may need to be made.

Method of Consumption

This metric would identify the ways in which different cannabis products are consumed, measuring the proportions of users that consume cannabis through these methods and the amounts that they consume using the different methods.

Health Canada (2013: 17-19), in an extensive guide on cannabis for health care professionals, listed the known methods of consumption of cannabis as: smoked; vaporized; oral; oro-muscular; rectal or vaginal; and topical. The guide further described the absorption rates and patterns of various psychoactive ingredients found in cannabis for different methods of consumption of cannabis. However, the statistics on how and when various methods of the administration of cannabis is not yet known. Nor are the differential harms that may be associated with different patterns of use. In Canada, it is unknown what proportion of cannabis is smoked, eaten, vaporized, or applied topically. An ideal place to collect such information would be on surveys, such as the CTADS. When respondents are asked about prevalence (and hopefully, someday, amount) of consumption, a follow-up question could and should enquire about the method of consumption of cannabis.

This metric would remain relevant regardless of any cannabis policy shifts. It is likely that cannabis will continue to be consumed in society. It is particularly useful to know this type of information in scenarios of decriminalization or legalization, where regulation, education and other policy changes can more directly impact consumer behavior.

Police-Reported Incidents and Charges

The number of incidents related to cannabis offences is currently an important performance metric related to cannabis policy. This metric can be expressed in a few different ways including the gross number of criminal incidents or the rate of criminal incidents in relation to other types of offending or as an offence rate per 100,000 population. Further, the metric may be expressed through the number of charges laid, cases cleared by charge, or cases cleared through other means. These metrics are often used as a proxy measure for the amount of cannabis offending that takes place or to understand the relative importance of cannabis crime in relation to other types of crime. These metrics are commonly used in combination with other data sets, to estimate such things as the cost of enforcing cannabis laws.

In Canada, three main types of cannabis-related offences are captured by the Uniform Crime Reporting Survey (UCR): possession; trafficking or distribution; and production of cannabis.[3]

[3] In Canada, cannabis-related offences are defined by the *Controlled Drugs and Substances Act* (S.C. 1996, c. 19). Cannabis is a Schedule II drug according to the Act. For more information, see http://laws-lois.justice.gc.ca/eng/acts/c-38.8/.

The rate at which people are charged for cannabis offences depends on many factors, among which are police resources dedicated to enforcement of cannabis policy regime, the demand for cannabis in an area where the incidents occured, the level of activity of organized crime in the area, and the level at which cannabis is produced.

The police-reported incident data is first recorded by the police during actual encounters throughout the year, and later on submitted to Statistics Canada for a national level roll-up into the UCR. In 2014, there were 57,314 police-reported incidents for possession of cannabis (down 4% since 2013, and up 7% since 2004), and an additional 10,696 police-reported incidents (down 25% since 2013 and down 52% since 200) for trafficking, production or distribution of cannabis (Statistics Canada, 2015a). Charges were laid in about 42% of cannabis possession cases (24,542) and 71% of cannabis trafficking, production and distribution (7,573) (Statistics Canada, n. d). Further, cannabis-related offences constituted 66% (55% for possession, and 10% for trafficking, production or distribution) of all drug-related offences.

Cannabis-related offences constitute the highest proportion of all drug-related offences, in all provinces. In 2013, British Columbia had the highest proportion of cannabis-related offences among all of the provinces; two-thirds (69%) of all police-reported, drug-related offences were related to cannabis in BC (Statistics Canada, 2015). The rate of cannabis-related offences in BC in 2013 was 398 per 100,000 population, by far the highest in Canada. Saskatchewan's (293 per 100,000) and Nova Scotia's (236 per 100,000) rates are the next highest in Canada. In two territories, the rates of cannabis-related offences are more than double those in BC: 930 per 100,000 in the Northwest Territories and 1,000 per 100,000 in Nunavut. Yukon's rate is similar to that of the provinces (302 per 100,000). Among the Canadian CMAs, Kelowna's rate is the highest among the Canadian CMAs (563 per 100,000), while Thunder Bay had the lowest (86 per 100,000).

When it comes to cannabis possession-only charges, Kelowna still tops the list among all of the Canadian CMAs at a rate of 250 per 100,000, while St. John's reports the lowest rate at 11 per 100,000 (Levasseur et al., 2015). Interestingly, however, Saskatoon, not Kelowna, is the CMA where a person is the likeliest to be charged for possession of cannabis among all of the Canadian CMAs. As such, Saskatoon police lays a possession charge in 77% of all cannabis-related stops. The municipal police service that is the least likely to lay a cannabis possession charge is St. John's, Newfoundland (7%) (CBC News, 2015). CBC's analysis concludes that police in Canada are occupied with a cannabis-related possession charge every nine minutes (Levasseur et al., 2015).

By further breaking down this type of data by age of offender, and other violations associated with cannabis-related crimes, more can be learned about specific populations that are of specific policy concern (see Statistics Canada, 2014). For example, refining the analysis by further demographic and other variables such as immigrant status (or generational status), education, ethnicity or Indigeneity, and past convictions of offenders, would be helpful in understanding the dynamics of cannabis-related offending, as well as some community level health harms. However, since most of this data is not captured by the UCR, until the UCR is revised, such a finely detailed analysis would need to be performed through separate studies that most likely would require supplemental (and original) data collection. An example of such a data collection strategy is that of the Drug Use Monitoring in Australia (DUMA). DUMA is a partnership program between the Australian government, state police services, and researchers. Data on drug use among detained populations is voluntarily collected directly from the arrestees. Aside from

data on drug use, information is also gathered on local drug markets, and drugs and crime. The DUMA example has proven to be a solid way to collect information on actual consumption of drugs, as well as several other metrics discussed throughout this paper.[4]

In the absence of other performance metrics on cannabis, which may be impossible to collect, particularly in regimes where cannabis is illegal, police-reported incident data can be used to calculate estimates of other metrics. These methodologies can account for some of the possible bias that differential enforcement may give to this group of metrics, too. For instance, the total number of offenders of various kinds (including those that avoid police detection) can be statistically inferred by tracking detailed information on arrests and re-arrests, much like wildlife populations can be estimated by banding or tagging birds or fish, releasing them and then capturing them later (Bouchard, et al, 2012).

The metrics that include cannabis-related incidents likely operate most accurately under policy regimes where cannabis is illegal along all parts of its supply chain and consumption circumstances. Since each of the three cannabis-related offence types would have a different configuration under a decriminalization or legalization scenario, incident data would not be the only metric of this class, but would likely need to be expanded to include being charged with regulatory infractions, or the goal of the metric transferred to a different data collection mechanism entirely. For example, it is often proposed that the possession of small amounts of cannabis become a civil rather than criminal offence under scenarios of decriminalization, or not an offence at all under legalization. Thus, number of fines issued for possession should be measured in the former case, and questions on possession should be asked on surveys in the latter. It is conceivable that possession of large amounts of cannabis, or possession for particular purposes, could still be a criminal offence under either of the scenarios; therefore, incidents may still occur and should be continuously measured.

Outcomes of Police-Reported Offenses

Measuring the outcomes of police-reported marijuana offenses provides insight into how these transgressions are handled by the criminal justice system. These types of outcomes are usually measured by following the disposition cannabis cases receive from the courts. They can serve to indirectly measure both the seriousness of cases or draw inferences about the nature of offenders, but also to measure enforcement attitudes towards cannabis offending, or to measure the application of alternative policy measures (particularly under a cannabis regime that is informally decriminalizing through de facto enforcement tendencies or has formally decriminalized through formal policy and program directives).

A good source of data on this metric comes from Statistics Canada (2015), which has linked police-reported data from the Uniform Crime Reporting (UCR) Survey with the Integrated Criminal Court Survey (ICCS) to examine drug-related offense statistics. In 2013, there were 73,000 police reported cannabis offenses, with nearly 80% being for possession. A large majority (78%) of drug-offenses in 2013 were cleared or solved by police. A considerably higher proportion of cleared marijuana offenses were done so by departmental discretion (41%),

[4] For more information about DUMA please see http://www.aic.gov.au/about_aic/research_programs/nmp/duma.html

compared to other cleared drugs (17%). Departmental discretion refers to situations where the police formally issue a warning or provide a referral to a community-based program, rather than laying a charge (Statistics Canada, 2015).

Statistics Canada (2015) data also reveals that in adult criminal courts, cannabis-related cases accounted for the majority (55%) of completed drug-related cases over the period of 2008/2009 to 2011/2012. Nearly half (48%) of completed cannabis related cases were single charge cases. Cannabis possession offenses accounted for the majority (79%) of cannabis related offenses. It was found that cannabis cases were stayed or withdrawn at a higher percentage by the courts than other drugs (55% compared to 38%), which occurs when alternative measures, such as community service or treatment, are deemed more appropriate than judicial proceedings (Statistics Canada, 2015). Cannabis cases also took less time to complete. The median case length of a cannabis-related offense was 105 days, roughly half as long as the median for cases involving a heroin offense (202 days).

In adult court over the period of 2008-2009 to 2011-2012, 49% of cannabis supply cases and 43% of cannabis possession cases resulted in a guilty decision. These percentages were lower than guilty cases involving other drugs (56% for supply and 65% for possession). For cannabis offence cases with a guilty decision, a sentence of custody was imposed on 27% of supply cases and 16% of possession cases (18% in total), which was less common than other drugs (55% for supply and 36% for possession, 44% in total). Fines are another common penalty imposed in completed drug related cases (32%). Completed cannabis cases with a guilty decision that involved a fine totaled 43%, which was about twice as much as other drugs. Fines were found to be more common for cannabis possession offences (52%) than supply offenses (16%). The median fine amount for cannabis possession offenses was $250, compared to $1,000 for cannabis supply offences. Finally, a sentence involving probation was imposed on 31% of completed cannabis cases with a guilty decision (35% for supply and 30% for possession), which was similar to other drugs (29% for supply, 38% for possession, 34% in total).

As with the metrics associated with cannabis-related incidents, the metrics relating to the outcomes of police-reported cannabis offences will likely take a different form under a changed policy on cannabis. Since less cannabis-related offences are criminalized under decriminalized or legalized policy regimes, the courts will likely be prosecuting fewer cases which are more serious in nature. However, it is conceivable that under particular scenarios for decriminalized and legalized cannabis markets, if certain specific criminal offences remain illegal, combined with high non-compliance with an increased number of regulatory offences, case volumes in the courts could remain significant. Currently, regulatory offences are reported in the UCR on an aggregate level,[5] making a detailed analysis nearly impossible. It will be important to measure the outcomes of cannabis cases in the justice system, on a detailed, disaggregated level, because it informs law

[5] In the UCR, regulatory offences are recorded as "6,000 series." Examples of regulatory offences recorded in the UCR include offences under *Bankruptcy Act*, *Canada Shipping Act*, or *Excise Act.* All violations that occurred under these acts are aggregated and presented annually. In other words, we could know how many offences were committed in Canada under, say, the *Canada Shipping Act*, and we cannot know the kind of violations or their level of severity.

makers about the illicit nature of the trade. In other words, it would be very important to record cannabis-related regulatory offences and analyze them on a non-aggregated, detailed level.

Illegal Production and Cultivation

The number of cannabis plants cultivated and the volume of cannabis products produced is the basic metric required for an understanding of the first stage of the cannabis supply chain. Unfortunately, it is extremely hard to understand this dynamic of the cannabis market at the current time in Canada, mainly due to the illicit nature of the enterprise. This metric is combined with other metrics to understand the efficiency of the cannabis market, what portion of the market goes to domestic consumption or is exported, how crime operates within the market and the nature of the associated harms, the value of the industry to the economy, etc. Information on illegal cultivation and production of cannabis originates mainly from police reports on grow-op busts, investigative and anecdotal material, as well as extrapolations done by economists using models. An extrapolation is a method of statistical inference used by economists and criminologists to infer, in this instance, information on the overall size of illegal production and cultivation of cannabis based on publically-available information on existing production. Other things, such as projected revenues should a cannabis policy shift, expected sales and taxation, expected consumption, etc. may be extrapolated as well (see Bryan et al., 2013; Caulkins, 2010; Clements and Zhao, 2009).

In 2013 in Canada, the production of cannabis accounted for 96% of all illicit drug production that came to the attention of the police (Statistics Canada, 2015). There were about 4,800 police-reported cases of illicit production of cannabis, with the majority (64%) of production occurring in a private house or nearby structure, followed by 27% of production occurring in an open area.[6] In general, open-area production occurred mostly in Eastern Canada, with Quebec (40%), Newfoundland and Labrador (33%), Prince Edward Island (47%), and New Brunswick (30%) reporting outdoor growth of cannabis at higher rates than the national average (Statistics Canada, 2015).

Research on the illegal production of cannabis is scarce, primarily due to the difficulty in obtaining detailed information and data on grow-ops. Public Safety Canada recently explored how demographic, socio-economic, and criminological characteristics of communities may contribute to the presence or absence of cannabis grow-ops in communities. Unfortunately, the project could not be undertaken because of the quality and availability of grow-ops seizure data that was currently collected. Further, data collected by Statistics Canada proved to not be sufficiently detailed at smaller geographic scales to supply the necessary neighbourhood indicators required to apply the proposed methodology. Subsequent to this project exploration, in 2014, the RCMP revised the reporting structure for cannabis grow-ops takedowns, which may produce more reliable and enhanced data. The reports will feed into the national grow-ops seizure database, which should greatly improve our knowledge and understanding of police-reported illicit cannabis production in Canada.

[6] A "nearby structure" may be a garage or a shed. An example of "open area" may be an area with public access, parks, playgrounds, bodies of water, etc. (Statistics Canada, 2015).

Should the policy on cannabis take a different direction in the future, it is probable that much of the current volume of illicit production and cultivation of cannabis will be replaced with licit production. For example, under some jurisdictions' decriminalized or legalized cannabis regimes, users that grow their own marijuana plants can legally produce small amounts of cannabis for their own consumption. This type of production would still need to be measured, but through different methods (such as by survey) and would probably be called by a different name, say "Production and Cultivation of Cannabis." However, illicit production and cultivation to meet particular illegal market segments (such as sales to foreign markets, children and youth, or addicts) or for tax avoidance purposes, will likely continue under many different decriminalization and legalization scenarios, but probably on a smaller overall scale than the current illicit prosecution and cultivation market. Thus, the metric of illicit production and cultivation would still be relevant to try to measure.

Police Calls for Service

Cannabis-related calls for service are a type of performance metrics that refers to different sources of data: public-initiated police contacts; and police-initiated contacts. Public-initiated police contacts occur when a concerned member of the public contacts the police regarding a cannabis-related offence that they believe is taking place in their community. Police-initiated contacts are when police deploy units to deal with cannabis-related offences that other investigations have uncovered, interactions with the public have happened upon, informants have provided, or routine patrol activities have identified.

Law enforcement contacts initiated as a result of intelligence or a complaint by a member of the public should be a rather straightforward metric given that police are recording such information at some point between the initiation of the call and its completion. However, no information is publically available on the proportion of law enforcement contacts that are initiated either by the police or the public in relation to cannabis offences. The most likely explanation for the lack of data is the administrative burden of recording this information during or after the call. Police respond to cases based on priority. Once the call is placed and police are dispatched, information is then recorded based on predefined categories of the incident. There are numerous categories of offences where cannabis could be a cause to contact the police. For example, a call about a possible marijuana grow-op in the neighborhood and a call about youth smoking marijuana on the corner of a street would both constitute a public-initiated law enforcement contact. The first could be recorded as a possible production and trafficking of cannabis offence, while the second could be a possible cannabis possession charge.

While all of the law enforcement contact information should be recorded in the police jurisdiction's calls-for-service database, it would be burdensome to determine the number of calls within a police jurisdiction in which cannabis was the reason, or one of the reasons, for dispatching a patrol officer. Yet, such information could be very useful for both the police and the policy makers in determining the amount of resources that the police dedicates or should allocate to enforcing the laws on cannabis. With the recent recognition of the importance of calls-for-service data by the Canadian Association of Chiefs of Police (CACP) (CACP, 2014b), collecting data on cannabis-initiated law enforcement contacts may be facilitated.

The metric of cannabis-related calls for service would likely need to be slightly changed under cannabis policy scenarios involving decriminalization or legalization because much currently illicit activity would become either civil offences or altogether licit. However, there will still be

public cannabis-related complaints and regulatory infractions to which the police will need to attend (as there are for both alcohol and tobacco), and there will still be police-initiated investigations when it comes to cannabis.

