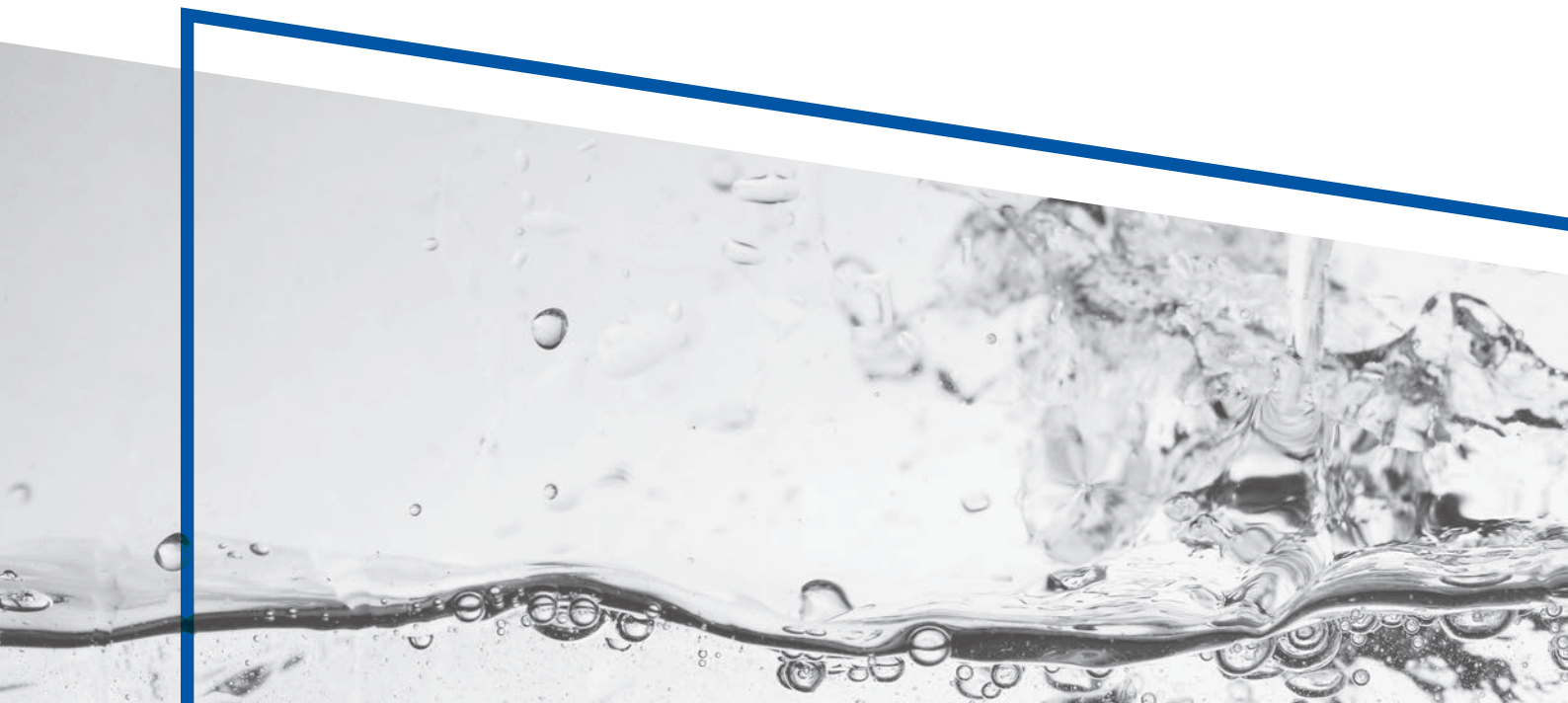
NATIONAL WASTEWATER DRUG MONITORING PROGRAM

REPORT 9

AUSTRALIAN CRIMINAL INTELLIGENCE COMMISSION

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

University of South Australia



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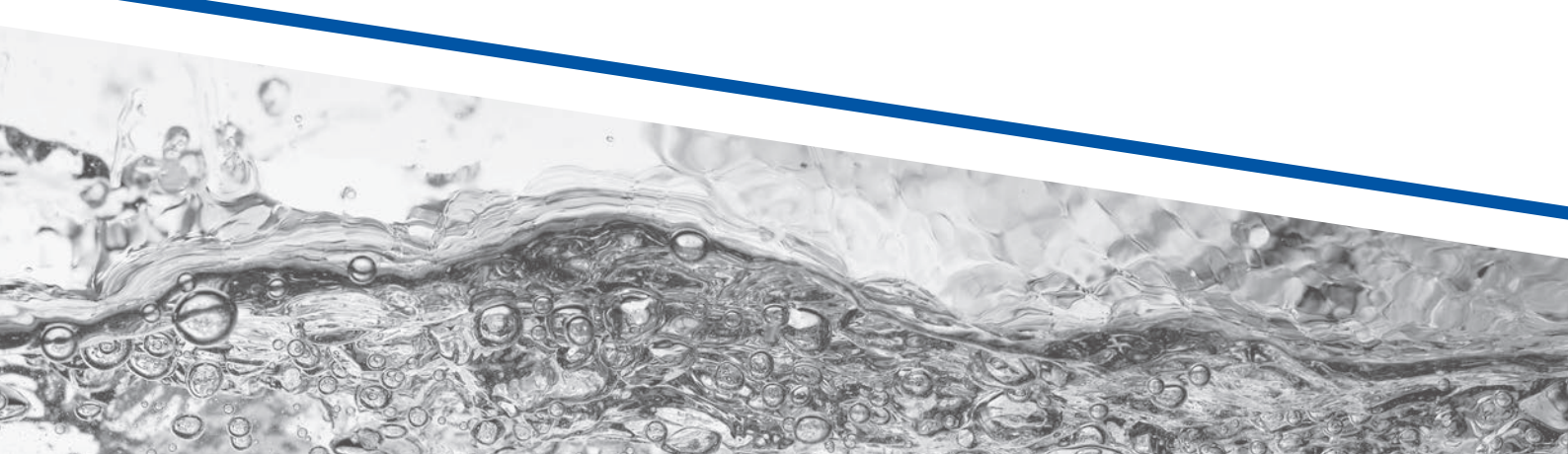


CEO FOREWORD

The Australian Criminal Intelligence Commission has a responsibility to provide information and intelligence on criminal activity to support the Government in creating a safer Australia. Much of the harm that Australians suffer at the hands of organised crime is due to illicit drugs. Serious and organised crime groups profit from the importation, manufacture, trafficking and sale of drugs which cause harm to the community.

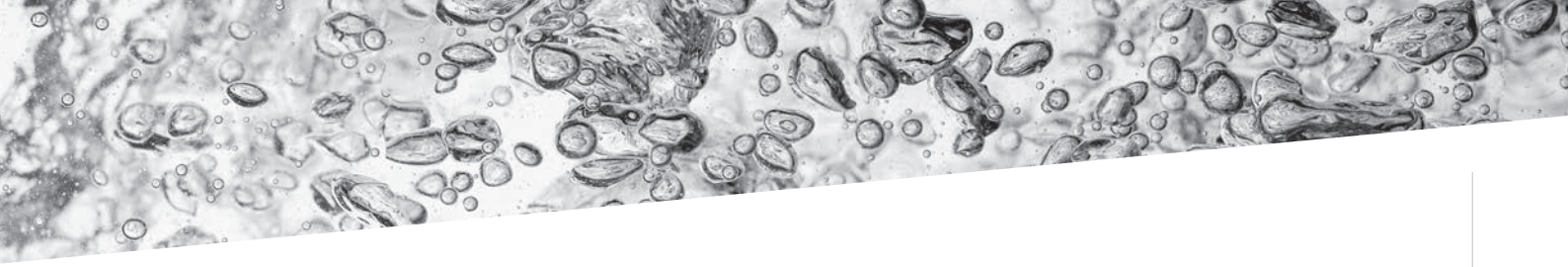
The National Wastewater Drug Monitoring Program represents world best practice in its field. Wastewater analysis is a tool to measure and interpret drug use within populations, providing a measure of one important aspect of national health—the demand for a range of licit and illicit drugs. Scheduled illicit drugs and licit drugs with abuse potential are inherently harmful. Reliable drug consumption data is a useful indicator of the level of harm experienced by the community. Understanding drug consumption at a population level supports the effective allocation of resources to priority areas. It also allows monitoring of the progress of demand, supply and harm reduction strategies.

The National Wastewater Drug Monitoring Program is an Australian Government initiative. This report concludes the third year of the program. The Australian Criminal Intelligence Commission has received an additional $4.8 million as part of its annual appropriation to continue delivery of this important program until 2023. The Australian Criminal Intelligence Commission will continue to provide an objective evidence base concerning illicit and licit drug use, and to work with partners to exploit the data by informing local and national response options and monitoring the effectiveness of responses. The Australian Criminal Intelligence Commission is also placing increasing priority on merging wastewater data with other Government, state and territory, industry and academic datasets to enhance responses aimed at reducing community harm.

TRENDS IDENTIFIED DURING THIS REPORTING PERIOD

This National Wastewater Drug Monitoring Program report is the ninth in a series of public reports that detail program findings. The program provides statistically valid datasets of drug use and distribution patterns across a large number of sites in capital cities and regional Australia. The number and diversity of regional sites provides unique drug data that facilitates analysis of drug trends outside of the capital cities and informs local responses to the different circumstances that apply in each location.

All states and territories participate in the National Wastewater Drug Monitoring Program, providing a timely and ongoing national picture of consumption. In August 2019, fifty-eight wastewater sites were monitored nationally. Based on 2016 Census data, these sites covered approximately 57 per cent of the Australian population—around 13.3 million people.



Of the drugs measured by the program with available dose data, alcohol and nicotine continue to be the most consumed substances, and methylamphetamine the most consumed illicit drug.

Of note in this report are the decreases in nicotine, alcohol, methylamphetamine, cocaine, MDMA, cannabis (capital city) and fentanyl consumption between April 2019 and August 2019, and the increases in heroin, oxycodone and cannabis (regional) consumption.

TRENDS IDENTIFIED DURING THE THREE YEARS OF THE PROGRAM

The population-weighted average consumption of all drugs monitored by the program has fluctuated. When comparing data for August 2016 and August 2019, the population-weighted average consumption of nicotine, methylamphetamine and cocaine increased, while the consumption of alcohol, oxycodone and fentanyl decreased. The population-weighted average consumption of MDMA increased in regional sites but decreased in capital city sites.

Consumption of most drugs was higher per capita in regional sites, with the exception of cocaine and heroin. The data also shows that of the illicit drugs with available dose data, methylamphetamine remains the most consumed drug by a large margin. When comparing data for Year 1 and Year 3 of the program, the national estimated weight of methylamphetamine, cocaine, MDMA, heroin, oxycodone and fentanyl consumed annually has increased.

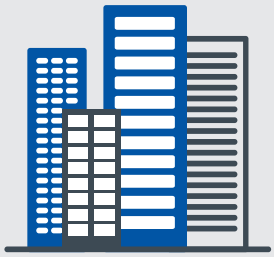
Australians spent an estimated $8.6 billion on methylamphetamine, cocaine, MDMA and heroin in Year 1 of the program, $9.4 billion in Year 2 and $11.3 billion in Year 3. More than 76 per cent of the combined estimated expenditure in Year 3 was spent on methylamphetamine. This is one of the more tragic, harmful and wasteful aspects of illicit drug markets—expenditure on drug purchases which might otherwise have been spent in the legitimate economy generates illicit profits for the sole benefit of organised crime groups.

I would like to acknowledge the valuable support and specialist expertise of the University of Queensland and the University of South Australia, that undertook the data collection and analysis which underpins this report, and the Australian Criminal Intelligence Commission officers who contributed to the project.

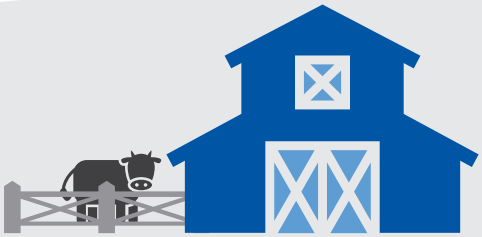
Michael Phelan APM
Chief Executive Officer
Australian Criminal Intelligence Commission

SNAPSHOT

The August 2019 collection covers around **57 per cent** of Australia's population—about **13.3 million Australians.**



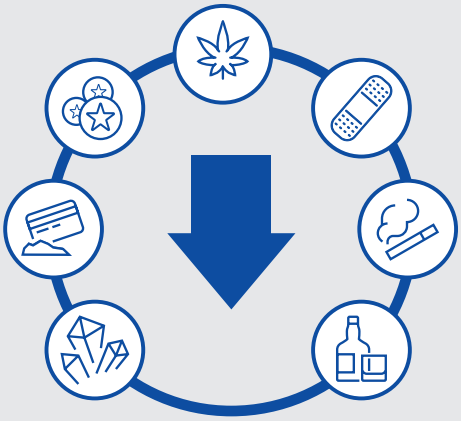
Capital city **cocaine** and **heroin** average consumption exceeded regional consumption.



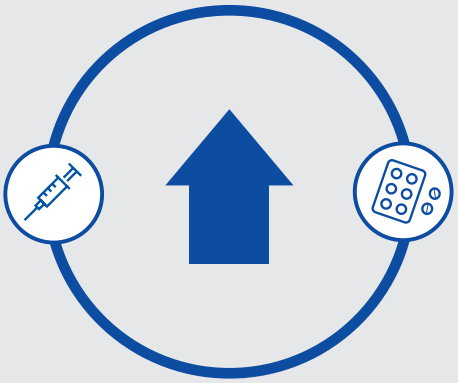
Regional **nicotine, alcohol, methylamphetamine, MDMA, MDA, oxycodone, fentanyl** and **cannabis** average consumption exceeded capital city consumption.

Of the drugs measured with available dose data, **alcohol** and **nicotine** remain the most consumed, with **methylamphetamine** the most consumed illicit drug.

Between April 2019 and August 2019, the population-weighted average capital city consumption of:



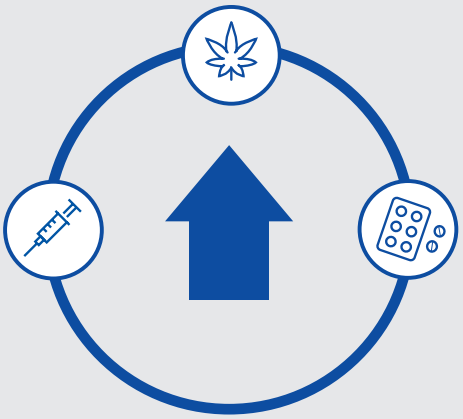
methylamphetamine, cocaine, MDMA, cannabis, fentanyl, nicotine and alcohol **decreased**



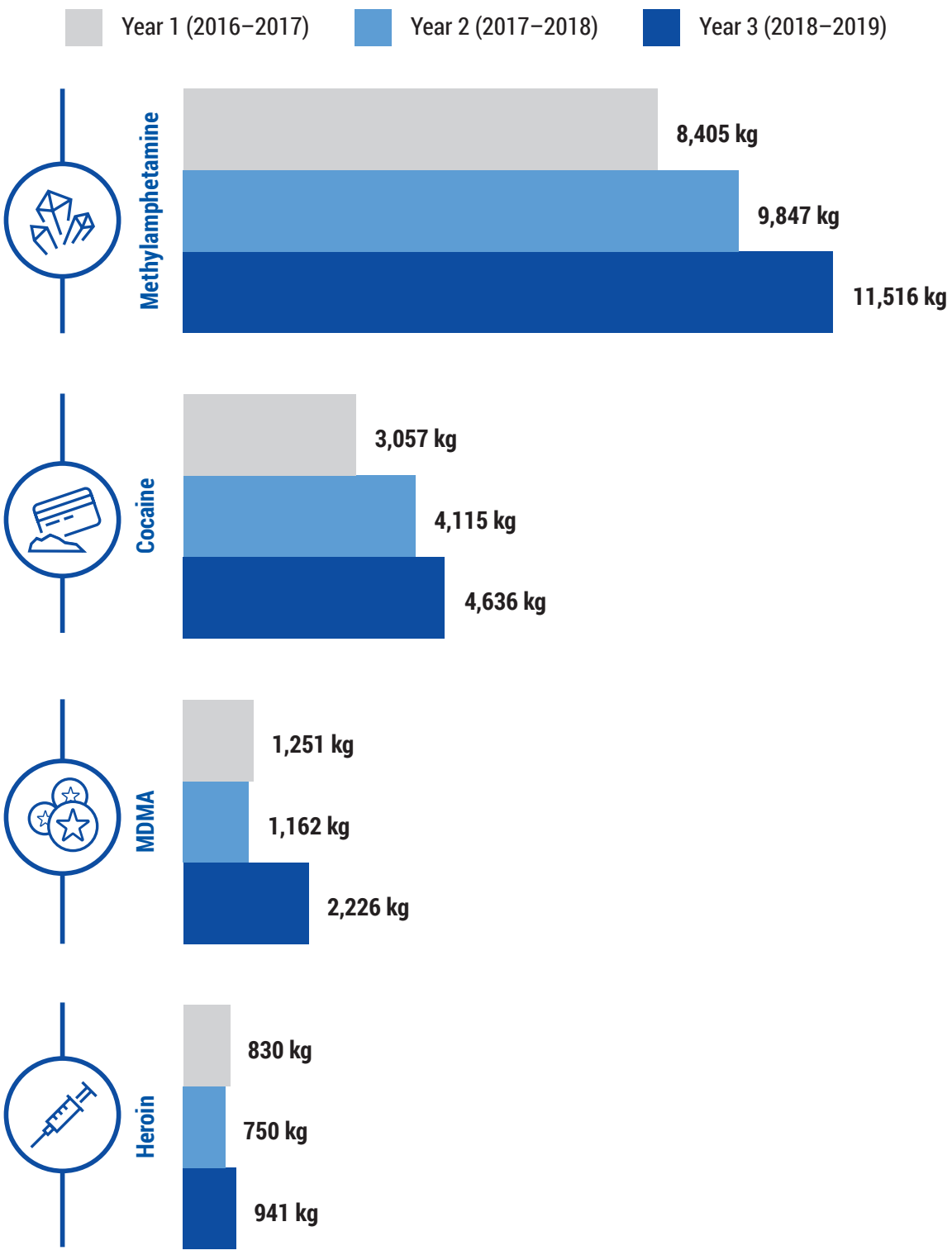
heroin and oxycodone **increased**

Between April 2019 and August 2019, the population-weighted average regional consumption of:

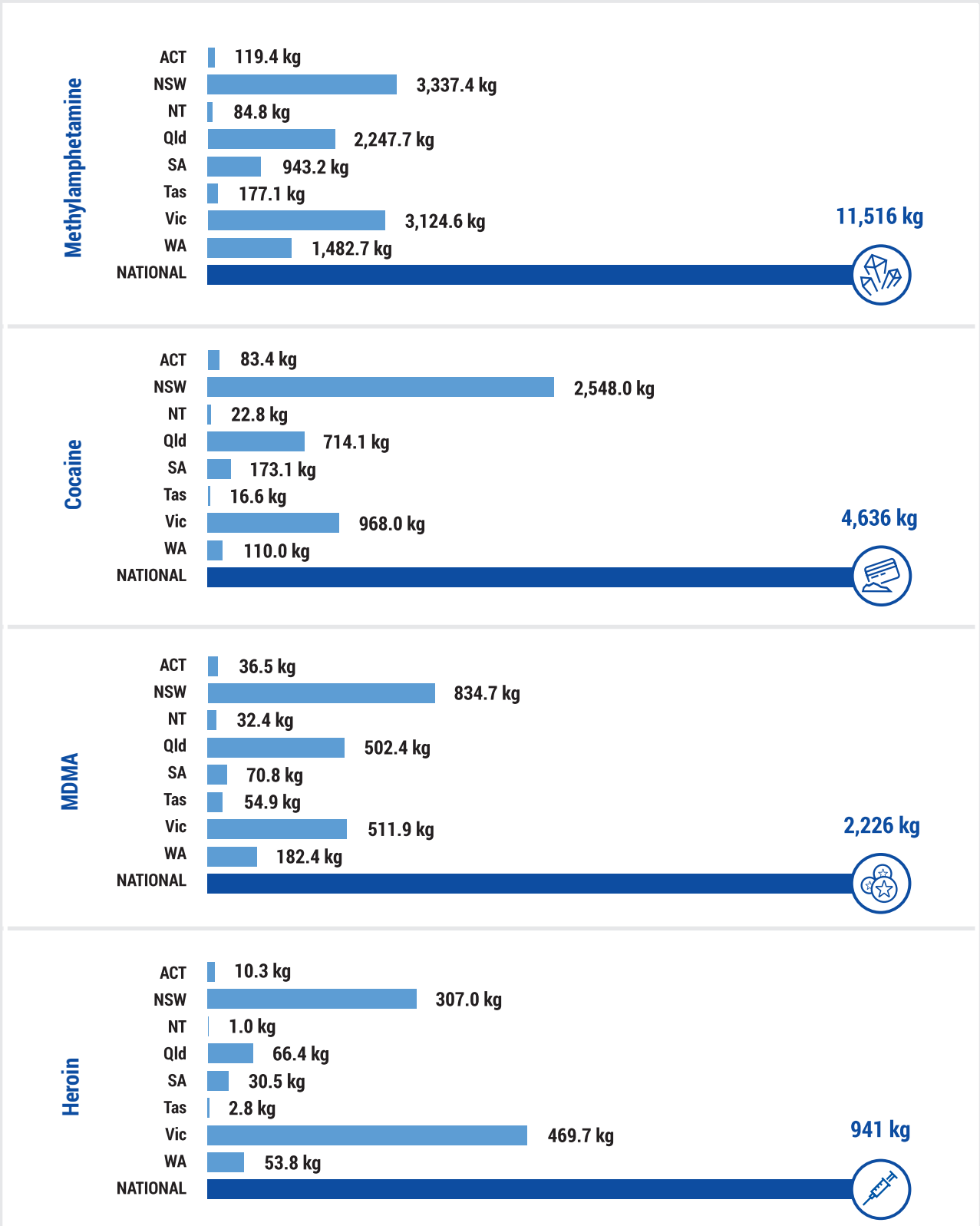
methylamphetamine, cocaine, MDMA, fentanyl, nicotine and alcohol **decreased**



heroin, cannabis and oxycodone **increased**



The estimated weight of methylamphetamine, cocaine, MDMA and heroin consumed annually increased from Year 1 to Year 3 of the program.



Estimated state and territory annual consumption of methylamphetamine, cocaine, MDMA and heroin for Year 3 of the program.

INTRODUCTION

This is the ninth in a series of National Wastewater Drug Monitoring Program reports to be publicly released by the Australian Criminal Intelligence Commission and marks the end of the first three years of the program. The program provides a measure, rather than an estimate, of the use of a number of illicit drugs, as well as licit drugs including nicotine, alcohol and some pharmaceuticals. It gives us valuable insight into the trends and emerging issues in drug consumption across Australia and can identify new sources of threat.

The program aims to deliver on the recommendations of the *Final Report* of the *National Ice Taskforce*. In 2016 the Australian Criminal Intelligence Commission received funding under the *Proceeds of Crime Act 2002* to deliver the National Wastewater Drug Monitoring Program over three years. Since then, additional funding in the Australian Criminal Intelligence Commission's annual budgetary appropriation has allowed for the extension of the program until 30 June 2023.

The ninth report presents data on Australia's drug consumption for 13 substances and primarily focuses on data for August 2019. Longitudinal data captured by the program increases our understanding of drug use in Australia nationally, in specific regions and over time. Findings presented in the reports provide law enforcement, policy, regulatory and health agencies with additional, objective data on the use of methylamphetamine and other drugs. These data create opportunities to shape the response to the demand and supply sides of the illicit drug market, particularly in high-use areas, and inform harm reduction strategies.

IMPLEMENTATION

The Australian Criminal Intelligence Commission has contracted the University of Queensland, and through it the University of South Australia, to deliver the program. Relationships have been built between the universities and the operators of wastewater facilities across Australia to permit the collection and analysis of samples.

In this report, wastewater analysis from the National Wastewater Drug Monitoring Program measured the presence[1] of the following substances:

- methylamphetamine
- amphetamine
- cocaine
- 3,4-methylenedioxymethylamphetamine (MDMA)
- 3,4-methylenedioxyamphetamine (MDA)
- heroin
- cannabis.
- mephedrone
- methylone
- oxycodone
- fentanyl
- nicotine
- alcohol

1 The contract recognises that threshold levels are substance dependent and will vary accordingly. Refer to the research findings for further information on detection levels, and whether it was possible to measure all substances.

The Australian Criminal Intelligence Commission continues to review the appropriateness of monitored substances with its partners, stakeholders and the universities.

Both contracted universities monitor wastewater across Australia, covering all state and territory capital cities and a range of regional cities and towns. In August 2019, 58 wastewater treatment plants participated nationally. Sites were selected to permit the Australian Criminal Intelligence Commission to provide data on major population areas, sites of actual or potential concern from a drug use perspective, and sites where the local authorities have established relationships with the two universities.

The breakdown of sites by jurisdiction for August 2019 is as follows:

Participation from all states and territories is vital to informing our understanding of the national picture of drug use and demand. In the event that one or more states and territories decides not to participate in the national program in the future, the Australian Criminal Intelligence Commission will identify replacement sites from participating states and territories to ensure that the largest possible segment of the national population is sampled. Accordingly, the location of sites within and between states and territories may change over the life of the program.

REPORTING

National Wastewater Drug Monitoring Program reports are completed three times a year and made public. In accordance with current wastewater analysis conventions, the terms of the contract, and to protect the integrity of the program, the exact locations of wastewater treatment plants sampled are not publicly released by the Australian Criminal Intelligence Commission. Stakeholders in law enforcement, health and other relevant policy agencies are provided with classified information identifying actual sampling locations to inform appropriate responses.

Reported results reflect per capita use in all locations and, with the exception of MDA and cannabis (for which reliable dose figures are not available), are expressed in terms of both the number of doses and the weight or volume per capita of the respective substances, to facilitate comparison between substances. Work is under way to determine a reliable dose figure for cannabis.

EXPLOITATION OF THE NATIONAL WASTEWATER DRUG MONITORING PROGRAM DATA

The National Wastewater Drug Monitoring Program is based on a well-established and internationally recognised methodology. The Australian Criminal Intelligence Commission considers that National Wastewater Drug Monitoring Program data provide an important basis for the development of empirically informed government policy and decision making. The reports provide regular, timely, unambiguous and detailed measures of the level of demand for the listed substances in the Australian population, complementing other drug datasets published in Australia. The ninth National Wastewater Drug Monitoring Program report measures the drug use of approximately 57 per cent of the Australian population.[2]

Wastewater data are also particularly useful for identifying differences in levels of drug consumption in capital city and regional areas of Australia. The data reinforce the different dynamics that apply to both capital city and regional markets and also illustrate drug preference variation that exists both within and between states and territories. Understanding these preferences is important in the development and delivery of national responses and in tailoring responses to suit the specific needs of individual jurisdictions. The number and diversity of regional sites that participate in the program permits confident assessments to be made of drug trends outside of the capital cities and facilitates local responses to the different circumstances that apply in each location.

Wastewater data are used with other available data sources to develop a comprehensive and accurate understanding of drug markets nationally and in the states and territories. Wastewater analysis data collected by the National Wastewater Drug Monitoring Program has been used to estimate the value of methylamphetamine, cocaine, MDMA and heroin consumed annually in Australia; to explore the relationship between drug consumption and different types of crime; and to assess the impact of law enforcement and health initiatives aimed at reducing drug supply and demand.

2 The August 2019 population estimate is based on the Australian Bureau of Statistics 2016 Census data and catchment data supplied by the operators of the wastewater facilities and service providers.

In collaboration with partners, the program is assisting to develop passive sampling techniques, which will allow for the monitoring of drug consumption at additional sites. Early indications are that passive sampling is viable in an Australian context and will extend the utility of the existing national program. Work continues on the practical application of this sampling strategy.

The Australian Criminal Intelligence Commission engages with academic institutions, industry and public sector agencies to identify further data applications. Opportunities identified include informing responses in high risk areas; measuring drug use in specific local areas; estimating the size of discrete illicit markets; and exploring options for monitoring the effectiveness of existing demand, supply and harm reduction initiatives. Advantages of the National Wastewater Drug Monitoring Program are that the data are collected on an ongoing basis, are reported regularly, and the program is sufficiently flexible to allow for focusing collection activity in different geographic locations and at more regular intervals in response to identified need.

A THREE YEAR RETROSPECTIVE

The feasibility of the National Wastewater Drug Monitoring Program has been established and has been recognised internationally as world best practice. With the passage of three years, sufficient data has now been collected to permit a range of stakeholders to commence longitudinal analysis of consumption trends. The data is also being used by third parties for a range of applications that were not anticipated at the commencement of the program.

The data has proven itself to be amenable to analysis from a variety of perspectives. A simple summary of some of this analysis is provided below.

CAPITAL CITY V REGIONAL COMPARISON

Consumption of most drugs was higher per capita in regional sites, with the exception of cocaine and heroin.

While the population-weighted average consumption of all drugs monitored by the program fluctuated, when comparing data collected for capital city sites and regional sites between August 2016 and August 2019 some patterns can be identified (see Table 1).

Table 1. Changes in estimated population-weighted average consumption of all drugs monitored by the National Wastewater Drug Monitoring Program.

	August 2016 and August 2017		August 2017 and August 2018		August 2018 and August 2019		August 2016 and August 2019	
	Capital City	Regional	Capital City	Regional	Capital City	Regional	Capital City	Regional
Alcohol	↓	↓	↑	↑	↓	↓	↓	↓
Nicotine	↑	↑	↑	→	↓	↓	↑	↑
Methylamphetamine	↑	↓	↑	↑	↑	↑	↑	↑
Cocaine	↑	↑	↑	↑	↓	↑	↑	↑
MDMA	↓	↓	↑	↑	↑	↑	↓	↑
Oxycodone	↓	↓	↑	↑	→	↑	↓	↓
Fentanyl	↓	↑	↑	↑	↓	↓	↓	↓
Heroin[a]	—	—	↓	↓	↑	↑	—	—
Cannabis[b]	—	—	—	—	↓	↓	—	—

Key: ↓ Decrease → Relatively stable ↑ Increase

[a] Heroin data is available from August 2017.
[b] Cannabis data is available from August 2018.

When comparing data for August 2016 and August 2019, the population-weighted average consumption of nicotine, methylamphetamine and cocaine increased, while the consumption of alcohol, oxycodone and fentanyl decreased. The population-weighted average consumption of MDMA increased in regional sites but decreased in capital city sites.

