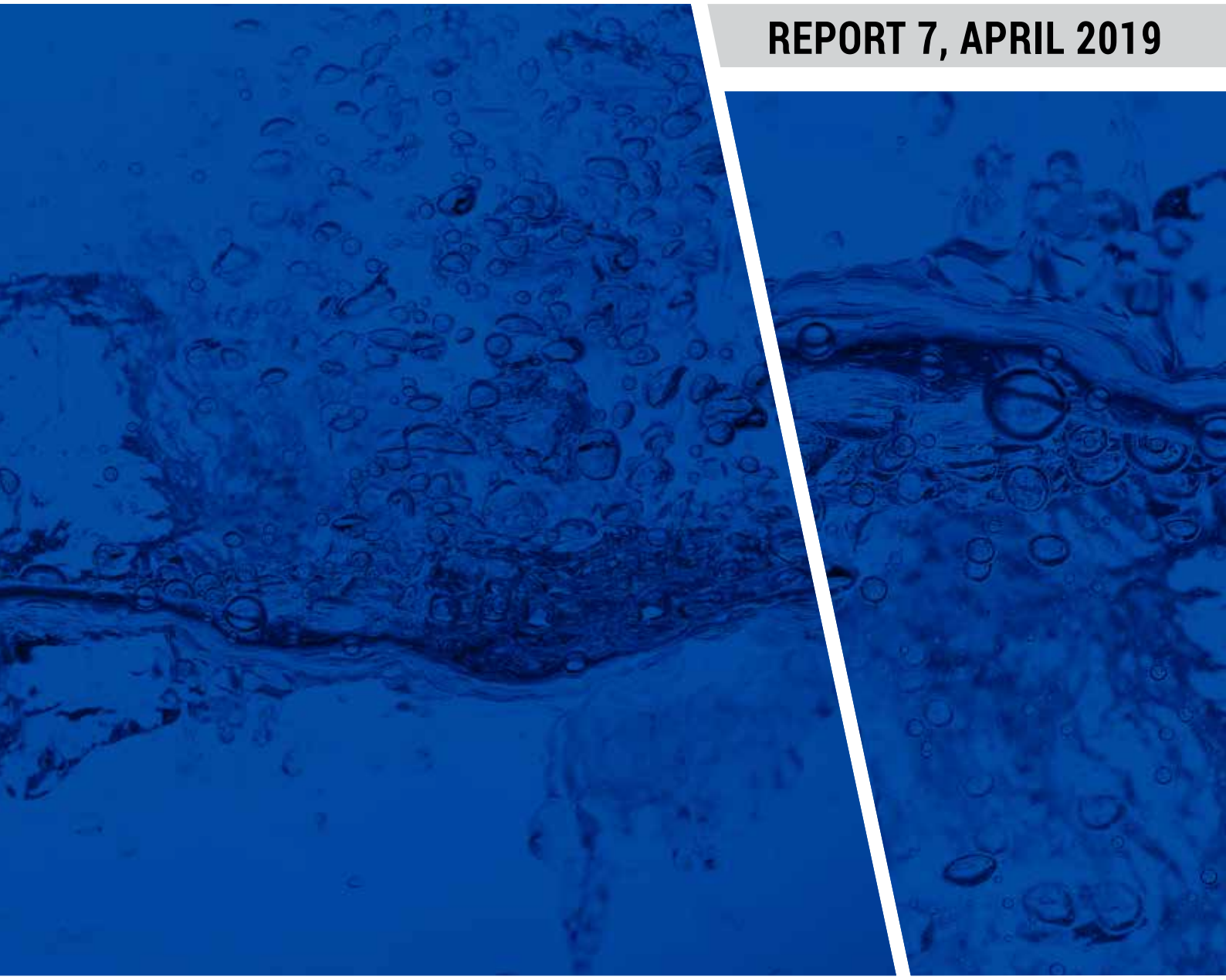
NATIONAL WASTEWATER DRUG MONITORING PROGRAM

REPORT 7, APRIL 2019



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 national responsibility to provide information and intelligence on criminal activity. Much of the harm that Australians suffer at the hands of organised crime is due to the trade in illicit substances and abuse of licit substances, with serious and organised crime groups profiting from the importation, manufacture, trafficking and sale of drugs.

This National Wastewater Drug Monitoring Program report is the seventh in a series of public reports that detail findings of the program. The program provides statistically valid datasets of drug use and distribution patterns across a large number of sites in capital cities and regional Australia, which are being used to build a comprehensive and increasingly detailed picture of national drug consumption.

The Australian Criminal Intelligence Commission is exploring opportunities to use data obtained from the program in new ways. For the first time in this report charting of national trends for a range of drugs is included to better understand long run patterns and market dynamics. More complex analysis that incorporates additional data collected by Commonwealth departments, state and territory agencies and industry will also be undertaken and outlined in future reports.

Wastewater analysis is widely applied internationally as a tool to measure and interpret drug use within populations, with the national program in Australia representing world best practice. Wastewater analysis provides a measure of one important aspect of national health—the demand for a range of licit and illicit drugs. An understanding of this behaviour allows resources to be effectively directed to priority areas and monitor the progress of demand, supply and harm reduction strategies.

TRENDS IDENTIFIED DURING THIS REPORTING PERIOD

This report includes wastewater data from all states and territories. In December 2018, 50 wastewater sites were monitored nationally. Based on 2016 Census data, these sites cover approximately 54 per cent of the Australian population—around 12.6 million people.

In December 2018, with the exception of cocaine, heroin and alcohol, the regional average consumption of drugs measured by the program exceeded capital city consumption. Of the drugs measured with available dose data, alcohol and nicotine continue to be the most consumed drugs in Australia, with methylamphetamine remaining the most consumed illicit drug. Consumption of other drugs measured by the program remains considerably lower. Overall, the average consumption of most drugs monitored by the program increased or remained relatively stable between August and December 2018.

Of note this reporting period is the increase in the population-weighted average consumption of MDMA in both capital city and regional sites and an increase in the population-weighted average consumption of heroin in capital city sites. While consumption of these drugs remains lower than other illicit drugs monitored by the program, these increases are of concern, with the related consumption at the highest levels recorded by the program. The continued monitoring of drug consumption in Australia will build longitudinal data and assist in identifying and understanding variations in use to inform the development of timely and appropriate responses.

This report also includes updated SCORE data, which provide international drug consumption comparisons for a number of stimulant drugs monitored by the program. Stimulant consumption in Australia continues to be primarily driven by methylamphetamine use. Of the 25 countries with comparable data, Australia ranks second highest for total estimated stimulant consumption. When comparing the individual stimulant drugs, Australia ranks second for methylamphetamine and MDMA, with relatively low cocaine consumption.

ADDITIONAL INSIGHTS GAINED FROM WASTEWATER ANALYSIS

Wastewater analysis provides a measure of the demand for a range of licit and illicit drugs. Analysis of wastewater data offers opportunities to address emerging problems, identify previously unknown drug threats and assists in measuring the effectiveness of demand reduction initiatives and supply disruption strategies.

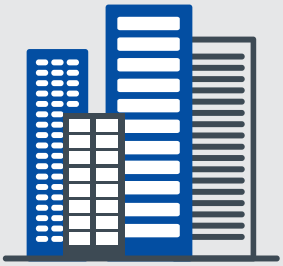
Following the annual national consumption estimates included in Report 6 for methylamphetamine, cocaine, MDMA and heroin, this report includes a further breakdown of these figures to the state and territory level. This shows that population size is not the sole influencing factor on drug consumption and again highlights the differences in consumption that exist between and within individual states and territories. Understanding these differences is important in the development and delivery of tailored responses to suit the specific needs of individual jurisdictions and locations.

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

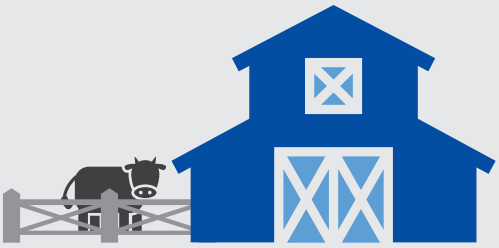
Michael Phelan APM
Chief Executive Officer
Australian Criminal Intelligence Commission

SNAPSHOT

The December 2018 collection covers around **54 per cent** of Australia's population—about **12.6 million Australians.**



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

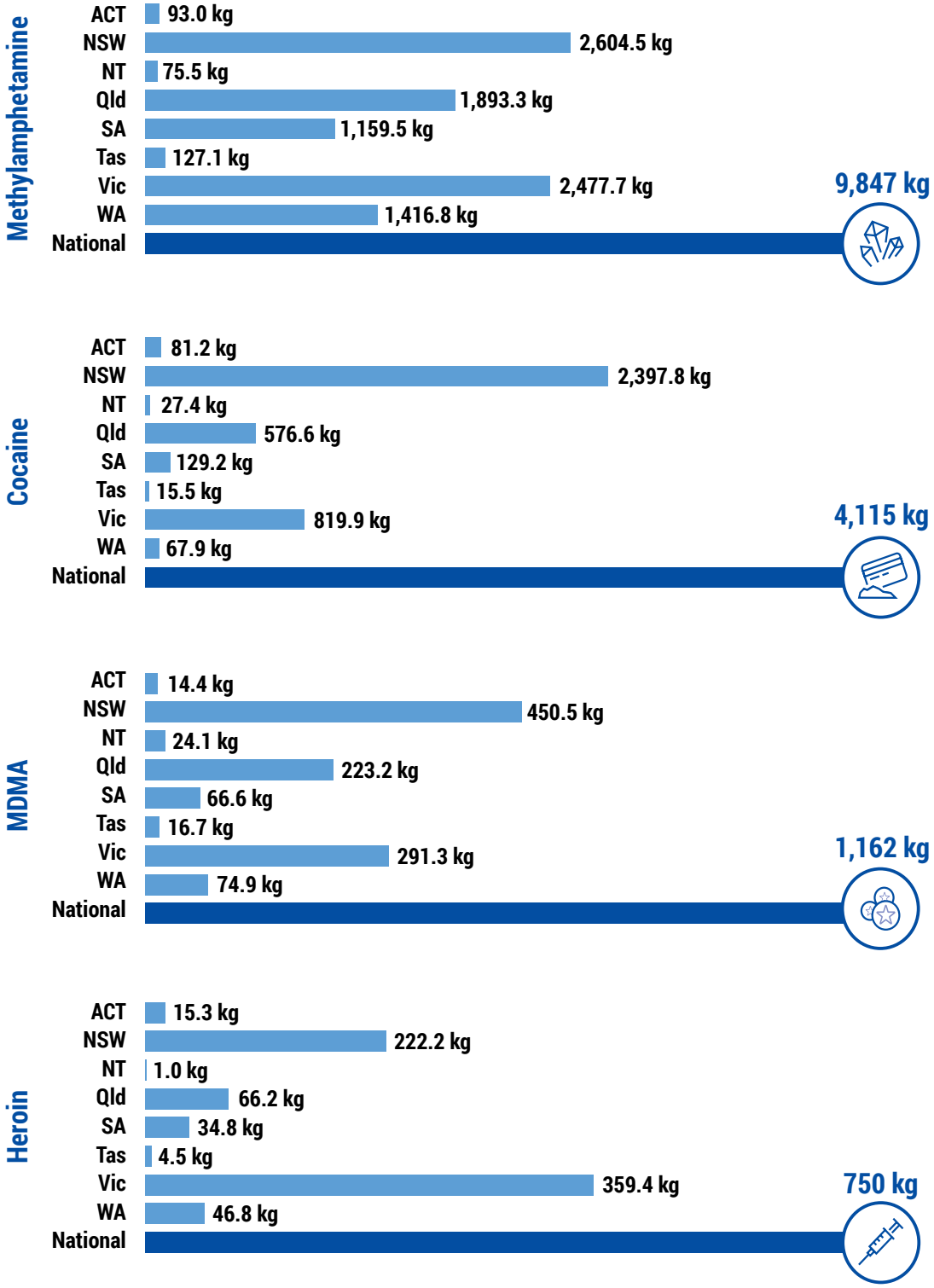


Regional **nicotine, methylamphetamine, MDMA, MDA, oxycodone, fentanyl** and **cannabis** average consumption exceeded capital city consumption.

SCORE INTERNATIONAL COMPARISONS

Of the 25 countries with comparable stimulant data, **Australia ranks second** for **methylamphetamine** and **MDMA**, with relatively **low cocaine consumption**.

Stimulant consumption in Australia continues to be primarily **driven by methylamphetamine** use.



Estimated state and territory annual consumption of methylamphetamine, cocaine, MDMA and heroin (based on NWDMP data for August 2017 to August 2018).

INTRODUCTION

This is the seventh in a series of National Wastewater Drug Monitoring Program reports to be publicly released by the Australian Criminal Intelligence Commission. 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 of drug consumption across Australia and can identify new sources of threat.

Findings presented in the reports provide law enforcement, policy, regulatory and health agencies 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 assist to 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.

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

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.

Both contracted universities monitor wastewater across Australia, covering all state and territory capital cities and a range of regional cities and towns. In December 2018, 50 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 December 2018 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 decide 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 three years of the contract.

REPORTING

National Wastewater Drug Monitoring Program reports are published as comprehensive public reports three times a year. 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 are not publicly released by the Australian Criminal Intelligence Commission. Stakeholders in law enforcement, health and other relevant policy agencies may be 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.

EXPLOITATION OF THE NATIONAL WASTEWATER DRUG MONITORING PROGRAM DATA

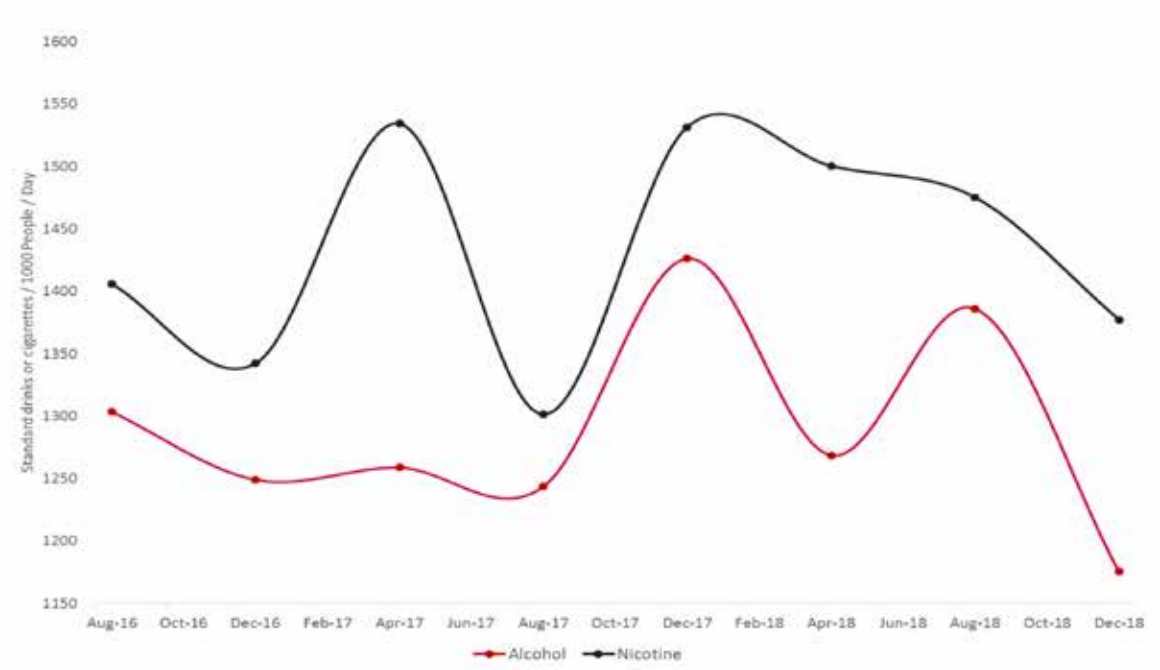
The National Wastewater Drug Monitoring Program is based on a well-established and internationally recognised methodology that has been applied to varying extents by many other nations. The Australian Criminal Intelligence Commission considers that National Wastewater Drug Monitoring Program data provide 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 commodities in the Australian population, complementing other drug datasets published in Australia. The seventh National Wastewater Drug Monitoring Program report measures the drug use of 54 per cent of the Australian population.[2]

The figures below reflect national average consumption of drugs where dose data are available. They demonstrate trends in actual and relative consumption levels within and between markets. The trend data confirm a number of key national trends:

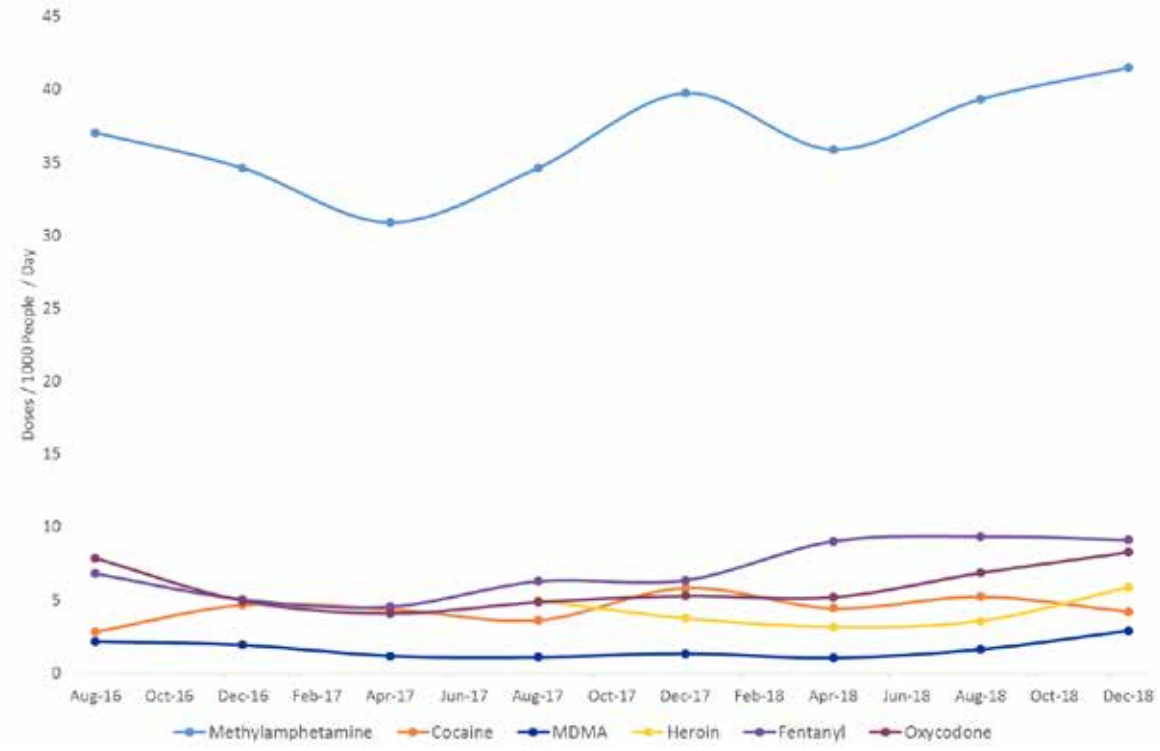
- consumption of nicotine and alcohol fell in the 12 months to December 2018
- methylamphetamine consumption continues to outstrip the consumption of all other illicit drug types and pharmaceuticals
- oxycodone use rose in the six months to December 2018, while fentanyl use plateaued in the same period.

2 The December 2018 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.

National average drug consumption of nicotine and alcohol:



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



Wastewater data are also particularly useful for identifying 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.

Wastewater data are used with other available data sources to obtain a more comprehensive and accurate understanding of drug markets nationally and in the states and territories. The Australian Criminal Intelligence Commission continues to engage with academic institutions, industry and public sector agencies concerning potential uses for data generated by the National Wastewater Drug Monitoring Program. Discussions have centred upon responses in high risk areas, measuring drug use in particular local areas, estimating the size of specific illicit markets, comparing wastewater data with other drug-related data and exploring options for monitoring the effectiveness of existing demand, supply and harm reduction initiatives. The advantage the National Wastewater Drug Monitoring Program offers in all these contexts is 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 as circumstances change.

Making National Wastewater Drug Monitoring Program data publicly available assists to enrich understanding and inform the national conversation on drug trends and related demand. It is also possible to compare domestic drug consumption with international drug consumption because the collection and analysis protocols are similar internationally. For instance, this report includes a comparison of national stimulant drug consumption data with recent Sewage analysis 'CORe group Europe (SCORE)' consumption data for Australia and a number of countries in Europe, North America and Africa.

ESTIMATED STATE AND TERRITORY CONSUMPTION

The Australian Criminal Intelligence Commission used wastewater data collected between August 2017 and August 2018 (Year 2 of the program) to estimate the annual weight of methylamphetamine, MDMA, cocaine and heroin consumed in each Australian state and territory (see tables below). These estimates have been calculated using the refined population estimates of wastewater treatment catchments derived from the latest Census data from the Australian Bureau of Statistics and geographical information system analysis of populations reported within wastewater treatment catchments.

Estimated annual state and territory methylamphetamine, cocaine, MDMA and heroin consumption (Year 2 of the program):

State / territory	Estimated drug consumption (kilograms per annum)				
	Methylamphetamine	Cocaine	MDMA	Heroin	TOTAL
Australian Capital Territory	93.0	81.2	14.4	15.3	203.9
New South Wales	2,604.5	2,397.8	450.5	222.2	5,675.0
Northern Territory	75.5	27.4	24.1	1.0	128.0
Queensland	1,893.3	576.6	223.2	66.2	2,759.3
South Australia	1,159.5	129.2	66.6	34.8	1,390.1
Tasmania	127.1	15.5	16.7	4.5	163.8
Victoria	2,477.7	819.9	291.3	359.4	3,948.3
Western Australia	1,416.8	67.9	74.9	46.8	1,606.4
National	**9,847**	**4,115**	**1,162**	**750**	

While methylamphetamine continues to be the most consumed illicit drug (with available dose data), there is variation in drug preferences within and between the states and territories. Understanding these preferences is important in the development and delivery of tailored responses to suit the specific needs of individual jurisdictions.

While it is expected that larger jurisdictions generally consume more drugs, population size is not the only factor influencing drug use. This is evident when the same data are presented as a proportion of the weight of drugs consumed. By expressing annual consumption estimates derived from the program as a proportion of the total weight of methylamphetamine, cocaine, MDMA and heroin consumed in each state and territory, it is possible to see this variation. Although there are changes in the proportion of each drug consumed from Year 1 to Year 2 of the program, the states and territories reporting the highest and second highest proportion consumed remained consistent across the two periods.

Estimated annual methylamphetamine, cocaine, MDMA and heroin consumption, as a proportion of the total weight consumed per state and territory (Year 2 of the program):

State / territory	Estimated annual consumption (proportion of state/territory total consumption)			
	Methylamphetamine	Cocaine	MDMA	Heroin
Australian Capital Territory	45.6%	39.8%	7.1%	7.5%
New South Wales	45.9%	42.3%	7.9%	3.9%
Northern Territory	59.0%	21.4%	18.8%	0.8%
Queensland	68.6%	20.9%	8.1%	2.4%
South Australia	83.4%	9.3%	4.8%	2.5%
Tasmania	77.6%	9.5%	10.2%	2.7%
Victoria	62.7%	20.8%	7.4%	9.1%
Western Australia	88.2%	4.2%	4.7%	2.9%

Highest consumption in Australia (as a proportion of state / territory consumption) per drug type

Second highest consumption in Australia (as a proportion of state / territory consumption) per drug type

RESULTS FROM THE COLLECTION

Wastewater data are an important part of the suite of datasets available to increase our understanding of drug consumption, demand and supply in Australia. This seventh report of the National Wastewater Drug Monitoring Program builds on national drug consumption data contained in the preceding six reports to identify drug use patterns 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, will contribute further data to identify trends and changes in patterns of use, building a comprehensive and increasingly detailed picture of national drug consumption. Benefits of longitudinal wastewater data include the identification of emerging trends and patterns of use.

RESEARCH FINDINGS

Prepared by the University of Queensland (B Tscharke, T Reeks, G Elisei, J O'Brien, 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

Wastewater analysis has become a standard method for measuring population-scale use of a range of different chemical compounds. The underlying concepts involved in wastewater analysis were demonstrated in the first national Australian report released in March 2017. 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. Spatial and temporal trends in drug use have since been included using this approach for several sites across Australia. 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. The current version of the NWDMP focuses on thirteen licit and illicit drugs, including nicotine, alcohol, methylamphetamine, cocaine and MDMA (ecstasy), with cannabis previously included for the first time in Report 6. Trends in estimated drug consumption are being established over the three-year project. 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 seventh report, wastewater samples were collected during weeks of October and December 2018. Twenty-four-hour composite wastewater samples were collected using time-proportional or flow-proportional autosamplers at the influent of 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 spectrometry (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 20 WWTPs in capital cities and a further 30 regional sites participated in the program for the December 2018 period, covering a population of 12.6 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 47 per cent and 54 per cent of Australia's population for October and December, respectively. A total of 3,260 individual daily samples have been collected and analysed since the beginning of the program, with new results from 459 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 estimated drug usage across the 50 sites provided a snapshot of the scale of use over a week in December 2018, 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. Consumption of nicotine was generally higher in regional areas compared to capital cities whereas, in the case of alcohol, there was virtually no difference between regional and capital city use. The Northern Territory had the highest consumption of nicotine and alcohol, while Tasmania had above average nicotine levels as well. In other parts of Australia, alcohol consumption was similar for the most part, except in regional South Australia, where it remained relatively low.

Methylamphetamine had the highest consumption levels of the illicit stimulants included in the report, both in capital cities and regional sites. Use in South Australia and Western Australia were highest in the nation, but a rising trend was evident in many regional parts of the country. Regional levels were on average higher than in the capital cities. The scale of use in the Northern Territory was below the national averages.

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

Compared to methylamphetamine, estimated usage of other stimulants was generally much lower, and no consistent pattern was apparent between states and territories. Cocaine consumption in Australia remains mostly centred in New South Wales, particularly the capital city. Levels in the Australian Capital Territory dropped off in recent periods but were still amongst the highest in the nation. 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 a spike at many sites nationwide was apparent in this reporting period.

Oxycodone and fentanyl, which are both prescription pharmaceutical substances with abuse potential, had elevated consumption levels at several sites, noticeably across Tasmania and regional Victoria. Regional areas had average oxycodone use well above capital city. The Northern Territory and Western Australia had the lowest national levels of oxycodone. Fentanyl consumption has been increasing in several regions, particularly Victoria and Tasmania and many regional parts of the country. 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.

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.

After removing the proportion of MDA attributable from MDMA metabolism, use of the drug appeared variable across the nation, with the capital city Northern Territory and Tasmania being the highest consumers. For the other drugs included in the NWDMP, methylone and mephedrone concentrations were generally at or below detection levels at most participating sites.

The collection of wastewater samples at regular intervals allowed for the temporal comparison of consumption data. While small incremental overall changes are evident at both a site and a state or territory level when comparing reporting periods, the growing set of measurements is showing longer term trends. Some of these include the consistently higher prevalence of nicotine, methylamphetamine, fentanyl and oxycodone in regional Australia. In contrast, heroin and cocaine consumption tends to be associated with capital cities. In terms of temporal trends, methylamphetamine use has been steady in the medium term, while MDMA is on the rise from a low base. Fentanyl and oxycodone levels have been increasing, particularly in regional Australia.

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 a period of three years, beginning in August 2016. 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 six reports with results obtained subsequently from October and December 2018.