Potency

Cannabis potency is a metric that is often used in public debates, by people discussing the possible harms of cannabis, but also those talking about the impacts of enforcement measures. Cannabis potency is usually measured as the proportion of psychoactive ingredients, such as tetrahydrocannabinol (THC) and cannabidiol (CBD), which are found in a given sample of cannabis product.

Information on the potency of cannabis is available from lab analyses of samples of seized and eradicated marijuana plants, as well as seized cannabis preparations and retail level products. All available analyses indicate that the percentage of concentration of the primary active ingredient in non-medical cannabis, the THC, in seized marijuana has been steadily increasing since 1975, both in the U.S. and in Canada. In the U.S., the average percentage of concentration of THC has increased from about 1% in 1975 to over 12% in 2013 (United States, 2014; Slade et al., 2012). In Canada, the average percentage concentration of THC has increased from below 1% prior to the early 1980's to 10.3% by 2006 (Slade et al., 2012).

One of the explanations as to why cannabis is becoming more potent is because there is a rise in consumer demand for stronger products. Other explanations are that a smaller volume of product per dose aids in illicit production, smuggling or hiding the possession of the illicit substance. Factors such as these in turn incentivize cannabis growers and producers to develop ways to produce smaller volumes of the product with higher concentrations of THC (CBC News, 2014). Cannabis is becoming more potent not only due to the continuous improvement of marijuana plant strains, but also due to the change in the technology used to grow marijuana. Powerful horticultural lights and hydroponic equipment, for instance, are major contributors to the increased production of higher potency cannabis products (Bouchard and Dion, 2009; Zhang, 2015). Another factor could be changes in the ways herbal cannabis is prepared for market and the way that cannabis concentrates are manufactured.

Ultimately, it is argued, it is the prohibition and enforcement that leads to more rapid shifts in production and consumption of more concentrated forms of drugs.[7] Researchers have started to draw a link between the consumption of high THC cannabis preparations and problematic and more harmful cannabis use; which has been argued results in more dependence and an increased risk of mental health problems. Early stages of scientific research into how prolonged cannabis use among youth affects the developing brain show that there indeed could be detrimental effects on a person's dependency and mental health to consuming higher potency cannabis (CBC News, 2014). However, much more research is needed to be able to draw the causal link

[7] Here, an analogy is often drawn to historical patterns observed when the prohibition of alcohol is instituted, when production and consumption of alcohol switched from the licit production of lower percentage of alcohol beverages (such as ale, beer and wine) to illicit concentrated forms of alcohol (such as gin and whiskey).

between these issues. For instance, the ratio of THC to CBD or other cannabinoids may be important to mitigating the harms of high THC potency, or the behaviours related to cannabis consumption may play a role.

The metric of cannabis potency will be different under decriminalized and legalized cannabis policy regimes than under an illegal regime. For one, under the scenario of legalization, the potency of licit market cannabis could be standardized should legal cannabis producers be required to determine the proportion of psychoactive ingredients in their products prior to selling them to consumers, as well as to control their level. This is similar to the current situation of legal tobacco and alcohol regimes, where producers are required by law to display the percentage of nicotine and alcohol that their products contain. Illicit tobacco and alcohol, due to their bootleg nature, do not often feature these proportions, which is also the situation with illicit cannabis. Thus, the metric of cannabis potency will still be relevant under a different cannabis policy regime, but mostly for bootleg cannabis. United States researchers have a longitudinal project and a standardized method for measuring the potency of cannabis preparations, while Canada currently does not, either in the forensic policing or medical communities.

Crime around Dispensaries[8]

The metric of crime around medical cannabis dispensaries assesses the level of crime that is geographically contiguous to these establishments, as well as whether it is heightened when compared to other businesses. Issues regarding this phenomena include the cannabis dispensary or its clients being a target for offenders, the clientele that is attracted by the business concentrating particularly criminogenic demographics in the geographic area (such as tourists or young men who then commit crimes), drug use in the vicinity of the dispensary predisposing intoxicated users to crime or being vulnerable to criminal victimization, or the owners or employees of the dispensaries being involved with committing crimes themselves (such as fraud, drug offences, or money laundering).

It is often asserted that medical marijuana dispensaries are popular targets for crime, including property and violent crime (Kepple and Freisthler, 2012; Police Foundation, 2015; Rucke, 2014). Over the past several years, many marijuana dispensaries in the U.S. and Canada have been victimized by crime (see Rucke, 2014; Ingold and Lofholm, 2011; Schmunk, 2015). Marijuana dispensaries tend to keep significant amounts of cash on hand, especially in the U.S., where the federal illegality of marijuana prohibits many banks from knowingly handling marijuana-related money (Rucke, 2014; O'Hara, 2014). Some dispensaries are unable to create bank accounts or use banking services, such as credit cards or armored car money transfers. However, it is expected that the federal legal issues will be resolved and that marijuana businesses in the U.S. will soon be able to use banks and credit unions (Rucke, 2014; O'Hara, 2014). Nonetheless, a

[8] Currently in Canada, the existing marijuana dispensaries are classified as "illegal marijuana stores." Under the existing *Marihuana for Medical Purposes Regulations*, only those with a license to manufacture can supply or sell marijuana directly to patients in possession of a prescription by a healthcare practitioner to access marijuana for medical purpose. The medical marijuana is distributed by mail to people who hold a prescription to purchase medical cannabis. Activity outside this framework is currently illegal. They are 29 licensed producers.

common belief is that medical marijuana dispensaries are still magnets for criminal activity and breed secondary crime in the surrounding area (Kepple and Freisthler, 2012; Rucke, 2014).

These claims have not been well supported by empirical research. In general, literature has shown medical marijuana dispensaries are no more likely to be a target for crime than other similar businesses. For instance, in 2009, the Denver Police Department estimated that 16.8% of medical marijuana dispensaries had been robbed or burglarized in the past year, compared to 19.7% of liquor stores and 33.7% of banks (Ingold, 2010). A 2010 Denver Police Department analysis found that crime around Denver's medical marijuana dispensaries decreased by 8.2% since 2009, which was comparable to the city's overall crime decrease of 8.8%. Moreover, a 2012 study by researchers from the University of California in Los Angeles concluded that medical marijuana dispensaries in Sacramento, California may not be linked to crime (Kepple and Freisthler, 2012). Researchers found that the density of medical marijuana dispensaries per neighbourhood was not associated with violent or property crime rates. However, Kepple and Freisthler (2012) note that crime prevention measures taken by dispensaries (e.g. video cameras, doormen) may deter possible offenders, a point that has been raised by others in relation to the Denver context (see Rucke, 2014).

In Canada and elsewhere, many medical marijuana dispensaries have gone to great lengths with security to deter potential offenders, including hiring private security firms to guard the premises and installing heavy gates and windows with bars. The extent to which these crime prevention measures are successful, however, remains unclear. Some medical cannabis advocates argue that dispensaries make neighborhoods safer (Sankin, 2013). This is mainly due to the increased foot traffic and security measures they bring to a community, along with allowing users to purchase the drug legally instead of buying it illicitly on the street from drug dealers (Sankin, 2013). With scores of medical marijuana dispensaries operating in Canada, carefully structured research should continue to monitor what effect these establishments have on crime.

The metric of crime around medical cannabis dispensaries will still be relevant under decriminalized and legalized cannabis policy scenarios. It should be changed to measure the crime around all cannabis dispensaries in the event cannabis is legalized. However, establishing causation regarding crime trends surrounding a particular drug dispensing location can be very difficult due to factors such as differing levels of police patrol and enforcement amongst other factors (Lawrence, 2012). Thus, care should be taken to carefully consult stakeholders on the design of data collection and analyses for metrics of this type, as well as consideration given to the standardization of the approaches to the measurement of this metric so that studies can be compared.

Crop Eradication

Law enforcement efforts on the suppression of cannabis production are often expressed through various crop eradication metrics. Commonly, such a metric would be the number of plants that are being seized and destroyed by law enforcement authorities. In certain cases, usually in countries where there is extensive outdoor growing of cannabis, the areas under cultivation are used as an alternative metric.

In Canada, information on cannabis crop eradication is largely lacking. The RCMP and other police services sometimes report on the number of plants eradicated during special operations, but annual statistics are not available. In the U.S., the Department of Justice reported that the number

of eradicated indoor-grown plants rose from 203,896 in 2004 to 450,986 in 2008. The number of eradicated outdoor-grown plants rose from 2,996,225 to 7,562,322 in the same time period (Department of Justice, 2010: 38).

Statistics on cannabis crop eradication rarely distinguish between strains of marijuana plants and so-called "ditchweed," or hemp plants (Caulkins et al., 2012). There are widely varying chemotaxonomic differences between strains of cannabis plants, which will contain varying levels of concentration of THC, CBD, and other psychoactive ingredients. Different strains will further produce different yields of cannabis that can later be sold and consumed. "Ditchweed," as the name suggests, is a wild-grown marijuana plant that has a concentration of THC of less than 1%. It will not produce the desired "high" effect if consumed, thus making it of little value to marijuana sellers or users. Hemp plants, much like "ditchweed," do not have a high concentration of psychoactive ingredients and are therefore not valuable to producers or users of marijuana or psychoactive cannabis products.

There is a visible difference between marijuana plants that are grown in a basement-type grow-op and "ditchweed," feral hemp, or cannabis that is grown outdoors. The former are usually shorter and have large flowering buds (the part that is consumed by users). These are often *Cannabis indica* or hybrids with other types of cannabis. The latter are tall plants with smaller buds, usually a type of *Cannabis sativa*. However, marijuana plants that are grown outdoors with a purpose of drug production are more similar to "ditchweed" and hemp in their appearance since most commercial hemp is a *Cannabis sativa* varietal. To distinguish properly, the plants would need to be sent for analysis in a lab environment and their levels of psychoactive ingredients analyzed.[9] It would be impossible to obtain such an analysis from every seizure that law enforcement authorities execute because it would require a vast amount of lab time and resources. Therefore, information on eradication of seized cannabis plants is reported through number of plants.

Statistics on cannabis eradication could often be misleading because each of the strains of marijuana, "ditchweed," and hemp all have very different levels of concentration of psychoactive ingredients. Eradicating a hundred "ditchweed" plants that are of no value to cannabis sellers or users is far from comparable to eradicating a hundred marijuana plants that are seized during a basement grow-op bust. What needs to be measured is the level of THC and other psychoactive ingredients that are being eradicated. Alternatively, the ratio of usable dried weight versus total biomass could be measured as a metric for crop eradication.[10] However, as mentioned earlier, to analyze the levels of concentration of psychoactive ingredients in each of the marijuana plants being seized would require a vast amount of lab time and resources, therefore making it unfeasible. Instead, a representative sample of all seizures could be analyzed for the content of

[9] Trained law enforcement officials sometimes have a hard time telling the difference between marijuana plants and hemp while on call in the field. Sometimes, plants are being seized and eradicated without lab analysis for psychoactive content of the plant because they are suspected of being marijuana plants. For an illustrative example of confusion between marijuana plants and hemp, see http://www.cbc.ca/news/canada/saskatchewan/sask-rcmp-cut-down-3150-suspected-marijuana-plants-1.3213531 (retrieved on September 3, 2015).

[10] For example, if 50% of one plant is one large flowering bud and another similarly sized plant has flowering buds that only represent 5% of the plant mass, these plants would carry a very different market values to marijuana producers and sellers.

psychoactive ingredients seized and eradicated on a monthly or annual basis. The overall content of psychoactive ingredients that is being eradicated could then be estimated using proper extrapolation methods.

A further issue, when counting plants as an eradication metric, is that different horticultural strategies can influence the number of plants at a grow site during different stages of the cultivation cycle. For instance, in some grow operations, after a period of time all male seedlings may be removed, plants in a plot thinned to allow for remaining plants to thrive, plants may be started from cuttings of a mature plant or through the longer process of germinating seedlings. In cannabis regimes where more plants are riskier to grow or their cultivation results in greater penalties, fewer plants may be grown as a risk mitigation strategy, but instead growers could focus on larger growing cannabis plant varieties and these plants trained for maximum volume of useful vegetation per plant.

In the past, crop eradication has sometimes been calculated by weight by some researchers and law enforcement agencies. However, this method of measuring this metric makes it very difficult to achieve an accurate comparable standard to measure what is intended, due to wet or dry weights of the plant being included in the same metric, the frequent inclusion of the vegetative parts of the cannabis plant never marketed as a drug, the inclusion of rootstock or adhering soil, etc.

Illicit cannabis cultivation will likely continue under most conceivable cannabis policy regimes. Therefore, eradication efforts will likely need to be a performance metric that should be tracked in most policy scenarios. However, when developing and applying crop eradication metrics, it is important that clear measurement definitions are applied and only cannabis plants destined for illicit consumption be measured. Thus, the recommendations regarding this metric are still applicable under most cannabis policy regimes.

Grow-Ops as Fire Hazard

There is a concern that indoor marijuana grow-ops are a fire hazard, particularly where illicit wiring or electricity theft is taking place. This concern also exists in the case of both illicit and licit marijuana grow-ops, which can be the cause of domestic and industrial fires. The number of fire incidents at grow-ops and to what extent the grow-op activity is the main cause of fire could to be measured as a metric.

The link between marijuana grow-ops and fire hazards is somewhat controversial and a solid academic consensus has not developed around the hypothesis. Indoor grow-ops tend to have bad, unprofessional electrical wiring and paneling, powerful and often excessive heat-producing lights, dangerous chemicals that are not handled properly, and excessive amounts of mold, all of which would contribute to higher rates of fire hazardous nature of the establishment (Surrey, 2009). According to a 2009 report produced by the city of Surrey, BC, a house with a grow-op is "24 times more likely to catch fire" when compared to a home with no grow-op inside (Surrey, 2009: 1).

On the other hand, Tim Moen, the fire captain and battalion chief of Fort McMurray, Alberta, argues that when illicit and licit grow-ops are separated, a rather different portrait of danger of fire emerges. While Moen's full analysis is not publically available, he argues that when only licit grow-ops, such are the ones producing medically-licensed cannabis, are taken into account, the

risk of fire in these establishments are only 0.24 per cent higher than that in regular homes (Hall, 2015). In other words, the presence of a legal grow-op is not a predictor of fire in the household.

The fire risk posed by marijuana grow-ops is an important one that deserves to be tracked. A proper analysis that separates licit and illicit grow-ops, as well as considers other factors such as type of neighbourhood, age of the house, size of the grow-op, method of growing, etc. would be good to conduct. Data that would permit such an analysis probably exists in different formats, but it needs to be obtained from the police, fire departments, and Statistics Canada, and then merged.

The metric of fire hazard at grow-ops will be relevant regardless of any change in the cannabis policy regime. If cannabis is legalized, more legal grow-ops will open up that will be presumably just as compliant with fire safety codes as other licit businesses, which will in turn reduce the hazardous nature of cannabis production operations overall. Still, it is probable that fires will still happen, particularly in illicit grows, the rate at which these incidents occur, and why, will need to be measured.

Organized Crime

The intent behind this group of metrics is to assess the extent of organized crime involvement in the production and trafficking of cannabis, as well as the extent to which organized crime is able to launder their illicitly-obtained money as a result of producing and trafficking the cannabis.

Due to the hidden nature of organized crime and money laundering mechanisms, it is extremely hard to measure the level of activity of organized crime in the area of possession, production or trafficking of cannabis (or, for that matter, any other illicit substances). The existing law enforcement estimates provided below are mainly based on investigative and anecdotal evidence which may or may not reflect the reality of the situation.

According to the Criminal Intelligence Service of Canada (CISC) at the RCMP, the majority of crime groups under observation by police services in Canada are involved at some level in the marijuana trade. The RCMP believes grow-ops to be major money-generating illicit businesses that both produces income and generates the capital that is used to fund other activities of criminal networks. BC's Organized Crime Agency believes that criminal networks in BC control about 85% of the province's cannabis trade[11] (Surrey, 2009). The RCMP further estimates that between 50% and 80% of cannabis grown in BC is trafficked into the U.S.

The RCMP also estimates that over 130 organized crime networks are active in BC, and all compete for a stake in the province's cannabis industry (Werb, 2014). The value of the province's cannabis market is estimated at $7 billion dollars per year (Werb, 2014). The extent to which legal marijuana industries in the U.S., notably in the State of Washington, reduces demand for the products of these drug gangs remains relatively unknown and is still debated.