DRUG CONSUMPTION TRENDS

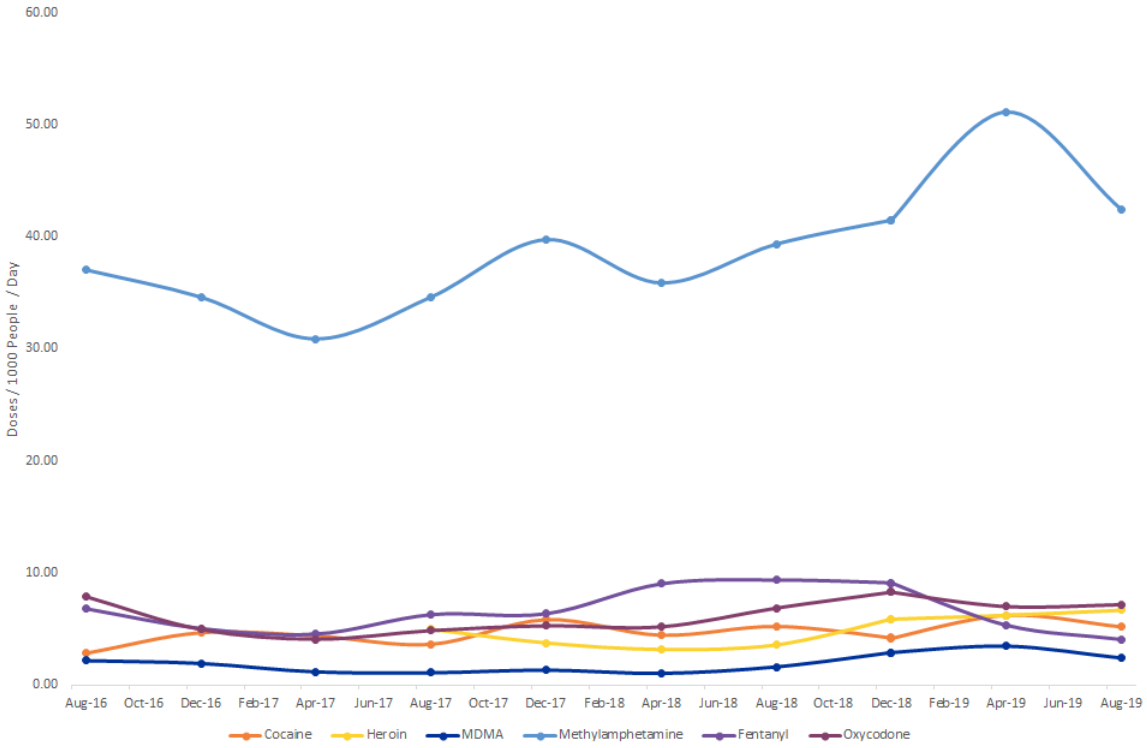
The data shows that consumption has fluctuated over the three year period. While no distinct pattern could be observed, 40 per cent of all record high drug consumption levels—in both capital cities and regional sites—was recorded in April 2019. April was the most common month where record high and low consumption levels were recorded, accounting for 50 per cent of all record highs and 45 per cent of all record lows. The majority of consumption records occurred in 2019, accounting for 50 per cent of all record highs and 40 per cent of all record lows (see Table 2).

Table 2. Months and years when the highest and lowest drug consumption was recorded by the National Wastewater Drug Monitoring Program.

	Highest drug consumption		Lowest drug consumption	
	Capital City	Regional	Capital City	Regional
Alcohol	February 2018	April 2018	February 2019	April 2017
Nicotine	April 2019	April 2019	October 2018	August 2016
Methylamphetamine	April 2019	April 2019	June 2017	April 2017
Cocaine	April 2019	April 2019	August 2016	August 2016
MDMA	April 2019	April 2019	April 2018	April 2017
MDA	December 2016	August 2017	August 2019	April 2019
Oxycodone	February 2019	August 2016	April 2017	April 2017
Fentanyl	August 2018	April 2018	February 2019	August 2019
Heroin	June 2019	August 2017	February 2019	April 2018
Cannabis	October 2018	August 2018	August 2019	April 2019

The data also shows that of the illicit drugs with available dose data, methylamphetamine remains the most consumed drug by a large margin.

National average drug consumption of methylamphetamine, cocaine, MDMA, oxycodone, fentanyl and heroin:



ESTIMATED NATIONAL CONSUMPTION BY WEIGHT

The Australian Criminal Intelligence Commission used wastewater data collected between August 2016 and August 2019 (Years 1 to 3 of the program) to estimate the weight of methylamphetamine, MDMA, cocaine and heroin consumed annually. These estimates are conservative and enable the identification of long-term trends in drug consumption in addition to providing drug to drug comparisons.

When comparing data from Year 1 and Year 3 of the program, the estimated national consumption of methylamphetamine, cocaine, MDMA and heroin has increased (see Table 3). Methylamphetamine continues to account for approximately 60 per cent of the combined estimated consumption of these four drugs.

Table 3. Estimated annual methylamphetamine, cocaine, MDMA and heroin consumption, as total weight consumed nationally, Year 1 to Year 3 of the National Wastewater Drug Monitoring Program.

Drug	Estimated consumption (kilograms per annum)			% Change
	Year 1	Year 2	Year 3	Year 1 to Year 3
Methylamphetamine	8,405	9,847	11,516	↑ 37.0
Cocaine	3,057	4,115	4,636	↑ 51.7
MDMA	1,251	1,162	2,226	↑ 77.9
Heroin	830[3]	750	941	↑ 13.4

ESTIMATED STATE AND TERRITORY CONSUMPTION

On a state and territory level, overall methylamphetamine, cocaine, MDMA and heroin consumption has fluctuated over the life of the program.

When comparing data from Year 1 and Year 3 of the program, methylamphetamine consumption increased in most states and territories, most notably in Tasmania. The exception is South Australia and Western Australia where methylamphetamine consumption decreased (see Table 4).

Table 4. Estimated methylamphetamine consumption per jurisdiction in Year 1 to Year 3 of the National Wastewater Drug Monitoring Program.

Jurisdiction	Estimated consumption (kilograms per annum)			% Change
	Year 1	Year 2	Year 3	Year 1 to Year 3
Australian Capital Territory	80.3	93.0	119.4	↑ 48.7
New South Wales	2,298.3	2,604.5	3,337.4	↑ 45.2
Northern Territory	65.5	75.5	84.8	↑ 29.5
Queensland	1,277.5	1,893.3	2,247.7	↑ 75.9
South Australia	1,005.3	1,159.5	943.2	↓ -6.2
Tasmania	92.0	127.1	177.1	↑ 92.5
Victoria	2,039.2	2,477.7	3,124.6	↑ 53.2
Western Australia	1,547.3	1,416.8	1,482.7	↓ -4.2
National	**8,405**	**9,847**	**11,516**	↑ 37.0

3 Heroin estimates for Year 1 are based on one collection period.

When comparing data from Year 1 and Year 3 of the program, cocaine consumption increased in all states and territories, most notably in Western Australia and Queensland (see Table 5).

Table 5. Estimated cocaine consumption per jurisdiction in Year 1 to Year 3 of the National Wastewater Drug Monitoring Program.

Jurisdiction	Estimated consumption (kilograms per annum)			% Change
	Year 1	Year 2	Year 3	Year 1 to Year 3
Australian Capital Territory	67.8	81.2	83.4	23.0
New South Wales	1,812.3	2,397.8	2,548.0	40.6
Northern Territory	19.0	27.4	22.8	20.0
Queensland	319.4	576.6	714.1	123.6
South Australia	107.1	129.2	173.1	61.6
Tasmania	10.9	15.5	16.6	52.3
Victoria	676.5	819.9	968.0	43.1
Western Australia	43.9	67.9	110.0	150.6
National	**3,057**	**4,115**	**4,636**	51.7

When comparing data from Year 1 and Year 3 of the program, MDMA consumption increased in most states and territories with the exception of the Northern Territory, where MDMA consumption decreased. The most notable increase occurred in Queensland (see Table 6).

Table 6. Estimated MDMA consumption per jurisdiction in Year 1 to Year 3 of the National Wastewater Drug Monitoring Program.

Jurisdiction	Estimated consumption (kilograms per annum)			% Change
	Year 1	Year 2	Year 3	Year 1 to Year 3
Australian Capital Territory	28.4	14.4	36.5	28.5
New South Wales	462.8	450.5	834.7	80.4
Northern Territory	37.8	24.1	32.4	-14.3
Queensland	216.5	223.2	502.4	132.1
South Australia	56.5	66.6	70.8	25.3
Tasmania	30.6	16.7	54.9	79.4
Victoria	319.6	291.3	511.9	60.2
Western Australia	99.0	74.9	182.4	84.2
National	**1,251**	**1,162**	**2,226**	77.9

When comparing data from Year 1 and Year 3 of the program, heroin consumption decreased in the Australian Capital Territory, South Australia and Tasmania. Heroin consumption remained stable in the Northern Territory, while other jurisdictions recorded an increase in consumption (see Table 7).

Table 7. Estimated heroin consumption per jurisdiction in Year 1 to Year 3 of the National Wastewater Drug Monitoring Program.

Jurisdiction	Estimated consumption (kilograms per annum)			% Change
	Year 1	Year 2	Year 3	Year 1 to Year 3
Australian Capital Territory	14.7	15.3	10.3	-29.9
New South Wales	264.6	222.2	307.0	16.0
Northern Territory	1.0	1.0	1.0	0.0
Queensland	65.5	66.2	66.4	1.4
South Australia	47.8	34.8	30.5	-36.2
Tasmania	3.3	4.5	2.8	-15.2
Victoria	402.1	359.4	469.7	16.8
Western Australia	31.1	46.8	53.8	73.0
National	**830**	**750**	**941**	13.4

The data demonstrates that domestic drug markets are complex and vary both between and within jurisdictions. Given that a relatively small proportion of the Australian population consumes illicit drugs, it is very important that data sets that purport to measure drug consumption cover a significant proportion of the population on a regular and ongoing basis and a variety of local drug markets. For this reason, it is also important that Australian drug data sets are constantly interpreted in a complementary manner.

VALUE OF DRUGS CONSUMED

Using national median price data for the relevant three consecutive financial years, Australians spent an estimated $8.6 billion on methylamphetamine, cocaine, MDMA and heroin in Year 1 of the program, $9.4 billion in Year 2 and $11.3 billion in Year 3. Of this, 76 per cent of this was spent on methylamphetamine in Year 3 (see Table 8).

Table 8. Estimated street value of annual methylamphetamine, cocaine, MDMA and heroin consumption for Year 1 to 3 of the National Wastewater Drug Monitoring Program.

Drug	Estimated street value			% Change
	Year 1 (A$)	Year 2 (A$)	Year 3 (A$)	Year 1 to Year 3
Methylamphetamine	7.24 billion	7.38 billion	8.63 billion	19.2
Cocaine	1.06 billion	1.54 billion	2.08 billion	96.2
MDMA	145.59 million	114.19 million	211.08 million	45.0
Heroin	207.50 million	375.00 million	423.45 million	104.1
Total	**8.6 billion**	**9.4 billion**	**11.3 billion**	31.4

RESULTS FROM THE COLLECTION

It is evident that a multi-dimensional approach that targets supply, demand and harm reduction is critical to addressing drug use in Australia. Drug consumption estimates derived from wastewater data, when used in combination with other data—such as seizure, arrest, price, purity, health and availability data—provide insight into related markets and the potential impact of supply, demand and harm reduction strategies.

Wastewater data are an important part of the suite of datasets available to increase our understanding of drug consumption, demand and supply in Australia. Making data from the program publicly available assists to enrich understanding and inform the national conversation on drug trends and related demand. This ninth report of the National Wastewater Drug Monitoring Program builds on national drug consumption data contained in the preceding eight reports to identify drug use temporal trends across states, territories and the nation. It provides data on capital city and regional drug use and, where possible, comparisons with previous levels of use in sites across Australia and internationally. This, and future reports, continue to build and shape understanding on trends and changes in patterns of use, creating an increasingly detailed picture of drug consumption in Australia.

RESEARCH FINDINGS

Prepared by the University of Queensland (B Tscharke, J O'Brien, T Reeks, G Elisei, J Lin, S Grant, J Mueller, K Thomas) and University of South Australia (M Ghetia, R Bade, L Nguyen, C Gerber, J White)

LIST OF ABBREVIATIONS:

ABS	Australian Bureau of Statistics
ACIC	Australian Criminal Intelligence Commission
ACT	Australian Capital Territory
DASSA	Drug and Alcohol Services South Australia
LC-MS/MS	Liquid chromatography tandem mass spectrometry
LOD	Limit of detection
LOQ	Limit of quantification
MDA	3,4-methylenedioxyamphetamine
MDMA	3,4-methylenedioxymethylamphetamine
NPS	New psychoactive substances
NSW	New South Wales
NT	Northern Territory
NWDMP	National Wastewater Drug Monitoring Program
Qld	Queensland
SA	South Australia
SPE	Solid phase extraction
Tas	Tasmania
THC	Tetrahydrocannabinol
THC-COOH	11-nor-9-carboxy-tetrahydrocannabinol (THC-COOH), metabolite of THC
Vic	Victoria
WA	Western Australia
WWTP	Wastewater treatment plant

TERMINOLOGY:

Methylamphetamine is also commonly known as methamphetamine. In this report, consistent with the preferences of the Australian Criminal Intelligence Commission, methylamphetamine is used.

MDMA is commonly known as ecstasy.

Alcohol consumption in this report refers to ethanol consumption, but the more general term ‘alcohol’ is used throughout.

Nicotine consumption has replaced tobacco consumption in this report as the target metabolites may also be derived from nicotine replacement products, such as gums and patches.

THC and THC-COOH: Tetrahydrocannabinol is the main psychoactive compound in cannabis and is referred to as THC throughout this report. Cannabis consumption levels have been calculated from the THC metabolite, 11-Nor-9-carboxy-Δ9-tetrahydrocannabinol (THC-COOH).

1: EXECUTIVE SUMMARY

The National Wastewater Drug Monitoring Program (NWDMP) for the Australian Criminal Intelligence Commission (ACIC) monitors selected substances of concern in most populated regions of Australia. Estimates of drug usage in a population were back-calculated from measured concentrations of drug metabolites (excreted into the sewer system after consumption) in wastewater samples. The current version of the NWDMP focuses on thirteen licit and illicit drugs, including nicotine, alcohol, methylamphetamine, cocaine and MDMA (ecstasy), with cannabis included from Report 6. Trends in estimated drug consumption are being established over the life of the program. Wastewater treatment plants (WWTPs) located across capital cities and regional Australia, covering all states and territories, have been invited to participate in this program.

For this ninth report, wastewater samples were collected during weeks of June and August 2019. Twenty-four-hour composite influent wastewater samples were collected using time or flow-proportional autosamplers at each WWTP by plant operators. Samples were collected for up to seven consecutive days. Concentrations of drug metabolites were determined in the wastewater using liquid chromatography-tandem mass spectrometric (LC-MS/MS) analytical methods. Drug consumption estimates for each catchment population were calculated from these measured concentrations using flow volumes and estimates of the catchment population size by evaluating census data vs. catchment maps, together with excretion and dose data obtained from the scientific literature.

A total of 22 WWTPs in capital cities and a further 36 regional sites participated in the program for the August 2019 period, covering a population of 13.3 million Australians.

To maintain treatment plant confidentiality, each site was allocated a unique code and site names are not included in this report. Site codes stay assigned to each WWTP throughout the course of the program. Data from this report equates to coverage of approximately 48 per cent and 57 per cent of Australia's population for June and August, respectively. A total of 4,285 individual daily samples have been collected and analysed since the beginning of the program, with new results from 525 additional samples added in this report. The collected samples provide comprehensive, Australia-wide baseline data against which subsequent results can continue to be compared to ascertain both spatial and temporal trends.

The estimation of drug use across the 58 sites provided a snapshot of the scale of use over a week in August 2019, which was compared with historical data included in previous reports. After normalising the amount of drug measured in wastewater for population size and average dose consumed, alcohol and nicotine remained consistently the highest consumed drugs in all states and territories. Cannabis will be included in the comparison once better estimates of a typical dose are available. The consumption of nicotine was substantially higher in regional areas compared to capital cities whereas, in the case of alcohol, there was a relatively small difference between regional and capital city use. The Northern Territory was among the highest consumers of nicotine and alcohol, followed by Tasmania. Locations in regional Queensland, New South Wales and Victoria were also among the highest. In other parts of Australia, alcohol consumption was similar for the most part, except in locations in regional South Australia, Victoria and Queensland, where it remained relatively low.

In terms of mass load of consumed drug, cannabis was the most used illicit substance. When expressed as doses per day, methylamphetamine had the highest doses of the illicit stimulants included in the report, both in capital cities and regional sites. The trend over the three-year interval of the program shows a rise in almost every part of the country, apart from South Australia. Historically, South Australia regularly had the highest amounts in the country. However, June and August 2019 use in the capital city of the state was at similar levels to many other parts of the country, while regional use in South Australia was towards the lower part of the national scale. Regional dose levels were on average higher than in the capital cities. In general, August values were below June in most regions of Australia.

Amphetamine is a metabolite of methylamphetamine. Measured amphetamine concentrations across the sites were mostly consistent with the observed levels being related to methylamphetamine metabolism rather than a consequence of direct amphetamine consumption.

Compared to methylamphetamine, estimated usage of other stimulants was generally much lower. Cocaine consumption in Australia remains mostly centred in New South Wales, particularly the capital city catchments. Although the use of the drug in the current reporting period was down in many parts of the country, the overall trend over the three-year length of the program shows increases almost everywhere. Consumption of cocaine was lowest in regional South Australia, Tasmania and Western Australia. Regional use of the drug was generally less than in capital cities. MDMA usage was relatively low across most sites, but the rise at many sites nationwide in the early part of 2019 was again apparent in this reporting period, with capital city Northern Territory and Tasmania being the highest users. MDA use was relatively low, with no consistent pattern being evident.

Oxycodone and fentanyl, both of which are prescription pharmaceutical drugs with abuse potential, had elevated consumption levels at several sites, noticeably across Tasmania and regional parts of the country. Western Australia was the exception, with relatively low oxycodone consumption across the state. Regional areas had average oxycodone use well above capital city. Over the course of the program, oxycodone consumption increased in most regional areas, while no consistent trends were evident in capital cities. Fentanyl use was also more prevalent in regional parts of the country, but not to the extent of oxycodone. Fentanyl consumption declined in most regions in this sampling period. Consumption of the drug appeared to peak in late 2018. Consumption of heroin varied widely, with minimal amounts detected in the Northern Territory and many regional areas of other states. The highest levels were recorded in capital city sites in Victoria, although capital city New South Wales showed an increase consumption rate since the program began measuring heroin in August 2017.

The cannabis metabolite, 11-nor-9-carboxy-tetrahydrocannabinol (THC-COOH), a specific marker for cannabis consumption, is excreted in extremely small amounts. This may be a cause of variability in back-calculated results, so caution has to be exercised when making comparisons. Nevertheless, cannabis consumption in Tasmania, regional South Australia and the Northern Territory were highest in the nation. Use was relatively low in capital city New South Wales and Victoria compared to other parts of the country. A feature of national cannabis consumption was the elevated regional average compared to capital cities. No obvious temporal trends were apparent over the relative short period of cannabis reporting.

For the other drugs included in the NWDMP, methylone and mephedrone concentrations were generally at or below detection levels at most participating sites. The detection frequency of mephedrone has been on the rise.

2: INTRODUCTION

2.1 PREAMBLE

Wastewater analysis is a technique for delivering population-scale consumption of substances. The University of Queensland and University of South Australia have been commissioned to provide drug consumption data to the ACIC, for an initial three-year program from 2016 to 2019, including nine public reports. The two universities have been re-commissioned to provide data for a further four years from 2019 to 2023, commencing with the tenth public report to be released in 2020. Wastewater treatment sites have been assessed, bimonthly in the case of capital city sites and every four months for regional sites. The aim has been to acquire data on the population-scale use of substances that cause potential harm, either through addiction, health risks, or criminal and anti-social behaviour. The intention is to establish baseline data of substance use across Australia. This NWDMP report compares consumption data from the first eight reports with results obtained subsequently from June and August 2019.

Compounds of concern include nicotine from nicotine intake (cigarettes, gum, patches, e-cigarettes, etc.), ethanol from alcohol intake, pharmaceutical opioids with abuse potential, illicit substances such as methylamphetamine, MDMA, cocaine and heroin, as well as a number of new psychoactive substances (NPS). Initially, amphetamine and MDA were measured but not included in the earlier reports. Amphetamine is a by-product of methylamphetamine pyrolysis and is also one of its metabolites. Amphetamine can also be used as an illicit drug. However we found the levels of amphetamine corresponded largely with the expected values from the excretion of methylamphetamine. Similarly, MDA is a metabolite of MDMA but can also be used as an illicit drug. However, since the proportion of MDA derived from MDMA is known, the difference between measured MDA and MDMA metabolite is included in the report. The amount of MDA was calculated by subtracting 1.65 mg of MDA for every 100 mg of MDMA consumed (Pizarro et al. 2002; Khan & Nicell 2011) and is expressed in units of mg excreted per day per 1,000 people. Cannabis was measured by its urinary metabolite, THC-COOH. The report presents patterns of substance use across Australia, showing differences in levels between capital cities and regional centres, within and between states and territories, and nationally. Cannabis results are expressed only as mg consumed per day per 1,000 people and will also be expressed as dose per day per 1,000 people when better estimates of a typical dose become available.

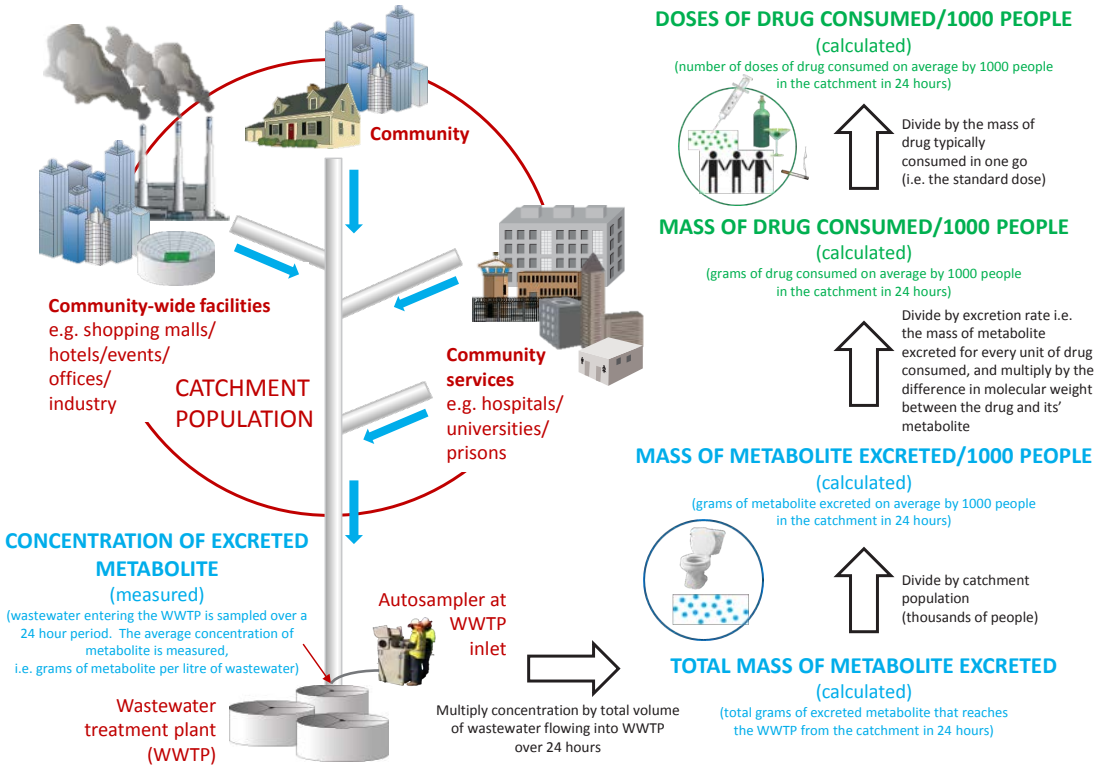
3: METHODS

The method underlying wastewater-based monitoring of drug use in a given population is based on the principle that any given compound that is consumed (irrespective of whether it is swallowed, inhaled/smoked or injected) will subsequently be excreted. This may be either in the chemical form it was consumed and/or in a chemically modified form that is referred to as a metabolite. The excreted compound or metabolite will eventually arrive in the sewer system. The drugs and their metabolites of interest in this study are given in the first NWDMP report (available at www.acic.gov.au), as well as an in-depth description of the methodologies involved.[4]

4 Information in relation to heroin appears in Report 3.

Collectively, waste products in the sewer system arrive at a WWTP where wastewater samples are collected over a defined sampling period. Measuring the amount of a target compound in the wastewater stream allows for a back-calculation factor to be applied to determine the amount of drug that was used over the collection period (Figure 1). The method is non-invasive and is done on a population-scale level, so individuals are not targeted, and privacy is respected.

Figure 1: Schematic of the population catchment area and methodology employed to convert measured concentration of substances in wastewater to mass loads or doses consumed per day per normalised population.



To obtain an estimate of drug use, representative samples are collected over a given period (typically 24 hours) using autosamplers that collect time or flow proportional samples. Wastewater treatment plant operators aid with collecting the samples from the influent autosampler (where the wastewater enters the treatment plants). Details of the calculation methods are given in Report 1. From the August 2018 collection period, operators collected a second daily influent sample with sodium metabisulphite (0.5% m/v) as preservative to allow for the detection of the cannabis metabolite.

Collected wastewater samples were analysed at the University of South Australia and the University of Queensland laboratories. The steps routinely performed in our laboratories are based on filtration of the samples followed by an enrichment/concentration step where the concentrated sample is injected, or (for chemicals with sufficiently high concentrations)

direct injection of samples into the analytical instruments. The instrumental analysis consists of chromatographic separation and subsequent compound specific detection. A summary of the extraction and analytical methods is given in Report 1. An updated excretion table including THC-COOH and dose can be found in Appendix 1. Methods to extract and analyse the cannabis metabolite are outlined in Tscharke et al. (2016).

3.1 PARTICIPATING WASTEWATER TREATMENT PLANTS (WWTPs)

Fifty-eight WWTPs across Australia participated in the NWDMP for the August 2019 collection period (Figure 2). Of these, 22 sites were located in capital cities and a further 36 were regional sites, covering a wide range of catchment population sizes. Sites were selected by the Australian Criminal Intelligence Commission. The number of participating sites for June and August 2019 and a complete list of participating sites, number of samples and relative catchment sizes are listed in Table 9 and Appendix 2. To maintain the confidentiality of the participating sites, all sites were allocated a unique code to de-identify their results. Only site codes are presented in the results sections.

Figure 2: Participating WWTPs in August 2019 showing the number of capital city and regional plants by state and territory. The colours in this figure are matched with others in the remainder of the report to identify results relating to individual states and territories.

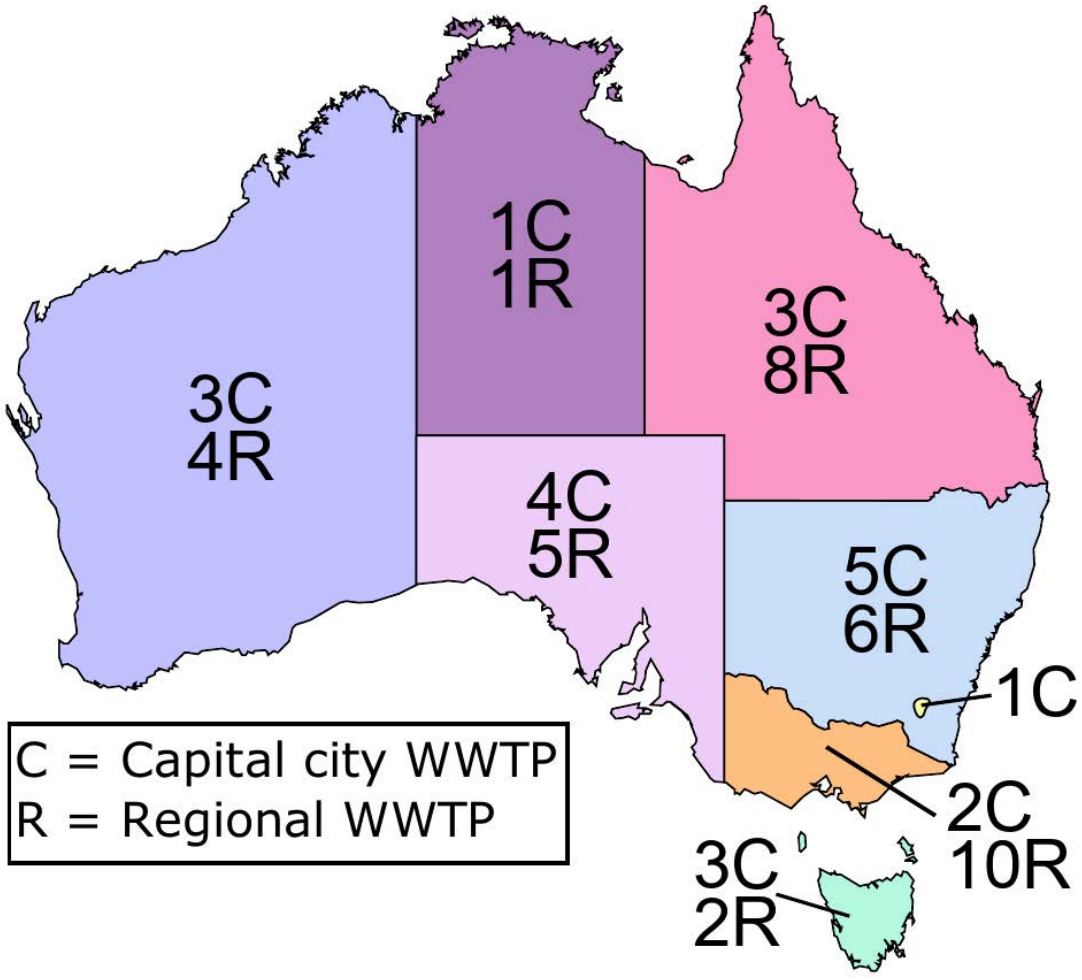


Table 9: Number of participating WWTPs for the periods covered in this report. Every second collection period aims to collect data from both regional (R) and capital city (C) sites, while the in-between collection period aims to collect data from capital city sites only.

	Jun–19		Aug–19	
State/territory	**C**	**R**	**C**	**R**
ACT	1	–	1	0
NSW	3	–	5	6
NT	1	–	1	1
Qld	3	–	3	8
SA	4	–	4	5
Tas	3	–	3	2
Vic	2	–	2	10
WA	3	–	3	4
Sites	**20**	**–**	**22**	**36**
Population (millions) C & R	**11.2**	–	**11.5**	**1.8**
% of Australian Population	**47.9**	–	**49.1**	**7.5**
Total population (millions)	**11.2**		**13.3**	
% of Australian population	**47.9**		**56.6**	

Estimates have been rounded to the nearest 0.1 million. Census 2016 population used (23,401,892) for population percentage estimates.

3.2 SAMPLE COLLECTION AND PREPARATION

Daily composite samples were collected by treatment plant staff on seven consecutive days, or where seven days was not feasible, across as many consecutive days as possible. Regional sites in South Australia have only been providing weekend samples since April 2018, which should be considered when interpreting historical results where number of sampling days was five—see Appendix 3, Report 6. Furthermore, small revisions may be made to historical data when more accurate data become available, for example, flow measurements supplied by wastewater treatment authorities. Samples were stored at 4°C or were frozen prior to transport to South Australia or Queensland. Further details of the sampling protocol and relevant quality controls are included in Irvine et al. (2011), Lai et al. (2011), Lai et al. (2015), Tscharke et al. (2016) and Bade et al. (2019). All other descriptions of calculations, extractions and analytical methods are outlined in Report 1 (available at www.acic.gov.au). Methods to detect and analyse THC-COOH are outlined in Tscharke et al. (2016).