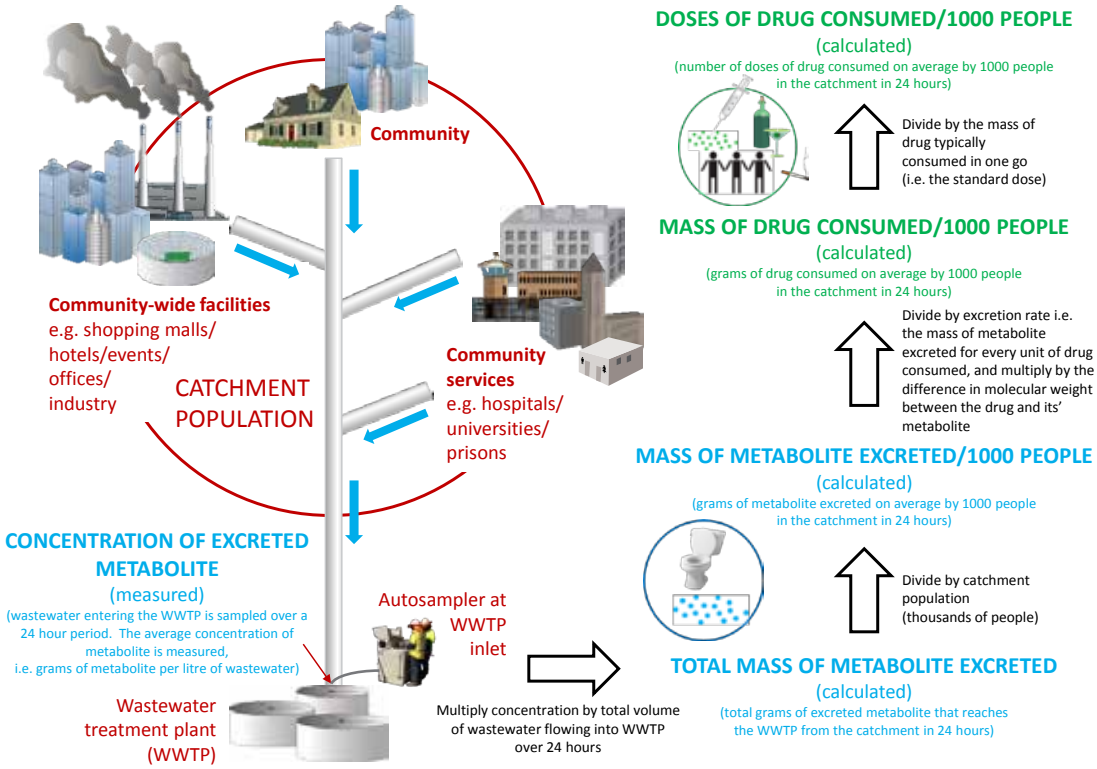
Compounds of concern include nicotine from nicotine intake (cigarettes, gum, patches, e-cigarettes, etc.), ethanol from alcohol intake, pharmaceutical opioids with abuse potential, illicit substances such as methylamphetamine, MDMA, cocaine and heroin, as well as a number of new psychoactive substances (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. We found the levels of amphetamine to correspond largely with the expected values from the excretion of methylamphetamine. MDA is a metabolite of MDMA, but 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 et al. 2011). 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 states and territories, and nationally.

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 (either in the chemical form it is 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.[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.

3 Information in relation to heroin appears in Report 3.

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 and dose table including THC-COOH 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 WWTPs across Australia participated in the NWDMP for the December 2018 collection (Figure 2). Of these, 20 sites were located in capital cities and a further 30 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 October and December 2018 and a complete list of participating sites, number of samples and relative catchment sizes are listed in Table 1 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 December 2018, 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.

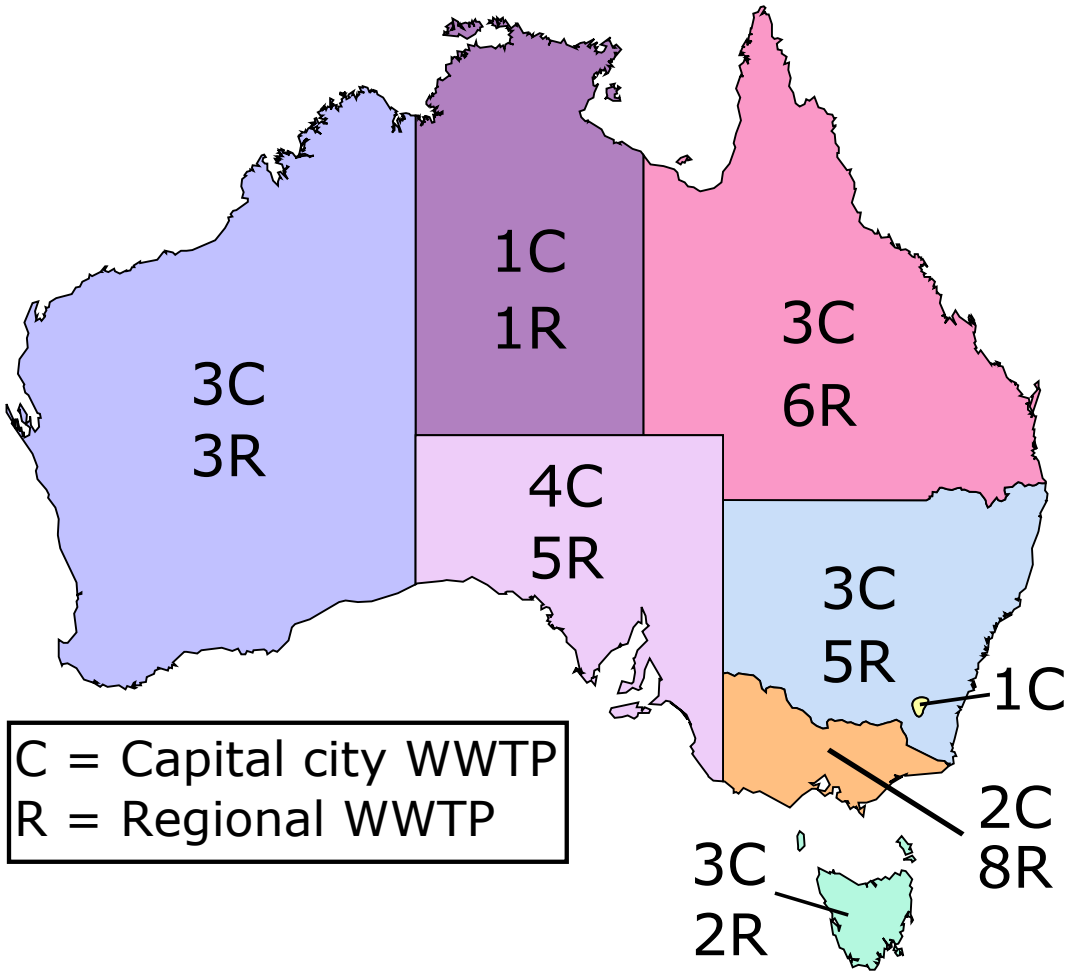


Table 1: Number of participating WWTPs for the periods covered in this report. Every second collection period aims to collect data from both regional (R) and capital city (C) sites, while the in-between collection period (October) aims to collect data from capital city sites only.

	Oct 2018		Dec 2018	
State/territory	**C**	**R**	**C**	**R**
ACT	1	–	1	–
NSW	3	–	3	5
NT	1	–	1	1
Qld	2	–	3	6
SA	4	–	4	5
Tas	3	–	3	2
Vic	2	–	2	8
WA	3	–	3	3
Sites	**19**	**–**	**20**	**30**
Population (millions) C & R	**11.2**	**–**	**11.5**	**1.5**
Total population (millions)	**11.0**		**12.6**	
% of Australian population	**46.9%**		**53.8%**	

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 been providing weekend samples over the past year, which should be considered when interpreting historical results where number of sampling days was five—see Appendix 3, Report 6. Samples were stored at 4°C or were frozen prior to transport to Adelaide or Brisbane. 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) and Tscharke et al. (2016). 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 for this drug we can only express the results 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.

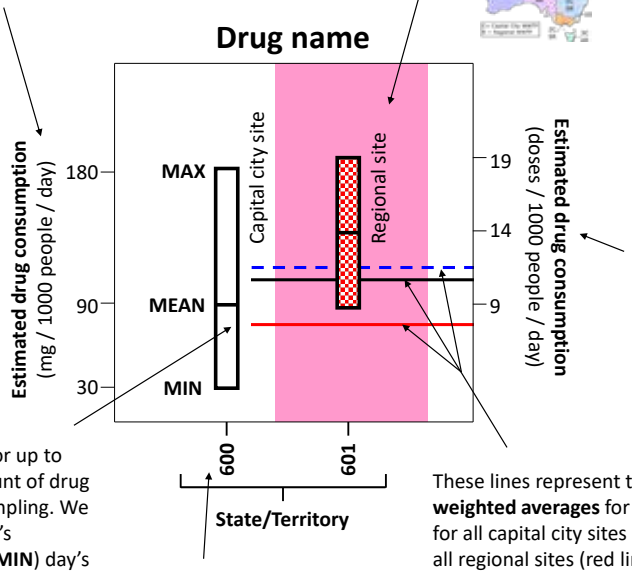
Figure 3: Explanation of the graphical representation of data for individual sites and bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).

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 of Report 7. 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).

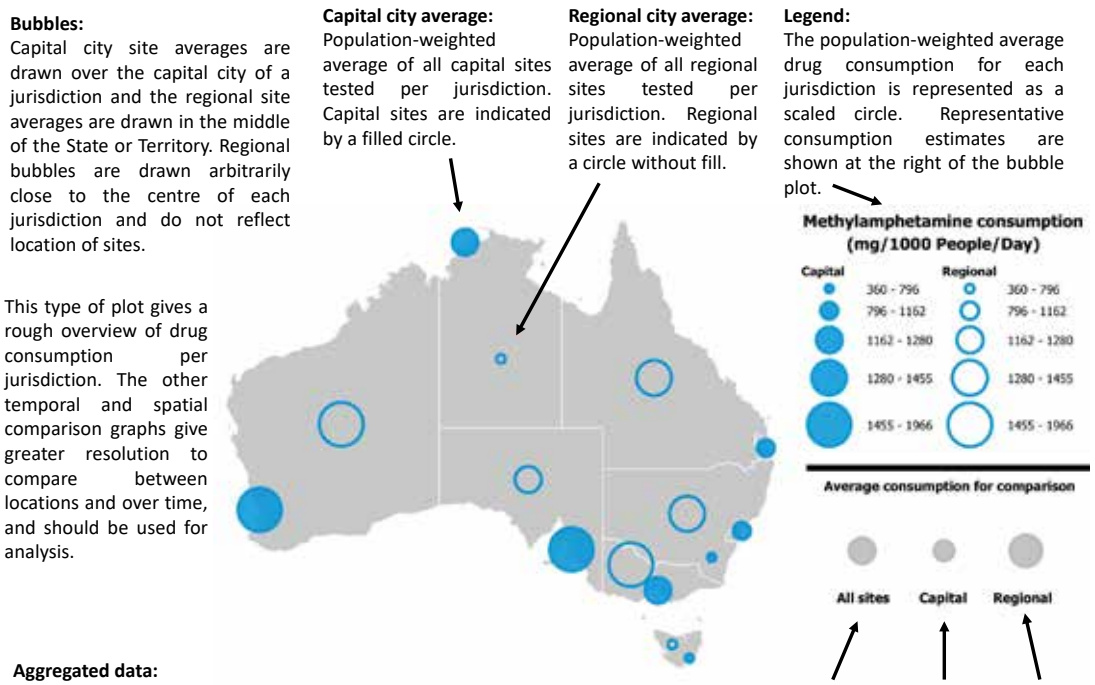


Unique number allocated to each WWTP to maintain confidentiality. WWTP names will not be disclosed publicly.

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 red checked 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).



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)[4] 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 is included as a value of LOD. 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 since the start of collection weeks did not always correspond for every plant. We present only maximum, minimum and average (for the individual sites) (Figure 3) and only average (or population weighted average, see above) 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 appear to have lower daily variation suggesting that their consumption is consistent throughout the week (Lai et al. 2015, Tscharke et al. 2016).

4 LOQ is the lowest level that can accurately be 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 December 2018 (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 are 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

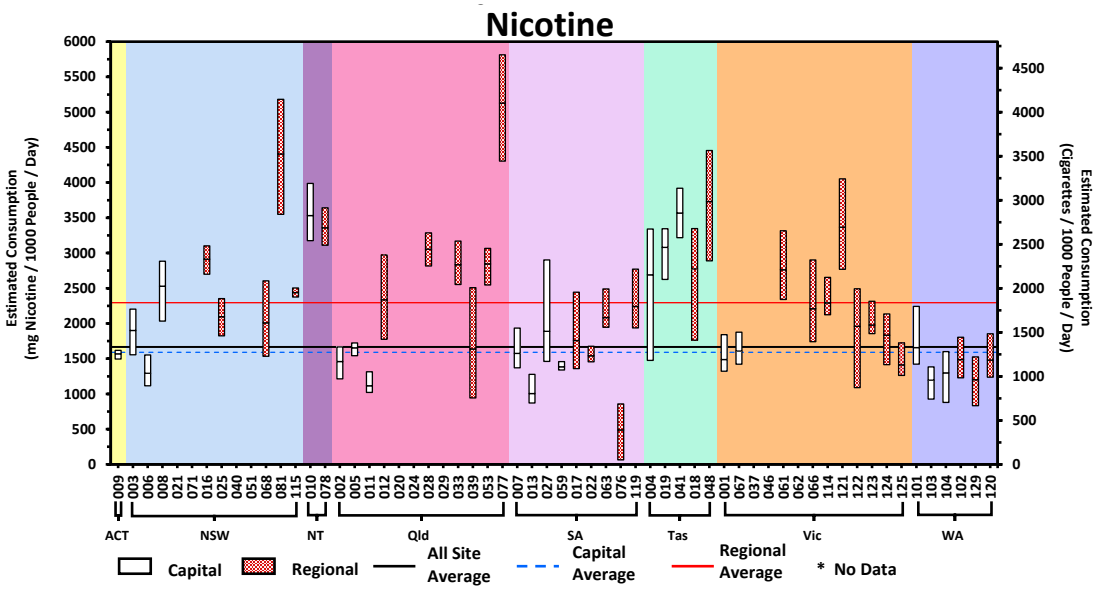
4.1.1 NICOTINE AND ALCOHOL

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 reported as nicotine in this report. The results show that the consumption of nicotine was highly variable between sites across the country (Figure 4). In general, large differences were observed over the course of the sampling week, particularly in regional catchments. Average levels of the compound were substantially higher in regional areas compared to the capital cities during December 2018 (red horizontal and dotted blue lines). Some sites in different states had unusually high consumption rates, while Western Australia tended to have values below the national averages. Sites in the Northern Territory and Tasmania had the highest weekly consumption of capital cities. Site 76 in South Australia had very low levels of nicotine compared to elsewhere. This site had low levels on a national scale during previous reporting periods as well.

Alcohol was measured using a specific metabolite of ethanol. The almost identical average consumption of alcohol between regional and capital city sites was a striking difference compared to nicotine (Figure 5). There were some relatively large differences in alcohol use between capital sites, and even within some states, such as Queensland. Similar to nicotine, a wide range of use over the collection week was evident at many sites. The Northern Territory, in general, and some capital sites of New South Wales and Tasmania were above the national averages. As with nicotine, site 76 had noticeably low levels of alcohol consumption.

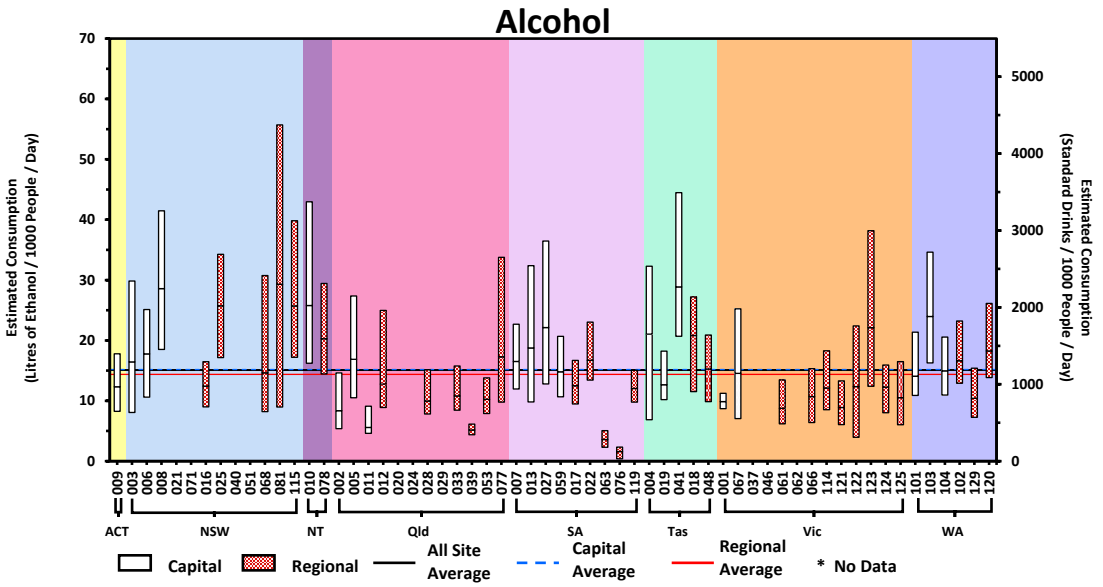
The approximate consumption levels can be represented in a pictorial way by showing the relative scale of use of nicotine (Figure 6) and alcohol (Figure 7) as capital city or regional ‘bubbles’ for each state and territory.

Figure 4: Estimated nicotine consumption for December 2018 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.



- High regional average
- Wide weekly spread

Figure 5: Estimated alcohol consumption for December 2018 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
- Similar city and regional averages

Figure 6: Estimated average nicotine consumption per jurisdiction for December 2018 in number of cigarettes per day per thousand people. The number of collection days varied from 5-7.

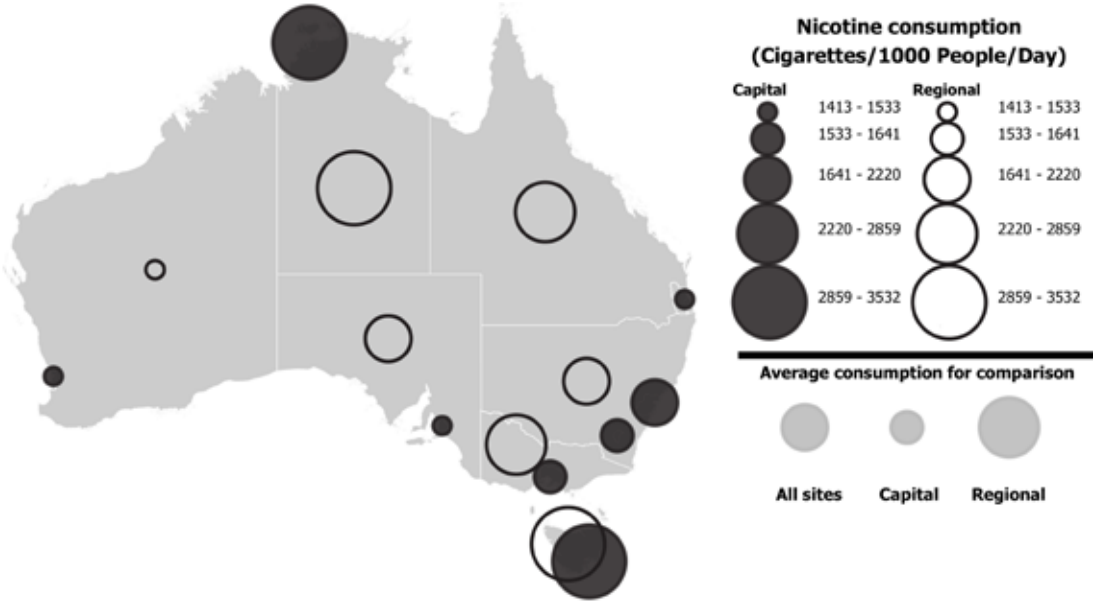
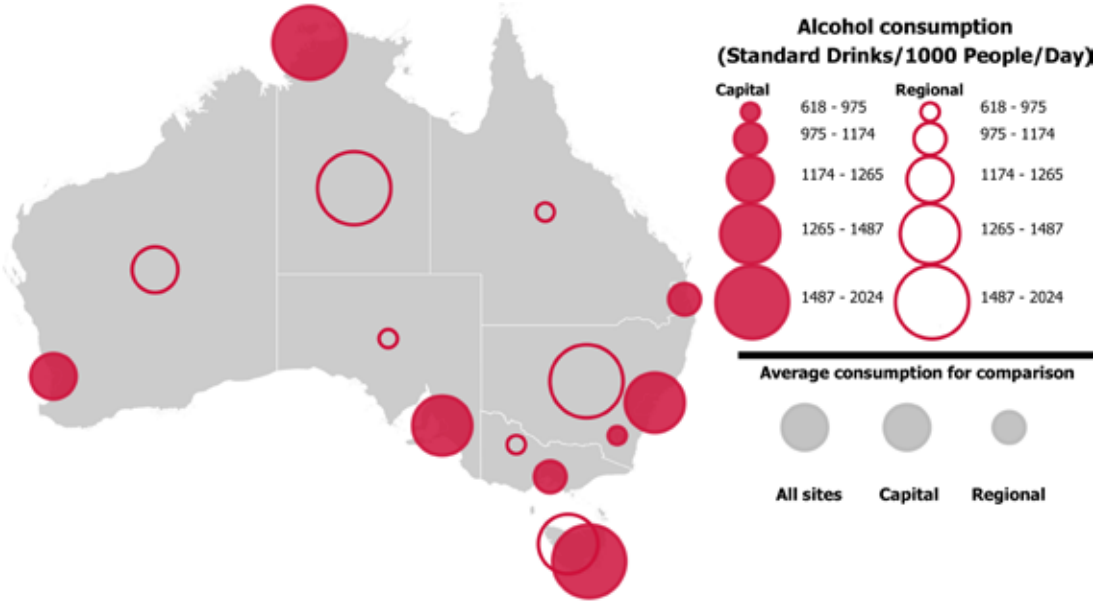


Figure 7: Estimated average alcohol consumption per jurisdiction for December 2018 in number of standard drinks per day per thousand people. The number of collection days varied from 5-7.



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 estimated mass loads of methylamphetamine remained high compared to other illicit substances. The capital city average increased in December 2018 compared to the previous reporting period, while the regional average was similar to before. However, the average regional loads remained well above capital city consumption levels (Figure 8). South Australia had the highest of the capital city loads, followed by Western Australia. In contrast to most other states, regional South Australia had levels well below that of the city. A few regional sites in each state and territory had very high consumption. Large differences were evident between regional catchments.

4.1.2.2 AMPHETAMINE

Due to the high nationwide methylamphetamine consumption and resultant excretion profile, it remains a challenge to determine amphetamine consumption levels. The concentration of amphetamine observed in the current reporting period was strongly correlated with the methylamphetamine concentrations (see Appendix 4 of Report 1) which is consistent with the reported amphetamine excretion range following methylamphetamine consumption (Gracia-Lor et al. 2016). Therefore, no attempt was made to differentiate amphetamine use from the proportion of methylamphetamine excreted as amphetamine. Nevertheless, it is recognised that some of the amphetamine measured could be a result of amphetamine ingestion.

4.1.2.3 COCAINE

Benzoylecgonine, the specific metabolite of cocaine, was used to estimate the consumption of the stimulant. Capital city areas on average had higher cocaine use than regional centres (Figure 9). Site 8 in New South Wales in particular had very high levels, approaching the scale of methylamphetamine use. Apart from a few exceptions in Queensland, cocaine consumption was relatively low in other parts of Australia. Western Australia had the lowest levels nationally.

4.1.2.4 MDMA (3,4-METHYLENEDIOXYMETHYLAMPHETAMINE)

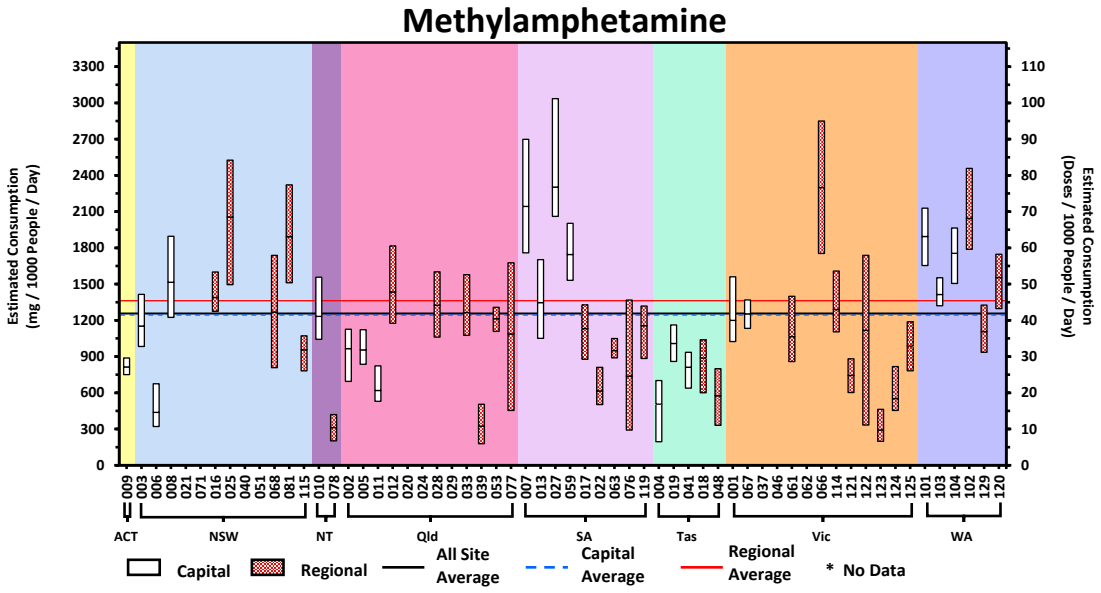
The average consumption of MDMA was similar between capital city and regional catchments (Figure 10). This is in contrast to historical data where regional averages tended to be higher than the capital cities. A number of sites in Tasmania, New South Wales, Northern Territory and Victoria had levels well above national averages with a large spread across the week. 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. The wide weekly spread is typical of drugs consumed on weekends.

4.1.2.5 MDA (3,4-METHYLENEDIOXYAMPHETAMINE)

MDA is a drug of preference in its own right, but it is also a metabolite of MDMA. The proportion of MDA eliminated after MDMA consumption is known. Therefore, the 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 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 higher than capital cities, with large variations at sites over the collection week a feature of the drug's prevalence (Figure 11). New South Wales appeared to be the main consumer of MDA.

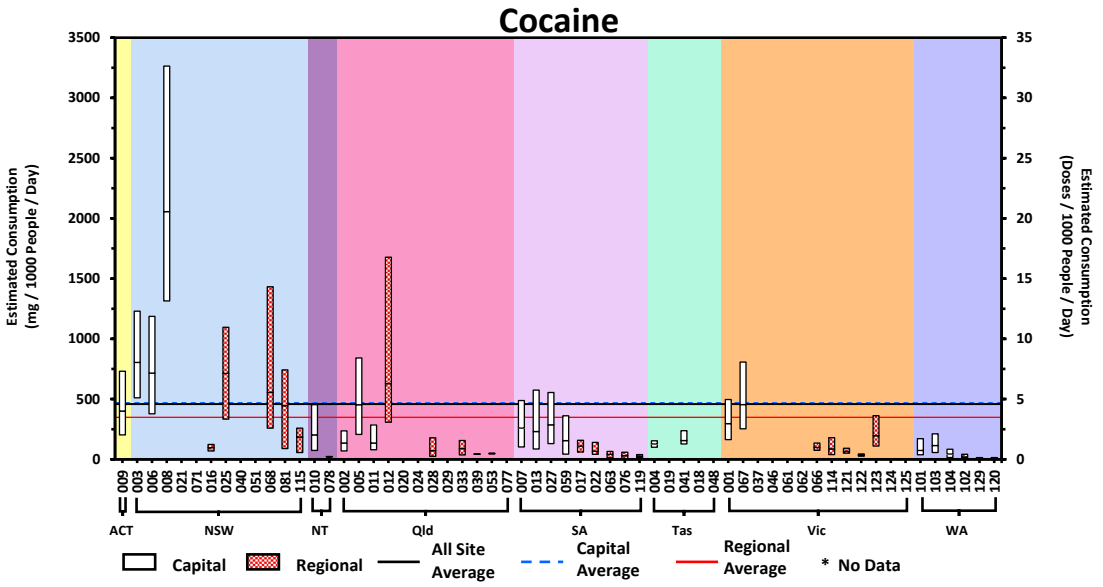
The scale of use of each stimulant is showed as bubble graphs. Regional and capital city use of methamphetamine (Figure 12), cocaine (Figure 13), MDMA (Figure 14) and MDA (Figure 15) are all represented to reflect the proportion of drug use across the country. The popularity of cocaine on the eastern seaboard remains apparent, while stimulant use in South Australia is low, with the obvious exception of methylamphetamine.

Figure 8: Estimated methylamphetamine consumption for December 2018 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.



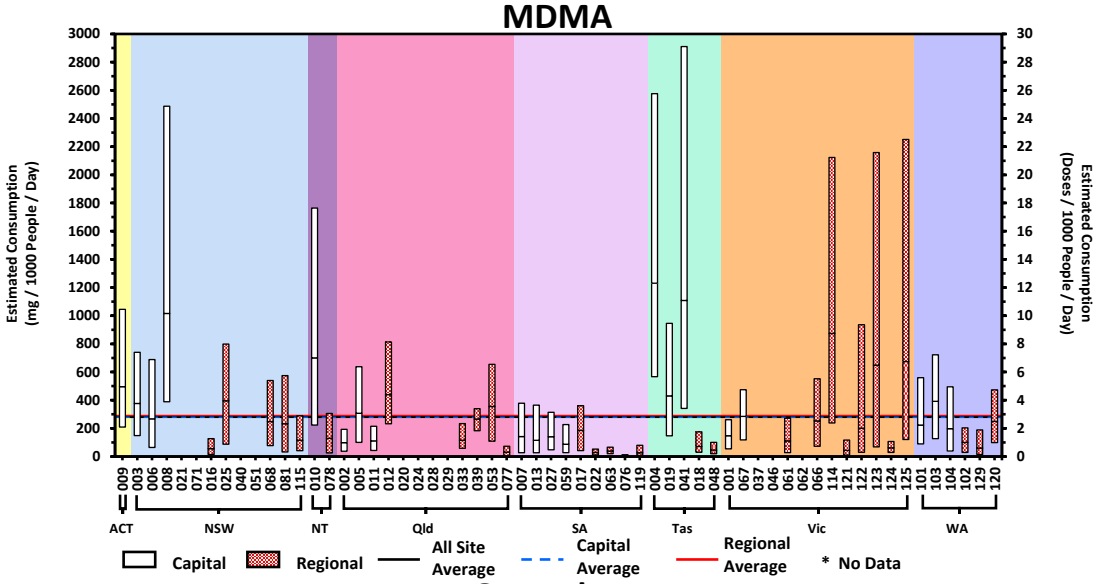
- **Capital city consumption in South Australia and Western Australia highest**
- **Higher regional consumption**

Figure 9: Estimated cocaine consumption for December 2018 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.