When it comes to the role of Mexican drug cartels in the U.S., one study estimated that the gangs' revenues from illicit cannabis operations could potentially decrease by between 22 and 30 percent

[11] It is unclear from the report whether the organized crime networks' control of 85% of BC's cannabis trade by volume of product, or by value of profits.

in the three states that legalized marijuana in the U.S. (Ramsey, 2012). Further, while officials of the U.S. government estimate that as much as 60% of the cartels' profits come from illicit cannabis operations, researchers from the RAND corporation estimate that the percentage should be more realistically estimated at somewhere between 15% and 26% (Kilmer et al., 2010).

It is evident that better, sounder estimates are needed when discussing the issue of organized crime activity in the area of the illicit cannabis industry. There are two possible approaches that could pave the way to better estimates. One approach is to estimate the proportion of cannabis-related incidents (offences) that are committed by organized crime groups. A recent study commissioned by Public Safety Canada (Bouchard et al., 2014) is a good example of how this could be done. The researchers obtained incident data from Sûreté du Québec (Quebec's provincial police force) and examined possible co-offences with the city of Montreal to estimate the proportion of criminal incidents that could have been committed by organized crime groups. The second approach is to count the actual incidents committed by organized crime groups. For this, incidents that are committed or suspected to be committed by organized crime groups would need to be flagged in police records. A recent initiative in Canada, supported by the CACP, is to flag murder, homicide, and manslaughter incidents as committed by organized crime groups (if committed), as well as some of the drug offences (CACP, 2014). The so-called "organized crime flag" involves marking certain UCR offences as related to organized crime activity in police's incident databases. The intent behind this project is to provide more solid figures on the level of organized crime activity in Canada.

The level of involvement of organized crime in the production and trafficking of cannabis will likely take a different form under most decriminalization and legalization scenarios. It is likely that most criminal organizations will continue to engage in criminal activities regardless of the policy, but the extent of their operations might switch to larger scale operations for different markets (i.e., for export, to take advantage of provincial differences in regulation or taxation) or to different substances (e.g., switching focus to the production and trafficking of other drugs). Some criminal organizations, perhaps smaller ones now solely focused on cannabis offending, could shift to become entirely legitimate businesses under certain possible legalization scenarios. Tobacco, for example, is a legal substance in Canada. Yet, a number of organized crime groups are heavily involved in the production and trafficking of illicit tobacco, partly due to differences in policies between jurisdictions, strict regulation, and significant levels of taxation. Thus, their involvement in illicit markets still needs to be monitored and measured. On the other hand, after the Prohibition of alcohol ended in the United States and parts of Canada, some illicit alcohol producers and traffickers converted their operations over to legitimate production and sale (Schneider, 2009).

Probation Infractions and Parole Violations

It is useful for the correctional system to understand how drug offending relates to their client population. Knowing about probation infractions and parole violations is useful to understand issues such as the impact of programming, the deterrent impact of imposed sanctions, as well as the burden placed upon the system by cannabis offenders. This can be measured by metrics such as the number of probation infractions committed by offenders that were convicted of a cannabis-related offence, as well as the number of probation infractions committed by offenders that were convicted of another offence, but infracted their probation with a cannabis-related offence.

Data on probation infractions and/or parole violations is not readily available in Canada. The Parole Board of Canada, an organization responsible for overseeing the process of release on parole, was contacted by the authors to ascertain if this data was available. Data was not provided at the time of writing. It may be important to collect information on parole infraction and/or parole violations because it would be an indication of how significant cannabis-related crime is among convicted offenders. There are two streams to this metric: a) infractions or violations by offenders who were convicted of a cannabis-related crime; and b) infractions or violations by offenders who were convicted of any other type of a crime, but violated the probation or parole with a cannabis-related crime. Both of these streams could be accounted for and measured. Data on these metrics possibly exist and could be accessible to use as a metric.

It would be useful to measure the metric of probation infractions and parole violations regardless of any change in cannabis policy regime. This is not only because some cannabis-related offences could remain criminal offences even under full legalization, but also that banning the use of psychoactive or addictive substances are common parole or probation conditions. Thus, even under a legalized cannabis regime, probations and paroles would likely continue to be violated for cannabis breaches.

Diversion to Other Jurisdictions

A major concern of jurisdictions that are nearby to a jurisdiction that changes drug policy enforcement priorities, or decriminalizes or legalizes elements of its illicit drug regime, is that the more liberal jurisdiction will become a source of drugs. This can occur in many ways, through organized criminal smugglers looking to make a profit through arbitrage, to individual drug tourists legally purchasing drugs in one jurisdiction and illicitly possessing them in another. This issue can exist where jurisdictions are within the same country or between countries (which is dealt with further below). Thus, it is useful to try to measure the amount of cannabis that is moved from one province or territory to another, as well as across international borders.

Canadian data is lacking when it comes to the trans-provincial transportation of cannabis. U.S. data, especially the data collected in states where the recreational use of marijuana has been legalized, may be considered an important indication of what could happen once the policy changes in one jurisdiction, but not in jurisdictions adjacent to it or elsewhere in the country. Data from the State of Colorado, where the recreational use of cannabis was legalized in 2012, indicates that there were an average of 251 significant seizures of cannabis destined to states outside of Colorado in the period between 2009 and 2013, compared to an average of only 52 in the period between 2005 and 2008 (Rocky Mountain, 2014). This represents an increase of almost 400% in significant seizures. Along with the increase in the number of significant seizures, the total average weight of seized cannabis increased as well from 2,763 pounds in 2005-2008 to 3,690 pounds in 2009-2013. The seized cannabis in 2013 was destined for 40 different states in the U.S.

On one hand, these findings could indicate that the demand for cannabis in the U.S., or parts of it, could be met by the legal production in Colorado. This, in turn, could lead to decreased production in the destination U.S. states, or perhaps in Mexico or Canada which also export cannabis to the United States, yet increase interstate trafficking of cannabis between Colorado and the destination states. On the other hand, these statistics may be somewhat misleading because more police resources could have been allocated to seizures by jurisdictions where marijuana is still illegal since the legalization in Colorado. This, in turn, would naturally result in

a higher rate of seizures. Nonetheless, this is still a significant increase in seizure activity. Further, an increase of 33.5% in the average weight of seized cannabis products indicates that there indeed may be a considerable diversion of cannabis out of Colorado.

This movement of cannabis across borders, either internal domestic borders or international borders, will be a relevant metric under all policy regimes, due to legal, regulatory and market differences between jurisdictions. Even if legalized, organized crime groups or individuals may still be exporting cannabis outside of their jurisdiction. Therefore, it is important to continuously measure the amount of cannabis exports. The difficulty with this metric is to design the data collection strategy in such a way that biases resulting from changing law enforcement practices are taken into account when the metric is interpreted.

Transfer Using Parcel Services

This metric specifically focuses on one of the main methods that cannabis is transferred between jurisdictions; through postal and parcel services.

There is no reliable publicly-available Canadian data on the transfer of cannabis through the mail. Data from the U.S. indicates a significant increase in intercepted parcels that contain cannabis shipped out of Colorado and destined for other U.S. states. Thus, the number of intercepted parcels has seen a steady increase from 0 in 2009, to 15 in 2010, to 207 in 2013 (Rocky Mountain, 2014). The total weight of cannabis products shipped in parcels too rose from 0 pounds in 2009, to 57.2 in 2010, to 493.1 in 2013. Finally, the number of States that the parcels containing cannabis were destined to rose from 10 in 2010 to 33 in 2013.

Just like the metrics of Diversion to Other Jurisdictions, the metric of Transfer Using Parcel Services needs to be interpreted with caution. More, or more effective, resources could have been put into intercepting these parcels containing cannabis since the legalization of medical, and then recreational, use of cannabis in Colorado. The more resources that are allocated to interception, the more parcels are going to be discovered and seized. Thus, for the metric to be properly interpreted, it would be ideal to know how many police resources were dedicated to seizure activity, what strategies were used, what the overall volume of parcels was, and what fraction were searched. If these were constant for the years under examination, then it could be concluded that there was indeed a significant rise in the transfer of cannabis through parcels.

This particular metric is one that should be considered for continuous measurement regardless of a change in policy regime. As noted, even if completely legalized, organized crime groups or individuals may still be exporting cannabis outside of their jurisdiction, even to other legalized jurisdictions that might have differing regulations, and parcel service is one of the major export methods. Therefore, it is important to continuously measure the amount of cannabis exports via parcels.

Exportation across Borders

It would be useful to know how much cannabis is exported from Canada to other countries, particularly from Canada to the United States, perhaps even distinguishing between states.

Police intelligence and border services indicate that the United States is a prime destination for Canadian-produced cannabis. It is used as a sort of commodity currency for criminal organizations in their transnational transactions, where it is traded in the U.S. for guns, other illicit narcotics or drug precursors, or illegal tobacco. The RCMP believes that between 50 and 80 per cent of BC-grown cannabis is destined for the U.S. (Surrey, 2009); an academic expert on cannabis supports this range, estimating the proportion of U.S.-bound BC cannabis exports at 70% (Larsen, 2011).

The readily-available metric of cannabis trafficking across the U.S.-Canada border comes in the form of seizures of cannabis by border patrol services. The actual number of seizures at the border is not publicly-available from the RCMP or the Canada Border Services Agency (CBSA). Still, the RCMP reports that their number has dropped by 36% in 2007 (Surrey, 2009). Larsen's (2011) findings indicate a similar pattern of decreased rate of marijuana seizures at the North-west Canada-U.S. border since 2001, which he attributed, among other things, to increased border enforcement since 9/11. However, the quantity of seized cannabis products has increased by 65% in 2007. Another available statistic from the RCMP states that the total seized weight of cannabis at the border increased from 2,235 kilograms in 2000 to 15,697 kilograms in 2003 (Surrey, 2009: 1). This suggests that while the number of shipments decreased, they became larger on average.

Just like the metrics of Diversion to Other Jurisdictions, the metric of Marijuana at the Border needs to be interpreted with caution. More or fewer resources could have been put into enforcing the law on either side of the border. The more resources are allocated into seizure, the more marijuana is going to be discovered and seized. Thus, for the metric to be properly interpreted, it would be ideal to know the resources invested in border patrol dedicated to seizure activity. If these were constant for the years under examination, then it could be concluded that there was indeed a significant rise in the transfer of cannabis through the border.

A good scientific method to estimate the amount of cannabis exported out of Canada would be to subtract the amount of cannabis consumed in Canada from the amount of cannabis produced (see Bouchard et al, 2012; and Maslov and Boucher, 2014). The difference, at least in theory, could be attributed to export. Of course, for this method to be properly applied, solid estimates of both production and consumption need to be available to researchers.

This metric would be useful regardless of the policy regime in place. Even if legalized, organized crime groups or individuals may still be exporting cannabis outside of their jurisdiction, especially to States where cannabis is illegal. Therefore, it is important to continuously measure the amount of cannabis transferred across the Canada-U.S., or other international borders.

Extraction Explosions and Injuries

As with fires, there are particular types of accidents that appear as harms associated with the marijuana production industry. In particular, being able to accurately track the number of explosions and burns that can be attributed to the process of extracting and concentrating the active constituents of cannabis is of interest.

Butane is a gas that is used in a process for the extraction of hash oil from cannabis plants. Butane is both highly toxic and explosive, and its improper use can lead to disaster. The improper use of

other volatile chemicals and alcohol used in alternative extraction processes, chemicals which are also highly flammable, in processes that can sometimes involve pressurized gases and vacuum chambers, can also result in explosions and burns. Canadian data on explosions due to improper processing of cannabis concentrates is not available. In the U.S., there were 32 blasts reported due to mishandling of butane recorded across Colorado in 2014, up from 12 in the previous year (Healy, 2015).

Monte et al. (2015: 241) further note that marijuana legalization in Colorado has led to unintended effects such as an "increased prevalence of burns, cyclic vomiting syndrome, and health care visits due to ingestion of edible products." For instance, the number of marijuana burn cases at University of Colorado burn center substantially increased. From 2012 to 2014, the center had 31 cases of marijuana-related burns, the majority of which are associated with a THC extraction process involving butane (Monte et al., 2015). According to the authors of the report, these unintended effects have emerged alongside other expected health care system effects such as increases in chronic health conditions.

Safer and controlled methods of extraction of hash oils or other concentrates could be regulated under various decriminalized or legalized cannabis policy scenarios, which would potentially reduce the number of explosions and burns that are attributable to this type of processing. However, it is likely that illicit extraction processes that produce bootleg hash oil or other concentrates will continue to be practiced illicitly. Further, explosions and burns could still be happening at licit extracting stations, albeit likely on a less frequent scale. Thus, the number of explosions and burns whose main cause is extraction of cannabis concentrates from cannabis should probably be continuously monitored regardless of any change in cannabis policy.

Traffic Accidents and Driving Under Influence of Drugs (DUID)

Deaths and mortality due to traffic accidents are a major concern in Canada.[12] In particular, alcohol-involved traffic accidents kill and injure huge numbers of people, particularly in certain demographic groups such as young adults and youth. Of similar concern is the degree to which being intoxicated by illicit drugs impairs driving abilities which result in changes to rates of traffic fatalities and injuries. It is of great importance to be able to accurately determine the proportion of road traffic accidents that are attributable to driving under the influence of cannabis. Related metrics include measuring the overall proportion of cases where drivers are charged with an offence of driving under the influence of cannabis.

CTADS is a good source of data when it comes to self-reported admission to driving while under the influence of drugs and alcohol. In 2012, 2.6% of respondents 15 years of age and older in Canada reported having driven a vehicle within two hours of consuming cannabis in the year preceding the survey (Beirness and Porath-Waller, 2015). Turning proportions into numbers, further analysis by the Canadian Centre on Substance Abuse (CCSA) reveals that in 2012 in Canada, an "… estimated 632,576 persons … reported making 10.4 million trips after using cannabis, an average of approximately 16 trips per person per year. This compares with 2.04 million persons (8.4% of all drivers) who made an estimated 13.3 million trips after consuming

[12] In 2013, there were a total of 1,923, down from 2,076 in 2012 fatalities due to road accidents in Canada (Transport Canada, 2015). This represents a per-capita rate of deaths of 0.05 per 1,000 population in 2013.

two or more drinks in the previous hour, an average of 6.5 trips per person per year" (Beirness and Porath-Waller, 2015: 2).

Younger drivers were the most likely among all age groups to have admitted to driving under the influence of cannabis: 8.3% of those 18 to 19 years of age, and 6.4% of those aged 15 to 17 years admitted to doing so. Further, males were three times more likely than females to admit to driving under the influence of cannabis (Beirness and Porath-Waller, 2015). A relatively high proportion of youth (15.8% of those aged 15 to 24 years old) were also found to have admitted to being a passenger in a vehicle operated by a driver who consumed cannabis in the two hours before driving the vehicle (Beirness, 2014). In another study of high school students from grades 10 and 12 (median ages of 16 and 18, respectively) in Atlantic Canada, the researchers found that 14.8% admitted to having driven under the influence of cannabis in the year preceding the survey (Asbridge et al., 2015). This rate was almost double those who admitted driving after having consumed alcohol (8.0%) or triple than those who admitted driving after having consumed opioid substances (4.3%). Moreover, 44.3% of student responders admitted to having ridden in a car whose driver was driving under the influence of cannabis in the 12 months preceding the survey. The percentage of passengers who admitted to having ridden in a car whose driver was under the influence of alcohol was half than that of cannabis – 19.5% of respondents admitted to having done so.

A thorough examination of factors that affect the likelihood of driving after consuming cannabis was conducted by a team of researchers in Canada in 2013. Fischer et al. (2013) found that frequent (at least weekly) cannabis use; daily driving; perception of own ability to drive not being impaired by cannabis use; and expectation of driving under the influence of cannabis in the next 12 months are all significant predictors of someone driving a vehicle within four hours of admitting to having consumed cannabis.

Unlike self-reported data on DUID, data gathered from random and independent roadside testing allows researchers to ascertain the actual number or drivers caught driving under the influence of drugs. In one study, researchers analyzed data from roadside breath and oral fluid tests of drivers in British Columbia between 2008 and 2012. It was revealed that 5.5% of drivers tested positive for cannabis, with younger drivers aged 16 to 18 year olds (7.5%) and 19 to 24 year olds (6.8%) being more likely to have tested positive than the rest of the sample (Beasley, Beirness, & Boase, 2013).