3.3 PRESENTATION OF DATA AND INTERPRETATION OF GRAPHS

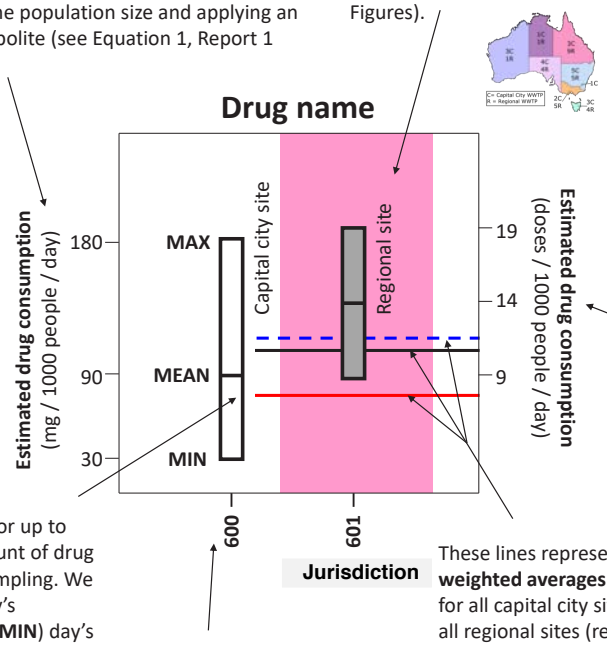
Reported averages: All averages for state/territory or Australia-wide drug consumption data are presented throughout this report as population weighted averages. The number of people in the catchment population is used as the weighting for the respective drug consumption data for that population. For example, to calculate the population weighted average of capital city methylamphetamine consumption, the methylamphetamine consumption data for each WWTP was multiplied by the respective population number, all data were then summed and divided by the total population across all capital city sites.

Reported average values are therefore not skewed towards usage data from small, non-representative populations.

Per capita consumption: The per capita consumption estimates presented in this report are calculated using the total estimated catchment population (which includes children). For example, per capita alcohol consumption has previously been reported by the Australian Bureau of Statistics (ABS) based on population numbers for people aged 15 and over. The consumption values presented in the current report will be under-estimated compared to those determined for an adult-only population. For consistency, data from other studies included in this report were recalculated where necessary using estimated total population.

Graphical presentation of data: An overview of how the data is presented in the graphs for the individual sites is given in Figure 3. This includes information on interpreting the consumption data presented on the vertical axes in all graphs in this report. In some graphs, the values plotted in the graph can be read as either mass of drug consumed (left axis) or doses of drug consumed (right axis). For the specific case of MDA, the amount of MDA excreted following MDA consumption is not known, and therefore this drug can only be expressed as how much drug was excreted into the sewer network, e.g. the mg excreted per 1,000 people per day. For cannabis, the approximate dosage is not well defined, and results are expressed as mg consumed per 1,000 people per day.

Figure 3: Explanation of the graphical representation of data for individual sites and bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).



The **left hand axis** shows the estimated total mass consumed (in milligrams, mg) of a drug which is calculated by measuring the concentration of the drug's metabolite in a 24 hour wastewater composite sample, multiplying by the flow volume in the 24 hours, dividing by the population size and applying an excretion factor for the metabolite (see Equation 1, Report 1 for details).

To convert the mass consumed (left axis) to the estimated doses consumed (right axis), we divide the estimated mass consumed by the standard dose amount. Dose amount and excretion factors are given in Appendix 1. In this example, at Site 600, the minimum consumption was 30 mg in one day, the maximum was 180 mg and average was 90 mg per day over the sampling period (for every 1,000 people).

We collect wastewater data for up to 7 days and estimate the amount of drug consumed for each day of sampling. We plot the maximum (**MAX**) day's consumption, the minimum (**MIN**) day's consumption and the average (**MEAN**) across the 7 days. If the box is long, there is a large difference in consumption patterns over the week; for example, if drugs are used excessively at weekends but not often during the week. Alternatively, a short box suggests a similar drug usage every day of the week. See also main text.

Colours help identify the State or Territory that the data relates to (colours are consistent between Figures).

Unique number allocated to each WWTP to maintain confidentiality. WWTP names will not be disclosed publicly.

The **right hand axis** shows the estimated number of doses of a drug consumed by 1,000 people in the catchment in a 24 hour period; e.g., one dose would be 1 cigarette, 1 standard drink or 1 injected amount of drug. In this example, at Site 601, the minimum consumption was 9 doses in one day, the maximum was 19 and average was 14 per day over the sampling period (for every 1,000 people).

These lines represent the **population weighted averages** for drug consumption for all capital city sites (blue dotted line), all regional sites (red line) and for all sites combined (black line). The method to calculate weighted population averages is given in the main text. In this example, the average consumption for regional Site 601 (horizontal bar within grey box) is above both the average for regional sites and all sites nationally. In contrast, the average consumption for capital city Site 600 is below the national average.

Figure 3 (continued): Explanation of the graphical representation of data for individual sites and bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).

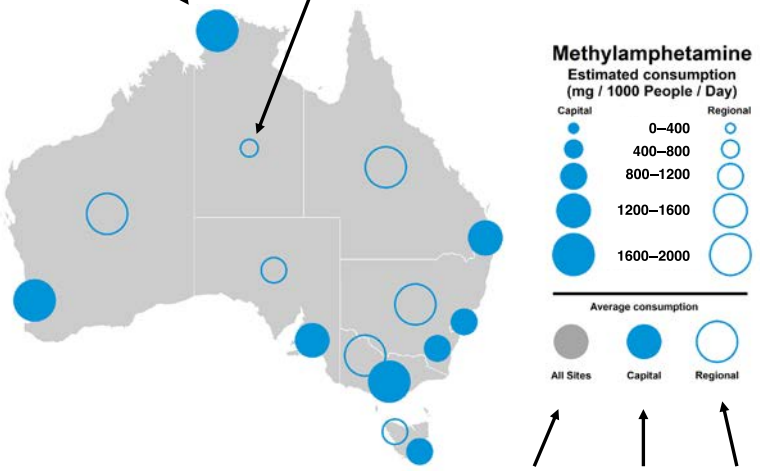
Bubbles:
Capital city site averages are drawn over the capital city of a jurisdiction and the regional site averages are drawn close to the middle of the State or Territory. Regional bubbles are drawn arbitrarily close to the centre of each jurisdiction and do not reflect location of sites.

This type of plot gives a rough overview of drug consumption per jurisdiction. The other temporal and spatial comparison graphs give greater resolution to compare between locations and over time, and should be used for analysis.

Capital city average:
Population-weighted average of all capital sites tested per jurisdiction. Capital sites are indicated by a filled circle.

Regional city average:
Population-weighted average of all regional sites tested per jurisdiction. Regional sites are indicated by a circle without fill.

Legend:
The population-weighted average drug consumption for each jurisdiction is represented as a scaled circle. Representative consumption estimates are shown next to the bubble plot.



Aggregated data:
The population-weighted average drug consumption is also shown as a point of comparison for all sites, all capital, and regional sites that were tested within the timepoint. This incorporates sites from **all jurisdictions** for the timepoint under investigation. These are also represented with sizes representing the scale of use categories used for the jurisdictional averages.

Instrumental method limits of detection and limits of quantification: Since the wastewater samples contain very low quantities of particular drugs, the limit of detection (LOD) was determined analytically as the lowest concentration of that drug that could be determined in the sample (using the methods described in Report 1). A drug may be present at a concentration below the LOD. However, trace quantities may be present at undetectable levels. The limit of quantification (LOQ)[5] is a concentration (higher than the LOD), above which we have high confidence that the concentration measured on the analytical instrument is accurate. Above the LOD but below the LOQ there may be some uncertainty as to the actual concentration. To be conservative (a drug may be present but there is uncertainty as to its concentration) and in line with current practice, for back calculations to estimate per capita consumption, a concentration below the LOD was included as a value of LOD/√2. A concentration above the LOD but below LOQ, is included at the midpoint between the LOD and LOQ (i.e. (LOD + LOQ)/2). The frequency of detection of each analyte of interest is included in Appendix 3.

Weekly pattern of drug use: The pattern of drug use over the sampling week for the sites in this report cannot be elucidated from the data included in the current report. This is because the starting day of the collection week did not always correspond for every plant. We present only maximum, minimum and average (for the individual sites) (e.g. Figure 3) and only population-weighted average values for all other graphs. Consistent patterns of drug use in Australia from previous wastewater-based epidemiology studies indicate that some illicit drugs such as cocaine, MDMA, mephedrone and methylone have high variation in weekly consumption rates, with higher consumption on weekends. Other drugs such as methylamphetamine, oxycodone and fentanyl tend to have lower daily variation suggesting that their consumption is consistent throughout the week (Lai et al. 2015, Tscharke et al. 2016).

5 LOQ is the lowest level that can be accurately measured.

4: RESULTS

Estimated drug consumption data are presented in several different ways in the following sections to allow comparisons of drug use at the individual site level for August 2019 (section 4.1), temporal trends for states and territories since August 2016 (section 4.2) and within each state and territory (section 4.3). We recommend exercising caution when comparing results between sites as some plants provided samples for fewer days than others and the collection week did not correspond in all instances. A list of the detection frequency for each drug can be found in Appendix 3. This report retained the current population estimates introduced in Report 4 by integrating the specific wastewater catchment areas against the high-resolution population data released from the 2016 Census. The uncertainties in individual population estimates have less impact when data are averaged, for example when broader comparisons at the state/territory or international level are undertaken. The uncertainties in population numbers may be particularly evident in smaller regional communities or sites where short-term population changes occur due to employment opportunities, tourism or festival events.

4.1 INDIVIDUAL SITE COMPARISON OF DRUG USE IN AUGUST 2019

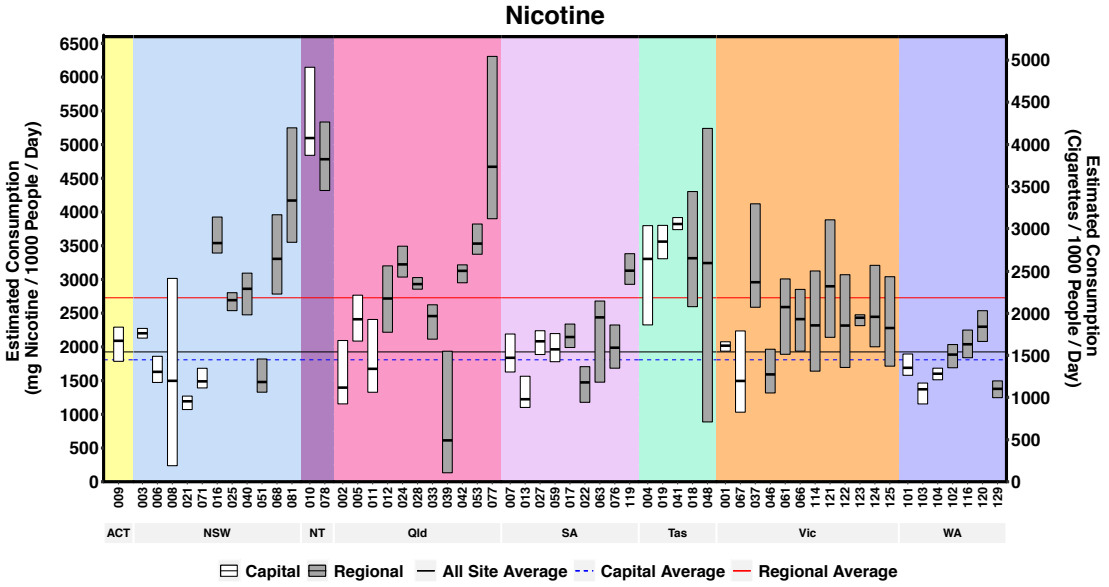
4.1.1 NICOTINE AND ALCOHOL

Two nicotine metabolites were used to estimate the consumption of tobacco. The method cannot distinguish between nicotine intake from tobacco, electronic cigarettes and nicotine replacement therapies such as patches and gums. Therefore, the estimate is expressed as nicotine in this report. The results show that in August 2019 the consumption of nicotine was highly variable between sites across the country (Figure 4). The regional average was well above that of the capital cities (red horizontal and dotted blue lines, respectively). The Northern Territory had the highest overall mean as well as sites in regional New South Wales and Queensland, while sites in capital city Tasmania and regional Tasmania were well above the national average.

Alcohol was measured using a specific metabolite of ethanol. The difference between the average consumption of alcohol in regional and capital city sites was much less compared to nicotine (Figure 5). No discernible pattern was evident in terms of use between states and territories, except in the case of Tasmania and Northern Territory, where sites generally had consumption rates above the national average, whereas use at South Australian regional sites was generally below the national mean. Some regional sites in Western Australia, Victoria, Queensland and New South Wales also had levels lower than the national average. Differences in use between days of the week was generally wide and in agreement with other wastewater studies, both in Australia and internationally, which have shown higher consumption of alcohol over weekend periods. The Northern Territory had some of the largest differences between weekday and weekend samples, as indicated by the large range in consumption estimates (Figure 5).

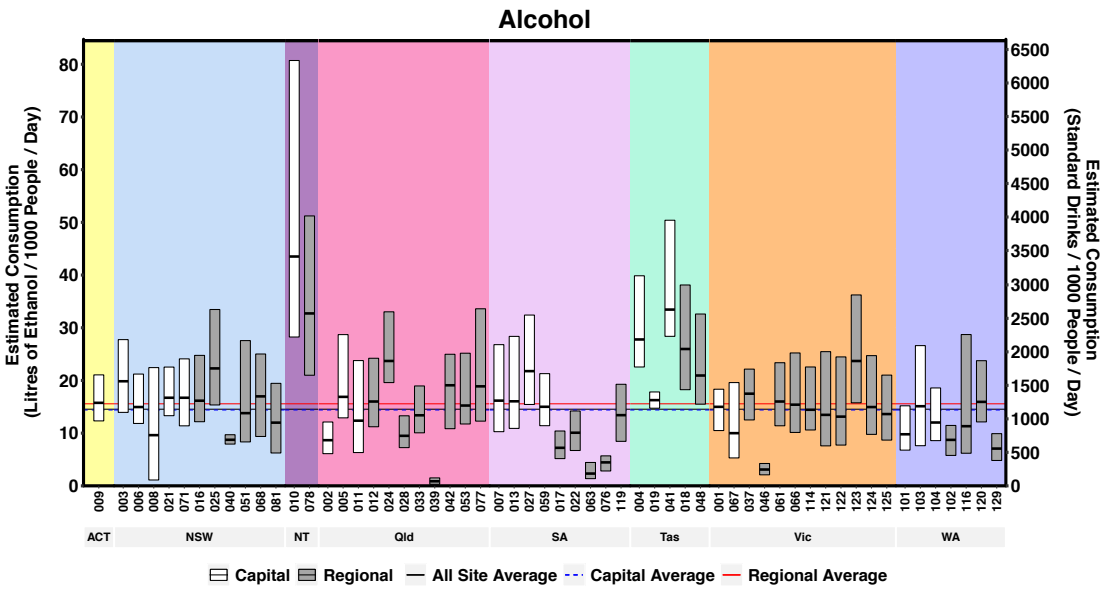
The relative consumption levels can be represented in a pictorial way by showing the relative scale of use of nicotine (Figure 6) and alcohol (Figure 7) as capital city or regional ‘bubbles’ for each state and territory.

Figure 4: Estimated nicotine consumption for August 2019 in mass of nicotine consumed per day (left axis) and number of cigarettes per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Variable across Australia
- High regional average

Figure 5: Estimated alcohol consumption for August 2019 in volume consumed per day (left axis) and standard drinks per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Wide weekly spread in the NT
- Regional average slightly higher

Figure 6: Estimated average nicotine consumption per jurisdiction for August 2019 in number of cigarettes per day per thousand people. The number of collection days varied from 5-7.

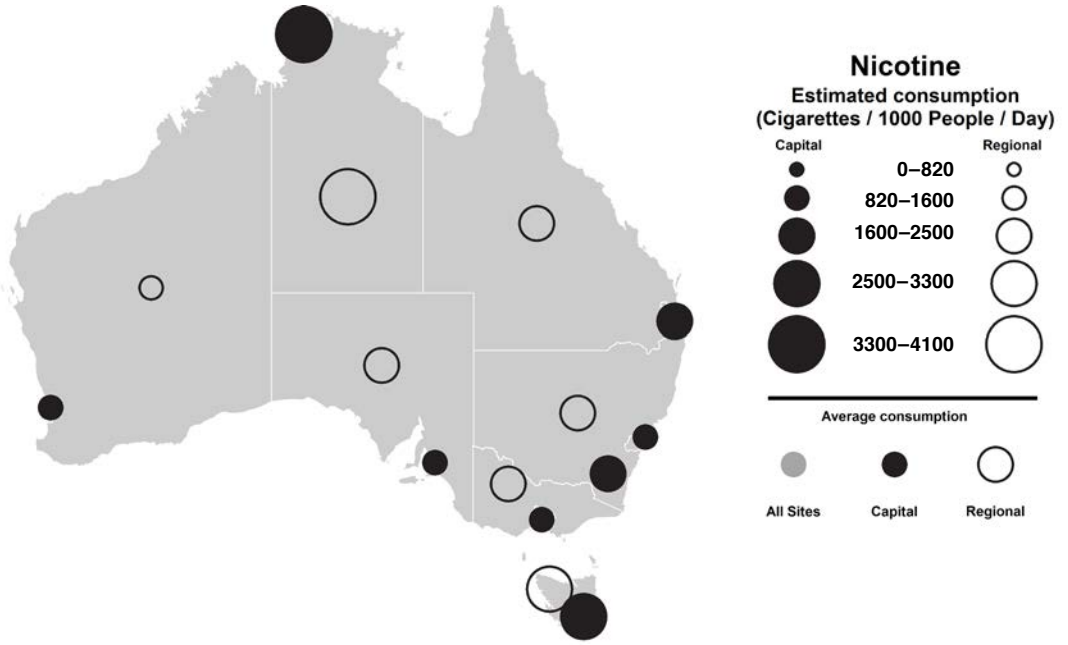
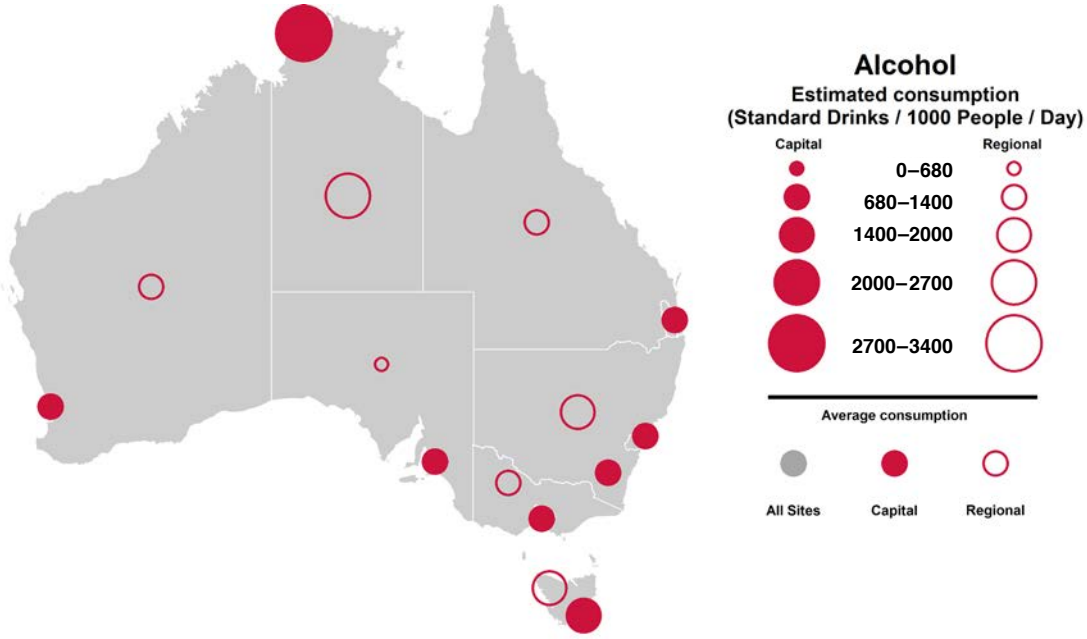


Figure 7: Estimated average alcohol consumption per jurisdiction for August 2019 in number of standard drinks per day per thousand people. The number of collection days varied from 5-7.



4.1.2 STIMULANTS

The relative estimated consumption levels across the participating sites for four stimulants—methylamphetamine, cocaine, MDMA and MDA—are described in more detail below.

4.1.2.1 METHYLAMPHETAMINE

The average regional use of methylamphetamine remained well above that of capital city sites (Figure 8). Site 77 in Queensland, Site 66 in Victoria, sites 25 and 81 in New South Wales, as well as sites 102 and 116 in Western Australia had among the highest mean weekly use of methylamphetamine in regional areas. Mean consumption estimates at sites 27 and 59 in South Australia and Site 3 in New South Wales were among the highest of the capital cities. South Australia historically had high values across the board. However, in this reporting period, use in two of the city sites and all of the regional sites were generally similar with other capital and regional cities, with regional use similar to the national regional average. Sites 25, 77, 48 and 66 had larger differences in consumption between days of the week.

4.1.2.2 AMPHETAMINE

The measured concentration of amphetamine in the August 2019 samples mostly fell within a range which is consistent with the reported excretion rates following methylamphetamine consumption (Gracia-Lor et al. 2016). The results were in agreement with our previous findings (see Appendix 4 of Report 1). Therefore, we assumed that the levels of amphetamine in wastewater samples were predominantly due to the metabolite of methylamphetamine. It is possible that some of the measured amphetamine could be the result of ingestion of the drug, but the high levels of methylamphetamine means a firm conclusion is not possible.

4.1.2.3 COCAINE

Benzoylecgonine, the specific metabolite of cocaine, was used to estimate the consumption of the stimulant. In contrast to methylamphetamine, capital city areas on average had higher cocaine use than regional centres (Figure 9). New South Wales tended to have higher consumption than other regions, although some sites in Queensland, the Northern Territory and the Australian Capital Territory had relatively high use as well. Cocaine consumption was generally low in most other parts of Australia. Consumption of cocaine in Tasmania and Western Australia and some regional Queensland sites were very low in comparison. Tasmanian regional sites were not able to provide weekend samples. As a larger proportion of cocaine may be consumed on weekends, these results may be under-representing consumption there.

4.1.2.4 MDMA (3,4-METHYLENEDIOXYMETHYLAMPHETAMINE)

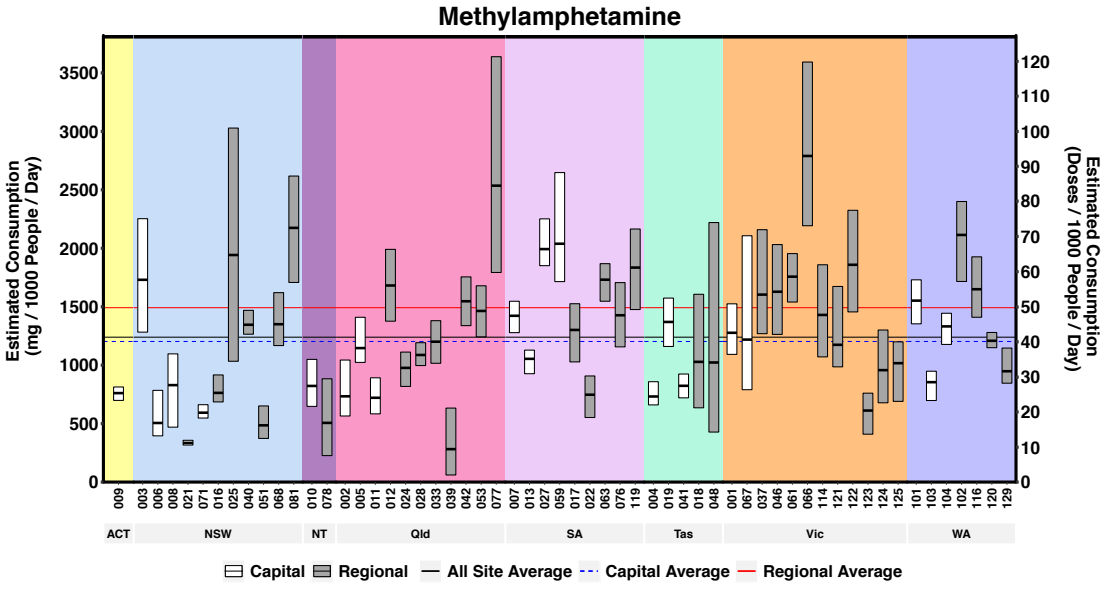
The average consumption of MDMA was lower in capital city than regional catchments (Figure 10). The large spread in values over the sampling week was consistent with the weekend use of the drug. The mean doses consumed per day were relatively low for most sites, partly accounting for the apparent variability of the data across catchments. Sites in the Northern Territory, Queensland, Tasmania and Western Australia had higher consumption estimates compared to the national averages. A direct comparison of regional and capital city sites in some regions (e.g. Tasmania) may be inappropriate as a few regional sites did not sample on weekends when MDMA consumption is typically higher. See Appendix 2 for a list of the number of samples collected per site.

4.1.2.5 MDA (3,4-METHYLENEDIOXYAMPHETAMINE)

MDA is both a drug in its own right and a metabolite of MDMA. Since the proportion of MDA eliminated after MDMA consumption is known, this proportion of MDA attributable to MDMA metabolism was subtracted from the total measured amount of MDA for each site. Results for MDA were expressed as mg excreted per 1,000 people per day (daily mass load) and not as consumption due to the lack of metabolic information of MDA elimination following MDA consumption. The daily mass loads for regional sites were on average slightly higher than capital cities. Large variations were evident over the collection week, particularly at a few sites in Tasmania, South Australia and New South Wales (Figure 11). Western Australia, Victoria and most of South Australia appeared to be the lowest consumers of MDA.

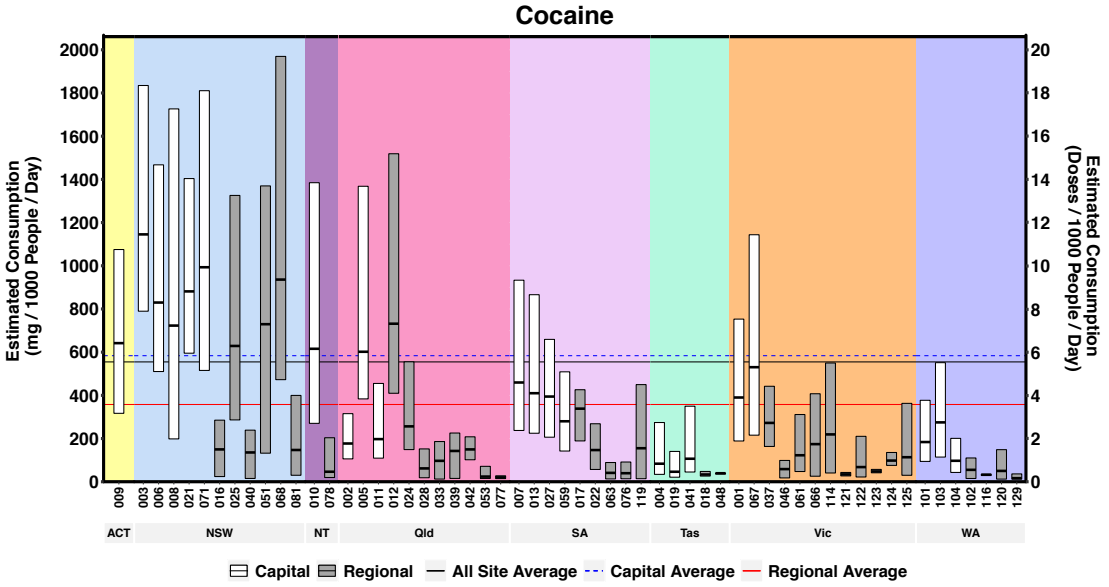
The scale of use of each stimulant is expressed as a bubble graph to compare regional and capital city use of methamphetamine (Figure 12), cocaine (Figure 13), MDMA (Figure 14) and MDA (Figure 15) across the country. The popularity of cocaine on the south-eastern seaboard remains apparent, with use in the Australian Capital Territory and Northern Territory capital sites at similar levels.

Figure 8: Estimated methylamphetamine consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



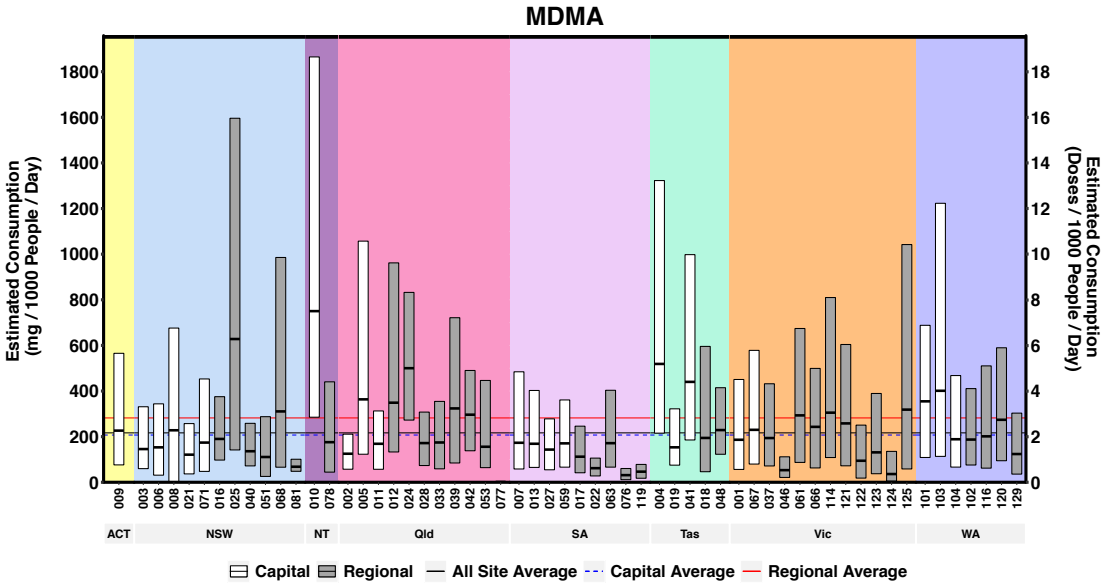
- Variable across Australia
- Higher regional consumption

Figure 9: Estimated cocaine consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



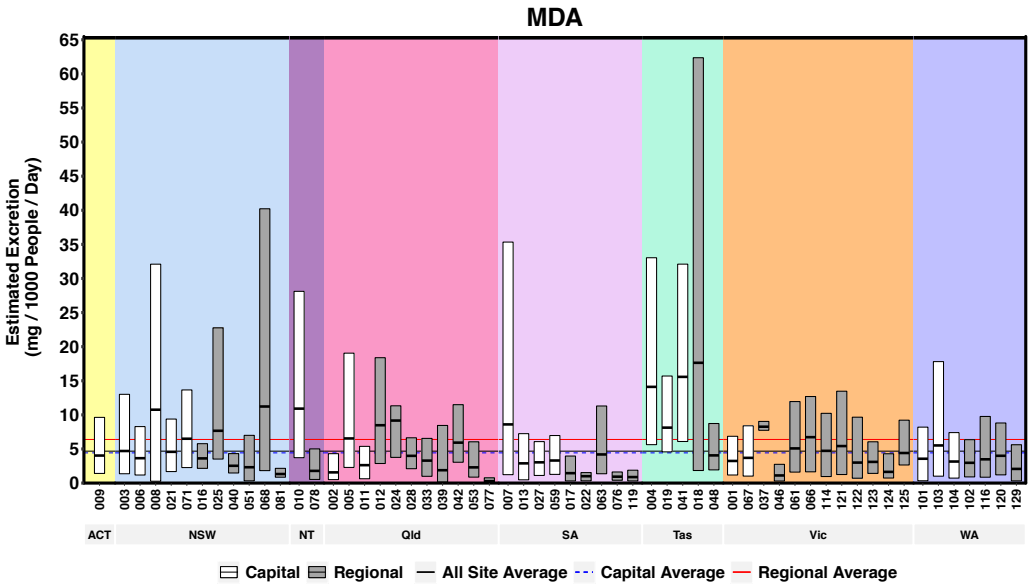
- Variable across Australia
- Higher regional consumption

Figure 10: Estimated MDMA consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Wide weekly spread indicates higher weekend consumption
- Some exceptions, but low consumption rates nationally

Figure 11: Estimated MDA excretion for August 2019 in mass excreted per day per thousand people. The number of collection days varied from 5-7.