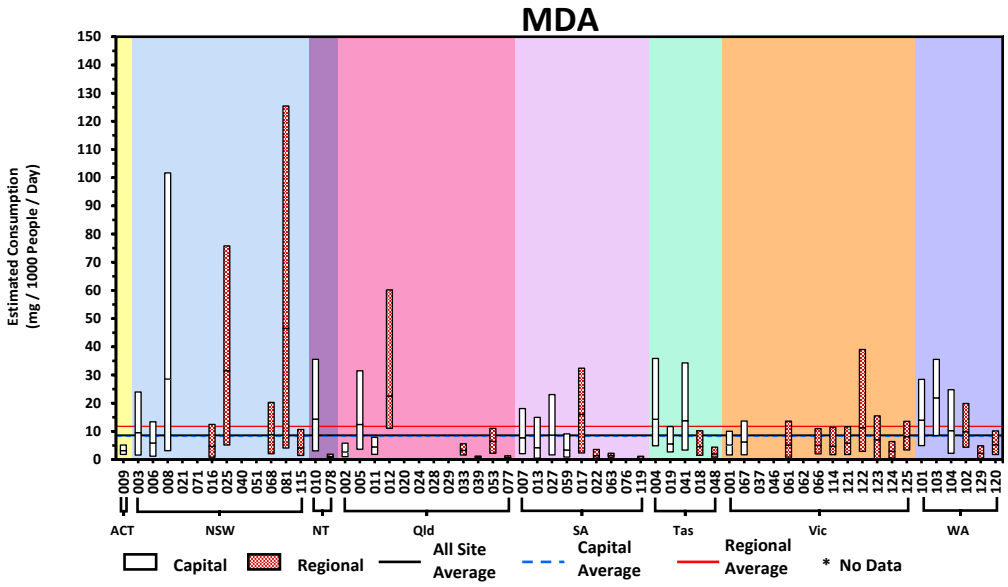
- High consumption in New South Wales
- Lower regional consumption

Figure 10: Estimated MDMA consumption for December 2018 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.



- High consumption at some sites, but low overall nationally
- Wide weekly spread indicates higher weekend consumption

Figure 11: Estimated MDA consumption for December 2018 in mass consumed per day per thousand people. The number of collection days varied from 5-7.



- Higher regional average
- New South Wales consumption highest

Figure 12. Estimated methylamphetamine consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

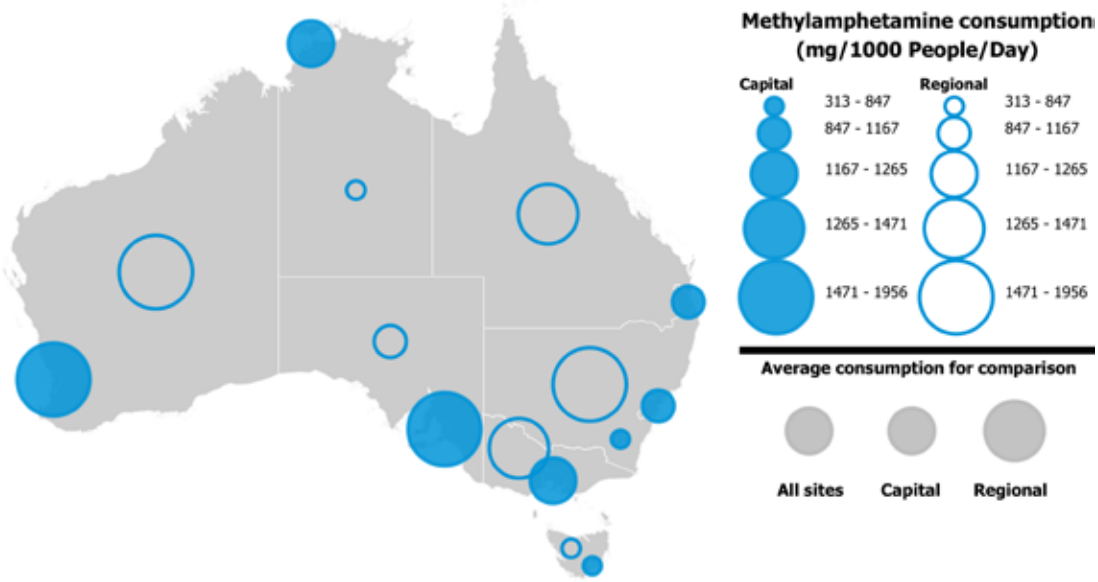


Figure 13: Estimated cocaine consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

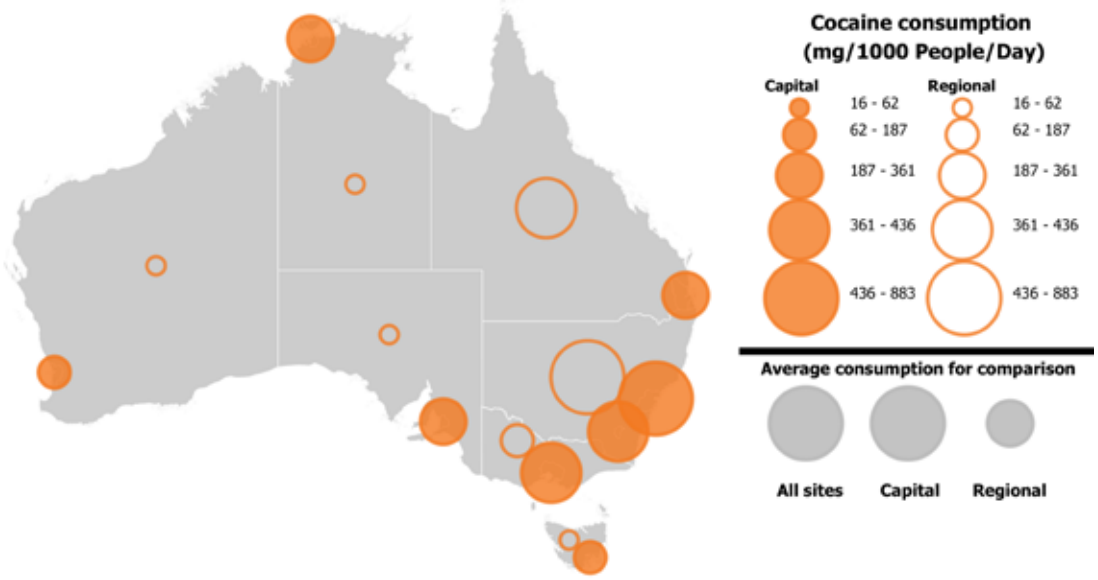


Figure 14: Estimated MDMA consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

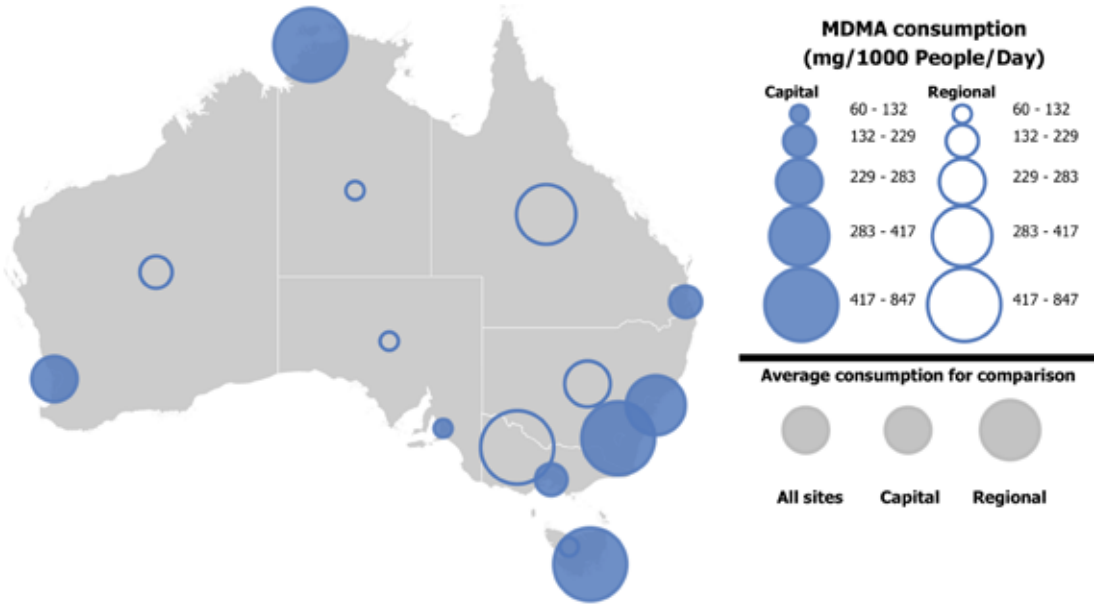
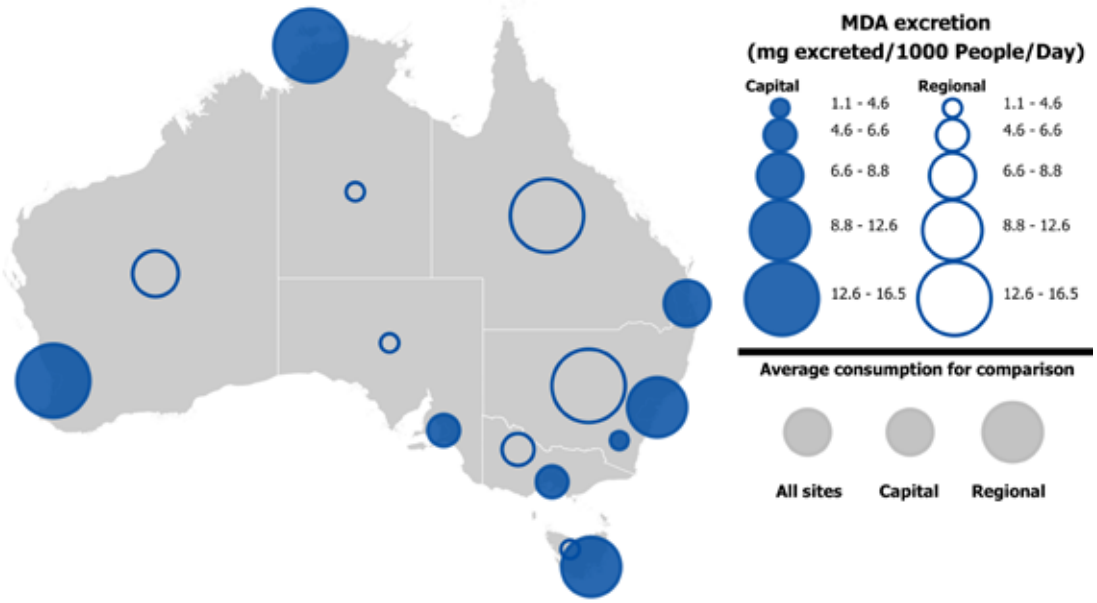


Figure 15: Estimated MDA consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



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 and illicit use, the relative scale of use of these substances remain of interest.

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.

Consumption of oxycodone in regional Australia was much higher than in capital cities, Tasmania being the only exception where overall use was high (Figure 16). The regional average has been steadily on the rise since previous reporting periods, with regional Victoria having the highest rates in the country. South Australia and Western Australia had relatively low consumption levels in the national context.

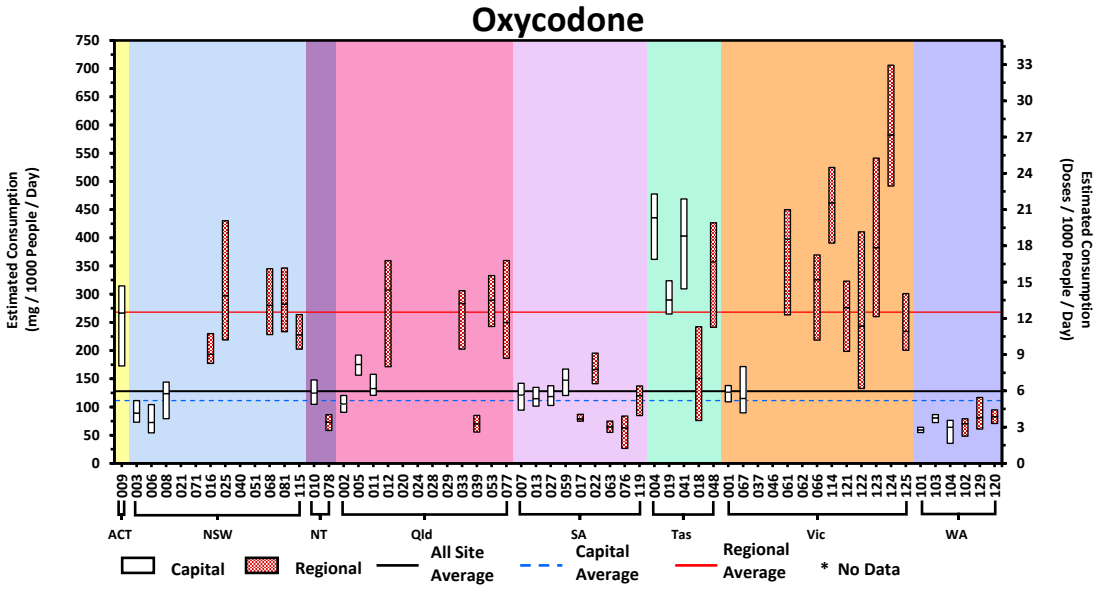
The extent of fentanyl use was very variable across Australia (Figure 17). Unlike oxycodone, regional use in Victoria was lower than in many other states, with consumption in parts of New South Wales, South Australia and Queensland being very prominent. The one participating regional site in the Northern Territory had very low use. The capital city site in the same territory gave a result below the method's lower limit of quantification. Tasmania had the highest capital city levels in the country. As with oxycodone, capital city Australia appeared to be lower consumers of fentanyl by a fair margin compared to regional Australia. Rates of fentanyl consumption in other capital cities across Australia were mostly of comparable levels.

The relative scale of oxycodone and fentanyl use is apparent when results are presented in bubble graph form. Oxycodone consumption in south eastern Australia was very apparent (Figure 18). Fentanyl use in regional centres was high compared to capital cities (Figure 19).

4.1.3.2 HEROIN

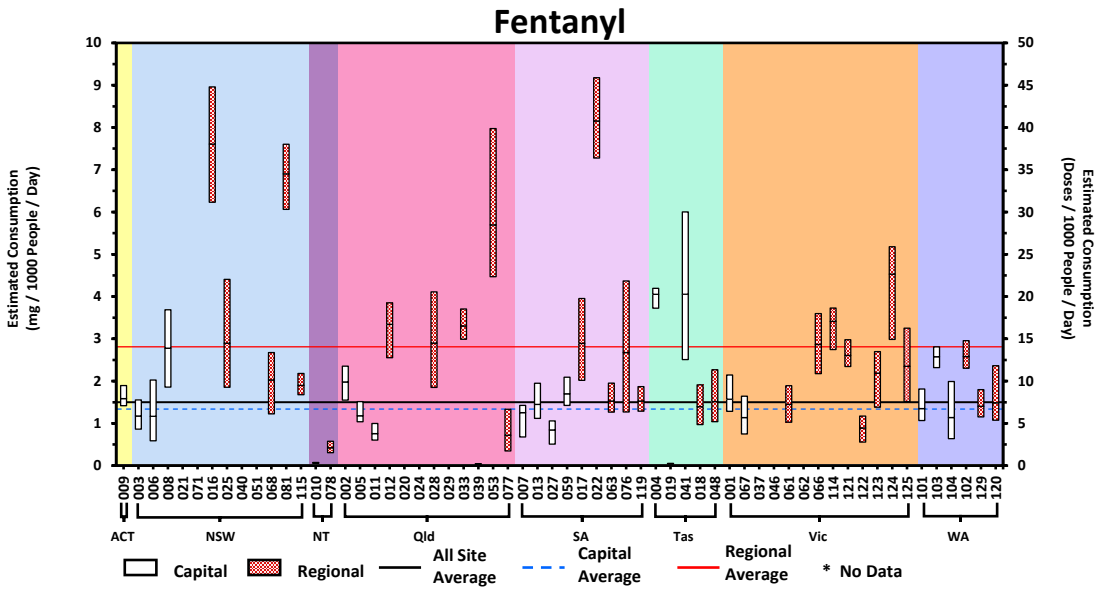
Heroin is metabolised by users and excreted in low amounts as the unique metabolite, 6-monoacetylmorphine (6-MAM). Since the metabolite is characteristic of heroin use, it can be used to distinguish heroin from other opioids such as morphine and codeine. Heroin consumption was prominent in Victoria site 67 in particular, and capital city New South Wales. Average capital city use in Australia in December 2018 was higher than before, but regional centres continued to have lower consumption on average (Figure 20). Many regional sites had levels at or below limits of quantification. 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 December 2018 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.



- **Very high regional average**
- **Highest capital city sites in Tasmania**

Figure 17: Estimated fentanyl consumption for December 2018 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.



- Higher and variable regional average
- Highest capital city consumption in Tasmania
- Some sites had non-detects for fentanyl (site 010, site 039, site 019)

Figure 18: Estimated oxycodone consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

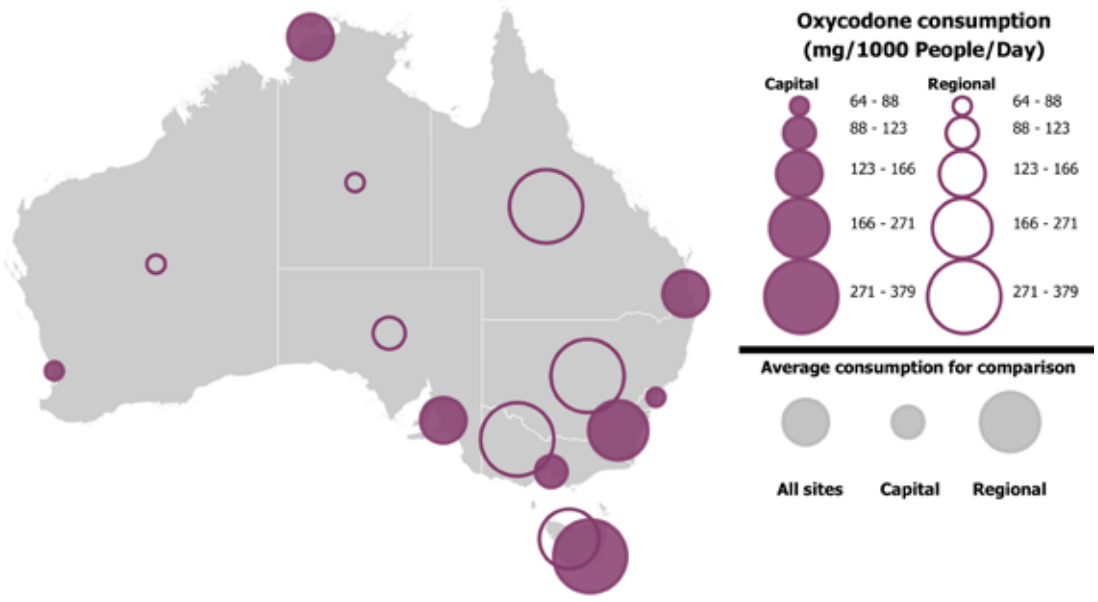


Figure 19: Estimated fentanyl consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

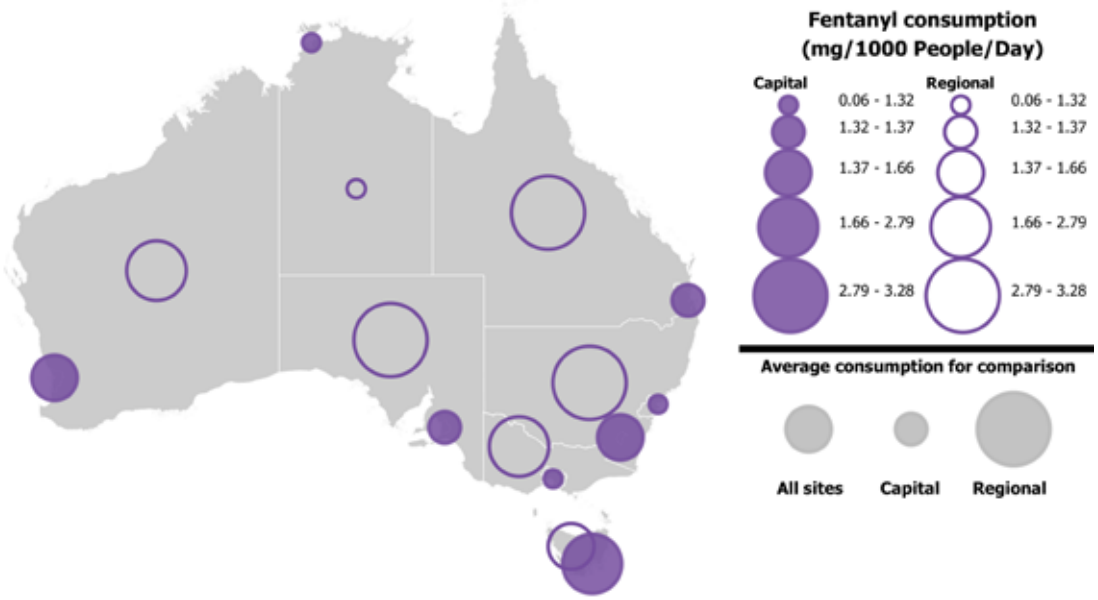
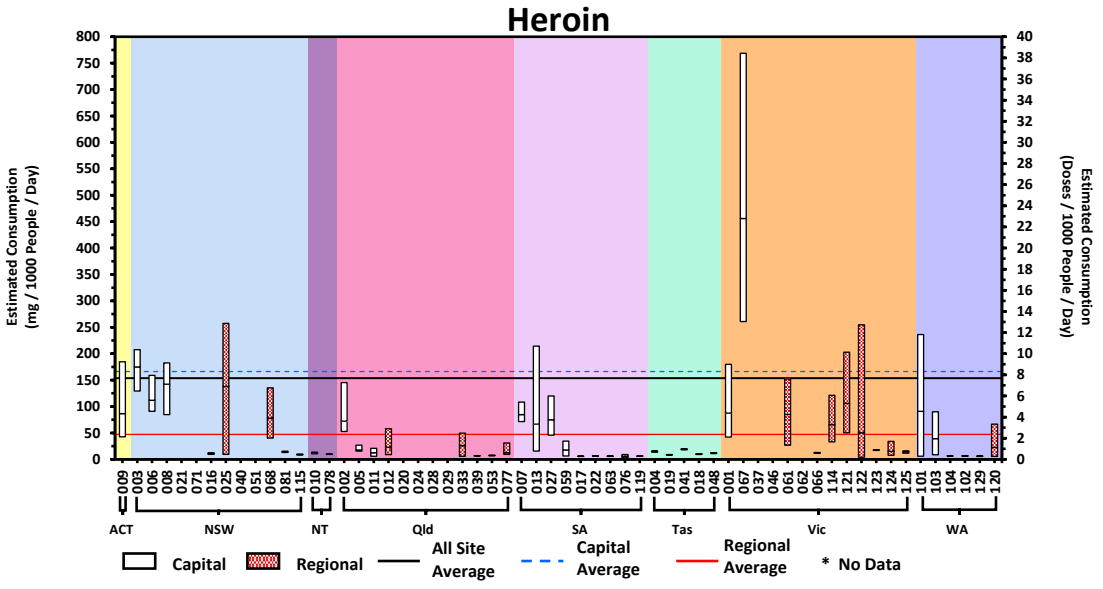
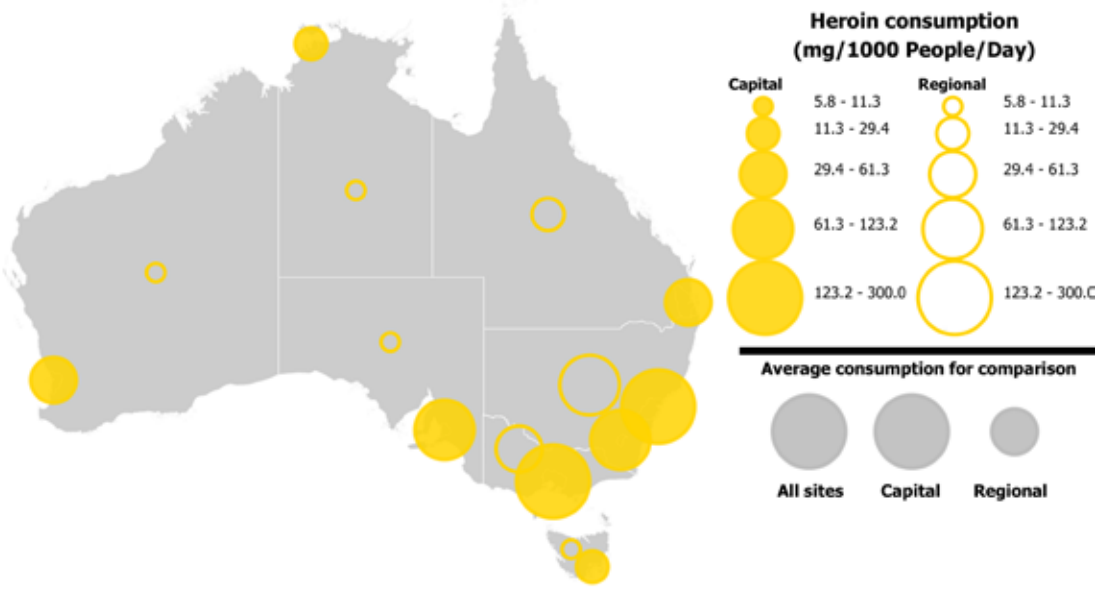


Figure 20: Estimated heroin consumption for December 2018 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional consumption
- Highest consumption in New South Wales and Victoria

Figure 21: Estimated heroin consumption per jurisdiction for December 2018 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. It is probable that a significant proportion of the ingested drug is converted into different metabolites. Sites that showed the presence of the two compounds are qualitatively listed in Table 2 for December 2018. A number of mephedrone detections occurred in New South Wales, Queensland and South Australia, while methylone use appeared at similar frequencies in New South Wales, Queensland, Western Australia, Victoria and Tasmania. The measured levels were mostly below the limits of reporting. The temporal changes in detections per state and territory (number of samples above LOD) are shown in Figure 22. It is evident that the number of detections of methylone has dropped since a peak in late 2017. While mephedrone detections have remained relatively low, the detection frequency has been on the increase. The national spread of detections is shown in Figure 23.

Table 2: The number and code of sites per state and territory where mephedrone and methylone were detected. The total number of daily samples that was assessed was 306.