When it comes to injuries and deaths as a result of DUID, one study that examined hospital admission data revealed that cannabis was detected in the system of 13.9% of seriously-injured drivers who were hospitalized following their accident in a trauma unit of a regional Toronto-based hospital (Stoduto, et al., 1993). Another study found that drugs of all kinds (other than alcohol) were found in the system of 35.4% of fatally-injured drivers aged 16-24 years in 2010 (Beirness, Beasley, & Boase, 2013). While still considerably lower than the prevalence of alcohol in the system of fatally-injured drivers (52.8% of drivers aged 16 to 25 years old in the same year), this is nevertheless an alarming statistic (Beirness, 2014). It should be mentioned, however, that since chemical traces of cannabis remain for longer periods of time in human blood than alcohol, it does not necessarily mean that the fatally-injured drivers were operating a vehicle while intoxicated. In other words, the drivers could have consumed drugs much longer before operating the vehicle and were not actually driving under the influence of drugs, but the drugs

were still detected because they remain in the blood column for a prolonged period of time. The methods of detecting drugs in the human body are still far from perfect (see below).

In the State of Colorado, which legalized the medical use of cannabis in 2006 and recreational cannabis in 2013, fatal traffic injuries that involve drivers who used cannabis while driving doubled between 2007 and 2012 (Rocky Mountain, 2014).

An international literature review estimated that the consumption of cannabis products while operating a motor vehicle can increase the chance of a road collision by almost two times, and a deadly injury as a result of a traffic accident by two to three times (Asbridge et al, 2012; also see Li et al, 2012). Somewhat counter-intuitively, however, in some scenarios of higher rates of cannabis use in the population, the overall number of traffic fatalities and injuries could be reduced due to cannabis use displacing alcohol use, thereby reducing the amount of alcohol impaired driving (Anderson, et al, 2013).

There is one major caveat when it comes to establishing statistics on marijuana-related traffic accidents, deaths, and non-self-declared DUID. Marijuana metabolites, unlike alcohol metabolites, remain in urine for a number of days following the use of the drug (Caulkins et at., 2012). If a test for drivers who are suspected of DUID involves urine sampling, a result would not necessarily indicate that the driver was driving under the influence of marijuana at the time of a traffic stop or an accident. A mouth swab or a blood test, on the other hand, would provide such information in a much more reliable way (Caulkins et al., 2012).

Various metrics related to traffic fatalities and injuries, of all types (including cannabis influenced driving), as well as survey data on drug consumption and driving behaviour, will need to be continuously measured regardless of any change in the cannabis policy regime. While the threshold of intoxication due to cannabis at which driving becomes dangerous and forbidden could change in the future, based on additional empirical research or other factors, as was the case for alcohol, driving under the influence of cannabis is likely to remain an offence.

Testing Information and Law Enforcement Training

No matter what cannabis policy regime is in place, infractions and convictions for impaired driving will be of concern. Police will continuously issue charges and report on these types of offences. However, although the methods for assessing alcohol impairment, collecting evidence of impairment, and the legal thresholds for impairment, have been clearly delineated for alcohol, the situation is much less clear in the case of other drugs, in this case cannabis. Thus, ways to measure for the presence of cannabis metabolites in the human body, as well as the quality of training of law enforcement officials in collecting related evidence of impairment due to cannabis intoxication is a key concern.

Determining and measuring cannabis impairment is difficult and often less reliable than the measures used to detect alcohol impairment (Owusu-Bempah, 2014). Techniques used by law enforcement to detect cannabis impairment in drivers include the Drug Evaluation and Classification (DEC) program, on-site oral fluid screening devices, and on-site urine screening devices (Owusu-Bempah, 2014). Drug-impaired motorists in Canada are detected by the DEC program, which is administered by police officers certified as Drug Recognition Experts (DRE's). The DEC procedure can occur on the roadside or at the police station. The DRE examines the

drivers' socio-behavioral cues, biological and vital signs, and engages in direct questioning. The purpose is to determine whether the suspect is impaired, and if so, which category or categories of drugs are most likely responsible. If the DRE believes that the impairment is due to a drug, a blood sample is taken and sent to a laboratory for toxicology testing (Owusu-Bempah, 2014).

Studies on the effectiveness of the DEC program in detecting cannabis impairment are mixed. Most DRE studies that are conducted in the field (by law enforcement) lend support to the argument that DRE's are effective in detecting cannabis impaired drivers. For instance, a Canadian study found that DRE officers are able to identify the class of drugs responsible for the impairment with an accuracy rate of 95% (Beirness, Beasley, & LeCavalier, 2009). Another study in Spain indicated that police officers can accurately identify levels of cannabis intoxication that correspond to particular THC oral fluid concentrations that cause significant driving impairment (Fierro et al., 2014).

However, Owusu-Bempah (2014) points out that the results of DRE field studies should be interpreted with caution. This is because there is no way to calculate the number of cannabis impaired drivers who were stopped and not considered to be impaired, and thus not subjected to the DEC. A body of controlled laboratory studies exist on DRE's, most of which reveal that their ability to identify cannabis consumption is quite poor (Owusu-Bempah, 2014). For example, Heishman et al. (1998) discovered that the patterns of correct DRE identification, among other things, depend heavily on the dose of administered drug. Higher doses, the authors argue, will results in better predictions than lower ones.

These metrics remains highly relevant regardless of changes in the cannabis policy regime. As newer methods of testing and training become available, improvements should be implemented in the field. Further, since driving under the influence of cannabis is likely to remain an offence under any policy scenario, improved testing approaches should become available and need to be evaluated. The ability of law enforcement to detect dangerous levels of intoxication should also be continuously monitored and evaluated.

Public Health

Medical Marijuana Industry

There are a host of metrics that can be used to describe the scope of the medical cannabis industry. These types of metrics, in some way, echo the types of metrics required to accurately describe illicit, decriminalized or legal cannabis markets. Such metrics can include such measures as: the amount of medical cannabis produced by the industry; the number of licenses issued; the number of prescriptions filled; proportion of production diverted to the licit market; etc.

Canada's medical marijuana industry is of substantial size and has recently undergone shifts in regulations concerning supply and acquisition. Dried marijuana is not recognized by Health Canada as an approved drug or medicine; however, usage is allowed when authorized by a healthcare practitioner (Health Canada, 2015). As of 2013, marijuana for medical purposes is accessed through the *Marihuana for Medical Purposes Regulation* (MMPR). Companies wishing to produce and distribute marijuana must undergo a strict and rigorous application process. According to Health Canada (2015a), twenty-six companies are licensed under the MMPR to provide dried and fresh marijuana, as well as cannabis oils. According to the CBC, more than 50,000 people in

Canada are authorized to use marijuana for medical purposes (Vartainian, 2015). To access marijuana, patients must possess a medical document provided by a healthcare practitioner (Health Canada, 2015). A number of scientific studies have found marijuana and the chemicals it contains can help with the relief of nausea and vomiting, certain types of pain, and the stimulation of the appetite (CCSA, 2015). Research is still ongoing regarding the therapeutic uses of cannabinoids for conditions such as multiple sclerosis, cancer, and glaucoma (CCSA, 2015).

Metrics to describe and assess the medical cannabis industry are not the focus of this report. There are many different types of data that would be useful to track to understand the medical cannabis industry, in scenarios of recreational cannabis illegality, decriminalization or legalization. In cases of legalization or decriminalization of recreational cannabis, if the medical cannabis industry remains a separate, licit regulated industry these metrics are likely to remain relevant because the regime for medical marijuana would co-exist alongside of decriminalized or legalized recreational use of marijuana.

Use of Other Licit and Illicit Drugs

Measuring the extent to which the use of cannabis is associated with the use of other substances, including tobacco, alcohol, and other drugs is an important health and safety consideration.

The relationship of cannabis use to other illicit substances and alcohol use, or what some call the "gateway" effect, is not well-researched and is controversial. There exists an established correlation between the use of cannabis and alcohol, tobacco, and other psychoactive substances (Caulkins et al., 2012). This correlation is further described by frequency and level of cannabis use, as well as age of initiation of use. Higher correlation of use of cannabis with other substances can be found among more frequent, heavier cannabis users, as well as those that started using cannabis at an earlier age (Fergusson et al., 2006). The causation of this clear correlation is disputed.

Another explanation for the correlation is that of peer association – those who use cannabis could tend to associate with peers that use other substances or dealers that sell them, and therefore be more tempted to try them (Hall and Lynskey, 2005). It is possible that the effect of peer association would be reduced in a licit cannabis regime.

And yet another explanation for the correlation is that of a predisposition. Those who use cannabis may be predisposed to the use of other psychoactive substances (Hall and Lynskey, 2005). However, with all the available research this correlation remains just a correlation, not a causal relationship. No study thus far has been designed to adequately explain the correlation as a causal relationship. Still, educated guesses tend to lean towards causality when it comes to use of cannabis and the use of other psychoactive substances. An example of such an educated guess would be the use of alcohol and tobacco that typically precedes the use of cannabis and a later progression to the use of harder drugs (Caulkins et al., 2012). Recent research appears to be leaning towards identifying tobacco or, usually, alcohol as the primary 'gateway drug' (Barry et al, 2016).

On a flip side of the relationship between cannabis and other drugs, a recent study (Lucas et al., 2015) found that cannabis could be the substance that helps chronic and problematic users of alcohol or illicit drugs to wean off their addictions to these substances and use a less harmful substance like cannabis instead. The study reported that 87% of substance users reported

substituting cannabis for either alcohol (51.7%), illicit (32.6%), or prescription drugs (80.3%). Younger users (under 40) were more likely to substitute marijuana than older users. From this data, it is suggested by the authors that cannabis substitution could reduce harms and lessen the public health and safety impact of alcohol and other drugs. Another recent qualitative study found that people who use cannabis and have used other drugs before saw cannabis as a safer alternative to other drugs in that cannabis has less severe side effects, lower risk of getting addicted, and was effective in relieving some symptoms such as pain (Lau et al., 2015). In the case of a legal cannabis market, switching away from interaction with illicit drug markets might also have the impact of being less exposed to subsidiary criminality or criminogenic associations. Thus, there are possible public safety implications to this group of metrics, as well.

Regardless of shifts in cannabis policy it is useful to understand the relationship between switching between the consumption of different drugs, as well as the causation and correlations between different types of legal and illegal drug use. Tobacco, alcohol, and other substances, licit or not, are likely to continue to be used in society.

Overdose

These metrics measure the extent to which overdoses and fatalities occur as the direct result of using cannabis. The main metric in this category includes the number of cases of overdoses and fatalities due to overdoses reported by hospitals and poison control centres.

An overdose of a substance may be thought of as a dose that, once taken, can cause an adverse reaction or risk of death for the user. An overdose can take the form of: a) toxicity causing death; b) toxicity causing adverse physical reactions accompanied by symptoms like vomiting, body ache, rashes, sweating, or heart attack; and c) toxicity causing adverse psychological reactions such as paranoia, panic attack, etc. Contrary to popular belief, it is in fact possible to experience an overdose using cannabis (Caulkins et al., 2012: 64). As is the case with any psychoactive substance, the dosage of an active ingredient that is required to achieve a "high" is different for many users. It depends on a variety of factors such as personal tolerance of the drug, history of past use, users' mood at the time of consumption, presence of other substances in the system, etc. Currently, there is simply no recommended dose to take. And even if there were one, it would likely be nearly impossible to calibrate because there are too many strains of cannabis, with each containing a different amount and number of psychoactive ingredients. The desired "high" achieved by taking a "puff" or smoking a whole joint by one user could result in an overdose to another or even to the same user in a different set and setting.

An "overdose" occurs when the amount of psychoactive ingredients in the consumed drug exceeds that which the body and mind of the user can tolerate. Gable (2006) created a scale of toxicity of various recreational drugs, including alcohol, which indicates how safe the substances are to the human body when overdosed. The scale indicates that, of the most common recreationally used licit and illicit drugs, cannabis is the safest to use, while heroin is the most dangerous. For example, according to Gable's scale the use of cannabis is over 100 times safer if overdosed than alcohol, and over 200 times safer if overdosed than heroin.

Fatal cases of cannabis overdose are extremely rare, and their occurrence is often linked to using cannabis together with other psychoactive substances and/or alcohol, or sometimes linked to creating physical symptoms that interact tragically with a pre-existing medical condition

(Caulkins et al., 2012; Gable, 2006). As a result, it is often disputed that these rare cases of fatal overdosing should be attributed to cannabis, if it was not the sole cause of death. However, an overdose of cannabis can be far from a pleasant experience and can often include side effects such as paranoia, panic attacks, severe anxiety, hyperventilation, etc.

As many American states legalize or decriminalize recreational marijuana use, information on the public health implications is emerging. One of the main health concerns has been increases in cases of child poisoning. Wang et al. (2014) found that the poison center call rate for unintentional marijuana exposure in children aged 9 years and younger increased by 30.3% per year in decriminalized states from 2005 to 2011. In comparison, the call rate in marijuana prohibited states did not change during this time period (Wang et al., 2014). Additionally, data from the Children's Hospital of Colorado indicates that the number of children evaluated for unintentional marijuana ingestion went from zero in the five years preceding medical liberalization to 14 in the 2 years following (Monte et al., 2015). Monte et al., (2015) note that this increased further after legalization, and from January, 2014 to September, 2014 fourteen children had been admitted for unintentional marijuana ingestion, with seven admitted into the intensive care unit (ICU). Admissions into the ICU were primarily caused by the ingestion of edible marijuana products (Monte et al., 2015).

This metric is to remain relevant regardless of any shifts in cannabis policy. Rates of overdoses and fatal overdoses could decrease as a result of legalization of cannabis because users could be more informed and educated. However, additional numbers of new users, inexperienced users, and careless users, could result in increases in overdoses. It is also possible that many users would be consuming standardized doses of cannabis, thereby perhaps reducing the likelihood of overdose. However, overdoses would still occur and need to be measured on a continuous basis. Further, research evidence to-date indicates that it will be important to track the form or type of cannabis product that caused the overdose and in what circumstance the overdose occurred.

Emergency Room Visits and Hospital Treatment Admissions

This metric measures the extent to which the consumption of cannabis results in emergency room visits and hospital admissions. It does not address issues of dependency and abuse (these are covered by a separate metric). The number of visits and admissions due to use of cannabis is the medium through which this metric is measured. This metric allows policy makers to better understand how much of a burden the use of cannabis could be on the healthcare system, as well as how adverse the use or, rather, overuse of cannabis could be on users' well-being. It is a very similar metric to the previous one on overdoses. While it excludes poison control or self-reported overdoses, it does include other non-overdose cannabis-related hospitalizations or treatments.

U.S. data on cannabis-related emergency room visits and hospital admissions is gathered by the Drug Abuse Warning Network (DAWN), which is a public health surveillance system managed by the Substance Abuse and Mental Health Services Administration (SAMHSA) of the U.S. Department of Health and Human Services (HHS). According to DAWN's estimates, the number of cannabis-related emergency room visits in the U.S. (376,467 in 2009) is second to cocaine (422,896 in 2009). Heroin was involved in 213,118 emergency room visits in the U.S. in 2009. This is a rather surprising, if not paradoxical, finding given that cannabis is ranked as the least dangerous substance on Gable's scale, yet the number of visits is so high compared to other, much more dangerous illicit drugs. One of the explanations for such phenomenon is that it is

common to consume marijuana together with alcohol and other substances, which, despite the known adverse effects, continues to be a common practice at parties and social gatherings where both of the substances are present. Further, an overdose of cannabis tends to produce adverse psychological rather than physical reactions. It is likely then that a sizeable portion, if not a majority of hospital and emergency room visits attributed to cannabis is applicable to cases where cannabis is not the main culprit. When it comes to hospitalization data, for example, in 2008 in California there were 181 cases of hospitalization where cannabis was identified as the primary culprit (Caulkins et al, 2012). In 25,000 other drug-related cases of hospitalization, cannabis was mentioned as a second, third, or fourth reason for admission.

In the State of Colorado, cannabis-related emergency room visits and hospitalization has seen an increase since the legalization of the drug in 2013. The rate of cannabis-related visits to the emergency room has increased from 313 per 100,000 emergency room visits in 2011 to 553 per 100,000 in the first half of 2014 (Rocky Mountain, 2015). The rate of cannabis-related hospitalizations has also increased from 963 per 100,000 hospitalizations in 2009 (the year in which cannabis was commercialized in the State) to 2,277 per 100,000 in the first half of 2014 (Rocky Mountain, 2015). Caution should be exercised when interpreting the increases in cannabis-related emergency room visits and hospitalizations since "…marijuana could be a causal, contributing, or coexisting factor noted by the physician during the HD [hospitalization] or ED [emergency room] visit. For these data, marijuana use is not necessarily related to the underlying reason for the HD or ED visit. Sometimes these data are referred to as HD or ED visits 'with any mention of marijuana.'" (Rocky Mountain, 2015: 26). The rate at which cannabis users are admitted into emergency is much higher for the State visitors (163 per 10,000 in 2014, up from 78 per 10,000 in 2012) than it is among Colorado residents (101 per 10,000 in 2014, up from 70 per 10,000 in 2012) (Vivanco, 2016).