- Wide weekly spread for some sites
- Regional averages slightly higher, similar to MDMA use

Figure 12: Estimated average methylamphetamine consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

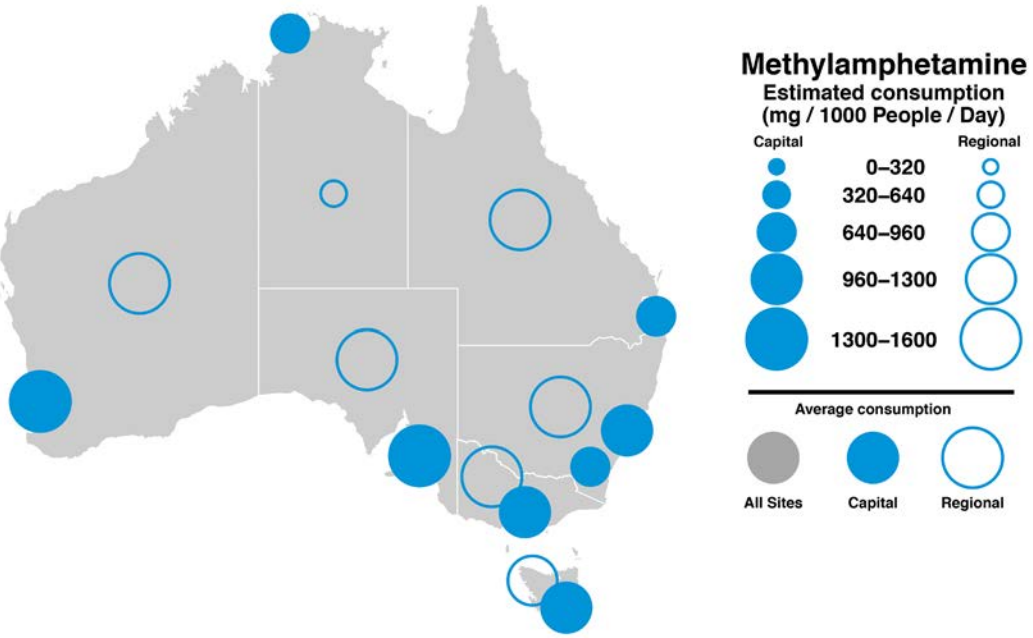


Figure 13: Estimated average cocaine consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

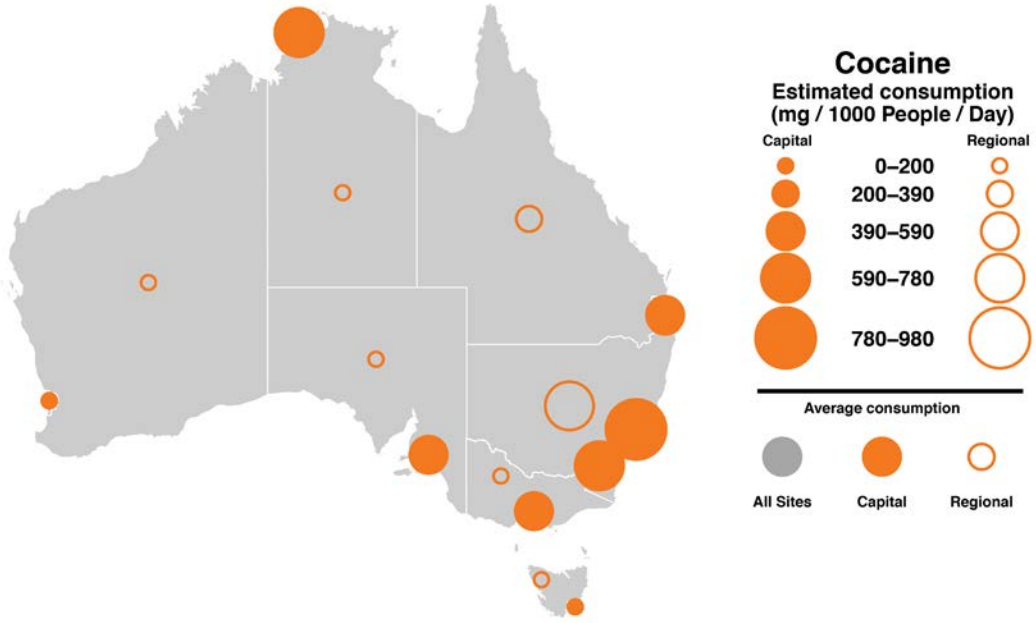


Figure 14: Estimated average MDMA consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

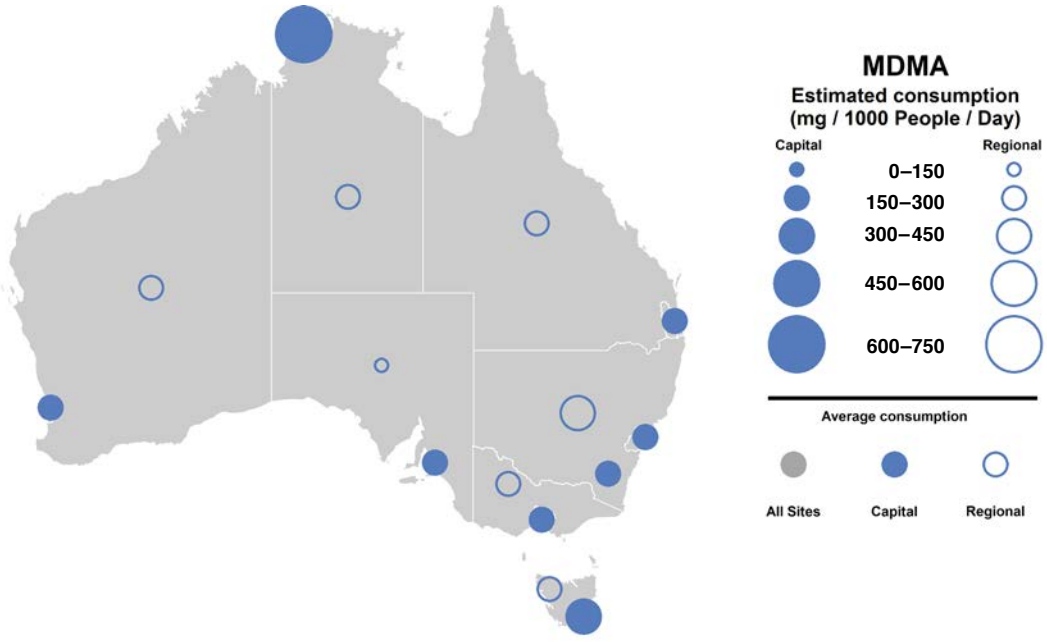
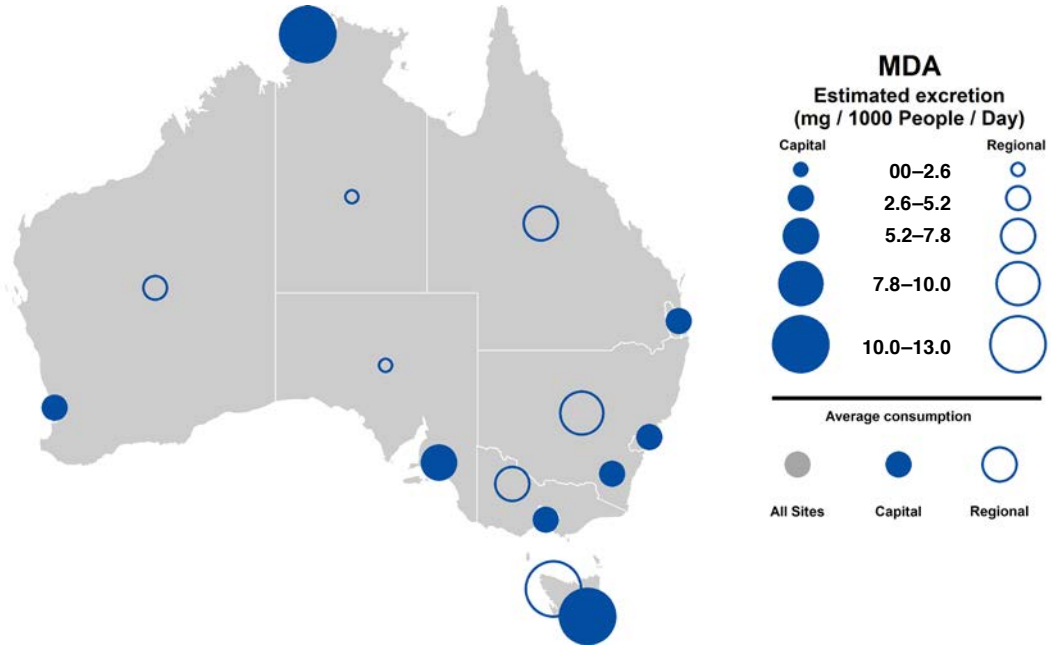


Figure 15: Estimated average MDA excretion per jurisdiction for August 2019 in mg excreted per day per thousand people. The number of collection days varied from 5-7.



4.1.3 OPIOIDS

Two prescription opioids were measured, as well as heroin, an illicit drug. Oxycodone and fentanyl are legally prescribed pharmaceuticals with abuse potential. Although wastewater analysis cannot be used to differentiate between prescribed use for therapeutic purposes and use for non-medical purposes, the relative scale of use of these substances remain of interest as they have the potential for addiction.

4.1.3.1 PHARMACEUTICAL OPIOIDS

The metabolism and excretion profiles of oxycodone and fentanyl are well characterised. The main metabolite of each compound was measured to estimate drug consumption.

A striking feature of oxycodone consumption across the nation was the very high levels in regional areas, the regional average being almost double that of the capital city average. Capital city Tasmania had the highest city use, while outside capital cities sites, use in regional Victoria were among the highest (Figure 16). Western Australia had relatively low consumption levels compared to the national averages, while city sites in New South Wales, Northern Territory, Queensland and Victoria were mostly similar.

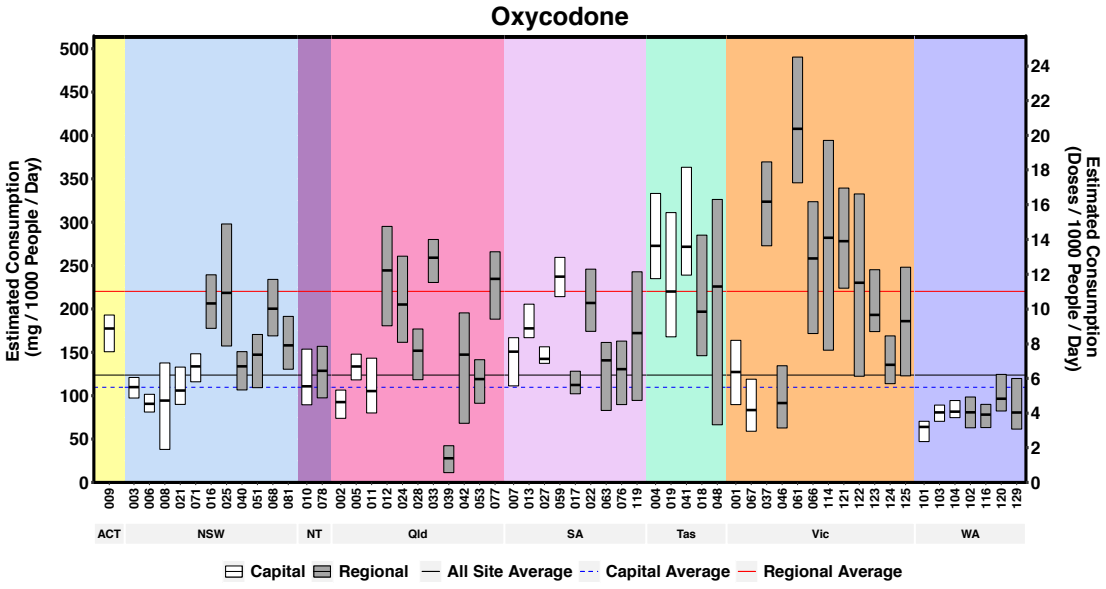
Fentanyl use was variable across Australia (Figure 17). Similar to oxycodone, regional use exceeded the capital city average, particularly in New South Wales and Victoria. Site 81 in regional New South Wales had much higher consumption than others (albeit consistent with previous results at that site). Factors such as average population age and density of medical services may account for some site-specific differences. The two Victorian capital city sites had very low use. Some sites in Tasmania, Queensland, New South Wales and Victoria had levels below the quantification limits of the method.

The relative scale of oxycodone and fentanyl use was apparent when results were aggregated by jurisdiction and capital or regional area and presented in bubble graph form. Generally higher oxycodone consumption rates in regional areas and in South Australia, the Australian Capital Territory and Tasmania were apparent (Figure 18). The use of both pharmaceuticals in regional centres was high compared to capital cities, while fentanyl consumption was relatively consistent between most capital cities (Figure 19).

4.1.3.2 HEROIN

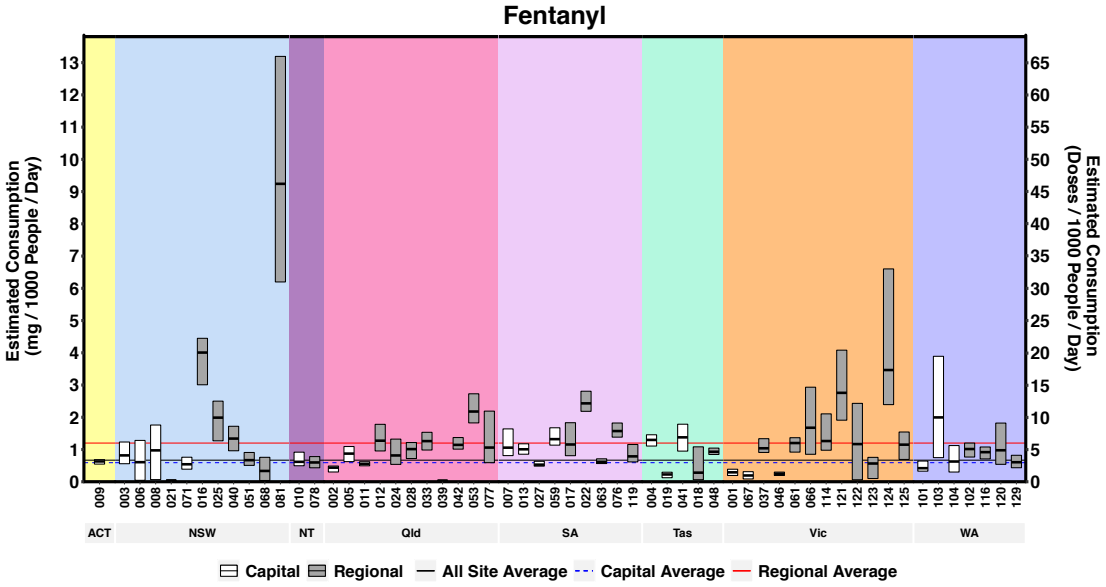
Heroin is metabolised in the body and excreted in low amounts as the unique metabolite, 6-monoacetylmorphine (6-MAM). Since the metabolite is characteristic of heroin use, it can be used to distinguish heroin from other opioids such as morphine and codeine. Unlike the two pharmaceutical opioids, heroin consumption in regional areas was generally much less than in the capital cities (Figure 20). Victoria Site 67 had very high consumption rates across the sampling week, well above any other catchment. Most regional sites had levels at or below limits of quantification, as well as capital city sites in Northern Territory and Tasmania. Some regional sites in New South Wales and Victoria had heroin consumption at or above the capital city average. The elevated heroin consumption in the south eastern parts of the country is clearly evident from the bubble graph (Figure 21).

Figure 16: Estimated oxycodone consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Tasmania and South Australia among the highest capital city sites
- Higher regional average with sites in regional Victoria among the highest

Figure 17: Estimated fentanyl consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Fentanyl fell below detectable levels at many sites
- Higher and variable regional average

Figure 18: Estimated average oxycodone consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

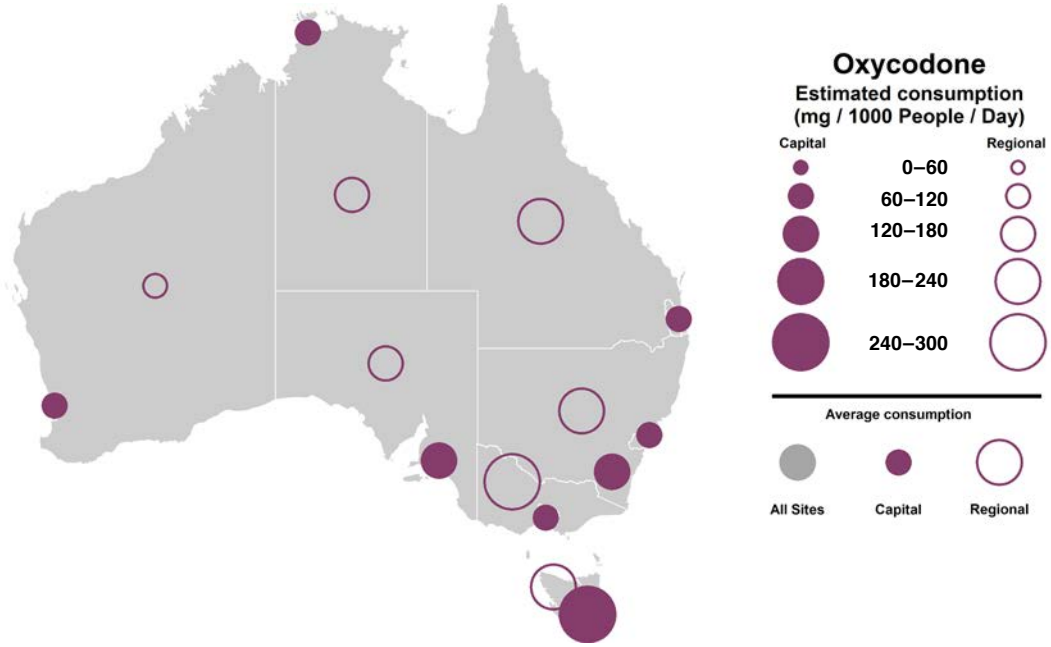


Figure 19: Estimated average fentanyl consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

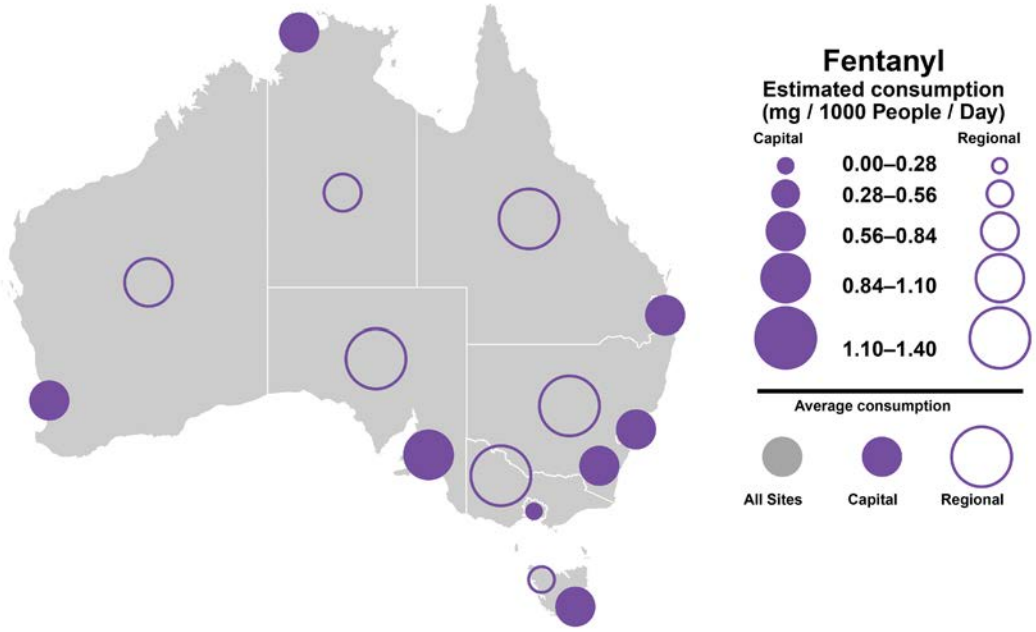
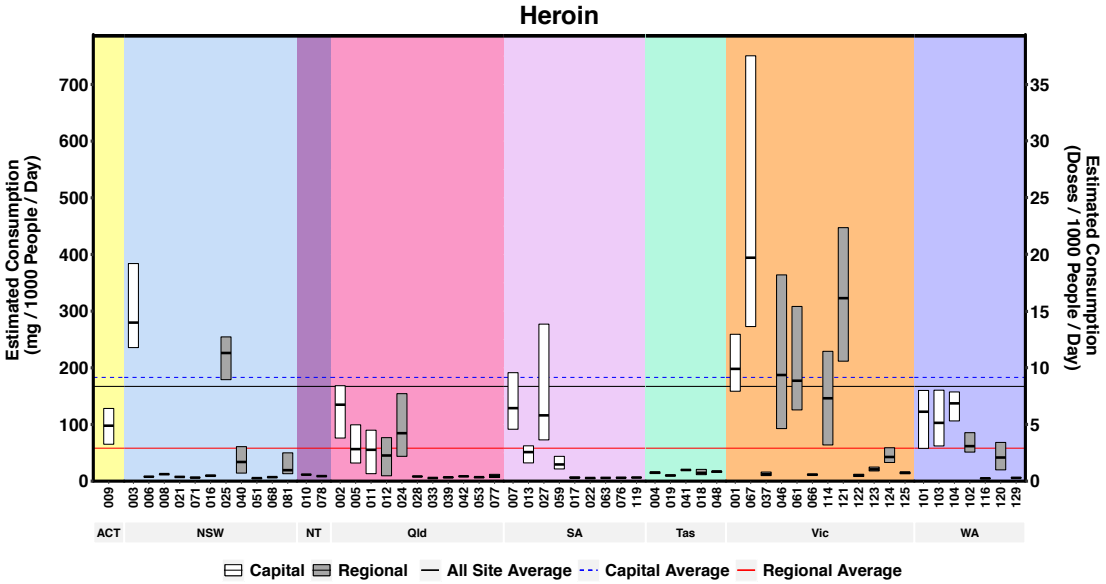
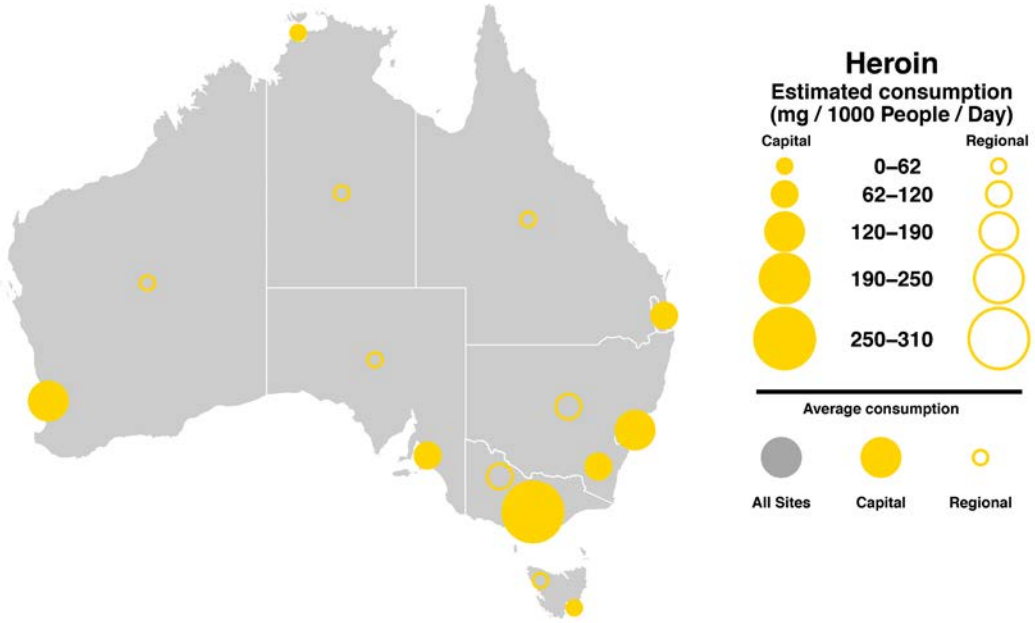


Figure 20: Estimated heroin consumption for August 2019 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Highest consumption in Victoria and New South Wales
- Lower regional consumption, mostly not detected

Figure 21: Estimated average heroin consumption per jurisdiction for August 2019 in number of standard drinks per day per thousand people. The number of collection days varied from 5-7.



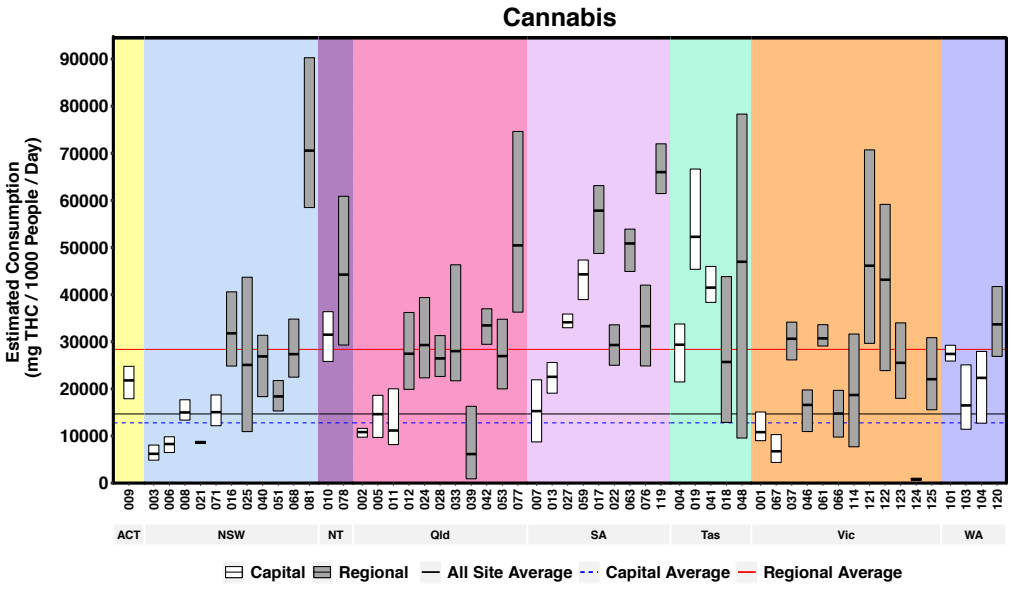
4.1.4 CANNABIS

Tetrahydrocannabinol (THC) is the main psychoactive compound found in cannabis. The compound is metabolised and largely cleared through the gut. A small proportion (0.06 per cent) is excreted through the kidneys as 11-nor-9-carboxy-THC (THC-COOH). The latter is known to adsorb to various surfaces, including sewer infrastructure. Therefore, in terms of wastewater analysis, the sewer design and collection method may play a part in the reportable levels of the target metabolite used for the purposes of the NWDMP. Upon collection, samples have to be preserved to avoid degradation of THC-COOH, without using acidification (McCall et al. 2016). This is one reason why cannabis consumption is not reported on a regular basis in other countries where wastewater analysis is routinely conducted as acidification is a common preservation technique. For the NWDMP, separate samples are collected each day and preserved specifically for THC-COOH analysis.

Cannabis consumption was expressed as the daily mass load (mg) of consumed active ingredient (THC) consumed per 1,000 people. An average dose was not defined as for other drugs in the report. The dose of cannabis depends on several factors, such as the part of the plant, strain, or whether an extract was used. This will be included in graphical representations of the data when an appropriate dose becomes available.

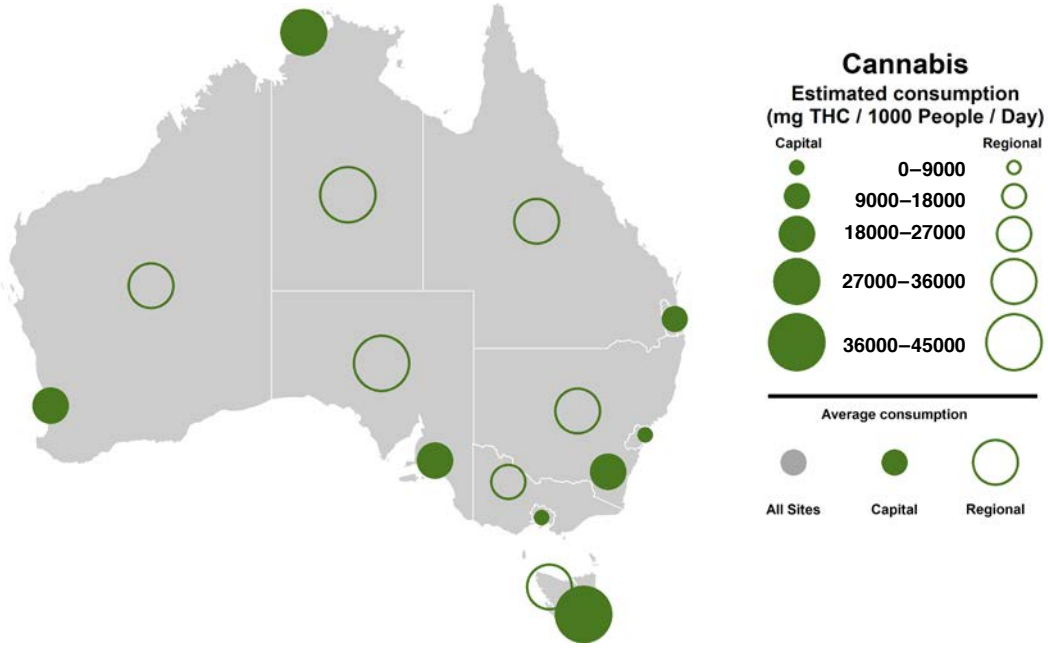
Clear spatial differences were evident across Australia (Figure 22). The regional average use exceeded capital city consumption. Parts of regional New South Wales, Queensland, South Australia, Tasmania and Victoria had higher consumption rates of the drug. Almost every state and territory had some catchments with use well above the averages. Except for Site 120, regional treatment plants in Western Australia were unable to provide a suitable composite sample for cannabis analysis. Cannabis was not detected above quantification limits at Site 124. The bubble plot and jurisdictional differences of cannabis use across Australia show the generally higher consumption in regional areas, and highest on average in Tasmania and Northern Territory sites (Figure 23).

Figure 22: Estimated cannabis consumption for August 2019 in mass consumed per day (left axis). The number of collection days varied from 5-7.



- Variable use across the country
- High regional consumption

Figure 23: Estimated average cannabis consumption per jurisdiction for August 2019 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



4.1.4 NEW PSYCHOACTIVE SUBSTANCES

Two compounds are included under the NPS class in the NWDMP; methylone and mephedrone. Limited information is available on the human metabolism and excretion of these drugs. Therefore, the parent compound was measured. Due to the low rates of detection for these drugs, they are reported as the number of detections made (Table 10) or the detection frequency (Figure 24). Sites that showed the presence of the two compounds are qualitatively listed in Table 10 for August 2019. The number of mephedrone detections were most frequent in New South Wales, closely followed by Queensland as well as a few detections in Victoria and Western Australia. For methylone, the majority of detections were observed in New South Wales, with one detection in the Northern Territory and two in Western Australia.

The temporal changes in detections per state and territory (proportion of samples above LOD) are shown for mephedrone and methylone in Figure 24a and 24b, respectively, and as bubble plots in Figure 24c. Mephedrone detections have remained relatively low, although the detection frequency has been on the increase in New South Wales and Queensland. The number of detections of methylone has dropped since a peak in late 2017, with most detections confined to New South Wales.