	Number of detections Dec 2018		Sites detected Dec 2018	
State/territory	**Mephedrone**	**Methylone**	**Mephedrone**	**Methylone**
NT	0	0		
ACT	0	0		
NSW	8	7	008, 068	003, 008, 025
Qld	3	7	012	012
SA	14	0	007, 027	
Tas	0	5		004
Vic	0	2		001
WA	0	5		122, 101, 103
Total	**25**	**26**	**5 sites**	**9 sites**

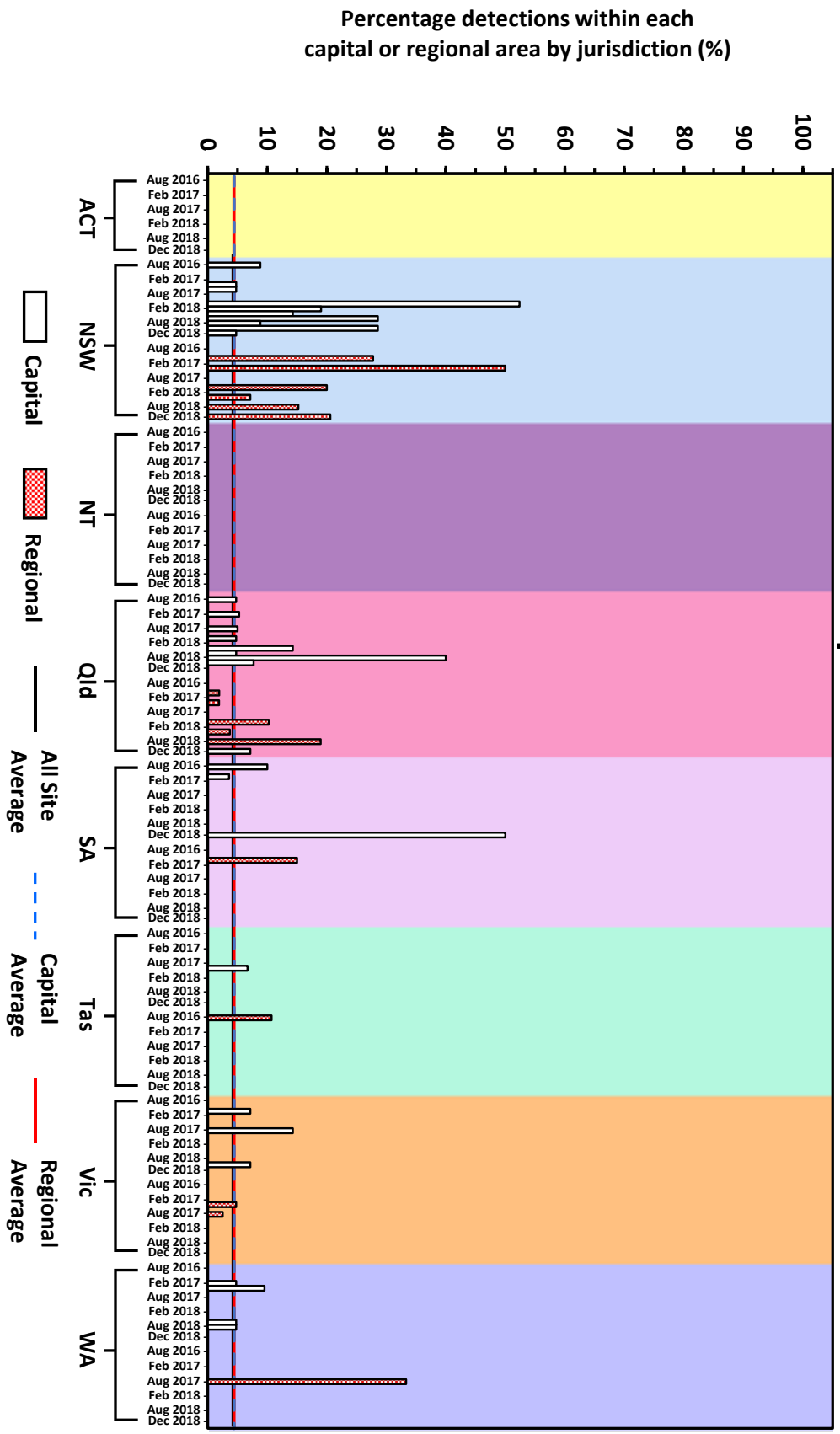


Figure 22: The percentage of all samples where mephedrone and methylone were detected.

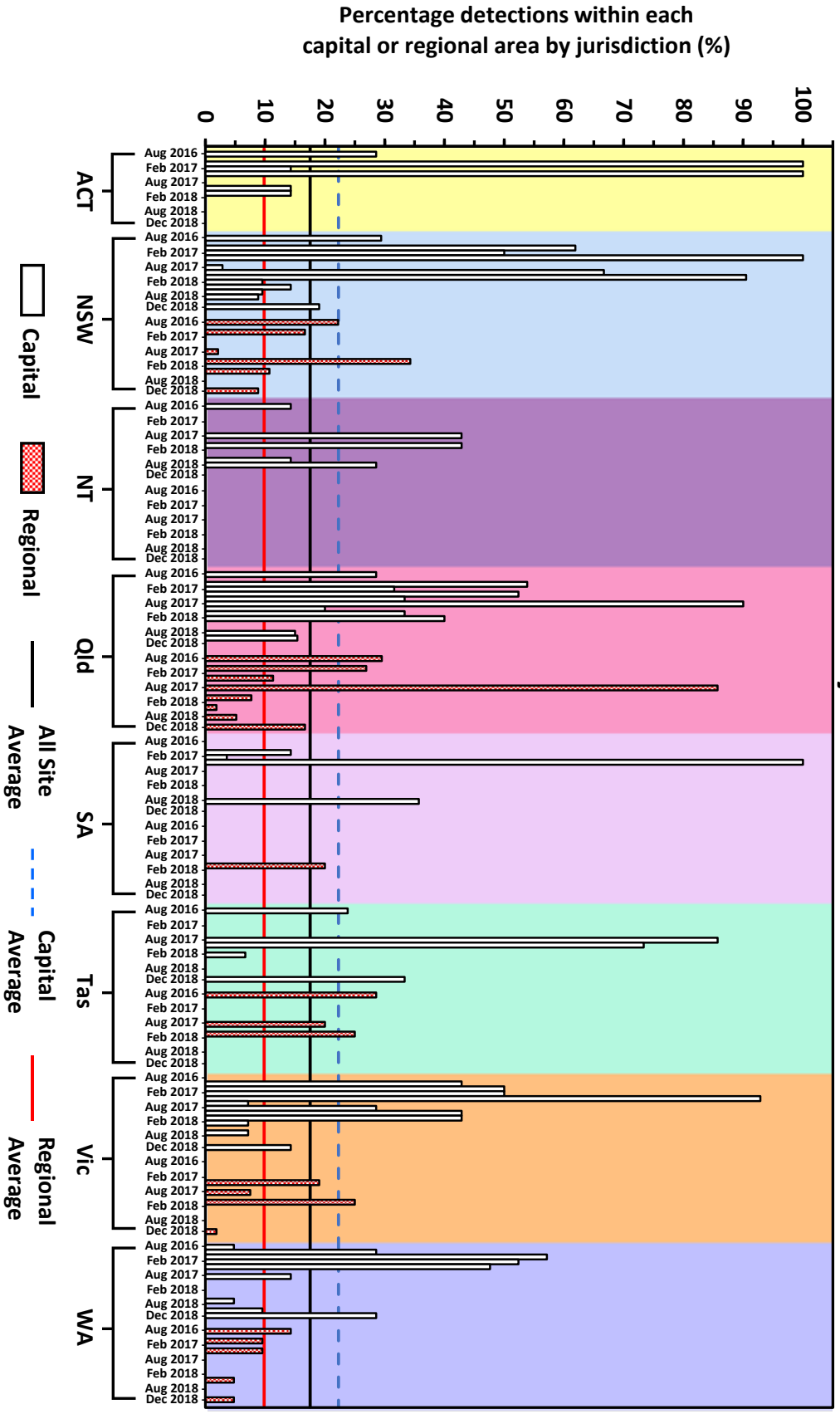


Figure 22 (continued): The percentage of all samples where mephedrone and methylone were detected.

Figure 22 (continued): The percentage of all samples where mephedrone and methylone were detected.

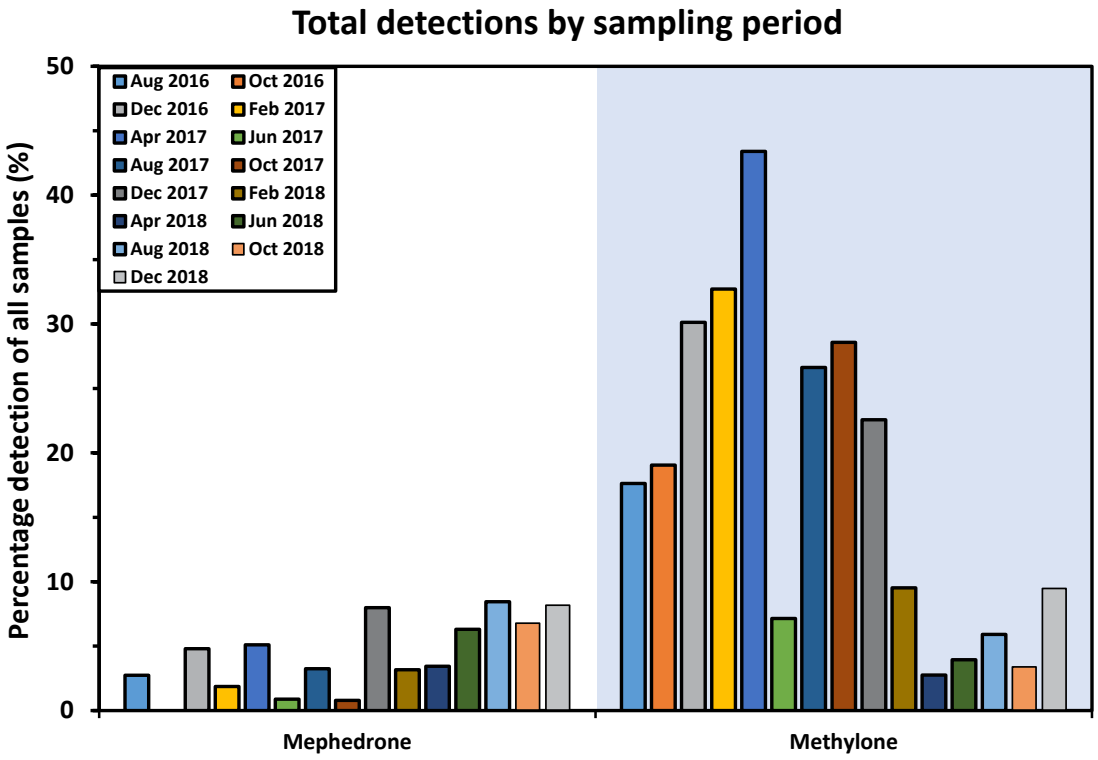


Figure 23: Estimated percentage positive detections per jurisdiction for mephedrone and methylone for December 2018. This is the number of detections as a percentage of the total number of samples analysed per jurisdiction. The number of collection days varied from 5-7.

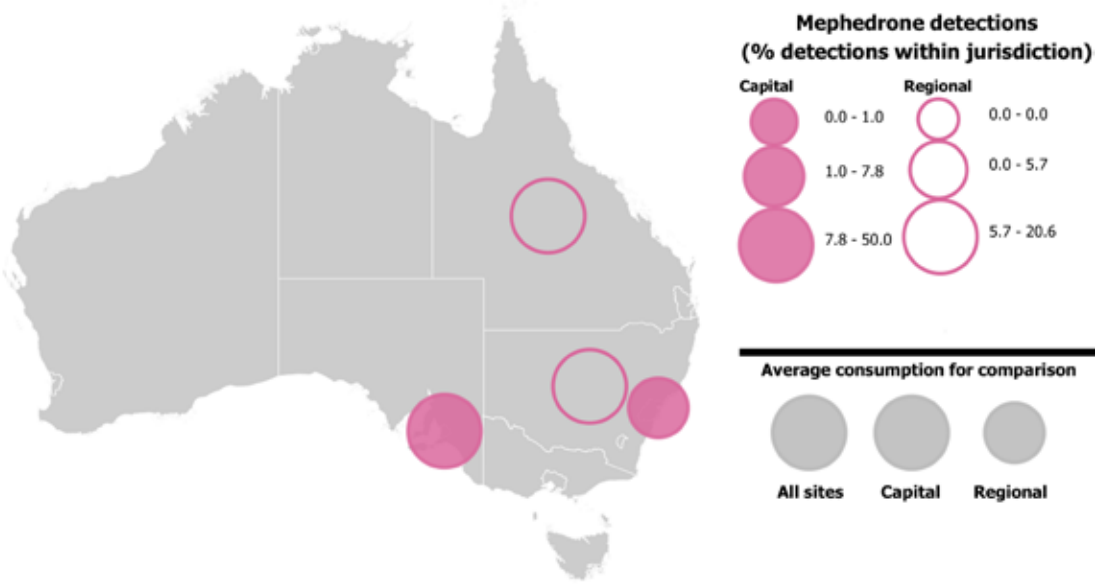
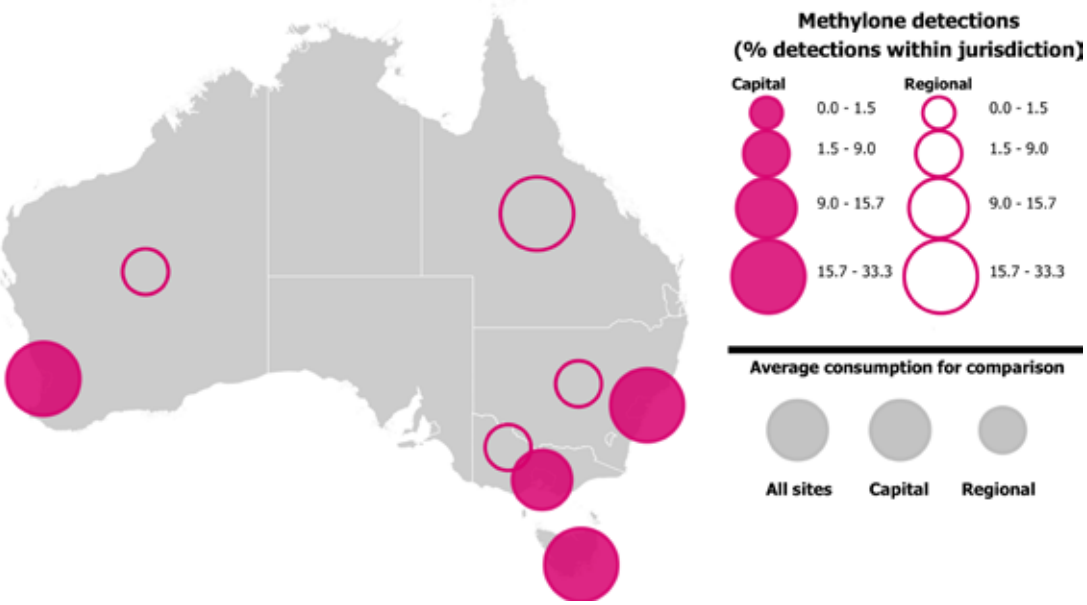


Figure 23 (continued): Estimated percentage positive detections per jurisdiction for mephedrone and methylone for August 2018. This is the number of detections as a percentage of the total number of samples analysed per jurisdiction. The number of collection days varied from 5–7.

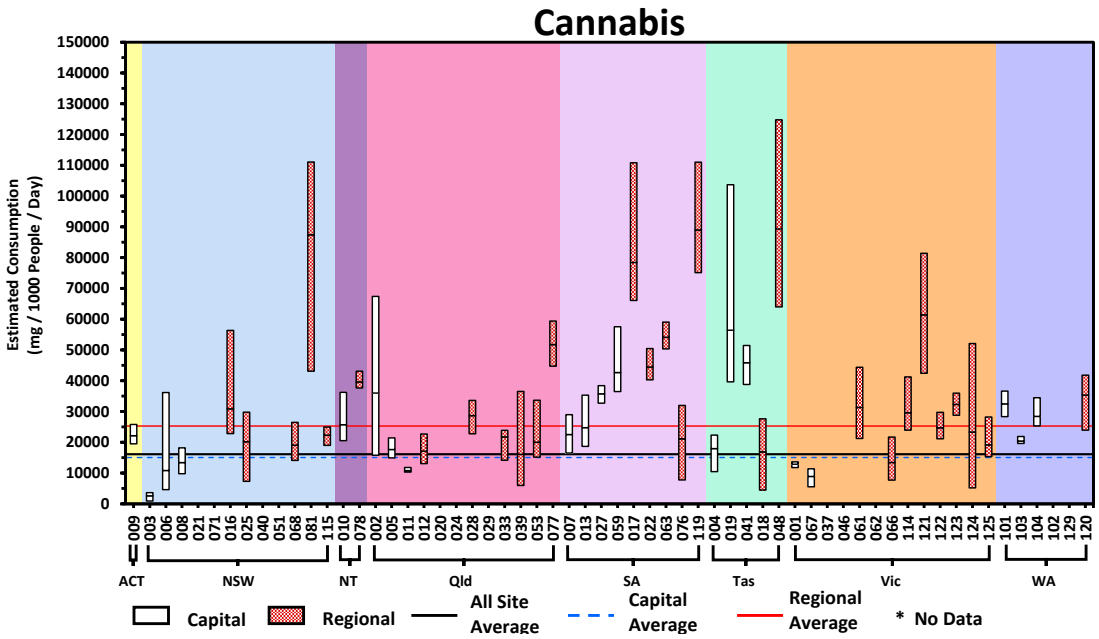


4.1.5 CANNABIS

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 (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.

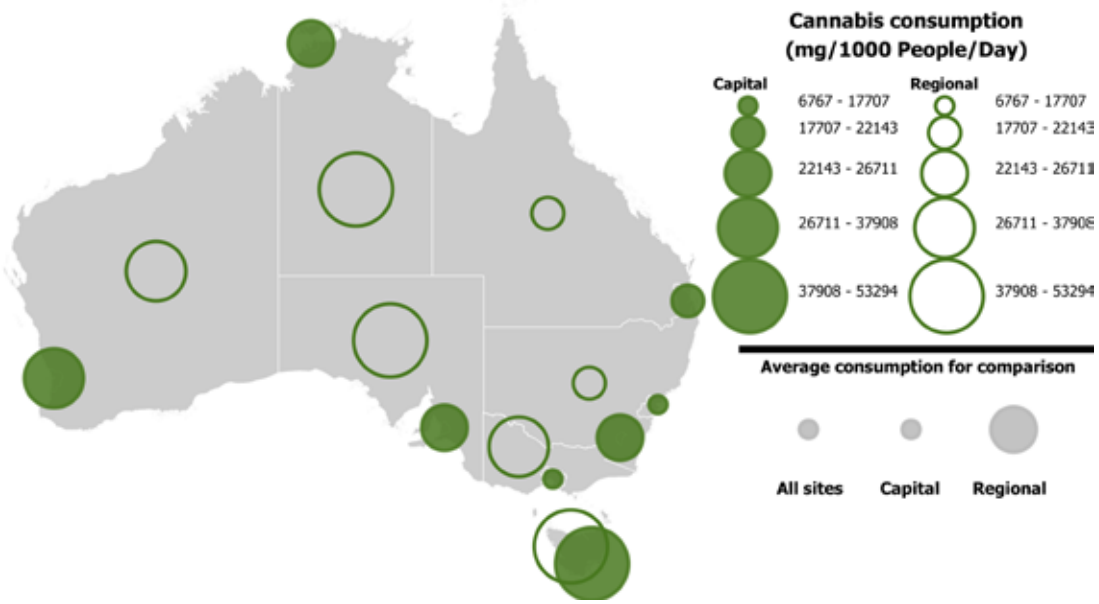
Cannabis consumption was expressed as the daily mass load (mg) of active ingredient (THC) consumed per 1,000 people. The dose of cannabis depends on several factors, such as the part of the plant, strain, or whether an extract was used. While some approximations can be made, an average dose was not defined as for other drugs in the report (e.g. right-hand axis in Figure 8, methylamphetamine). Spatial differences were evident across Australia (Figure 24). Regional use exceeded capital city levels (red vs dotted blue line). Specific sites in New South Wales, South Australia and Tasmania had the highest use, but with very large variations over the course of the week. In terms of capital cities, Northern Territory, Tasmania and South Australia were at the higher end of consumption levels. Sites 102 and 129 in Western Australia were unable to provide a suitable composite sample for cannabis analysis. The bubble plot and jurisdictional differences of cannabis use across Australia show the generally higher consumption in regional areas (open circles of Figure 25 and in Figure 37).

Figure 24: Estimated cannabis consumption for December 2018 in mass consumed per day (left axis). The number of collection days varied from 5-7.



- High regional consumption
- Tasmania highest overall consumption

Figure 25: Estimated cannabis consumption per jurisdiction for December 2018 in mg consumed per day per thousand people. 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 lines on each graph representing averages are the cumulative average across all sampling time points.

4.2.1 NICOTINE AND ALCOHOL

Nicotine consumption remained relative steady over the total collection periods in most states and territories. The medium term decrease in Western Australia appears to have levelled out in recent results (Figure 26). The high regional use of nicotine is reflected in the average use remaining well above capital city levels.

The difference between average capital city and regional centre consumption of alcohol within each state or territory was minimal. South Australia continued to be the only state where regional alcohol use was lower than in the capital city (Figure 27). For the most part, national consumption levels remained steady with no clear pattern in terms of changes in use over recent time within each region.

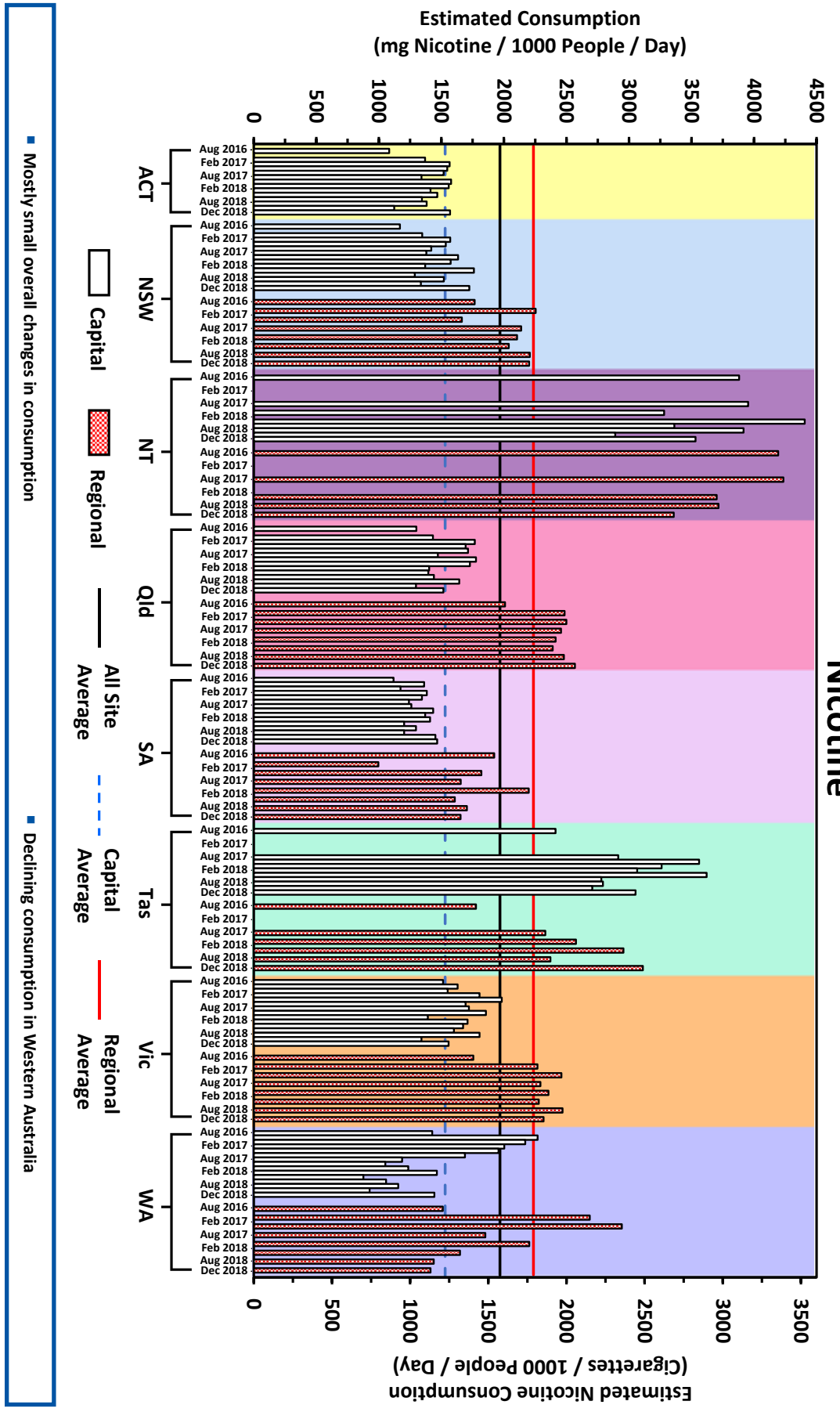
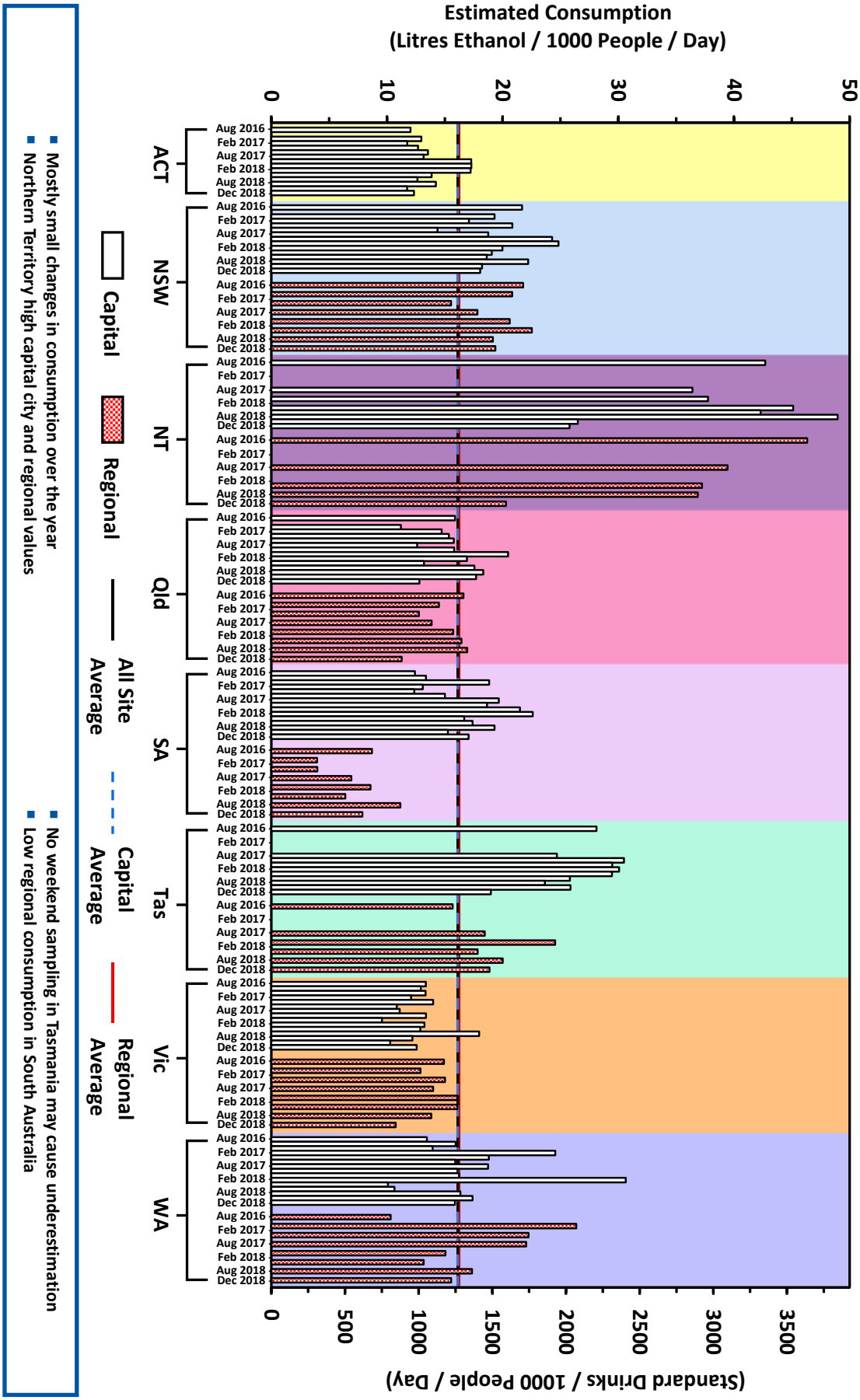


Figure 26: Estimated average consumption of nicotine by state/territory, where 1 cigarette provides 1.25 mg of nicotine.

Figure 27: Estimated average consumption of alcohol by state/territory. A standard drink is 10.0 g or 12.5 mL.



4.2.2 ILLICIT DRUGS

No uniform trend was apparent for methylamphetamine use on a national scale (Figure 28). The consumption of the drug in Queensland and regional Victoria has been increasing steadily over the longer term. However, levels have remained relative steady in these states since the last reporting period. Use of methylamphetamine in the Australian Capital Territory and regional New South Wales continue to rise, while the capital city site in the Northern Territory has been steady over the medium term, with a decline evident in the regional area. South Australia and Western Australia experienced a large drop in use in early 2018 but have started to return to the historical levels.

