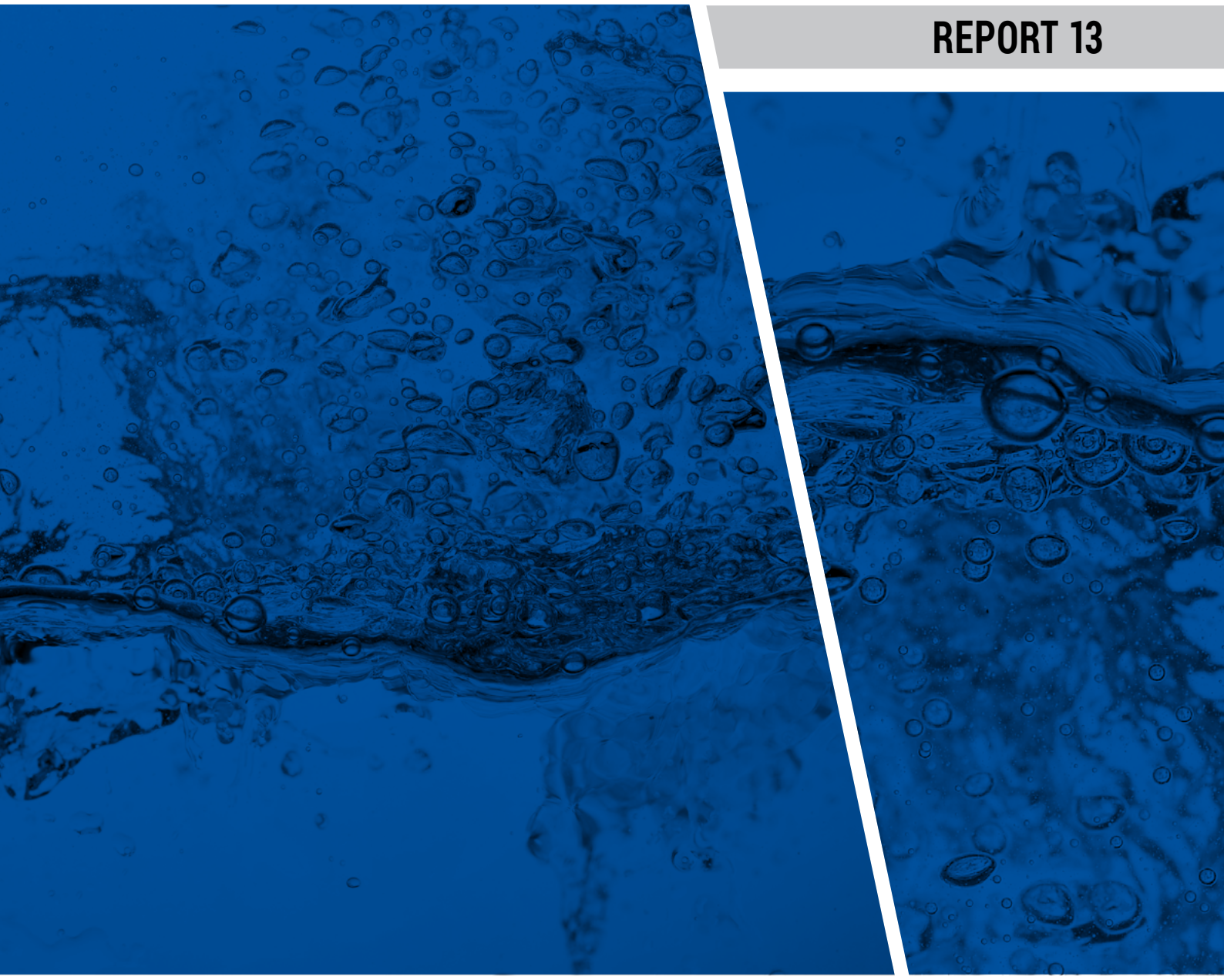
NATIONAL WASTEWATER DRUG MONITORING PROGRAM

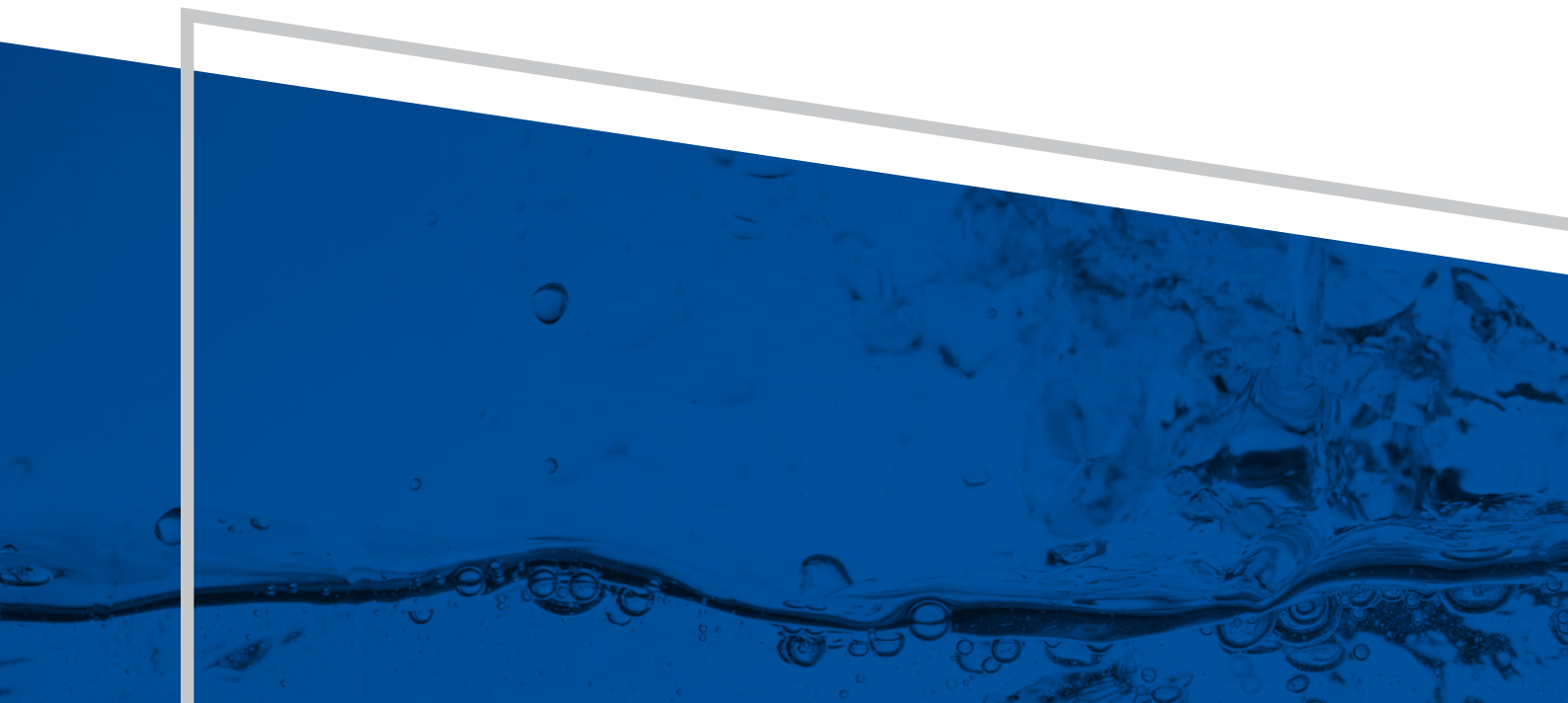
REPORT 13



AUSTRALIAN CRIMINAL INTELLIGENCE COMMISSION

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

University of South Australia



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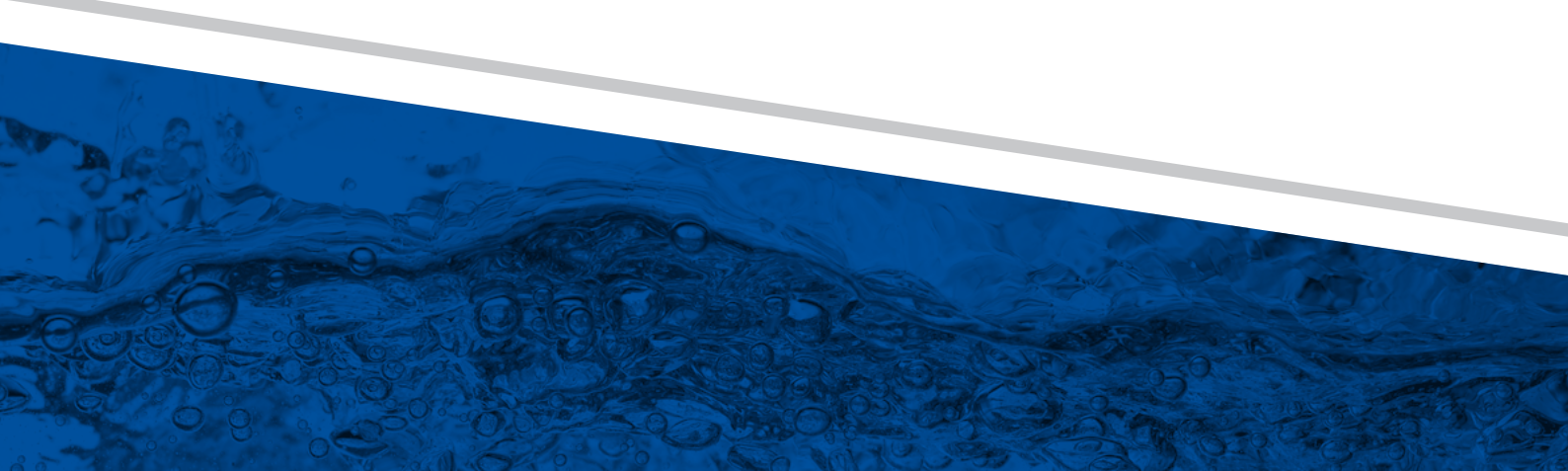


CEO FOREWORD

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

The National Wastewater Drug Monitoring Program (the Program) is an Australian Government funded initiative that continues to evolve. Work continues to consolidate the ACIC's collaboration with international partners in New Zealand, Asia, North America and Europe, and also with academic institutions. Wastewater analysis assists in understanding drug use within populations, providing a measure of one important aspect of national health—the demand for a range of licit and illicit drugs. Illicit drugs and licit drugs with abuse potential are inherently harmful. Reliable drug consumption data are a key indicator of the level of harm experienced by the community, because logically the level of harm to the community is a function of the quantity of the substance that is consumed. Understanding drug consumption at a population level supports effective allocation of resources to priority areas. It also allows the progress of demand, supply and harm reduction strategies to be monitored.

The other dimension to wastewater analysis is its ability to generate insights into jurisdictional and local drug markets. The ACIC is increasingly seeking partnerships to merge wastewater data with other drug data in locations of interest to develop a more granular appreciation of high risk markets. Per capita drug use in regional areas remains higher than capital city consumption for many drugs measured by the Program and the harms generated by these markets are significant. Initiatives generated by the ACIC indicate that the challenges facing different regional cities and towns have some common features, but also tangible differences, and wastewater analysis can form a meaningful part of bespoke solutions for regional locations.

THE ONGOING REQUIREMENT TO ASSESS DRUG MARKETS DURING THE COVID-19 PERIOD

This is the third reporting period during which the ACIC has provided advice to Government, law enforcement and policy partners on drug trends during the COVID-19 pandemic and the period of related restrictions. Some of this advice has been derived from more regular and focused sampling than is routinely undertaken as part of the Program. The regularity of wastewater reporting permits partner agencies to plan with greater confidence as the country and different jurisdictions respond to COVID-19.

TRENDS IDENTIFIED DURING THIS REPORTING PERIOD

In December 2020, 57 wastewater sites were monitored nationally. Based on 2016 Census data, these sites cover approximately 56 per cent of the Australian population. This reporting period again demonstrated varying trends in drug consumption, both nationally and within jurisdictions. For example, in December 2020 average capital city methylamphetamine consumption exceeded regional consumption for the first time since April 2017 and there appears to have been a gradual recovery in the market since August 2020. Conversely, demand for MDMA has continued to decrease over the same period. Since record capital city consumption of heroin was reported in August 2020, the overall trend in the market has been down.

INTRODUCTION OF KETAMINE TO THE PROGRAM

The ACIC continues to ensure that the Program evolves in line with trends in drug markets. Accordingly, for this and future reports, the ACIC will monitor the excretion of ketamine in wastewater. Ketamine is a central nervous system depressant used as an anaesthetic and analgesic in medical and veterinary settings. It can also be used illicitly in its own right, or in combination with other substances. The United Nations Office on Drugs and Crime reports that illicit ketamine manufacture and trafficking is centred in Asia but is spreading to other regions of the world, including Australia. Early indications from the Program are that ketamine use is low and relatively consistent across the country, but there is a much wider spread of use over the collection week than might be expected if the substance is purely being used for medical applications.

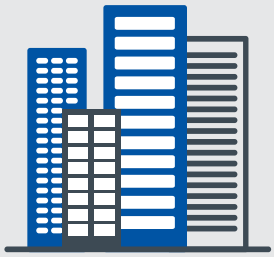
ACKNOWLEDGEMENT

I would like to acknowledge the valuable support and expertise of the Universities of Queensland and 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.

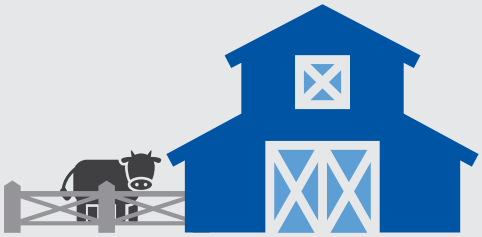
Michael Phelan APM
Chief Executive Officer
Australian Criminal Intelligence Commission

SNAPSHOT

The December 2020 collection covers around **56 per cent** of Australia's population—about **13.1 million Australians.**



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

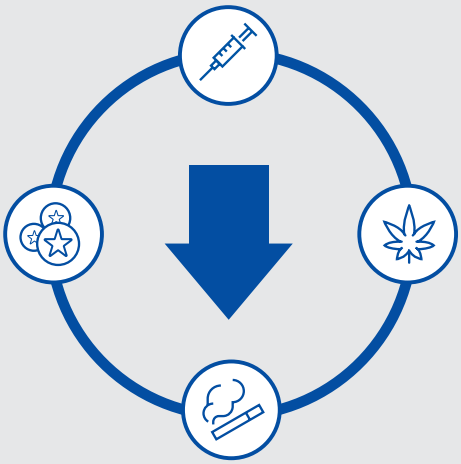


Regional **nicotine, alcohol, MDMA, MDA**, **oxycodone**, **fentanyl** and **cannabis** average consumption exceeded capital city consumption.

Ketamine excretion levels are included in the Program for the first time.

Capital city **methylamphetamine** consumption exceeded regional consumption for the first time since April 2017.

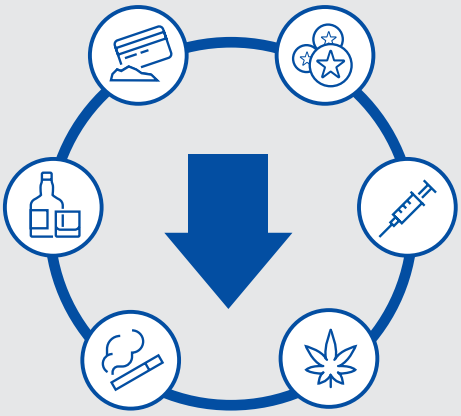
Between August and December 2020, the population-weighted average capital city consumption of:



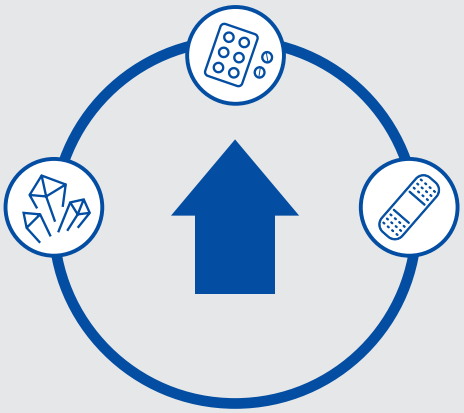
nicotine, MDMA, heroin and cannabis **decreased**

alcohol, methylamphetamine, cocaine, oxycodone and fentanyl **increased**

Between August and December 2020, the population-weighted average regional consumption of:



nicotine, alcohol, cocaine, MDMA, heroin and cannabis **decreased**



methylamphetamine, oxycodone and fentanyl **increased**

INTRODUCTION

This is the thirteenth in a series of National Wastewater Drug Monitoring Program reports to be publicly released by the Australian Criminal Intelligence Commission, under budgetary arrangements that will see reports delivered until early 2024. The Program provides a measure, rather than an estimate, of the consumption of a number of illicit drugs, as well as licit drugs including nicotine, alcohol and some pharmaceuticals. It gives us valuable insight into the trends and emerging issues in drug consumption across Australia and can identify new sources of threat.

The thirteenth report presents data on Australia's drug consumption for 12 substances and includes data for December 2020 (capital city and regional sites) and February 2021 (capital city sites). Longitudinal data captured by the Program increases our understanding of drug use nationally, in specific locations and over time. As with the two previous reports, wastewater analysis continues to provide us with unique insight into the impact of COVID-19 and related restrictions. Findings presented in the reports provide law enforcement, policy, regulatory and health agencies with additional, objective data on the use of methylamphetamine and other drugs. These data create opportunities to shape the response to the demand and supply sides of illicit drug markets, particularly in high-use areas, and inform harm reduction strategies. They permit priorities to be set and modified in a manner that is consistent with constantly evolving drug markets and broader world circumstances.

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
- ketamine
- oxycodone
- fentanyl
- nicotine
- alcohol.

The Australian Criminal Intelligence Commission continues to review the appropriateness of monitored substances with its partners, stakeholders and the universities. As part of this process, the Program will be incorporating analysis of ketamine excretion in this and subsequent reports, replacing mephedrone and methylone, which will be the subject of separate reporting as part of broader coverage of emerging stimulants by Australian researchers.

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 2020, 57 wastewater treatment plants participated nationally.[2] 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 treatment plant operators have established relationships with the two universities.

The breakdown of sites by jurisdiction for December 2020 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(s) not to participate in the national program in the future, the Australian Criminal Intelligence Commission will identify replacement sites from participating states and territories to ensure that the largest possible segment of the national population is sampled. Accordingly, the location of sites within and between states and territories may change over the life of the Program, although the intention is to ensure as much continuity as possible in relation to site participation.

2 Sampling also occurred in February 2021 at capital city sites, with 20 participating wastewater sites nationally, covering approximately 48 per cent of the Australian population.

REPORTING

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

Reported results reflect per capita use in all locations and, with the exception of MDA, cannabis and ketamine (for which reliable dose figures are not available), are expressed in terms of both the number of doses and the weight or volume consumed 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. The Australian Criminal Intelligence Commission considers that National Wastewater Drug Monitoring Program data provide an important basis for the development of empirically informed government and private sector policy and decision making. The reports provide regular, timely, unambiguous and detailed measures of the level of demand for the listed substances in the Australian population, complementing other drug datasets published in Australia. The thirteenth National Wastewater Drug Monitoring Program report measures the drug use of approximately 56 per cent of the Australian population.[3]

Wastewater data are also particularly useful for identifying differences in levels of drug consumption in capital city and regional areas of Australia. The data reinforce the different dynamics that apply to both capital city and regional markets and also illustrate drug preference variation that exists both within and between states and territories. Understanding these preferences is important in the development and delivery of national responses and in tailoring responses to suit the specific needs of individual jurisdictions. The number and diversity of regional sites that participate in the Program permits confident assessments to be made of drug trends outside of the capital cities and facilitates local responses to the different circumstances that apply in each location. This is important because it permits wastewater data to complement a number of other sources of drug data in Australia which have very limited regional coverage, or are confined to capital cities.

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

3 The December 2020 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.

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

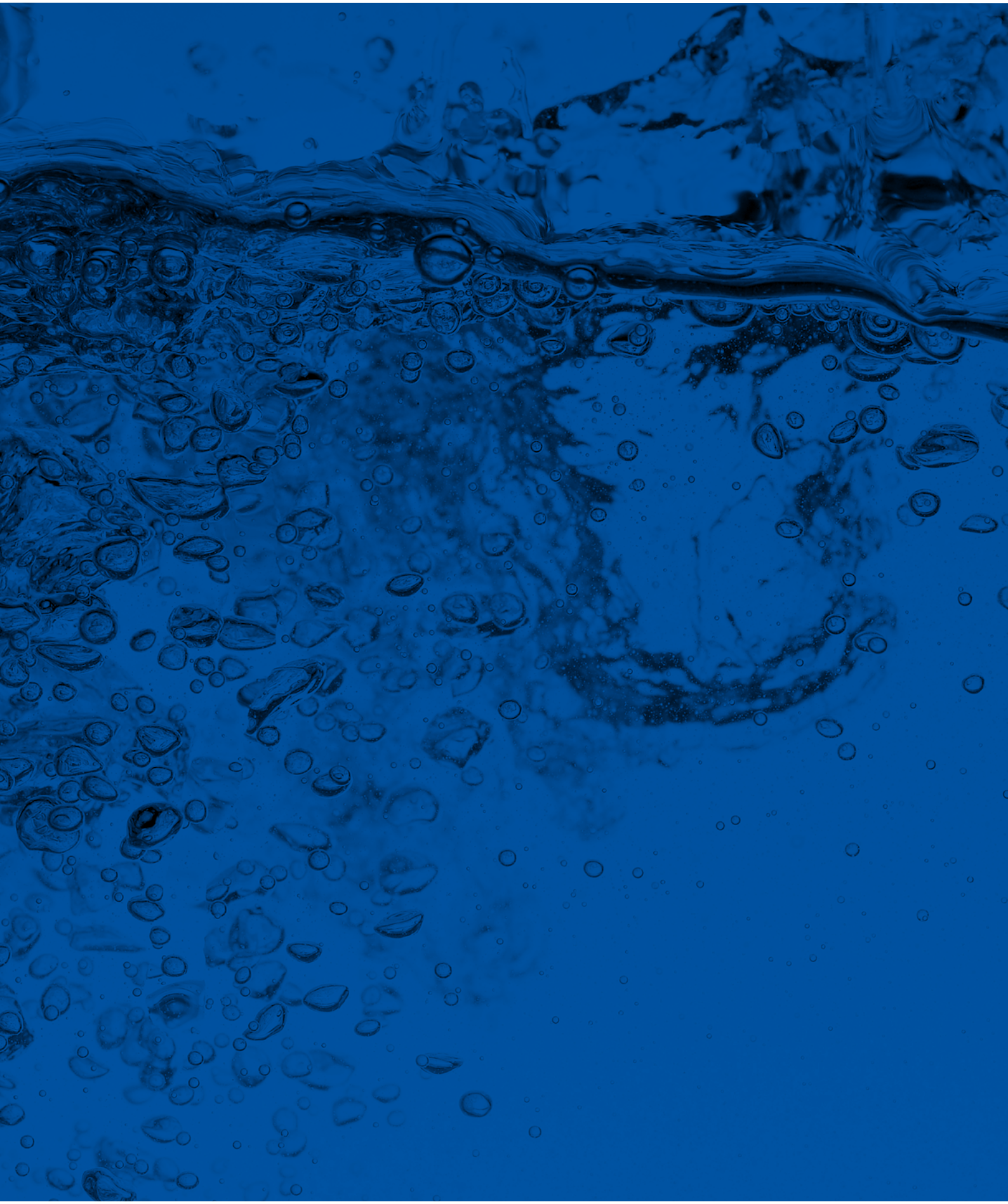
RESULTS FROM THE COLLECTION

The growing body of longitudinal data permits the Australian Criminal Intelligence Commission and other stakeholders to closely monitor trends in drug consumption across Australia. In the current report, one of the more interesting insights is the apparent (albeit slow) recovery of the methylamphetamine market in both capital cities and regional areas since August 2020. Conversely, consumption of MDMA nationally has continued to decline. Longer term declines in the consumption of pharmaceutical opioids appear to have stabilised or slowed during the current period.

Another feature of the Program is its ability to generate meaningful data at a jurisdictional and local level. For example, capital city sites in New South Wales had record high consumption of methylamphetamine and fentanyl in December 2020 and capital city sites in Tasmania had record high consumption of cocaine in the same month. In December 2020 there was also record low regional consumption of MDMA in Victoria, Western Australia and Tasmania.

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

Wastewater data are an important part of the suite of datasets available to increase our understanding of drug consumption, demand and supply in Australia. Making data from the Program publicly available assists to enrich understanding and informs the national conversation on drug trends and related demand. This thirteenth report of the National Wastewater Drug Monitoring Program builds on national drug consumption data contained in the preceding eleven reports to identify temporal trends in drug use across states, territories and the nation. This, and future reports, continue to build and shape understanding on trends and changes in patterns of use, creating an increasingly detailed picture of drug consumption in Australia.



RESEARCH FINDINGS

Prepared by the University of Queensland (B Tscharke, J O'Brien, T Reeks, P Prasad, G Elisei, H Sichani, S Grant, J Mueller, K Thomas) and University of South Australia (M Ghetia, R Bade, S Adiraju, J Rillo, 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
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-tetrahydrocannabinol (THC-COOH).

1: EXECUTIVE SUMMARY

The Australian Criminal Intelligence Commission (ACIC)'s National Wastewater Drug Monitoring Program (NWDMP) reports on selected substances of concern in most populated regions of Australia. The Program commenced in August 2016. The current version of the NWDMP focuses on twelve licit and illicit drugs, including nicotine, alcohol, methylamphetamine, cocaine and MDMA (ecstasy), with cannabis included from Report 6. Ketamine has been included for the first time, while methylone and mephedrone have been removed as examples of new psychoactive substances (NPS) due to the low abundance of this class of compounds. Estimates of drug usage in a population are being determined from measured concentrations of drug metabolites (excreted into the sewer system after consumption) in wastewater samples and results are used to monitor trends in drug consumption over the life of the Program. Wastewater treatment plants (WWTPs) located across capital cities and regional Australia, covering all states and territories, have been invited to participate in this program. Each site has been allocated a unique code. Site names are not included in this report to maintain treatment plant confidentiality. Site codes stay assigned to each WWTP throughout the course of the Program.

For this thirteenth report, wastewater samples were collected for up to seven consecutive days during weeks in December 2020 and February 2021. The December collection involved regional and capital city catchments, while February covered capital cities only. Concentrations of drug metabolites were determined in the wastewater using liquid chromatography-tandem mass spectrometric (LC-MS/MS) analytical methods. Drug consumption estimates for each catchment population were calculated from these measured concentrations using flow volumes and estimates of the catchment population size by evaluating census data vs. catchment maps, together with excretion and dose data obtained from the scientific literature.

A total of 20 WWTPs in capital cities and a further 37 regional sites participated in the Program for the December 2020 period, covering a population of 13.1 million Australians. Data from this report equates to coverage of approximately 56 per cent of Australia's population for December 2020 and 48 per cent for February 2021 (capital city sites only). A total of 6,453 individual daily samples have been collected and analysed since the beginning of the Program, with new results from 521 additional samples added in this report. The collected samples provide comprehensive, Australia-wide baseline data against which subsequent results can be compared to ascertain both spatial and temporal trends. The snapshot of the scale of drug use over a week in December 2020 was compared with historical data included in previous reports. The December 2020 dataset was used for the spatial comparison as it was more comprehensive, including both capital city and regional sites. The temporal comparison includes the latest capital city collection data for February 2021.

The spatial trends in the current reporting period and longer-term temporal data should also be considered in the context of the COVID-19 pandemic. Australian borders were closed to non-resident arrivals in late March 2020, with Stage 3 restrictions coming into effect in April, including bans on public gatherings, closures of businesses and inter-state borders, social-distancing restrictions and employees working from home. Towards the end of April 2020 restrictions began to ease on a jurisdiction by jurisdiction basis. With the exceptions of Victoria and some areas in New South Wales, restrictions were gradually lifted across the country through May and June 2020. Government income support payments started to be distributed from June 2020. Victoria experienced a second wave of restrictions following a resurgence in infections and by early July restrictions were re-imposed state-wide. The results outlined in this report need to be understood in this context.

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 in December 2020. Cannabis was not included in the comparison but will be once better estimates of a typical dose are available. The consumption of nicotine was substantially higher in regional areas compared to capital cities and very variable between sites. The rise in nicotine use in some jurisdictions since the start of the Program in 2016 accelerated after the start of the COVID-19 pandemic, but in the current reporting period, use declined almost nationwide. Overall, nicotine use remains highest in Tasmania and the Northern Territory. Unlike previous reporting periods, alcohol consumption in regional areas was very similar to the capital cities. Alcohol use was more consistent across regional parts of the country, with some exceptions in South Australia and Queensland where use was substantially lower. December data shows that overall, the Northern Territory and Tasmania had the highest capital city consumption of alcohol. Alcohol consumption has been relatively steady since the start of the Program, averaging out short-term fluctuations. South Australia has been the most obvious exception, with declining longer-term alcohol consumption rates. During the pandemic lock-down restrictions, the usual weekend increase in alcohol consumption was less prominent, with a lower difference between weekday and weekend use. This was during a period when pubs, clubs and restaurants serving alcohol were closed or had restricted numbers. Following the introduction of COVID-19 restrictions in April 2020, several jurisdictions showed a rebound in alcohol use in June once restrictions were eased. This also returned the weekly trend back to higher weekend use. For the most part, alcohol consumption has continued at levels within the ranges observed prior to the outbreak of the pandemic.

Methylamphetamine was significantly affected by events in 2020. In general, a steep decrease of methylamphetamine consumption was observed in many jurisdictions immediately after the introduction of COVID-19 restrictions, which has been followed by a slow recovery to levels just below those in December 2019. Prior to the pandemic, daily levels were in the range of 50 doses per thousand people. By August 2020, that amount dropped to approximately 30 doses, while the December results in the current collection period shows that use has increased again to nearly 40 daily doses per thousand people. Another significant finding was that during the current sampling period average regional use of the drug fell below capital city levels for the first time since 2017. Large differences were evident between sites in December 2020, even within the same state or territory. New South Wales and South Australia had some of the highest capital city levels, while sites in Tasmania and Victoria had the highest regional use. The impact of COVID-19 was most dramatic in the Northern Territory, Tasmania and Western Australia, where the capital city averages reached historical low levels in August. A site in Sydney showed signs of methylamphetamine dumping into the sewer network on one day of the February 2021 collection period. This was equivalent to approximately 9 kilograms of methylamphetamine above usual levels.