Table 10: The number and code of sites per state and territory where mephedrone and methylone were detected. The total number of daily samples that were assessed was 391.

	Number of detections Aug 2019		Sites detected Aug 2019	
State/territory	**Mephedrone**	**Methylone**	**Mephedrone**	**Methylone**
ACT	0	0	0	0
NSW	18	21	6, 8, 68	3, 6, 21, 51, 68
NT	0	1	0	10
Qld	15	0	2, 5, 11, 12	0
SA	0	0	0	0
Tas	0	0	0	0
Vic	2	0	1, 67	0
WA	3	2	101, 103, 104	103, 116
Total	**38**	**24**	**12 sites**	**8 sites**

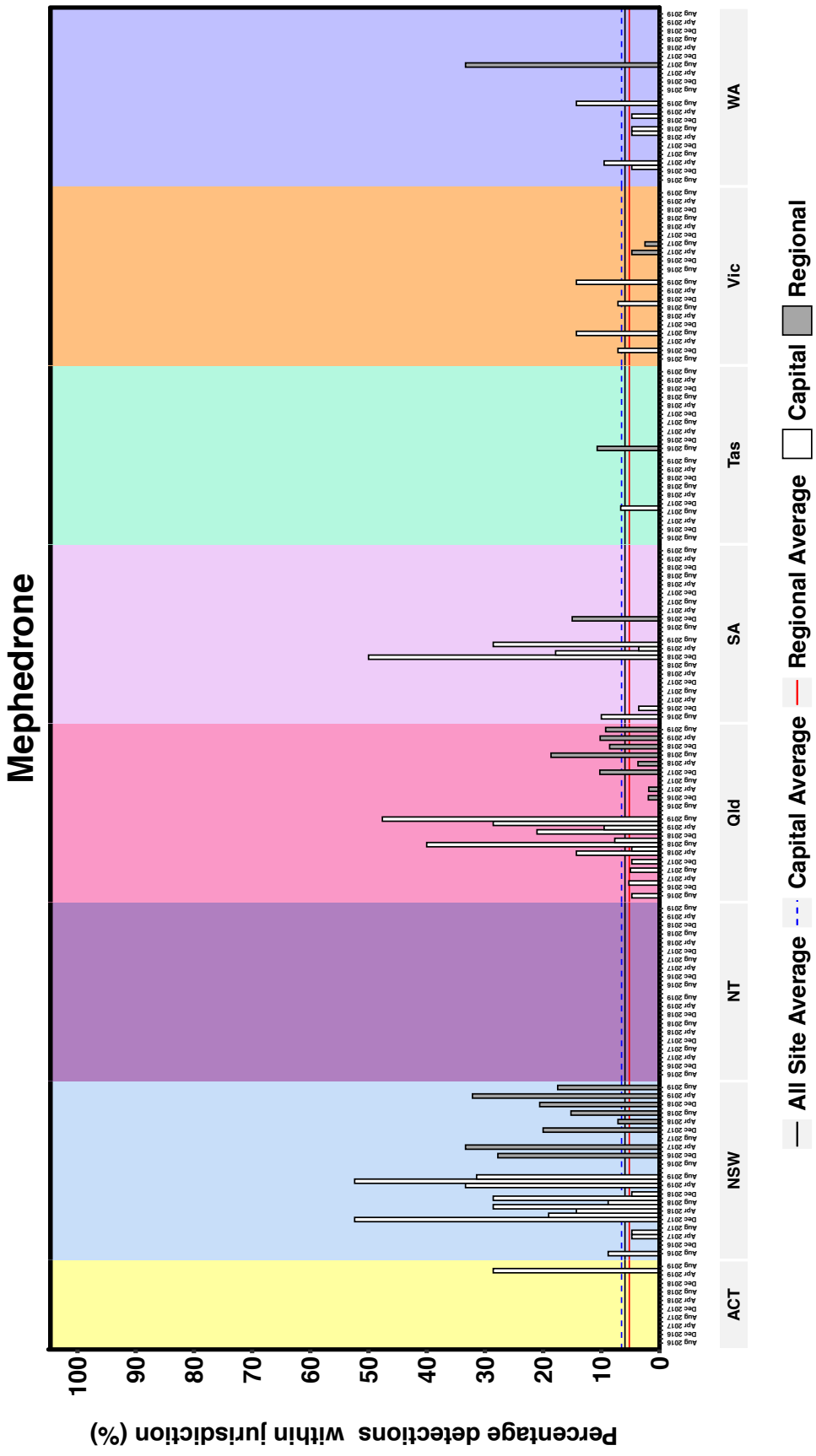


Figure 24a: Estimated percentage positive detections per jurisdiction for mephedrone and methylone for August 2019. This is the number of detections as a percentage of the total number of samples analysed per jurisdiction.

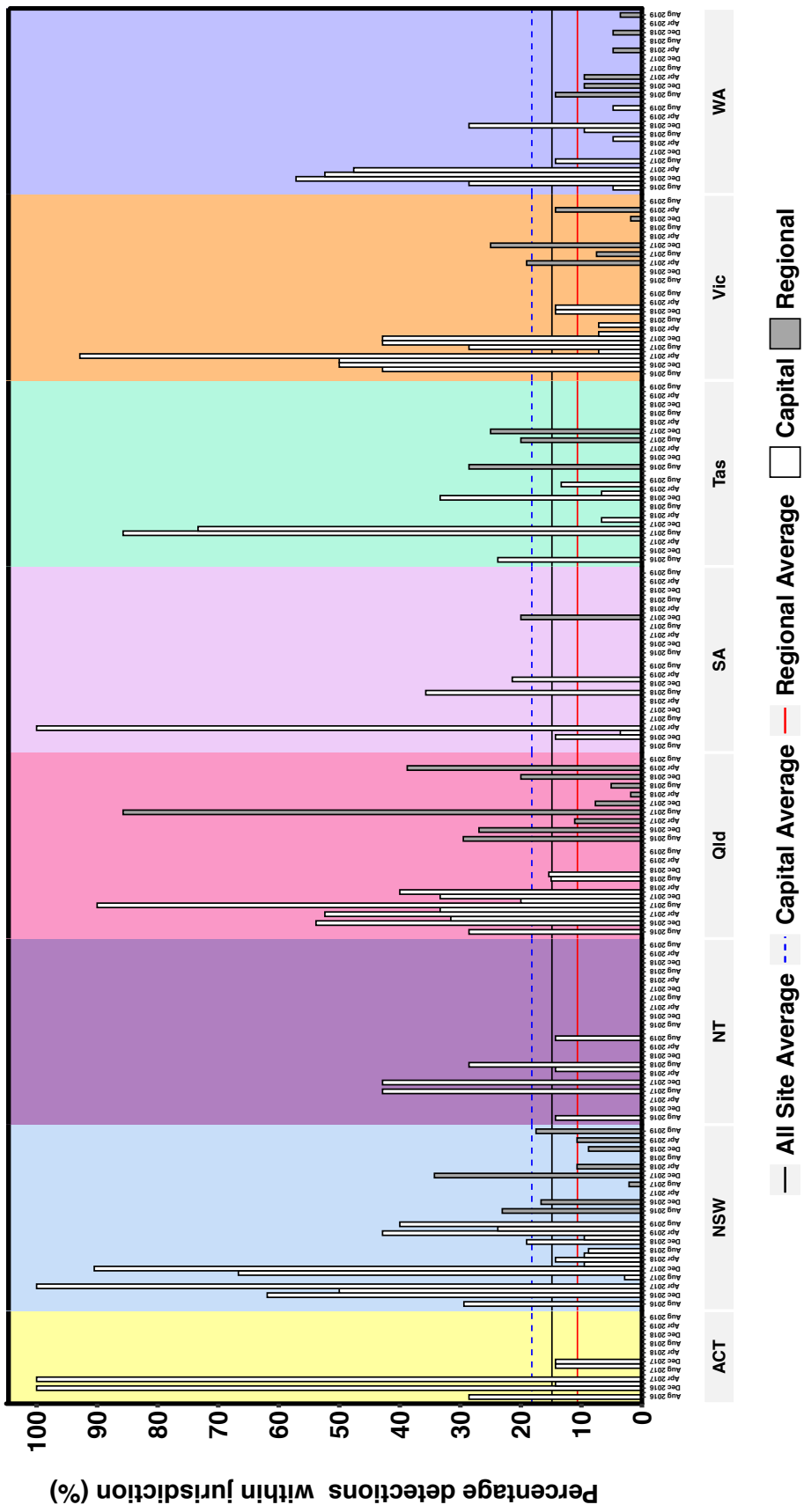
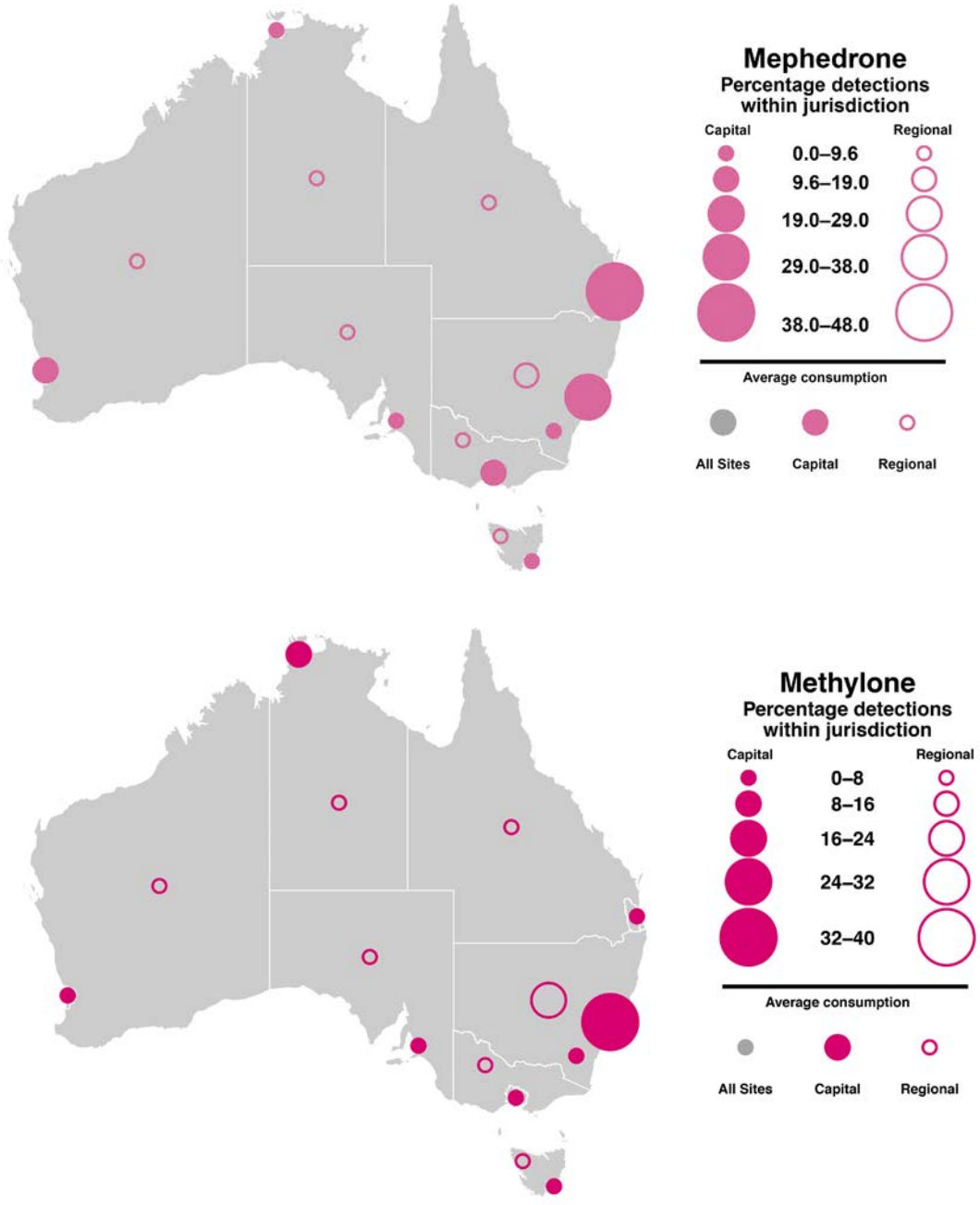


Figure 24b (continued): Estimated percentage positive detections per jurisdiction for mephedrone and methylone for August 2019. This is the number of detections as a percentage of the total number of samples analysed per jurisdiction. The number of collection days varied from 5–7.

Figure 24c (continued): Estimated percentage positive detections per jurisdiction for mephedrone and methylone for August 2019. This is the number of detections as a percentage of the total number of samples analysed per jurisdiction. The number of collection days varied from 5–7.



4.2 TEMPORAL CHANGES IN DRUG CONSUMPTION ESTIMATES BY JURISDICTION

The total level of each drug outlined in the preceding reports per state or territory was compared with subsequent collection periods included in the current report. Although every effort was made to assess the same sites for each period, the individual sites and the number of sites used to generate the population-weighted averages may have changed between periods. Comparing between time points should be done with caution. This would be most evident for the regional averages, which had more variation in participation between each period (see Appendix 2 and Appendix 3, Report 6 and Appendix 2 in this report).

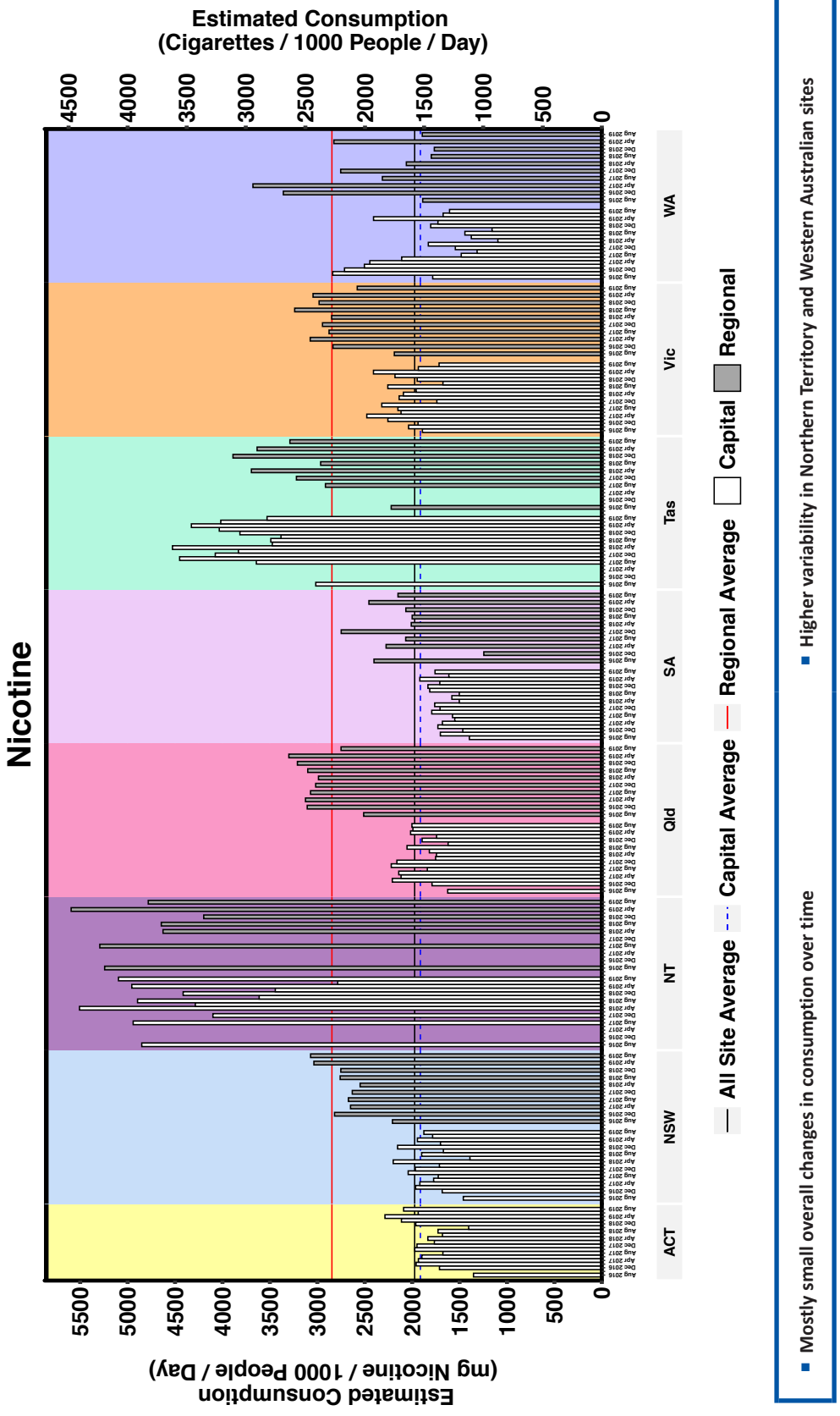
Note: the horizontal red, blue and black lines on each temporal graph which represent the averages are the cumulative average across all sampling time points and all samples analysed.

4.2.1 NICOTINE AND ALCOHOL

Over the first two years of the program, nicotine consumption remained largely steady in most parts of the country, with some variability (Figure 25). Use in regional New South Wales has increased, but no apparent long-term pattern was obvious elsewhere. The current sampling periods of June and August 2019 were generally similar or slightly lower than the previous sampling periods in February and April 2019. The cumulative regional average nicotine consumption (red line) remains well above capital city levels (blue dashed line).

For alcohol the cumulative average consumption in regional areas remains slightly higher than capital city areas. However, the difference was not as pronounced as for nicotine. South Australia continued to be the only state where regional alcohol use was much lower than in the capital city (Figure 26). Consumption trends remained mostly steady in states such as New South Wales, Tasmania and Victoria, while others such as in the Northern Territory appear to be more variable. Some states, such as Western Australia, have observed an overall slight decline in alcohol consumption from peaks observed in late 2017 and early 2018 to the present reporting period, albeit with some month-to-month variation.

Figure 25: Estimated average consumption of nicotine by state/territory, where 1 cigarette provides 1.25 mg of nicotine.[6]



6 Nicotine consumption data have been adjusted to refine the factor used to convert consumed mass load to dose. Overall trends in nicotine consumption remain unchanged.

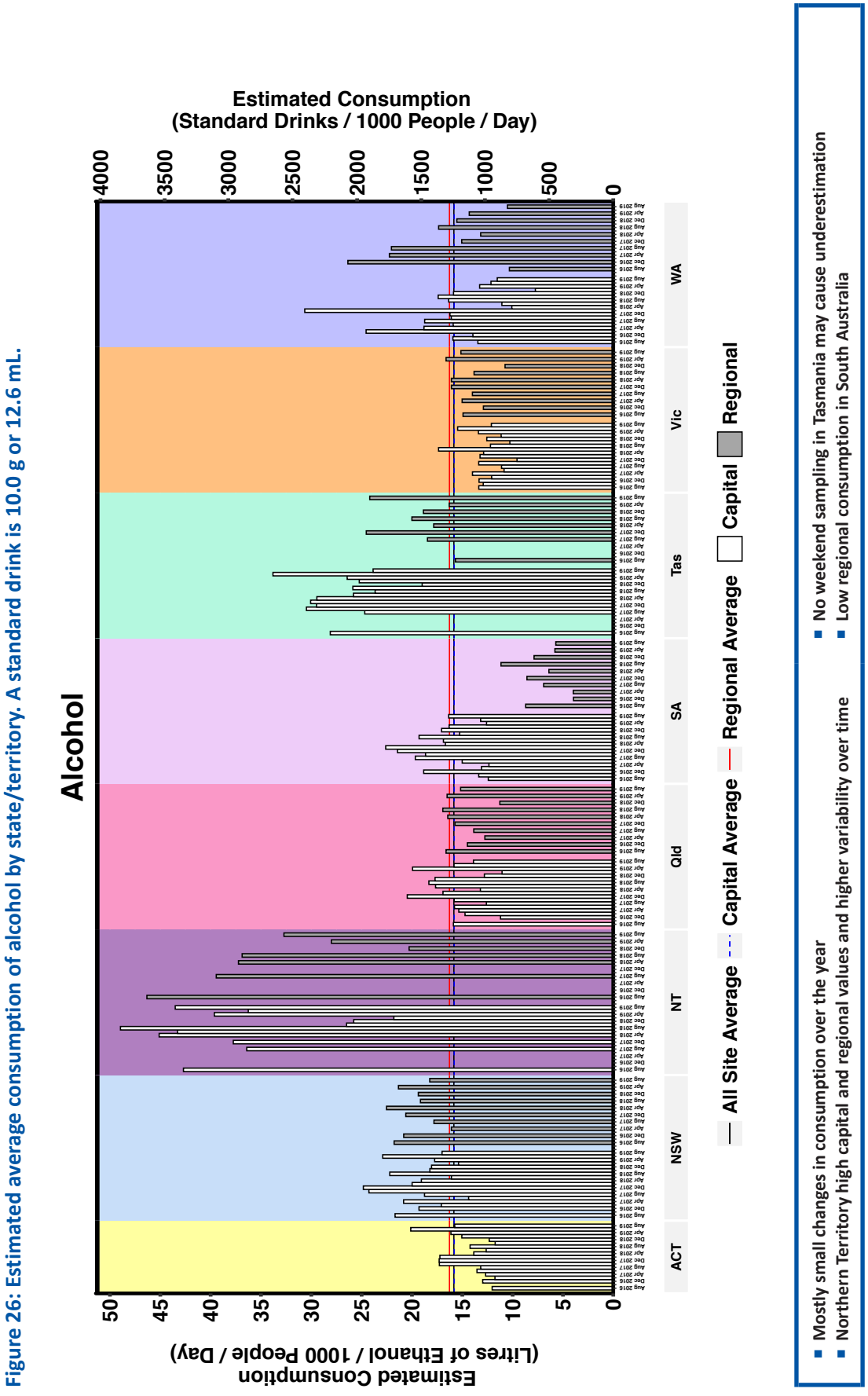


Figure 26: Estimated average consumption of alcohol by state/territory. A standard drink is 10.0 g or 12.6 mL.

4.2.2 STIMULANTS

A consistent upward trend in the use of methylamphetamine in capital cities and regions of virtually each state and territory is evident over the total period of the program (Figure 27). Capital city South Australia and Western Australia are the clear exceptions, where the trend has been interrupted by distinct troughs. As a consequence, methylamphetamine levels are no longer a feature of South Australian and Western Australian consumption. Rather, rising levels in regional parts of the country and cities have led to current levels being very similar across the nation. Many jurisdictions were slightly lower in August 2019 compared to the previous reporting period in June or April 2019.

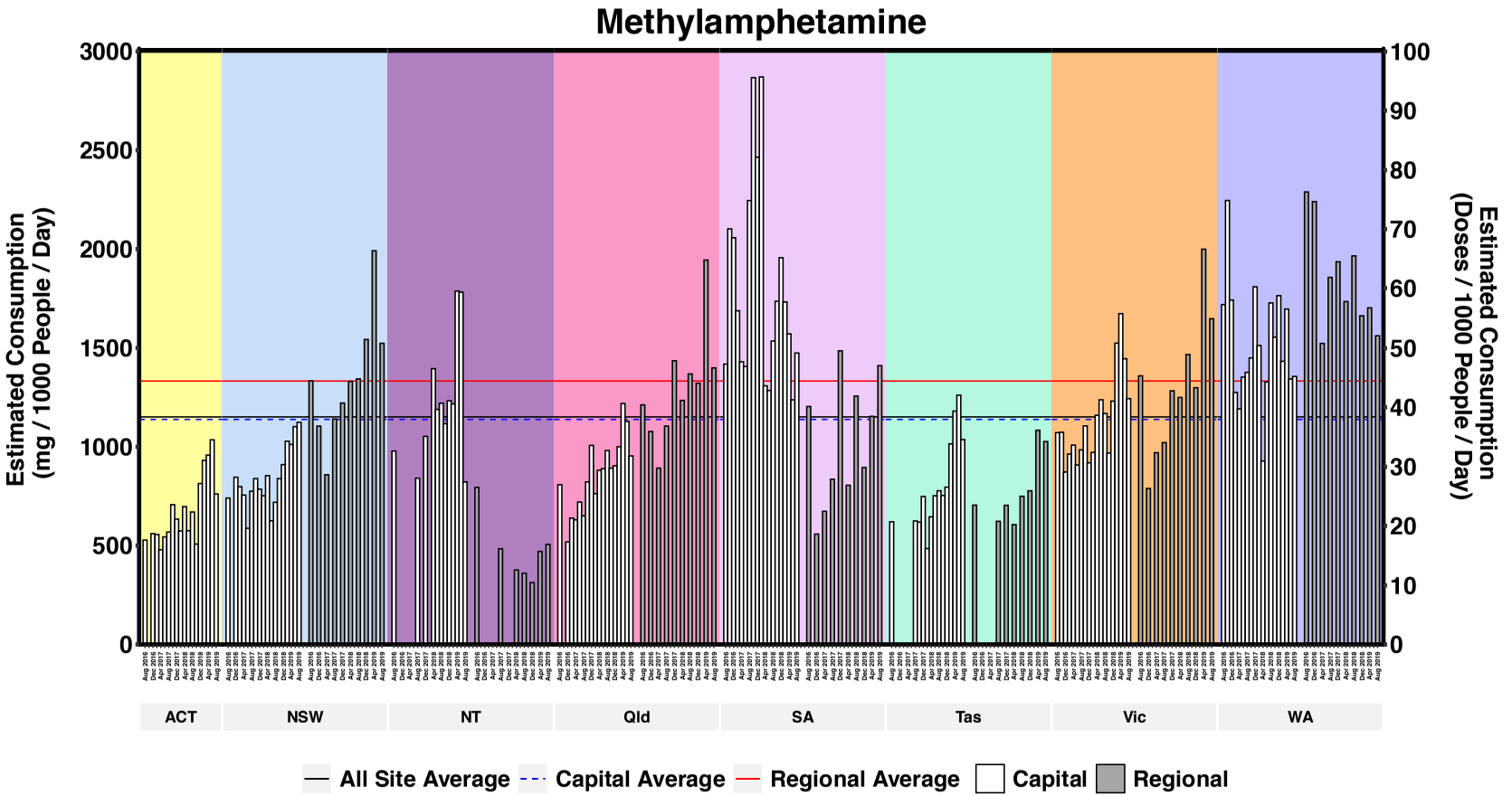
The changes in use of methylamphetamine is also apparent over the long term in Queensland, South Australia and Western Australia, where data is available back to before the start of the NWDMP (Figure 28a and b). The short-term declines in South Australia in mid-2017 and mid-2018 have been the longest continuous periods over which the drug's use has been maintained at a lower level, following an approximate four-fold increase between 2009 and 2016. The historical increase in South Australia was also apparent between 2009 and 2016 in sites in regional Queensland, with up to five-fold increases in methylamphetamine consumption rate being observed.

Trends in cocaine use appears to show an overall increasing trend in many jurisdictions since the commencement of the program in 2016 (Figure 29). However, cocaine use in many of the capital city and regional jurisdictions showed either a stable or short-term decline compared to the previous reporting period. Levels of cocaine use in New South Wales and the Australian Capital Territory remained high compared to other parts of Australia. Regional consumption of the drug has been variable with differences evident across the country; for instance, relatively low consumption in the Northern Territory, Tasmania and Western Australia. In regional Queensland, Victoria and New South Wales, this is generally driven by the larger population centres, sites 12 and 24, sites 37 and 114, and sites 68 and 25, respectively. The average capital city results also makes the generally lower regional use quite apparent, together with very low consumption in the Northern Territory and Western Australia.

MDMA use across Australia remained low overall, compared to methylamphetamine (Figure 41). Levels of the drug have been largely variable in many parts of the country from 2016, but increases have become apparent in some jurisdictions since early 2018. This was the case in both capital city and regional areas of almost every state and territory (Figure 30). The per capita consumption of drug use in capital city Northern Territory and Tasmanian sites remained high compared to most other parts of the country, with decreases from June to August 2019. Some spikes in MDMA consumption have been observed in December months, particularly in the Australian Capital Territory, New South Wales and Northern Territory in 2016 and 2018.

MDA use, corrected for the proportion derived from MDMA (Khan & Nicell 2011), had relatively similar use between capital cities across the country, with slightly higher consumption in the Northern Territory and Tasmanian sites (Figure 31). No long-term trends were apparent, with fluctuations a feature of the drug's use. Since 2018, levels of MDA in regional Northern Territory have been the lowest in the nation. The national regional average was skewed somewhat by the high MDA levels detected at Site 012 in Queensland in August 2017, as well as regional New South Wales sites.

Figure 27: Estimated average consumption of methylamphetamine by state/territory.



- Overall increasing consumption in many jurisdictions
- Except for South Australia and Western Australia, August 2019 results are similar or lower than April and June
- Regional use higher than city use in many jurisdictions
- Acute short-term declines visible in South Australia and Western Australia trend

Figure 28a: Change in methylamphetamine consumption for sites with historical data.