A very similar portrait emerges in Canada when hospitalization and emergency room data is examined. The Canadian Institute for Health Information (CIHI) collects hospital and emergency department admission data for all of the provinces, except Quebec. The publically-available CIHI data indicates that the number of hospital and emergency department visits where at least one of the diagnoses was related to the use of cannabis and which may or may not have resulted in hospitalization rose from 11,869 in 2007–2008 to 20,751 in 2012–2013 (Canada, 2014a). The number of cases that resulted in actual hospitalization and in which marijuana was recorded as the main cause for hospitalization rose from 598 in 2007–2008 to 908 in 2012–2013 (Canada, 2014a). Examination of 2002 hospitalization data reveals that cannabis-related hospitalization constituted only 0.3% of all hospitalizations in Canada. This compares to 1.4% of all hospitalizations due to the use of other illegal drugs, 5.8% for alcohol-related hospitalizations, and 10.3% for tobacco-related hospitalizations, in 2002 (Canada, 2014a).

Another proxy to be used when hospital and emergency department visits and hospitalizations are examined is hospital discharge data. According to Callaghan and Macdonald (2009), the rate of discharge from hospital for cases where use of cannabis was identified as a primary issue in diagnosis doubled from 14 per 100,000 population in 1996 to 31 per 100,000 in 2005.

Yet another proxy that may be used for cannabis-related emergency visits and hospitalizations is the number of adverse reactions experienced by users of cannabis. Health Canada collects

information on adverse reactions to different products and substances through the Canada Vigilance Program.[13]

In an in-depth study of hospitalization data in Toulouse, France between 2004 and 2007, the rate for hospitalization where use of cannabis was identified as a main cause was estimated at between 1.2 and 3.2 per 1,000 regular cannabis users (Jouanjus et al, 2011). The most frequent causes for cannabis-related hospitalization were "central and peripheral nervous system disorders (15.8%), acute intoxication (12.1%), respiratory system disorders (11.1%) and cardiovascular disorders (9.5%)" (Jouanjus et al, 2011: 758).

This metric will remain relevant regardless of any shifts in cannabis policy. Rates of emergency department visits and hospitalizations could decrease as a result of legalization of cannabis because users could be more informed and educated. It is also likely that users would be using standardized doses of cannabis, thereby reducing the likelihood of overdose. However, emergency department visits and hospitalizations would still occur and need to be measured on a continuous basis.

Issues of Dependency and Abuse of Cannabis

Users of cannabis can become dependent on, or abuse, the use of cannabis products or their chemical constituents. Dependence and abuse are sometimes measured separately, sometimes lumped together, either as a rate of all current users, all people who have ever used the substance, or the general population.

The terms "dependency" and "abuse" nowadays replace the word "addiction" in the field of medicine, with "dependence" being the stronger of the terms when it comes to evaluating how harmful the problem of the use of cannabis is for the consumer. The guide called the Diagnostic and Statistical Manual of Mental Disorders, currently in its fifth edition (DSM-5), published by the American Psychiatric Association, and is the standard for the diagnosis of abuse and dependence among cannabis users. According to DSM-5, "abuse" of cannabis or any other substance is defined by a situation where the user continues using cannabis despite adverse outcomes (Caulkins et al., 2012). "Dependence" is diagnosed when three or more of the following conditions are established for a cannabis user (Caulkins et al., 2012: 24):

1. tolerance (needing more to get same effect);
2. withdrawal (cessation causes a characteristic set of symptoms)
3. using more than intended;
4. wanting to or having tried unsuccessfully to cut down on use;
5. spending considerable time obtaining and using the substance;
6. interference with important work, social, or other activities; and
7. continued use despite knowledge of adverse consequences.

In Canada, results from the 2012 CCHS administered by Statistics Canada indicate that 1.3% of Canadians 15 years or older met the criteria for either abuse or dependence of cannabis in the

[13] Please see http://www.hc-sc.gc.ca/dhp-mps/medeff/vigilance-eng.php for details.

year preceding the survey, which is almost double the percentage of Canadians who met the criteria for abuse or dependence of other illicit drugs[14] (0.7%), but less than half the rate for alcohol (3.2%) (Pearson et al., 2013). Further, the rate of abuse or dependence on cannabis in the overall Canadian population is almost twice as high among males as it is among females (1.7% and 0.9%, respectively) (Pearson et al., 2013), and about five times higher for those who are between 15 and 24 years old than those who are 25 to 64 years old (5% and less than 1%, respectively) (Canada, 2014), which can probably be expected because males and younger Canadians use cannabis at higher rates than other groups.

The risk of developing an addiction to cannabis is estimated at about 9% for all users of cannabis, and it is increased to about 17% for a user of cannabis if their initiation of use was during adolescence (Canadian Medical Association, 2014). Of note, while the proportion of Canadians who met the criteria for abuse or dependence on cannabis is almost double the proportion of those who met the criteria of abuse or dependence for other illicit drugs, the risk of developing dependence among users is actually lower for cannabis than it is for other substances. As such, for users, the risk of developing dependence on alcohol is 15%; on heroin is 23%; and on nicotine it is 32%, all of which are much higher than the 9% risk for cannabis (Canadian Medical Association, 2014).

Various metrics related to cannabis dependence and abuse are relevant regardless of any shifts in cannabis policy. There is the possibility that rates of dependency and abuse of cannabis and subsequent seeking of treatment could decrease as a result of legalization of cannabis because users could be more informed and educated. Also, in policy scenarios of legalization or decriminalization the social and legal repercussions of using cannabis are by definition lessened, which could ease some of the conditions being present that contribute to diagnoses of abuse or dependency. However, if rates of cannabis consumption increase in the overall population, so too may rates of abuse or dependence. Thus, dependency and abuse of cannabis would still occur and should to be measured on a continuous basis.

Treatment Admissions

There are many reasons to be in treatment for cannabis abuse or dependence. People who recognize their dependence on, or abuse of, cannabis voluntarily enroll themselves in treatment programs, older family members may require youth or children in their charge to undergo treatment, schools may require students to undergo treatment in lieu of expulsion, insurers or employers may require treatment as a condition of continued employment after a failed drug test, or courts may mandate treatment as part of a sentence for a drug crime or other crime, or in exchange for a reduction in the period of incarceration or other penalties.

There are severe data limitations and gaps when it comes to cannabis-related treatment admissions in Canada. The National Treatment Indicators (NTI) project collects information on publically-funded treatment programs. NTI data is submitted by a variety of groups, including Alcoholics Anonymous (AA), private drug treatment centers, and providers of primary care such

[14] In this context, 'other illicit drugs' include "club drugs, cocaine, heroin, solvents, prescription drugs used for nonmedical reasons, and any other illicit drugs" (Pearson, 2013).

as family physicians. There is no uniform format to collect drug treatment admission data in Canada, and as such it is difficult to draw a reliable national portrait of cannabis-related drug treatment admissions. Still, the latest report on NTI data concluded that cannabis was the second most common psychoactive substance after alcohol for which people received treatment in Ontario and Nova Scotia, the only two jurisdictions for which data on reason for seeking treatment was available in 2012-2013 (Pirie et al., 2015). In Ontario, about a third of all recorded admissions for substance abuse treatment had cannabis listed as a primary reason, whereas in Nova Scotia this percentage is about 10%. The total number of cannabis-related treatment admissions is not available, even for Ontario and Nova Scotia, due to definitional issues and limitations in data collection.

Caulkins et al. (2012) report that, in 2009 in the United States, cannabis was the cause for more than 350,000 drug treatment admissions, representing about 2% of roughly the 17 million current cannabis users (i.e., those who said they used cannabis in a month prior to the survey). As is the case in Ontario and Nova Scotia, cannabis is the second main reason for substance abuse treatment admission after alcohol in the U.S. The number of admissions for cannabis-related treatment has increased four times since 1992. Almost half (46%) of these admissions were for youth under the age of 21 (Caulkins et al., 2012). The intensity and costs of these programs vary dramatically. The majority of cannabis-related treatment (85%) in the U.S. is provided by outpatient programs, which cost $1,000 or less per occurrence. Residential programs, on the other hand, can cost tens of thousands of dollars per occurrence.

The metric is to remain relevant regardless of any shifts in cannabis policy. Rates of dependency and abuse of cannabis and subsequent seeking of treatment could decrease as a result of the legalization of cannabis because users could be more informed and educated, as well as through reducing the social and economic burden of use. However, dependency and abuse of cannabis would still occur and need to be measured on a continuous basis. The measurement of treatment admissions would need to be refined and improved. As discussed above, information on treatment admissions is scarce and only available for Ontario and Nova Scotia. Reasons as to why people are seeking treatments could be recorded and analyzed as well, since this is important for a number of analytic purposes.

Respiratory Effects

Certain types of cannabis use can have detrimental impacts on the respiratory system. Such harms can be measured through the number of recorded cases of particular types of adverse health effects among users.

Cannabis smoke contains a mixture of poisons that are similar to tobacco smoke (Tashkin et al., 2005). As a result, much research has been dedicated to documenting the respiratory effects of marijuana smoking and comparing them to those associated with tobacco use. Research has found that the respiratory effects of marijuana smoking are quite dangerous, perhaps even more so than tobacco smoking. For instance, marijuana smoking can potentially pass unhealthy levels of aluminum through the lungs (Exley et al., 2006), and has a comparable 'tar content' to that of tobacco smoke (Taylor and Hall, 2003). Further, the common inhalation technique of long, deep breaths retains combusted particulate matter inside the lungs for longer periods of time, resulting in approximately three to five times the level of tar deposition than cigarette smokers (Taylor and Hall, 2003). According to the Canadian Centre on Substance Abuse, common respiratory problems reported by regular cannabis smokers involve wheezing,

shortness of breath after exercising, early morning phlegm, chest tightness at night, and bronchitis (Diplock and Plecas, 2009).

Research on the links between lung cancer and marijuana use has received attention due to the popularity of smoking marijuana; however, so far results have been inconclusive. Studies do exist that report an association between marijuana and lung cancer (Aldington et al. 2008; Berthiller et al., 2008); however their results have been challenged on the basis of methodological problems (Plecas et al., 2012). In contrast, research exists that has found no association between marijuana smoking and lung cancer, yet these too have been faced with methodological limitations (Plecas et al., 2012).

Metrics designed to understand the specific harm of smoking cannabis will remain relevant regardless of any shifts in cannabis policy. The quality of cannabis can improve under legal cannabis regimes, as more controlled and standardized cannabis products become available. However, adverse health effects can still occur and need to be measured on a continuous basis. Research into how the use of cannabis affects the respiratory system should continue to evolve and better measures for this metric should be designed.

Although smoking cannabis is the dominant method of consumption, there are differences in how cannabis can be smoked, either the apparatus used, the cannabis product being combusted or the smoking technique. There are also respiration methods of consuming cannabis that are similar to that used for 'vaping' tobacco and nicotine products. Cannabis is also consumed orally and topically in various proportions. These differences in rates and modes of consumption are complicating issues to consider when developing data collection plans for metrics in this area, as well as for when the metrics are interpreted.

Cancer

This metric measures the extent to which the use of cannabis is a risk factor, or causal agent, in developing various cancers. It can be measured through the number of recorded cases of cancer among cannabis users.

Marijuana smoke contains many harmful carcinogens and could possibly be associated with various types of cancers (Tashkin et al., 2002). However, research to date has been inconclusive about this association. A common methodological difficulty is the fact that the majority of marijuana users also consume tobacco products (Berthiller et al., 2008; Plecas et al., 2012). In terms of forms of cancer such as oral cancer and breast cancer, Plecas et al. (2012) report that results have been inconclusive. A growing body of research has suggested that certain types of cannabis products can play an effective role in killing cancer cells. Evidence from several pre-clinical animal studies has revealed that marijuana can lead to cancer cell death and inhibit the growth of tumors (Plecas et al., 2012). However, it has not yet been determined if marijuana smoking can prevent any forms of cancer in humans.

This metric will remain relevant regardless of any shifts in cannabis policy. The quality and accessible variety of cannabis preparations may improve under a legal cannabis regime, as more controlled and standardized cannabis products become available. However, adverse health effects can still occur and will need to be measured on a continuous basis. Research on the relationship

between the use of cannabis products and cancer should continue to evolve and better measures for this metric should be designed.

Cardiovascular Health

This metric measures the extent to which the use of cannabis can contribute to adverse effects on the heart and cardiovascular system. It can be measured through the number of recorded cases of specific adverse health effects among cannabis users.

An area of public health research has been concerned with examining the potential harms of marijuana use on the heart and cardiovascular system. The use of marijuana does affect the heart, leading to a 20-50% increase in heart rate immediately after consumption (Copeland et al., 2006). Evidence does not suggest that serious heart and cardiovascular problems are typically experienced by most marijuana users. However, research has shown marijuana use by those who are predisposed to, or have survived, heart-related illnesses such as coronary disease can pose a serious health risk (Plecas et al., 2012). In a review of the literature, Plecas et al. (2012) note that in rare instances, marijuana can trigger heart attacks or other serious cardiovascular problems. However, they also note that the link between marijuana and cardiovascular issues is confounded by psycho-social factors such as poor diet and genetic predisposition.

This metric will remain relevant regardless of any shifts in cannabis policy. The quality of cannabis could improve with legalization, as more controlled and standardized cannabis products become available. However, adverse health effects may still occur and need to be measured on a continuous basis. Research into how cannabis affects the cardiovascular system should continue to evolve and better measures for this metric should be designed.

Pregnancy and Reproductive Health

Mothers may consume cannabis during their pregnancy for a number or reasons. The exposure to the fetus can be accidental because they did not know they were pregnant, from second hand smoke, due to negligence, dependence or abuse, or intentionally consumed as a medical measure (Waugh, 2015). This metric measures the extent to which the use of cannabis can impact the human reproductive system and the fetus or a newborn if used during pregnancy. It can be measured through the number of recorded cases of adverse effects among users, as well as long-term impacts of using cannabis during pregnancy on the children of mothers who consumed the drug during pregnancy.

Cannabis is the most common illicit drug used during pregnancy (Porath-Waller, 2015). In 2011, approximately 11% of women in childbearing age (15-44) in Canada reported using cannabis within the past year (Porath-Waller, 2015). The actual percentage of women in Canada who have used marijuana while pregnant is not known. In the U.S., 5.2% of pregnant women in 2011 reported using cannabis while pregnant (Porath-Waller, 2015).

To date, studies that examine the effects maternal cannabis use has on the fetus have suggested prenatal exposure to cannabis use leads to subtle adverse effects. These can start as early as age three, and impact cognitive functioning, behavioral functioning, mental health, and substance use during adolescence (Porath-Waller, 2015). There is also research that suggests cannabis-related deficits may impair a child's academic functioning (Porath-Waller, 2015). As of now, no link has

been found between maternal cannabis use and premature births, miscarriages or major physical abnormalities (Porath-Waller, 2015). On the other hand, some research exists regarding possible positive side effects of cannabis use during pregnancy as well, such as more acute vision (Chakraborty et al, 2015).

Metrics related to cannabis use by pregnant mothers will remain relevant regardless of any shifts in cannabis policy. The quality of cannabis may improve with legalization, as more controlled and standardized cannabis products become available. Users may also become more informed and educated. However, adverse health effects can still occur and need to be measured on a continuous basis. Research into how cannabis affects pregnant mothers and fetuses is only in the early stages and data collection should continue to evolve requiring better measures for this metric to be designed.

Mental Health

There is a significant body of research that links the consumption of cannabis to particular mental health problems, as well as some literature linking cannabis use to the treatment of certain mental health problems. Metrics in the area measure the extent to which the use of cannabis can impact the users' mental health. These metrics generally measure the number of recorded cases of adverse mental health effects among users, as well as long-term impacts of using cannabis on mental health.