Cocaine consumption in Australia in December 2020 remained a feature of capital city sites in New South Wales and much of the regional part of that state. Several catchments in Queensland and Victoria also had above average consumption. Consistent with previous findings, the regional levels were on average below the capital cities. The overall long-term trend over the life of the Program showed increases in many states and territories. The pandemic only briefly interrupted measured levels in April 2020. Since then, use has mostly returned to pre-COVID-19 levels or has slightly increased, including Victoria with its extended lockdown. The Northern Territory, South Australia and Western Australia experienced the only extended periods of reduced consumption of the capital cities, while the Australian Capital Territory showed a decrease in the current period, reversing a long-term trend.

MDMA use was relatively low compared to methylamphetamine and cocaine. Regional use was only marginally different to the capital cities. Levels in the capital cities of the Northern Territory and New South Wales were highest. The recent trend in MDMA use is a decline, with historically low levels being observed in many parts of the country, particularly regional Northern Territory, Tasmania and Western Australia. The stimulant, and metabolite of MDMA (ecstasy), MDA was present at relatively low levels too, with no consistent pattern being evident. Sites in New South Wales and regional Queensland recorded the highest levels, while regional averages overall were similar to the capital cities. With the ongoing pandemic, MDA use has declined almost everywhere.

Oxycodone and fentanyl are prescription pharmaceutical opioids with abuse potential. Oxycodone consumption was substantially higher in regional parts of the country in December 2020 compared to the capital cities, consistent with previous trends. Sites in regional Queensland, New South Wales, Tasmania and Victoria recorded the highest overall levels, while Tasmania had the highest rates of use of the capital cities, closely followed by the Australian Capital Territory and parts of South Australia. A decline in long-term use of the substance in Australia has been a feature. However, over the course of 2020, levels have plateaued in many jurisdictions, or have even risen in the case of capital city Victoria. The average consumption of fentanyl was very similar across the country, unlike previous reports when regional use exceeded that in the capital cities. Parts of New South Wales and regional South Australia had above average consumption. The decline in fentanyl consumption appeared to accelerate after COVID-19 in many parts of the country, particularly the Northern Territory, South Australia and Tasmania.

Heroin consumption was high in part of capital city Victoria, as well as some sites in New South Wales and Queensland. After the historical high levels recorded in Victoria in August 2020, heroin use in the state has declined, including during the present collection period. Average use of the drug was lower in regional areas compared to the capital cities. Although no consistent long-term trends of heroin use have been apparent over the course of the Program, a rising trend is appearing in the two territories, New South Wales, Queensland and Tasmania.

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 a cautious approach is needed when making comparisons. Use of the substance increased in many jurisdictions after the initial COVID restrictions were put in place in March 2020. However, the upward swing was temporary for the most part, with current levels of consumption returning to the range seen over the life of the Program. Capital city Northern Territory was the notable exception. Substantially lower amounts of cannabis markers were measured there in the current collection period.

Methylone and mephedrone were specific examples of NPS included in previous reports. These have now been replaced by ketamine, a pharmaceutical compound of growing concern due to its abuse potential. With the drug being included for the first time, results are only available for two collection periods of capital city (December 2020 and February 2021) and one regional collection (December 2020) in this report. Early indications are that ketamine use is low and consistent across the country, with similar averages across capital cities and regional Australia. Parts of capital city New South Wales and regional Victoria were found to be the highest users, with much wider spread of use being apparent over the collection week than might be expected for a substance with medical applications.

2: INTRODUCTION

2.1 PREAMBLE

Wastewater analysis is a technique for monitoring the population-scale consumption of substances. The University of Queensland and University of South Australia were commissioned to provide drug consumption data to the ACIC for an initial three-year program from 2016 to 2019, including nine public reports. The two universities have been re-commissioned to provide data for a further four years, including 12 public reports. 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 build on the baseline data of substance use across Australia to establish trends. This latest NWDMP report compares consumption data from previous reports with results obtained subsequently from all sites in December 2020 and capital cities in February 2021. The report presents patterns of substance use across Australia, showing differences in levels between capital cities and regional centres, within and between states and territories, and nationally.

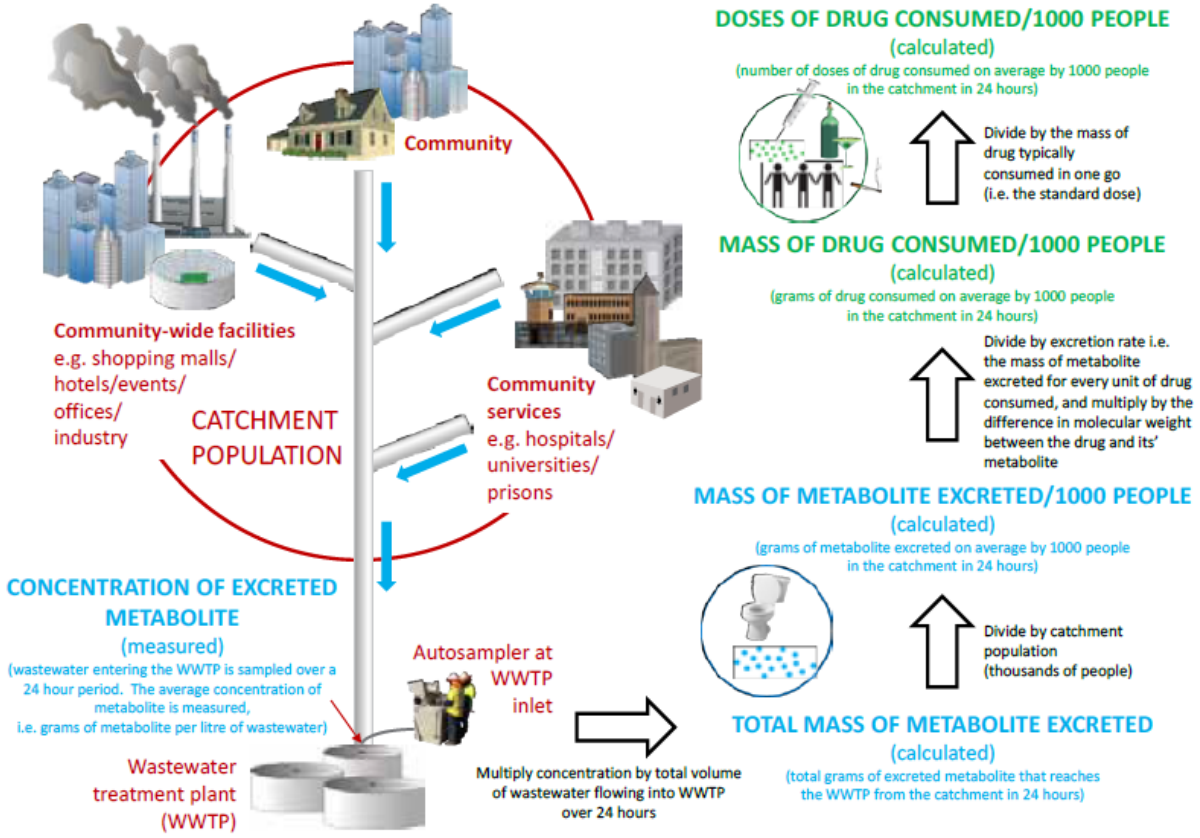
Compounds of concern include nicotine from nicotine intake (cigarettes, gum, patches, e-cigarettes, etc.), ethanol from alcohol consumption, pharmaceutical opioids with abuse potential, illicit substances such as methylamphetamine, MDMA, cocaine and heroin, as well as ketamine. Previously, methylone and mephedrone were included as examples of new psychoactive substances (NPS). Due to their low overall abundance, they have now been replaced by ketamine. The latter is a pharmaceutical substance used primarily for the treatment of acute pain. However, it is known for its abuse potential and is listed by the United Nations Office on Drugs and Crime (UNODC) as an NPS. Amphetamine and MDA were not included in the initial reports. The former is a by-product of methylamphetamine pyrolysis as well as one of its metabolites. Amphetamine is also a prescribed drug, but can be used as an illicit substance. However, we found the levels of amphetamine corresponded largely with the expected values from the excretion of methylamphetamine. Similarly, MDA is a metabolite of MDMA but can also be used as an illicit drug. However, since the proportion of MDA derived from MDMA is known, the difference between measured MDA and MDMA metabolite has been included in the NWDMP since Report 3. The amount of MDA was calculated by subtracting 1.65 mg of MDA for every 100 mg of MDMA consumed (Pizarro et al. 2002; Khan & Nicell 2011) and is expressed in units of mg excreted per day per 1,000 people. Cannabis was measured by its urinary metabolite, THC-COOH. Cannabis results are expressed only as mg consumed per day per 1,000 people and will also be expressed as dose per day per 1,000 people when better estimates of a typical dose become available. Ketamine has now also been included for the first time and is being measured via its metabolite, norketamine. Ketamine results are reported as the amount (mg) of drug excreted per day per 1,000 people.

3: METHODS

The method underlying wastewater-based monitoring of drug use in a given population is based on the principle that any given compound that is consumed (irrespective of whether it is swallowed, inhaled/smoked or injected) will subsequently be excreted. This may be either in the chemical form it was consumed and/or in a chemically modified form that is referred to as a metabolite. Once the excreted compound or metabolite is flushed, it will enter the sewer system, assuming the toilet forms part of a wastewater catchment.

The drugs and their metabolites of interest were included in the first NWDMP report (available at www.acic.gov.au), as well as an in-depth description of the methodologies involved.[4] Collectively, waste products in the sewer system arrive at a WWTP where wastewater samples are collected over a defined sampling period. Measuring the amount of a target compound in the wastewater stream allows for a back-calculation factor to be applied to determine the amount of drug that was used over the collection period (Figure 1). The method is non-invasive and is done on a population-scale level, so individuals are not targeted, and privacy is respected.

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



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

Collected wastewater samples were analysed at the University of South Australia and the University of Queensland laboratories. The steps routinely performed in our laboratories are based on filtration of the samples followed by an enrichment/concentration step where the concentrated sample is injected, or (for chemicals with sufficiently high concentrations) direct injection of samples into the analytical instruments. The instrumental analysis consists of chromatographic separation and subsequent compound specific detection. A summary of the extraction and analytical methods is given in Report 1. An updated excretion table including THC-COOH and dose can be found in Appendix 1. Methods to extract and analyse the cannabis metabolite are outlined in Tscharke et al. (2016).

4 Information in relation to heroin appears in Report 3.

3.1 PARTICIPATING WASTEWATER TREATMENT PLANTS (WWTPS)

Fifty-seven WWTPs across Australia participated in the NWDMP for the December 2020 collection period (Figure 2). Of these, 20 sites were located in capital cities and a further 37 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 this report 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 for the course of the Program. Only site codes are presented in the results.

Figure 2: Participating WWTPs in December 2020 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.

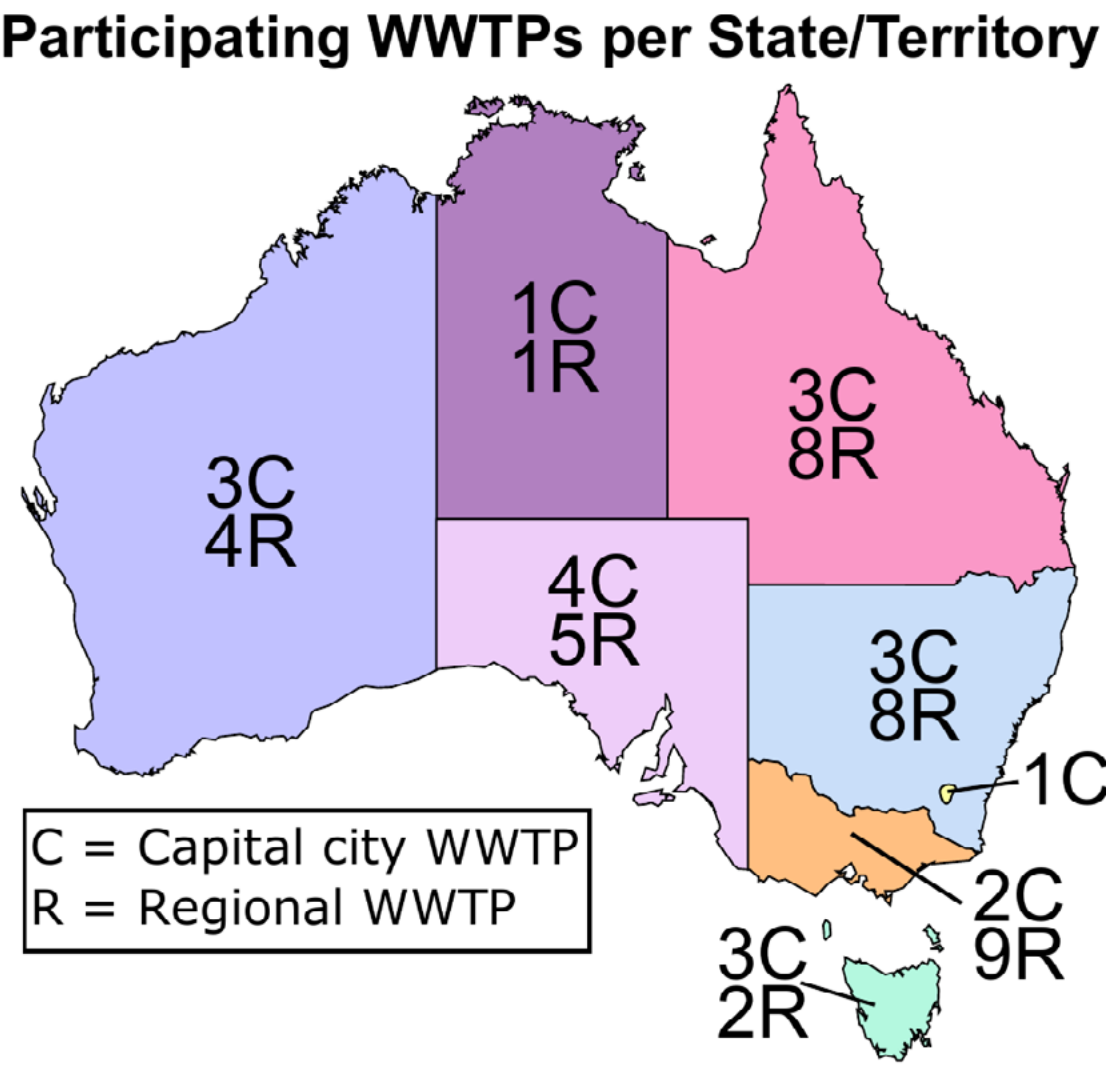


Table 1: Number of participating WWTPs for the periods covered in this report. One collection period aims to collect data from both regional (R) and capital city (C) sites, while the other collection period aims to collect data from capital city sites only.

State or territory	Dec 2020 Capital	Dec 2020 Regional	Feb 2021 Capital
ACT	1	0	1
NSW	3	8	3
NT	1	1	1
Qld	3	8	3
SA	4	5	4
Tas	3	2	3
Vic	2	9	2
WA	3	4	3
Sites	20	37	20
Population (millions) C & R	**11.2**	**1.9**	**11.2**
% of Australian Population	**47.9**	**7.9**	**47.9**
Total population (millions)		**13.1**	**11.2**
% of Australian population		**55.8**	**47.9**

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

3.2 SAMPLE COLLECTION AND PREPARATION

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

3.3 PRESENTATION OF DATA AND INTERPRETATION OF GRAPHS

Reported averages: All averages for state/territory or Australia-wide drug consumption data are presented throughout this report as population weighted averages. The number of people in the catchment population is used as the weighting for the respective drug consumption data for that population. For example, to calculate the population weighted average of capital city methylamphetamine consumption, the methylamphetamine consumption data for each WWTP was multiplied by the respective population number, all data were then summed and divided by the total population across all capital city sites. Reported average values are therefore not skewed towards usage data from small, non-representative populations.

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

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

The presentation of bubble charts has been adjusted from Report 12 to scale the size of each bubble to the consumption estimate, which allows for better comparability between data points. Bubble charts in previous reports grouped the data into 5 equal groups (rounded to 2 significant figures) and assigned the same bubble size to data that lay within the range. See Figure 4 for a description for how to interpret the bubble charts.

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) is a concentration (higher than the LOD), above which we have high confidence that the concentration measured on the analytical instrument is accurate. Above the LOD but below the LOQ there may be some uncertainty as to the actual concentration. To be conservative (a drug may be present but there is uncertainty as to its concentration) and in line with current practice, for back calculations to estimate per capita consumption, a concentration below the LOD was included as a value of LOD/$\sqrt{5}$. 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.

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

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

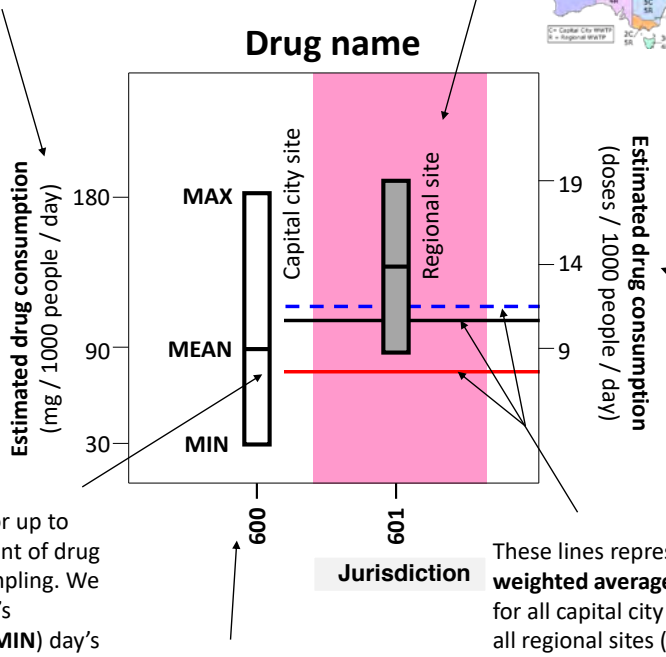
Figure 3: Explanation of the graphical representation of data for individual sites . General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).

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

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

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

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

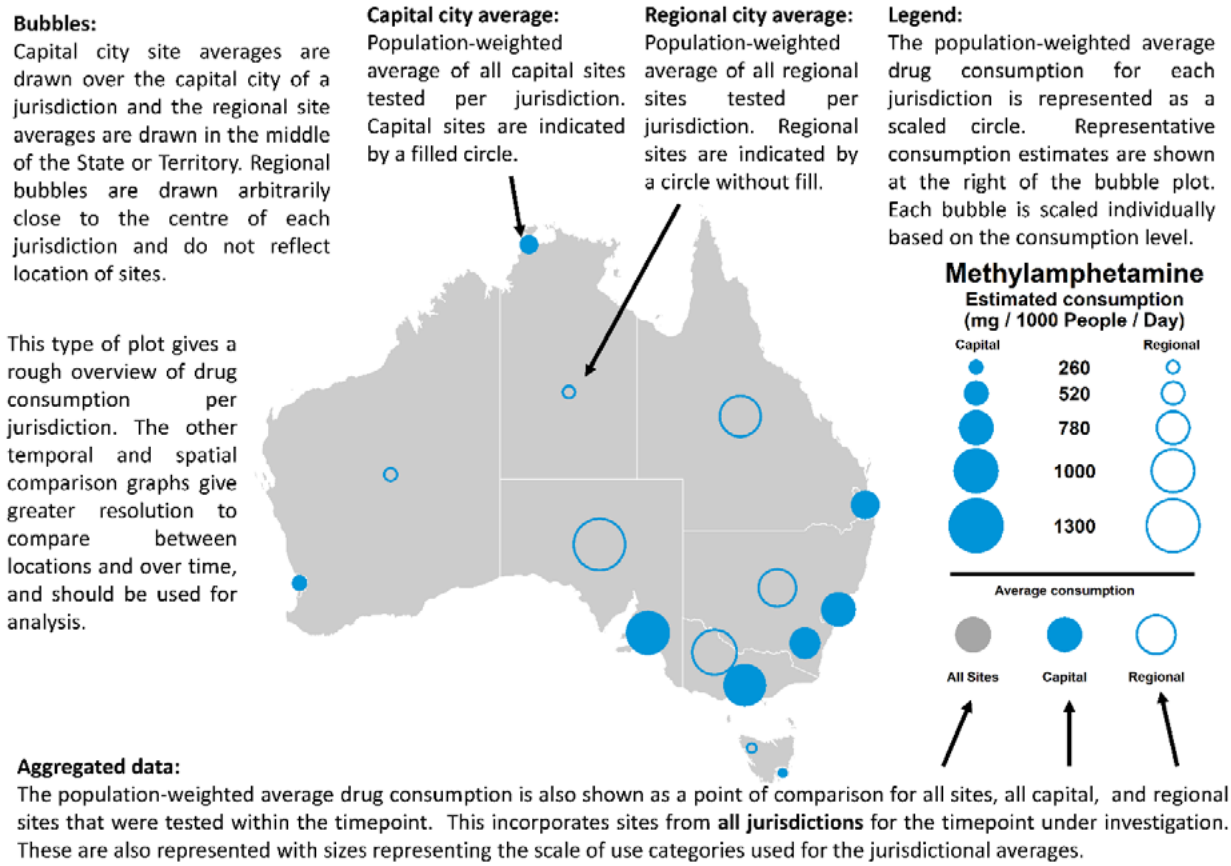


The **right hand axis** shows the estimated number of doses of a drug consumed by 1,000 people in the catchment in a 24 hour period; e.g., one dose would be 1 cigarette, 1 standard drink or 1 injected amount of drug. In this example, at Site 601, the minimum consumption was 9 doses in one day, the maximum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

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

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

Figure 4: Explanation of the graphical representation of data for bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).



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 2020 (Section 4.1), temporal trends for states and territories for the past two years (Section 4.2) and within each state and territory (Section 4.3). December 2020 data were used for Section 4.1 comparing the individual sites as it included the latest set of results for the full suite of sites included in the Program. We recommend exercising caution when comparing results between sites as some plants provided samples for fewer days than others and the collection week, and the days of the month, did not correspond in all instances. A list of the detection frequency for each drug can be found in Appendix 3. This report retained the current population estimates introduced in Report 4 by integrating the specific wastewater catchment areas against the high-resolution population data released from the 2016 Census. The uncertainties in individual population estimates have less impact when data are averaged, for example when broader comparisons at the state/territory or international level are undertaken. The uncertainties in population numbers may be particularly evident in smaller regional communities or sites where short-term population changes occur due to employment opportunities, tourism or festival events.

4.1 INDIVIDUAL SITE COMPARISON OF DRUG USE IN DECEMBER 2020

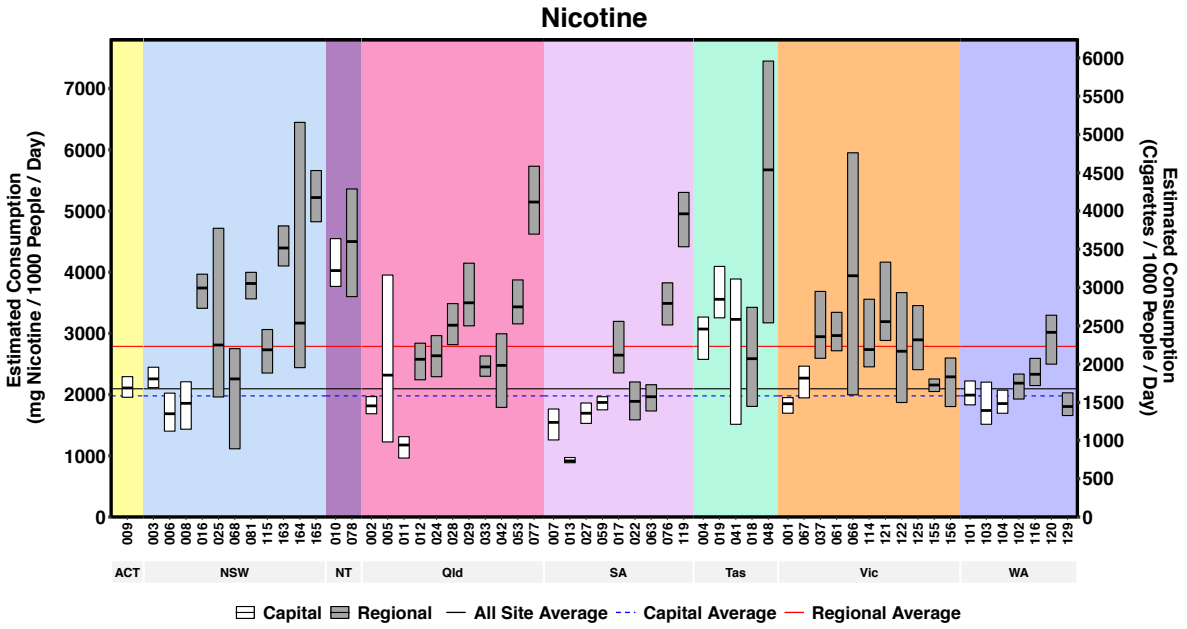
4.1.1 NICOTINE AND ALCOHOL

Nicotine is the main psychoactive substance present in tobacco products. Two nicotine metabolites, cotinine and hydroxycotinine, were used to represent the consumption of tobacco. The estimate is expressed as nicotine in this report as the method cannot distinguish between nicotine intake from tobacco, electronic cigarettes and nicotine replacement therapies such as patches and gums. The results show that in December 2020 nicotine consumption varied widely between sites across the country (Figure 5). Average use in regional Australia was substantially higher than in the capital cities (red horizontal and dotted blue lines, respectively). The Northern Territory capital city site had the highest consumption of all capital cities, followed by Tasmania. Regional catchments in Western Australia tended to have below average nicotine consumption.

Alcohol consumption was measured using a specific metabolite of ethanol. In the December 2020 reporting period there was very little difference between the average consumption of alcohol in regional and capital city sites (Figure 6). No clear spatial patterns were evident for the most part. The mean capital city values were highest in the Northern Territory and sites in Queensland and Tasmania. Sites in South Australia generally had below average alcohol consumption.

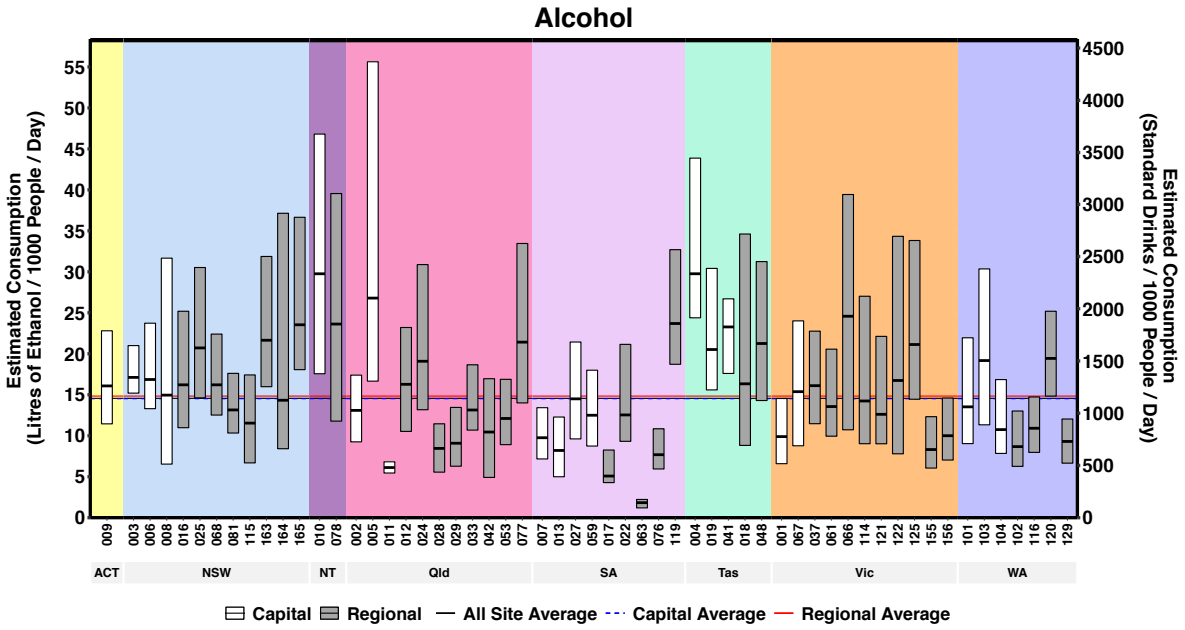
The relative consumption levels can be represented in a pictorial way by showing the relative scale of use of nicotine (Figure 7) and alcohol (Figure 8) as capital city or regional 'bubbles' for each state and territory. The higher than average consumption of nicotine in the Northern Territory is evident from the size of the bubbles in that region.

Figure 5: Estimated nicotine consumption for December 2020 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**
- **Variable across Australia**

Figure 6: Estimated alcohol consumption for December 2020 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.



- Near identical national averages
- Wide weekly spread a common feature

Figure 7: Estimated average nicotine consumption per jurisdiction for December 2020 in number of cigarettes per day per thousand people. The number of collection days varied from 5-7.