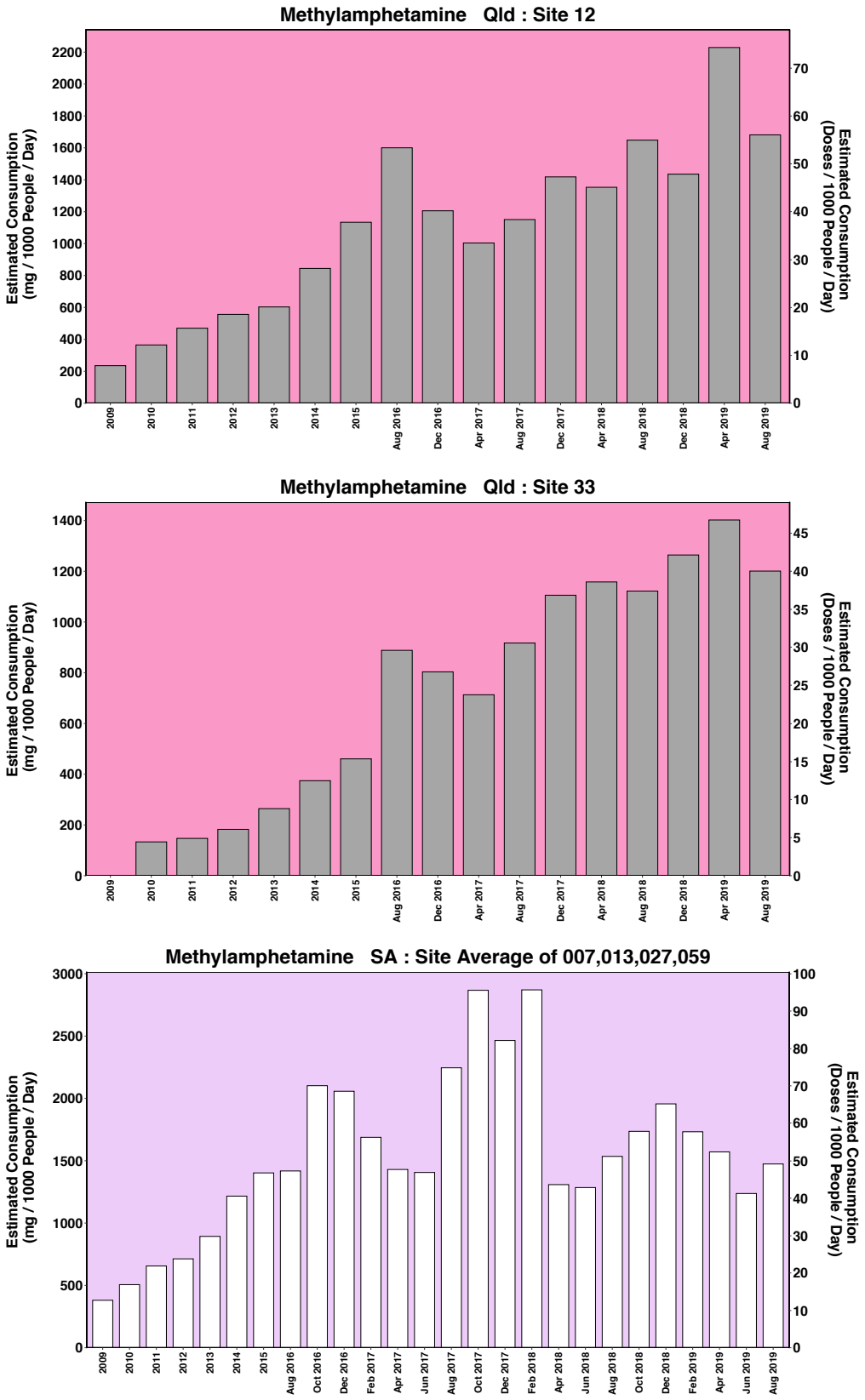
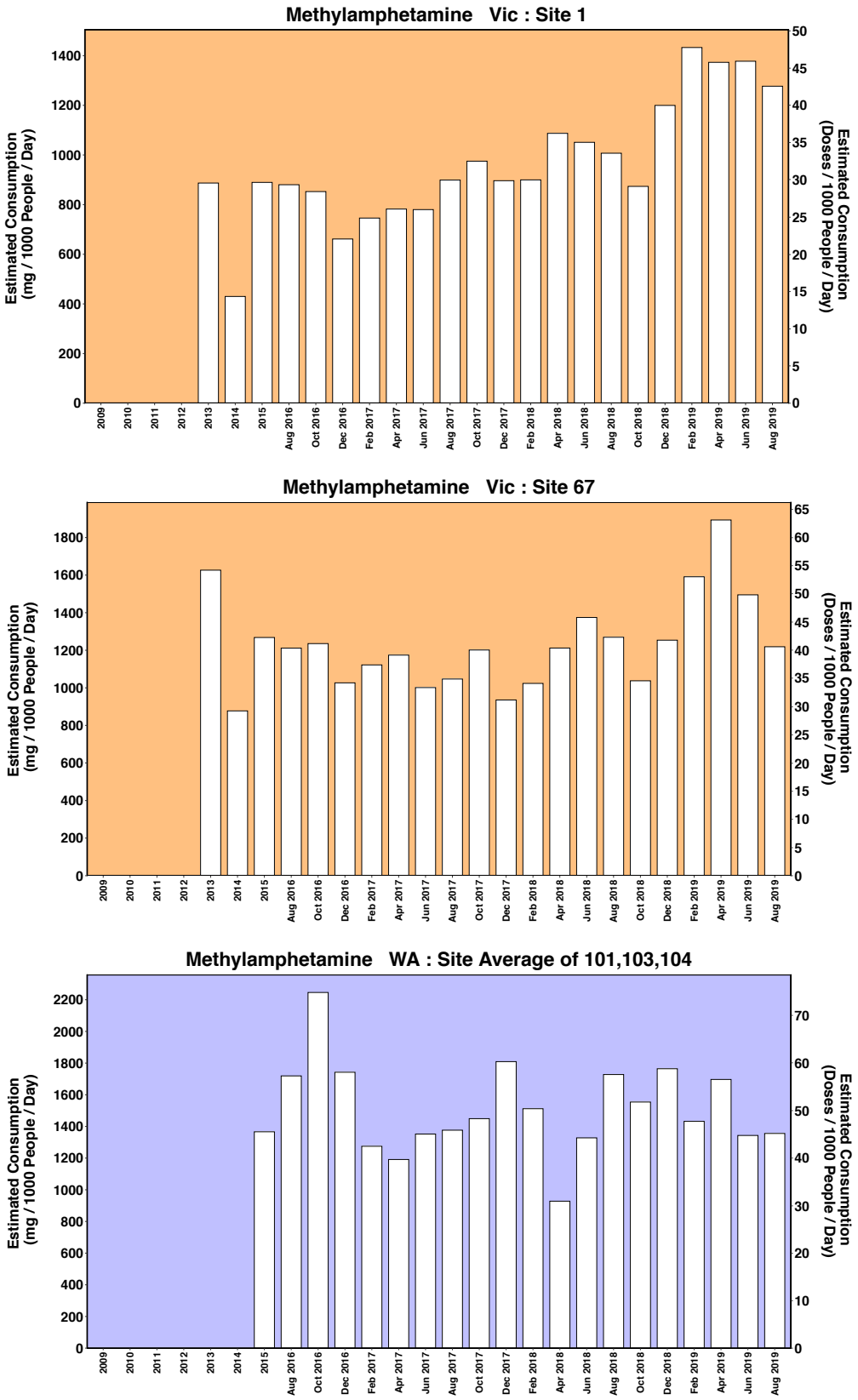


Figure 28b: Change in methylamphetamine consumption for sites with historical data.



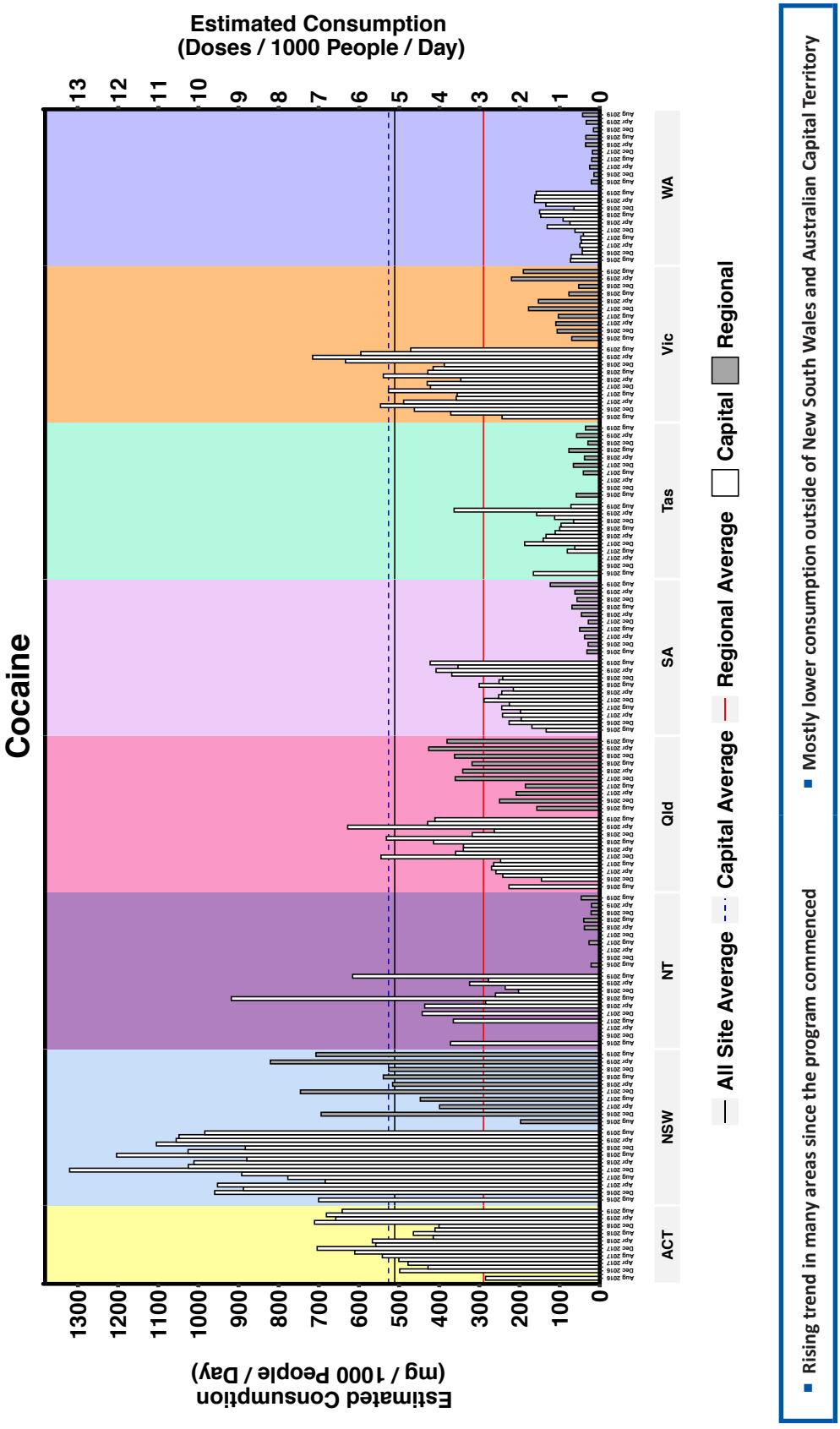


Figure 29: Estimated average consumption of cocaine by state/territory.

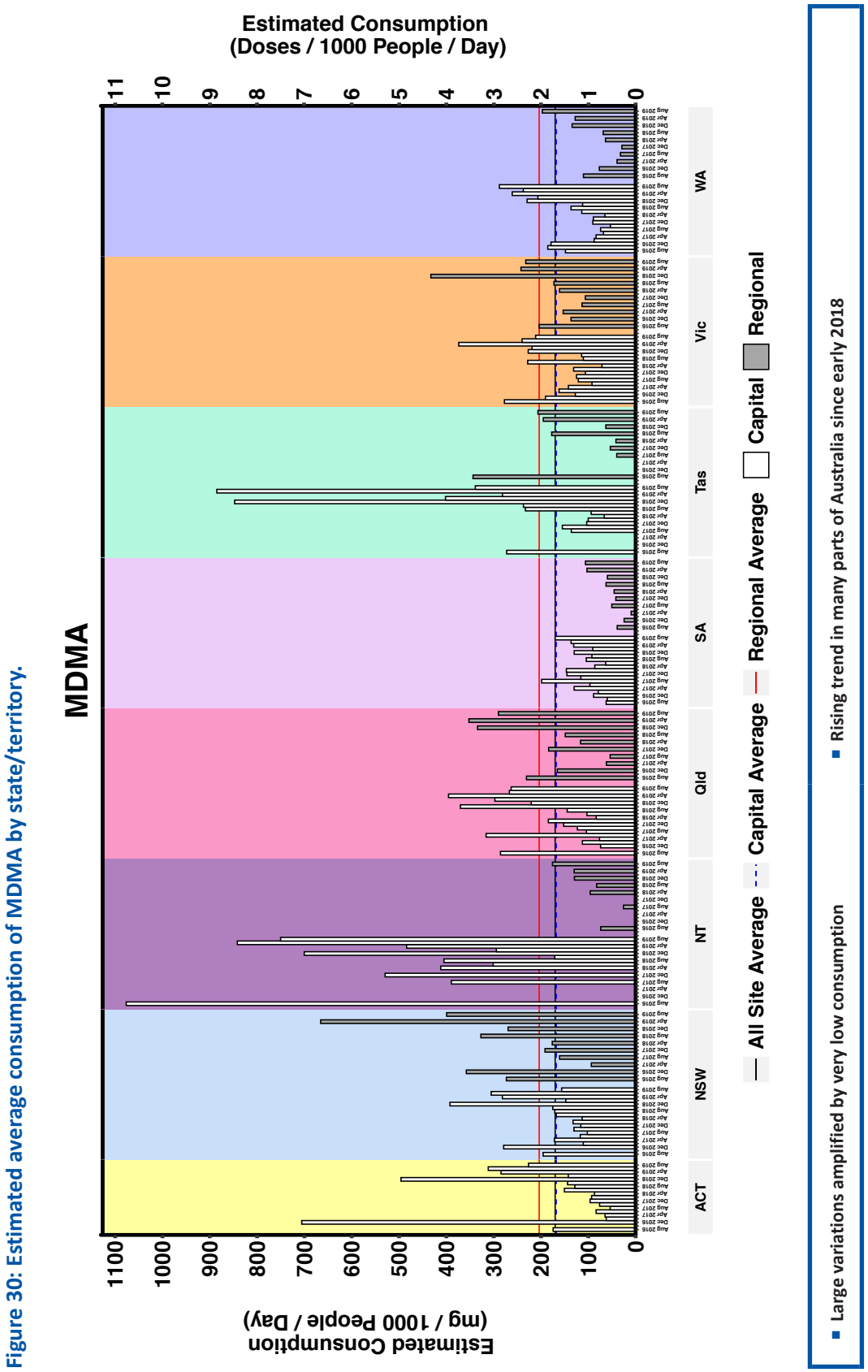


Figure 30: Estimated average consumption of MDMA by state/territory.

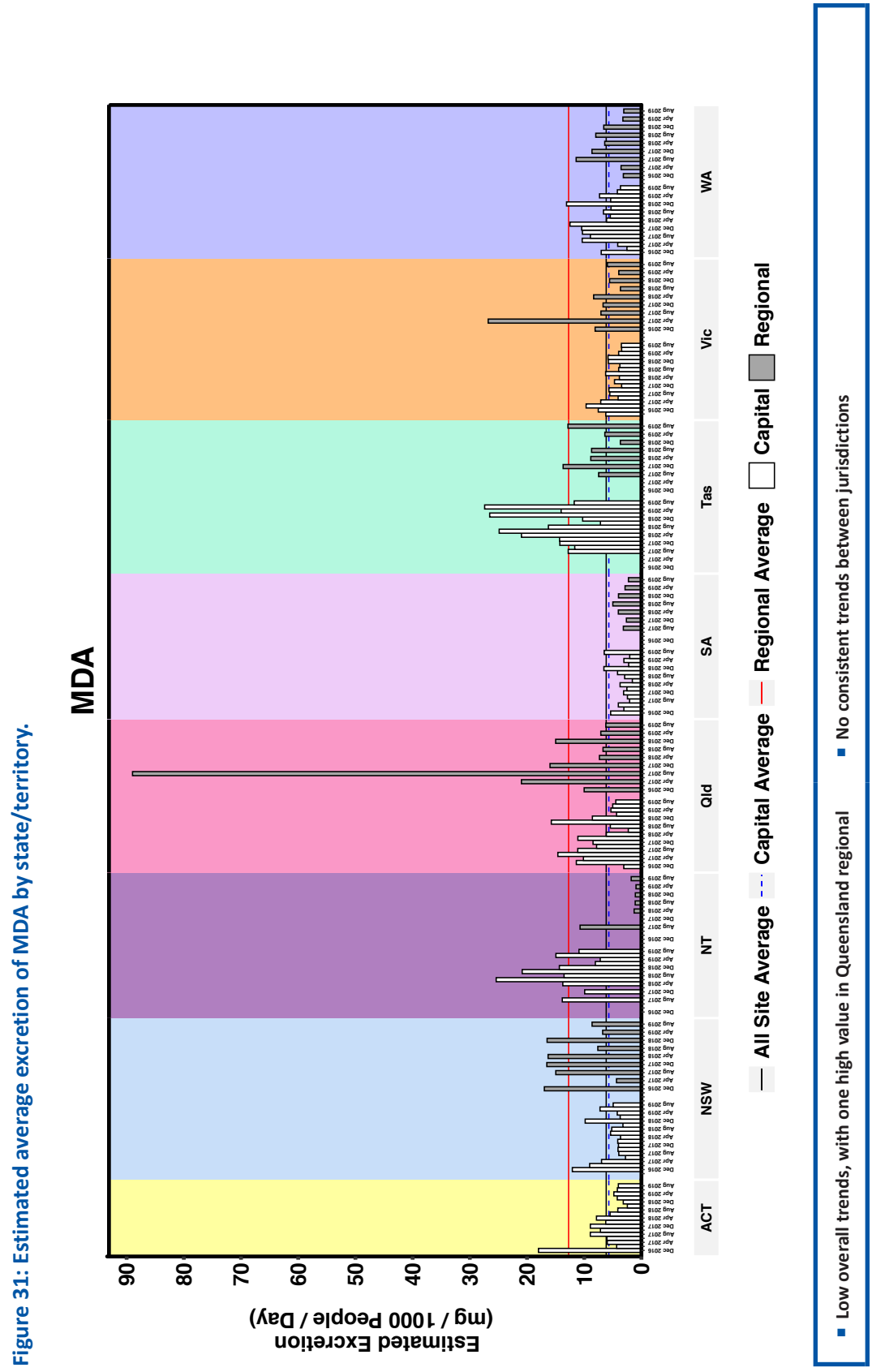


Figure 31: Estimated average excretion of MDA by state/territory.

4.2.3 OPIOIDS

The consumption of oxycodone is showing an overall upward trend since the inception of the program in many parts of Australia, especially regional areas, most evident in Queensland and Victoria (Figure 32). Sites in capital city Tasmania and the Australian Capital Territory measured among the highest consumption of the drug. However, since mid-2018, regional Tasmanian sites, as well as sites across Queensland and Victoria, have become prominent. A feature of oxycodone use in Australia is the very high regional levels compared to the capital cities, driven by regional areas in New South Wales, Queensland, Victoria and Tasmania. However, some sites in New South Wales, Northern Territory, Western Australia and Victoria are amongst the lowest users of oxycodone on a population basis.

Fentanyl use in regional Australia remain similarly high in comparison to capital cities (Figure 33). The longer-term upward trend in some states and territories has been arrested since middle to late 2018. The reversal in consumption of fentanyl was consistent across all parts of the country, except capital city parts of the Northern Territory. An apparent peak in fentanyl consumption appears to be evident between mid to late 2017 and late 2018 in most jurisdictions, particularly for sites in Australian Capital Territory, New South Wales, Queensland South Australia and Victoria. Results for the current period are lower than the previous period for most jurisdictions.

Heroin use in Australia occurs largely in the capital cities, especially Victoria, New South Wales and the Australian Capital Territory. Different trends are emerging across the country (Figure 34). Use in the Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria and Western Australia have been on the increase since the end of 2018, following declines since the start of the program in 2016. Victoria are the highest overall consumers of heroin, followed by New South Wales and the Australian Capital Territory. Use in Western Australia spiked in this reporting period, in contrast to the declining trend since the inception of the NWDMP. In all jurisdictions, regional use is lower than that in the capital city areas. Heroin consumption has been measured in capital city South Australia since 2013 (Figure 35). The declining levels of heroin consumption in South Australia have been part of a long-term trend, reaching the lowest levels in February 2019. Since then heroin use in South Australia appears to have increased to similar levels to the beginning of the program in 2016.

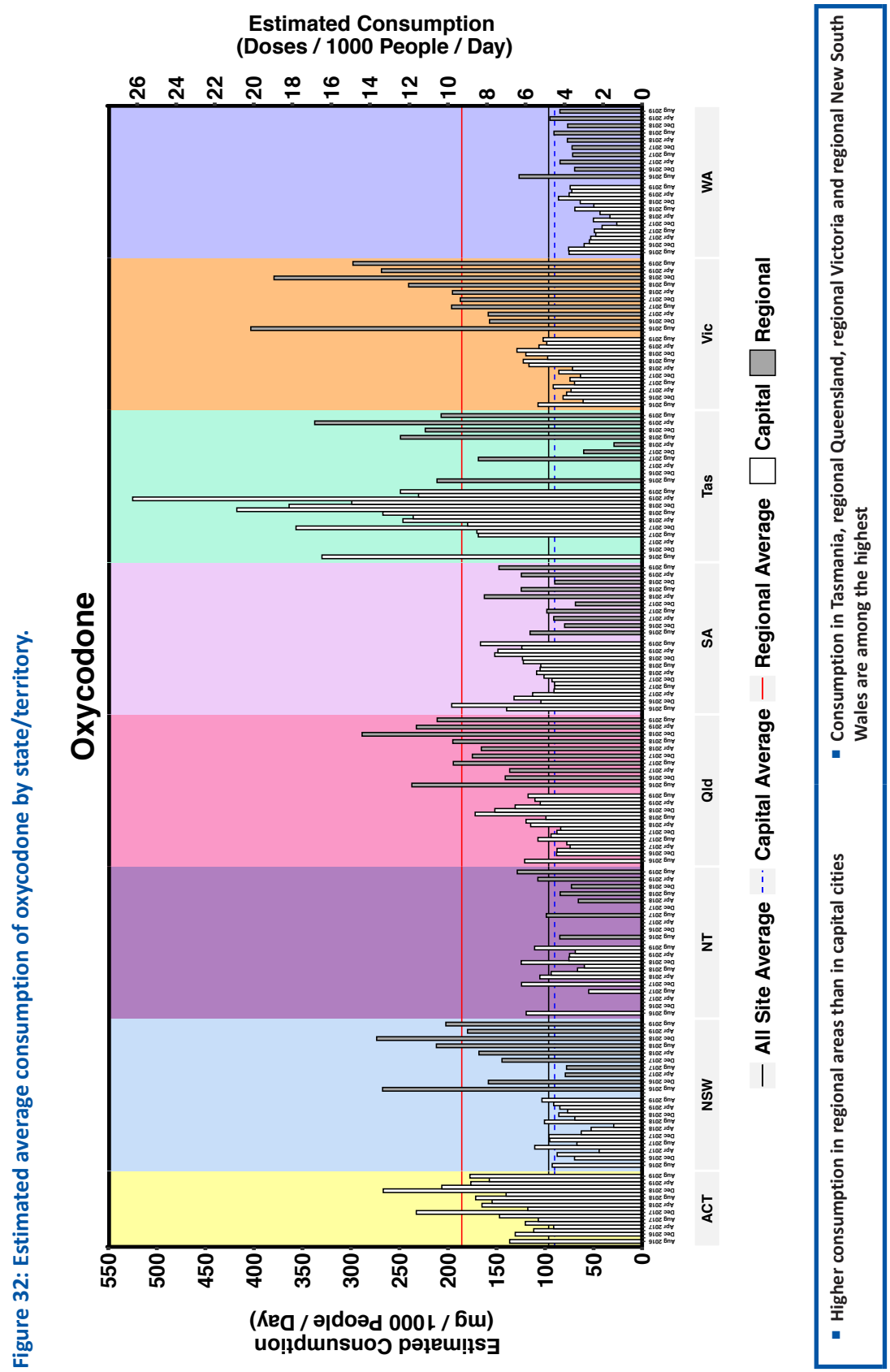


Figure 32: Estimated average consumption of oxycodone by state/territory.

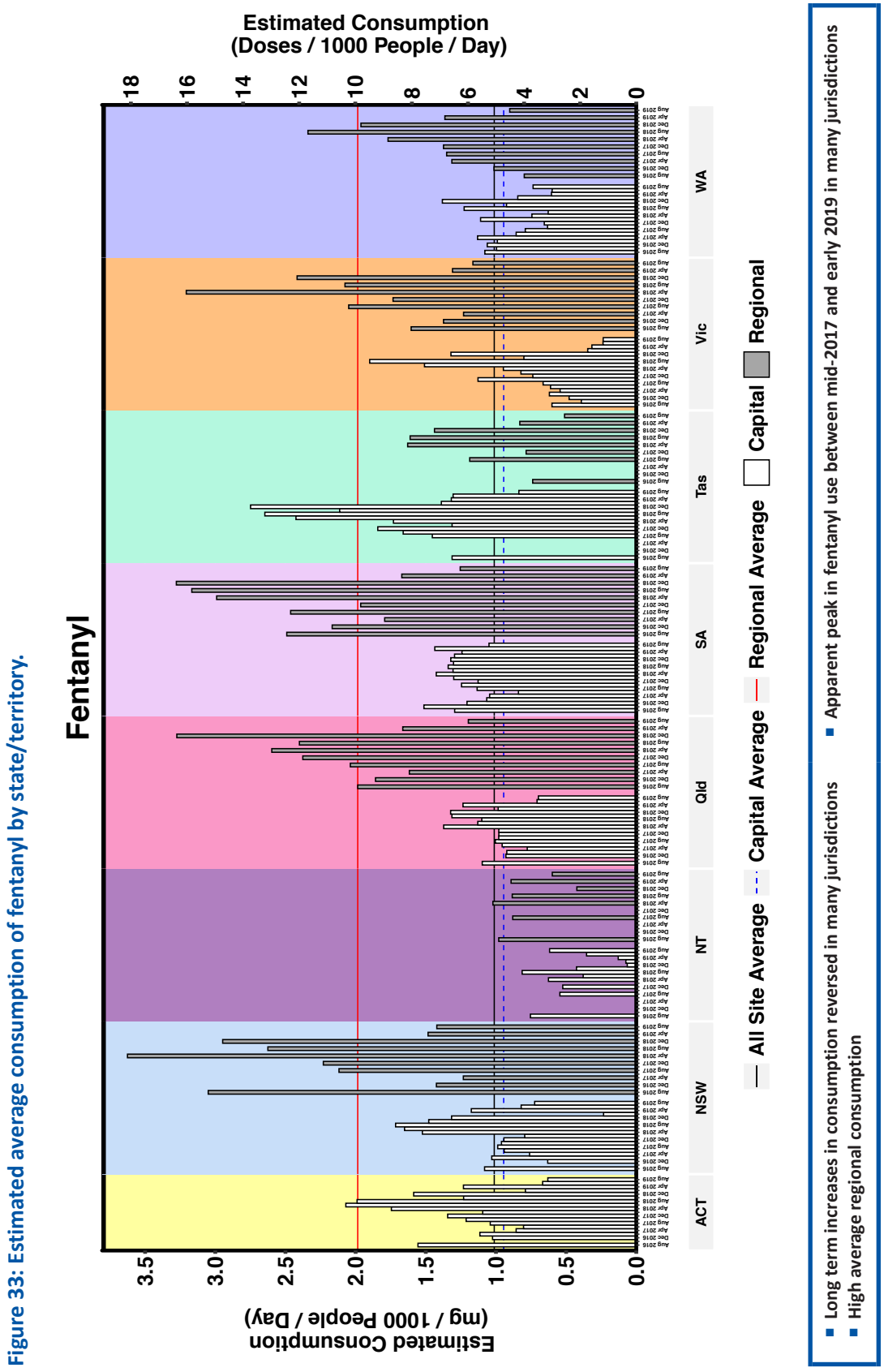


Figure 33: Estimated average consumption of fentanyl by state/territory.

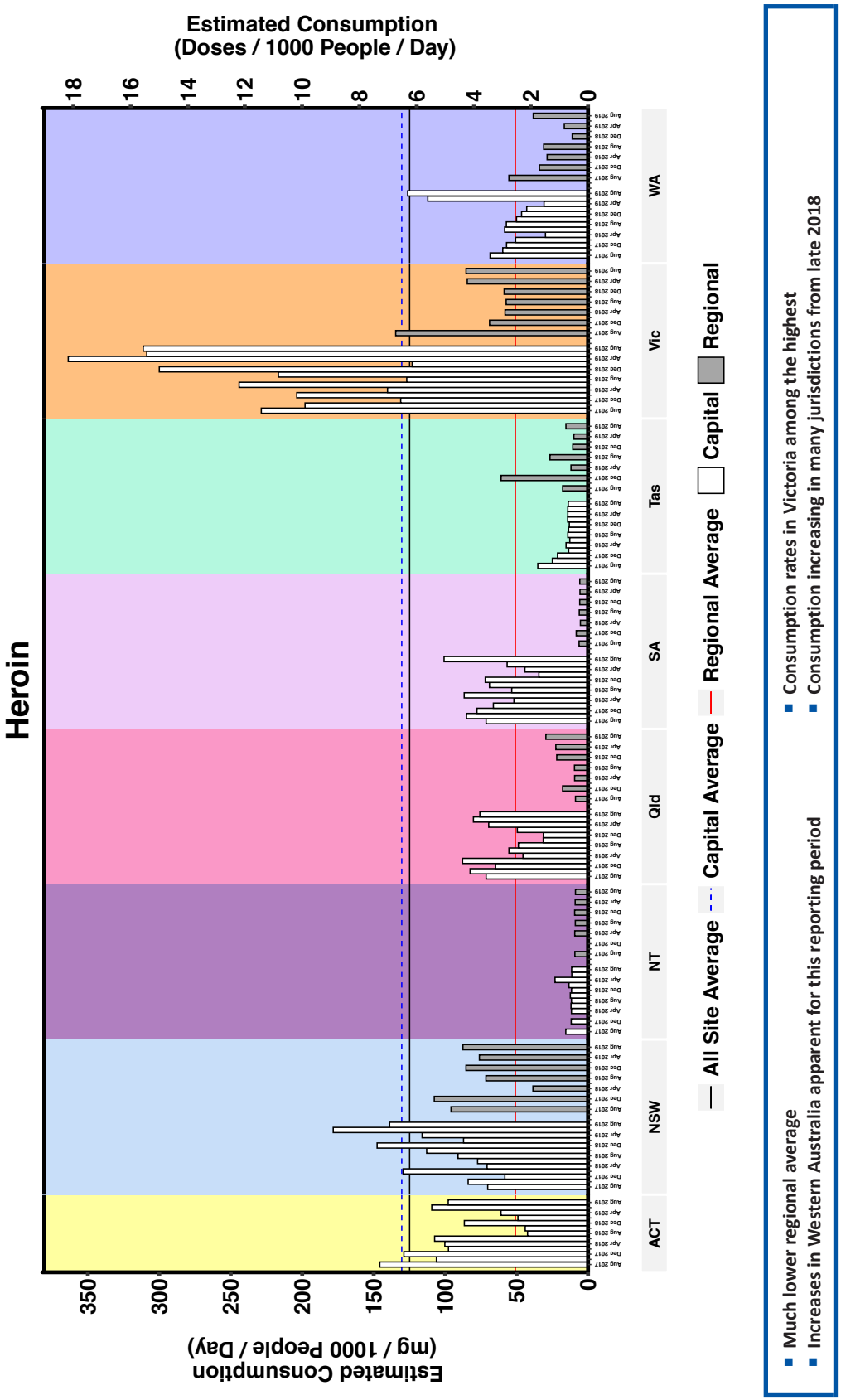
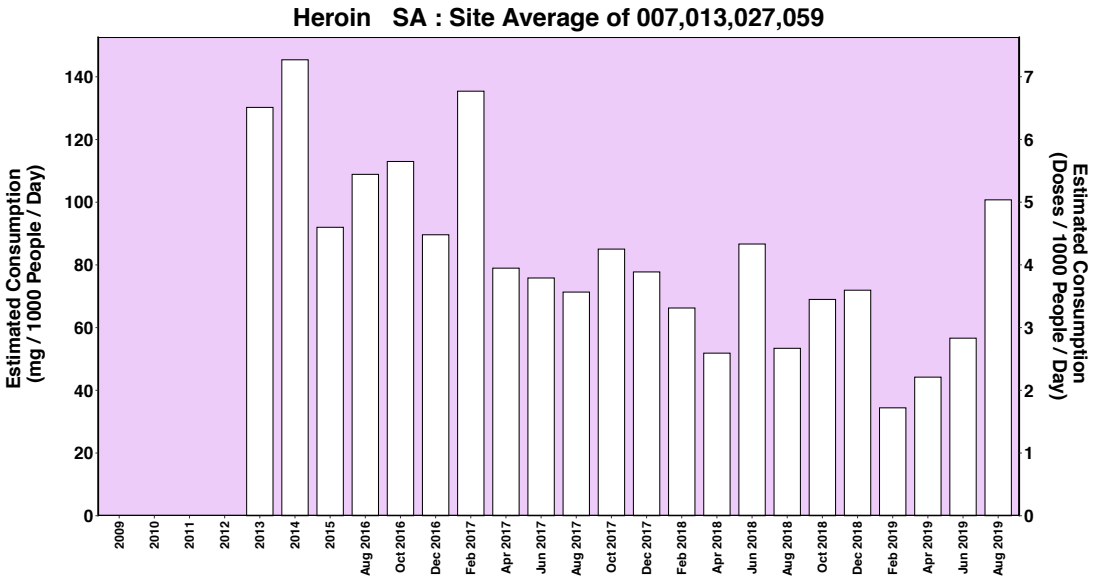


Figure 34: Estimated average consumption of heroin by state/territory.