A growing amount of research has demonstrated a correlation between early marijuana use and future mental health problems, including psychosis, bi-polar disorder and depression. However, determining if marijuana plays a casual role in these relationships is a difficult task. To date, a large body of research has suggested that regular and heavy marijuana use, especially by younger populations, can lead to a heightened risk of developing earlier onset and more severe psychosis, including schizophrenia (see Zammit et al., 2012; Castle, 2013). Studies have also shown that the onset of bi-polar disorder may be earlier for those who use cannabis, and that cannabis use is associated with higher risks of inducing bi-polar mania (see Silberberg et al., 2012).

A considerable amount of literature has demonstrated that rates of depression are correlated with those who use cannabis regularly (see Degenhardt et al., 2012). The reasons for this association remain unclear, and there is insufficient evidence to discern whether cannabis use causes depression, cannabis is used to self-medicate the symptoms of depression, or if no direct relationship exists. While some studies have found that cannabis use is correlated with increases in suicidal behavior (see Fergusson et al., 2003), this research area is still in its infancy and it has not yet been determined if cannabis use is responsible for increases in the risk of suicide (Degenhardt et al., 2012). On the other hand, cannabis is used as a treatment for the symptoms of certain mental health disorders, such as anxiety and post-traumatic stress disorder (Baldwin et al, 2015).

Keeping track of the relationship between cannabis use and the incidence of mental health disorders will be relevant regardless of any shifts in cannabis policy. The quality of cannabis may be improved with legalization, as more controlled and standardized cannabis products become available. Users may also become more informed and educated. However, adverse health effects may still occur and need to be measured on a continuous basis. Research into how cannabis affects mental health should continue to evolve and better measures for this metric should be designed by scientists, mental health and other medical professionals in the future.

Athletic Performance

Cannabis use by athletes is banned in many professional and organized amateur sports competitions. Measuring the effects cannabis has on athletic performance, as well as the number of athletes using cannabis for the enhancement of performance, is relevant to the dialogue surrounding regulation and enforcement related to these activities.

Cannabis use is banned in most professional sports leagues, and remains on the prohibited list of substances of the World Anti-Doping Agency (WADA). To be on the WADA prohibited list, a substance must meet two of the following three criteria: 1) be performance enhancing; 2) potentially be a health risk; or 3) be against the spirit of the sport. Marijuana is usually considered to be in violation of all three criteria. Urine tests are usually used to detect the presence of cannabinoids in athletes' systems (Huestis et al., 2011). Cannabis accounted for up to 15.7% of all drug-positive tests conducted by the International Olympics Committee (IOC) between 1998 and 2004, decreasing to 7.7% in 2009 (Huestis et al., 2011).

In regards to performance enhancement, athletes have reported that marijuana use improves concentration, decreases anxiety and fear, reduces pain, and limits the stress of competition (see Huestis et al., 2011). Along with documented health risks from chronic use, marijuana can impair athletes' coordination, movement, and technical skills in a way that may increase the probability of accident or injury.

Measuring the incidence of cannabis uses amongst athletes for performance enhancement, or otherwise, as well as measures designed to study the impact of cannabis use on athletic performance will likely remain of interest regardless of any cannabis policy shifts. Even in cases of decriminalization or legalization, it is likely that cannabis will remain an illicit drug on the list of substances for athletes. Athletes are further not likely to stop using cannabis as a performance enhancer. Therefore, its use should continue to be monitored and measured.

Healthcare Costs

We know that the diseases caused by, and correlated with, the use of tobacco and alcohol have a massive impact on health care costs. It is of interest to assess the costs that are incurred by the healthcare system as a result of cannabis use. At minimum this can include the cost of administering care during emergency department visits due to consuming cannabis, as well as cannabis-related hospitalization and long-term care.

Costs related to hospitalization related to cannabis were calculated by the CCSA in 2014. The authors of the report (Young and Jesseman, 2014) used data from the Hospital Mental Health Database (HMHDB) which is available from CIHI for several substances, including cannabis, between the fiscal years 2006-2007 and 2011-2012 in Canada. Costs were estimated based on the number of hospital stays and the length of stay. Results indicate that the cost of hospitalization related to cannabis increased in Canada from $9 million in 2006-2007 to $14 million in 2011-2012 (Young and Jesseman, 2014). This represents an increase of 52%. This study, like any other study on costs of services, is based on several assumptions and is limited to information available to researchers. The authors argue that the estimates produced in this study are very conservative, and that it is possible that the costs are higher than the ones estimated. Better

estimates could be produced if other variables, such as reasons for hospitalization, how and by who it was decided that the patients need to be hospitalized, etc., were available to researchers.

Capturing data of this kind would remain relevant regardless of any change in cannabis policy. Under legalized or decriminalized regimes, it is possible that the overall direct burden on the healthcare system from cannabis related hospital stays might decrease if the non-medical use of cannabis is legalized because users could be more informed and educated, or it might increase due to an expansion of the number of cannabis users. Under legalized regimes, it is also likely that users would be using standardized doses of cannabis, thereby reducing the likelihood of overdose or misuse. Still, just as the case with legalized tobacco and alcohol, cannabis users will still need treatment due to misuse, overdose, or long-term care. Therefore, the healthcare costs need to be continuously monitored. In addition, in the longer-term, after more research on the secondary and tertiary health impacts of cannabis are better researched, costing might include increased health care for diseases associated with cannabis use (such as certain mental illnesses or respiratory diseases) or possible reductions in health care costs due to declines in risk factors for disease, such as obesity, or other population level declines in other diseases.

Economics

Value of Electricity Used by Grow-Ops

Indoor cannabis growing operations use a vast amount of electricity, which in turn can create a burden on the electrical grid and decrease the sustainability of the whole electrical system. An average grow-op consists of about 36 lights, with each light consuming 1,000 watts per hour (Diplock and Plecas, 2011). The lights need to be on for an average of 14 hours per day during the 90-day growing cycle of the marijuana crops, amounting to 181,440 kWh of electricity consumed per one grow-op, per year (Diplock and Plecas, 2011). With an estimated 6,867 grow-ops in the province of BC that diverted (stole) electricity in 2010, it can be said a total of 1,246 GWh per year of electricity was stolen in BC in 2010. The lowest rate of pay for electricity in BC in 2010 was $0.0627 per kWh, and the highest was $0.0878 per kWh. Thus, an estimated monetary value of electricity stolen by grow-ops in BC in 2010 was between $78.1 and $109.4 million per year (Diplock and Plecas, 2011). Further, an estimated 6,339 grow-ops did not steal, but legally purchased their electricity in BC in 2010. The monetary value of electricity used by these grow-ops added an additional $43.7 to $61.2 million (Diplock and Plecas, 2011).

The metric of the value of electricity used by grow-ops should remain relevant regardless of any future cannabis policy shift. Consumption of electricity should be constantly monitored for licit grow-ops to make sure they do not create too heavy a burden on the grid or to account for efficiency improvements in grow-op technology, such as the use of LED or natural lighting. Further, should illicit grow-ops continue to operate, some are likely to continue to use the strategy of stealing electricity to avoid detection and improve profits. The value of stolen electricity needs to be monitored.

Market Origin

This metric identifies the market source, or the origin of cannabis that users consume. In other words, the intent is to measure the proportion of cannabis that users grow themselves, obtained

via licit mechanisms (e.g., by filling a prescription for medical marijuana), obtained for free through gifting or sharing, purchased at cost, or purchased from an illegal source turning a profit (e.g., bought from a dealer), etc.

Data on the source or origins of cannabis that users consume is not readily available in Canada. Cannabis could be sourced via indoor or outdoor horticulture; diversion of medical marijuana; obtained from black or grey markets; etc. This is probably due to the difficulty in obtaining this kind of information due to the illegality of cannabis, as well as ignorance of many cannabis users when it comes to knowing the initial source of the drug they are consuming. Further, questions on surveys to obtain this type of data can be methodologically complex because the cannabis supply consumed by a single user may come from a number of different sources depending on timing and context.

According to The Globe and Mail (2013), in 2012 in Canada, for medical marijuana users, 13% of users obtained cannabis from Health Canada, 64% grew marijuana by themselves, 16% obtained cannabis from a friend who grows marijuana under license, and 7% had a license to buy from Health Canada, but did not.[15] Further, 70% of medical marijuana users were reported to grow at least 25 plants in their own homes (Globe and Mail, 2013).

Not taking into account legally-produced medical marijuana, it is estimated that 16% of cannabis grown in BC is grown outdoors, whereas 82% was grown indoors between 1997 and 2003 (Diplock et al., 2013).

This metric should remain relevant regardless of any cannabis policy shifts, and is likely more relevant under legalization regimes. The way this metric is measured will likely change if the non-medical use of cannabis is legalized because information on many sources will be more readily-available from producers. Producers of licit alcohol and tobacco, for example, are required by legislation to report on the quantity and the quality of their products. It is likely that similar legislation would be adopted requiring cannabis producers to report on their produce in a similar manner.

Sharing and Sale by Users

This metric is an elaboration on the previous metric regarding the market source of cannabis. It assesses the extent to which cannabis is shared among users, as well as sold by users to others either at cost or for profit. It can be measured both in terms of amounts of cannabis and proportions of the drug that is sold and shared among users.

Cannabis is often shared among users as part of the ritual of smoking. It is also common for dealers to smoke together with their customers during transactions. Cannabis may be further re-sold by users to other users. Cannabis can be purchased at cost through the mechanism of cooperative bulk purchases amongst friends or associates. Empirical data on the sharing and selling of cannabis products by users is not available for Canada or elsewhere, although

[15] It is unclear whether users obtained or bought cannabis directly from Health Canada or from Health Canada-licensed cannabis producers.

qualitative studies in other countries exist (Mohamed and Fritsvold, 2010; Hammersvik, et al, 2012). Yet it is very important to understand the sharing and selling dynamics not only from the perspective of economics, but also from the perspective of public safety, public health, and to understand the consumption of cannabis by children and youth. Questions on sharing and selling could be added to already existing surveys like CTADS and CCHS.

This metric should remain relevant regardless of any cannabis policy shifts. It could become more relevant under legalization and decriminalization regimes because laws and regulations towards some of the behaviours could become less restrictive while others remain covered by criminal law, instead of all of the mechanisms being illegal. Cannabis is likely to continue to be consumed, shared, and re-sold among users, as is the case with both alcohol and cigarettes.

Pricing

There are many reasons why knowing the price at which different cannabis products and volumes are sold, as well as how these prices fluctuate over time, by geography and by market segment, would be useful.

A change in price could mean, among other things, a change in either the supply of cannabis or consumption patterns. Thus, information on the price of cannabis is important for many reasons. First, law enforcement and policy makers need to know about price fluctuations to better direct law and regulatory enforcement resources. Second, the price of cannabis could tell you things about how cannabis is being supplied to a market. As is the case with any consumer product, the economic modelling of supply and demand of cannabis is contingent upon the price of cannabis.

Assessing the price of illicit marijuana can reveal important insight about the current state of the industry. As Clements and Zhao (2009) point out, marijuana pricing can be examined using a number of metrics, including the geography of marijuana prices, fluctuations in price over time, and packaging prices (e.g. bulk discounts). While data is not officially collected on illicit marijuana prices in Canada, information from a 2013 Public Safety report (see Boucher et al., 2013) provides some preliminary answers to some of the metrics identified by Clements and Zhao (2009). Drawing from information available on the site priceofweed.com, researchers at Public Safety found that the mean price of marijuana in Canada in 2010-2012 was $7.54 per gram and the median was $7.39 per gram of cannabis. Data also indicated that marijuana prices had been fairly stable over the two year, four month period for which data was available, despite seasonal variations. The average price during the last four months in 2010 was $7.26 per gram, in 2011 it was $7.25 per gram and in 2012 it was $7.64. Further, researchers found marijuana prices to be higher in the territories than the provinces and identified several apparent price regions in Canada (Boucher et al., 2013).

Research from other Western countries has noted a substantial decline in marijuana prices, much more than other illicit commodities (Clements and Zhao, 2009). In Australia, for example, the price for an ounce of cannabis declined by more than 25% between 1990 and 1999. According to Clements and Zhao (2009), there are likely two equally plausible explanations for the decline in prices: productivity improvement in the production of marijuana associated with the adoption of hydroponic growing techniques and lower expected penalties for producing and selling.

Tracking the price of licit cannabis is also useful. In Colorado, during the first year of legality, the price of a standard ounce of recreational cannabis declined between $50 and $100 dollars. The decline was attributed to increased competition, maturing of established production facilities, and the development of a market equilibrium price (Verhage, 2015). Evidence from self-reported purchases of illicit cannabis in US jurisdictions where recreational cannabis has been legalized indicates that cannabis prices in the black market have declined (Dyer, 2015).

Understanding the price of marijuana is relevant regardless of any cannabis policy shifts. The way this metric is measured will likely change if the recreational use of cannabis is legalized because information on the price of cannabis will be readily-available from sellers. A simple survey of sellers will determine the price for which the drug is sold. If cannabis is legalized to be sold through government-owned retail stores, as is the case with alcohol in Ontario, the price information will be readily-available from the respective government agency.

However, research on the illicit tobacco trade (Maslov & Boucher, 2014) has taught us that, in situations of legalization, it is important to measure price differences between different segments of a market for psychoactive substances, particularly the licit versus illicit price. This is because if licit prices are higher than illicit prices, consumers may be enticed to purchase their product, in this case cannabis, on the black market. This, in turn, creates criminal opportunities for organized crime to become entrenched.

Economic Impact of Legalization

This metric assesses the impact that different policy scenarios could have on the economy. It can be measured through a number of means, including expected gains in tax revenue, savings as a result of reductions in law enforcement expenditures, or long-term impacts on public education, programs, and healthcare.

There are some very creative studies on the effects that the legalization of the non-medical use of cannabis would have on the overall economy in general, and on tax revenue and other government savings in particular. Clements and Zhao (2009) applied the concept of price elasticity of demand to the Australian context, while Bryan et al. (2013) used the same principle, but in the U.K. The first study projects the revenue in Australia at $245 per capita (user),[16] while the second proposes the net benefit[17] of moving towards a regulated legal market at between £200 and £300 million per year. An analysis paper by Gieringer (1994) used extrapolation methods to predict tax revenues of between $2.2 and $6.4 billion dollars a year, and a savings of between $8 and $16 billion dollars a year as a result of legalization of marijuana throughout the entire United States.

These three studies are examples of economic models that use available data on the price and consumption levels of cannabis to model potential revenues and savings if the policy on cannabis were to change. One of the main issues with these models, Pacula and Lundberg (2014) argue, is

[16] Here, the authors are following the logic of taxing vices like alcohol and tobacco in Australia.

[17] The authors include in their models costs of policing, courts, prevention programs and several healthcare cost impacts as a result of moving towards regulated cannabis market.

that the measures of consumption of cannabis used by economic models are limited to prevalence of usage, not actual volumes consumed. This approach essentially excludes an important and significant population of regular and heavy users of cannabis. The amounts of cannabis that they consume are not taken into account when calculating the demand portion of the economic models, which would certainly affect the predictions for savings and revenues as a result of a change in cannabis policy (Pacula and Lundberg, 2014). Data from Colorado, for example, indicate that about 22% of cannabis users are considered to be heavy users that use cannabis daily or almost daily; and, this population is responsible for about two-thirds (67%) of the demand for cannabis in the State (Rocky Mountain, 2014). In the same vein, about 10% of consumers of alcohol, which could be classified as heavy drinkers, account for over 50% of sales of alcohol in the U.S. (Dovey, 2014). This is a substantial amount of cannabis for which the current economic models cannot account because they are based on prevalence of use as an indicator of demand. Once again, this shortcoming can be corrected if better measures of consumption, such as actual amount of cannabis consumed rather than prevalence of use, were available.

The idea that the illicit production and sale of cannabis adds value to the overall economy needs to be mentioned. Money and resources are being invested in the production of cannabis, and grow-ops employ people and pay them for their labour. Further, money is being spent by buyers when they purchase cannabis products. While it is true that when cannabis is illegal, taxes are not being directly levied from these transactions and employers do not contribute to the employment insurance and Canada Pension Plan funds, there is nevertheless an economic value that should be accounted for in the illicit cannabis industry. Cost-of-crime calculators, for example, could be updated to account for the money generated and exchanged by the cannabis industry.