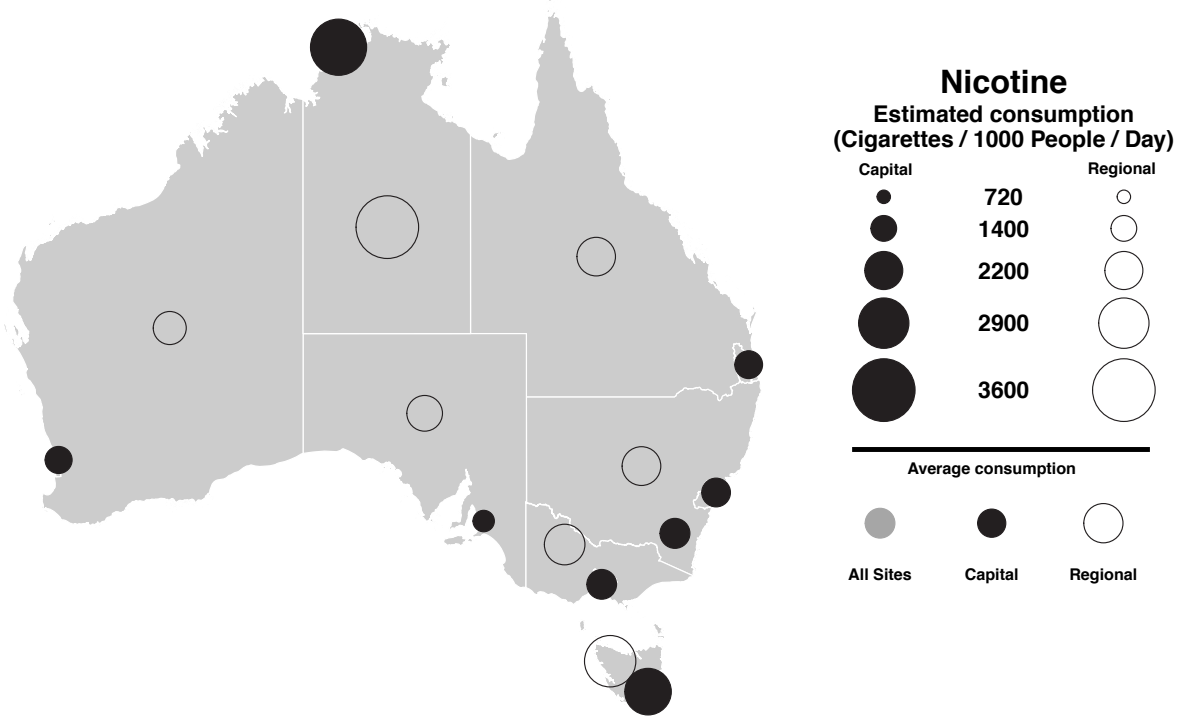
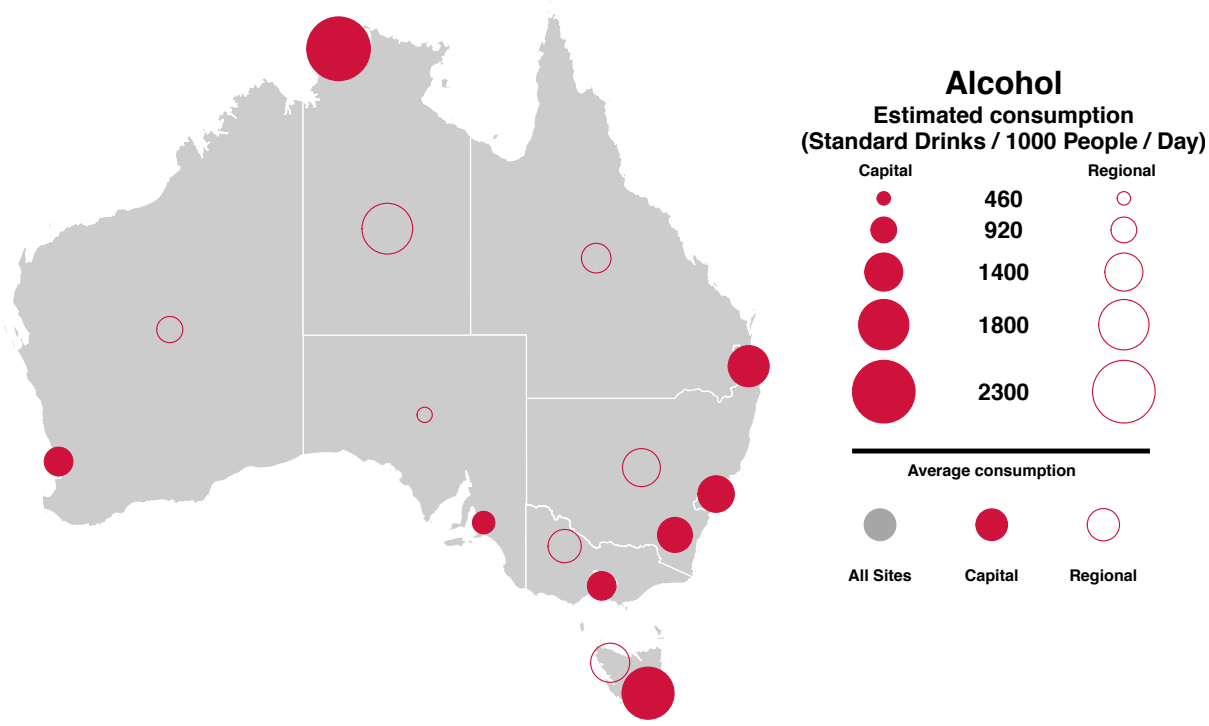


Figure 8: Estimated average alcohol consumption per jurisdiction for December 2020 in number of standard drinks per day per thousand people. The number of collection days varied from 5-7.



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

Methylamphetamine levels varied considerably across sites, both in terms of capital cities and regional catchments (Figure 9). Site 3 in New South Wales had particularly high use on one day of the week during the February 2021 collection period which was consistent with the drug being released into the sewer network. This event was equivalent to approximately 9 kilograms of methylamphetamine. This was evidenced by the methylamphetamine metabolites, amphetamine and pholedrine (not reported in the NWDMP), which were not higher on that day, suggesting the higher level was not due to higher consumption, but likely representing methylamphetamine release into the sewer (dumping). That single day result was removed from the methylamphetamine data for that site. Although less dramatic, a wide weekly spread was also found at regional Site 66 in Victoria. As the reported amounts relate to the drug being consumed, the possibility of methylamphetamine being disposed into the sewer system was also considered. The relatively elevated levels on the day after the spike in measured amounts is consistent with the clearance profile of an ingested drug which may span several days. Further evidence of the high measured levels being attributable to consumption at Site 66, pholedrine and amphetamine, metabolites of methylamphetamine, were also higher on the same days, consistent with consumption. Regional centres had lower average use than capital cities in December 2020, which is contrary to previous findings for this drug. Aside from the unusual drug use at Site 3 in capital city New South Wales and Site 66 in regional Victoria, parts of regional South Australia recorded the highest daily levels. The Australian Capital Territory, Northern Territory, most of Queensland, Tasmania and Victoria showed use well below the national averages for the December 2020 period.

4.1.2.2 AMPHETAMINE

The measured concentration of amphetamine in the December 2020 samples mostly fell within a range which is consistent with the reported excretion rates following methylamphetamine consumption (Gracia-Lor et al. 2016). The results were largely in agreement with our previous findings (see Appendix 4 of Report 1). Therefore, we assumed that the levels of amphetamine in wastewater samples were predominantly due to the metabolism of methylamphetamine. It is possible that some of the measured amphetamine could be the result of ingestion of the drug, but the high levels of methylamphetamine means a firm conclusion is not possible.

4.1.2.3 COCAINE

Benzoylecgonine, the specific metabolite of cocaine, was used to estimate the consumption of the stimulant. Capital city areas on average had substantially higher cocaine use than regional centres (Figure 10). Compared to methylamphetamine, daily doses per thousand people were much lower at 7 doses, compared to around 40 doses for methylamphetamine. In general, New South Wales had the highest overall consumption figures in the nation. Sites in the Australian Capital Territory, Queensland and Victoria also recorded high values. Cocaine consumption was generally low in most other parts of Australia, particularly the regional centres of the Northern Territory, South Australia, Tasmania and Western Australia. Tasmanian regional sites were unable to provide weekend samples. As a larger proportion of cocaine may be consumed on weekends, these results may be under-representing consumption in that state.

4.1.2.4 MDMA (3,4-METHYLENEDIOXYMETHYLAMPHETAMINE)

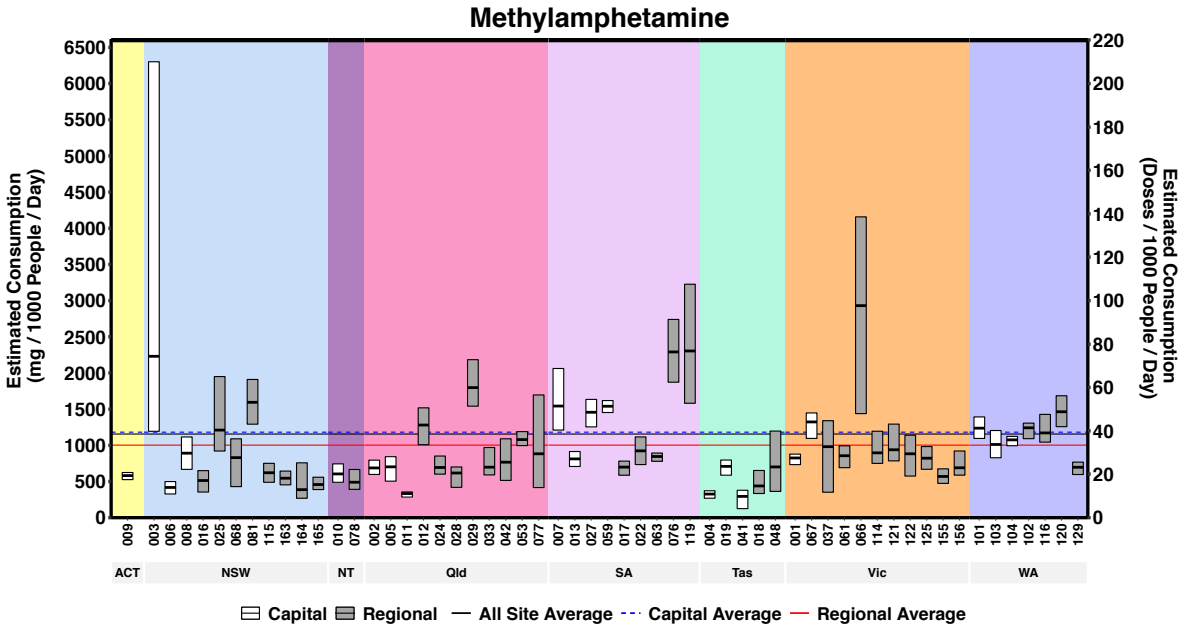
The average consumption of MDMA was lower than the previous two stimulants (Figure 11). The variation over the course of the sampling week was large, especially capital city sites in the Northern Territory and parts of New South Wales where the highest use was recorded. The large spread in values over the short term was consistent with the weekend use of the drug, particularly at Sites 8 and 10. A direct comparison of regional and capital city sites in Tasmania is inappropriate as the regional centres did not sample on weekends when MDMA consumption is typically higher. See Appendix 2 for a list of the number of samples collected per site. Overall, regional average use of MDMA was only slightly higher than in the capital cities. This appeared to be a consequence mainly of regional use of the drug across New South Wales and Victoria. Regional Western Australia had levels well below the national average.

4.1.2.5 MDA (3,4-METHYLENEDIOXYAMPHETAMINE)

MDA is both a drug in its own right and a metabolite of MDMA. Since the proportion of MDA eliminated after MDMA consumption is known, this proportion of MDA attributable to MDMA metabolism was subtracted from the total measured amount of MDA for each site. Results for MDA were expressed as mg excreted per 1,000 people per day (daily mass load) and not as consumption due to the lack of metabolic information of MDA elimination following MDA consumption. Levels of the drug were low across Australia (Figure 12). The capital city and regional average were very similar. Spikes in MDA levels were evident at a few locations, e.g. Sites 8 and 10 in New South Wales and the Northern Territory, respectively. However, this was amplified by the very low levels elsewhere.

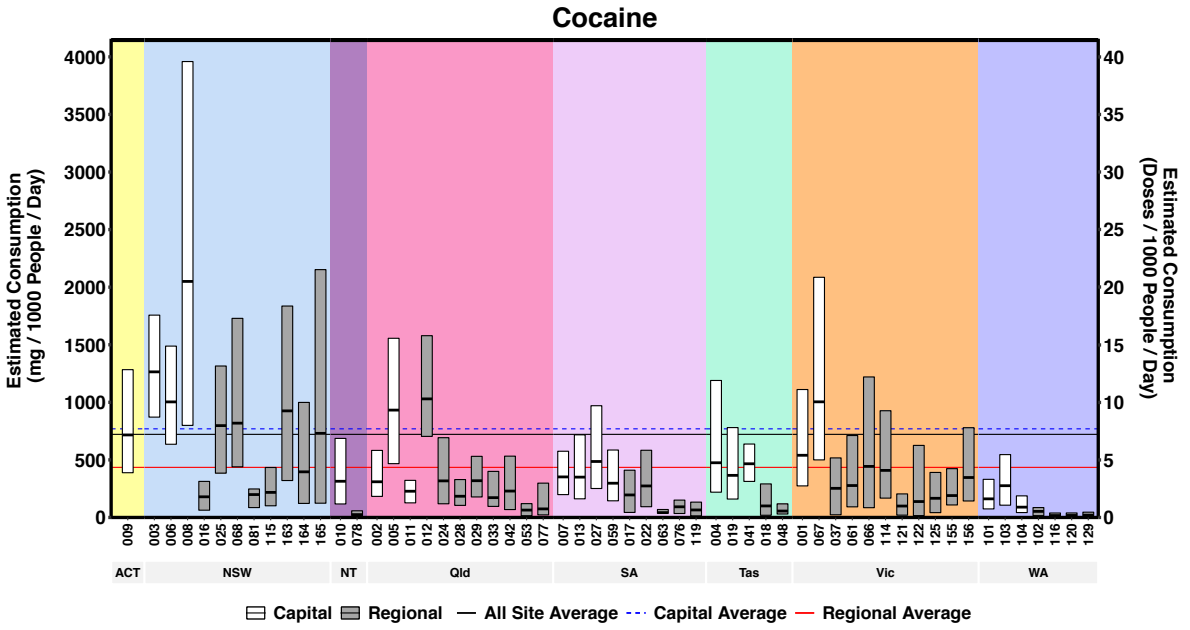
The scale of use of each stimulant is expressed as a bubble graph to compare regional and capital city use of methamphetamine (Figure 13), cocaine (Figure 14), MDMA (Figure 15) and MDA (Figure 16) across the country. The popularity of cocaine on the south-eastern seaboard remains apparent. The scale of MDMA and MDA use in the Northern Territory has to be seen in the context of low overall use of these substances as well as the fact that only a single capital city site is included in the Program.

Figure 9: Estimated methylamphetamine consumption for December 2020 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.



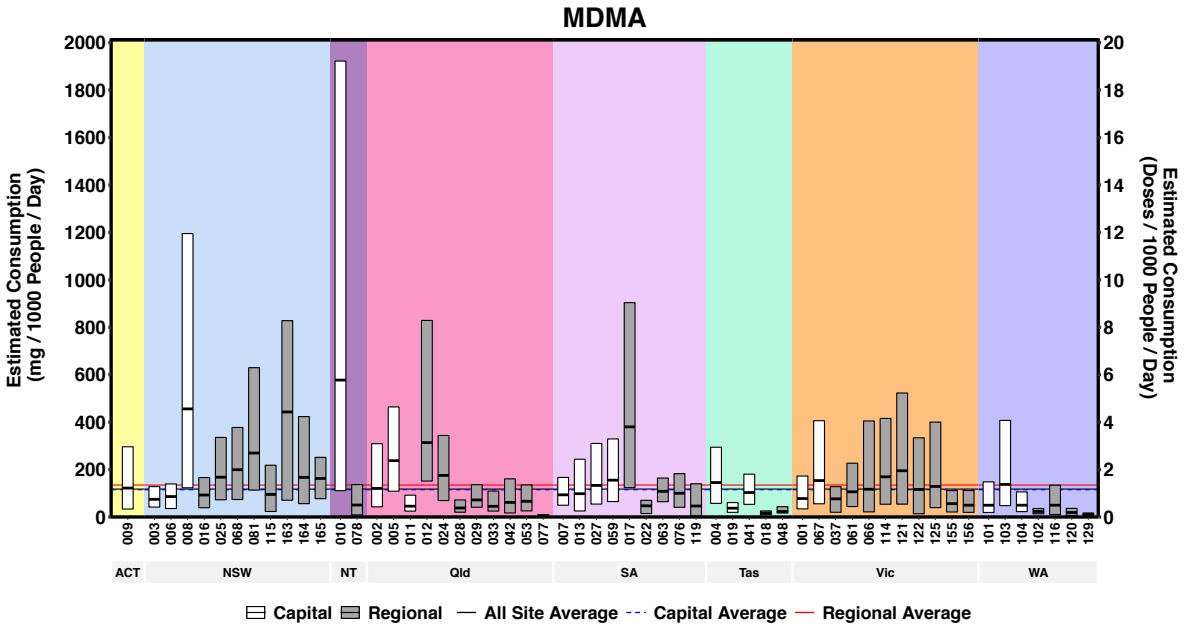
- Lower regional consumption
- Daily spikes at specific sites

Figure 10: Estimated cocaine consumption for December 2020 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.



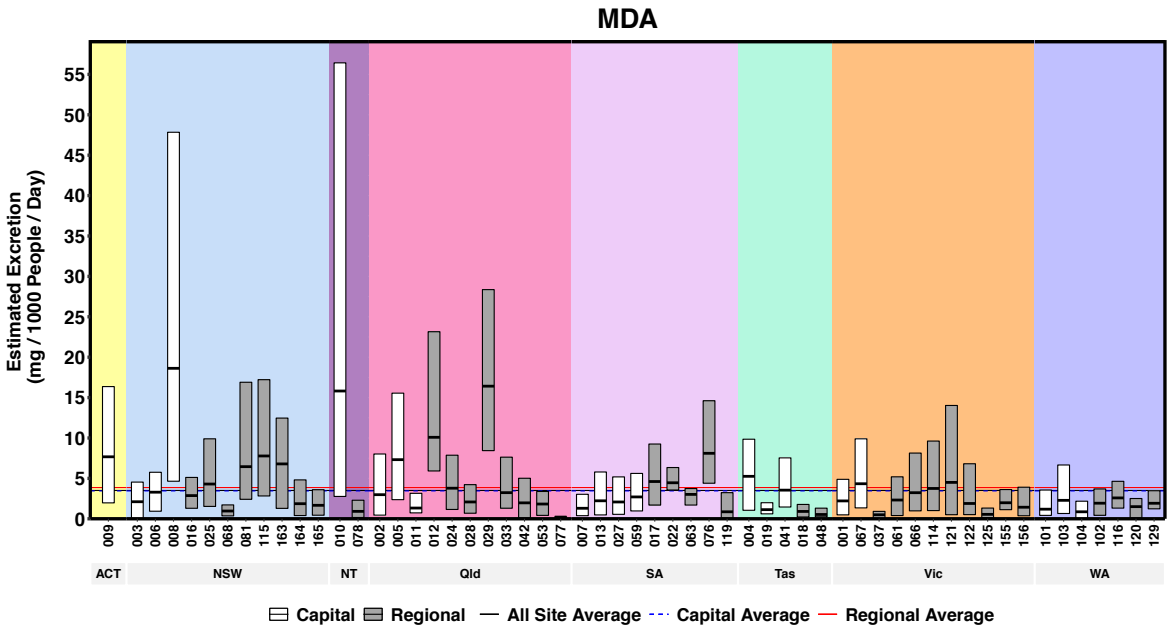
- Higher capital city consumption
- High overall consumption in New South Wales

Figure 11: Estimated MDMA consumption for December 2020 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.



- Mostly low consumption rates nationally
- Wide weekly spread indicates higher weekend consumption

Figure 12: Estimated MDA excretion for December 2020 in mass excreted per day per thousand people. The number of collection days varied from 5-7.



- Relatively low levels overall
- Similar averages in regions and capital cities

Figure 13: Estimated average methylamphetamine consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

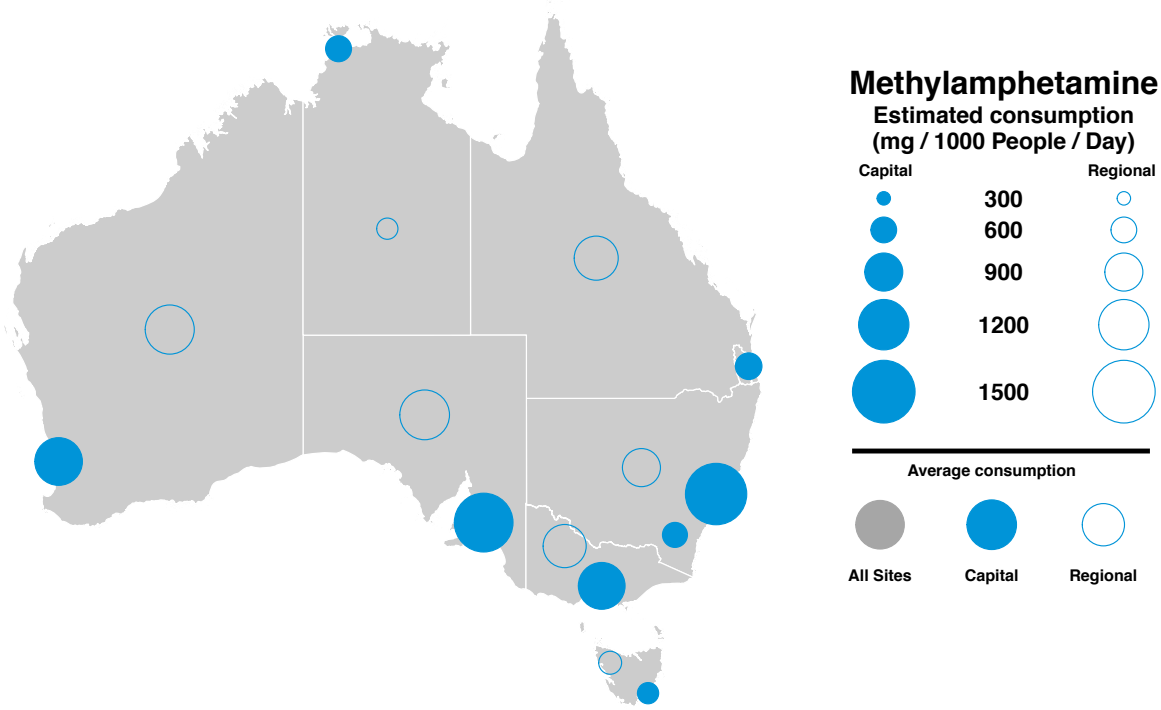


Figure 14: Estimated average cocaine consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

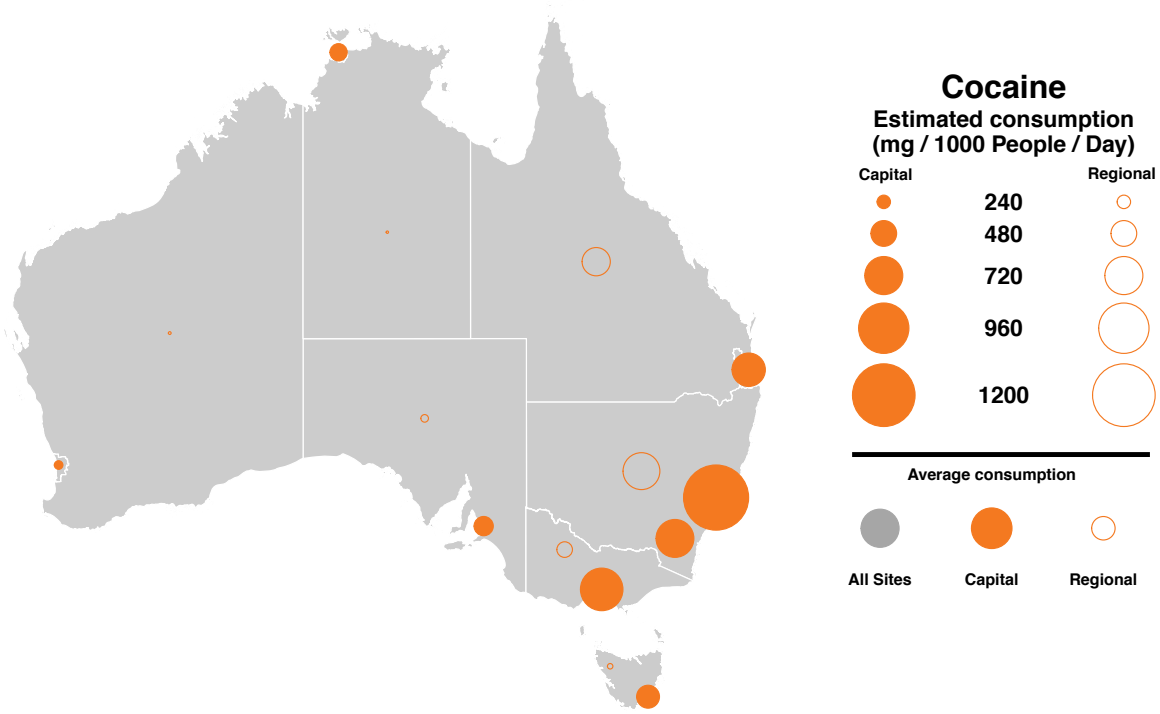


Figure 15: Estimated average MDMA consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

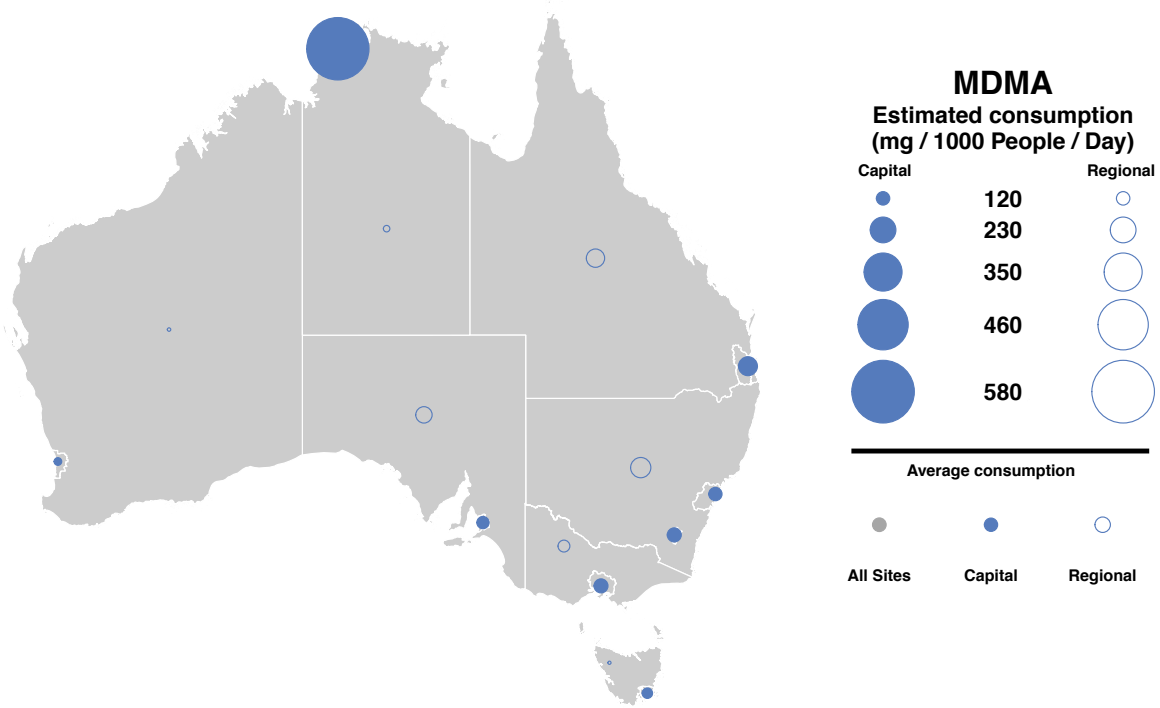
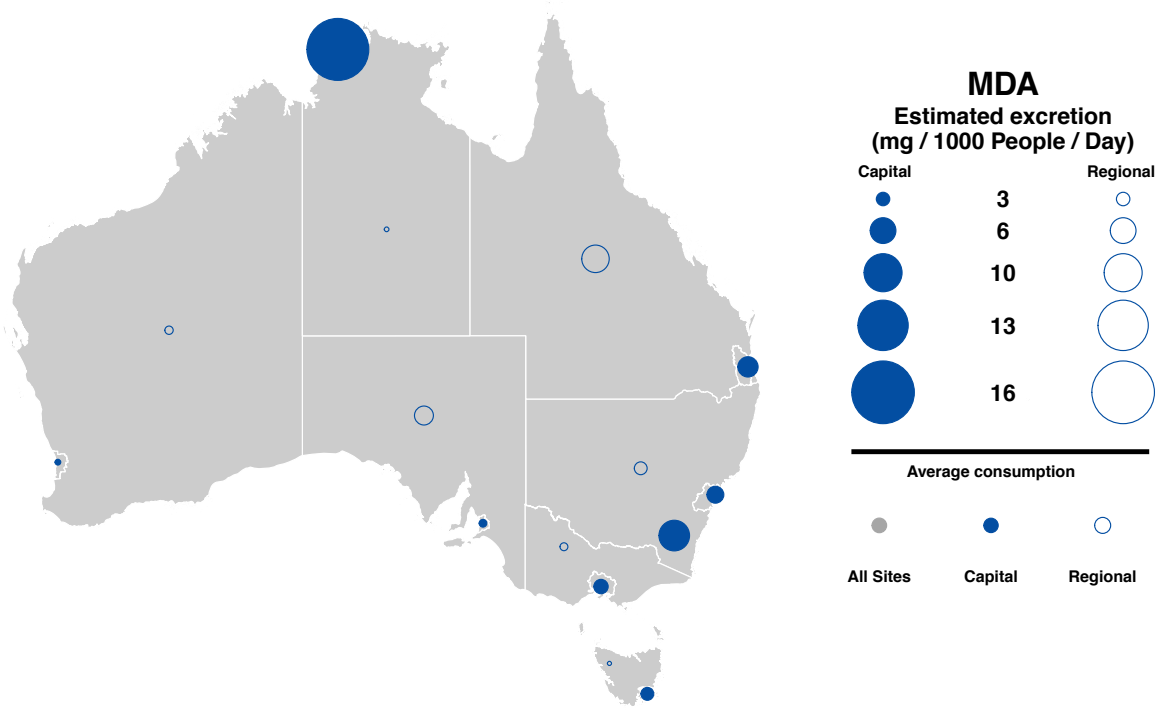


Figure 16: Estimated average MDA excretion per jurisdiction for December 2020 in mg excreted per day per thousand people. The number of collection days varied from 5-7.



4.1.3 OPIOIDS

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

4.1.3.1 PHARMACEUTICAL OPIOIDS

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

Oxycodone consumption across Australia in December 2020 was variable and a very large difference was evident between the overall regional and capital city averages (Figure 17). Western Australia had relatively low overall consumption levels compared to the national averages. Capital city catchments with above average consumption of oxycodone included the Australian Capital Territory, South Australia and Tasmania. The spread of use over the December 2020 collection week was small in the capital cities, with bigger daily variations evident in many regional centres.