Figure 35: Change in heroin consumption for South Australia.

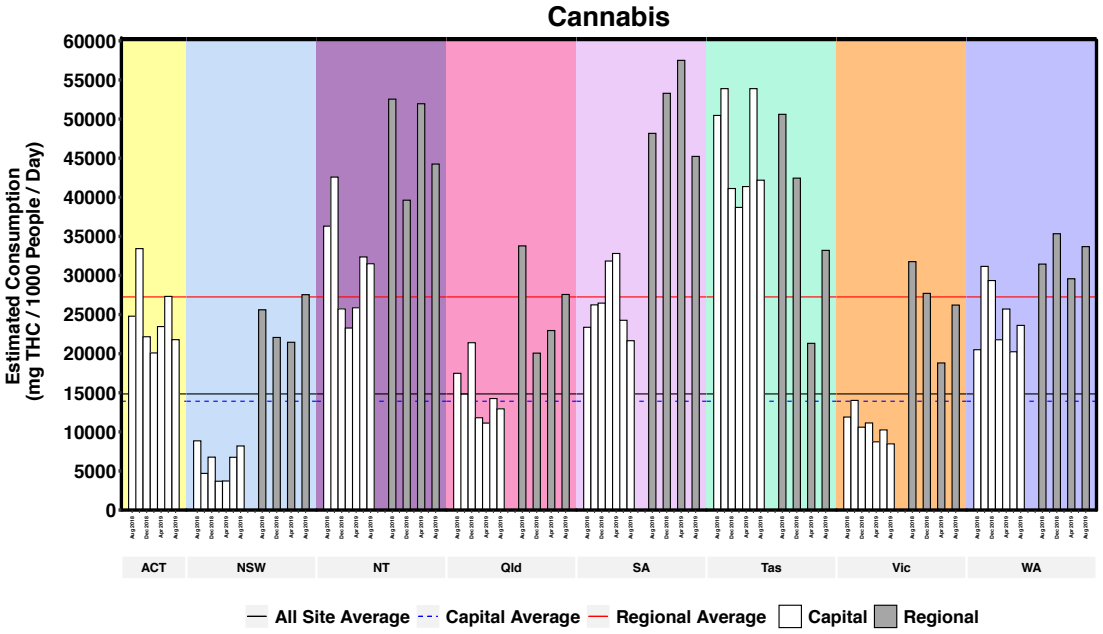


4.2.4 CANNABIS

Cannabis has been included in the program since August 2018. Over this short period, trends appear to be relatively stable with some short-term fluctuations (Figure 36). Further trends may become apparent with a longer time series, as has become evident with other substances recorded in the program. Regional consumption was higher than capital city levels, with the highest consumption spread over several states and territories, in particular the Northern Territory, Tasmania and regional South Australia. Use in sites of the larger population centres of New South Wales, Victoria and Queensland were much lower. Consumption in these capital areas were approximately two to three times lower than the regional areas within the jurisdiction, while consumption in city areas of Western Australia and Tasmania were closer to that in the regional areas.

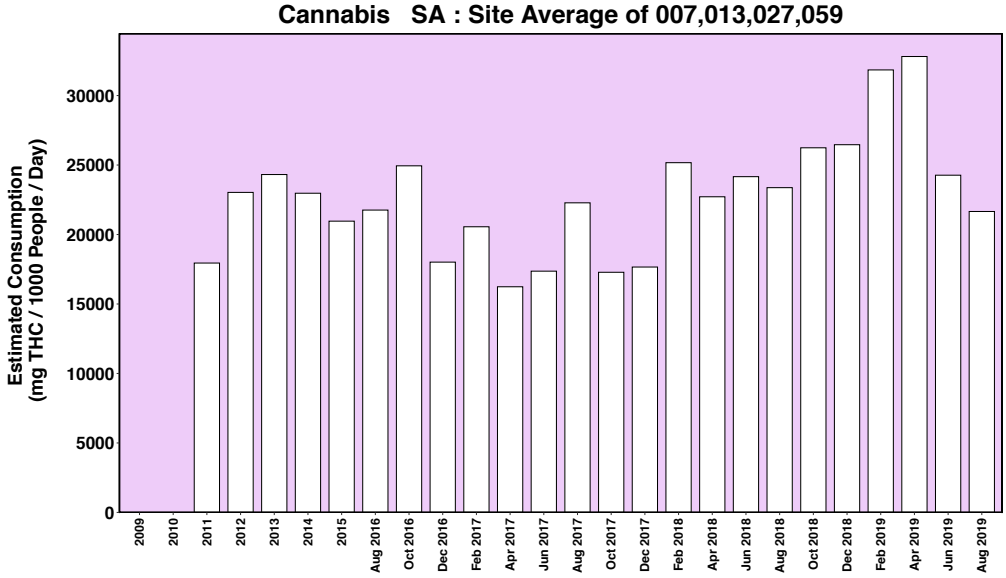
Consumption of cannabis has previously been measured in capital city South Australia since 2011. Use of the substance has seen small but steady increases over the course of the program, particularly between April 2017 to the highest consumption rate in April 2019 (Figure 38). Consumption rates are currently similar to historical levels observed within the last six years.

Figure 36: Estimated average consumption of cannabis by state/territory.



- Larger capital cities lower in consumption
- Variable between states
- Consumption of cannabis generally higher in regional areas, except Tasmania

Figure 37: Change in cannabis consumption in capital city South Australia. Cannabis is detected via the THC metabolite THC-COOH.



4.2.5 NEW PSYCHOACTIVE SUBSTANCES (NPS)

Methylone and mephedrone were only detected sporadically and at very low levels compared to other substances included in the report (August 2019 mephedrone and methylone results are shown in Table 10).

4.2.6 CAPITAL CITY AND REGIONAL AVERAGES

In order to show the national trends in the use of individual substances, all capital city and regional sites were combined separately and graphically displayed for the total sampling period (Figure 38). Fewer sites were sampled in between August 2016 and December 2016. Therefore, the contributing population was smaller between these dates and some approximations were necessary to account for the absence of densely populated regions (e.g. October 2016 for capital city New South Wales and Queensland).

Methylamphetamine consumption rates declined from October 2016 to June 2017, followed by increases from mid to late 2017, particularly in regional areas. Since then the trend has remained relatively steady, with higher consumption rates recorded for April 2019. Capital and regional use of methylamphetamine at the national level has decreased from the previous to the current reporting period.

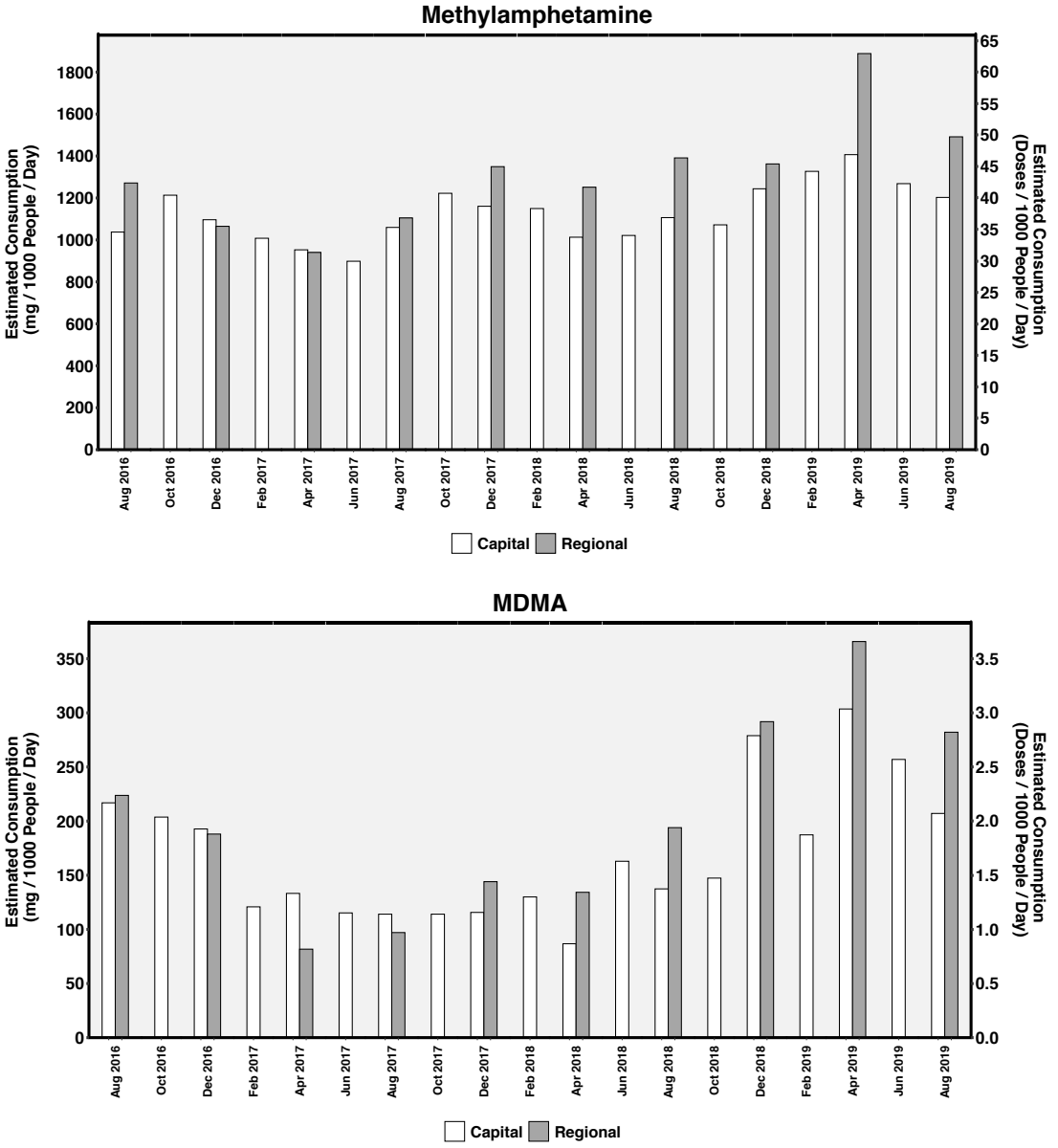
MDMA consumption rates declined overall over the first year of the program but have since increased gradually with some month-to-month variation observed over the course of 2018 and 2019. The initial rate of decline was more pronounced in regional areas (August 2016 to April 2017). From mid-2018 to the present, use of MDMA has increased in both capital city and regional parts of Australia, reaching its highest levels of the program in April 2019, before decreasing during the current reporting period.

Cocaine and heroin consumption showed some short-term variations, both in terms of capital city and regional levels. However, the long-term trend over the entire program shows that cocaine consumption is increasing, with national consumption rates in April 2019 at its highest point since the beginning of the program for both regional and capital city averages. Heroin use in the capital cities is more variable, following a saw-tooth pattern, but similarly shows a long-term increase. The opposite appears to be true in regional areas, where use remains low with periods of decline. Slight increases occurred in the reporting periods from April 2018 to August 2019.

In terms of legal substances with abuse potential, alcohol and nicotine consumption remained largely unchanged from the start of the program, with only small fluctuations evident (Figure 39). Results from this reporting period have decreased since the previous reporting period in April 2019. Nicotine consumption was substantially higher in regional areas compared to the capital city average, whereas alcohol averages were similar.
A distinct difference between capital cities and regional Australia was observed for the two pharmaceutical opioids monitored in the program. Capital city populations consumed both drugs at substantially lower levels compared to regional areas. Fentanyl use observed a small peak in consumption from late 2017 to early 2019, particularly in city areas, stabilising to the lowest consumption rates observed during the program. Oxycodone consumption in regional areas increased steadily after early 2017 and reached a peak in December 2018, declining since then. In contrast, average capital city use of oxycodone has remained relatively stable.

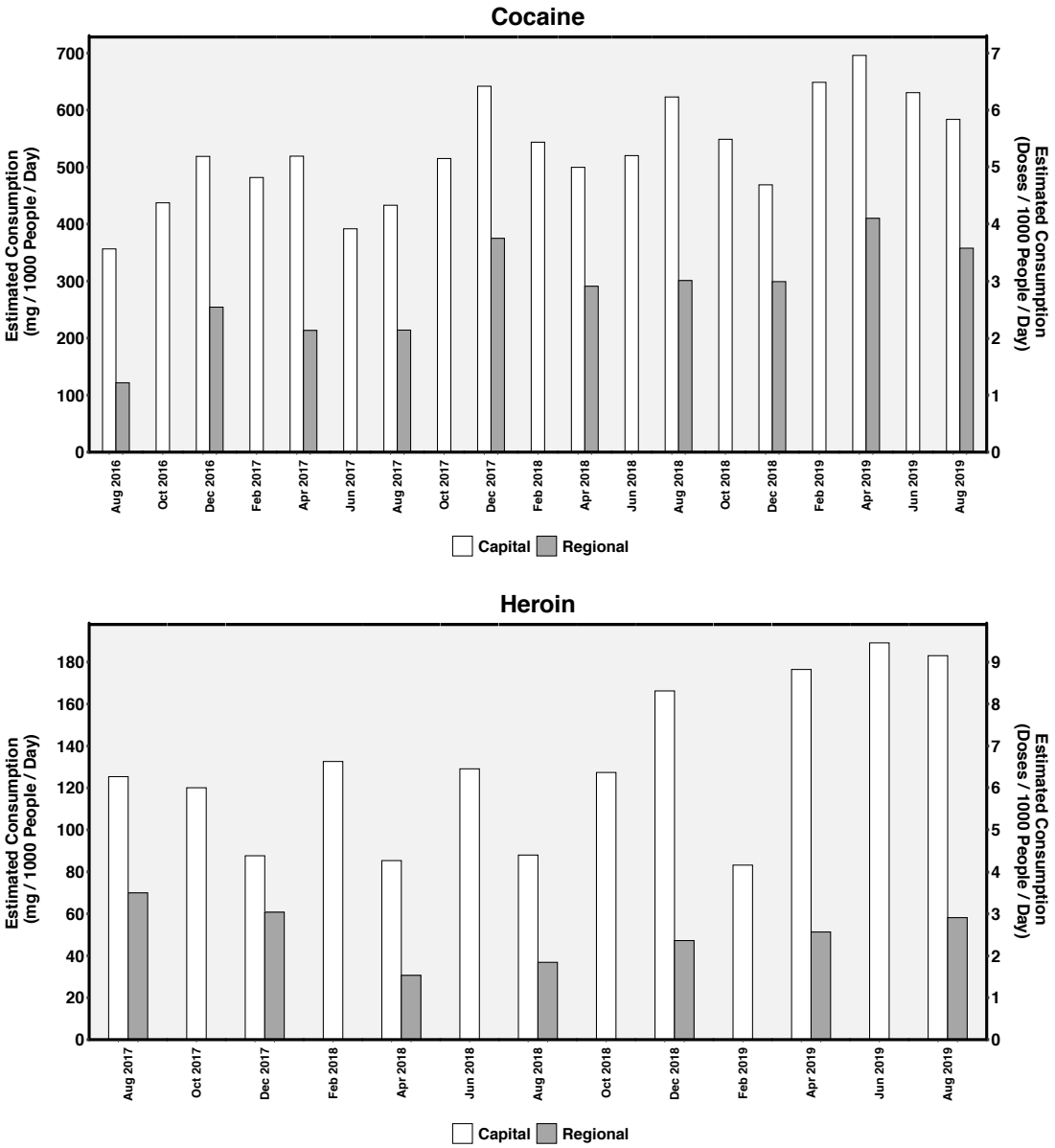
The remaining substances, cannabis, MDA, mephedrone and methylone had mixed results in the national context. Cannabis appeared essentially steady across capital city and regional areas (Figure 40). MDA also appeared stable across city sites, although regional sites had large variability which has partially been driven by sites in Queensland (for example, August 2017 high consumption rates were mainly influenced by Site 012). The mephedrone and methylone detection rate has varied across the course of the program for samples collected in capital city and regional areas. Apart from a spike in December 2017, the mephedrone detection frequency has increased from a low base to the highest capital city levels observed in the program in June 2019. However, methylone detections have been on the decline and have remained low since 2017.

Figure 38: The population-weighted average of all sites for methylamphetamine, MDMA, cocaine and heroin.



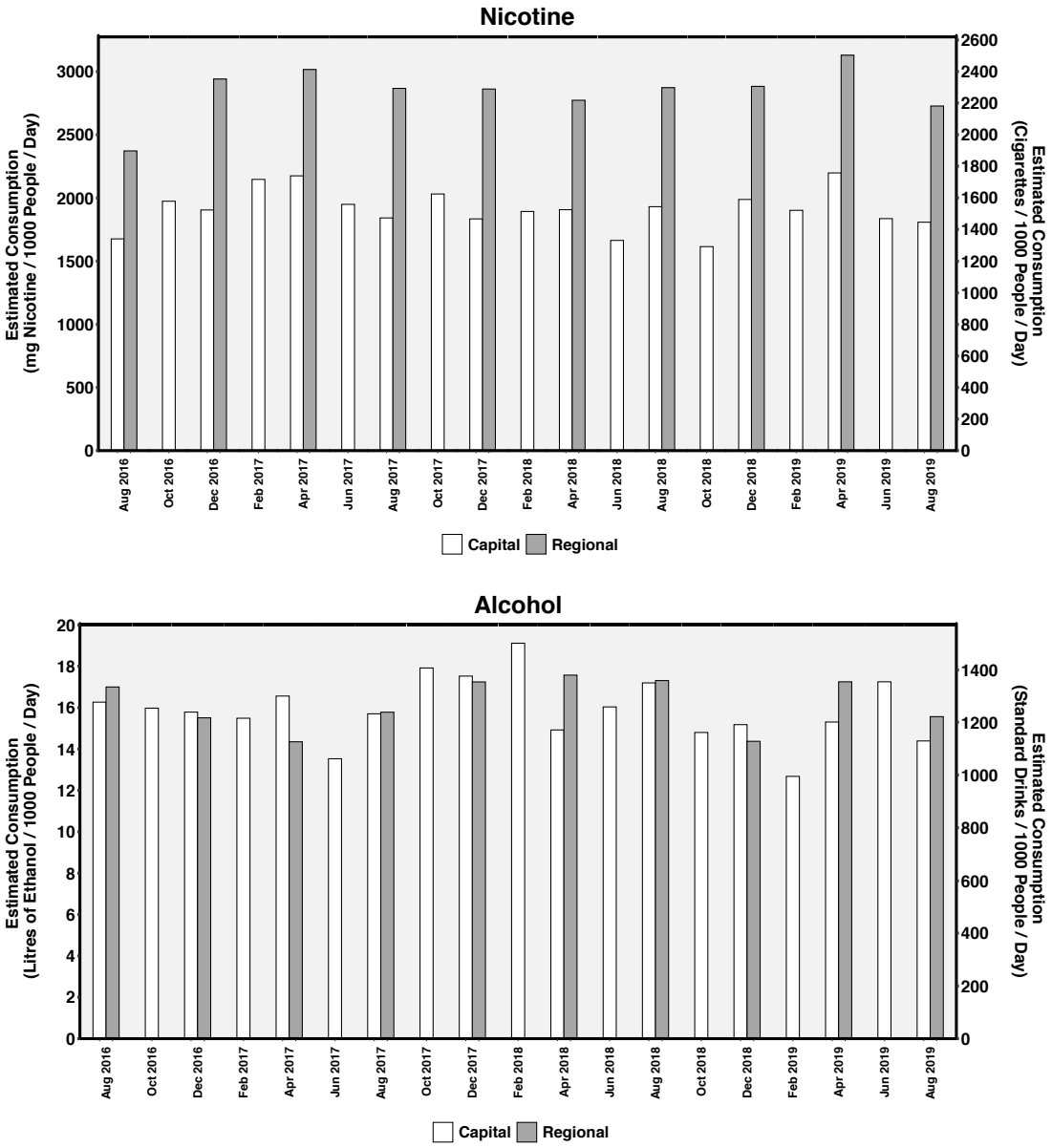
As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 38 (continued): The population-weighted average of all sites for methylamphetamine, MDMA, cocaine and heroin.



As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

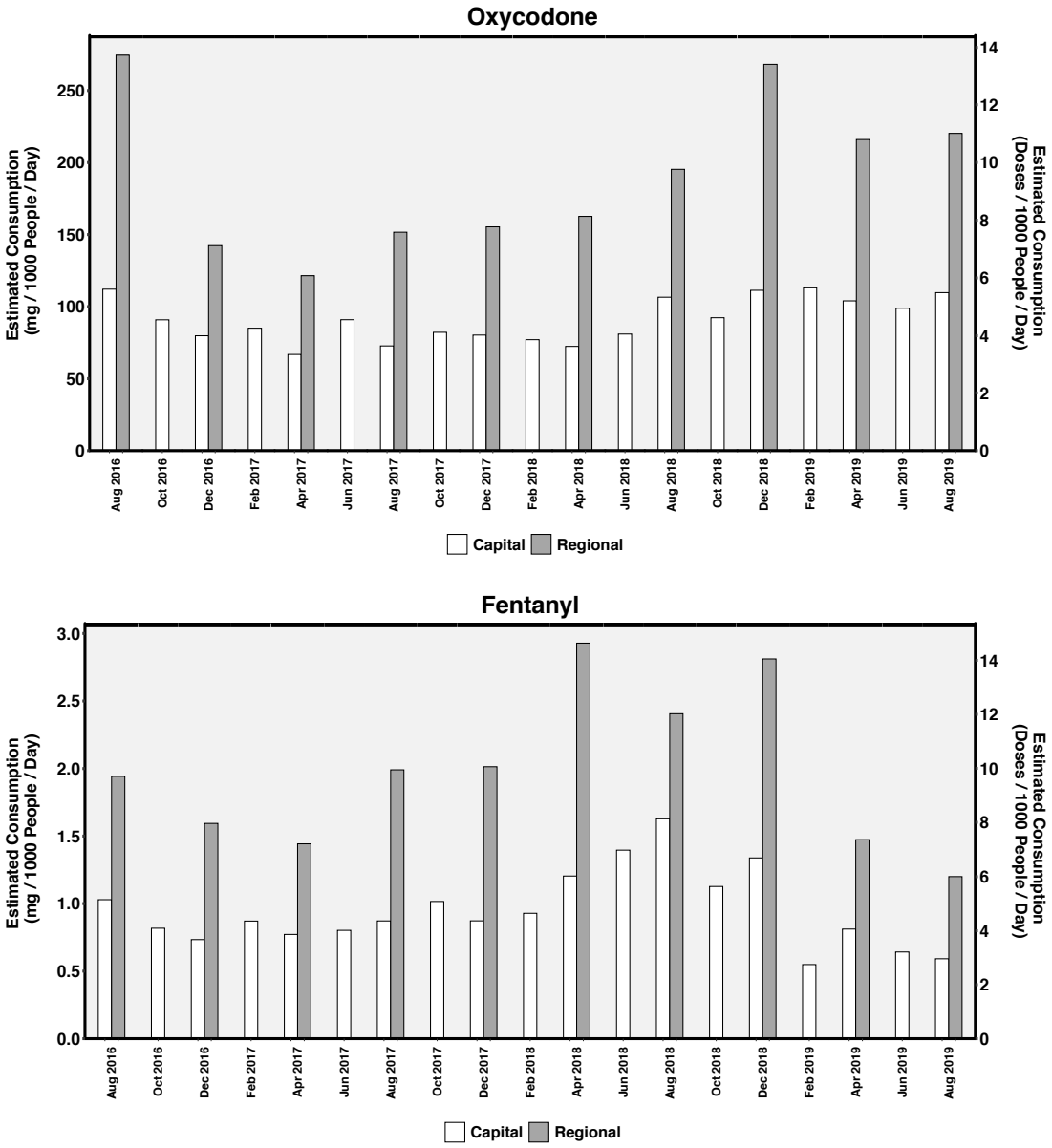
Figure 39: The population-weighted average of all sites for nicotine[7], alcohol, oxycodone and fentanyl.



As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

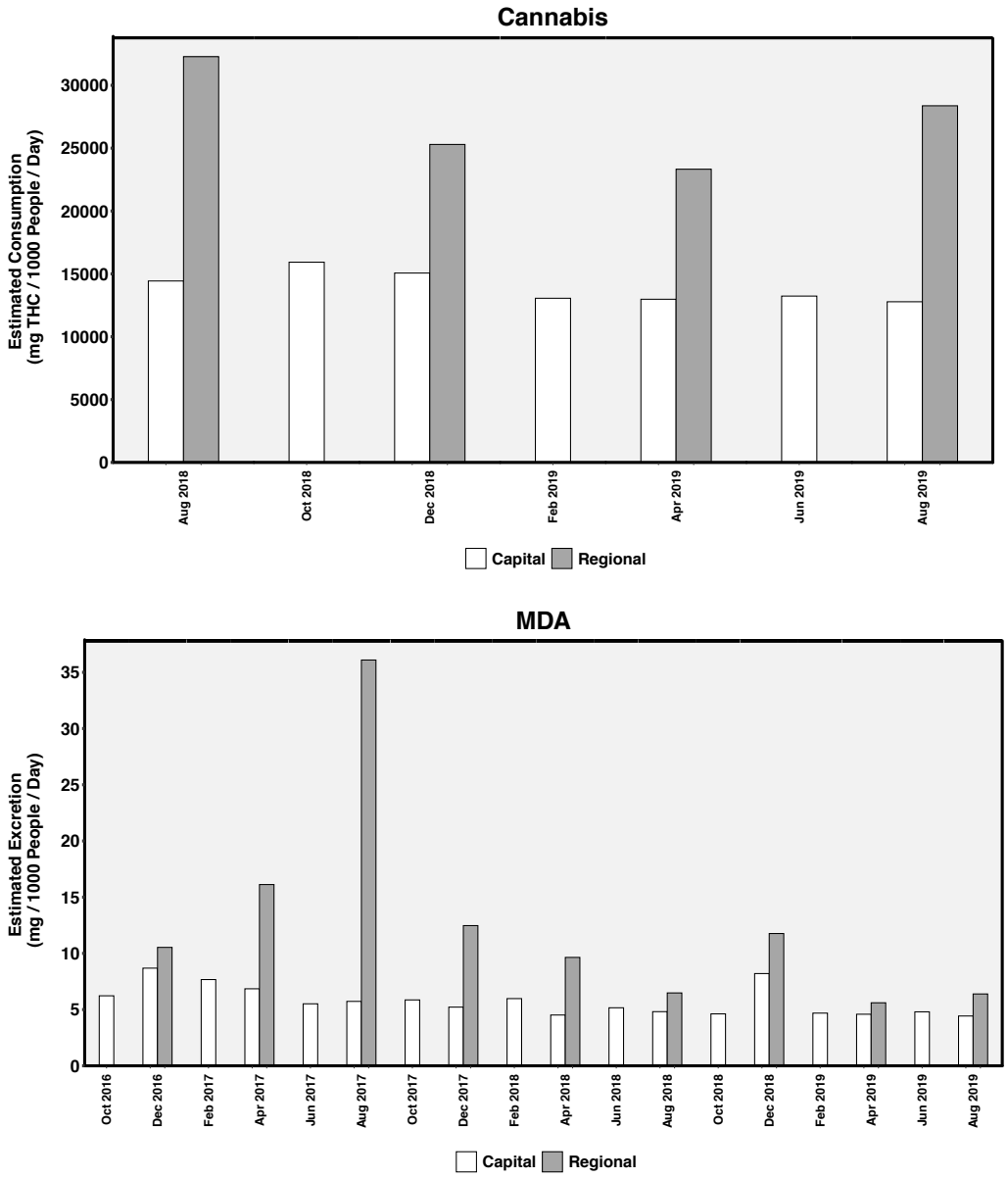
7 Nicotine consumption data have been adjusted to refine the factor used to convert consumed mass load to dose. Overall trends in nicotine consumption remain unchanged.

Figure 39 (continued): The population-weighted average of all sites for nicotine, alcohol, oxycodone and fentanyl.



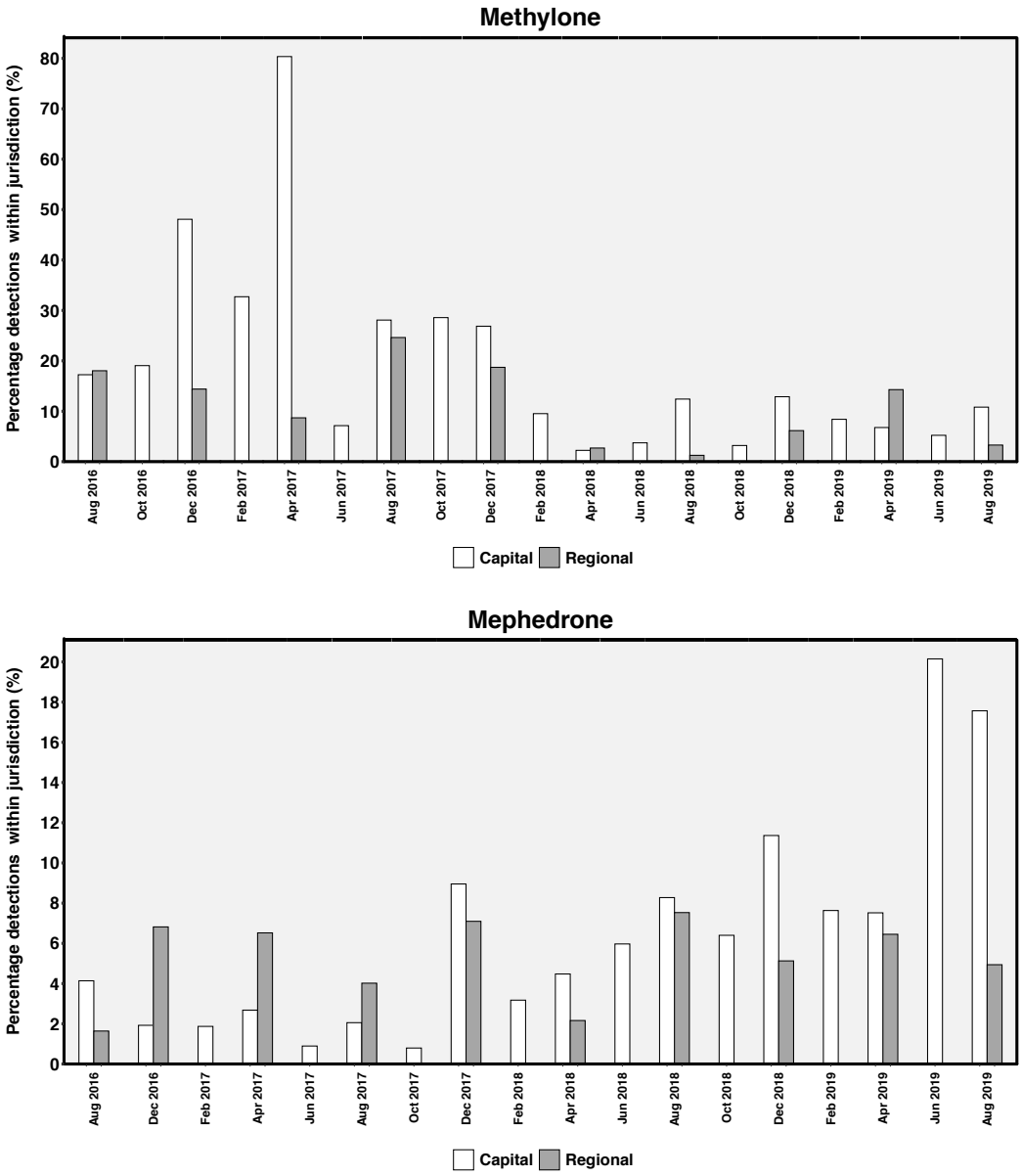
As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 40: The population-weighted average of all sites for cannabis, MDA, methylone and mephedrone.