Post-legalization data from Colorado indicated that projected revenues from sales of cannabis in the State are $35 million for the 2013-2014 fiscal year and $118 million for 2014-2015 (Rocky Mountain, 2014: 144). More revenue could be expected as more shops open up and the amounts of cannabis purchases increases. However, the proposed State expenditures for the same fiscal years total to $103.5 million[18] in addition to $29 million already allotted to law enforcement and issues related to public safety. It is therefore too early to draw conclusions on the actual net economic benefit (or harm) of the cannabis policy shift in Colorado.

The concepts of the economic impact of marijuana should remain relevant regardless of any cannabis policy shifts. The way these concepts are measured will likely change if the non-medical use of cannabis is decriminalized or legalized because some types of economic data on cannabis will be actual rather than projected or estimated. In the case of alcohol and tobacco, for example, information on the quantity of legally-produced and sold products in Canada is readily available. Information on the illicit tobacco and alcohol markets, however, still needs to be estimated (Maslov and Boucher, 2014).

[18] Colorado State expenditures include youth prevention programs; substance abuse treatments; public health; regulatory oversight; law enforcement and public safety; and statewide coordination (Rocky Mountain, 2014: 144).

Real Estate Market

This metric measures the impact that a shift in cannabis policy has on the real estate market in the jurisdiction where the shift occurred.

Recent research has demonstrated that marijuana legalization can have a significant effect on the surrounding real estate market. Studies emerging from the Denver area have found that the recent move to legalize marijuana has boosted Denver's housing market (Crone, 2015). One report notes that the legalization of marijuana has potentially contributed to a 15% rise in Denver's house prices, and the average property is now worth $40,000 more than the previous year (Crone, 2015). Other research has noted that 1 in 11 industrial buildings in the city is now host to a marijuana grow-op, with grow-ops occupying 3.7 million square feet of industrial space (Rusche, 2015). From 2009-2014 marijuana cultivation accounted for 35.8% of all industrial space leased in Denver (Rusche, 2015). Despite these findings, little pre-legalization data has been analyzed and other factors may also account for the increases in price. Further, no studies have been yet completed on the value of real estate situated around cannabis dispensaries or production facilities, which, according to anecdotal evidence, could potentially decrease in value.

This metric is most relevant to decriminalized and legalized cannabis markets because analyzing this information in environments of illegality is extremely difficult to accomplish. However, if it is possible to measure the pre- and post-policy shift information on the real estate market before and after legalization, that would be ideal. Further, different regulations or policies on how cannabis can be grown or sold (such as restrictions in business location, number of plants or volume of inventory, indoor versus outdoor growing, or security requirements) could have vastly different impacts on segments of real estate markets, requiring differences in how market fluctuations in price are analyzed.

Impact on Productivity

There are a number of related metrics that examine how the use of cannabis can affect labour market productivity. Productivity impacts of cannabis use can be measured in a number of ways, many of which mirror the way that productivity lost due to alcohol use is measured, which includes: the number of hours of work missed due to cannabis use; the ability or inability to concentrate on certain tasks while under the influence of cannabis; and various other measures of physical or cognitive performance while under the influence of cannabis.

The impact of cannabis to productivity is usually discussed from a negative perspective, largely due to stereotypes of cannabis consumers as being lazy and slothful that has arisen in popular culture and the media (Cohen, 2014). From a medical perspective, the use of cannabis can indeed affect the "sensory, psychomotor, and cognitive function and the ability to perform certain tasks" (Martin et al., 2002: 1520). This depends on many factors, including the amount and frequency of consumed cannabis, when the cannabis is consumed, the drug's potency, and the complexity of the task (Martin et al., 2002). Further, cannabis users' personality traits, the frequency of their cannabis use, and their levels of personal motivation and productivity prior to consumption of cannabis plays a role in their motivation and productivity after consumption (Hickox, 2012).

Others may argue that even heavy smokers of cannabis may not display signs of decreased motivation and productivity (Cohen, 2014). Increased levels of dopamine, the so-called pleasure

chemical released in the brain as a result of consumption of cannabis, could contribute to higher motivation or productivity among some users (Cohen, 2014), while lower levels may explain the laziness and unmotivated mood of other users (Bloomfield et al., 2014). Workplace absenteeism due to cannabis use or cannabis-related work accidents is also a hotly contested topic, and there is no agreement in the research community on whether there is a causal relationship between these concepts (Hickox, 2012). It is argued that, similarly to alcohol consumers, most cannabis consumers do not consume drugs while at work and therefore do not perform their duties while intoxicated (Evans, 2013). Thus, the construction of metrics related to productivity and cannabis use must be constructed in a sophisticated manner to take into account not just the number of workers who consume cannabis, but how and when the workers consume cannabis, under what circumstances, including intervening relevant personal variables, etc.

Metrics of this type will remain relevant regardless of any cannabis policy changes. Research into how cannabis affects productivity should continue to evolve and more sophisticated measures will need to be designed to further explore the overall negative or positive impact of cannabis use on productivity in various types of workplaces.

Environmental Impact

The production and marketing of all goods and services has an impact on the environment. There are particularly harmful impacts on the environment that have been associated with the illicit cannabis industry, such as the excessive use of electrical energy, the heavy use of fertilizers, pesticides, and herbicides used, the overall amount of greenhouse gases produced, etc. The environmental harms of the cultivation of illicit cannabis as a drug has been contrasted with the environmental benefits proponents extoll for the fiber hemp industry (Ecological Agriculture Projects, 1997).

It has been widely debated whether the growth and production of cannabis has a substantial impact on the environment. Mills (2011) argues that the carbon footprint of indoor cannabis production is substantial. A production of one kilogram of cannabis has been estimated to result in the net production of 3,000 kilograms of carbon-dioxide, one of the greenhouse gases believed to be contributing to the phenomenon of global warming. Based on 2011 U.S. estimates that the author applied in his study, about $5 billion worth of energy would have been spent on producing cannabis in the U.S. in 2011, with a corresponding 17 million tons of CO2 being emitted into the atmosphere (Mills, 2011: 1). Still, when put in the national perspective, the energy required to produce the annual amount of cannabis consumed in the U.S. constitutes only about 1% of national energy consumption. To put it in more perspective, the energy required to grow the annual amount of cannabis consumed in the U.S. is only a third of the energy that U.S. data centers require annually or only a sixth of what U.S. household refrigerators consume (Gerken, 2012).

However, it is also believed that the growth and production of cannabis causes a serious environmental impact other than energy consumption and production of carbon-dioxide. Illegal grow-ops in residential neighbourhoods can pose a health threat to people who live in the neighbourhoods because of chemicals that are used and the mold accumulation that commonly occurs during carelessly managed illicit cannabis production (RCMP, 2012). Further, grow-ops often use herbicides, pesticides, and fertilizers that may be very harmful to the environment and to humans if not handled properly (Wilkey, 2014).

The environmental harms of cannabis production, as with the harms of other agricultural products, generally appear to increase as the intensity and technology used in production increases and becomes more sophisticated. Another element to consider is that the method and location of production has an impact on the ecological impact of the product. The method and location of the production of cannabis are both sensitive to the law enforcement and regulatory environment.

To what extent cannabis production and cultivation actually harms the environment, especially in comparison to other crops, remains unclear. Scientific literature is lacking in the field. Research on the impact of production of cannabis on the environment should continue to evolve and better measures for this metric can be designed.

Grow-Op Technology

This category of metrics assesses and quantifies the use of the ever-evolving agricultural and security technologies used by indoor and outdoor cannabis in the production of cannabis.

A recent innovation in indoor cannabis grow-op technology is the introduction of high-intensity light emitting diode (LED) lights. All of the equipment required to assemble and run an indoor grow-op can be purchased from a local hydroponics store (Bouchard and Dion, 2009). About 200 watts of energy is required to light one square foot of active grow-op by LED-type lamp (Mills, 2011). An average marijuana plant takes a space of about 1.25 square feet (RCMP, 2012). An average yield per square foot is about 40 grams of cannabis product (Caulkins et al., n.d.).[19] Examples of other technologies are web-enabled automated agricultural sensors, hydroponic systems, and remote security surveillance.

Under regimes where all cannabis production is illegal, it has been shown that the supply of hydroponic growing supplies largely corresponds to cannabis production patterns (Bouchard and Dion, 2009). This does not mean that the management of these hydroponic stores is criminally involved. However, what this observation does mean is that, perhaps combined with other metrics, information on the hydroponic equipment industry can supply indirect information about illicit cannabis supply trends and patterns.

It is useful to track the sales of technologies primarily used by cannabis production operations, as well as the proportion of known cannabis production that uses these particular types of technologies. These metrics should remain relevant regardless of any cannabis policy shifts. The way these metrics are measured will likely change if the non-medical use of cannabis is legalized because information on the technology could be readily-available from licit grow-op operators.

[19] BOTEC Analysis Corporation released a series of reports for Washington State Liquor and Cannabis Board in which they discuss a number of issues related to legal grow-op technology. Themes covered include costs of running a grow-op; estimated production; testing for psychoactive ingredients; revenues from legal grow-ops, etc. The reports can be found at http://liq.wa.gov/marijuana/botec_reports (retrieved on November 4, 2015).

Children and Youth[20]

Usage Trends among Youth

The average age at which youth first used marijuana was 16.1 years in 2012, compared to 15.6 in 2011. The 15.6 "initiation age" has remained steady since 2004 (Health Canada, 2012). The prevalence of cannabis use among Canadian youth is arguably among the best-measured cannabis performance metrics. This is probably due to the well-established link between the dangers of early exposure to cannabis and the subsequent health and other detriments as the person grows up (Caulkins et al, 2012).

Multiple surveys capture the self-reported rate of cannabis use among youth. Depending on the survey, the prevalence of use is anywhere between 3% and 53%. Results from CCHS indicate that younger Canadians are the biggest consumers of marijuana in Canada. Among one-time users, in 2012, one third (33.3%, down by 2.7% since 2002) of 18–24 year olds admitted to having consumed cannabis in the year preceding the survey, followed by 20% of those who are 15–17 years old (down by 8.5% since 2002) (Rotermann and Langlois, 2015). When it comes to repeat users, in 2012, 30.8% of 18–24 year olds admitted to having consumed cannabis in the year preceding the survey (down by 0.4% since 2002), followed by 17.1% of those who are 15–17 years old (down by 7% since 2002) (Rotermann and Langlois, 2015).

Another national survey, CTADS, produced similar results. Lifetime prevalence of cannabis use among Canadians aged 15 to 24 years almost halved from 61.4% in 2004 to 34.8% in 2012, while past year use also almost halved, from 37% to 20.3% during the same period (Health Canada, 2012).

According to a 2013 UNICEF Report, the percentage of children aged 11, 13 and 15 who self-reported having used cannabis in the last 12 months in Canada was 28% (UNICEF, 2013). This was the highest rate of cannabis use in the 29 countries they examined.

The Centre for Addiction and Mental Health (CAMH) administers the Ontario Student and Drug Use Survey every two years. The 2013 survey results place the prevalence of use of cannabis in the year preceding the survey among Ontario high school students at 23%, ranging from 2% of grade 7 students to 39% of grade 12 students. About 3% of Ontario high school students report the daily use of cannabis (Boak et al., 2013).

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[20] The age categories of "adult," "children" and "youth" can be defined in different ways depending on the issue being discussed. In Canada, when speaking of criminal offending, generally "children" are those 12 years of age and younger, "youth" are aged 13 to 17, and "adults" are 18 years and older. Similar categories are used in public health and demographic research. However, the 'adult' age implied by the legal ability to purchase, possess, or consume the regulated licit drugs of tobacco or alcohol can vary between 16 and 19 years of age across Canada. In the United States, for alcohol, the legal age for consumption is frequently 21 years of age.

The Ontario estimates are more or less representative of the national ones. In 2012–13 in Canada, 19.3% of students in grade 7–12 reported cannabis use within the year preceding the survey. The average age of initiation of cannabis consumption was 14 years old (Health Canada, 2014). Data also indicates that cannabis usage increases for each grade. Depending on the province, approximately 3–8% of students in grade 7 reported marijuana use, in comparison to 30-53% for those in grade 12 (Young et al., 2011).

In Colorado, where the recreational use of cannabis is legal and access to youth is restricted, the use of marijuana in this population is a grave concern since legalization. In 2010-2011, teenagers between 12 and 17 years old admitted to using cannabis at a rate close to 40 per cent higher than the national average in the U.S. in the month preceding the survey (Police Foundation, 2015).

Data from the 2013 National College Health Assessment Survey study on post-secondary students revealed 60.1% of post-secondary students have never used marijuana, 28.3% had used it (but not in the past 30 days), and 16% had used marijuana within the past 30 days (ACHA, 2013).

The metric of usage trends among children and youth corresponds to the one on adult usage rates. When collection of empirical data on cannabis usage is discussed, it should be done for both adults, and children and youth.

Police-Reported Incidents and Charges among Youth

Data on cannabis-related police-reported incidents among youth is available from police-reported crime via UCR. Statistics Canada reports that in 2013 in Canada, 17,700 youth aged 12 to 17 years were charged with a drug offence under the *Controlled Drugs and Substance Act*. The vast majority (81%) of these charged were for possession of cannabis (Boyce et al., 2014). The rate of youth charged with possession of cannabis declined slightly (by about 1%) from 2012 to 2013. Still, the rate of cannabis possession charges among youth remained about 30% higher than in 2003 (600 per 100,000 in 2013 versus 462 per 100,000 in 2003) (Boyce et al., 2014).

A more detailed analysis of the UCR 2013 data reveals that an overwhelming majority (90%) of youth aged 12 to 17 years charged for a drug offence in 2013 was for cannabis (Statistics Canada, 2015). With 81% of charges being for possession of cannabis, it could be said that 9% of all drug-related charges among youth were for production and/or trafficking of cannabis. The proportion of cannabis-related charges among all drug charges decreases among older age groups. For instance, the proportion of cannabis-related charges among those who are 35 to 44 years old is 52% (Statistics Canada, 2015). In other words, a higher proportion of charges for drugs other than cannabis are noticeable among older groups of people.

As in the case of usage trends, the metric of cannabis-related incidents among youth corresponds to the one on police-reported incidents and charges among the adult population. When collection of empirical data on cannabis-related offences is discussed, it should be done for both adults and youth.

Youth Court

According to Statistics Canada (2015), the vast majority (77%) of completed drug-related cases in Canada's youth courts from 2008–2009 to 2011–2012 involved a cannabis related offense. Data also indicates that during this time period half (50%) of youth accused of a cannabis possession

offense and a third (35%) accused of supply offences involved a single charge. Cannabis-related cases involving possession were less likely to result in a guilty verdict than drug-related possession offences involving other drugs (42% compared to 60%). The same holds true for cannabis supply offences (51% compared to 61%). Most cannabis-related cases in youth court that are found guilty end with sentences that involve probation rather than custody or fines (Statistics Canada, 2015).

This metric corresponds to the one on police-reported offences. When collection of empirical data on cannabis-related, police-reported offences is discussed, it should be done for both adults and youth.

School Performance

A considerable body of research has examined the relationship between marijuana use and school performance. Depending on the amount consumed, research has shown marijuana can negatively affect memory, attention, and learning in adolescents, including sound decision-making and concentration (Dougherty et al., 2013; Hanson et al., 2010; Lisdahl et al., 2013). Young people who smoke marijuana tend to be less successful educationally than their nonsmoking peers. This tends to be measured by number of years spent in school or dropout status. For example, a 25-year longitudinal study of 1,265 adolescents undertaken in New Zealand found that increasing cannabis use was associated with leaving school early without qualifications and failing to enter into university or receive a university degree (Fergusson and Horwood, 1997). A review of 48 relevant studies also found marijuana use to be associated with reduced chances of graduating (Macleod et al., 2004). Another study conducted by Lynskey and Hall (2000) found that marijuana use had a strong relation to school absenteeism, lack of retention of students in schools, and not graduating.

The extent to which marijuana use and poor school performance is a casual relationship has been debated by researchers. It has been argued by some that poor schooling outcomes precede regular or heavy marijuana consumption, and thus cannot be caused by marijuana use (Fergusson and Horwood, 1997; Hawkins et al., 1992). Other studies contend that a common third factor or set of factors, such as socio-demographic factors, personality traits, and/or alcohol consumption (Barnes et al., 2005; Kumar et al., 2002) could account for poor schooling outcomes among marijuana users.

This metric is related to the adult metric, Impact on Productivity. When collection of empirical data on productivity or performance is discussed, it should be done for both adults and youth.