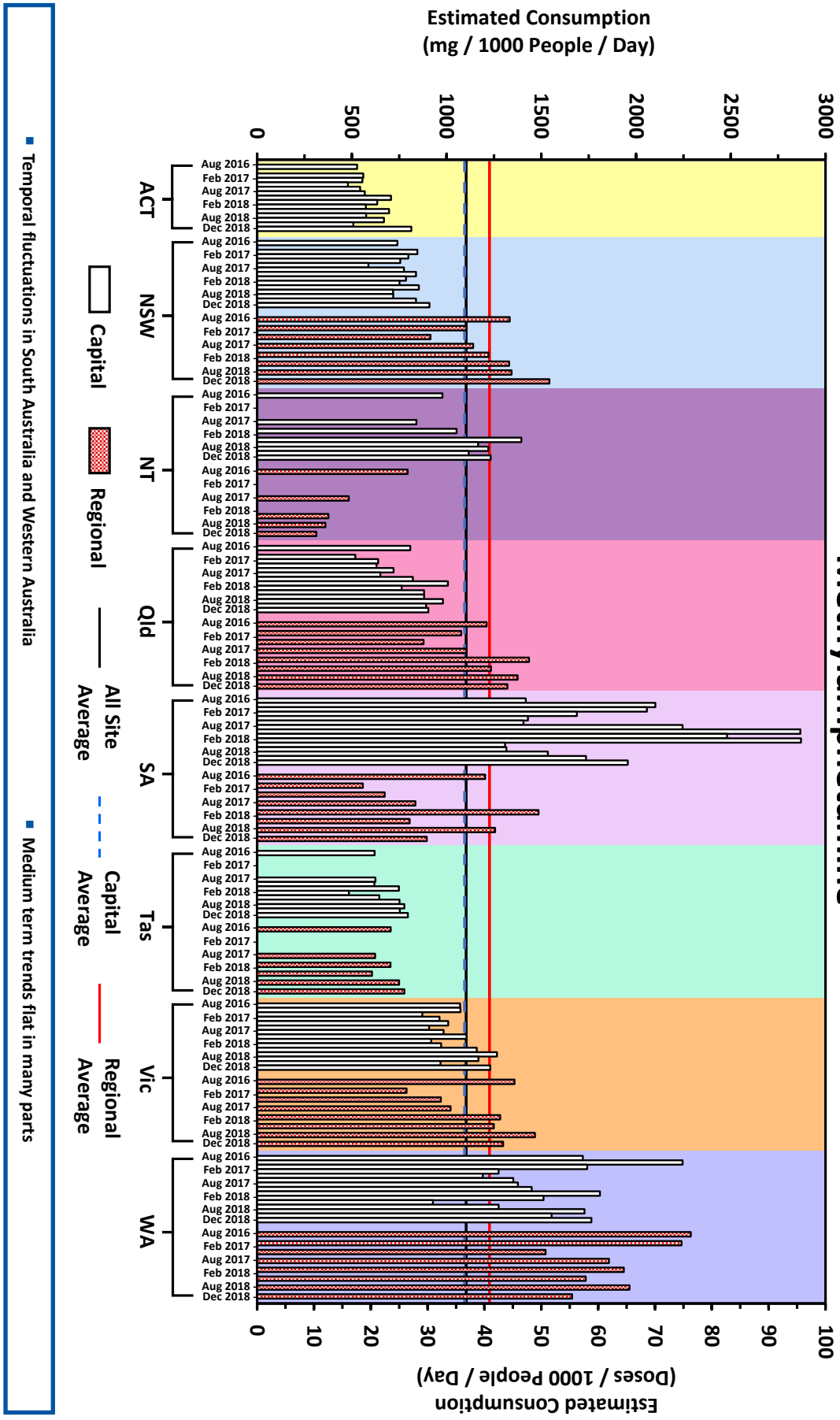
Considering the long-term trends in Queensland, South Australia and Western Australia, the sudden drop-off in use of methylamphetamine in capital city South Australia in early 2018 remains a striking feature (Figure 29). The corresponding decline in Western Australia has since been reversed. Measured amounts of the drug in regional Queensland and Victoria are slowly increasing but have remained essentially steady in the capital cities.

Cocaine use in capital city Australia has shown an overall decline in almost every state and territory since December 2017; Queensland being the only exception with a rise in October 2018 (Figure 30). Regional consumption of the drug has either been levelling off or declining over the medium term in every part of the country. The combined results for all sites in each state and territory also makes the generally lower regional use quite apparent, together with low consumption in Tasmania and Western Australia.

MDMA use across Australia remained low overall, compared to other stimulants. However, large increases in consumption since the previous reporting period were evident in almost every state and territory. In the longer term, the consumption patterns appear variable with no obvious trends (Figure 31). The per capita consumption of drug use in the capital city site of the Northern Territory remained high compared to most other parts of the country, but the recent increase in Tasmania was at a similar level. Recent spikes in MDMA consumption have increased the population-weighted average MDMA consumption for all sites to the highest on record since the beginning of the program.

MDA use, corrected for the proportion derived from MDMA (Khan 2011), was relatively low across the country (Figure 32). Capital city New South Wales and South Australia showed medium term increases, but these were offset by declining rates in the territories and Tasmania. The regional average was skewed somewhat by the high MDA levels detected at site 012 in Queensland in August 2017.

Figure 28: Estimated average consumption of methylamphetamine by state/territory.



- Temporal fluctuations in South Australia and Western Australia
- Medium term trends flat in many parts

Figure 29: Change in methylamphetamine consumption for sites with historical data.

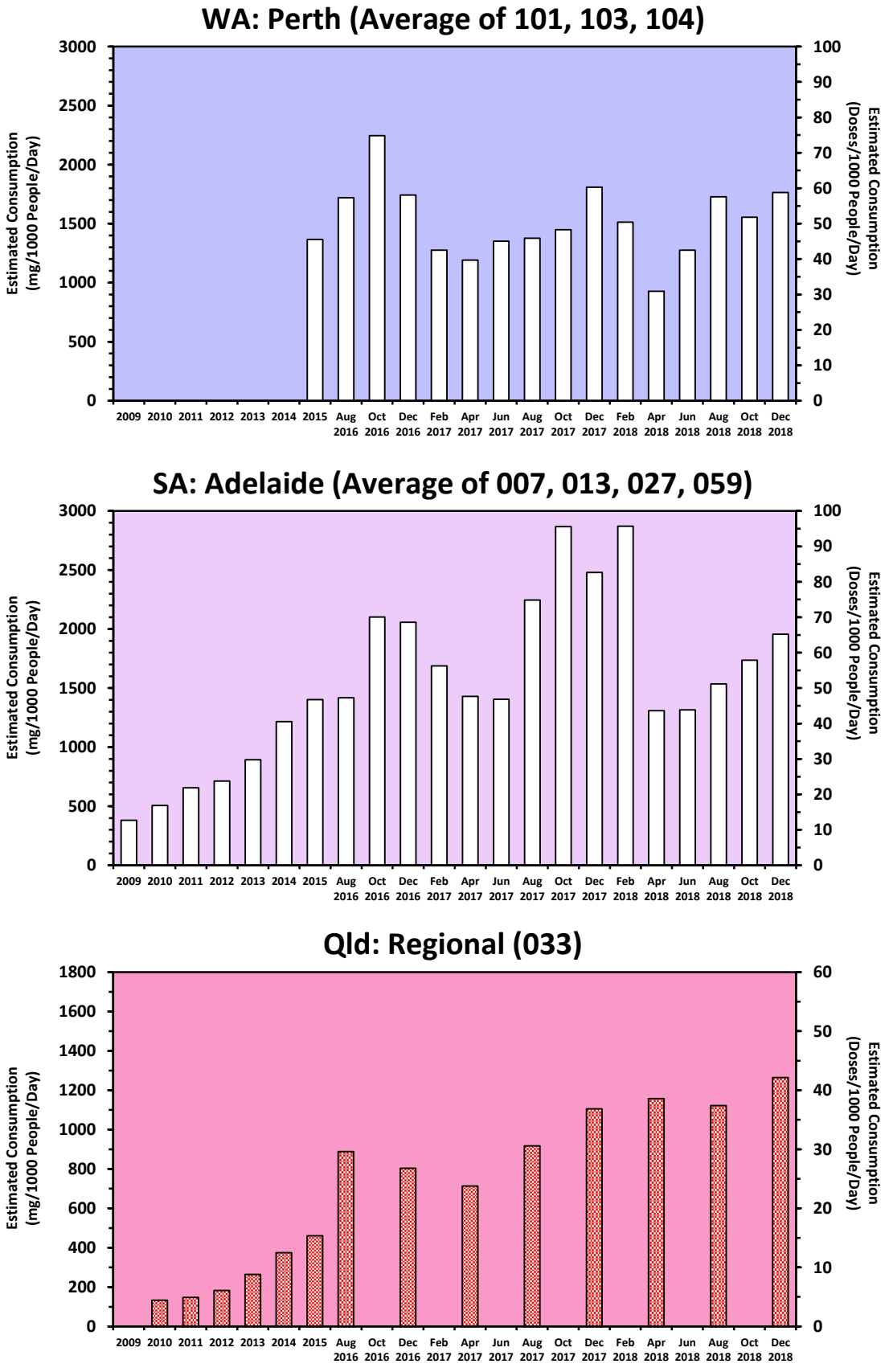
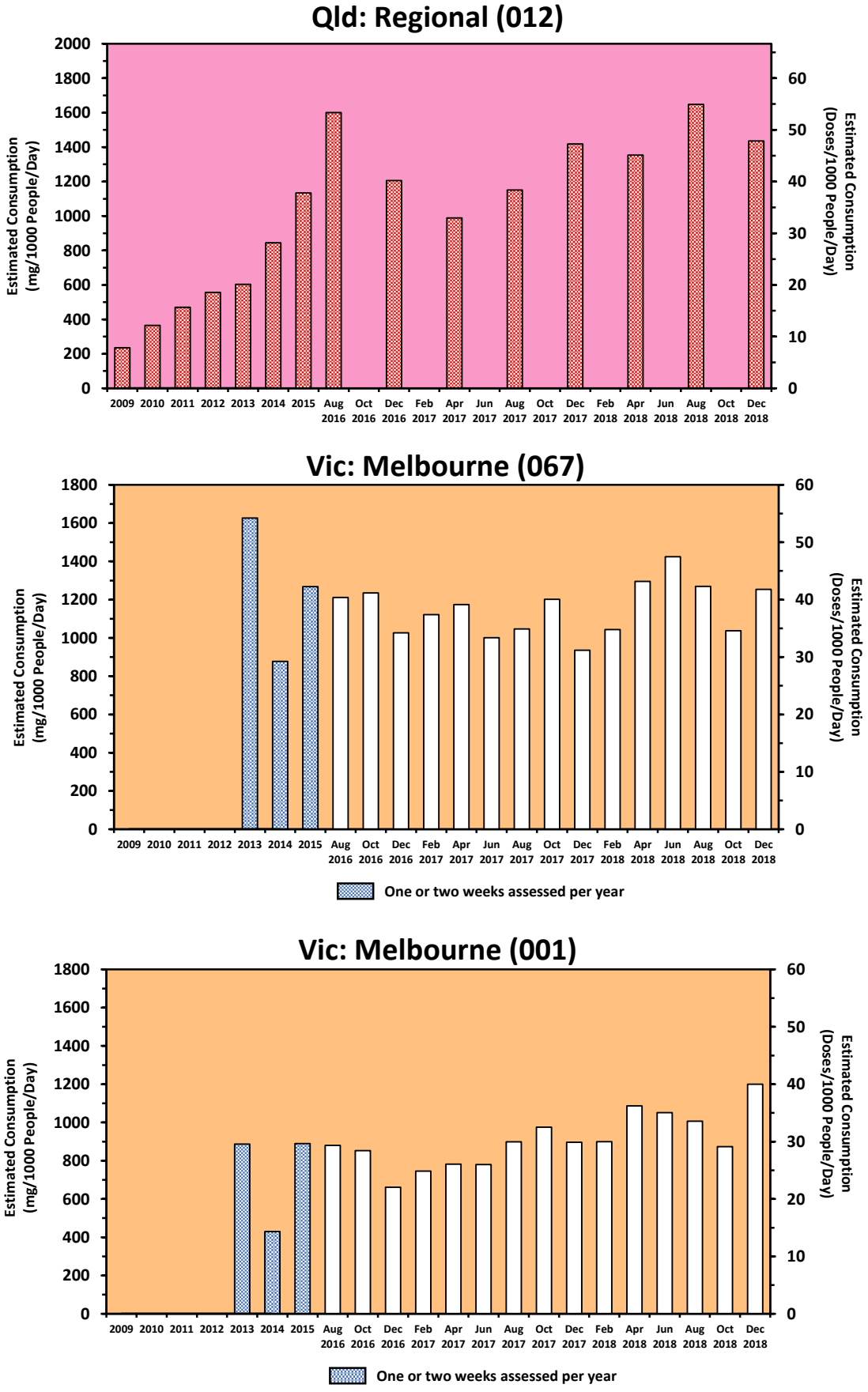


Figure 29 (continued): Change in methylamphetamine consumption for sites with historical data.



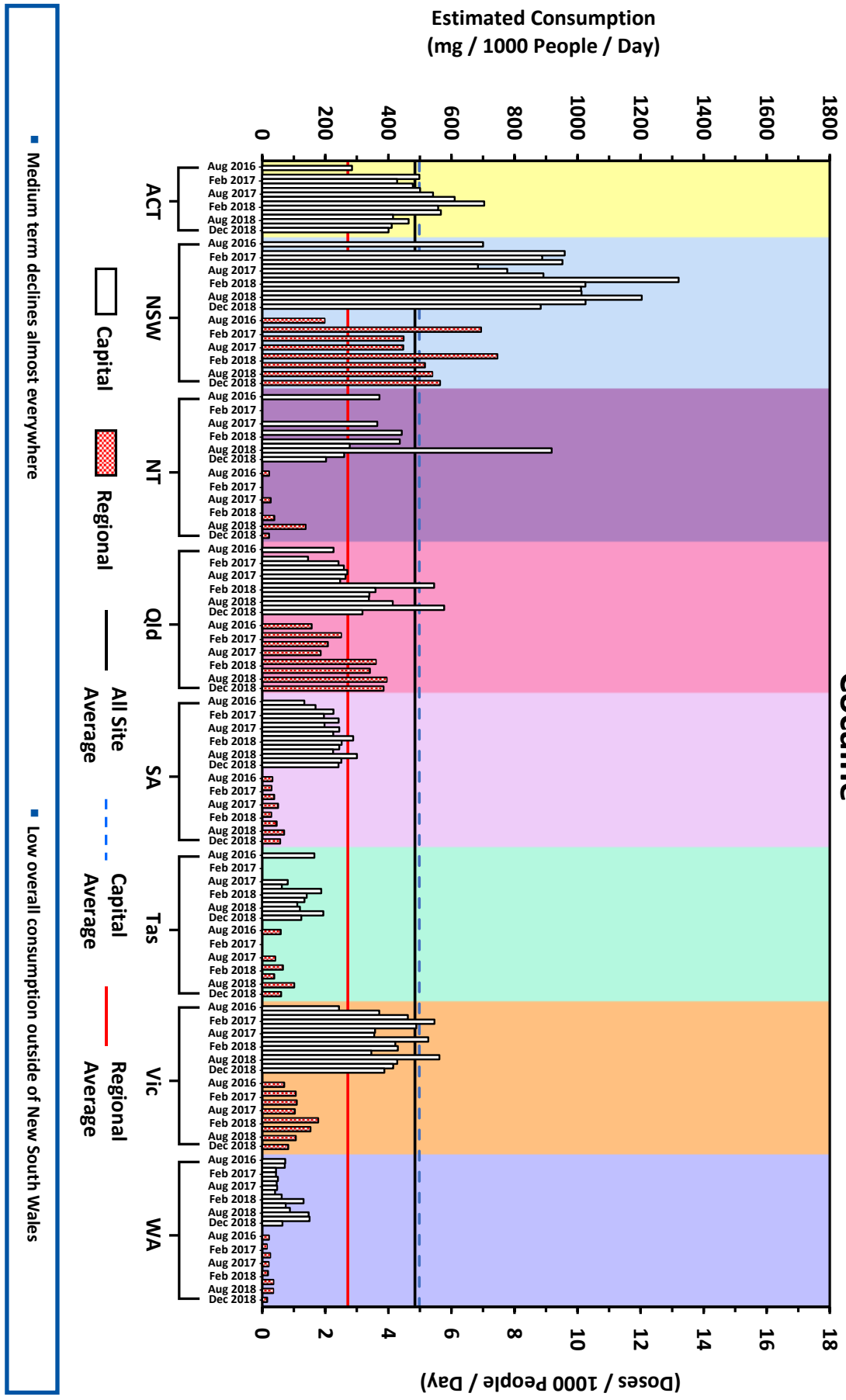
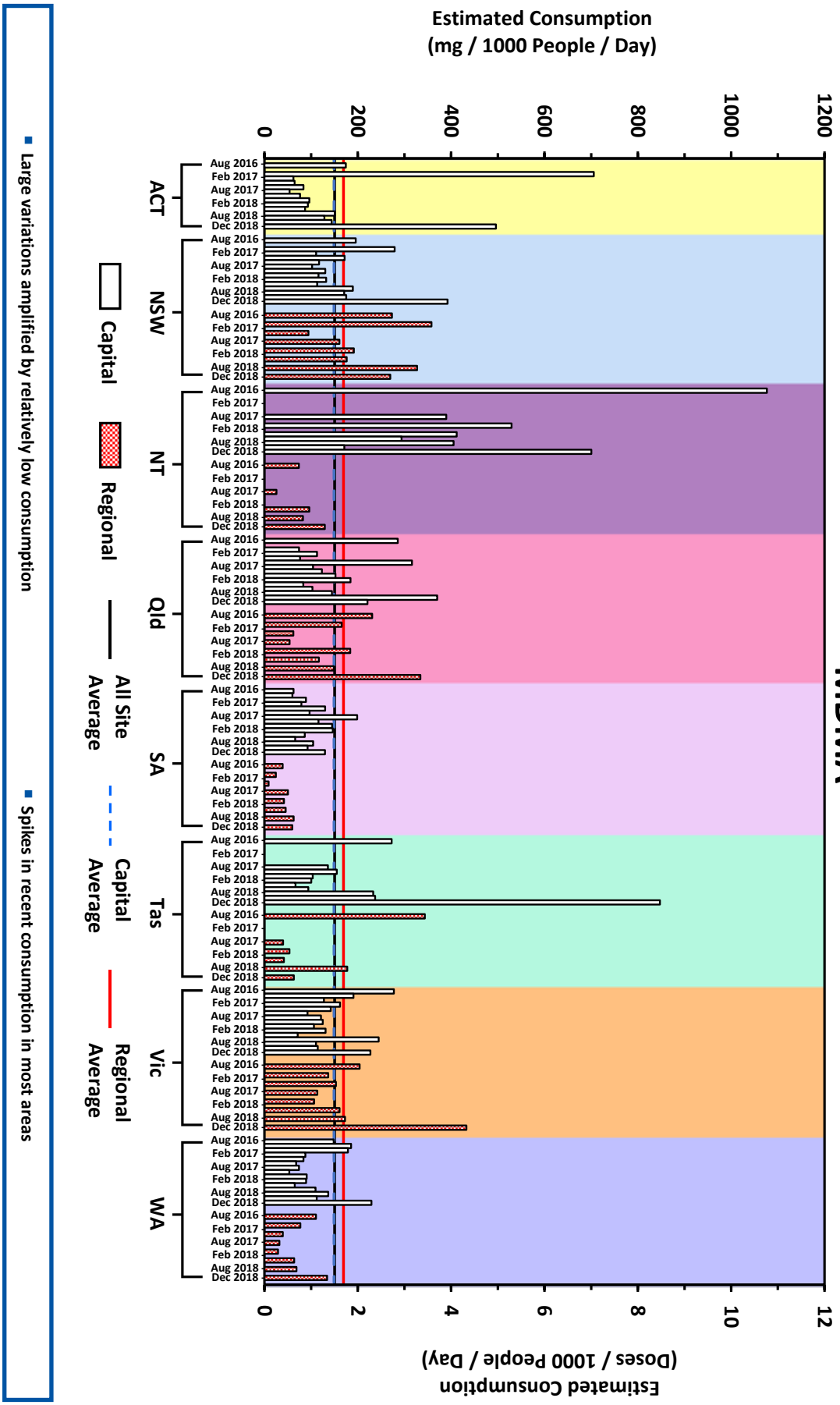


Figure 30: Estimated average consumption of cocaine by state/territory.

Figure 31: Estimated average consumption of MDMA by state/territory.



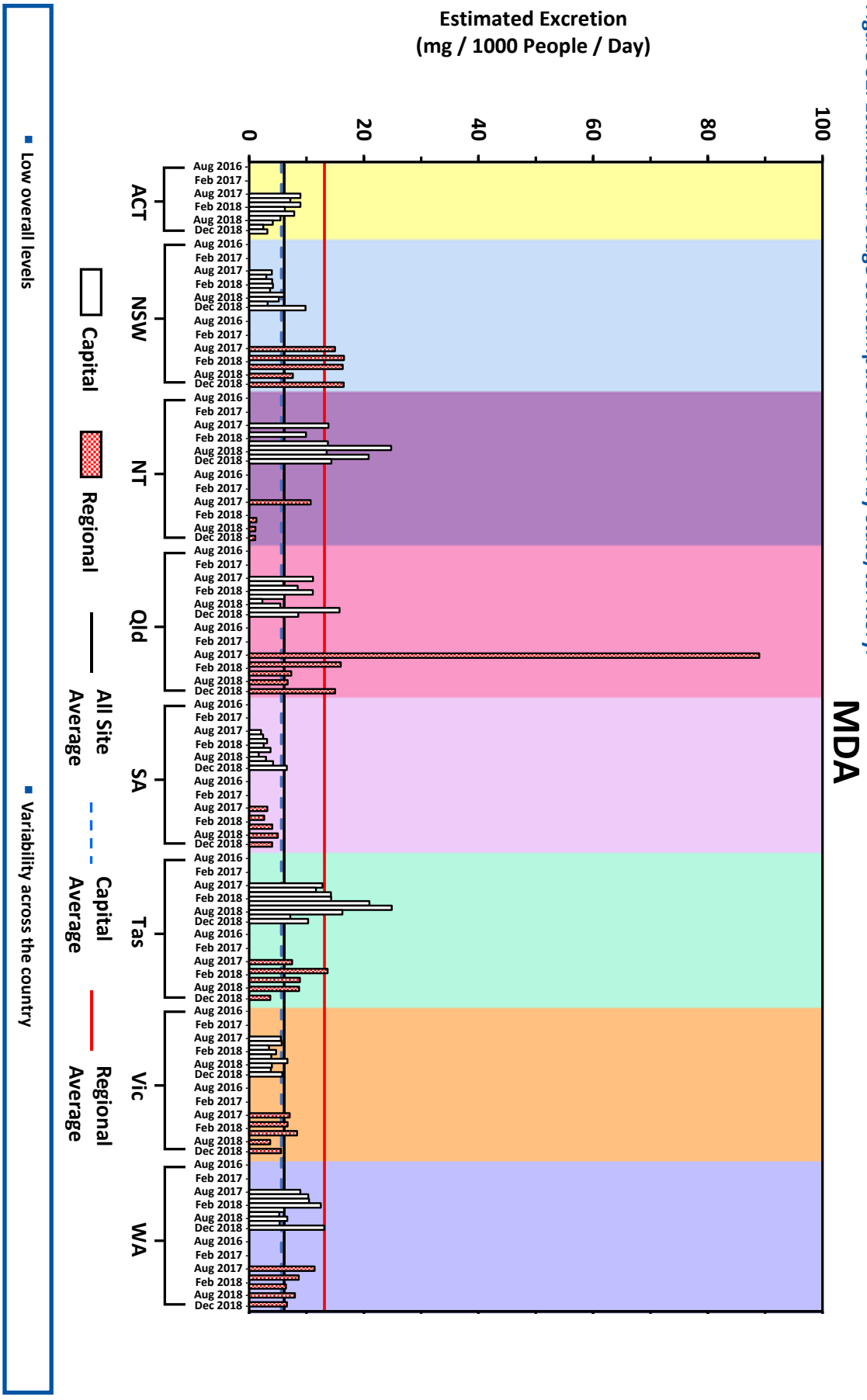


Figure 32: Estimated average consumption of MDA by state/territory.

4.2.3 OPIOIDS

The consumption of oxycodone spiked in many parts of the country in the current reporting period, particularly the Australian Capital Territory and capital city Tasmania and many parts of regional Australia (Figure 33). A feature of oxycodone use in Australia is the very high regional levels compared to the capital cities. Trends since December 2017 are rising in many regional areas of the various states and territories. This is not the case in the capital cities, except for Tasmania.

Fentanyl use in regional Australia remain similarly high in comparison to capital cities (Figure 34). The longer-term upward trend in most states and territories was maintained in the regional centres in this reporting period. The rising trends were also evident in capital city Victoria and the Australian Capital Territory.

Heroin use in Australia is stable or on the decline in most parts of the country over the course of the program, except for New South Wales and Victoria. Victoria has the highest use of capital cities, while regional use in that state remains low in comparison (Figure 35). The population-weighted average consumption of heroin in the capital city sites is the highest recorded since August 2017. This is largely driven by the large population centres in Victoria and New South Wales. The use of the drug has been measured in capital city South Australia since 2013 (Figure 36). Together with the current reporting period, levels of heroin consumption for the region have been declining in South Australia.

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

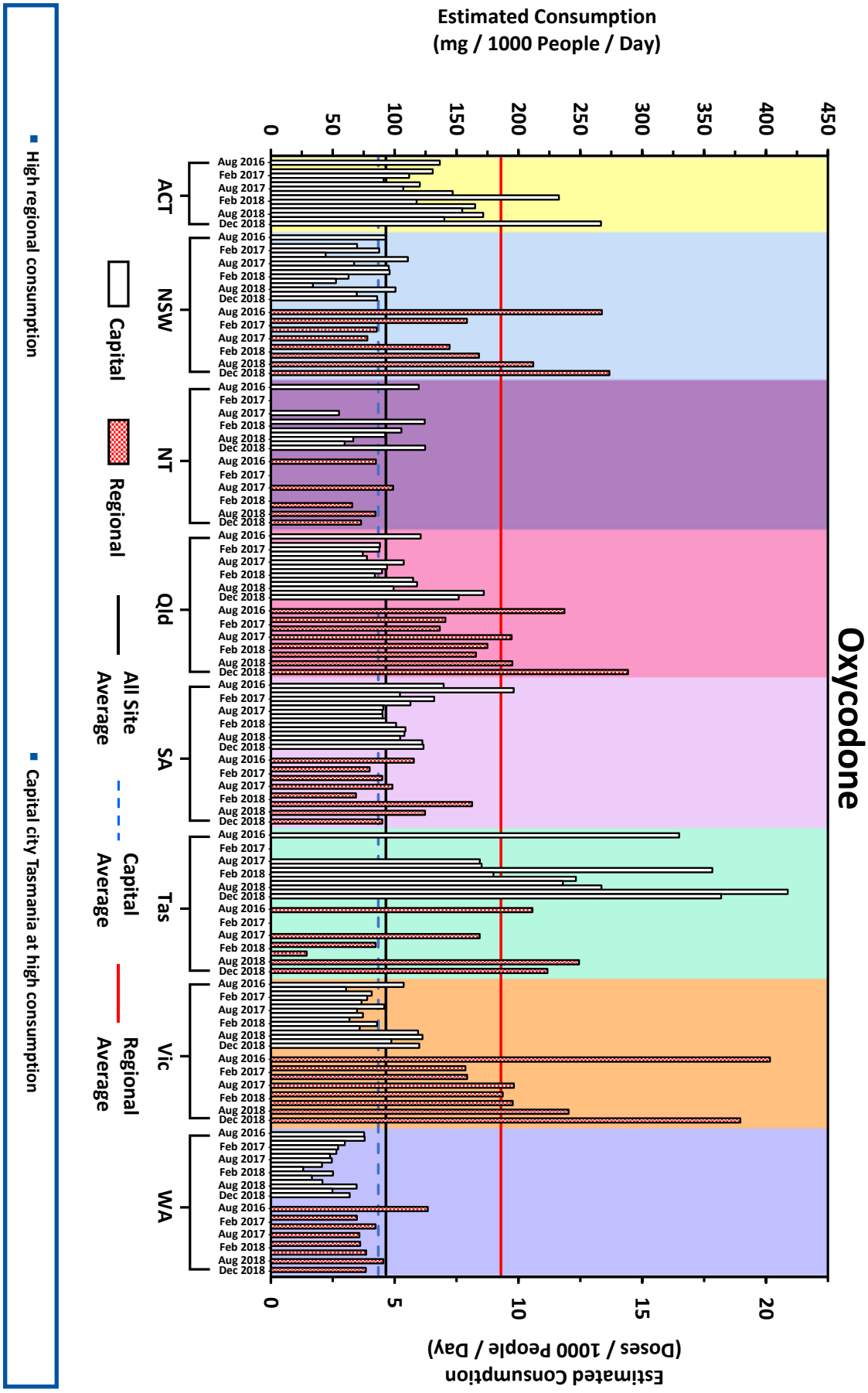
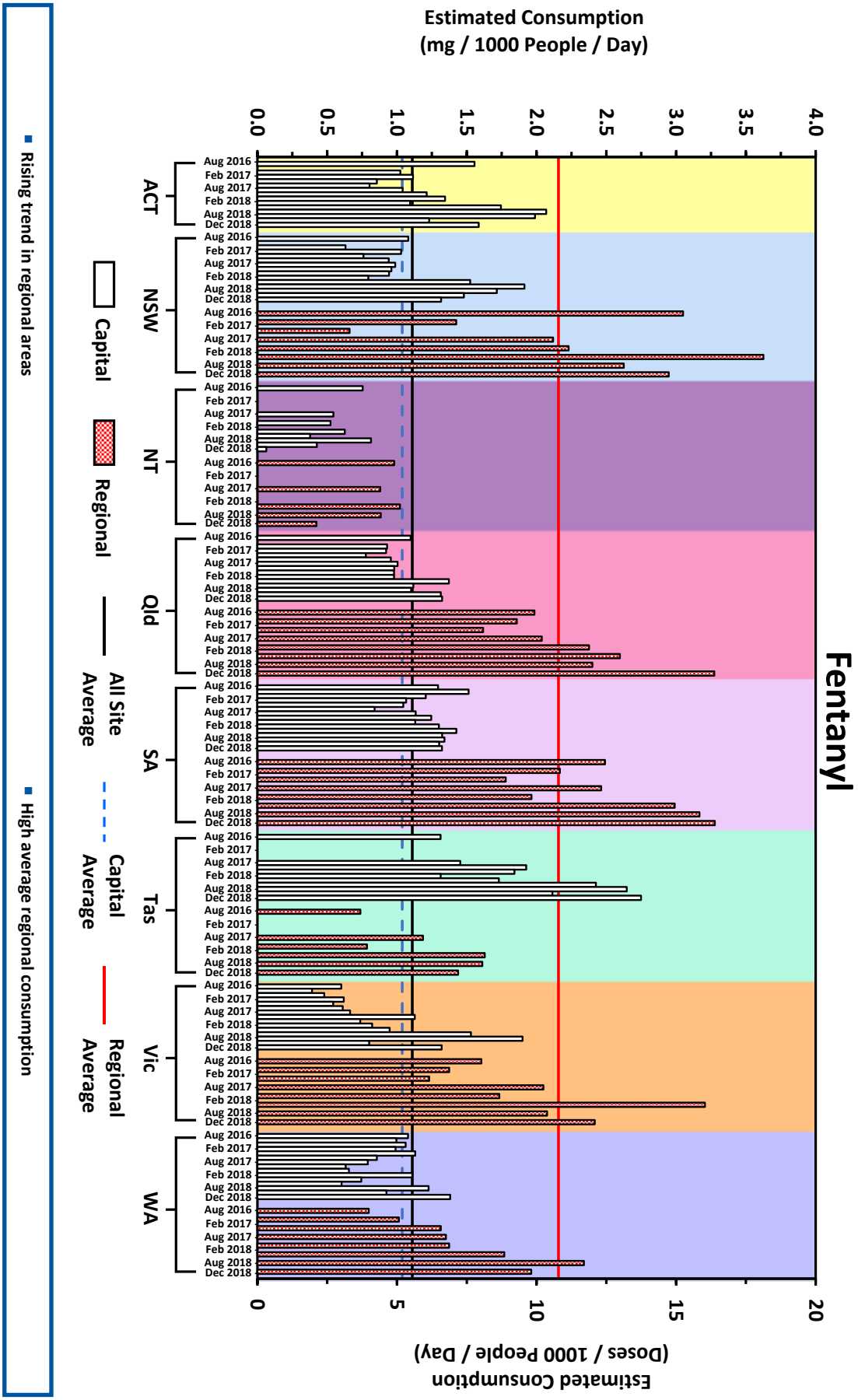


Figure 34: Estimated average consumption of fentanyl by state/territory.