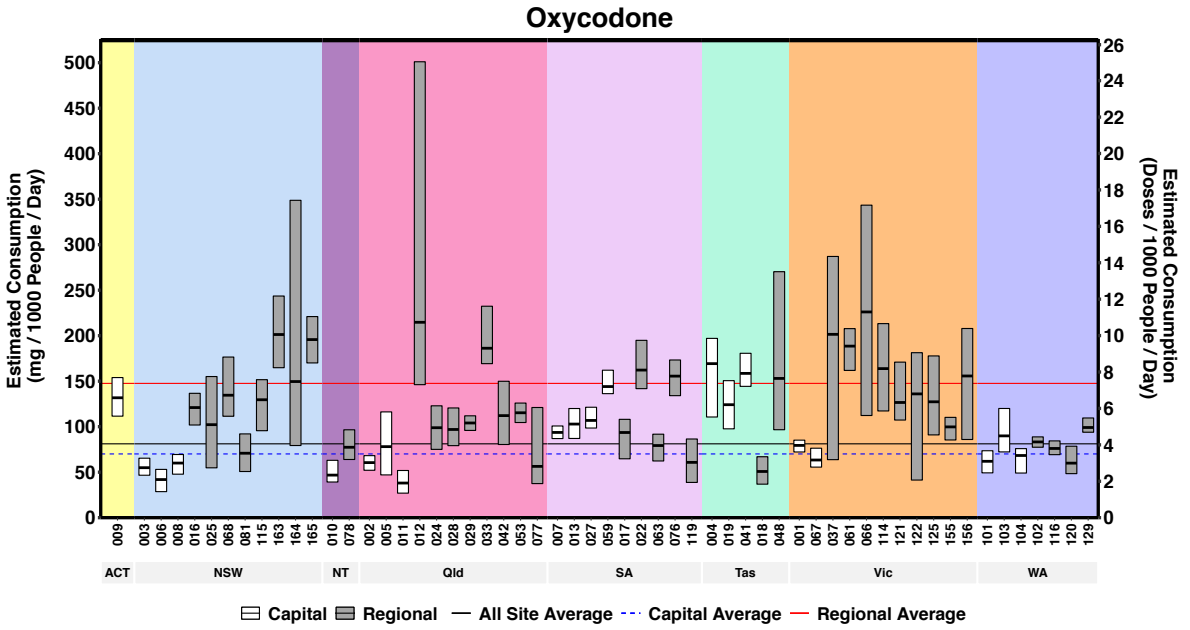
Fentanyl use was similarly characterised by large spatial variations across Australia. Unlike oxycodone, average regional use of this pharmaceutical opioid was similar to that in the capital cities (Figure 18). Some capital city catchments in New South Wales had the highest levels of use, with large differences evident between collection days. This is unusual for treatment of medical conditions on a population scale. Specific days at some sites had levels below the quantification limits of the method, including at some of the Western Australian capital city catchments.

The relative scale of oxycodone and fentanyl use was apparent when results were aggregated by jurisdiction and capital or regional area and presented in bubble graph form. Generally higher oxycodone consumption rates in regional areas and in capital city Tasmania were apparent (Figure 19). Fentanyl consumption was relatively low in most capital cities, apart from New South Wales (Figure 20).

4.1.3.2 HEROIN

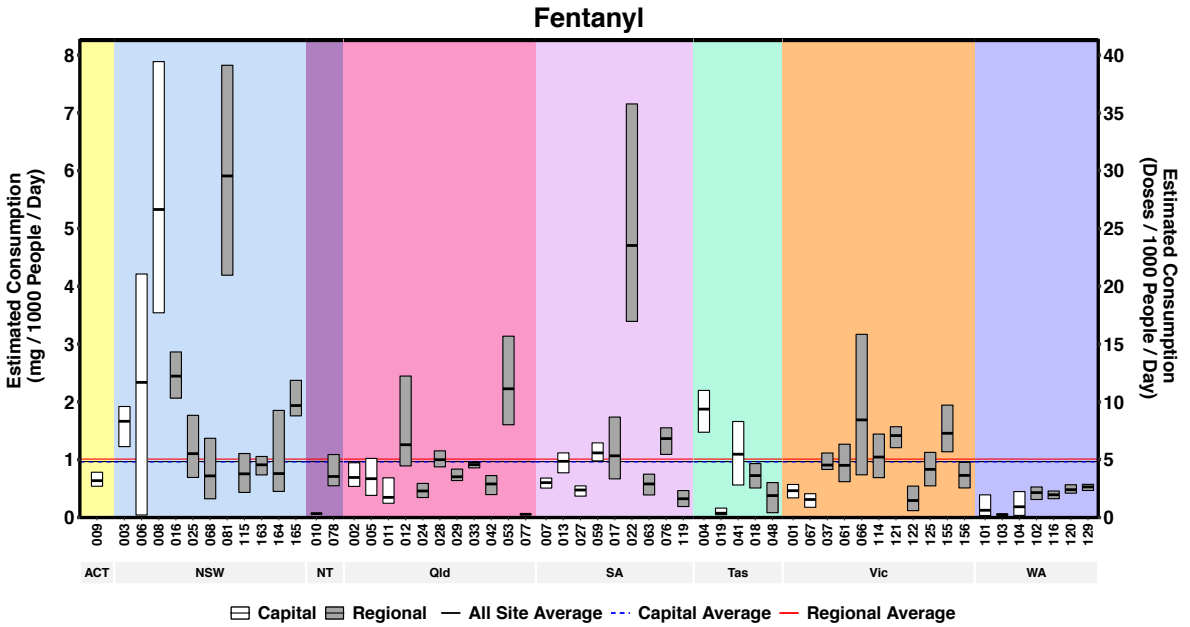
Heroin is metabolised in the body and excreted in low amounts as the unique metabolite, 6-monoacetylmorphine (6-MAM). Since the compound is characteristic of heroin metabolism, it can be used to distinguish heroin from other opioids such as morphine and codeine. Use of heroin in regional areas was generally much less than in the capital cities (Figure 21). Victoria Site 67 had very high levels across the sampling week, well above most other catchments. Single capital city sites in a number of states and the Australian Capital Territory had relatively high levels as well. Regional use of the drug tended to be the highest in parts of New South Wales and Victoria. Many regional sites had levels at or below limits of quantification. The elevated heroin consumption in capital city Victoria is clearly evident from the bubble graph (Figure 22).

Figure 17: Estimated oxycodone consumption for December 2020 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 regional average
- Tasmania highest of the capital cities

Figure 18: Estimated fentanyl consumption for December 2020 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.



- Similar regional and city averages
- Highest use in New South Wales

Figure 19: Estimated average oxycodone consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

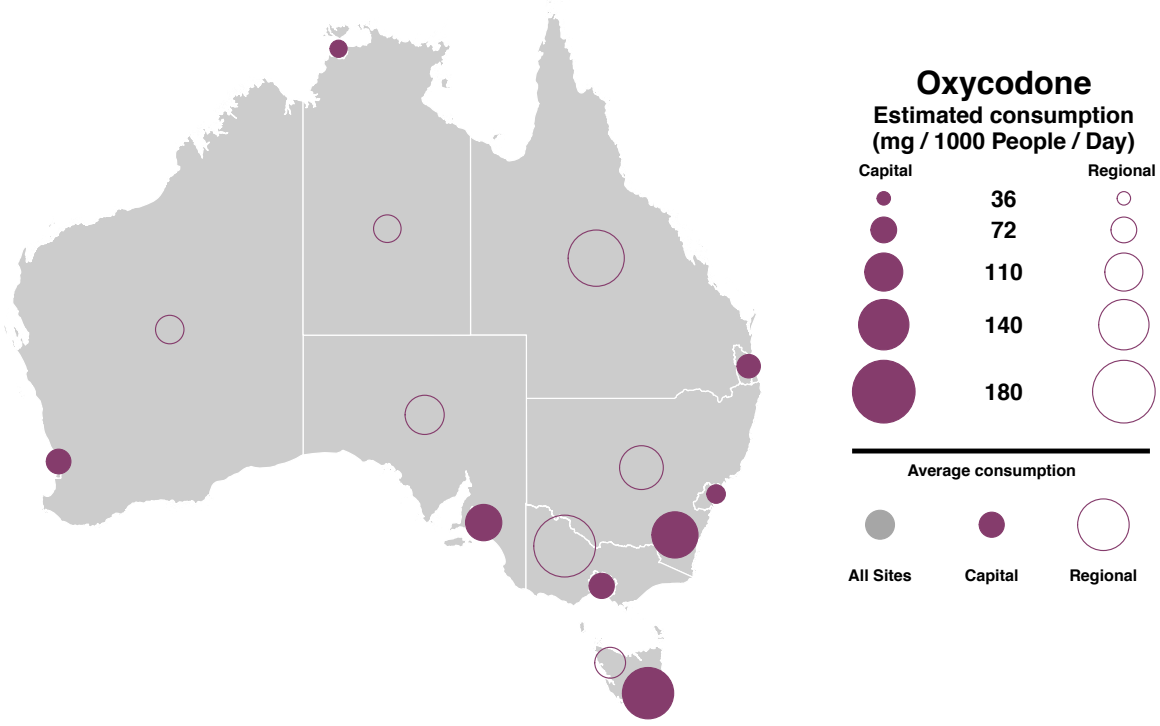


Figure 20: Estimated average fentanyl consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

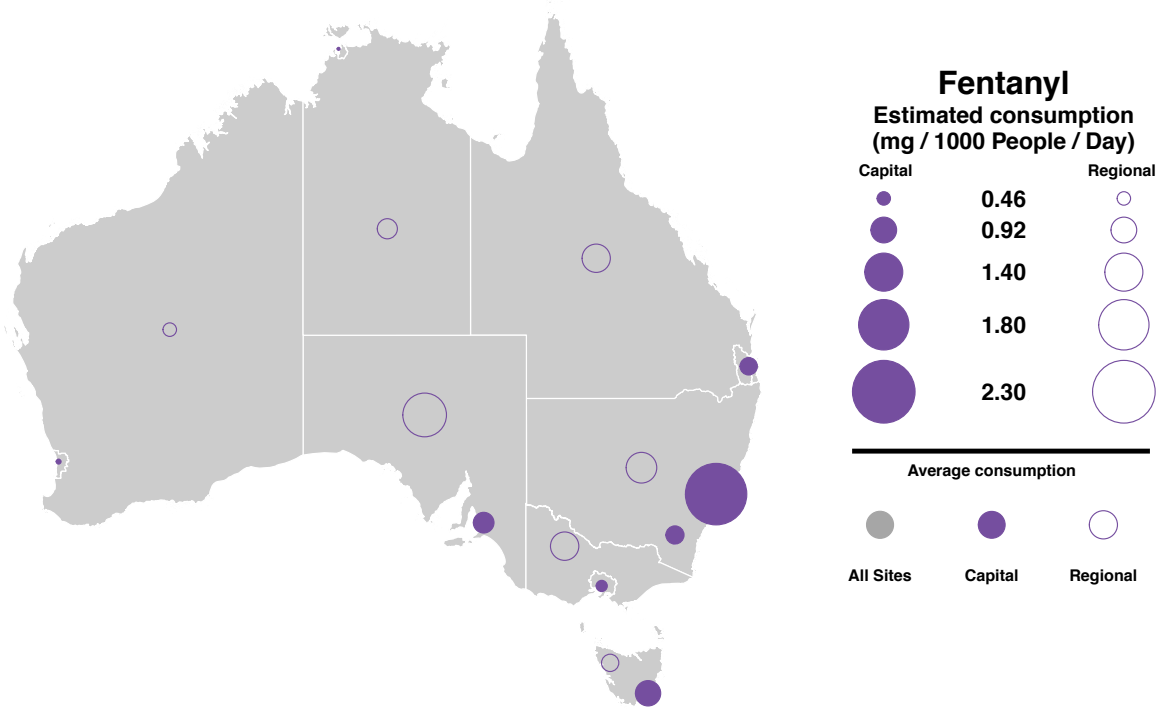
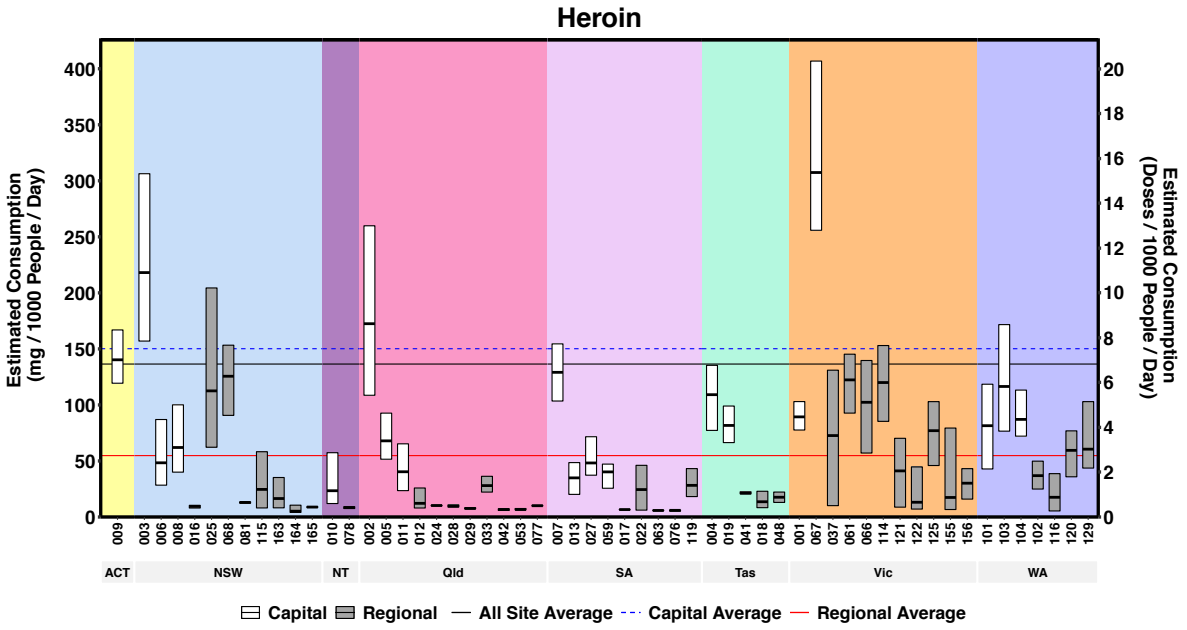
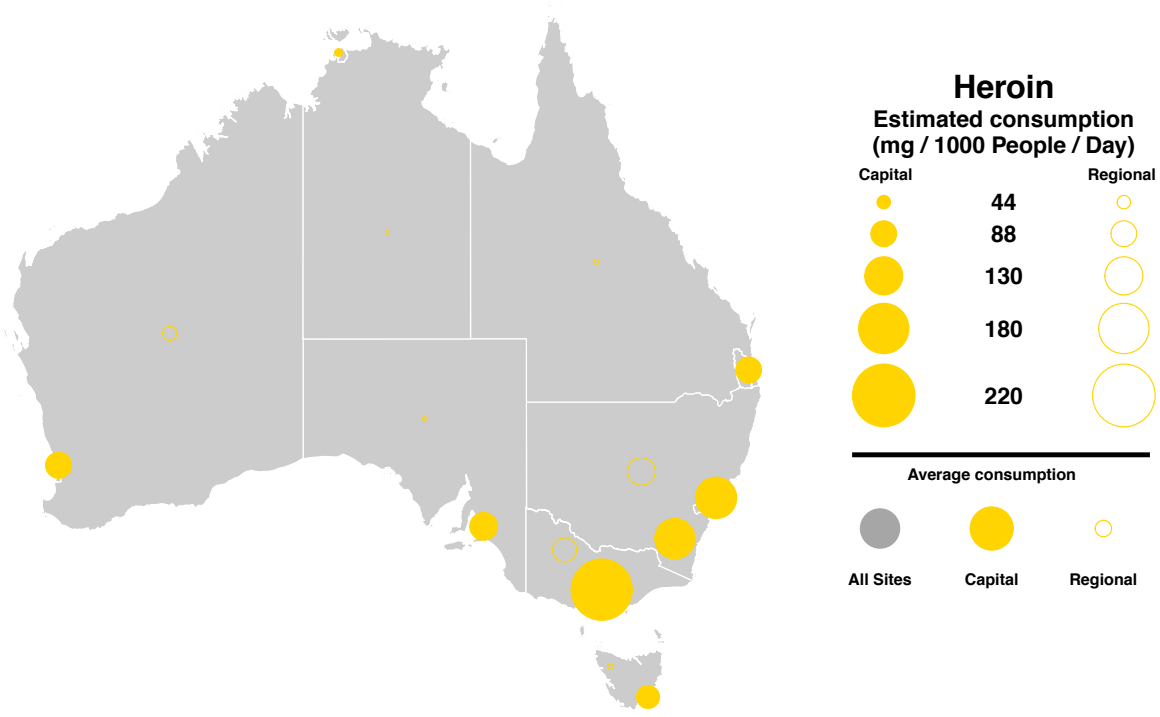


Figure 21: Estimated heroin consumption for December 2020 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional consumption, often not detected
- Highest consumption in Victoria

Figure 22: Estimated average heroin consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



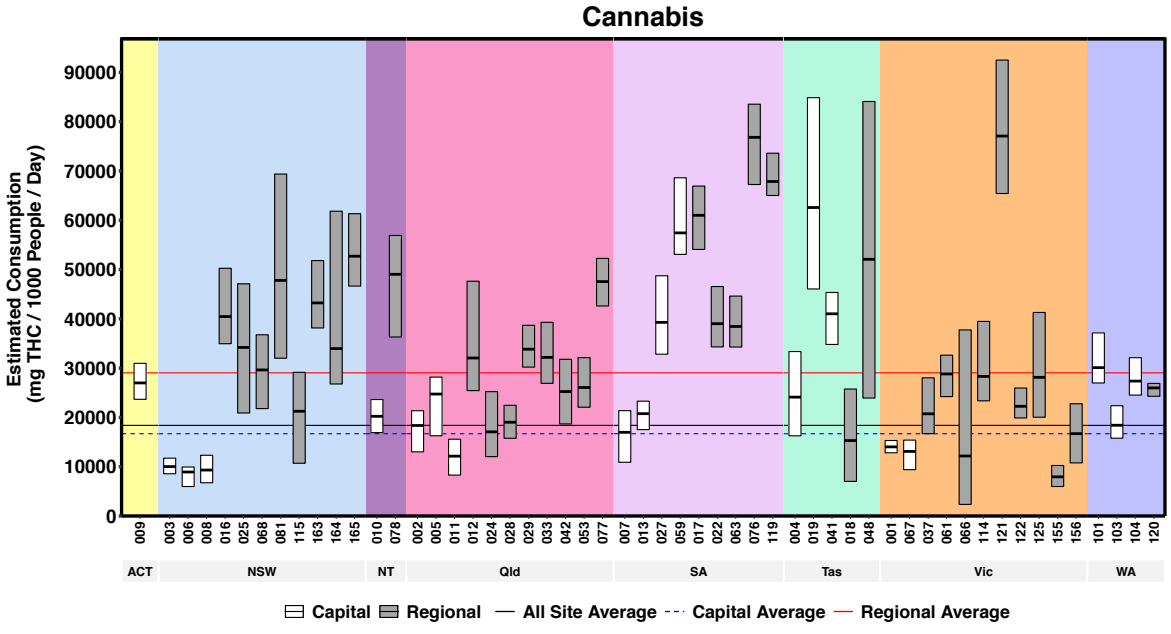
4.1.4 CANNABIS

Tetrahydrocannabinol (THC) is the main psychoactive compound found in cannabis. The compound is metabolised and largely cleared through the gut. A small proportion (0.06 per cent) is excreted through the kidneys as 11-nor-9-carboxy-tetrahydrocannabinol (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 need to be preserved to avoid degradation of THC-COOH, without using acidification (McCall et al. 2016). This is one reason why cannabis consumption is not reported on a regular basis in other countries where wastewater analysis is routinely conducted. Acidification is a common preservation technique. For the NWDMP, separate samples are collected each day and preserved specifically for THC-COOH analysis.

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

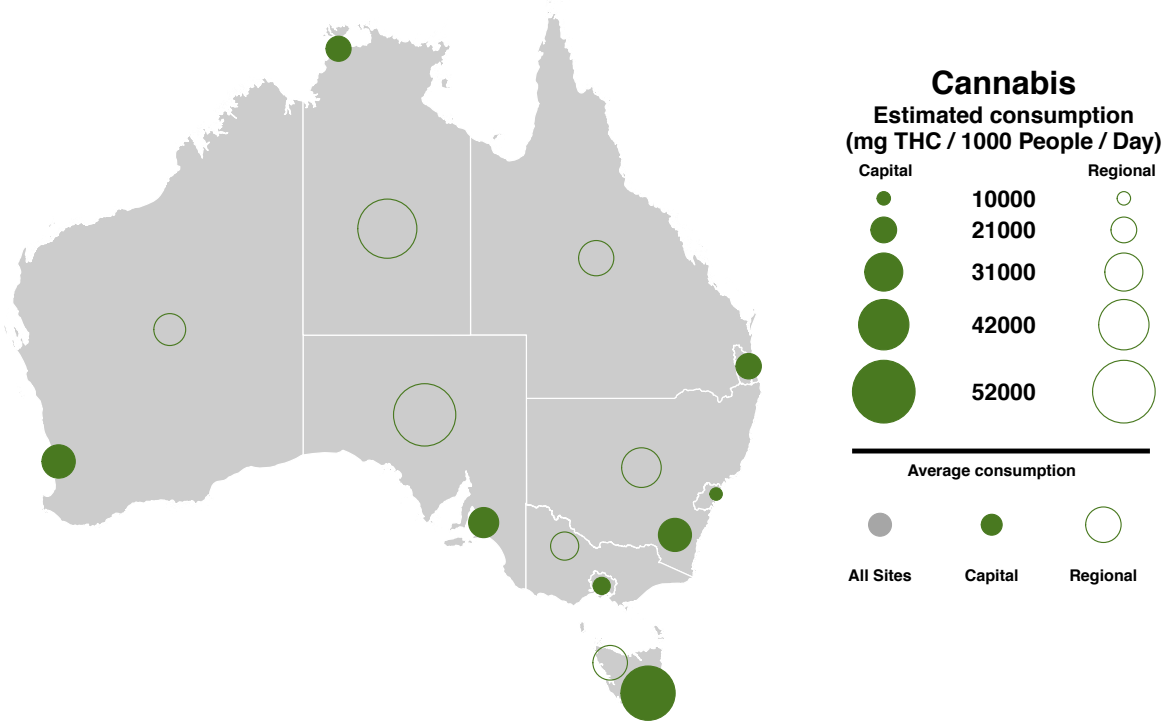
Very large spatial differences were evident across Australia (Figure 23). The average use across regional Australia in December 2020 exceeded capital city consumption. The highest mean values were observed in regional South Australia and Victoria, while sites in South Australia and Tasmania recorded the highest levels of consumption in capital cities. In contrast, capital city New South Wales mostly had very low levels of cannabis use, while sites in Queensland and Victoria also had levels below the national average. The bubble plot and jurisdictional differences of cannabis use across Australia show the generally higher consumption in regional areas (Figure 24).

Figure 23: Estimated cannabis consumption for December 2020 in mass consumed per day (left axis). The number of collection days varied from 5-7.



- **High regional consumption**
- **Variable use across the country**

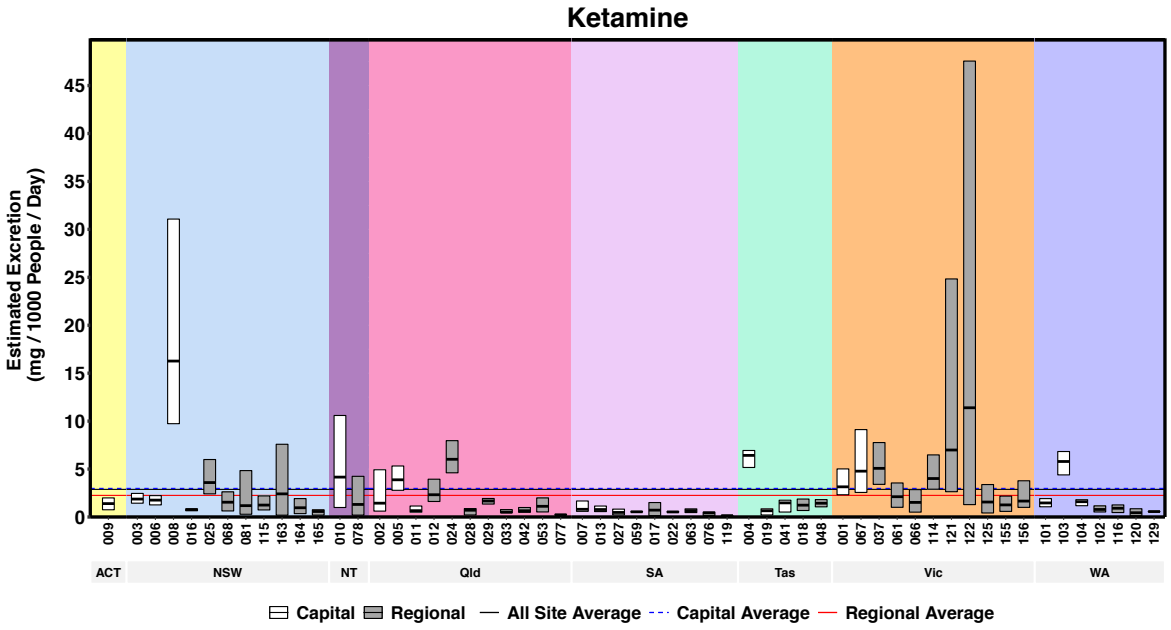
Figure 24: Estimated average cannabis consumption per jurisdiction for December 2020 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



4.1.5 KETAMINE

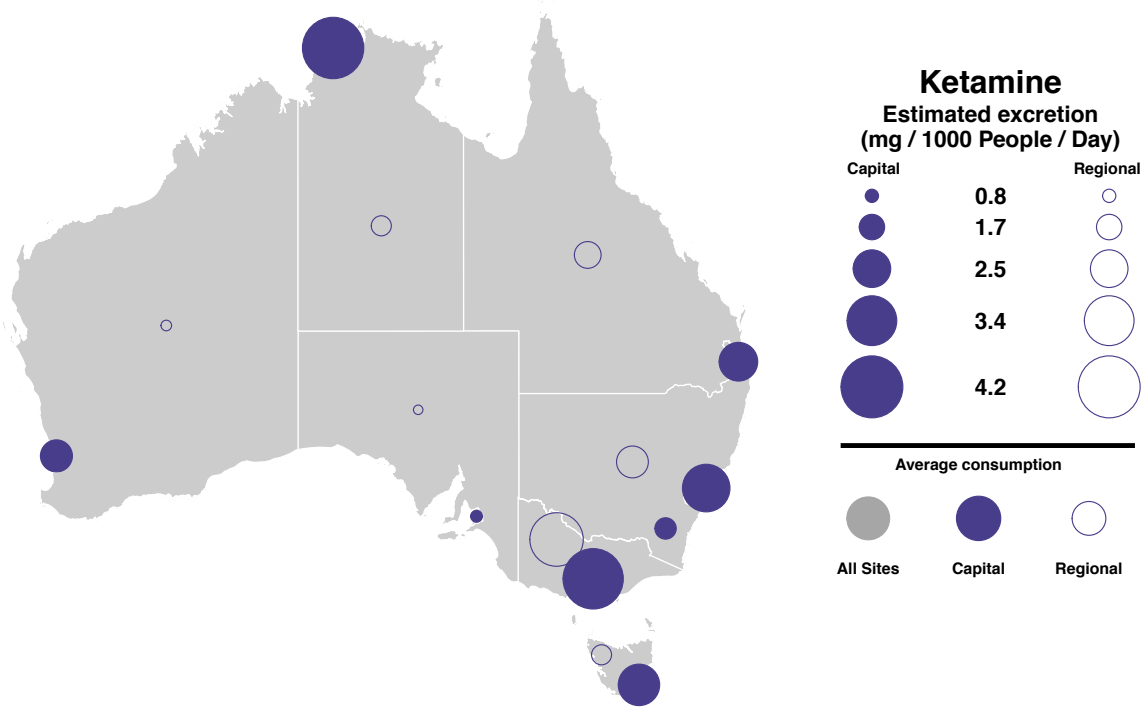
Ketamine, measured as its metabolite, norketamine, has been included in the Program for the first time. The compound is used medically for the management of acute pain, often associated with surgery or trauma. It has veterinary applications as well, although this may have less relevance in terms of wastewater monitoring due to the separation of stormwater and agricultural run-off and the sewer network in most Australian catchments. Due to its sedative and hallucinogen effects, the drug has been associated with illicit substance abuse and is listed as a new psychoactive substance by the United Nations Office on Drugs and Crime (UNODC). The reported proportion of ketamine and its metabolites in wastewater leaves some doubt as to an appropriate factor to convert excreted amounts to consumed amounts. Therefore, measured levels are being shown here as excreted daily mass loads, similar to the case of the stimulant MDA. The regional average was slightly lower than the capital cities, partly because values fell below the method detection limits on certain days at various catchments. On a spatial level, use was only well above the averages at a few sites, particularly in capital city New South Wales and regional Victoria (Figure 25). Although the wide weekly spread at these sites appears to be inconsistent with medical use on a population scale, the low overall values may distort the scale of the variations to some extent. A bubble plot shows the relative scale of ketamine use across Australia (Figure 26).

Figure 25: Estimated ketamine consumption for December 2020 in mass excreted per day (left axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional average
- Higher levels in specific catchments

Figure 26: Estimated average ketamine consumption per jurisdiction for December 2020 in mg excreted 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. The data relating to capital cities in this section have been updated to include both the December 2020 and February 2021 collections, while regional areas were updated for December 2020. This needs to be considered when comparing results between sections 4.1 and 4.2. Ketamine has been included in the Program for the first time, and so has less data points than the other substances. 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). Due to the larger number of data points collected by the Program, the current reporting period is populated with up to two years of previous data. Prior data dating back to 2016 for each substance of interest is made available on the ACIC website by jurisdiction.

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

4.2.1 NICOTINE AND ALCOHOL

Patterns in nicotine consumption have been variable across Australia (Figure 27). Parts of the country showed increasing use over the two-year period up to mid-2020, e.g. the two territories, regional New South Wales, Queensland and South Australia. Nicotine use in other parts of the country declined over the same period, e.g. capital city South Australia, or remained relatively steady, including Victoria and Western Australia. The cumulative regional average nicotine consumption (red line) remains well above capital city levels (blue dashed line). The onset of COVID-19 in early 2020 appeared to change some of the previous trends. The steady rise in the Australian Capital Territory levelled off over the middle part of 2020, after which nicotine use decreased . Consumption in regional New South Wales and the Northern Territory capital city has also declined since the start of the outbreak. Other parts of the country showed some differences after COVID-19 as well. Queensland experienced an escalation in use immediately following lockdowns associated with the pandemic in April 2020, but in the past six months use has decreased to pre-COVID-19 levels. Similar effects were evident in Tasmania and Victoria.