Homeless Youth

A study by the Public Health Agency of Canada (PHAC, 2006) found that homeless youth in Canada have a higher prevalence of substance abuse than non-homeless youth, with marijuana often being the preferred drug of choice. The study discovered that 78.3% of homeless youth in various cities across Canada used marijuana. Qualitative interviews undertaken during this study revealed that marijuana was used so regularly that both service providers and youth did not consider marijuana use to be problematic.

Other Canadian studies have found similar results. A study conducted by researchers from the CAMH and other community organizations found that 73% of homeless youth in Toronto,

Ontario reported using marijuana within the past 30 days, with marijuana use higher amongst males (82%) than females (64%) (Kirst & Erickson, 2013). Even higher usage rates were reported by a study conducted among youth in street-based settings in Victoria, British Columbia. There, researchers discovered that 88% of the homeless youth (15-24) surveyed reported marijuana use within the past 30 days (Sekharan, 2015).

In Colorado, an unexpected effect of legalization of marijuana was observed in influx of homeless people into the state, especially young adults who are between 18 and 26 years old (Police Foundation, 2015). The phenomenon may be explained by being attracted to the easy legal access to cannabis, as well as people's desire to find employment in the cannabis industry (Police Foundation, 2015).

Conclusion

This discussion paper on cannabis performance metrics outlined in-depth some of the more obvious policy metrics that may be considered for measurement to understand the impact of policies related to cannabis. Good policy discussion should be guided by an empirical base of evidence. It is useful to be able to model different policy scenarios and alternative policies using reliable data. If policy is guided by only one or two research studies, not enough perspective and critical insight on a particular issue is provided. While some of the identified metrics need targeted and rigorous research in order to be properly understood (e.g., Mental Health or Cancer), others would require constant monitoring at equal time intervals so that trends could be analyzed (e.g., Usage Trends, Incidents, or Potency).

The objective of this paper is to identify for policy makers what data and evidence they may want to continue considering when discussing changes in cannabis policy or the impact of any changes. Some of the metrics discussed in this paper are more precise, or operationalized, than others. Some will be easy to implement and measure through surveys, interviews, police records, or various databases. Other metrics are more general in their nature and should be regarded by policy makers as policy-research issues to consider exploring further. Finally, there are several metrics identified in the paper that are not currently being measured at all, and yet appear to be important to measure. The appendix at the end of this paper serves as a companion to this discussion paper, and can be used as a reference guide to all the metrics discussed in this paper, and how they should be measured. Of the approximately 45 types of metrics identified in this paper, Canada currently collects data to calculate about seven, some partial information on a further 17, and little to no data on the remaining 21 metrics.

A number of groups could share the burden of collecting the data required to calculate the metrics discussed in this paper. These groups could include federal government departments and agencies, such as Public Safety Canada, Health Canada, Industry Canada, Statistics Canada, and the RCMP, as well as provincial and municipal governments, police services, industry and professional associations, and certain not-for-profit groups or academics. Regardless who ultimately collects which data and who produces which metrics, collaboration among stakeholders should be fostered on the complex issue of measuring the performance of cannabis policy.

It is important to remember that most of the issues identified in this paper need to be continuously monitored and measured. Metrics of relevance to assessing any policy are most beneficial when they exist prior to any shift in policy, during the shift, and measured continuously following the shift. Only then policy makers will be able to determine whether the shift in policy achieved its desired purpose, and whether or not it did more good than harm. In Colorado, for example, much of the baseline data described in this paper was largely absent both prior- and post- legalization of marijuana (Police Foundation, 2015). There is a continuous call from policy makers and law enforcement officials to establish some sort of data collection framework in order to understand the effects of the legalization policy (Police Foundation, 2015: 9):

> Law enforcement leaders … warned that until there is a statewide data collection system, it will not be possible to fully understand the impact of legalized marijuana and related crime in the state of Colorado. … Given the time needed to create a statewide data system, it may be years before Colorado law enforcement can fully analyze the impacts of legalized marijuana.

Collection of data to develop metrics is expensive and would require both initial and continuous funding. Funds generated from any changes in cannabis policy regimes, for example from sales taxes in scenarios where the recreational use of cannabis might be legalized, could be continuously reinvested not only into harm reduction and public education, but also into the continuous collection of data on metrics of the types identified in this paper. Considering how little data is currently collected regarding many of these suggested metrics, there is a great opportunity to make high quality research and evaluation an important part of cannabis policy in the future.

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Appendix

The metrics identified in this paper and summarized in Table 1 should be viewed as examples that can guide understandings and discussion regarding the implementation of cannabis-related data collection and analysis. The metrics are grouped, as in the paper, by broad category of metrics (e.g., Public Safety) and by class of metric (e.g., Usage Trends). As a mnemonic, a sample metric or two is provided to illustrate each class of metrics. Some metrics are more clearly operationalized or easier to collect than others, so a rough assessment of whether or not the class of metrics is thoroughly measured in Canada is provided. For example, the metric of Usage Trends is fairly well-operationalized. Further, data collection on this metric is more or less straightforward. Yet, it is considered as partially measured in Canada because only prevalence of use of cannabis is currently measured, not the actual volume of the drug that is consumed. Finally, information on some metrics might be collected elsewhere in the world, but the work might still be relevant to Canada even without confirming the findings or trends with Canadian data (e.g., Mental Health or Cancer). The chart also outlines possible sources of data and possible data holders to calculate the metric, along with a space for some relevant explanatory notes.

Table 1: Summary of Cannabis Performance Metrics

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
Public Safety	*Usage Trends*	- % of people consuming. - Amount of cannabis consumed.	Partially	CTADS and CCHS Surveys	Statistics Canada	Only prevalence of use is measured. Volume consumed is not measured.
	Method of Consumption	- Proportion of smoked, eaten, vaporized, topically-applied, etc. cannabis among users.	No	None	Statistics Canada	Questions on the method of consumption should be asked on surveys.
	Police-reported Incidents	- # of cannabis-related incidents. - # of people charged.	Partially	UCR	Statistics Canada	Police-reported data. Possession, production and trafficking offences do not capture information on amounts.
	Outcomes of Police-reported Offences (Adult)	- # of charges. - # of drug court cases.	Yes	UCR and ICCS	Statistics Canada	Police-reported data merged with courts data.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
	Illegal Production and Cultivation	- Amount of illegally-produced cannabis.	Partially	UCR and RCMP	Statistics Canada, RCMP	Only data from UCR is available, not yet from RCMP.
	Police Calls for Service	- # of citizens' cannabis-related calls for service. - # of police-initiated calls for service.	No	Law Enforcement databases	RCMP and other law enforcement agencies	Calls-for-service data from law enforcement is essential for this metric.
	Potency	- % of THC and CBD content in cannabis.	Partially	RCMP and Health Canada forensic labs analysis	RCMP and Health Canada	No open-source data is available on potency. If potency analyses are being conducted, data could be made more widely available.
	Crime around Dispensaries	- Rate and severity of crime around cannabis dispensaries.	No (some studies in U.S.)	Law Enforcement databases	RCMP and other law enforcement agencies	Law enforcement incident-level databases could be examined to data needs for this metric.
	Crop Eradication	- Number of cannabis plants eradicated. - Amount of psychoactive constituents eradicated.	No (some studies in U.S.)	Law Enforcement databases	RCMP and other law enforcement agencies	Data is not readily available for Canada. Data holders may have data, but it is not public.
	Grow-ops as Fire Hazard	- Number of fire incidents in grow-ops.	No	Law Enforcement and Fire Departments' databases	Fire departments, law enforcement, Statistics Canada	Data may exist in police and fire departments' databases, but it is not public.
	Organized Crime	- Amount of cannabis produced and trafficked by organized crime. - Amount of money laundered from illicit cannabis operations.	No	Law Enforcement databases	RCMP and other law enforcement agencies	Organized Crime Flag could be helpful. Also, other estimation methods exist.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
	Probation Infractions and Parole Violations	- # of probation infractions related to cannabis. - # of probation infractions by offenders convicted of a cannabis-related offence.	No	Parole Board of Canada database	Parole Board of Canada, law enforcement agencies	Parole Board of Canada's administrative database and law enforcement databases could be used as a source of data.
	Diversion to Other Jurisdictions	- Amount of cannabis trafficked out of state or province.	No (some studies in U.S.)	RCMP and provincial police databases	RCMP and provincial police	Data may exist in RCMP and provincial police's databases, but it is not public.
	Transfer Using Parcel Services	- Amount of cannabis transferred via parcels.	No (some studies in U.S.)	RCMP and other law enforcement databases	RCMP and other law enforcement agencies	Data may exist in RCMP and other law enforcements' databases, but it is not public.
	Exportation across Borders	- Amount of cannabis trafficked across the border.	No (some studies in U.S.)	RCMP and CBSA databases	RCMP and CBSA	Data may exist in RCMP and CBSA's databases, but it is not public. It is also released on a one-off basis, but could be reported upon regularly.
	Extraction Explosions and Injuries	- # of explosions due to concentration of cannabis products.	No (some studies in U.S.)	Law enforcement and fire departments' databases	Fire departments and law enforcement	Data may exist in police and fire departments' databases, but it is not public.
	Traffic Accidents and DUID	- # of accidents due to cannabis drugged driving. - # of deaths as a result of cannabis drugged driving.	Yes	CTADS Survey, law enforcement and hospital databases	Statistics Canada, law enforcement agencies, hospitals	Data exists and is accessible. Statistics should be published on a regular basis (i.e., not as a one-off study).
	Testing Information and Law Enforcement Training	- % reliability of cannabis testing during a traffic stop. - Quality of training of law enforcement.	Yes	International DEC Program	DEC	Standardized cannabis testing measures exist. More research into effective training is needed.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
Public Health	*Medical Marijuana Industry*	- Amount of medical cannabis produced. - # of licenses issued. - # of prescriptions filled.	Partially	Health Canada	Health Canada	The number of licensed companies is known. However, other metrics such as quantities produced and sold are lacking.
	Use of Other Licit and Illicit Drugs	- Examination of causal relationship between using cannabis and other drugs.	No (some studies in U.S.)	Mostly primary data collection	Researchers who collect primary data	The "gateway" hypothesis is not perfectly explained. More research is needed.
	Overdose	- # of overdoses as a result of use of cannabis. - # of fatal cases as a result of use of cannabis.	No	Hospital databases; CIHI; Canada Vigilance Program.	CIHI; Health Canada	CIHI hosts hospital data for Canada. But mortality and overdose data is not available.
	Emergency Room Visits and Hospital Treatment Admissions	- # of emergency room visits as a result of use of cannabis. - # of hospitalizations as a result of use of cannabis.	Yes	Hospital databases; CIHI; Canada Vigilance Program.	CIHI; Health Canada	CIHI hosts hospital data for Canada. Data is limited to very few demographics.
	Issues of Dependency and Abuse of Cannabis	- % of users that are abusing the use of cannabis or are dependent on the drug.	Yes	CCSH Survey	Statistics Canada	Self-reported survey data is available using the DSM-5 guideline for abuse and dependency.
	Treatment Admissions	- # of admissions into cannabis treatment programs.	Partially	Treatment programs, NTI	NTI	Very limited data is available. Does not cover all of the programs.
	Respiratory Effects Smoking Cannabis	- # of adverse respiratory conditions as a result of use of cannabis.	Partially	Hospital databases, primary data collection	Hospitals, CIHI, Researchers who collect primary data	Some research has been done in the area. Much more is needed to understand the metric.
	Cancer	- # of cases of cancer among users of cannabis.	Partially	Hospital databases, primary data collection	Hospitals, CIHI, Researchers who collect primary data	Some research has been done in the area. Much more is needed to understand the metric.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
	Cardiovascular Health	- # of adverse heart and cardiovascular conditions as a result of use of cannabis.	Partially	Hospital databases, primary data collection	Hospitals, CIHI, Researchers who collect primary data	Some research has been done in the area. Much more is needed to understand the metric.
	Pregnancy and Reproductive Health	- # of pregnant mothers using cannabis - # of adverse conditions as a result of use of cannabis during pregnancy.	Partially	CCSH, CTADS, hospital databases, primary data collection	Statistics Canada, Hospitals, CIHI, researchers who collect primary data	Prevalence of use among women who are in their reproductive age is known. Some further research has been done in the area. Much more is needed to understand the metric.
	Mental Health	- # of adverse mental health conditions as a result of use of cannabis. - # of cases where use of cannabis led to mental health issues.	Partially	Hospital databases, primary data collection	Hospitals, CIHI, researchers who collect primary data	Some research has been done in the area. Much more is needed to understand the metric.
	Athletic Performance	- # of athletes using cannabis.	Partially	WADA database	WADA	Some statistics of prevalence of use are known. Much more research is needed to understand the metric.
	Healthcare Costs	- Healthcare costs incurred due to treatment of cannabis-related episodes.	Partially	CIHI database	CIHI	Some cost estimates exist. More research is needed to refine the method and provide better estimates.
Economics	*Value of Electricity Used by Grow-Ops*	- Amount of electricity used - Monetary value of electricity used	Partially	Police records for number of grow-ops, electricity utility company records for rates and consumption	Police databases, electrical utility companies	Existing research provides estimates and extrapolations. More research is needed to provide solid numbers.
	Market Origin	- % of cannabis that is grown, obtained for free, purchased legally or illegally by users.	Very limited	Health Canada records, RCMP	Health Canada, RCMP	Questions on source of cannabis should be asked on surveys. More research is needed to understand the metric.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
	Sharing and Sale by Users	- % or amount of cannabis that is shared and sold (at cost or for profit) among users.	No	Primary data collection, surveys	Researchers who collect primary data and national surveys	Data is not collected anywhere. Research is needed to understand the metric.
	Pricing	- The price users pay for their cannabis.	Partially	Priceofweed.com, investigative data	Priceofweed.com, RCMP and other law enforcement agencies	Some preliminary work exists. Much more research is needed to understand price dynamics.
	Economic Impact of Legalization	- Tax revenue gained from a change in cannabis policy.	No (some studies in U.S.)	Survey data, priceofweed.com	Priceofweed.com, RCMP and other law enforcement agencies	Some econometric research exists. Some actual data is available from Colorado. Much more refined research is needed to understand the metric.
	Real Estate Market	- Change in the value of property in jurisdictions where cannabis is legalized.	No (some studies in U.S.)	Real estate and CMHC databases	Canadian Real Estate Association and CMHC	Some data available from Colorado. More research is needed to understand the metric.
	Impact on Productivity	- % of employees absent from work as a result of use of cannabis. - Increase or decrease in productivity as a result of use of cannabis.	Some studies in the U.S.	Workplace database, primary data collection, surveys	Statistics Canada, researchers who collect primary data	Some research is done in the area, but it is controversial. A lot more research is needed to understand the metric.
	Environmental Impact	- Amount of pesticides, fertilizer, and herbicides used at a grow-op. - Amount of greenhouse gas emissions by the grow-op.	Very limited	Primary data collection, agriculture databases	Researchers who collect primary data, Agriculture and Agri-Food Canada	Very limited information is available from the U.S. No scientific studies in Canada or elsewhere. More research is needed to understand the metric.

	Class of Metric	Sample Metric	Measured in Canada?	Source of Data for Canada	[Possible] Data Holders	Notes
	Grow-op Technology	- Efficiency of grow-op technology.	No (some studies in U.S.)	Independent tests	Researchers and corporation conducting independent testing	A series of independent reports were commissioned by the Washington State Liquor and Cannabis Board.
Children and Youth	*Usage trends among Youth*	- % of youth using cannabis. - Amount of cannabis consumed by youth.	Partially	CTADS and CCHS Surveys, CAMH survey	Statistics Canada, CAMH	Only prevalence of use is measured. Actual consumption is not measured.
	Police-reported incidents among Youth	- # of cannabis-related incidents among youth. - # of youth charged.	Yes	UCR	Statistics Canada	Police-reported data. Possession, production and trafficking offences do not capture information on amounts.
	Youth Court	- # of cannabis-related cases in youth courts.	Yes	UCR and ICCS	Statistics Canada	Police-reported data merged with courts data.
	School Performance	- # of youth expelled from school as a result of use of cannabis. - # missed classes as a result of use of cannabis. - Change in school accomplishments as a result of use of cannabis.	No (some studies in U.S.)	Mostly primary data collection mixed with survey data	Researchers who collect primary data and national surveys	Some research has been done in the area. Much more is needed to understand the metric.
	Homeless Youth	- # of homeless youth that use cannabis.	Partially	Mostly primary data collection	PHAC and researchers who collect primary data	Some research has been done in the area, mostly descriptive statistics. Much more is needed to understand the metric.