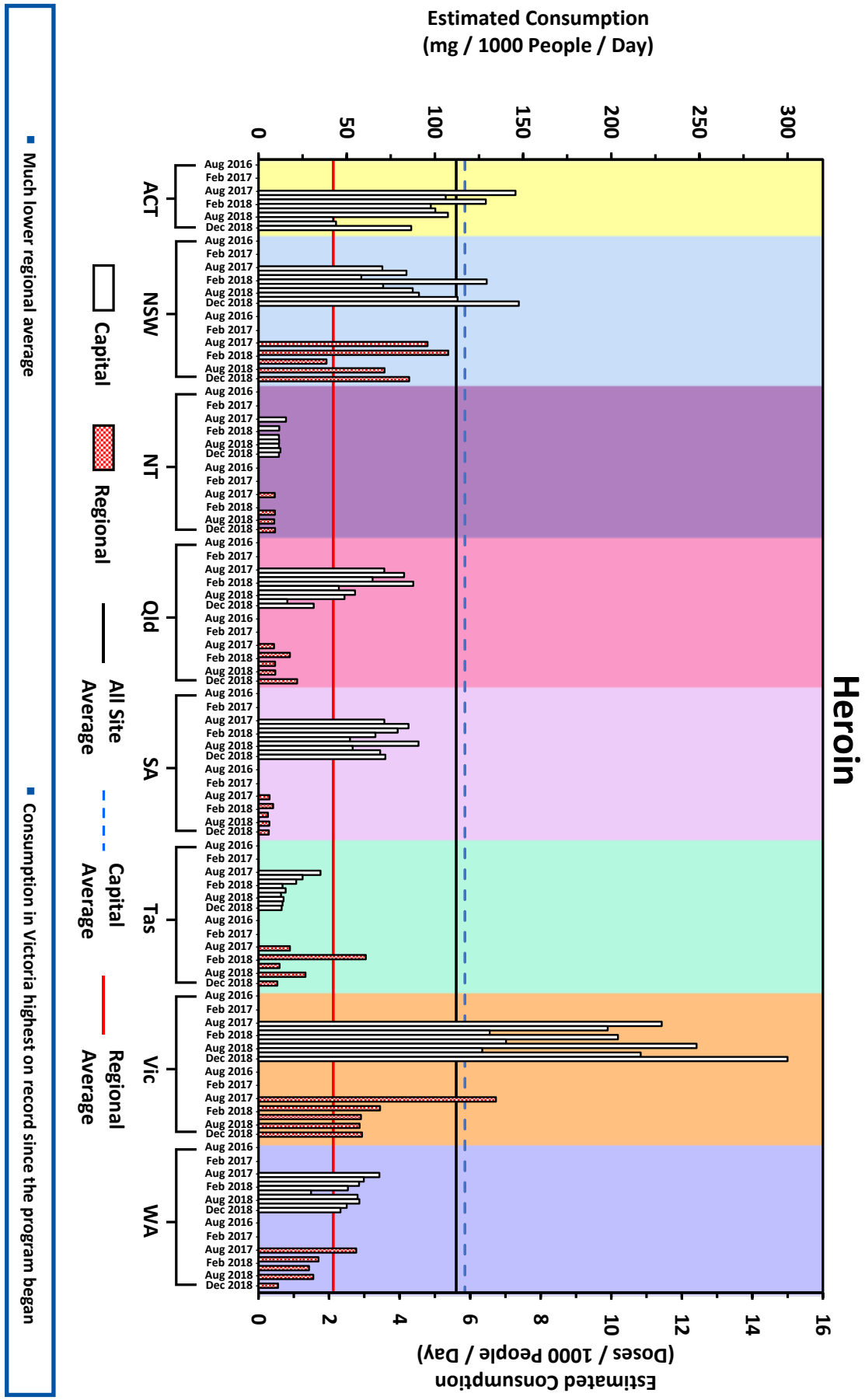
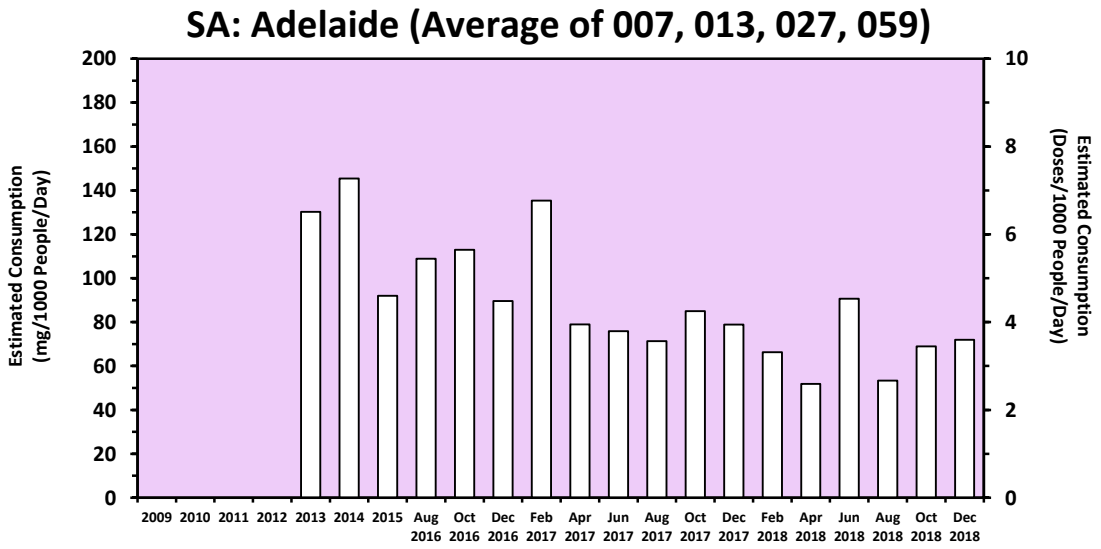


Figure 35: Estimated average consumption of heroin by state/territory.

Figure 36: Change in heroin consumption for South Australia.



4.2.4 CANNABIS

Cannabis was only included in the program since August of 2018. It may be too early to draw any conclusions in terms of temporal trends. Nevertheless, only minor fluctuations were evident for the various parts of Australia (Figure 37). Regional consumption was higher than capital city levels, with highest consumption centred in Tasmania and regional Northern Territory and South Australia.

Consumption of cannabis has previously been measured in capital city South Australia. Use of the substance has been steady over the last year at a level slightly above the preceding reporting periods (Figure 38).

Figure 37: Estimated average consumption of cannabis by state/territory.

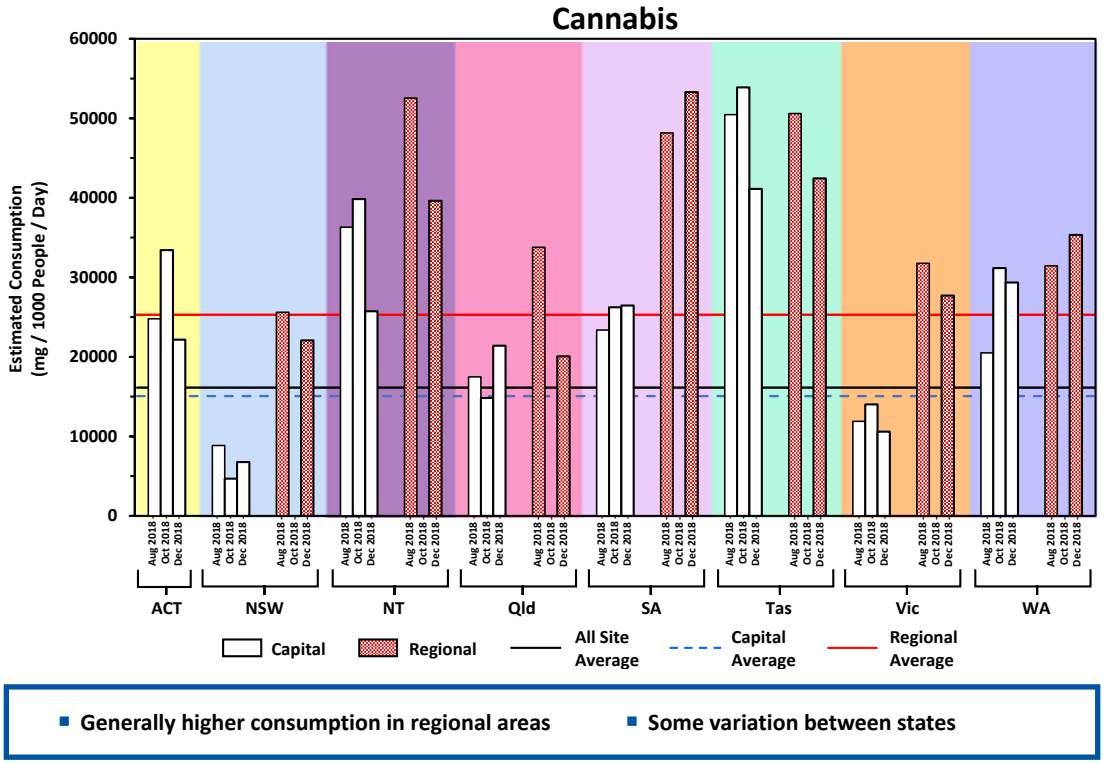
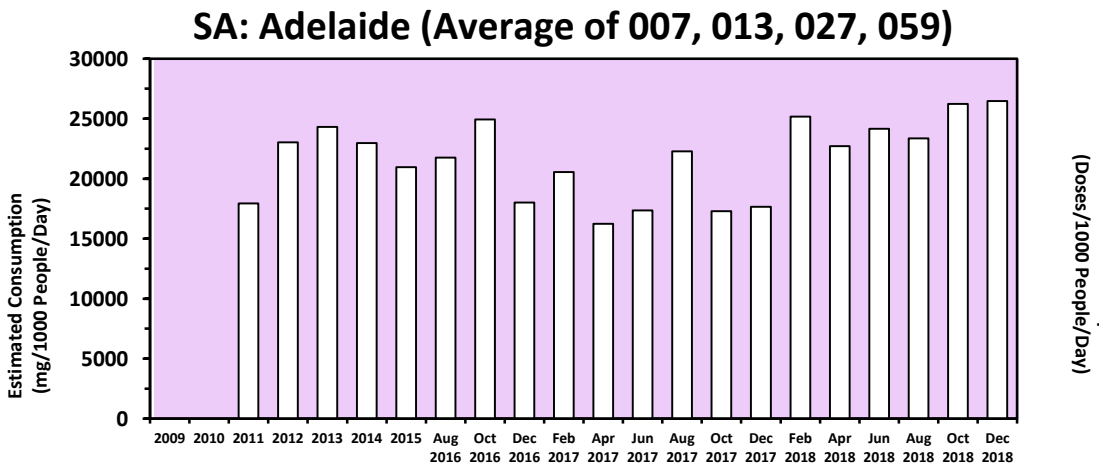


Figure 38: Change in cannabis consumption in capital city South Australia. Cannabis is detected via the THC metabolite THC-COOH.



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 (December 2018 mephedrone and methylone results are shown in Table 2).

4.2.6 CAPITAL CITY AND REGIONAL AVERAGES

For the purposes of determining representative population trends for the collective catchments included in the report over the total sampling period, the averaged overall capital city and regional site populations were expressed as the combined average capital or regional consumption of illicit drugs (Figure 39). Fewer sites were sampled in between August 2016 and December 2017. Therefore, the contributing population was smaller between these dates and some approximations was necessary to account for the absence of some densely populated regions (e.g. October 2016 for capital city New South Wales and Queensland).

In terms of the population included in the report, methylamphetamine levels declined from October 2016 to June 2017. After that, regional use increased substantially over the course of 2017, but has remained steady since then. Capital city levels increased to a lesser extent in 2017 and have fluctuated within a narrow window up to the present reporting period.

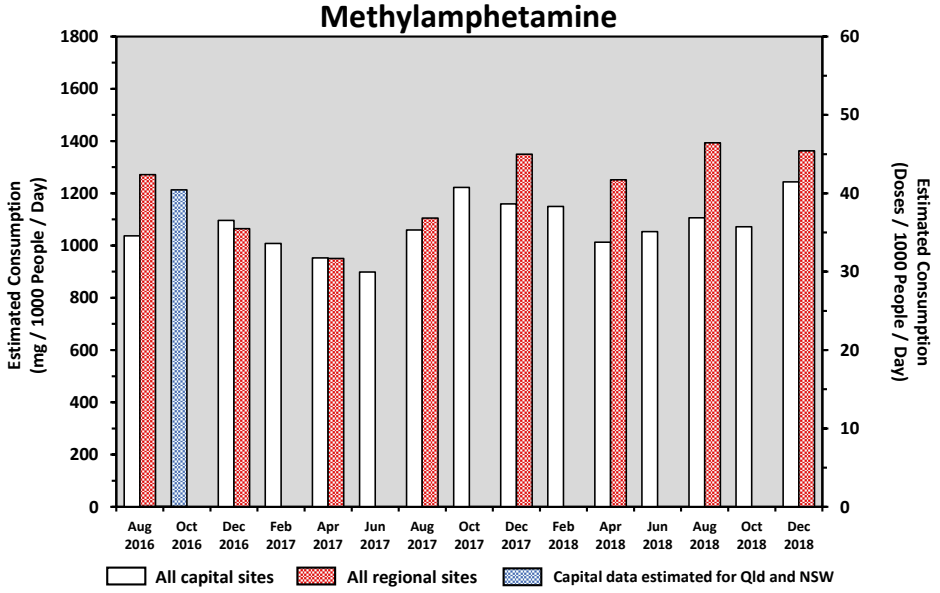
MDMA levels declined overall over the first part of the program. Although the rate of decline was more pronounced in regional areas during the first part of the program (August 2016 to August 2017), use of MDMA increased in capital cities and regional Australia to almost the same level in December 2018. Rates of use remain low compared to methylamphetamine, although current use of MDMA is at its highest levels since the beginning of the program.

Cocaine and heroin consumption showed some short-term variations, both in terms of capital city and regional levels. However, capital city consumption was well above regional use over the entire program for both drugs. Heroin in capital cities have increased slightly, with use in December 2018 the highest recorded since the program commenced monitoring heroin in August 2017, while regional use has declined over the course of the program.

In terms of legal substances with abuse potential, alcohol and nicotine consumption remained largely unchanged over the reporting period, with only small fluctuations evident (Figure 40). Nicotine consumption was higher in regional areas, whereas in the case of alcohol, averages were similar in capital cities and regional catchments. A distinct difference between capital cities and regional Australia was observed for the two pharmaceutical opioids monitored by the NWDMP, cities being at a much lower level. Fentanyl use in 2018 stabilised after an increase over the course of 2017, while oxycodone consumption in regional areas have been increased steadily since early 2017. In contrast, average capital city use of oxycodone levels has remained relative stable.

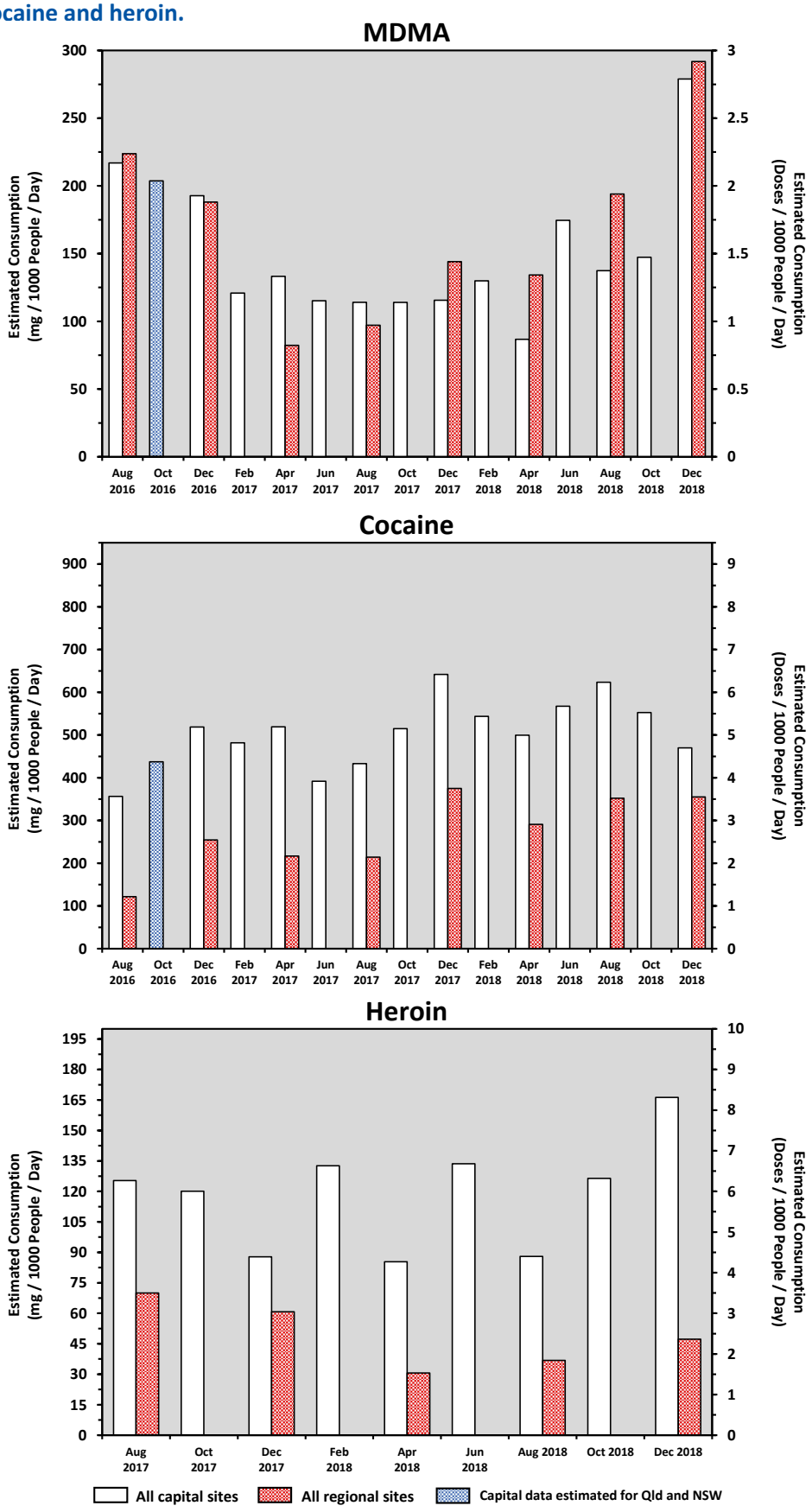
The remaining substances, cannabis, MDA, mephedrone and methylone had mixed results in the national context. Cannabis appears stable across capital city areas, with a slight decrease in regional areas (Figure 41). MDA also appeared stable across city sites, although regional sites had large variability which has partially been driven by sites in Queensland (for example, August 2017 high consumption rates were mainly driven by site 012).
The mephedrone and methylone detection rate has varied across the course of the program without obvious patterns, except for capital city mephedrone which after decreasing from highs in December 2017 has steadily increased.

Figure 39: The population-weighted average of all sites for methylamphetamine, MDMA, cocaine and heroin.



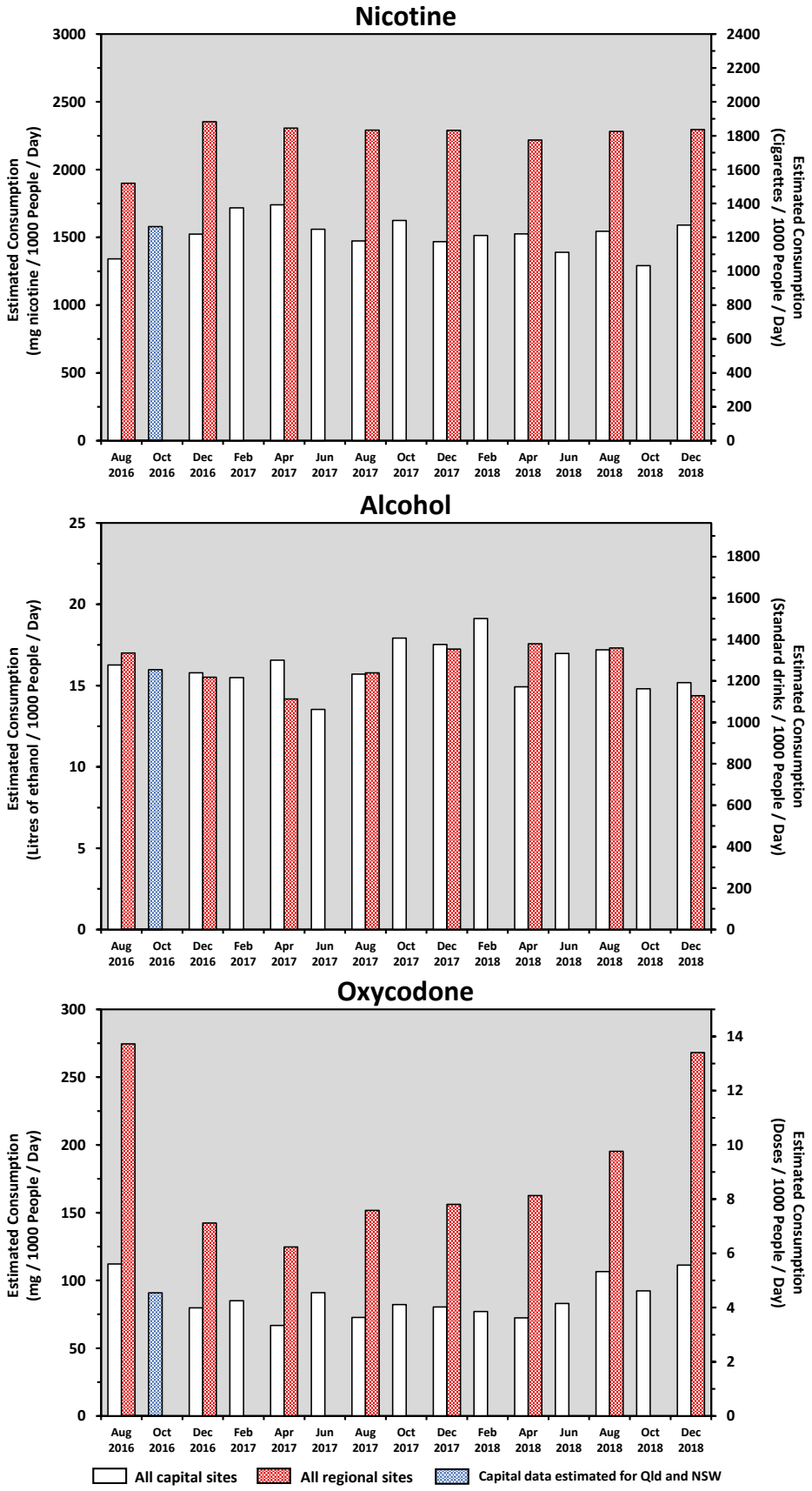
Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 39 (continued): The population-weighted average of all sites for methylamphetamine, MDMA, cocaine and heroin.



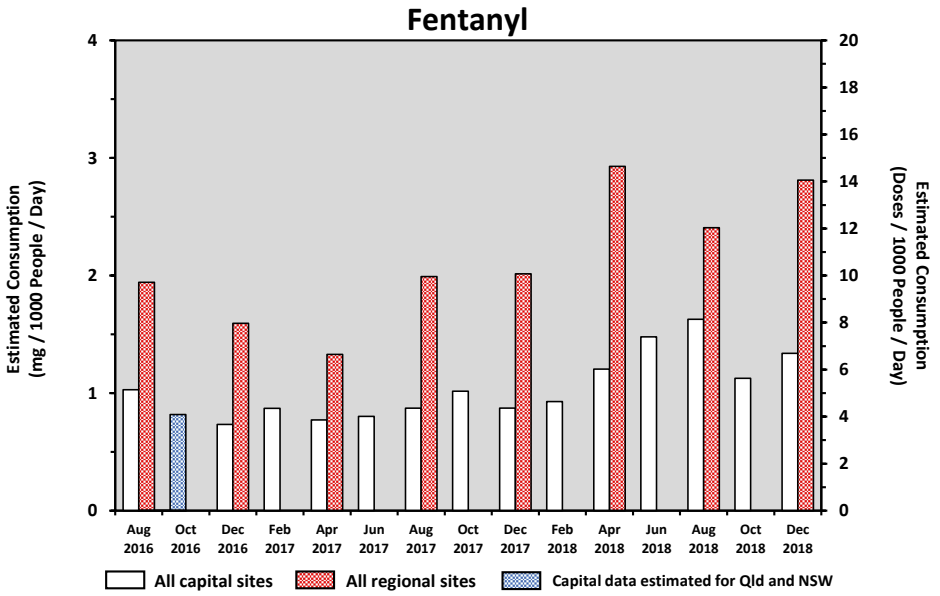
Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 40: The population-weighted average of all sites for 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 December 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 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 December 2016 was used to provide the overall October estimate. Regional areas were only sampled every second collection period.

Figure 41: The population-weighted average of all sites for cannabis, MDA, methylone and mephedrone.