Apart from a declining trend in South Australia, no obvious patterns in alcohol consumption are evident over the past two years (Figure 28). COVID-19 had an immediate effect in many parts of the country, as seen by the drop in alcohol consumption coinciding with the initial lockdown period in April 2020. However, consumption recovered quickly to previous levels or even increased, particularly in the Northern Territory where restrictions were eased before most other parts of the country. In the current reporting period spanning December 2020 and February 2021 in the case of capital cities and December of last year for regional Australia, alcohol use appeared to have declined in many parts of the country. Considering the variability in levels over the life of the Program, the changes were relatively minor. Victoria was the only state severely affected by a second wave of the pandemic and alcohol consumption in the state appears to reflect that, with lower levels detected since June in regional parts of the state. The difference in the cumulative average consumption of alcohol in regional areas compared to the cities was less pronounced than nicotine, but consumption was also higher outside the capital cities. The Northern Territory has tended to have the highest overall use of alcohol since the start of the Program, followed by Tasmania.

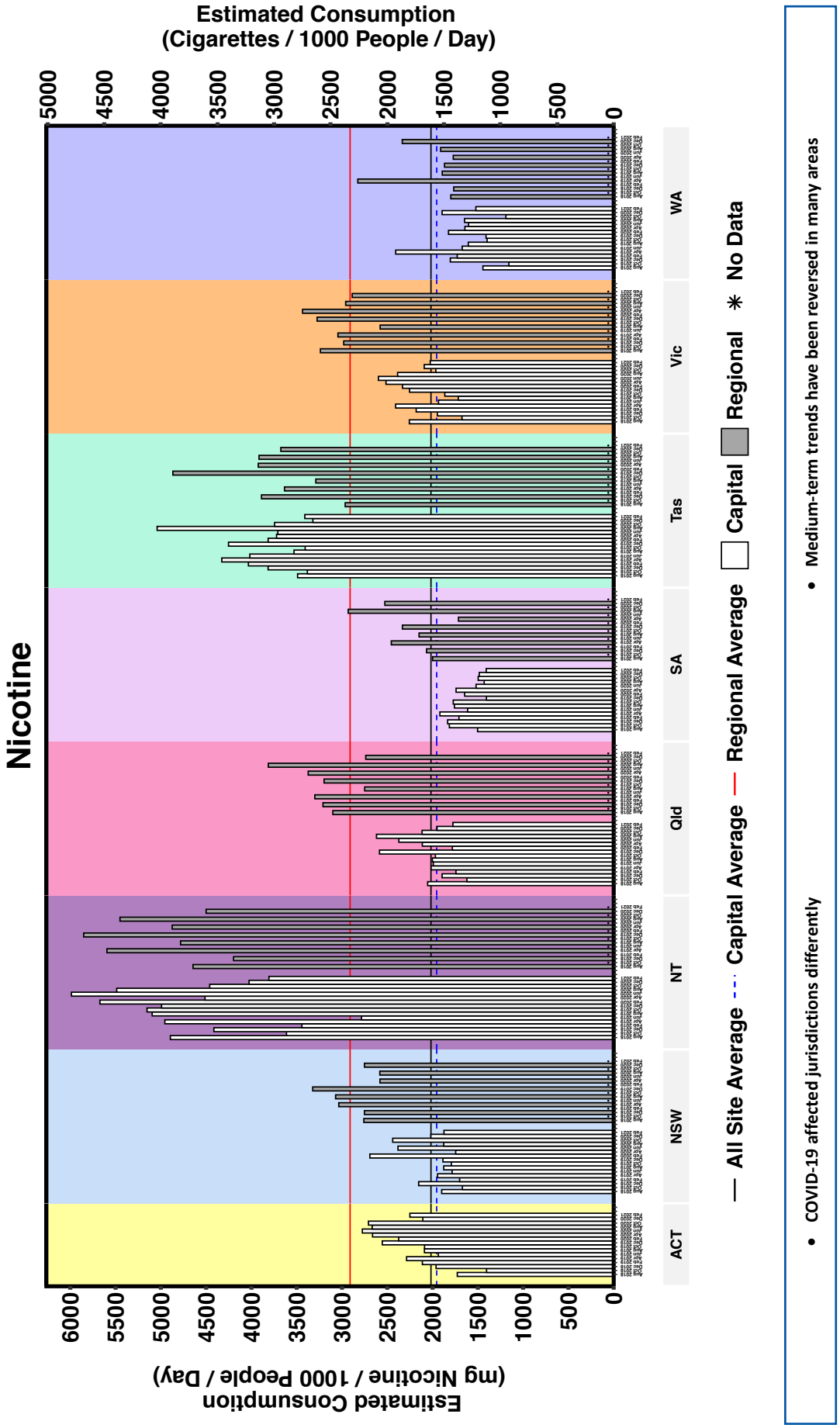


Figure 27: Estimated average consumption of nicotine by state/territory, August 2018 to February 2021, where 1 cigarette provides 1.25 mg of nicotine.

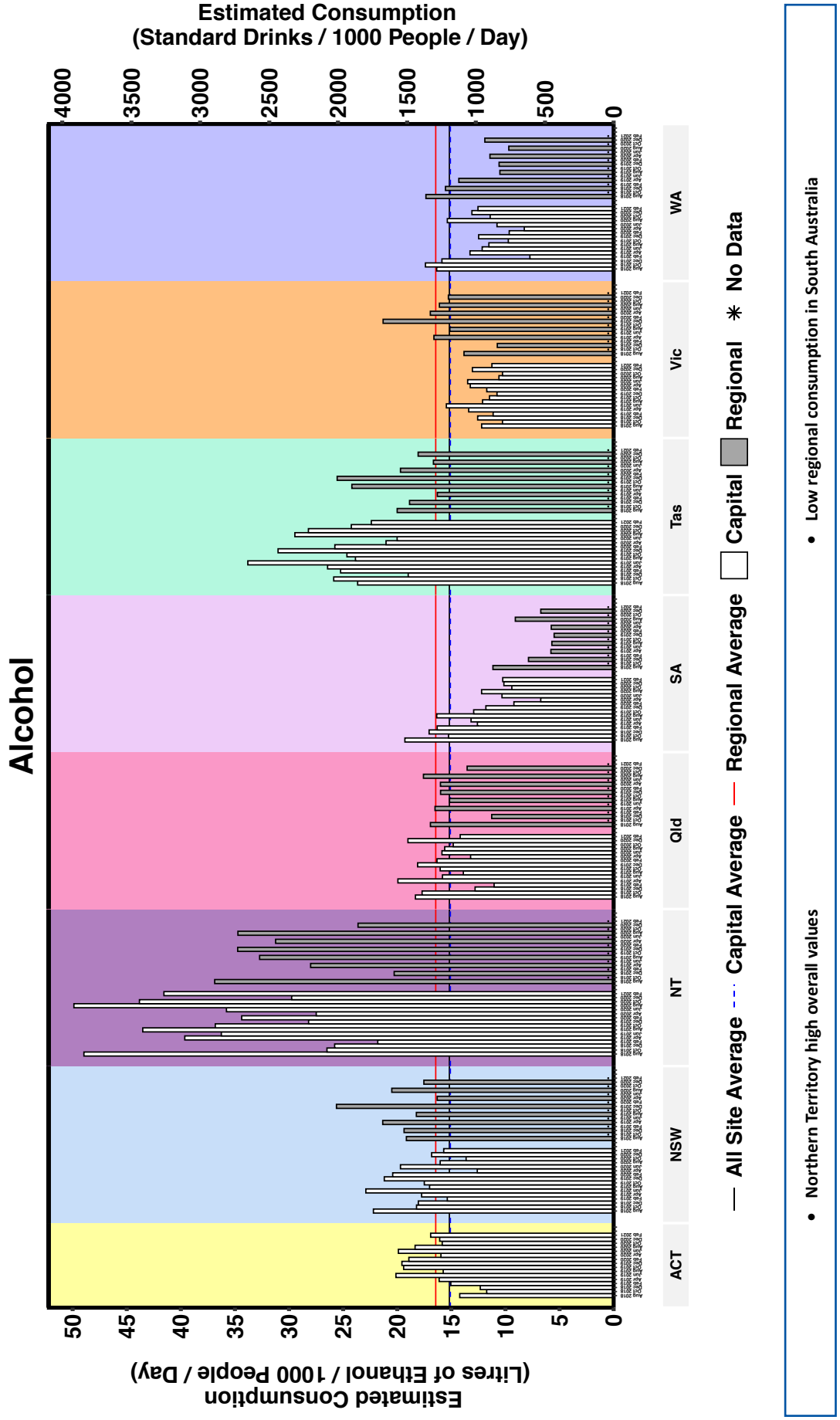


Figure 28: Estimated average consumption of alcohol by state/territory, August 2018 to February 2021. A standard drink is 10.0 g, or 12.6 mL.

4.2.2 STIMULANTS

The longer term trends in methylamphetamine use were substantially impacted by the COVID-19 pandemic (Figure 29). Use of the drug was increasing in many jurisdictions up to the start of border closures and other measures in the first half of 2020. As Australia managed to navigate relatively successfully through the pandemic, restrictions have been eased and social activities have resumed. Over the same period, following a decline in methylamphetamine use during initial COVID-19 restrictions, a restoration of methylamphetamine use in parts of the country has begun to occur, such as in capital city New South Wales and to a lesser extent, South Australia and Western Australia. In other jurisdictions, reductions in supply or demand have caused lasting declines in the use of methylamphetamine over the COVID-19 period. Most obvious examples include the Northern Territory, Queensland, Tasmania and regional New South Wales and Victoria, while use in the Australian Capital Territory has remained down over an extended period as well. The decrease in methylamphetamine consumption was less apparent in regional areas early on in the pandemic, but the last two reporting periods have shown that these areas have been impacted too.

Sites where data are available back to before the start of the NWDMP show long-term changes in use of methylamphetamine (Figure 30). The effect of COVID-19 restrictions is clearly evident, with large declines in associated drug use in every jurisdiction. This was despite some medium and longer trends showing rising levels up to this point, particularly in sites in Queensland and Victoria. In Western Australia, the decrease in use towards the middle of 2020 was unprecedented in the context of the Program. As the nation emerged from the worst of the restrictions, methylamphetamine use started returning to pre-COVID levels.

Cocaine consumption had been steadily increasing in most capital cities and many regional parts of Australia for the few years leading up to the start of the COVID-19 pandemic (Figure 32). The April 2020 collection which followed shortly after the initial social restrictions were implemented, showed an immediate reduction in cocaine use in many centres. Tasmania and regional Queensland appear to be the only parts of the country where cocaine use has continued to rise. Everywhere else, historical increases were interrupted. As restrictions got progressively lifted in parts of the country, cocaine consumption levels started increasing again, even reaching historically high levels in the Australian Capital Territory and Victoria. In the current reporting period, consumption of the drug has declined or remained steady in most jurisdictions. New South Wales remains the state with the highest levels of use.

MDMA use across Australia has declined to some of the lowest levels since the Program commenced in 2016. Use of the drug is down in virtually every state and territory, with the current collection period showing the near-disappearance of MDMA from some regional areas (Figure 33). As COVID-19 restrictions were eased in mid-2020, use of the drug started re-emerging in parts of the country. However, current levels show the substantial impact of the pandemic on supply and/or demand. The Northern Territory and Tasmania capital cities had been two regions where MDMA use tended to be the highest in the nation. There too, current levels have declined markedly. Regional areas initially appeared to be less affected by the pandemic, but the latest consumption levels reflect the overall national decline in MDMA use.

MDA use, corrected for the proportion derived from MDMA (Khan & Nicell 2011), showed a decline after the introduction of social restrictions (Figure 34). Parts of regional Queensland have shown sporadic spikes in use, but generally the pattern across most jurisdictions is a decreasing trend. The Australian Capital Territory is one of the few areas where MDA use has been essentially steady, albeit at a low level.

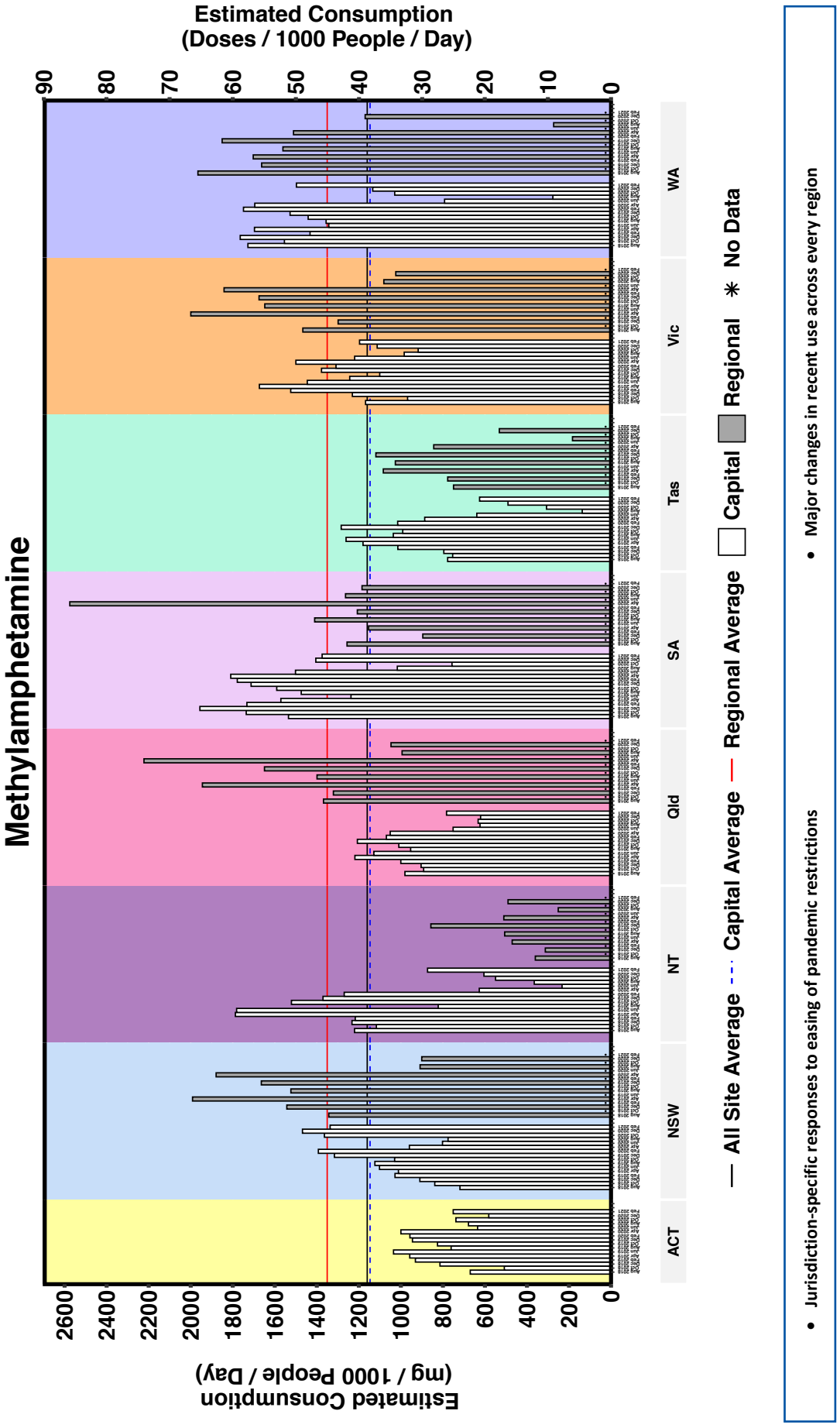


Figure 29: Estimated average consumption of methylamphetamine by state/territory, August 2018 to February 2021.

Figure 30: Change in methylamphetamine consumption for sites with historical data.

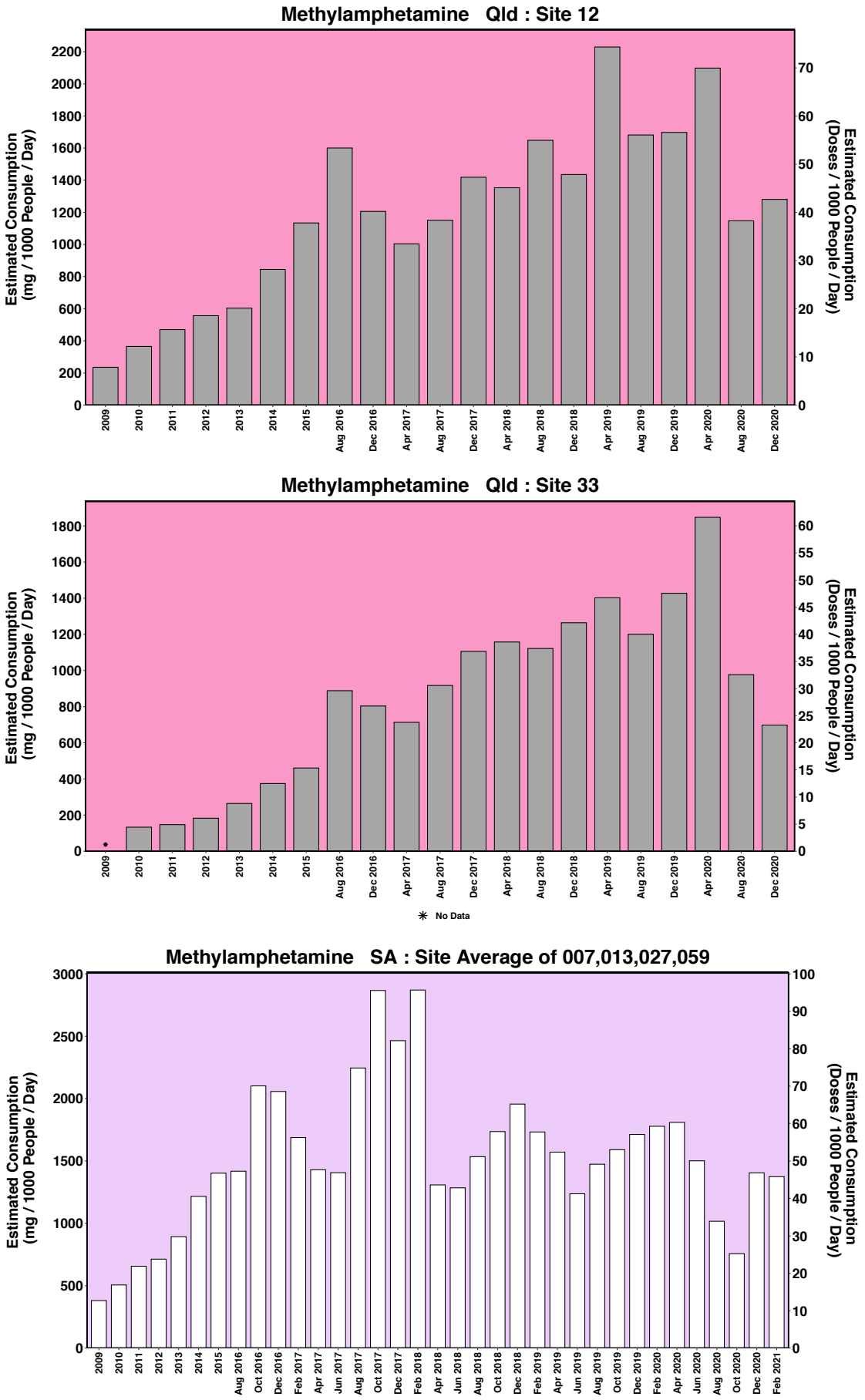
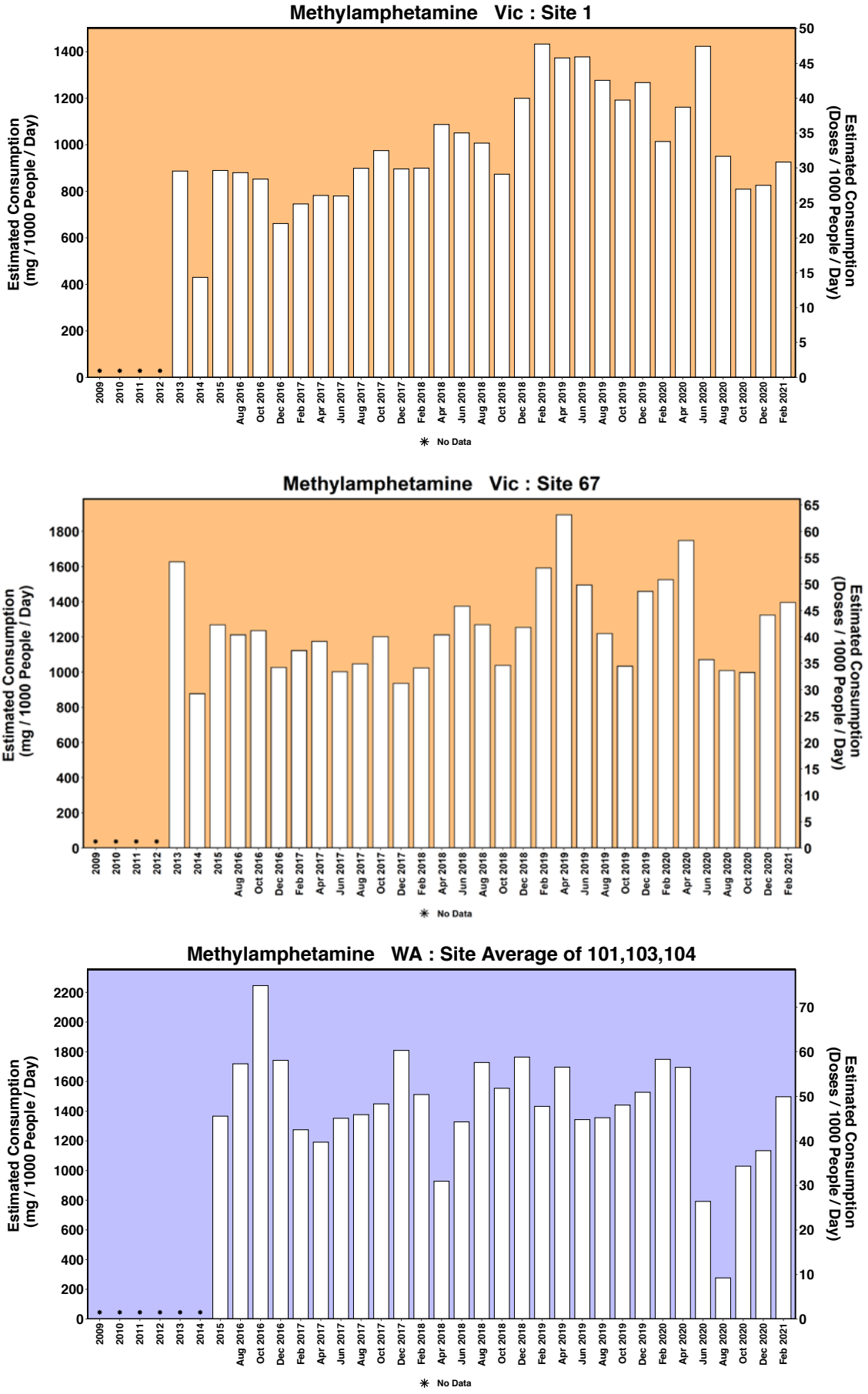


Figure 31 (continued): Change in methylamphetamine consumption for sites with historical data. Both Victorian sites were the average of one week per year in 2013, 2014 and 2015.



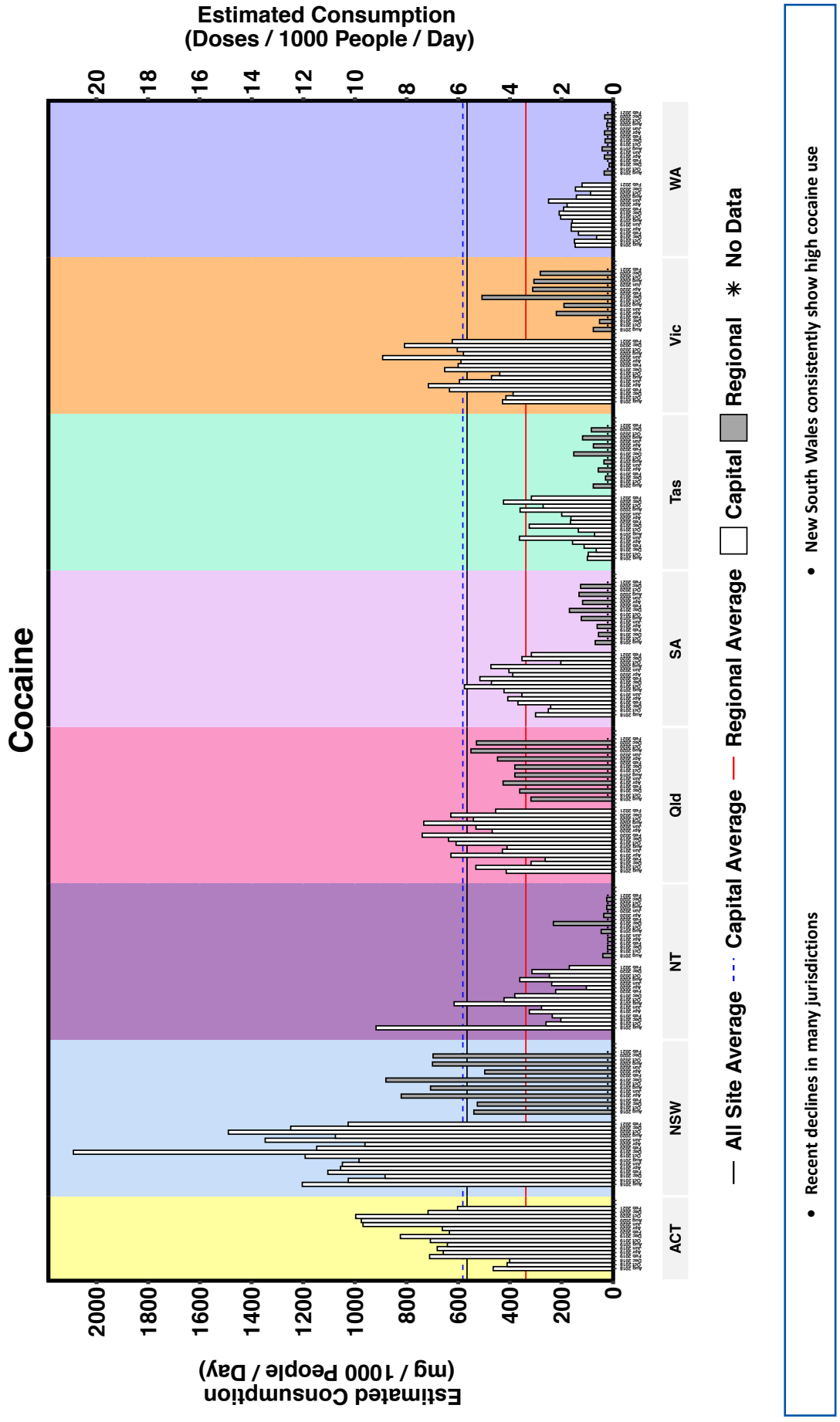


Figure 32: Estimated average consumption of cocaine by state/territory, August 2018 to February 2021.

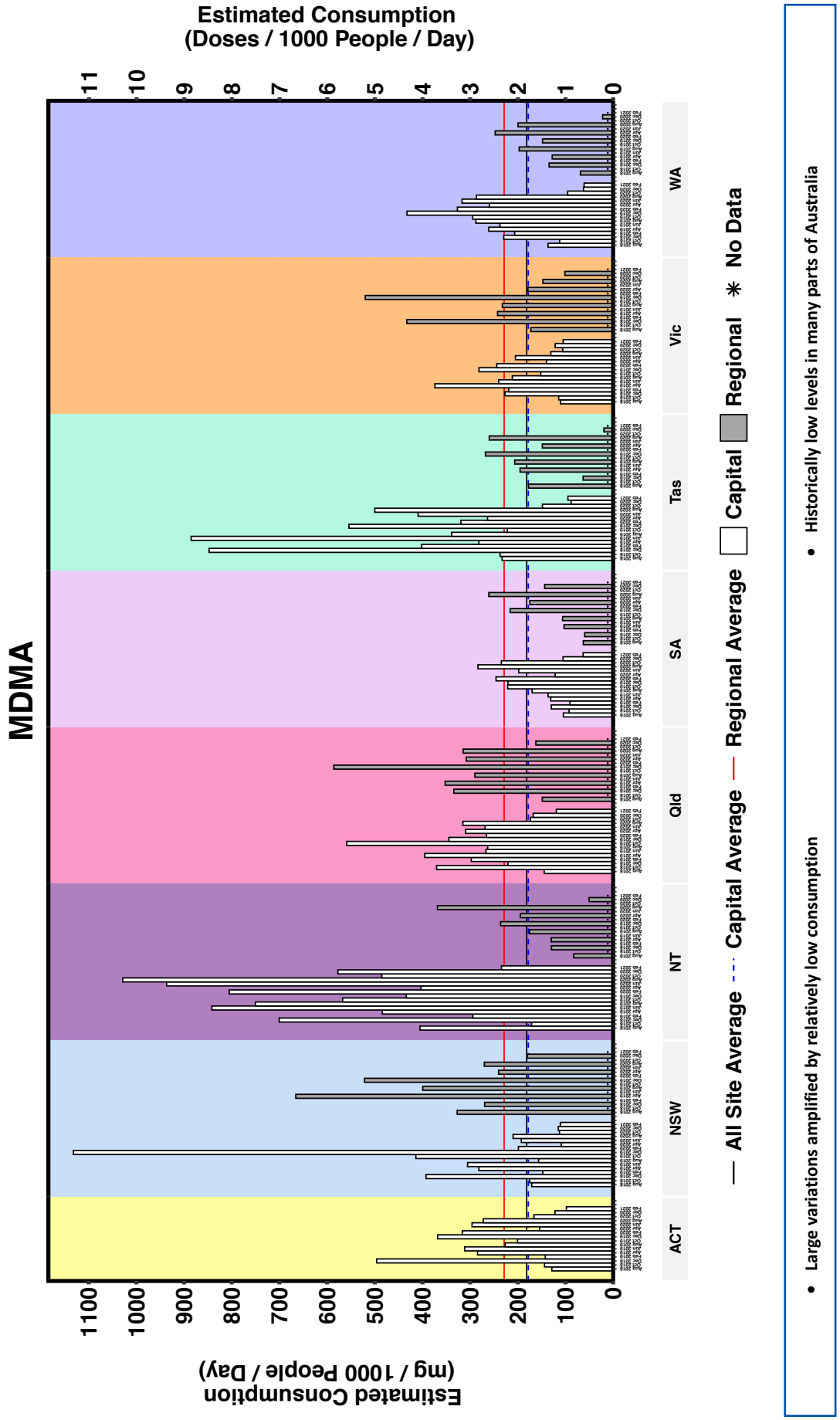


Figure 33: Estimated average consumption of MDMA by state/territory, August 2018 to February 2021.