As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 40 (continued): The population-weighted average of all sites for cannabis, MDA, methylone and mephedrone.



As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and April 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

4.3 DRUG PROFILE FOR EACH STATE AND TERRITORY

For the purpose of comparing the scale of use of different types of drugs within the same region (for example, within a state or territory), drug consumption was reported as the number of doses consumed. Cannabis was omitted from this section since the definition of a typical dose of cannabis is not well defined and has not been included in this or previous reports. This will be included in comparisons when an appropriate dose for cannabis becomes available. In the absence of pharmacokinetic excretion data for MDA, methylone and mephedrone, these compounds were also excluded from the section.

When the amount of drug measured in wastewater was normalised for population size and average dose consumed (conversion factors listed in Report 1, and in Appendix 1), alcohol and nicotine remained consistently the highest consumed drugs in all states and territories. For example, the national average consumption of nicotine and alcohol per 1,000 people per day were approximately 1,500 cigarettes per 1,000 people (Figure 4) and 1,200 standard drinks per day per 1,000 (Figure 5), whereas for methylamphetamine, the national average consumption was closer to 40 doses per 1,000 people per day (Figure 8).

Aside from nicotine and alcohol, of the illicit stimulants with dose information available, methylamphetamine use remained highest of the drugs included in the report. This was the case across all regions of Australia, with the scale of use of methylamphetamine consistently high for both capital cities and regional sites (Figure 41). When a dose becomes available for cannabis, this will be included in comparisons. Based on the large amounts (mg) of cannabis consumed (Figure 36), the doses of cannabis consumed is likely to be much higher than methylamphetamine. In terms of the profiles of other drugs monitored by the NWDMP (cocaine, MDMA, oxycodone and fentanyl), no other consistent patterns of usage within the different states and territories were observed other than previously described.

Figure 41: Profile of average drug consumption by state or territory. Consumption is shown as the number of doses per 1,000 people per day to allow comparison of drugs of different types within the same region (state or territory). The circles represent the cumulative average of all time points for respective drugs.

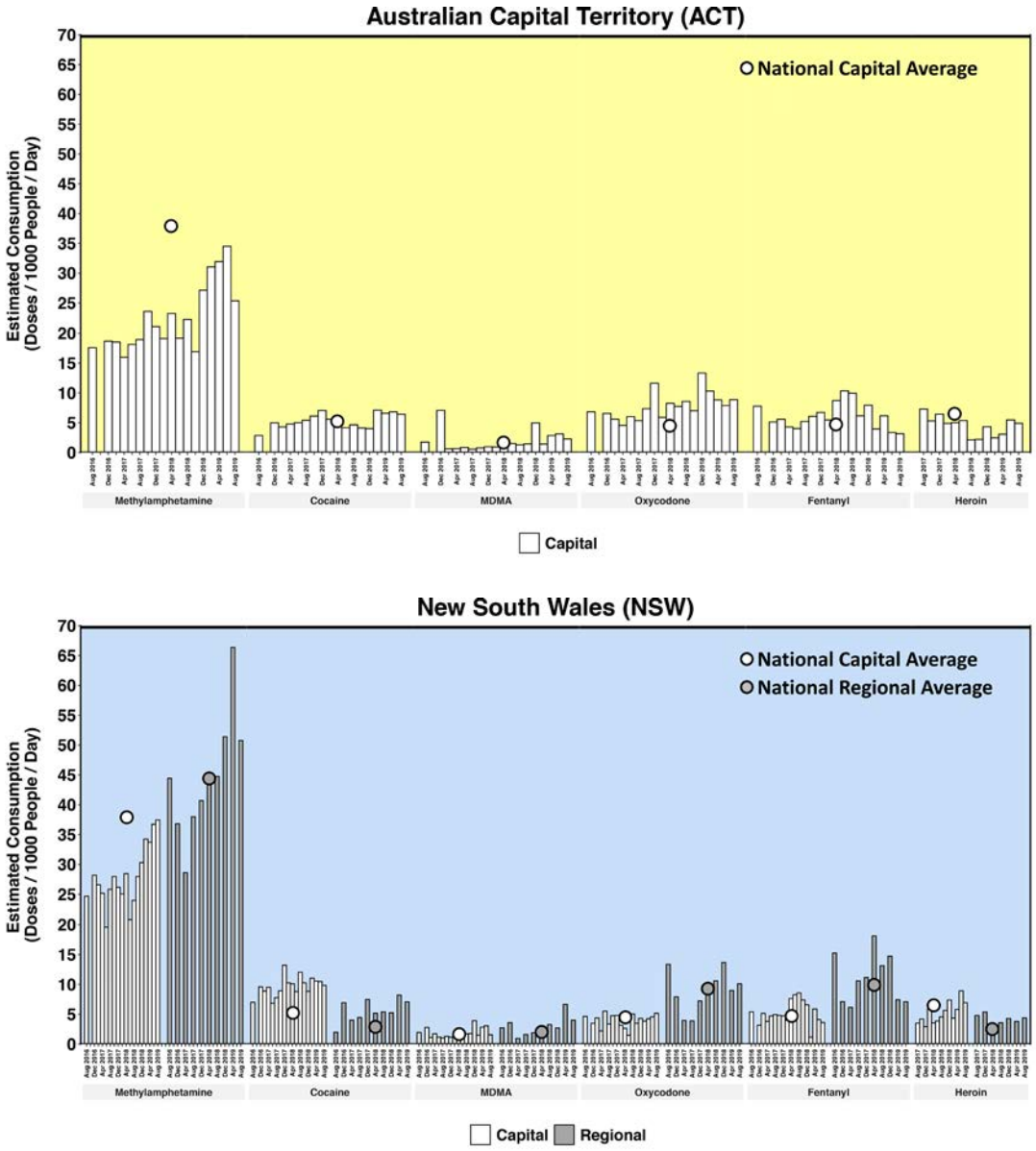
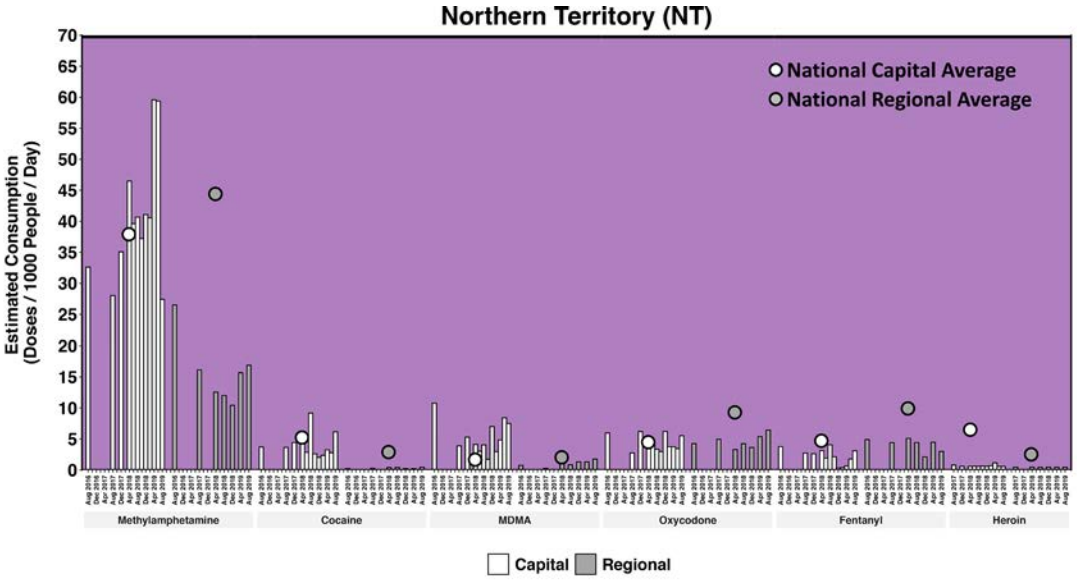


Figure 41 (continued): Profile of average drug consumption by state or territory.



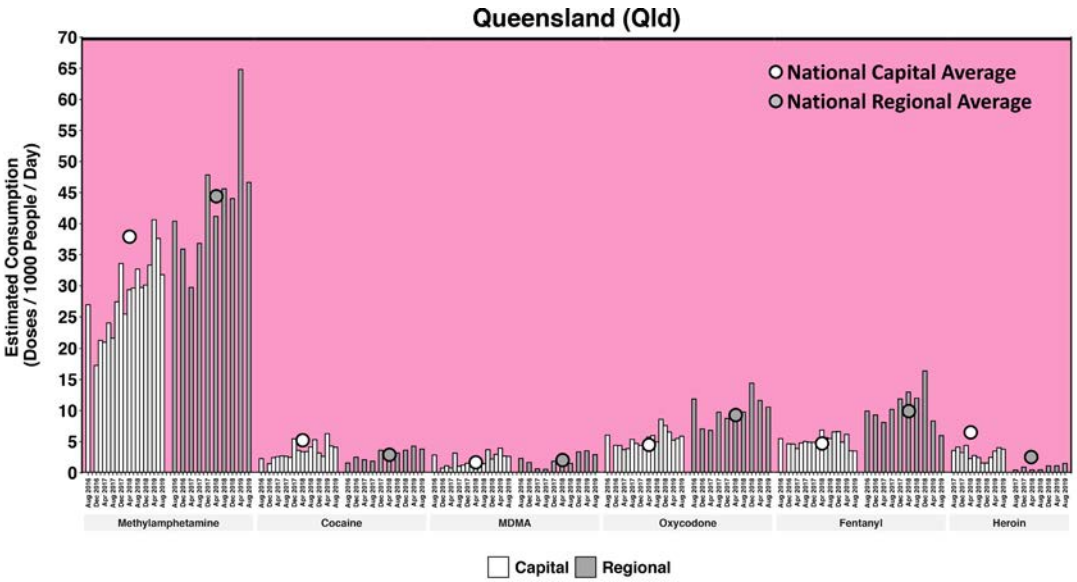


Figure 41 (continued): Profile of average drug consumption by state or territory. Note: the y axes for South Australia is higher than the other jurisdictions.

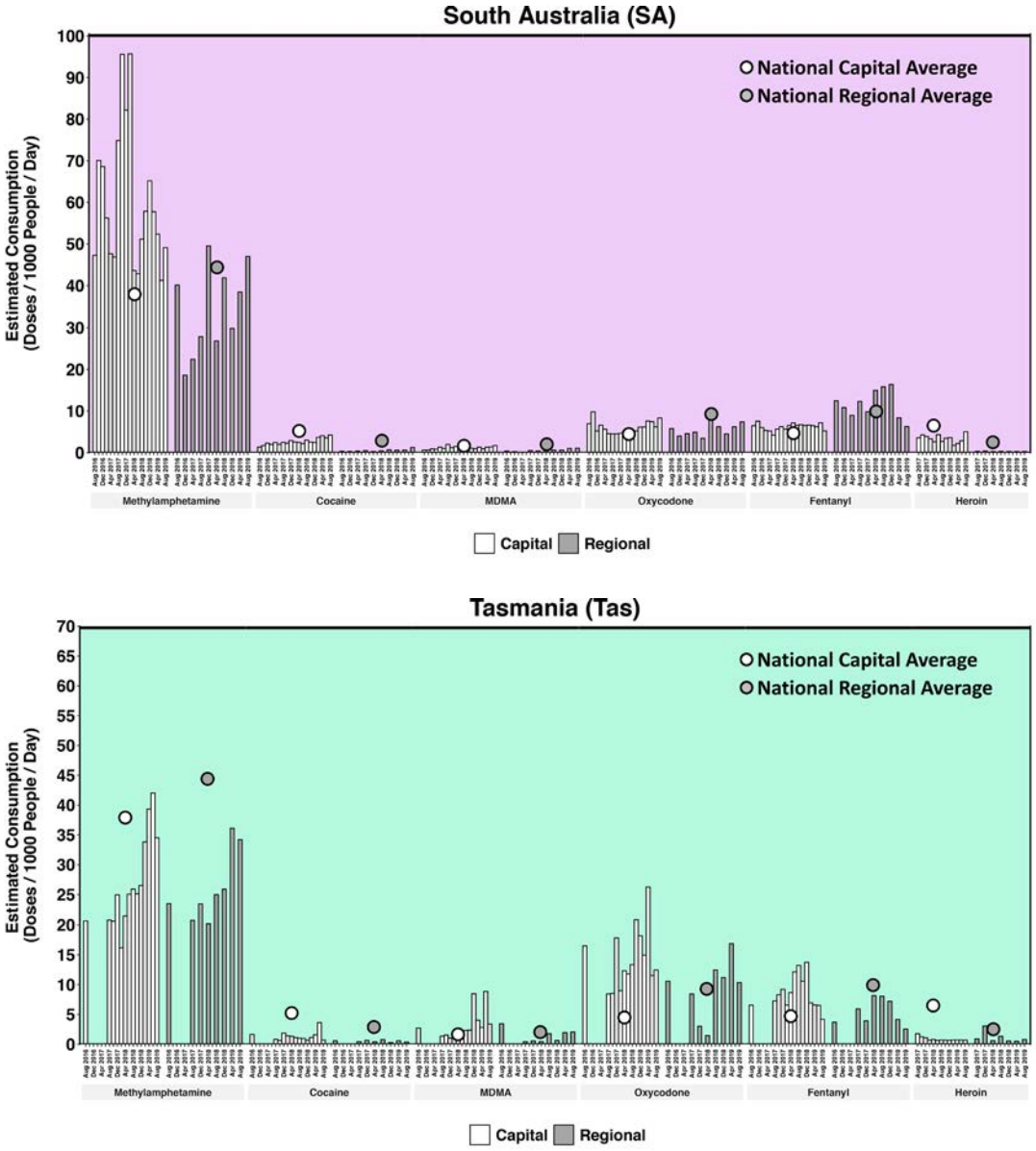
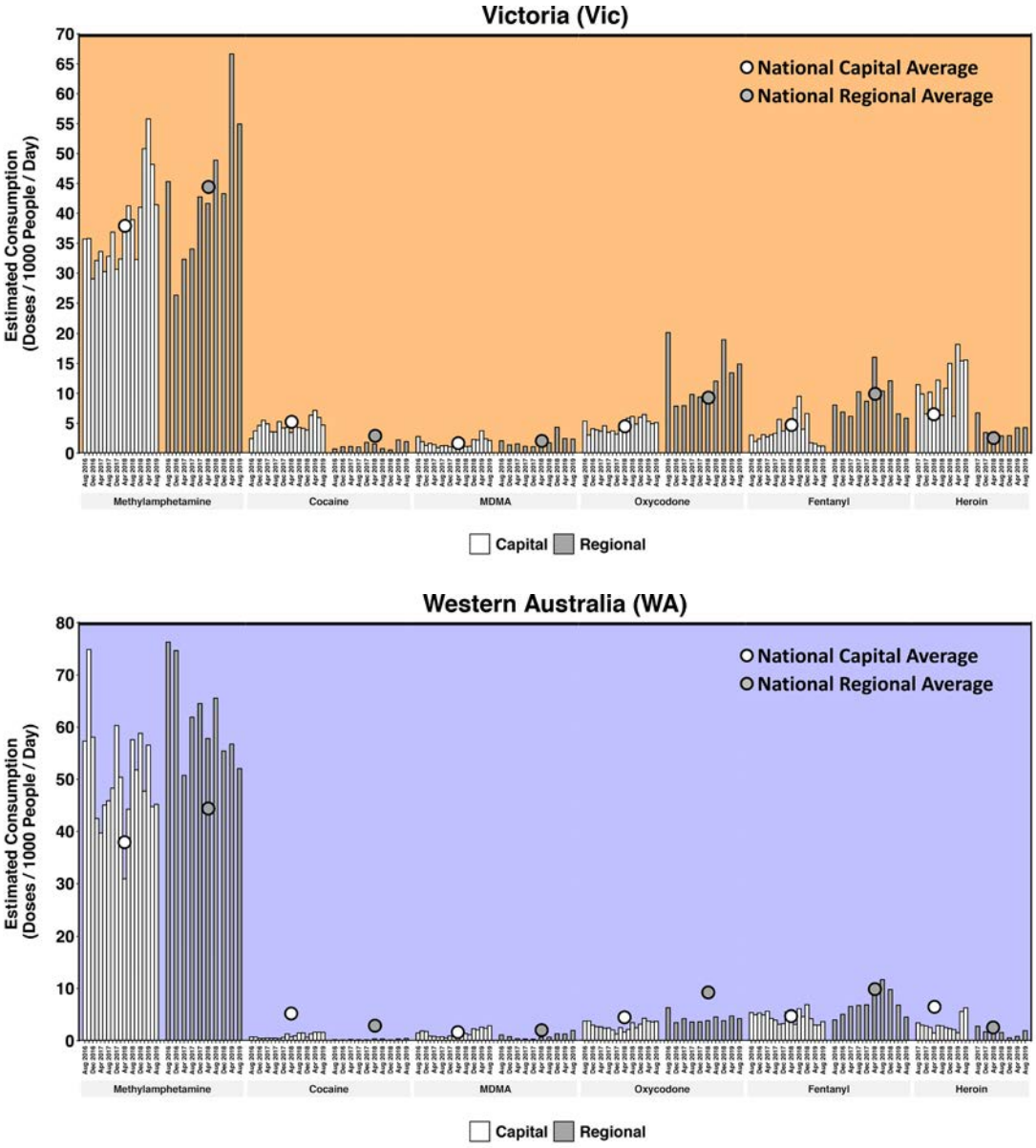


Figure 41 (continued): Profile of average drug consumption by state or territory. Note: the y axes for Western Australia is higher than the other jurisdictions.



5: ACKNOWLEDGMENTS

The project team sincerely thank the numerous WWTP operators involved in sample collection and WWTP management agencies for providing flow volumes and site information. The cooperation of the plants and management agencies is critical to the ongoing success of this project.

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We also thank the members of the Emerging Environmental Health Risks research group at QAEHS (incorporating the former Entox) for assistance with preparing and shipping sampling bottles to the various plants, and those members, past and present, who helped establish this field at the university.

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The symbols/images used in Figure 1 in the report were provided courtesy of the Integration and Application Network, University of Maryland, Center for Environmental Science (ian.umces.edu/symbols/).

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7: APPENDICES

APPENDIX 1: DRUG-SPECIFIC PARAMETERS FOR ANALYTICAL REPORTING AND USAGE CALCULATIONS

Analyte levels of detection, levels of reporting, highest detection, excretion factors and standard doses from the literature.

Analyte/metabolite	Drug	Limit of detection (LOD) [ng/L]	Limit of quantification (LOQ) [ng/L]	Excretion factor	Standard dose pure drug (mg)
Amphetamine	Amphetamine	12	16	0.394[a]	30[b]
Cocaine	Cocaine	17	50	0.075[b]	100[b]
Cotinine	Nicotine	33	100	0.3[c]	1.25[c]
Norfentanyl	Fentanyl	0.1	0.1	0.3[d]	0.2[d]
MDA *	MDA	1	4	n.a.	n.a.[#]
MDMA	MDMA	1.5	2	0.225[b]	100[b]
Mephedrone	Mephedrone	0.4	0.8	n.a.	n.a.
Methylamphetamine	Methylamphetamine	33	100	0.39[g]	30[b]
Methylone	Methylone	0.01	0.1	n.a.	n.a.
Hydroxycotinine	Nicotine	17	50	0.44[c]	1.25[c]
Noroxycodone	Oxycodone	0.1	1	0.22[f]	20[d]
Ethyl Sulphate	Alcohol (ethanol)	167	500	0.00012[e]	10g[e]
Benzoylecgonine	Cocaine	33	100	0.35[g]	100[b]
6-Monoacetylmorphine	Heroin	0.5	1.0	0.013[h]	20[j]
THC-COOH	THC (Cannabis)	30	180	0.006[b]	n.a.

n.a. = data not available; a = (Khan and Nicell 2012); b = (Zuccato et al. 2008); c = (Castiglioni et al. 2015); d = (Rossi 2016); e = (Ryu et al. 2016); f = (Lalovic et al. 2006); g = (Lai et al. 2011); h = (Boerner et al. 1975); i = (Sullivan et al. 2006).

* Data is not available in the scientific literature for the proportion of MDA that is eliminated after MDA consumption. However, data is available detailing the proportion of MDA eliminated after MDMA consumption. Therefore, our MDA estimate of mg excreted per day per 1,000 people is the amount of MDA excreted from the population after considering the metabolic fraction excreted from MDMA.

It is likely that the dose for MDA is similar to that of MDMA, or 100 mg.

APPENDIX 2: SAMPLING DETAILS OF EACH SITE FOR JUNE AND AUGUST 2019[8]

Site Code	Capital or Regional	Jun 2019	Aug 2019	Population
ACT: 009	Capital	7	7	> 150,000
NSW: 003	Capital	7	7	> 150,000
NSW: 006	Capital	7	7	> 150,000
NSW: 008	Capital	7	7	> 150,000
NSW: 021	Capital	–	7	30,000 to 150,000
NSW: 071	Capital	–	7	> 150,000
NSW: 016	Regional	–	5	30,000 to 150,000
NSW: 025	Regional	–	7	30,000 to 150,000
NSW: 040	Regional	–	7	< 30,000
NSW: 051	Regional	–	7	< 30,000
NSW: 068	Regional	–	7	> 150,000
NSW: 081	Regional	–	7	< 30,000
NSW: 115	Regional	–	–	30,000 to 150,000
NT: 010	Capital	7	7	30,000 to 150,000
NT: 078	Regional	–	7	< 30,000
QLD: 002	Capital	7	7	> 150,000
QLD: 005	Capital	7	7	> 150,000
QLD: 011	Capital	7	7	> 150,000
QLD: 012	Regional	–	7	> 150,000
QLD: 020	Regional	–	–	< 30,000
QLD: 024	Regional	–	7	30,000 to 150,000
QLD: 028	Regional	–	7	30,000 to 150,000
QLD: 029	Regional	–	–	30,000 to 150,000
QLD: 033	Regional	–	7	30,000 to 150,000
QLD: 039	Regional	–	7	< 30,000
QLD: 042	Regional	–	5	30,000 to 150,000
QLD: 053	Regional	–	7	< 30,000
QLD: 077	Regional	–	7	< 30,000
QLD: 092	Regional	–	–	< 30,000
SA: 007	Capital	7	7	> 150,000
SA: 013	Capital	7	7	> 150,000
SA: 027	Capital	7	7	30,000 to 150,000
SA: 059	Capital	7	7	> 150,000
SA: 017	Regional	–	7	< 30,000
SA: 022	Regional	–	7	< 30,000
SA: 063	Regional	–	7	< 30,000
SA: 076	Regional	–	7	< 30,000
SA: 119	Regional	–	7	< 30,000

8 Sampling details of each wastewater treatment plant for the previous collection periods are available in Report 7, Appendix 2 and Report 6, Appendix 3.

APPENDIX 2 (CONTINUED): SAMPLING DETAILS OF EACH SITE FOR JUNE AND AUGUST 2019

Site Code	Capital or Regional	Jun 2019	Aug 2019	Population
TAS: 004	Capital	5	5	< 30,000
TAS: 019	Capital	5	5	< 30,000
TAS: 041	Capital	5	5	< 30,000
TAS: 018	Regional	–	5	< 30,000
TAS: 038	Regional	–	–	< 30,000
TAS: 048	Regional	–	5	< 30,000
TAS: 058	Regional	–	–	< 30,000
VIC: 001	Capital	7	7	> 150,000
VIC: 067	Capital	7	7	> 150,000
VIC: 037	Regional	–	6	> 150,000
VIC: 046	Regional	–	7	30,000 to 150,000
VIC: 061	Regional	–	7	30,000 to 150,000
VIC: 062	Regional	–	–	< 30,000
VIC: 066	Regional	–	7	30,000 to 150,000
VIC: 114	Regional	–	7	30,000 to 150,000
VIC: 121	Regional	–	7	< 30,000
VIC: 122	Regional	–	7	< 30,000
VIC: 123	Regional	–	7	< 30,000
VIC: 124	Regional	–	7	< 30,000
VIC: 125	Regional	–	7	30,000 to 150,000
WA: 101	Capital	7	7	> 150,000
WA: 103	Capital	7	7	> 150,000
WA: 104	Capital	7	7	> 150,000
WA: 102	Regional	–	7	30,000 to 150,000
WA: 116	Regional	–	7	< 30,000
WA: 118	Regional	–	–	< 30,000
WA: 120	Regional	–	7	30,000 to 150,000
WA: 129	Regional	–	7	< 30,000
Regional Sites		–	36	
Capital Sites		20	22	
Total Sites		**20**	**58**	
Regional Samples		–	243	
Capital Samples		134	148	
Total Samples		134	391	
Cumulative Samples*		**3,894**	**4,285**	

*Flow data has been made available for a total of 19 historical samples which have been included in the study results retrospectively. These were 14 samples in April 2017 (Site 016, 7 samples and Site 114, 7 samples), 3 samples in August 2017 (Site 011, 1 sample and Site 062, 2 samples), 1 sample in December 2017 (Site 59), and 1 sample in August 2018 (Site 039). None of the additional datapoints have significantly altered the interpretation of results. Therefore, the total number of samples for reports 1-8 is revised to 3,760.

APPENDIX 3: PROPORTION OF SAMPLES ABOVE LOD (%) FOR EACH DRUG IN JUNE AND AUGUST 2019[9]

Drug	Capital or Regional	Jun 2019	Aug 2019
Alcohol	Capital	100	100
Alcohol	Regional	–	100
Cannabis	Capital	100	100
Cannabis	Regional	–	97
Cocaine	Capital	99	92
Cocaine	Regional	–	61
Fentanyl	Capital	93	93
Fentanyl	Regional	–	93
Heroin	Capital	83	66
Heroin	Regional	–	29
MDA	Capital	99	99
MDA	Regional	–	95
MDMA	Capital	100	99
MDMA	Regional	–	95
Mephedrone	Capital	16	11
Mephedrone	Regional	–	2
Methylamphetamine	Capital	100	100
Methylamphetamine	Regional	–	100
Methylone	Capital	5	11
Methylone	Regional	–	3
Nicotine	Capital	100	100
Nicotine	Regional	–	100
Oxycodone	Capital	100	100
Oxycodone	Regional	–	100

9 Percentage detection for previous collection periods are available in Reports 7 and 8, Appendix 3 and Report 6, Appendix 4.

CONCLUSIONS

CONCLUSIONS

For the ninth report of the National Wastewater Drug Monitoring Program, wastewater analysis was conducted in June and August 2019. The program has identified variations in patterns of drug consumption, both over time and within and between jurisdictions. Consistent with previous reports, findings show that of the substances monitored with known doses, nicotine and alcohol are the most consumed drugs in Australia, while methylamphetamine remains the most consumed illicit drug.[10]

METHYLAMPHETAMINE

When comparing data for April 2019 and August 2019, the population-weighted average consumption of methylamphetamine decreased in both capital city and regional sites. Regional average methylamphetamine consumption continues to exceed capital city average consumption. South Australia had the highest estimated average capital city consumption of methylamphetamine in August 2019, while Victoria had the highest estimated average regional consumption.

COCAINE

When comparing data for April 2019 and August 2019, the population-weighted average consumption of cocaine decreased in both capital city and regional sites. Capital city average cocaine consumption continues to exceed regional average consumption. New South Wales had the highest estimated average cocaine consumption in both capital city and regional sites in August 2019.

3,4-METHYLENEDIOXYMETHYLAMPHETAMINE (MDMA)

When comparing data for April 2019 and August 2019, the population-weighted average consumption of MDMA decreased in both capital city and regional sites. Regional average MDMA consumption continues to exceed capital city average consumption. The Northern Territory[11] had the highest estimated average capital city consumption of MDMA in August 2019, while New South Wales had the highest estimated average regional consumption.

3,4-METHYLENEDIOXYAMPHETAMINE (MDA)

MDA is a metabolite of MDMA. When comparing data for April 2019 and August 2019, MDA excretion in capital city sites decreased in August 2019 to the lowest levels recorded by the program, while excretion in regional sites increased. Regional average MDA excretion continues to exceed capital city average excretion. Tasmania had the highest estimated average MDA excretion in both capital city and regional sites in August 2019.

10 Throughout this report, unless otherwise stated, all comparisons on the consumption of different drugs are based on doses consumed rather than drug mass.

11 As the Northern Territory only had two participating sites, results may not be representative of the Territory as a whole.

HEROIN

When comparing data for April 2019 and August 2019, the population-weighted average consumption of heroin increased in both capital city and regional sites. Capital city average heroin consumption continues to exceed regional average consumption. Victoria had the highest estimated average capital city consumption of heroin in August 2019, while New South Wales and Victoria had the highest estimated average regional consumption.

CANNABIS

The program began measuring cannabis consumption in August 2018. When comparing data for April 2019 and August 2019, the population-weighted average consumption of cannabis decreased in capital city sites in August 2019 to the lowest level recorded by the program, while consumption in regional sites increased. Regional average cannabis consumption continues to exceed capital city average consumption. Tasmania had the highest estimated average capital city consumption of cannabis in August 2019, while South Australia had the highest estimated average regional consumption.

OXYCODONE

When comparing data for April 2019 and August 2019, the population-weighted average consumption of oxycodone increased in both capital city and regional sites. Regional average oxycodone consumption continues to exceed capital city average consumption. Tasmania had the highest estimated average capital city consumption of oxycodone in August 2019, while Victoria had the highest estimated average regional consumption.

FENTANYL

When comparing data for April 2019 and August 2019, the population-weighted average consumption of fentanyl decreased in both capital city and regional sites, with average regional consumption in August 2019 the lowest level recorded by the program. Regional average fentanyl consumption continues to exceed capital city average consumption. South Australia had the highest estimated average capital city consumption of fentanyl in August 2019, while New South Wales had the highest estimated average regional consumption.

NICOTINE

When comparing data for April 2019 and August 2019, the population-weighted average consumption of nicotine decreased in both capital city and regional sites. Regional average nicotine consumption continues to exceed capital city average consumption. The Northern Territory[12] had the highest estimated average capital city and regional consumption of nicotine in August 2019.

12 As the Northern Territory only had two participating sites, results may not be representative of the Territory as a whole.

ALCOHOL

When comparing data for April 2019 and August 2019, the population-weighted average consumption of alcohol decreased in both capital city and regional sites. Regional average alcohol consumption exceeded capital city average consumption. The Northern Territory[13] had the highest estimated average alcohol consumption in both capital city and regional sites in August 2019.

MEPHEDRONE

Consistent with previous reporting periods, mephedrone was mostly detected below the level at which it could be reliably quantified. The number of national detections of mephedrone increased, from 24 in April 2019 to 38 in August 2019, with the number of detections in capital city sites exceeding the number of detections in regional sites. The number of sites where mephedrone was detected increased, from 8 in April 2019 to 12 in August 2019. Mephedrone was detected in New South Wales, Queensland, Victoria and Western Australia, with New South Wales reporting the highest number of detections in August 2019.

METHYLONE

Consistent with previous reporting periods, methylone was mostly detected below the level at which it could be reliably quantified. The number of national detections of methylone decreased, from 40 in April 2019 to 24 in August 2019, with the number of detections in capital city sites exceeding the number of detections in regional sites. The number of sites where methylone was detected decreased, from 11 in April 2019 to 8 in August 2019. Methylone was detected in New South Wales, the Northern Territory and Western Australia, with New South Wales reporting the highest number of detections in August 2019.

NEXT REPORT

The tenth report of the National Wastewater Drug Monitoring Program is scheduled for public release in mid-2020.

13 As the Northern Territory only had two participating sites, results may not be representative of the Territory as a whole.