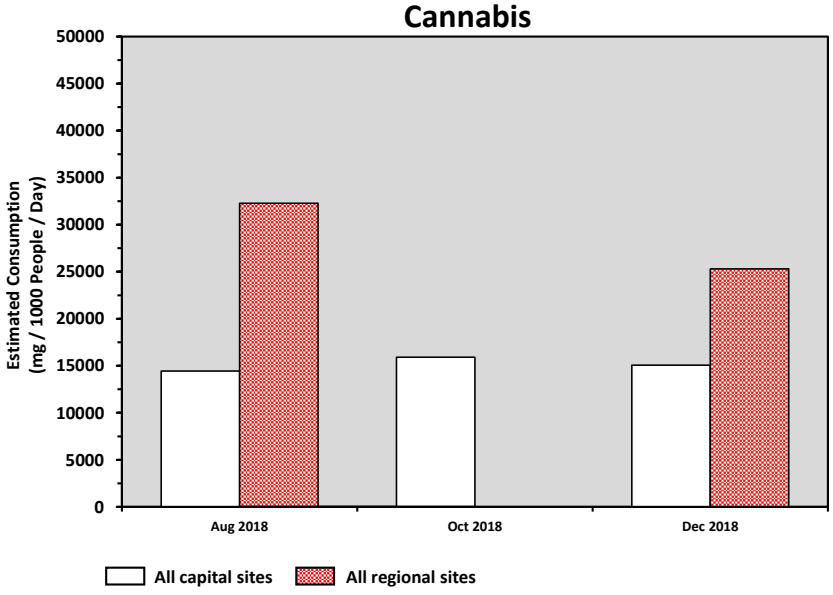
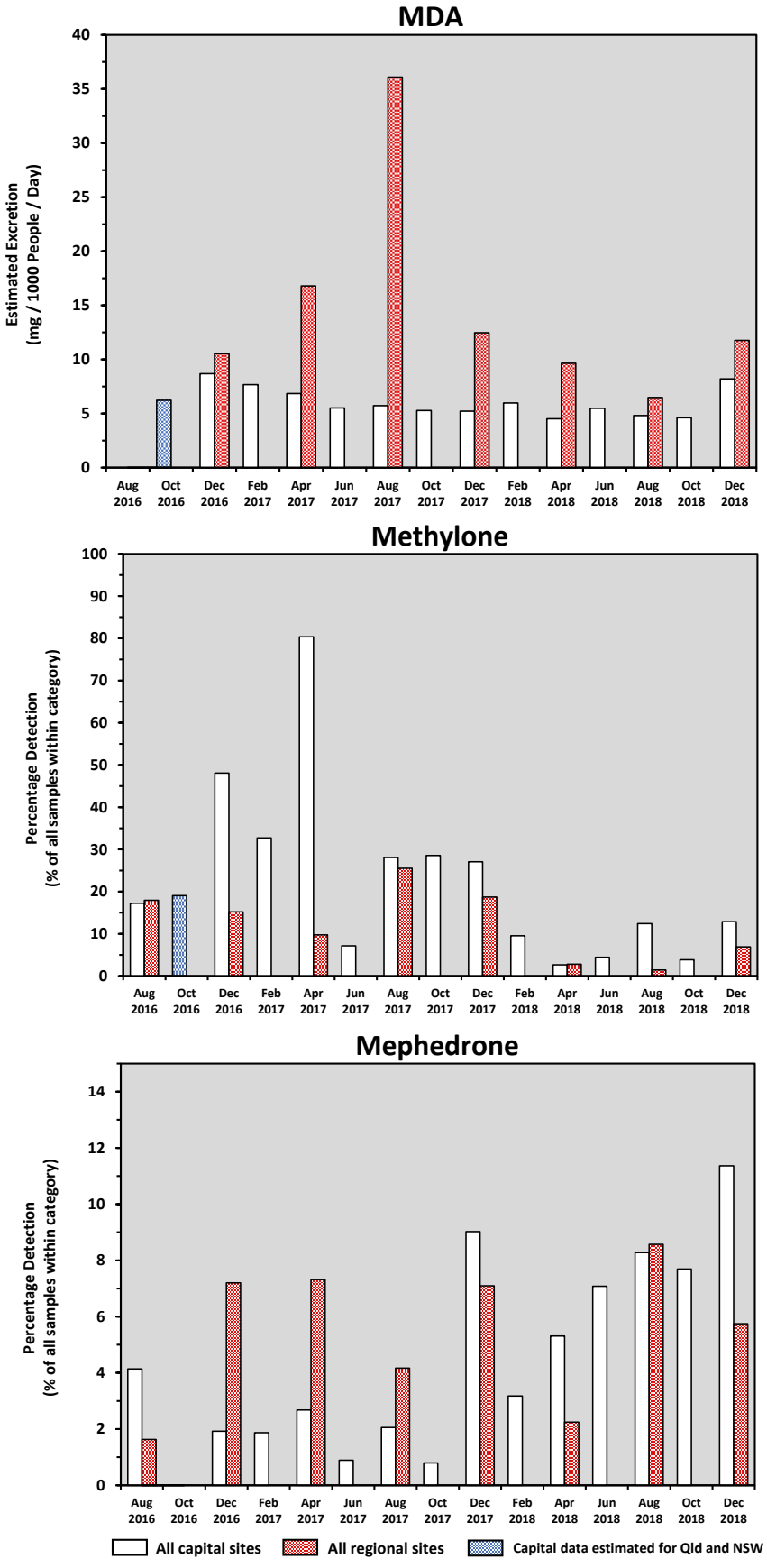


Figure 41 (continued): The population-weighted average of all sites for cannabis, MDA, methylone and mephedrone.



As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 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. The definition of a typical dose of cannabis is debatable, since various parts or different strains of the herb may be used, containing different proportions of the psychoactive substance, THC. Therefore, the amounts of THC consumed were not expressed in doses used per day. Accordingly, cannabis was omitted from this section which is a comparison of doses of drugs in a region.

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 1,300 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 43 doses per 1,000 people per day (Figure 8).

After nicotine and alcohol, methylamphetamine use remained highest of the other 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 42 and Figure 43). 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. The scale of use of oxycodone and fentanyl in Tasmania was much closer to methylamphetamine than in other states or territories, while in New South Wales, the proportion of cocaine was high in the capital city.

Figure 42: Profile of average drug consumption by state or territory, for the Australian Capital Territory, New South Wales, Northern Territory and Queensland. 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).

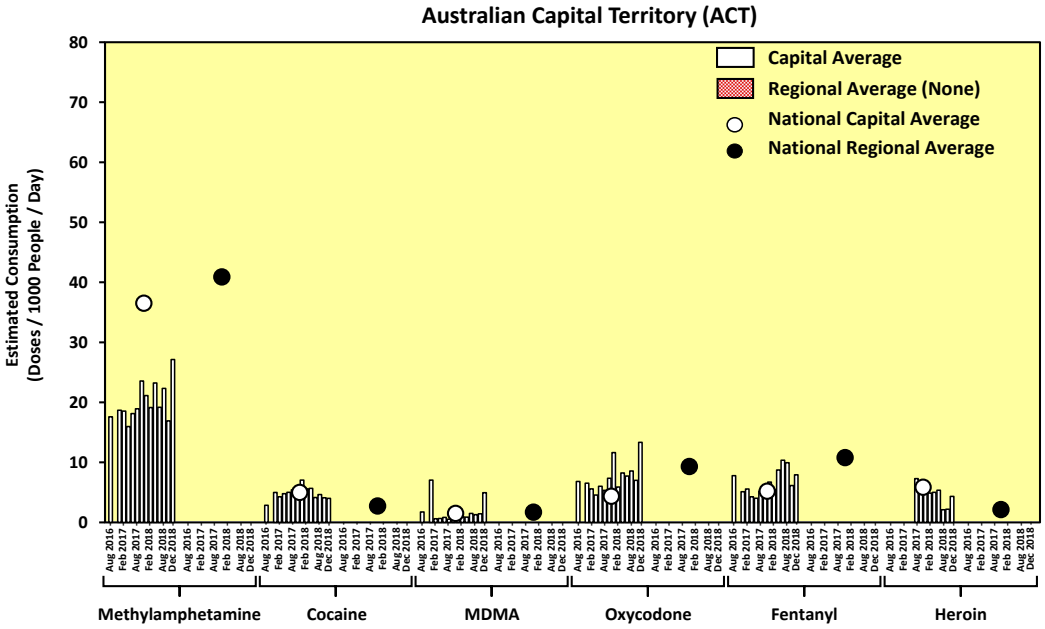


Figure 42 (continued): Profile of average drug consumption by state or territory, for the Australian Capital Territory, New South Wales, Northern Territory and Queensland.

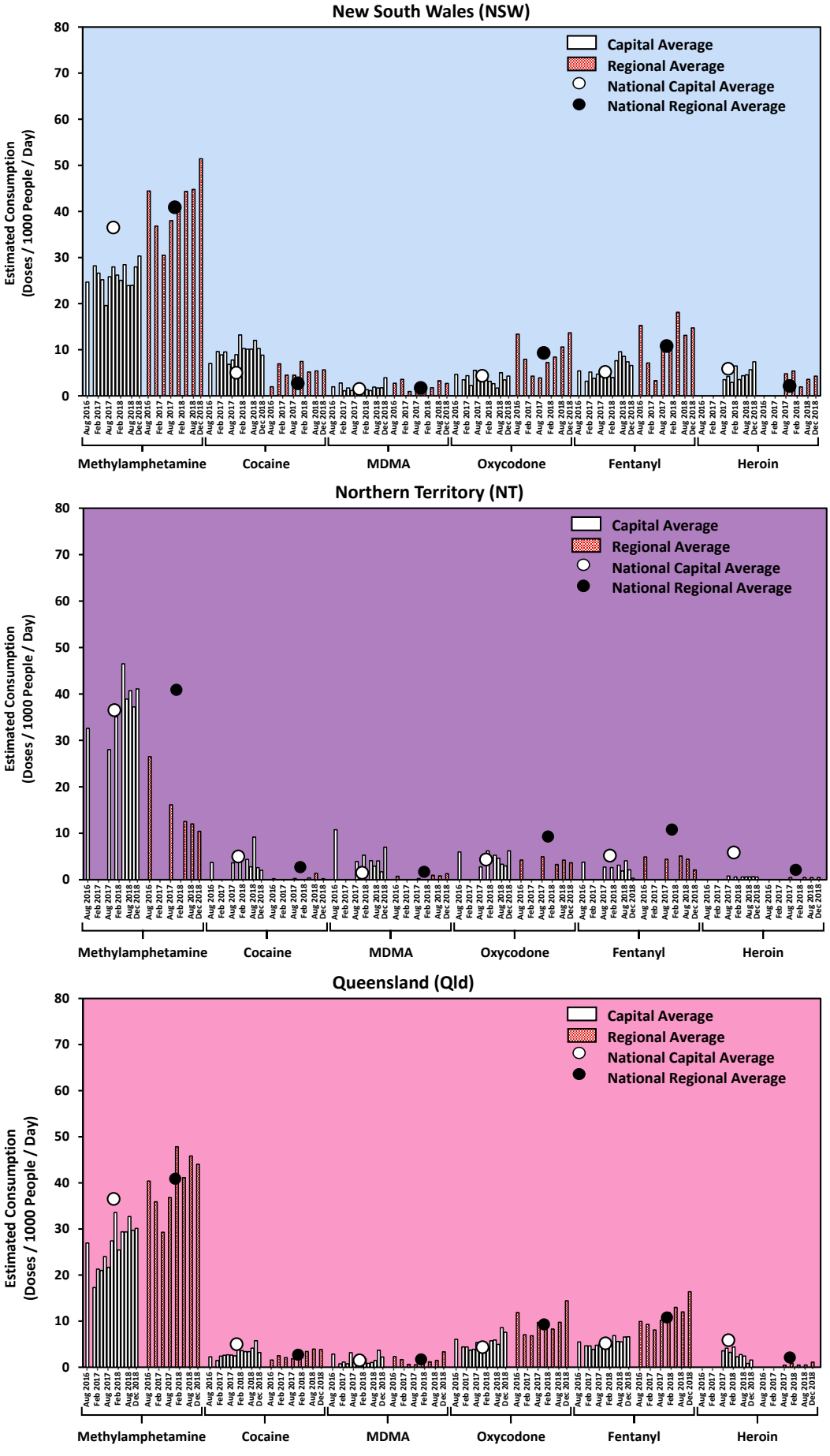


Figure 43: Profile of average drug consumption by state or territory, for South Australia, Tasmania, Victoria and Western Australia. Consumption is shown as the number of doses per 1,000 people per day to allow comparison of drugs of different types within the same region (state or territory). The red y axis for South Australia indicates a higher number of doses compared to other jurisdictions.

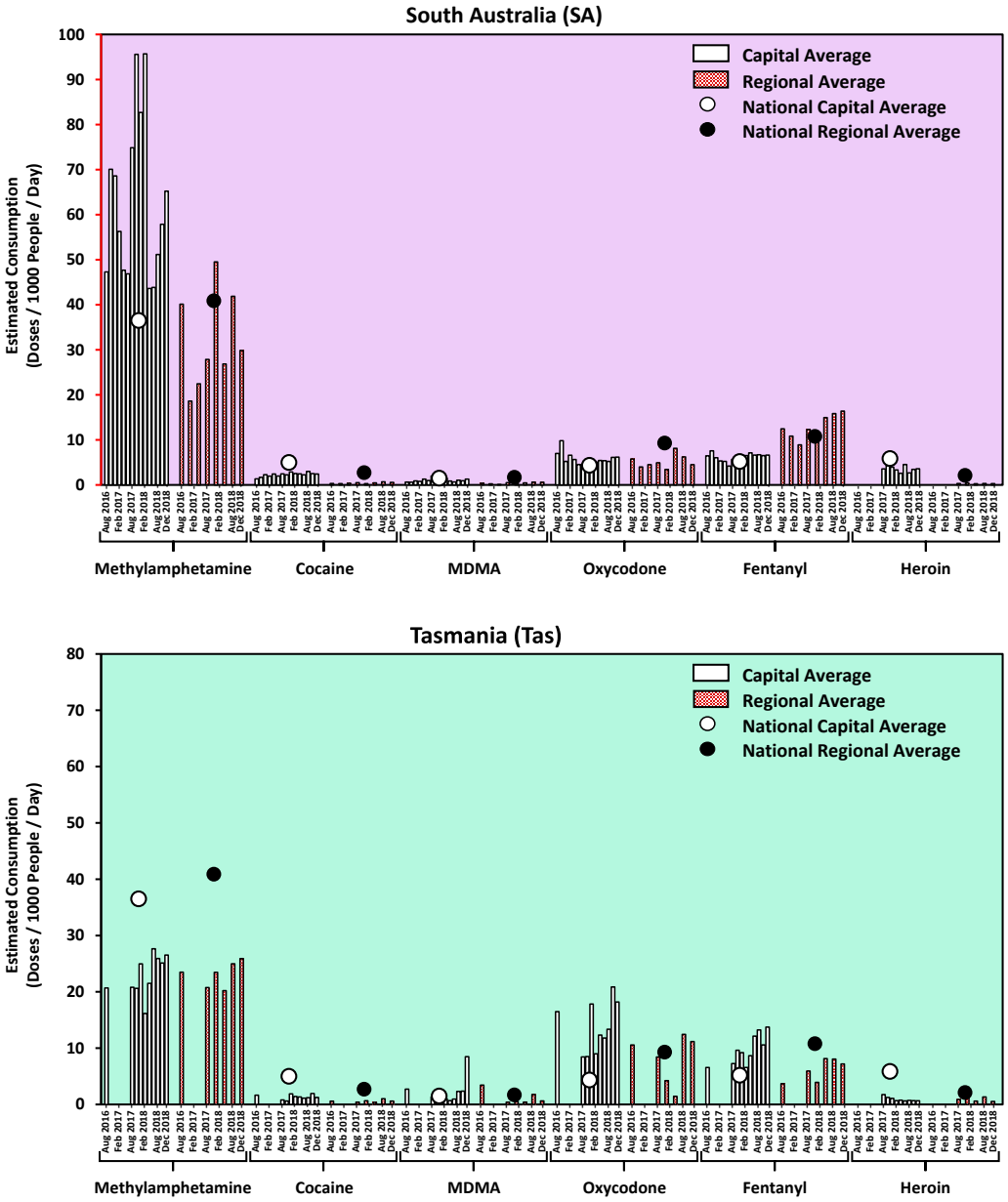
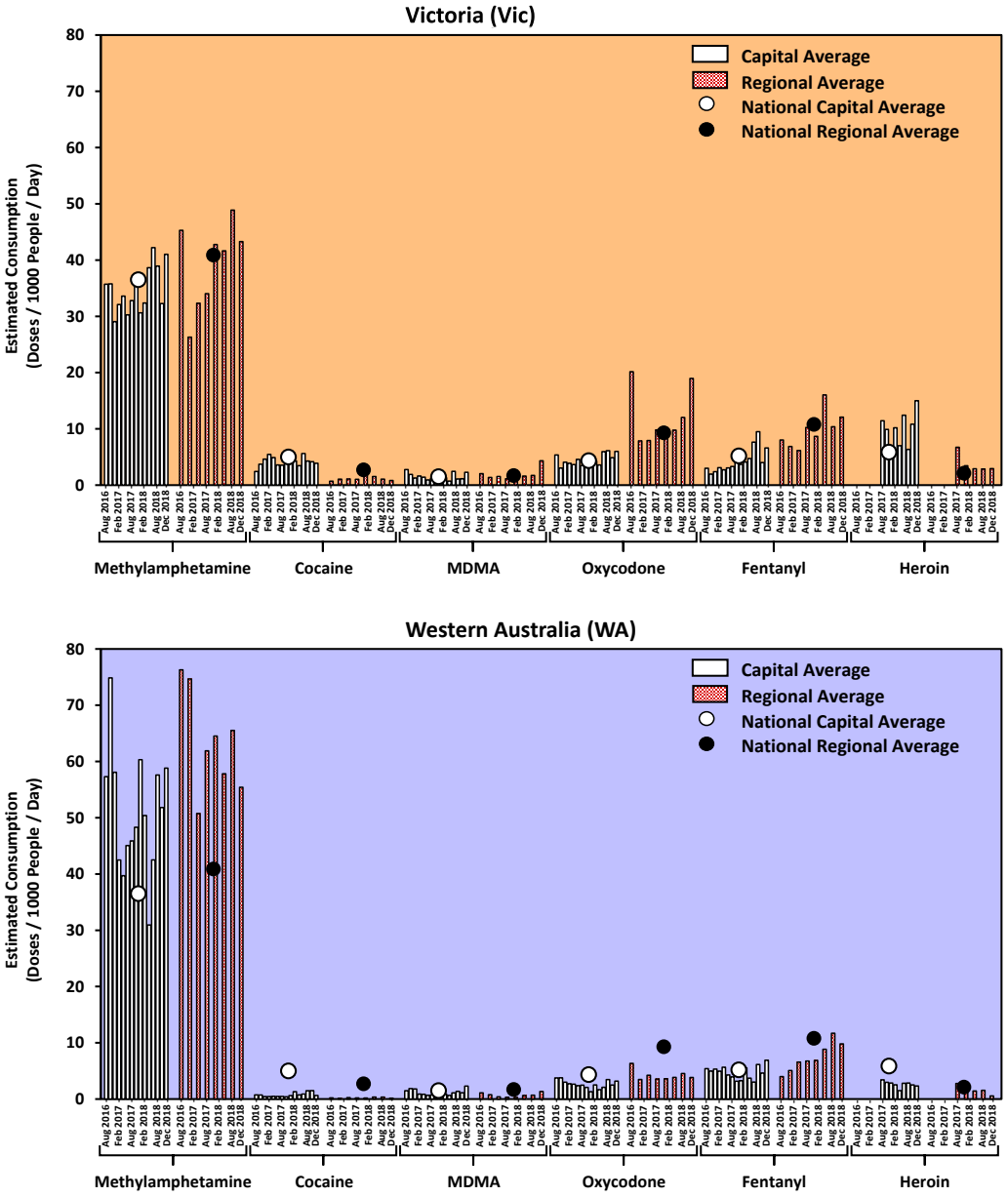


Figure 43 (continued): Profile of average drug consumption by state or territory, for South Australia, Tasmania, Victoria and Western Australia.

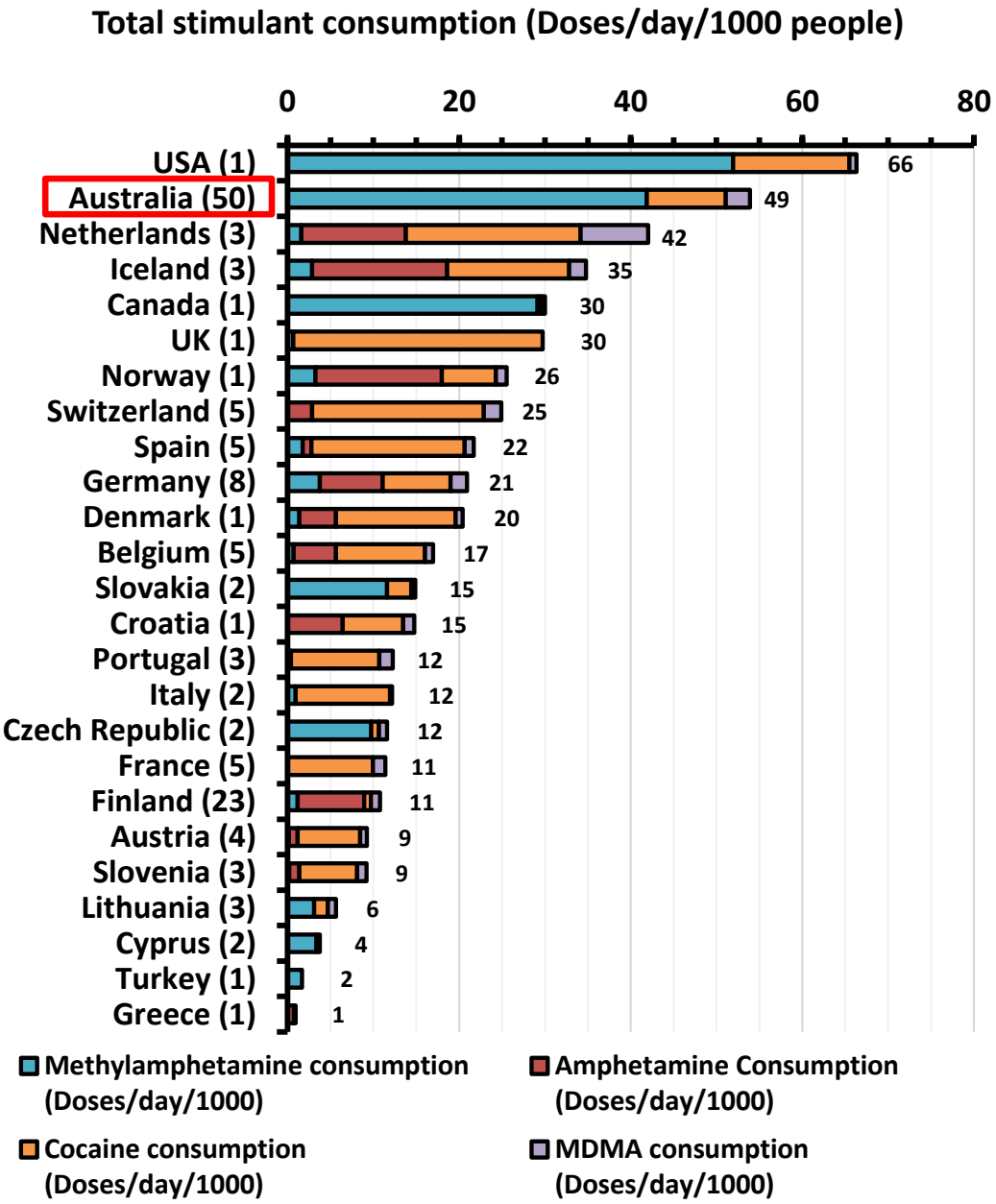


5: INTERNATIONAL COMPARISON OF STIMULANT USE

A comparison of stimulant use levels in Australia with international levels was done to show the relative scale of use. Such comparisons need to be understood in the context of different global preferences and availability of drugs between countries. Latest international data for Europe, the United States of America (USA), Canada and South Africa were used as reported by the Sewage Core Group Europe (SCORE) for samples collected in March 2018 (SCORE 2019). Consumption rates are compared against Australian levels in the present report (December 2018). It has to be recognised that the SCORE data relate in many cases to only a single site per country participating in the study and is therefore unlikely to be representative of drug use in the entire country.

Throughout many parts of Europe, amphetamine is more commonly used than methylamphetamine, while the opposite is true in Australia. Therefore, in the first instance, the four common stimulants were added together and expressed as doses per day per normalised population (Figure 44). Australia ranked second highest in terms of combined stimulant use after the USA. It is apparent that the ranking is very much a consequence of local methylamphetamine consumption.

Figure 44: The total amount of stimulant consumed (as doses per 1,000 people per day) by a country as a population-weighted average of the number of reported sites (given in brackets after country name).

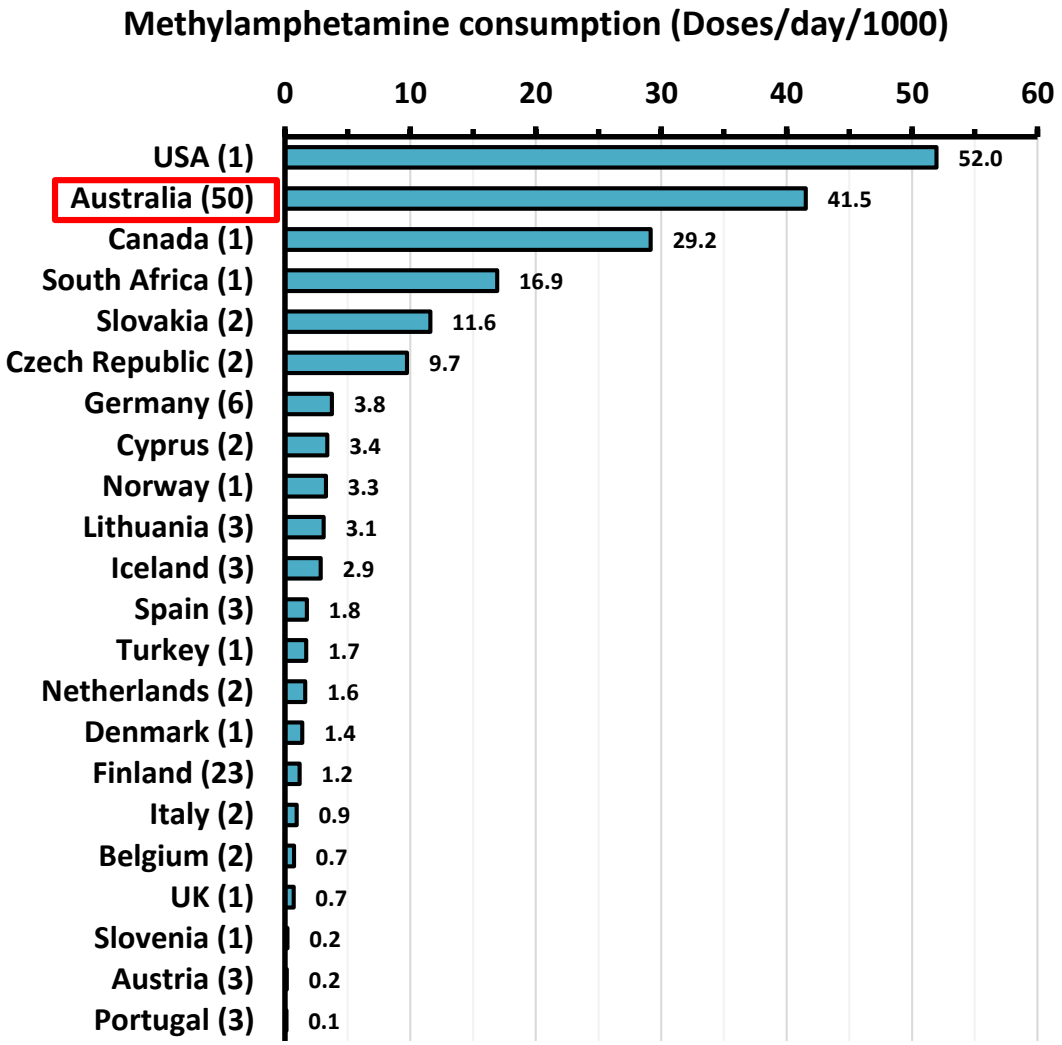


Note: the international estimates are based on data for a few WWTPs per country only and may not be reflective of the national per capita consumption for a given drug in a given country. European, North American and African data are from SCORE (2019) and various excretion factors applied are reported in Report 1, Appendix 1 (Table 3). SCORE reports measured raw loads in sewers and doses were calculated for the purposes of this report in the same way as for Australia. Not all substances were detected in all regions in the SCORE study.

The high methylamphetamine levels in Australia in the international context was evident when comparing the drugs individually on an international level (Figure 45). Methylamphetamine levels were the second highest compared to the other countries participating in the SCORE study. Some countries in the world with reasonably high methylamphetamine use according to police actions or research papers, such as in Asia and other parts of the Americas, are not represented here.