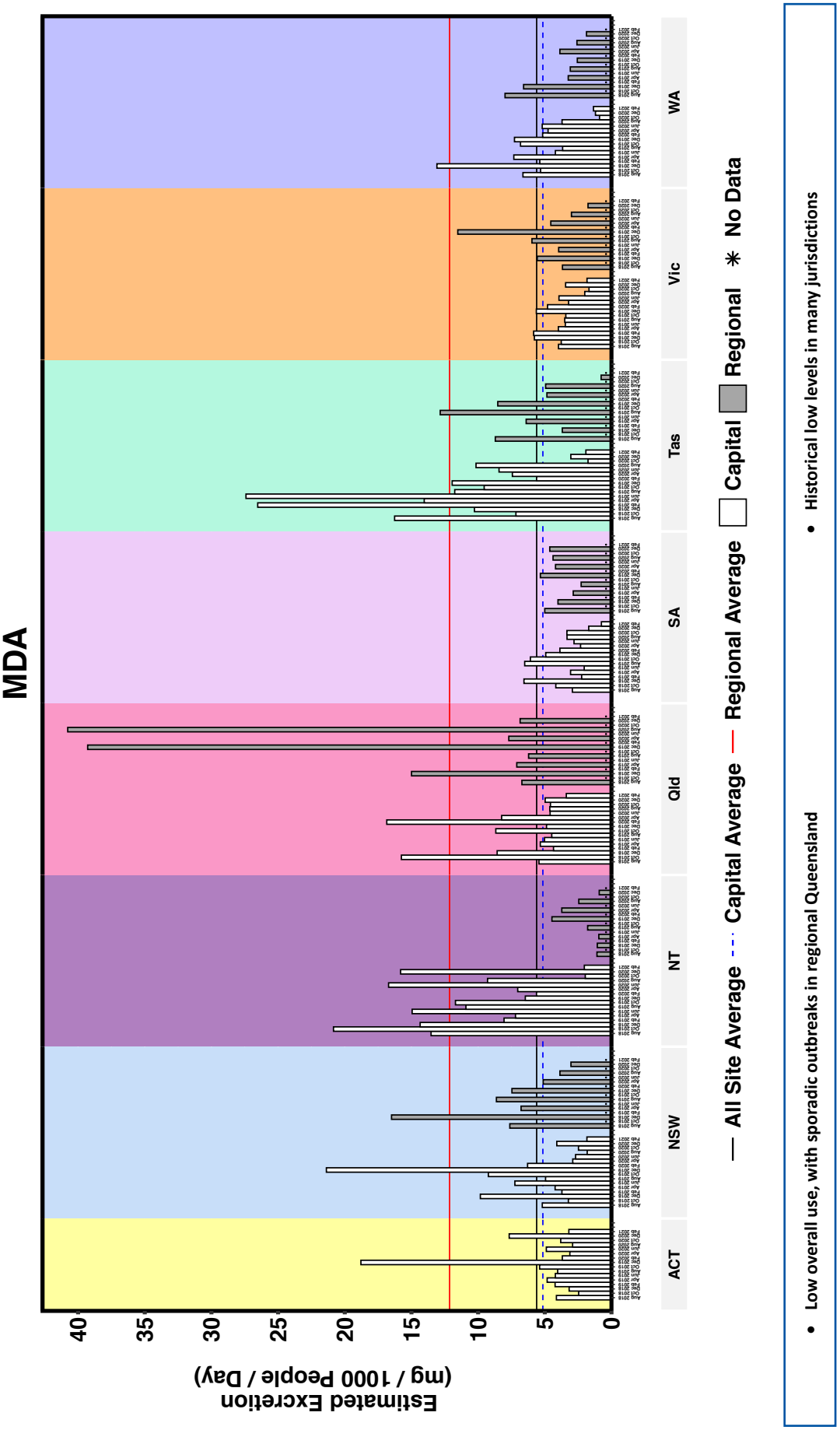


Figure 34: Estimated average excretion of MDA by state/territory, August 2018 to February 2021.

4.2.3 OPIOIDS

The levels of oxycodone consumption have been steadily declining since 2018 (Figure 35). This has been in contrast to the first two years of the Program when use steadily increased. Results from the current period showed that the downward trend levelled off over the course of 2020 in many jurisdictions. Consumption rates in the regional catchments remained very high compared to the capital cities. Tasmania and regional parts of Queensland and Victoria tend to be the highest consumers of oxycodone on a population basis, followed by the Australian Capital Territory.

The trend relating to fentanyl consumption has been downward, even though some sporadic increases have been evident in parts of the country (Figure 36). In most jurisdictions, levels have reached the lowest measured to date in the Program. This is most obvious when comparing the current reporting period with long-term averages. Capital city Victoria showed an increase in use immediately following the COVID-19 lockdown, but levels declined and then stabilised as the state subsequently went through a second round of restrictions. Results for the current collections were lower than the previous period for all sampling areas. Regional South Australians were amongst the highest consumers of fentanyl at the time of the current sampling period.

In contrast to the pharmaceutical opioids, heroin use in Australia occurs largely in the capital cities (Figure 37). Victoria has consistently been the centre of heroin use in the nation, but in the current period use in New South Wales reached the same level. Consumption of the drug appeared to peak in 2020 in many jurisdictions. Capital city sites in Victoria and the Australian Capital Territory recorded their highest levels in August 2020, although use has declined for the most part since. Tasmania, the Northern Territory and regional parts of South Australia have been amongst the lowest users. Heroin consumption has been measured in capital city South Australia since 2013 (Figure 38). A gradual, long-term decline was evident from 2013 to early 2019, followed by a rapid increase towards the end of that year. However, since the start of the pandemic in Australia, heroin use has fluctuated at a lower level in the capital city catchments.

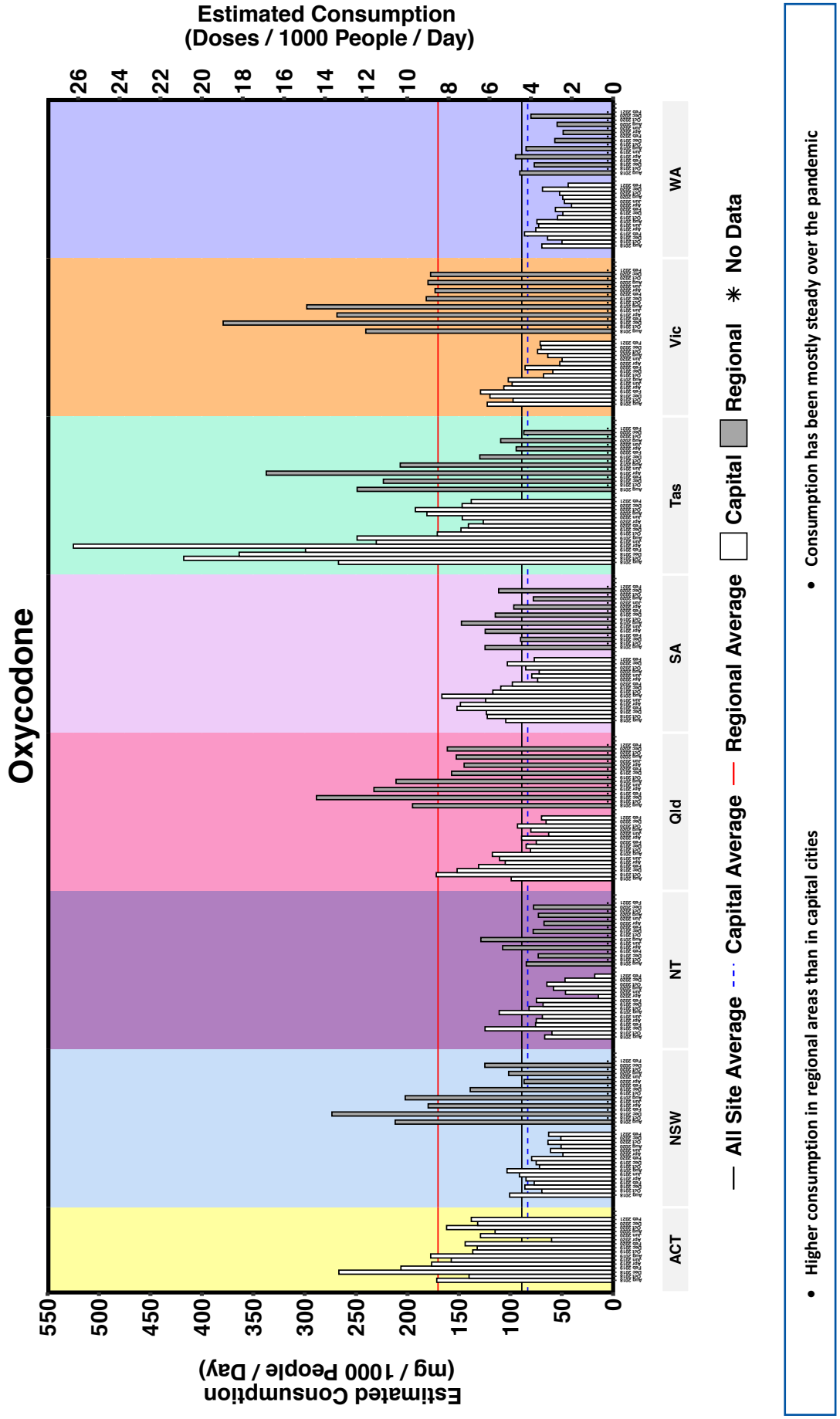


Figure 35: Estimated average consumption of oxycodone by state/territory, August 2018 to February 2021.

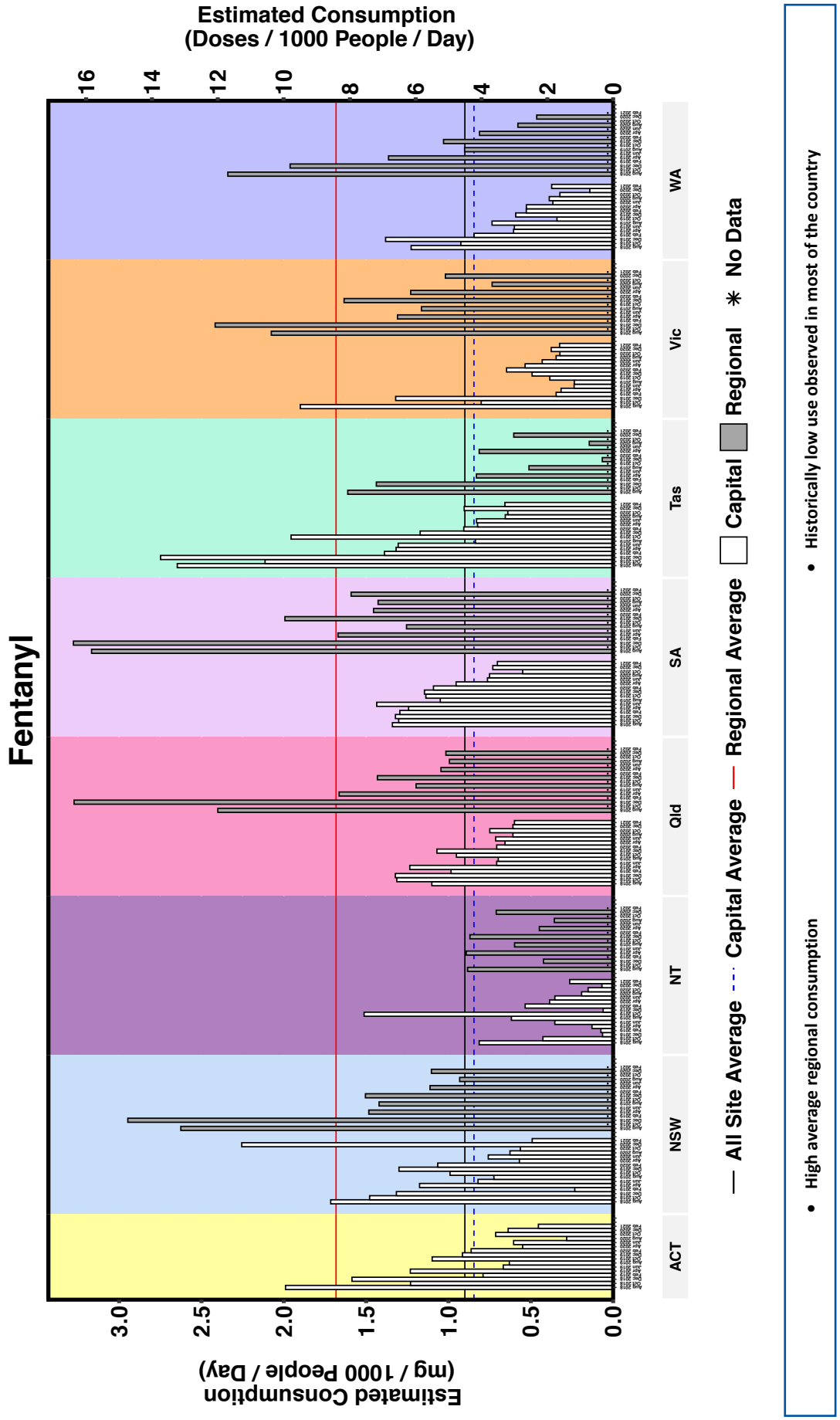


Figure 36: Estimated average consumption of fentanyl by state/territory, August 2018 to February 2021.

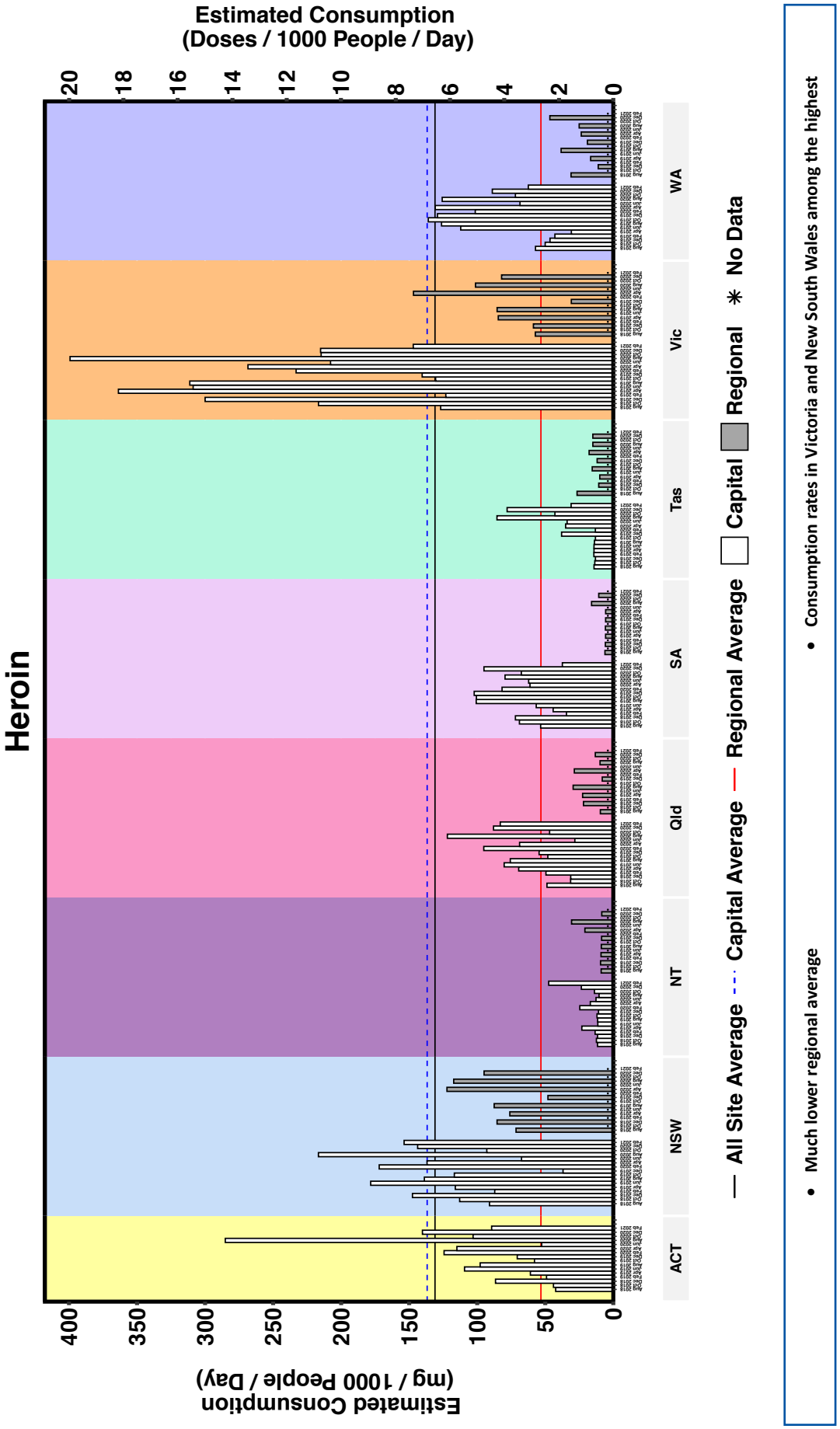
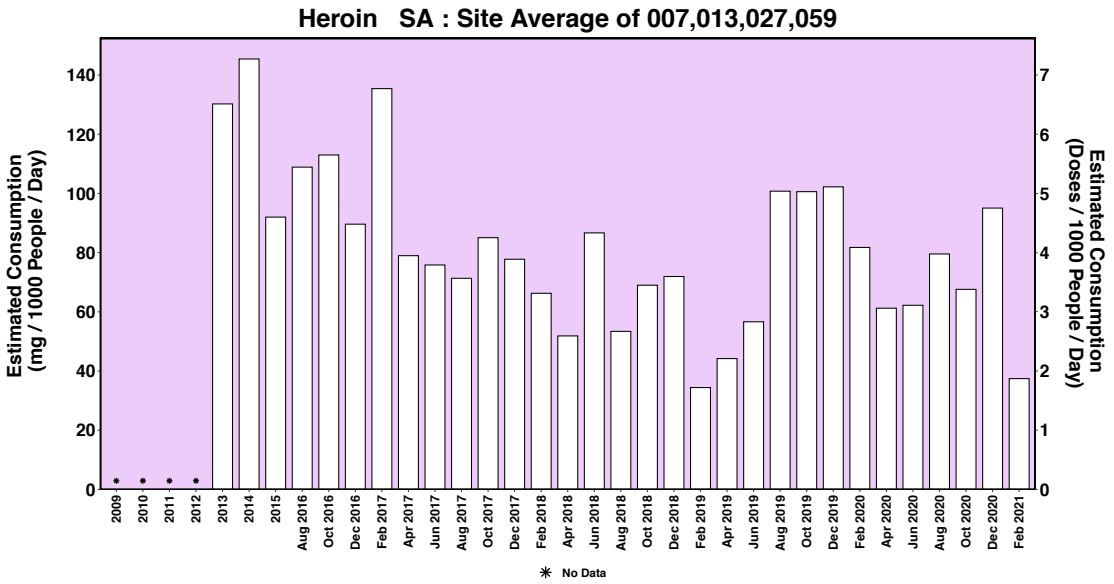


Figure 37: Estimated average consumption of heroin by state/territory, August 2018 to February 2021.

Figure 38: Change in heroin consumption for South Australia.



4.2.4 CANNABIS

Cannabis was first included in the Program in August 2018. Longer term trends are starting to emerge and show that cannabis use in the Australian Capital Territory and regional parts of the New South Wales, the Northern Territory and Queensland have been steadily increasing (Figure 39). Elsewhere, consumption has been largely stable, with some short-term fluctuations. When COVID-19 related restrictions came into effect in April 2020, cannabis consumption in most capital cities increased compared to February 2020. Consumption appeared to peak by the second half of 2020 across regional parts of the country as well, with many jurisdictions reaching historically high levels. Regional consumption has been substantially higher than capital city levels, with the highest consumption spread over several states and territories, in particular the Northern Territory, Tasmania and regional South Australia. Use in sites covering the larger population centres of New South Wales, Victoria and Queensland was much lower. Consumption in these capital cities was less than half that in the regional areas within the respective jurisdictions.

Consumption of cannabis has previously been measured in capital city South Australia since 2011. An upward trend emerged up to early 2019, followed by a short term decline up to February 2020 (Figure 40). After COVID restrictions, cannabis use in the capital of the state increased toward the middle of the year, but then declined towards the current reporting period.

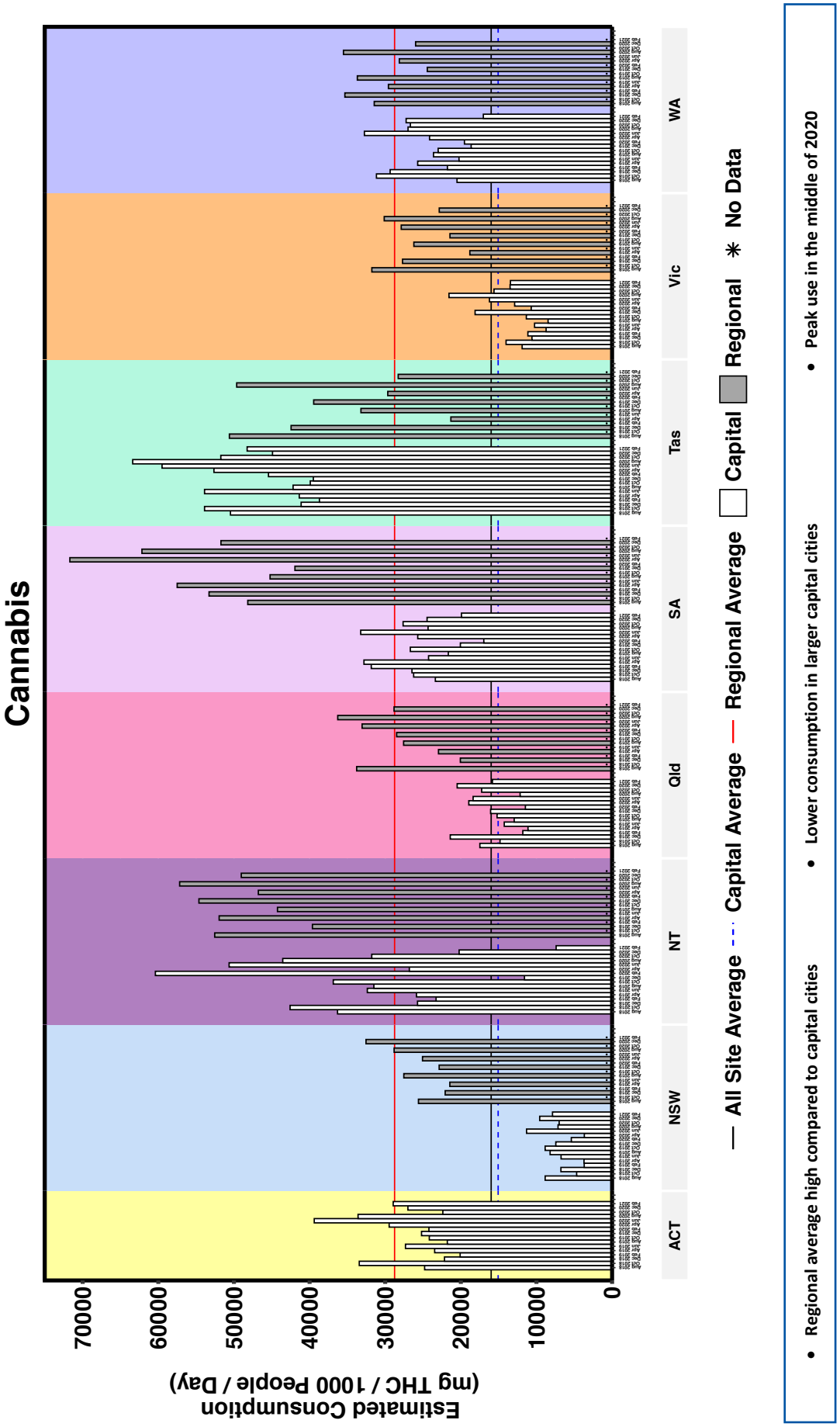
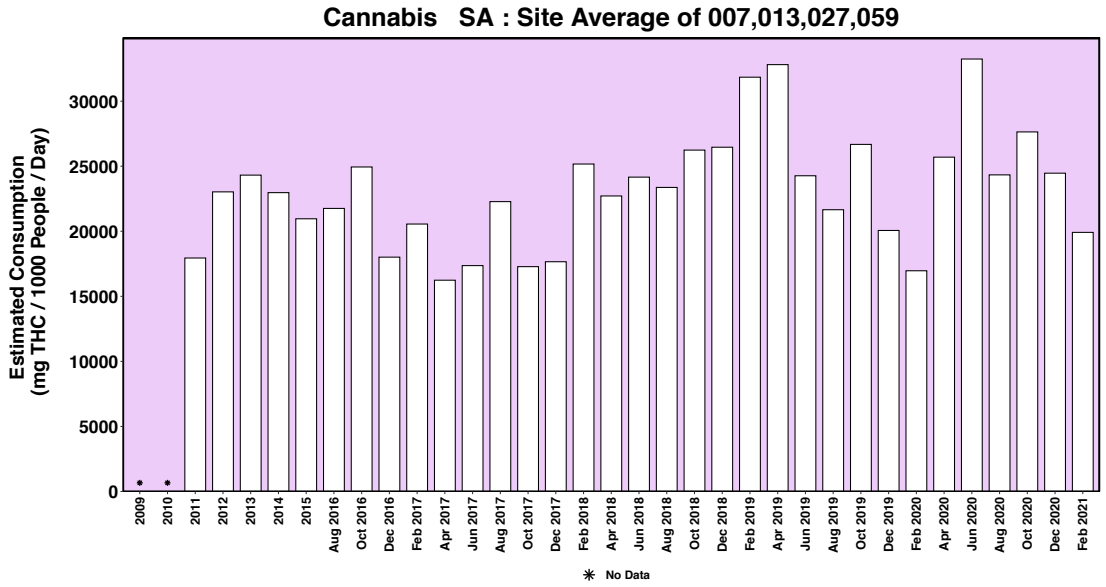


Figure 39: Estimated average consumption of cannabis by state/territory, August 2018 to February 2021.

Figure 40: Change in cannabis consumption in capital city South Australia. Cannabis is detected via the THC metabolite, THC-COOH.



4.2.5 KETAMINE

Ketamine has only been included in the Program since December 2020. Therefore, only two collections have been conducted in capital cities and one in regional Australia. The early findings suggest that use in the capital cities exceeds that in regional areas, with Victoria being the state with the highest overall use (Figure 41).

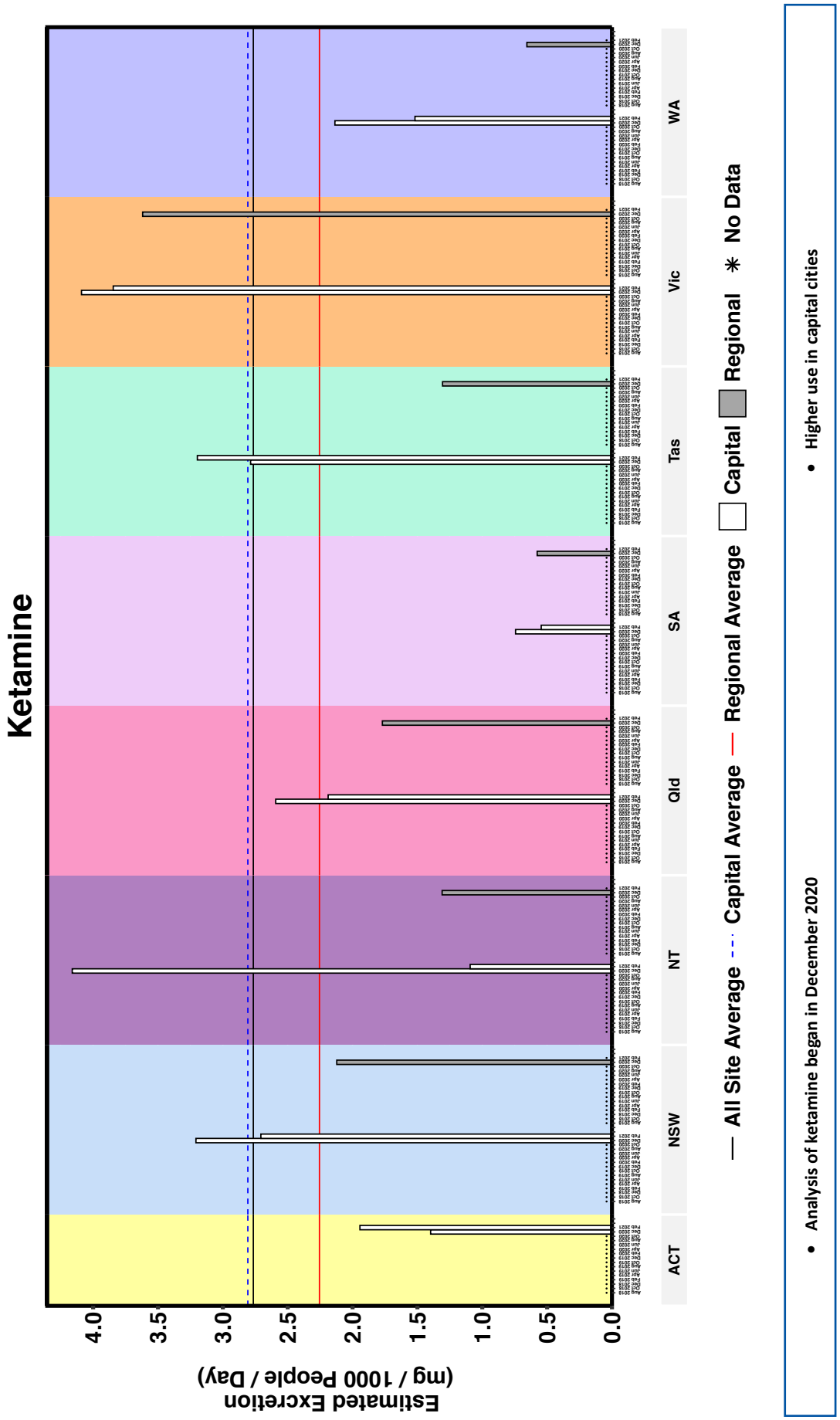


Figure 41: Estimated average excretion of ketamine by state/territory, August 2018 to February 2021.

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. Due to the limited detections of the two compounds in samples, these have been discontinued from the main NWDMP reports. Both substances were included in NWDMP Reports 1 to 12, which are available on the ACIC website.

4.3 NATIONAL CAPITAL CITY AND REGIONAL AVERAGES

In order to show the national trends in the use of individual substances, all capital city and regional sites were each combined and displayed as separate graphs for the total sampling period (Figure 42 to Figure 52). Fewer sites were sampled in October 2016. Therefore, the contributing population was smaller between these dates and some approximations were necessary to account for the absence of densely populated regions (e.g. October 2016 for capital city New South Wales and Queensland).

In terms of legal substances with abuse potential, alcohol and nicotine consumption remained relatively unchanged from the start of the Program, with only small fluctuations evident (Figures 42 and 43). In contrast, the use of pharmaceutical opioids included in the Program have been more varied. Capital city use of nicotine has been consistently lower than in regional Australia and also more variable. The COVID-19 period in 2020 was associated with a rise in nicotine consumption in capital city catchments. As restrictions eased throughout the year, consumption started declining once again. Results from this reporting period show a marginal decline in capital city and regional nicotine consumption. In the case of alcohol, the April 2020 ban on social events and general restrictions caused a decline in averages in both regional and capital city areas. Levels recovered after April but have declined again in the regional areas and have been variable in the capital cities more recently.

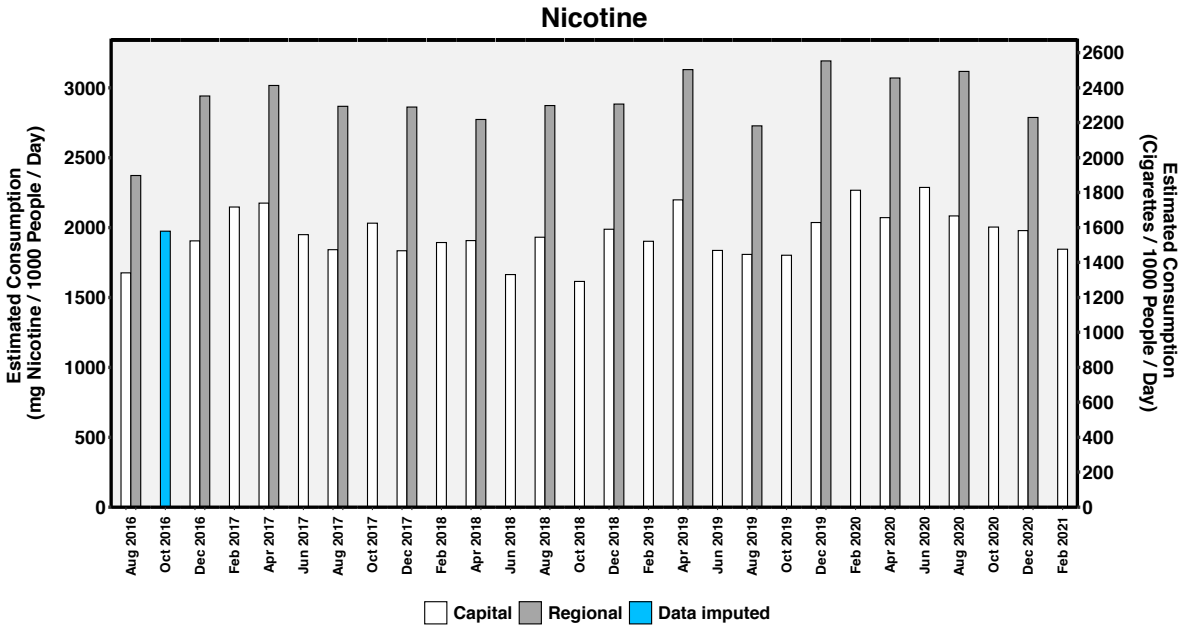
Overall methylamphetamine consumption rates in regional Australia increased more than in the capital cities from early 2017 to late 2019 (Figure 44). With the onset of the pandemic and various restrictions coming into effect throughout the year, use of methylamphetamine dropped substantially over the course of 2020. In the current reporting period of December 2020 (all sites), levels in regional Australia have remained low, while in capital cities, use has started increasing to the latest collection in February 2021. It was interesting to note that capital city use of methylamphetamine exceeded that in regional Australia for the first time since April 2017. MDMA consumption rates declined overall over the first year of the Program, followed by a gradual increase towards the end of 2019 (Figure 45). The rates of change were more pronounced in regional areas, with a larger decline early on (August 2016 to April 2017), followed by a more substantial increase than in the cities. Levels of MDMA reached their peaks in both demographical areas in late 2019. The April 2020 lockdowns had an immediate effect on the use of the substance. Consumption levels across the country declined to those last observed in 2017–18.

Long-term trends relating to cocaine and MDA consumption clearly showed the discrepancy between capital city and regional use of these illicit substances (Figures 46 and 47). Overall cocaine consumption in the capital cities has been trending upwards over the lifespan of the Program, reaching a peak in mid-2020. At a regional level, short-term fluctuations early on changed to a rising trend towards the end of 2019. COVID-19 appears to have interrupted the increased regional consumption, although the effect is less dramatic than methylamphetamine. MDA appeared stable across city sites for much of the monitoring period, declining over the course of 2020. The regional overall rates of MDA use were variable, mainly driven by sites in Queensland.

A distinct difference between capital cities and regional Australia was observed for the two pharmaceutical opioids monitored in the Program (Figures 48 and 49). Capital city populations consumed both drugs at substantially lower levels compared to regional areas, although the gap in fentanyl consumption closed over the course of 2020. Oxycodone consumption increased steadily after early 2017 and reached a peak in December 2018, declining since then. This has been more apparent in the case of regional centres. Fentanyl use showed a peak in consumption from late 2017 to early 2019, stabilising for a period at relatively low rates, before declining again over the course of 2020. Currently fentanyl use is at the lowest levels since the Program commenced in 2016.

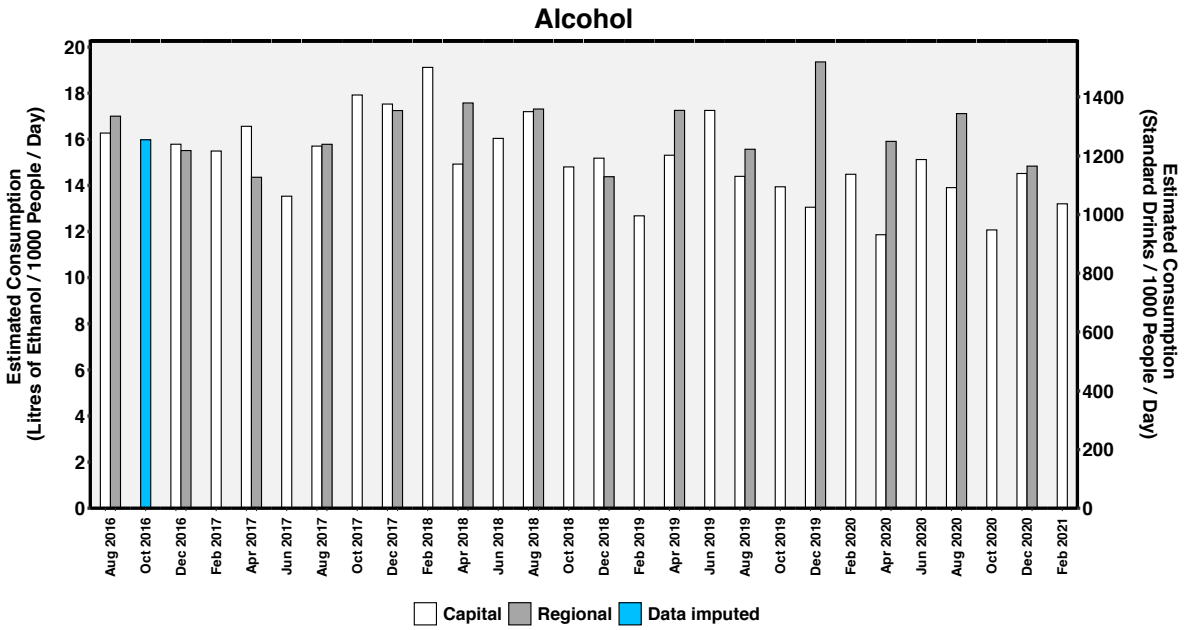
The remaining substances, heroin, ketamine and cannabis, had mixed patterns in the national context (Figures 50, 51 and 52, respectively). Heroin reached its highest recorded levels in capital cities during the pandemic, dropping back after August 2020. Consumption of the drug in regional areas is at a relatively low rate and patterns are more erratic. Ketamine was included for the first time in this reporting period. Early signs are that use of the pharmaceutical compound, which is also listed as an NPS by the UNODC, tends to be higher in the capital cities, although this is based on one collection week in regional Australia and will be clarified with subsequent sampling campaigns. Cannabis showed relatively steady consumption rates across capital cities, with a rising trend towards the end of 2019 and again after the introduction of COVID-19 lockdowns (Figure 52). Cannabis use reached its highest levels in regional Australia in mid-2020.

Figure 42: The population-weighted average of all sites for nicotine.



Regional areas are only sampled every second collection period. 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.

Figure 43: The population-weighted average of all sites for alcohol.



Regional areas are only sampled every second collection period. 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.

Figure 44: The population-weighted average of all sites for methylamphetamine.

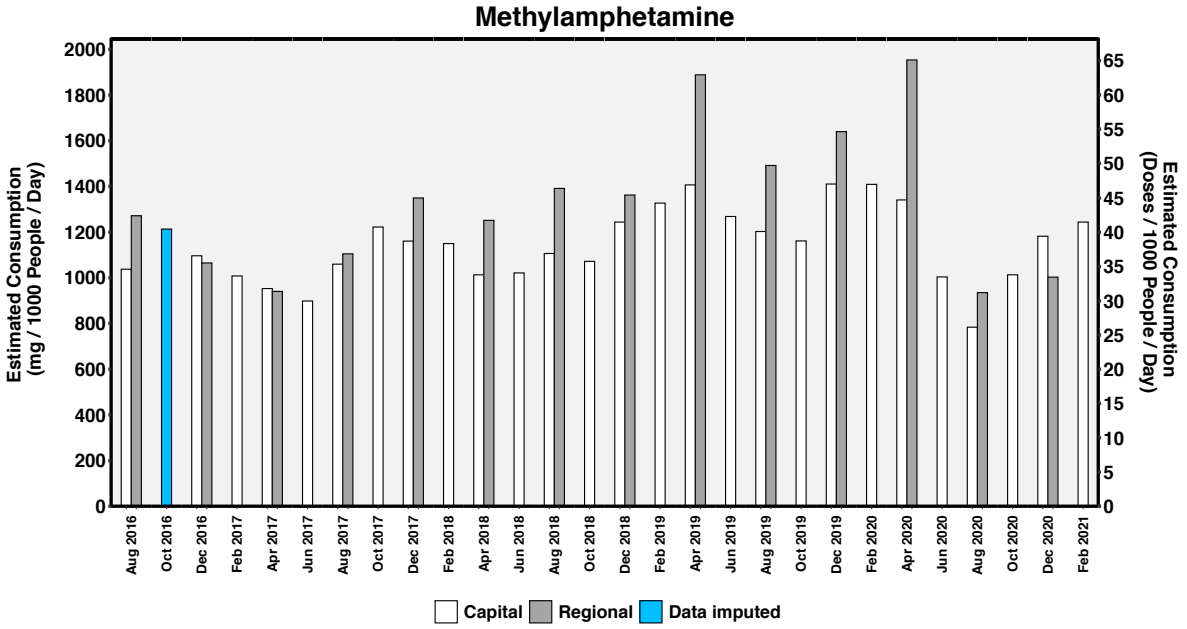
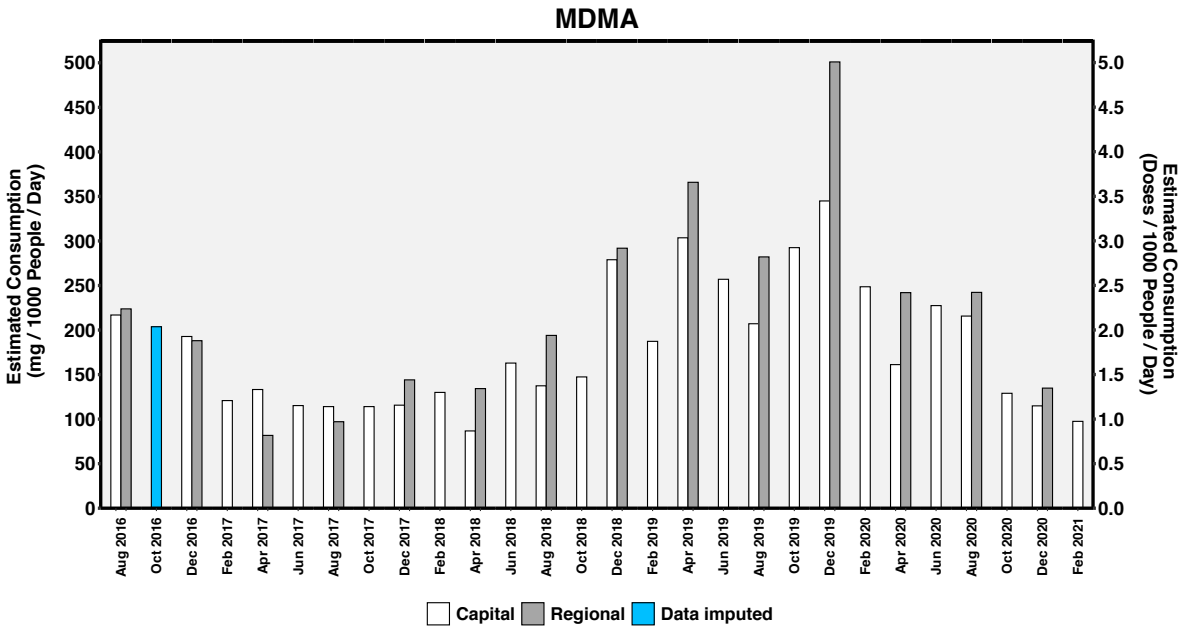


Figure 45: The population-weighted average of all sites for MDMA.



Regional areas are only sampled every second collection period. 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.

Figure 46: The population-weighted average of all sites for cocaine.

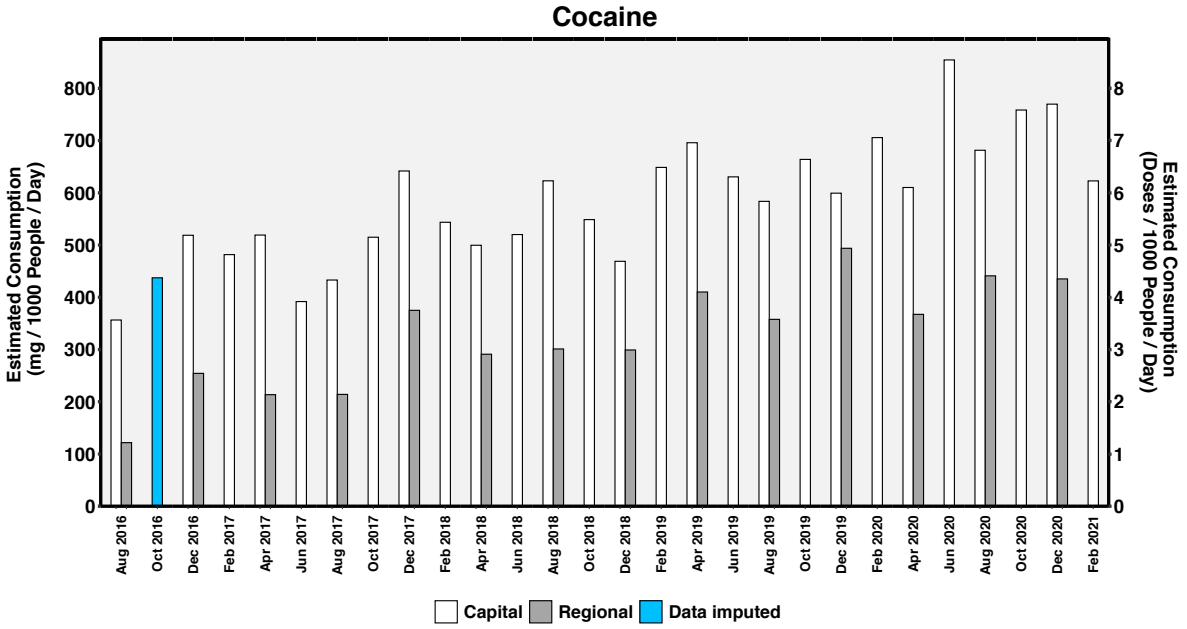
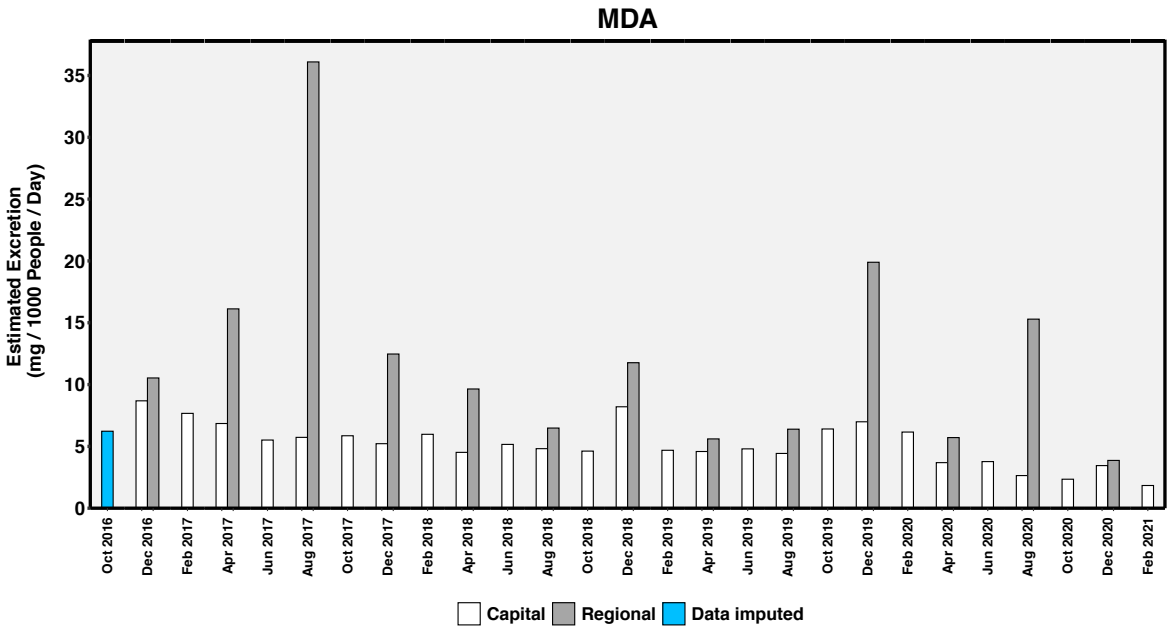


Figure 47: The population-weighted average of all sites for MDA.



Regional areas are only sampled every second collection period. 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.

Figure 48: The population-weighted average of all sites for oxycodone.

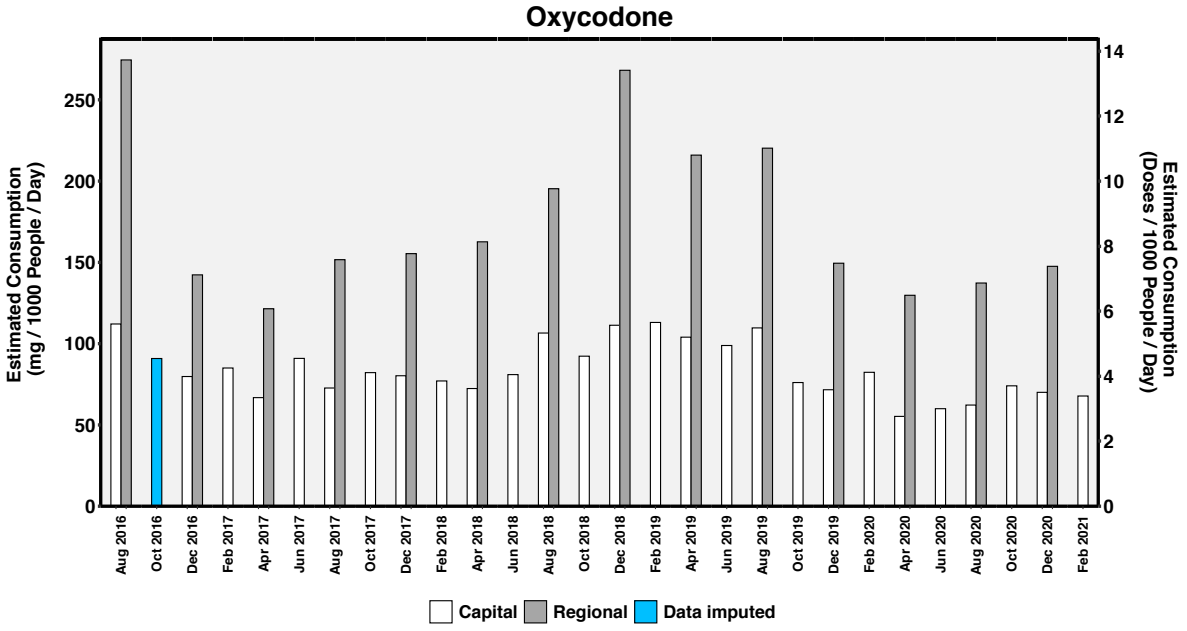
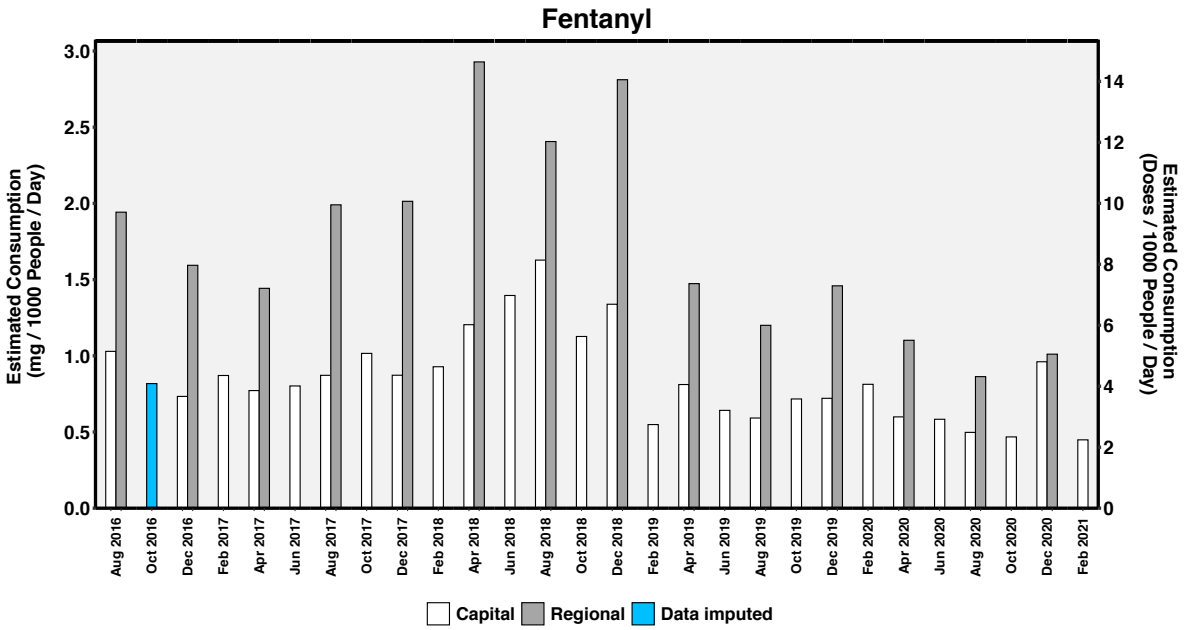


Figure 49: The population-weighted average of all sites for fentanyl.



Regional areas are only sampled every second collection period. 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.

Figure 50: The population-weighted average of all sites for heroin.

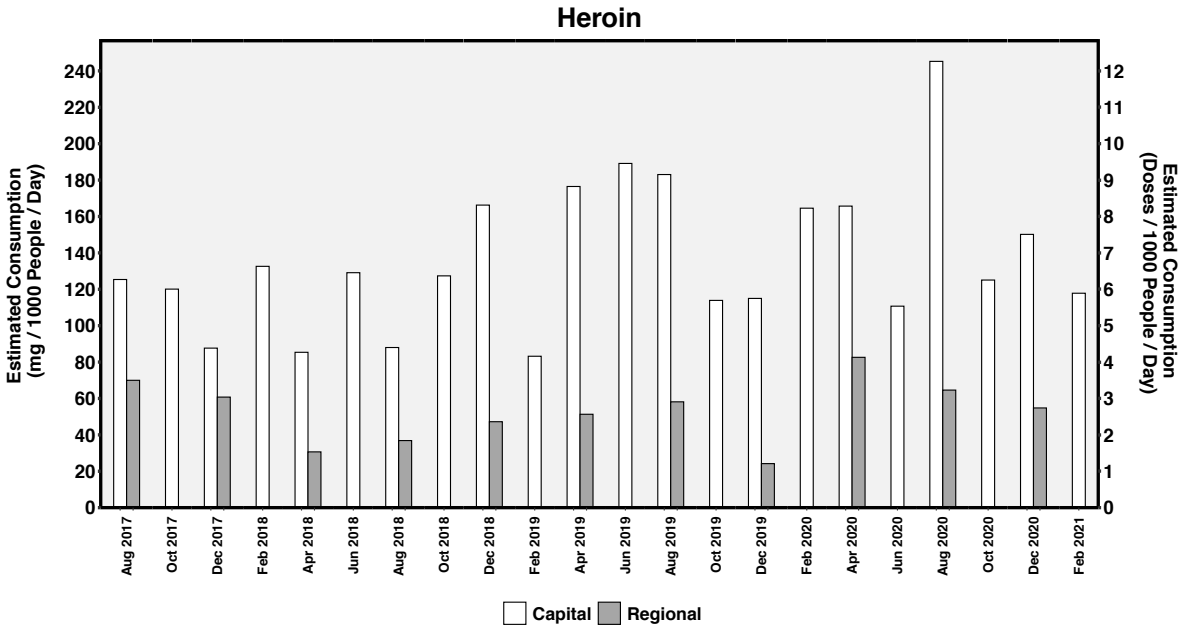
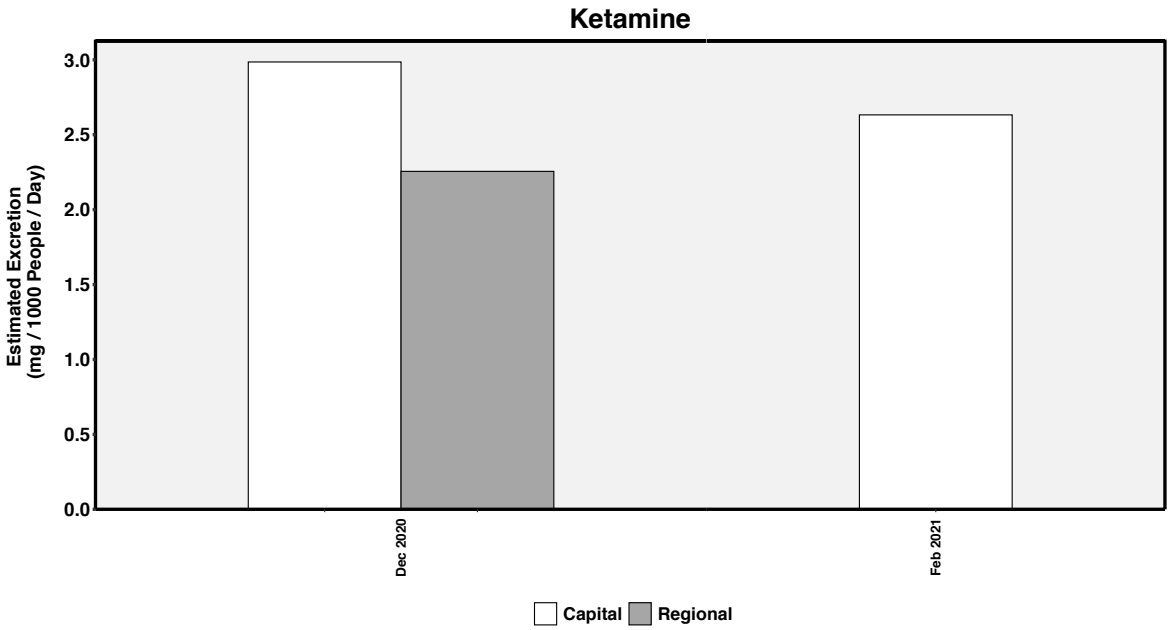
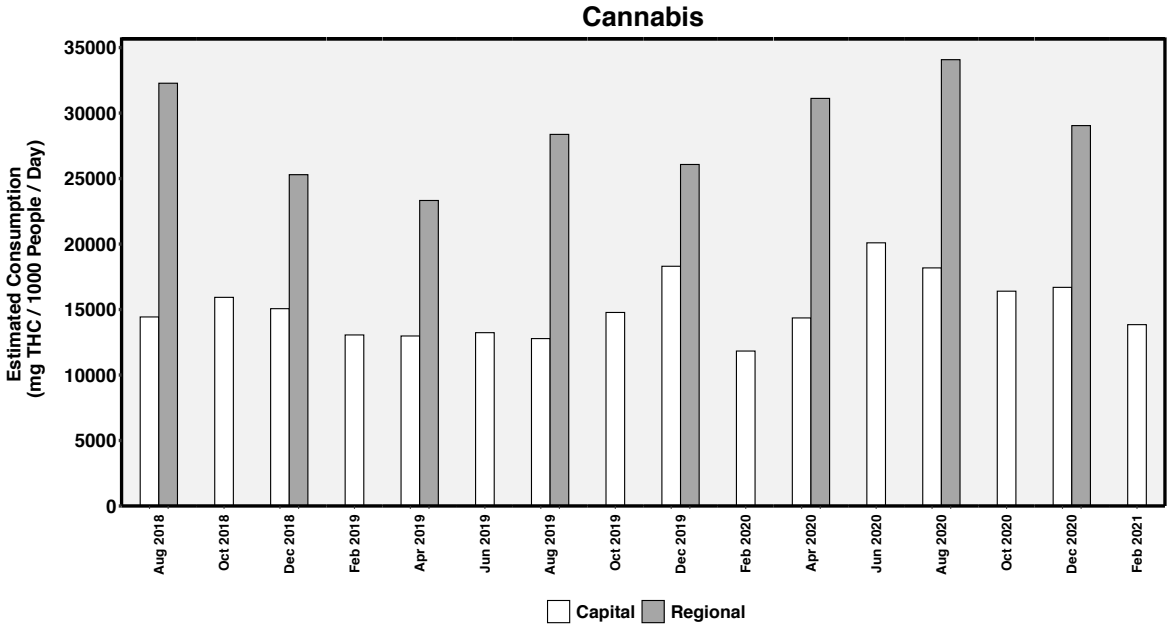


Figure 51: The population-weighted average of all sites for ketamine.



Regional areas are only sampled every second collection period.