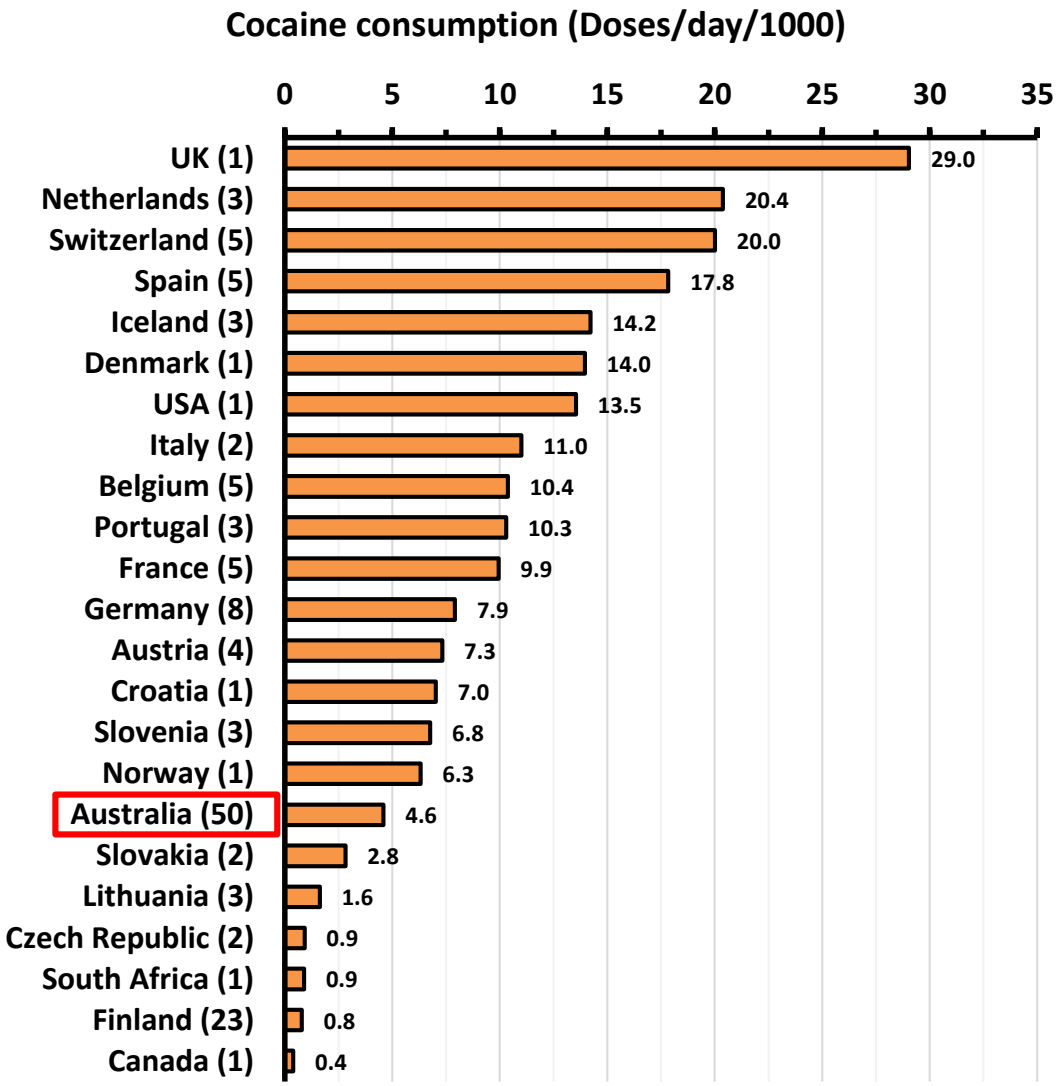
Compared to European drug usage patterns, Australian cocaine consumption was at the lower level (Figure 46), while MDMA use ranked towards the higher end of European levels (Figure 47).

Figure 45: National population-weighted average consumption of methylamphetamine of cities in Europe, North America, Africa and Australia. The number in brackets reflects the number of wastewater treatment plants included in the average.



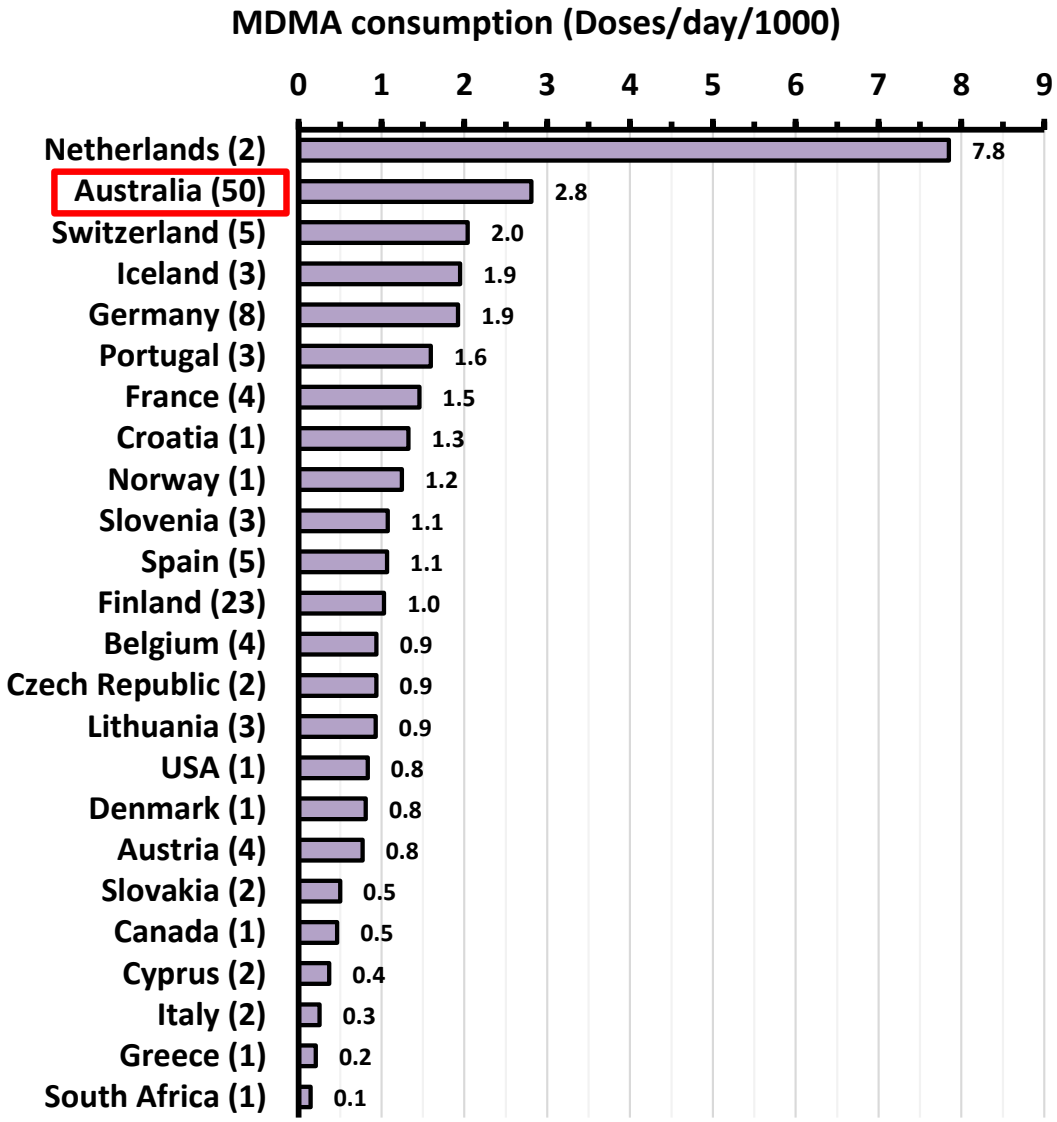
Note: the international estimates are based on data of a few WWTPs per country only and, therefore, may not represent the national per capita consumption for a given analyte in a given country. The number of reported cities is given in brackets after the country name. European and USA data are from SCORE (2019) and various excretion factors applied are reported in Report 1, Table 1. SCORE reports measured raw loads in sewers and doses were calculated in the same way as for Australia. All SCORE data were from March 2018. Australian data is from December 2018.

Figure 46: National population-weighted average consumption of cocaine for cities in Europe, North America, Africa and Australia. The number in brackets reflects the number of wastewater treatment plants included in the average.



Note: the international estimates are based on data of a few WWTPs per country only and, therefore, may not represent the national per capita consumption for a given analyte in a given country. The number of reported cities is given in brackets after the country name. European and USA data are from SCORE (2019) and various excretion factors applied are reported in Report 1, Table 1. SCORE reports measured raw loads in sewers and doses were calculated in the same way as for Australia. All SCORE data were from March 2018. Australian data is from December 2018.

Figure 47: National population-weighted average consumption of MDMA for cities in Europe, North America, Africa and Australia. The number in brackets reflects the number of wastewater treatment plants included in the average.



Note: the international estimates are based on data of a few WWTPs per country only and, therefore, may not represent the national per capita consumption for a given analyte in a given country. The number of reported cities is given in brackets after the country name. European and USA data are from SCORE (2019) and various excretion factors applied are reported in Report 1, Table 1. SCORE reports measured raw loads in sewers and doses were calculated in the same way as for Australia. All SCORE data were from March 2018. Australian data is from December 2018.

6: ACKNOWLEDGMENTS

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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/).

7: REFERENCES

Boerner, U., Abbott, A., and Roe, L. (1975). The metabolism of morphine and heroin in man. Drug metabolism reviews **4**(1): 39-73.

Castiglioni, S., Senta, I., Borsotti, A., Davoli, E. and Zuccato, E. (2015). A novel approach for monitoring tobacco use in local communities by wastewater analysis. Tob Control **24**(1): 38-42. DOI: 10.1136/tobaccocontrol-2014-051553.

Gracia-Lor, E., Zuccato, E. and Castiglioni, S. (2016). Refining correction factors for back- calculation of illicit drug use. Sci Total Environ **573**: 1648-1659. DOI: 10.1016/j.scitotenv.2016.09.179.

Irvine, R.J., Kostakis, C., Felgate, P.D., Jaehne, E.J., Chen, C. and White, J.M. (2011). Population drug use in Australia: a wastewater analysis. Forensic Sci Int **210**(1-3): 69-73. DOI: 10.1016/j.forsciint.2011.01.037.

Khan, U. and Nicell, J.A. (2011). Refined sewer epidemiology mass balances and their application to heroin, cocaine and ecstasy. Environment International **37**: 1236-1252.

Khan, U. and Nicell, J.A. (2012). Sewer epidemiology mass balances for assessing the illicit use of methamphetamine, amphetamine and tetrahydrocannabinol. Sci TotalEnviron **421-422**: 144-162. DOI: 10.1016/j.scitotenv.2012.01.020.

Lai, F.Y., Ort, C., Gartner, C., Carter, S., Prichard, J., Kirkbride, P., Bruno, R., Hall, W., Eaglesham, G. and Mueller, J.F. (2011). Refining the estimation of illicit drug consumptions from wastewater analysis: Co-analysis of prescription pharmaceuticals and uncertainty assessment. Water Research **45**(15): 4437-4448. DOI: 10.1016/j.watres.2011.05.042.

Lai, F.Y., Anuj, S., Bruno, R., Carter, S., Gartner, C., Hall, W., Kirkbride, K.P., Mueller, J.F., O'Brien, J.W., Prichard, J., Thai, P.K. and Ort, C. (2015). Systematic and day-to-day effects of chemical-derived population estimates on wastewater-based drug epidemiology.Environ Sci Technol **49**(2): 999-1008. DOI: 10.1021/es503474d.

Lalovic, B., Kharasch, E., Hoffer, C., Risler, L., Liu-Chen, L.Y. and Shen, D.D. (2006). Pharmacokinetics and pharmacodynamics of oral oxycodone in healthy human subjects: role of circulating active metabolites. Clin Pharmacol Ther **79**(5): 461-479. DOI: 10.1016/j.clpt.2006.01.009.

McCall, A.K., Bade, R., Kinyua, J., Lai, F.Y., Thai, P.K., Covaci, A., Bijlsma, A.L.N. and van Nuijs, C.O. (2016). Critical review on the stability of illicit drugs in sewers and wastewater samples. Water Research **88**: 933-947.

Pizarro, N., Ortuño, J., Jarré, M., Hernández-López, C., Pujadas, M., Llebaria, A., Joglar, J., Roset, P.N., Mas, M., Segura, J., Camí, J. and De la Torre, R. (2002). Determination of MDMA and its metabolites in blood and urine by gas chromotography-mass spectrometry and analysis of enantiomers by capillary electrophoresis. Journal of Analytical Toxicology **26**(3): 157-165.

Rossi, S. (2016). Australian Medicines Handbook, (internet). Adelaide, Australia, Australian Medicines Handbook, Pty. Ltd.

Ryu, Y., Barcelo, D., Barron, L.P., Bijlsma, L., Castiglioni, S., de Voogt, P., Emke, E., Hernandez, F., Lai, F.Y., Lopes, A., de Alda, M.L., Mastroianni, N., Munro, K., O'Brien, J., Ort, C., Plosz, B.G., Reid, M.J., Yargeau, V. and Thomas K.V. (2016). Comparative measurement and quantitative risk assessment of alcohol consumption through wastewater-based epidemiology: An international study in 20 cities. Sci Total Environ **565**: 977-983. DOI: 10.1016/j.scitotenv.2016.04.138.

Sewage analysis CORe group Europe (SCORE) (2019). Wastewater analysis and drugs—a European multi-city study. Available at (http://www.emcdda.europa.eu/topics/pods/waste-water-analysis)

Sullivan, M. A., Vosburg, S. K. and Comer, S. D. (2006). Depot naltrexone: antagonism of the reinforcing, subjective, and physiological effects of heroin. Psychopharmacology **189**(1): 37-46.

Tscharke, B.J., Chen, C., Gerber, J.P. and White, J.M. (2016). Temporal trends in drug use in Adelaide, South Australia by wastewater analysis. Sci Total Environ **565**: 384-391. DOI: 10.1016/j.scitotenv.2016.04.183.

Zuccato, E., Chiabrando, C., Castiglioni, S., Bagnati, R. and Fanelli, R. (2008). Estimating community drug abuse by wastewater analysis. Environ Health Perspect **116**(8): 1027-1032. DOI: 10.1289/ehp.11022.

8: 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[i]
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

Sampling details of each wastewater treatment plant for October and December 2018.[5]

Site Code	Capital/Regional	# Samples Oct 18	# Samples Dec 18	Population Category
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	-	-	30,000 to 150,000
NSW: 071	Capital	-	-	>150,000
NSW: 016	Regional	-	7	30,000 to 150,000
NSW: 025	Regional	-	7	30,000 to 150,000
NSW: 040	Regional	-	-	<30,000
NSW: 051	Regional	-	-	<30,000
NSW: 068	Regional	-	7	>150,000
NSW: 081	Regional	-	7	<30,000
NSW: 115	Regional	-	6	30,000 to 150,000
NT: 010	Capital	6	7	30,000 to 150,000
NT: 078	Regional	-	7	<30,000
QLD: 002	Capital	-	7	>150,000
QLD: 005	Capital	7	7	>150,000
QLD: 011	Capital	6	5	>150,000
QLD: 012	Regional	-	7	>150,000
QLD: 020	Regional	-	-	<30,000
QLD: 024	Regional	-	-	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: 053	Regional	-	7	<30,000
QLD: 077	Regional	-	7	<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	-	6	<30,000
SA: 119	Regional	-	7	<30,000

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

APPENDIX 2 (CONTINUED): SAMPLING DETAILS OF EACH SITE

Sampling details of each wastewater treatment plant for new data in this report.

Site Code	Capital/Regional	# Samples Oct 18	# Samples Dec 18	Population Category
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	-	-	>150,000
VIC: 046	Regional	-	-	30,000 to 150,000
VIC: 061	Regional	-	5	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: 129	Regional	-	7	<30,000
WA: 120	Regional	-	7	30,000 to 150,000
WA: 118	Regional	-	-	<30,000
Total Days		125	334	**Grand total number of samples Report 1–7: 3,260**
Total Sites		19	50	
Total Capital		19	20	
Total Regional		0	30	
Total samples Report 7:Oct & Dec 2018			**459**	

APPENDIX 3: PERCENTAGE OF SAMPLES ABOVE LOD (%) FOR EACH DRUG AND PERIOD ASSESSED

The proportion of samples that each drug was detected above LOD. Note: regional sites are only sampled every second period.

		Drug detections % (Above LOD)														
		Aug 2016	Oct 2016	Dec 2016	Feb 2017	Apr 2017	Jun 2017	Aug 2017	Oct 2017	Dec 2017	Feb 2018	Apr 2018	Jun 2018	Aug 2018	Oct 2018	Dec 2018
Methylamphetamine	**Capital**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Methylamphetamine	**Regional**	100	-	100	-	100	-	100	-	100	-	100	-	100	-	100
Cocaine	**Capital**	97	97	96	96	97	96	90	90	95	99	97	99	99	100	99
Cocaine	**Regional**	45	-	52	-	53	-	53	-	56	-	82	-	77	-	76
MDMA	**Capital**	100	100	100	100	100	96	100	100	100	100	100	100	100	100	100
MDMA	**Regional**	95	-	96	-	100	-	98	-	100	-	98	-	100	-	100
MDA	**Capital**							98	92	100	100	100	100	100	100	100
MDA	**Regional**							86	-	95	-	95	-	95	-	93
Oxycodone	**Capital**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Oxycodone	**Regional**	100	-	100	-	100	-	100	-	100	-	100	-	100	-	100
Fentanyl	**Capital**	100	97	100	99	100	100	100	100	100	100	96	100	100	100	100
Fentanyl	**Regional**	96	-	94	-	99	-	100	-	100	-	100	-	100	-	100
Heroin	**Capital**							83	92	84	85	76	83	72	76	72
Heroin	**Regional**							37	-	59	-	22	-	24	-	24
Alcohol	**Capital**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alcohol	**Regional**	100	-	100	-	100	-	100	-	100	-	100	-	100	-	100
Nicotine	**Capital**	100	100	100	100	100	97	100	100	100	100	100	100	100	100	100
Nicotine	**Regional**	100	-	100	-	100	-	100	-	100	-	100	-	100	-	100
Mephedrone	**Capital**	2	-	-	-	-	1	-	1	24	3	4	5	8	4	9
Mephedrone	**Regional**	-	-	3	-	3	-	1	-	12	-	3	-	3	-	6
Methylone	**Capital**	45	19	47	28	79	7	28	46	59	10	2	4	12	3	13
Methylone	**Regional**	41	-	14	-	9	-	22	-	22	-	3	-	1	-	7
Cannabis	**Capital**													100	100	100
Cannabis	**Regional**													100	-	100

CONCLUSIONS

CONCLUSIONS

For the seventh report of the National Wastewater Drug Monitoring Program, wastewater analysis was conducted in October and December 2018. 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 to allow comparison, nicotine and alcohol are the most consumed drugs in Australia, while methylamphetamine remains the most consumed illicit drug.[6]

METHYLAMPHETAMINE

When comparing data for August and December 2018, the population-weighted average consumption of methylamphetamine increased in capital city sites and decreased in 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 December 2018, while Western Australia had the highest estimated average regional consumption.

COCAINE

When comparing data for August and December 2018, the population-weighted average consumption of cocaine in capital city sites decreased, while consumption in regional sites remained relatively stable. Average cocaine consumption in capital city sites continues to exceed regional average consumption. New South Wales had the highest estimated average capital city and regional consumption of cocaine in December 2018.

3,4-METHYLENEDIOXYMETHYLAMPHETAMINE (MDMA)

When comparing data for August and December 2018, the population-weighted average consumption of MDMA in both capital city and regional sites increased to the highest levels recorded since the program began in 2016. Regional average MDMA consumption exceeded capital city average consumption. Tasmania had the highest estimated average capital city consumption of MDMA in December 2018, while Victoria had the highest estimated average regional consumption.

3,4-METHYLENEDIOXYAMPHETAMINE (MDA)

MDA is a metabolite of MDMA. When comparing data for August and December 2018, MDA consumption increased in both capital city and regional sites. Regional average MDA consumption exceeded capital city average consumption. The Northern Territory[7] had the highest estimated average capital city consumption of MDA in December 2018, while New South Wales had the highest estimated average regional consumption.

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

7 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 August and December 2018, the population-weighted average consumption of heroin for both capital city and regional sites increased, with the average capital city consumption in December 2018 the highest recorded since the program began measuring heroin in August 2017. Consistent with previous reporting periods, capital city average heroin consumption exceeded regional average consumption. Victoria had the highest estimated average capital city consumption of heroin in December 2018, while New South Wales had the highest estimated average regional consumption.

CANNABIS

The program began measuring cannabis consumption in August 2018. When comparing data for August and December 2018, the population-weighted average consumption of cannabis in capital city sites remained relatively stable and decreased in regional sites. Regional average cannabis consumption exceeded capital city consumption. Tasmania had the highest estimated average capital city consumption of cannabis in December 2018, while South Australia had the highest estimated average regional consumption.

OXYCODONE

When comparing data for August and December 2018, the population-weighted average consumption of oxycodone increased in both capital city and regional sites. Oxycodone consumption levels remain high, particularly in regional areas, with regional average oxycodone consumption exceeding capital city average consumption. Tasmania had the highest estimated average capital city consumption of oxycodone in December 2018, while Victoria had the highest estimated average regional consumption.

FENTANYL

When comparing data for August and December 2018, the population-weighted average consumption of fentanyl decreased in capital city sites and increased in regional sites. Fentanyl consumption levels remain high, particularly in regional areas, with regional average fentanyl consumption exceeding capital city average consumption. Tasmania had the highest estimated average capital city consumption of fentanyl in December 2018, while Queensland and South Australia had the highest estimated average regional consumption.

NICOTINE

When comparing data for August 2018 and December 2018, the population-weighted average consumption of nicotine remained relatively stable in both capital city and regional sites. Average nicotine consumption in regional sites exceeded capital city average consumption. The Northern Territory[8] had the highest estimated average nicotine consumption in both capital city and regional sites in December 2018.

8 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 August and December 2018, the population-weighted average consumption of alcohol decreased in both capital city and regional sites. Average alcohol consumption in capital city sites exceeded regional average consumption. The Northern Territory[9] had the highest estimated average alcohol consumption in both capital city and regional sites in December 2018.

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 decreased, from 30 in August 2018 to 25 in December 2018, 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 decreased, from 8 in August 2018 to 5 in December 2018. Mephedrone was detected in New South Wales, Queensland and South Australia in December 2018, with the highest number of detections reported in South Australia.

METHYLONE

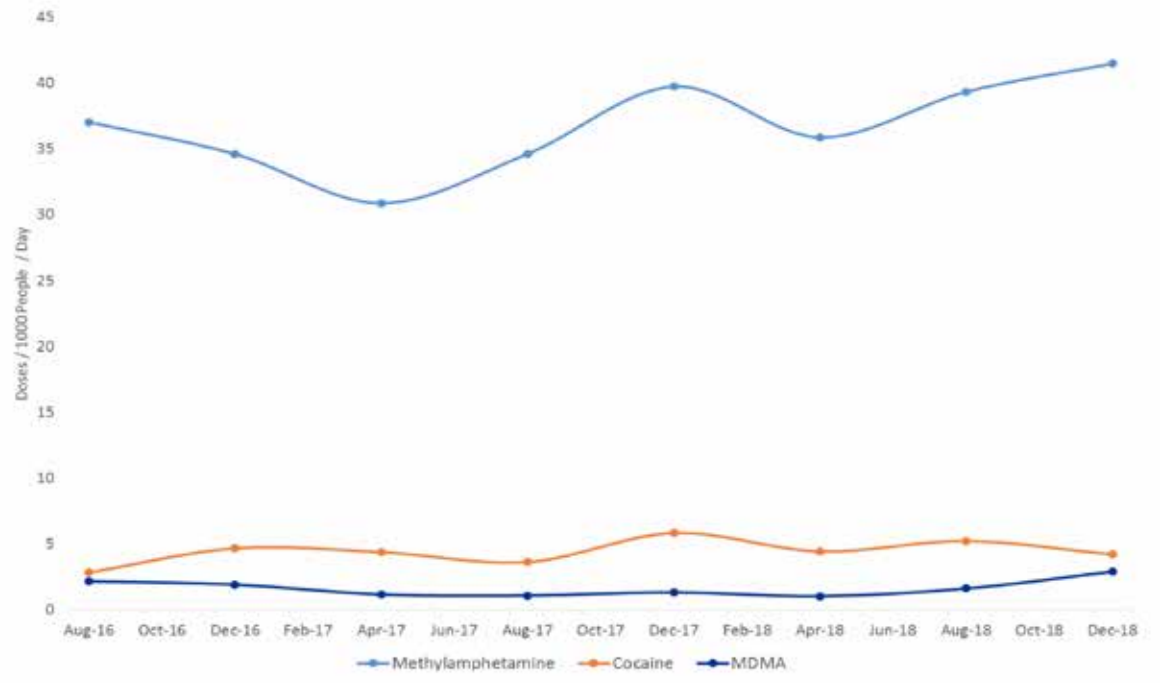
Consistent with previous reporting periods, methylone was mostly detected below the level at which it could be reliably quantified. The number of national detections of methylone increased, from 21 in August 2018 to 26 in December 2018, with the number of detections in capital city sites exceeding the number of detections in regional sites. The number of sites where methylone was detected increased, from 6 in August 2018 to 9 in December 2018. Methylone was detected in New South Wales, Queensland, Tasmania, Victoria and Western Australia in December 2018, with the highest number of detections reported in New South Wales and Queensland.

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

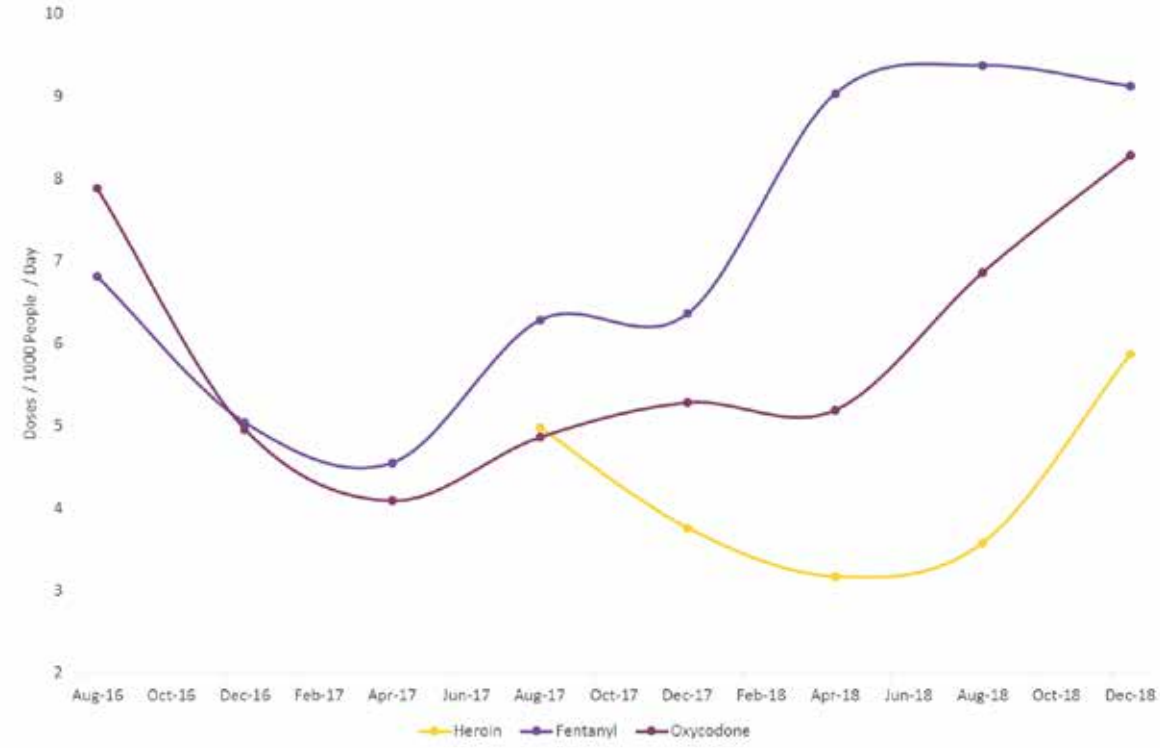
COMPARISONS BETWEEN MARKETS FOR ILLICIT STIMULANTS AND OPIOIDS

Wastewater data also permit ongoing comparison of trends in the markets for illicit stimulants and opioids.

STIMULANTS



OPIOIDS



INTERNATIONAL COMPARISONS (SCORE)

There are a number of factors that influence drug consumption, including but not limited to different drug preferences and drug availability. This concept is illustrated in the SCORE data and the notable differences in stimulant drug preferences. Noting that SCORE data in many cases relate to a single or small number of sites per participating country, consistent with previous SCORE findings, of the 25 countries with comparable reported data for MDMA, cocaine and methylamphetamine, Australia ranks second highest after the United States of America for total estimated stimulant consumption. Stimulant consumption in Australia continues to be primarily driven by methylamphetamine use. In comparing the individual stimulant drug components, of the countries with comparable consumption data Australia ranks second for methylamphetamine and MDMA and seventeenth for cocaine.

NEXT REPORT

The eighth report of the National Wastewater Drug Monitoring Program is scheduled to be publicly released in third quarter of 2019.