Figure 52: The population-weighted average of all sites for cannabis.



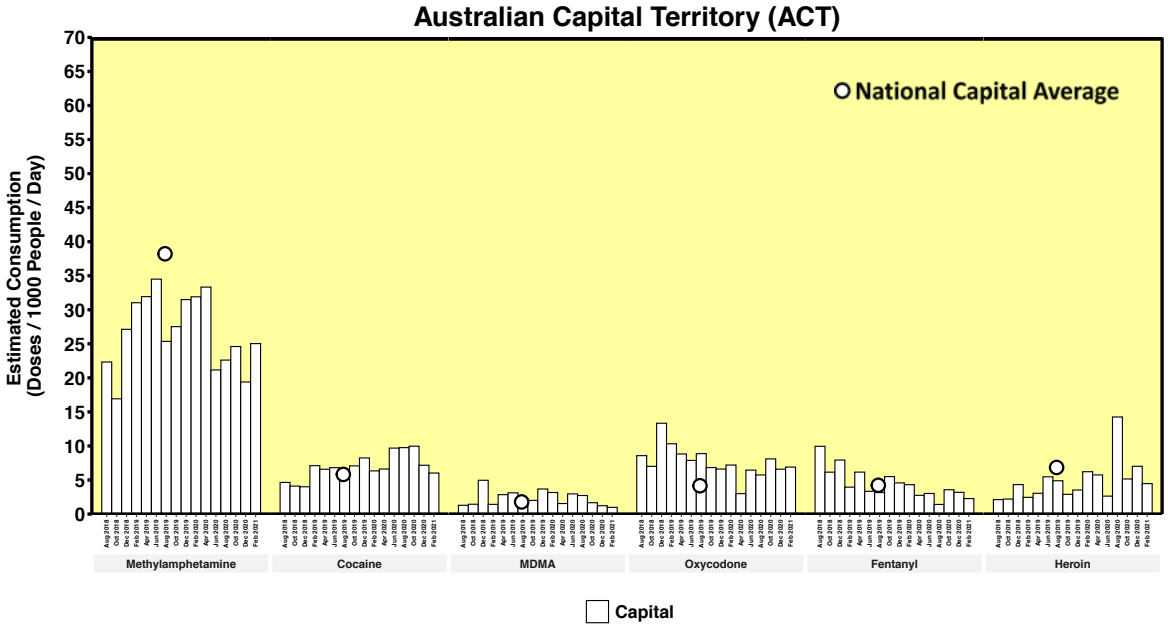
4.4 DRUG PROFILE FOR EACH STATE AND TERRITORY

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

When the amount of drug measured in wastewater was normalised for population size and average dose consumed (conversion factors listed in Report 1, and in Appendix 1), alcohol and nicotine remained consistently the highest consumed drugs in all states and territories. For example, the national average consumption of nicotine and alcohol per 1,000 people per day was approximately 1,650 cigarettes (Figure 5) and 1,150 standard drinks (Figure 6), whereas for methylamphetamine, the national average consumption was around 40 doses per 1,000 people per day (Figure 9).

Aside from nicotine and alcohol, of the illicit stimulants with dose information available, methylamphetamine use remained highest of the drugs included in the report (Figures 53 to 56). 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. Even with the dramatic reduction in methylamphetamine use in some states due to the pandemic, e.g. Western Australia where use declined to historical lows, the drug was still present at higher levels than any other illicit substance included in the graphs (Figure 56). In terms of the profiles of other drugs monitored by the NWDMP (cocaine, MDMA, oxycodone and fentanyl), the patterns were less consistent. The proportional increase in cocaine in the Australian Capital Territory up to the latter part of 2020 was conspicuous, but levels have declined in the current reporting period. In most states, a decline in pharmaceutical opioid use is apparent, especially in regional areas. Victoria was the state most affected by a second wave of COVID-19 infections and associated lockdowns. However, for the most part, recent patterns in illicit drug use appeared to be consistent with other states (Figure 56). Overall, 2020 had a large impact on the drug landscape in Australia, with massive reductions in methylamphetamine use to levels not seen before during the span of the NWDMP. The pandemic resulted in short term changes in alcohol use at a national level, while use of drugs such as MDMA and cocaine varied more on a state and territory level.

Figure 53: Profile of average drug consumption by state or territory, August 2018 to February 2021 for capital city sites and to December 2020 for regional sites. Consumption is shown as the number of doses per 1,000 people per day to allow comparison of drugs of different types within the same region (state or territory). The circles represent the cumulative national average of all time points for respective drugs.



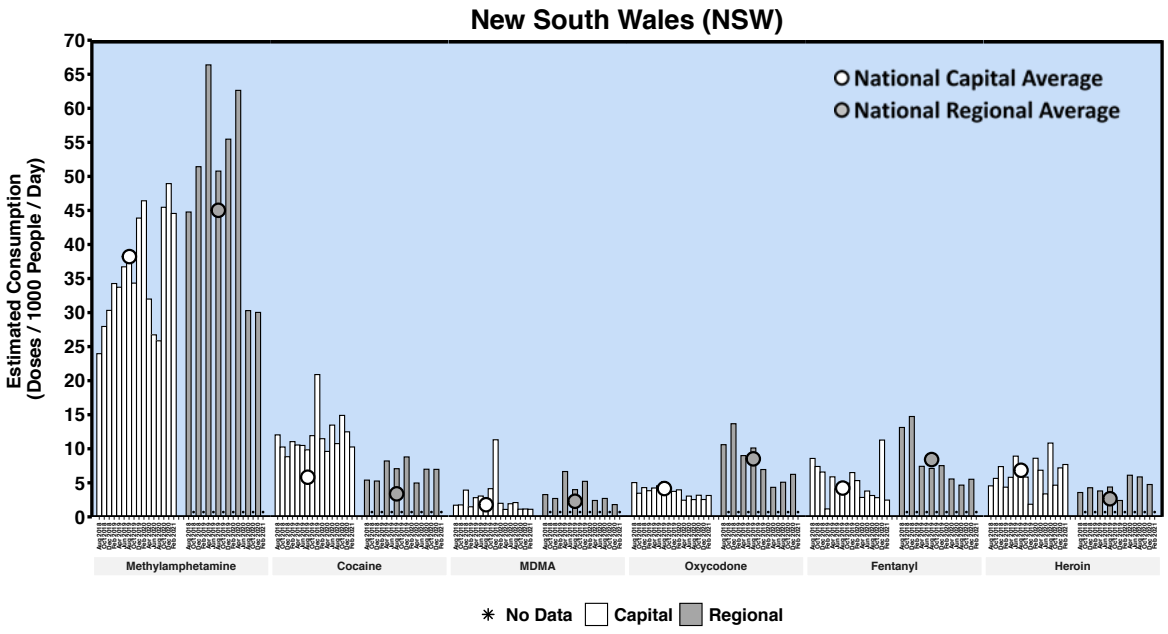
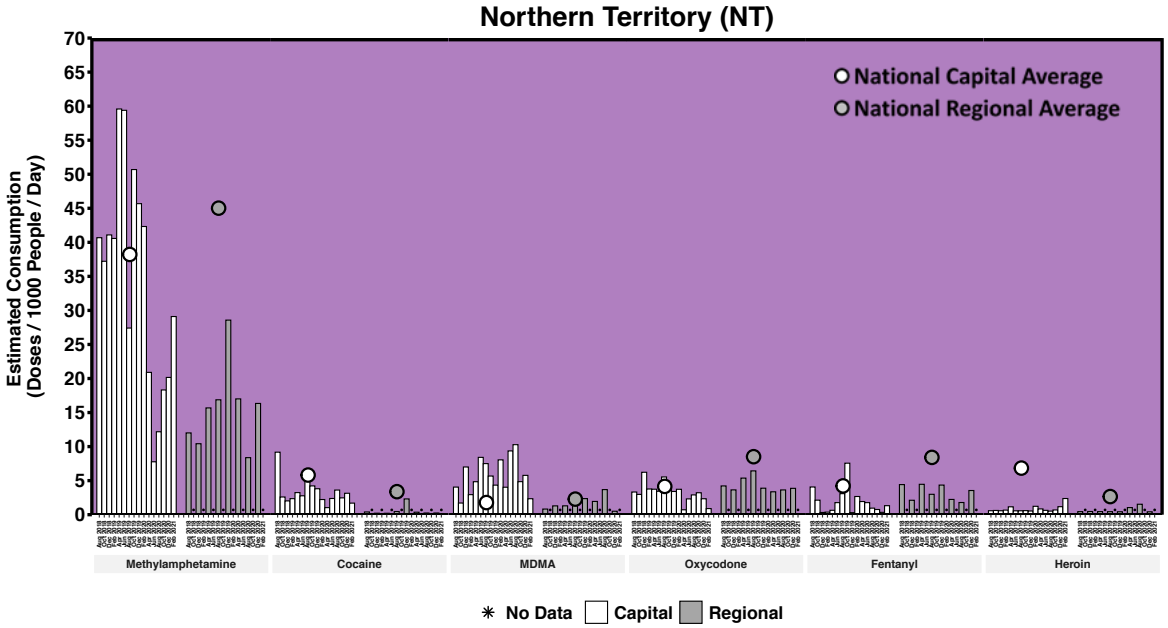


Figure 54: Profile of average drug consumption by state or territory, August 2018 to February 2021 for capital city sites and to December 2020 for regional sites.



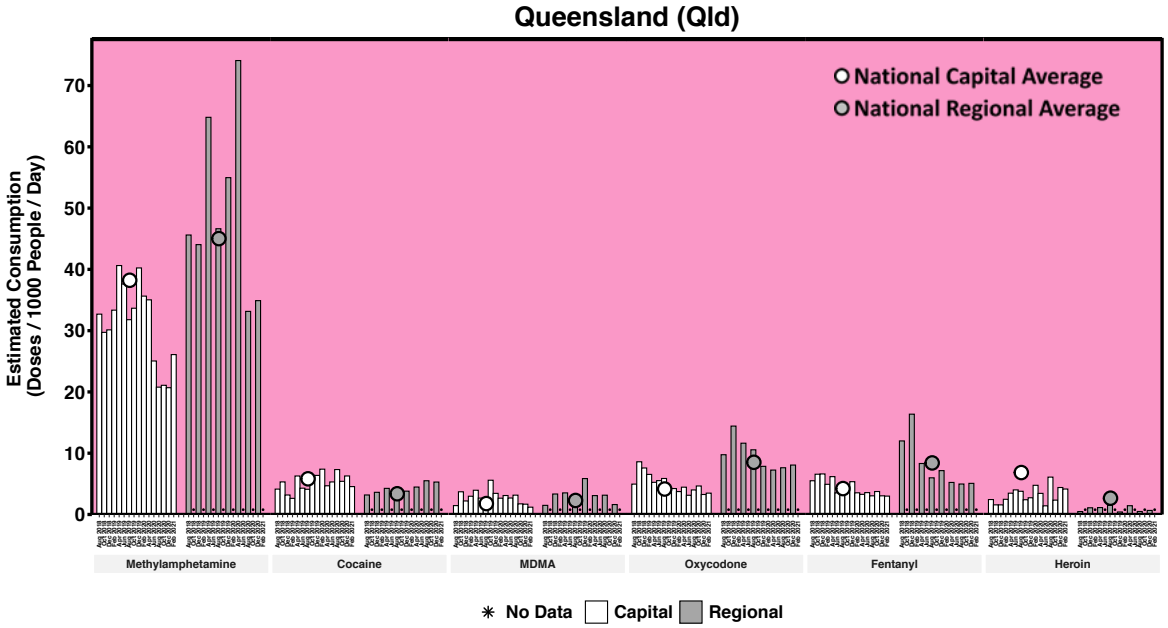
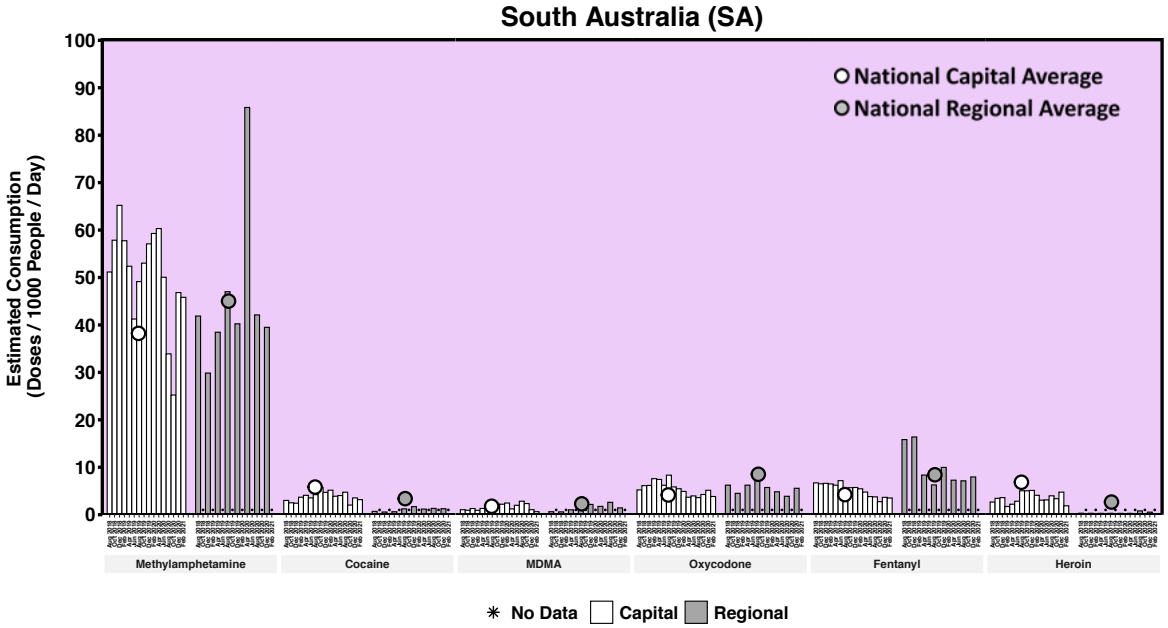


Figure 55: Profile of average drug consumption by state or territory, August 2018 to February 2021 for capital city sites and to December 2020 for regional sites. Note: the y axes for South Australia is higher than the other jurisdictions.



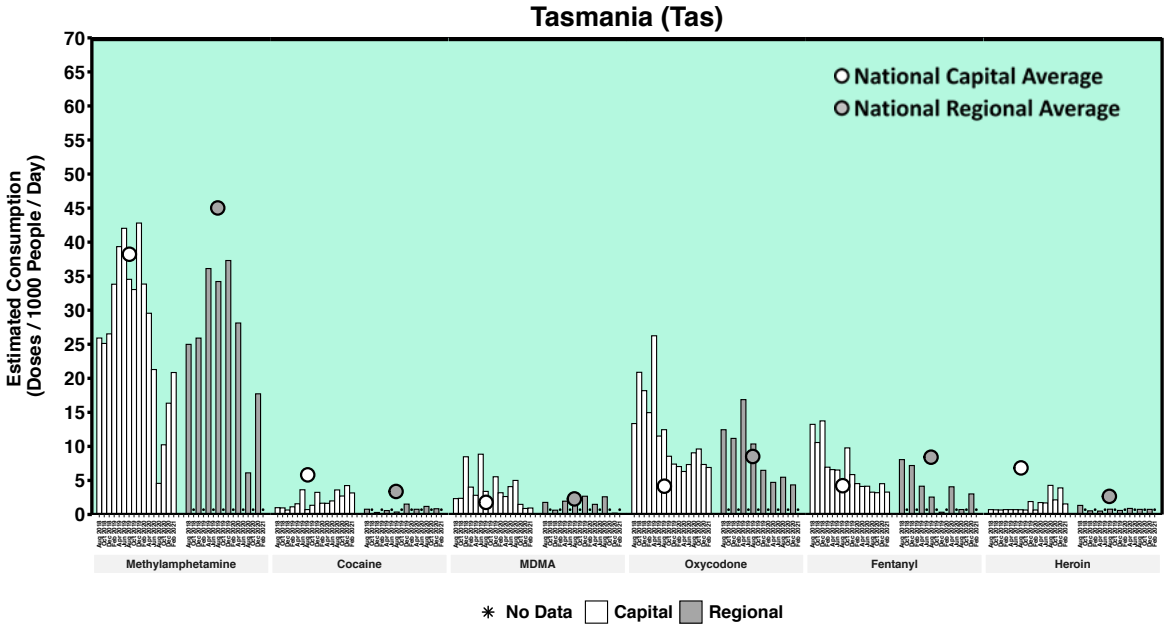
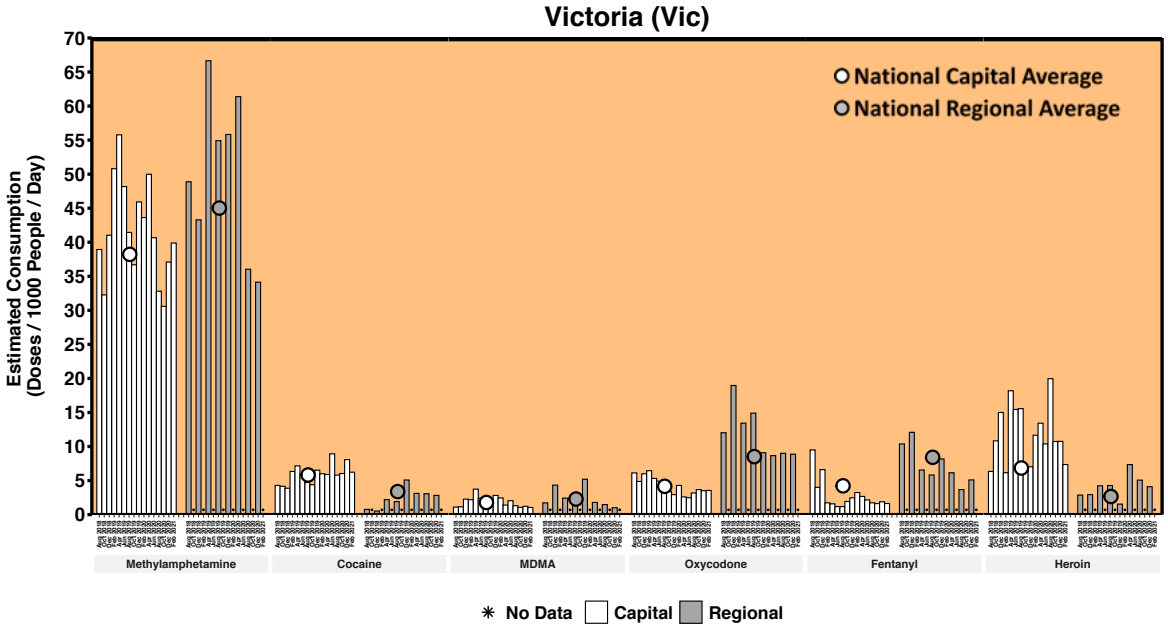
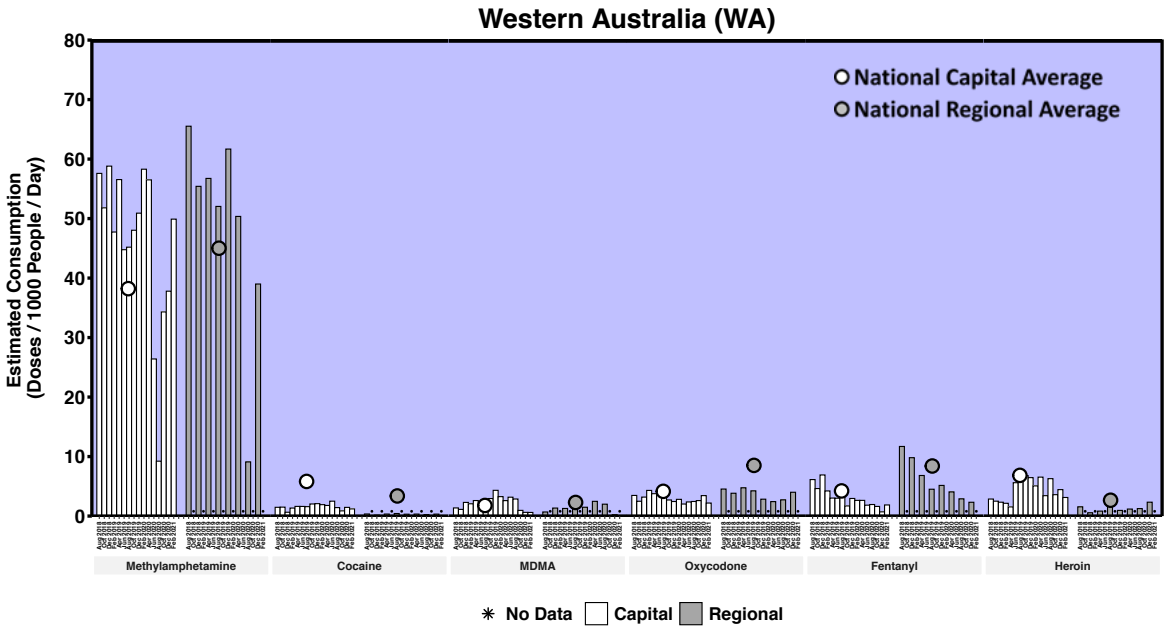


Figure 56: Profile of average drug consumption by state or territory, August 2018 to February 2021 for capital city sites and to December 2020 for regional sites. Note: the y axes for Western Australia is higher than the other jurisdictions.





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

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

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7: APPENDICES

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

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

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

^Ketamine is excreted as norketamine and several conjugated metabolites. As the level of conjugation is not well known and conjugated metabolites (e.g. glucuronides) are likely to deconjugate in the sewer, a ketamine excretion rate has not been assigned at this time. Once the impact of in-sewer deconjugation is known, this will be revised.

APPENDIX 2: SAMPLING DETAILS OF EACH SITE FOR DECEMBER 2020 AND FEBRUARY 2021[6]

Sites	Capital or Regional	Dec 2020	Feb 2021	Population category
ACT: 009	Capital	7	7	> 150,000
NSW: 003	Capital	7	7	> 150,000
NSW: 006	Capital	6	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	6	–	< 30,000
NSW: 115	Regional	7	–	30,000 to 150,000
NSW: 163	Regional	7	–	< 30,000
NSW: 164	Regional	7	–	< 30,000
NSW: 165	Regional	7	–	< 30,000
NT: 010	Capital	7	7	30,000 to 150,000
NT: 078	Regional	7	–	< 30,000
Qld: 002	Capital	7	7	> 150,000
Qld: 005	Capital	7	7	> 150,000
Qld: 011	Capital	7	7	> 150,000
Qld: 012	Regional	7	–	> 150,000
Qld: 020	Regional	–	–	< 30,000
Qld: 024	Regional	7	–	30,000 to 150,000
Qld: 028	Regional	7	–	30,000 to 150,000
Qld: 029	Regional	7	–	30,000 to 150,000
Qld: 033	Regional	7	–	30,000 to 150,000
Qld: 039	Regional	–	–	< 30,000
Qld: 042	Regional	7	–	30,000 to 150,000
Qld: 053	Regional	7	–	< 30,000
Qld: 077	Regional	7	–	< 30,000
Qld: 092	Regional	–	–	< 30,000
SA: 007	Capital	7	7	> 150,000
SA: 013	Capital	7	7	> 150,000
SA: 027	Capital	7	7	30,000 to 150,000
SA: 059	Capital	7	7	> 150,000
SA: 017	Regional	7	–	< 30,000
SA: 022	Regional	7	–	< 30,000
SA: 063	Regional	7	–	< 30,000
SA: 076	Regional	7	–	< 30,000
SA: 119	Regional	7	–	< 30,000

6 Sampling details of each wastewater treatment plant for the previous collection periods are available in Report 7, 8, 9, 10, 11, 12, Appendix 2 and Report 6, Appendix 3.

APPENDIX 2 (CONTINUED)

Sites	Capital or Regional	Dec 2020	Feb 2021	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	7	–	> 150,000
Vic: 046	Regional	–	–	30,000 to 150,000
Vic: 061	Regional	7	–	30,000 to 150,000
Vic: 062	Regional	–	–	< 30,000
Vic: 066	Regional	7	–	30,000 to 150,000
Vic: 114	Regional	7	–	30,000 to 150,000
Vic: 121	Regional	7	–	< 30,000
Vic: 122	Regional	7	–	< 30,000
Vic: 123	Regional	–	–	< 30,000
Vic: 124	Regional	–	–	< 30,000
Vic: 125	Regional	7	–	30,000 to 150,000
Vic: 155	Regional	7	–	30,000 to 150,000
Vic: 156	Regional	7	–	< 30,000
WA: 101	Capital	7	7	> 150,000
WA: 103	Capital	7	7	> 150,000
WA: 104	Capital	7	7	> 150,000
WA: 102	Regional	7	–	30,000 to 150,000
WA: 116	Regional	7	–	< 30,000
WA: 118	Regional	–	–	< 30,000
WA: 120	Regional	7	–	30,000 to 150,000
WA: 129	Regional	7	–	< 30,000
Regional Sites		37	–	
Capital Sites		20	20	
Total Sites		**57**	**20**	
Regional Samples		254	–	
Capital Samples		133	134	
Total Samples		387	134	
Cumulative Samples		**6,319**	**6,453**	

APPENDIX 3: PROPORTION OF SAMPLES ABOVE LOD (%) FOR EACH DRUG AND PERIOD ASSESSED[7]

Drug	Capital or Regional	Dec 2020	Feb 2021
Alcohol	Capital	100	100
Alcohol	Regional	100	–
Cannabis	Capital	100	100
Cannabis	Regional	100	–
Cocaine	Capital	100	96
Cocaine	Regional	81	–
Fentanyl	Capital	79	90
Fentanyl	Regional	97	–
Heroin	Capital	92	85
Heroin	Regional	44	–
Ketamine	Capital	95	87
Ketamine	Regional	88	–
MDA	Capital	98	89
MDA	Regional	88	–
MDMA	Capital	100	100
MDMA	Regional	100	–
Methylamphetamine	Capital	100	100
Methylamphetamine	Regional	100	–
Nicotine	Capital	100	100
Nicotine	Regional	100	–
Oxycodone	Capital	100	100
Oxycodone	Regional	100	–

7 Percentage detection for previous collection periods are available in Report 7, 8, 9, 10, 11, 12, Appendix 3 and Report 6, Appendix 4.

CONCLUSIONS

CONCLUSIONS

Consistent with previous reports, findings show that of the substances monitored with known doses, nicotine and alcohol are the most consumed drugs in Australia, while methylamphetamine remains the most consumed illicit drug.[8]

METHYLAMPHETAMINE

When comparing data for August and December 2020, the population-weighted average consumption of methylamphetamine increased in both capital city and regional sites, with capital city methylamphetamine consumption further increasing in February 2021. In December 2020, capital city methylamphetamine consumption exceeded regional consumption for the first time since April 2017. In December 2020, New South Wales had the highest estimated average capital city consumption of methylamphetamine, while South Australia had the highest estimated average regional consumption.

COCAINE

When comparing data for August and December 2020, the population-weighted average consumption of cocaine increased in capital city sites and decreased in regional sites, with capital city cocaine consumption decreasing from December 2020 to February 2021. Average capital city cocaine consumption continues to exceed average regional consumption. In December 2020, New South Wales had the highest estimated average capital city and regional consumption of cocaine.

3,4-METHYLENEDIOXYMETHYLAMPHETAMINE (MDMA)

When comparing data for August and December 2020, the population-weighted average consumption of MDMA decreased in both capital city and regional sites, with capital city MDMA consumption further decreasing in February 2021. Average regional MDMA consumption continues to exceed average capital city consumption. In December 2020, the Northern Territory[9] had the highest estimated average capital city consumption of MDMA, while New South Wales had the highest estimated average regional consumption.

3,4-METHYLENEDIOXYAMPHETAMINE (MDA)

MDA is a metabolite of MDMA. When comparing data for August and December 2020, MDA excretion increased in capital city sites and decreased in regional sites. Capital city MDA excretion decreased from December 2020 to February 2021. Average regional MDA excretion continues to exceed average capital city excretion. In December 2020, the Northern Territory had the highest estimated average capital city excretion of MDA, while Queensland had the highest estimated average regional excretion.

HEROIN

When comparing data for August and December 2020, the population-weighted average consumption of heroin decreased in both capital city sites and regional sites, with capital city heroin consumption further decreasing in February 2021. Average capital city heroin consumption continues to exceed average regional consumption. In December 2020, Victoria had the highest estimated average capital city consumption of heroin, while New South Wales had the highest estimated average regional consumption.

CANNABIS

When comparing data for August and December 2020, the population-weighted average consumption of cannabis decreased in both capital city and regional sites, with capital city cannabis consumption further decreasing in February 2021. Average regional cannabis consumption continues to exceed average capital city consumption. In December 2020, Tasmania had the highest estimated average capital city consumption of cannabis, while South Australia had the highest estimated average regional consumption.

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

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

KETAMINE

The Program began measuring ketamine excretion in December 2020, when the population-weighted average excretion of ketamine was higher in capital city sites than in regional sites. Capital city ketamine excretion decreased from December 2020 to February 2021. In December 2020, the Northern Territory had the highest estimated average capital city excretion of ketamine, while Victoria had the highest estimated average regional excretion.

OXYCODONE

When comparing data for August and December 2020, the population-weighted average consumption of oxycodone increased in both capital city and regional sites. Capital city oxycodone consumption decreased from December 2020 to February 2021. Average regional oxycodone consumption continues to exceed average capital city consumption. In December 2020, Tasmania had the highest estimated average capital city consumption of oxycodone, while Victoria had the highest estimated average regional consumption.

FENTANYL

When comparing data for August and December 2020, the population-weighted average consumption of fentanyl increased in both capital city and regional sites. Capital city fentanyl consumption decreased from December 2020 to February 2021. Average regional fentanyl consumption continues to exceed average capital city consumption. In December 2020, New South Wales had the highest estimated average capital city consumption of fentanyl, while South Australia had the highest estimated average regional consumption.

NICOTINE

When comparing data for August and December 2020, the population-weighted average consumption of nicotine decreased in both capital city and regional sites, with capital city alcohol consumption further decreasing in February 2021. Average regional nicotine consumption continues to exceed average capital city consumption. In December 2020, the Northern Territory[10] had the highest estimated average capital city and regional consumption of nicotine.

ALCOHOL

When comparing data for August and December 2020, the population-weighted average consumption of alcohol increased in capital city sites and decreased in regional sites. Capital city alcohol consumption decreased from December 2020 to February 2021. Average regional alcohol consumption exceeded average capital city consumption. In December 2020, the Northern Territory[11] had the highest estimated average capital city and regional consumption of alcohol.

NEXT REPORT

The fourteenth report of the National Wastewater Drug Monitoring Program is scheduled for public release in October 2021.

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