

## The 2015 NSW prison population forecast

Neil Donnelly\*, Imogen Halstead\*, Simon Corben<sup>§</sup> and Don Weatherburn\*

\* NSW Bureau of Crime Statistics and Research, <sup>§</sup> Corrective Services NSW

**Aim:** To provide short and long term forecasts of growth in the NSW prison population.

**Method:** ARIMA modelling was used to generate the short-term forecast. The long-term forecasts are based on forecast changes in the population and population age structure, coupled with information about long-term changes in age-specific rates of imprisonment.

**Results:** The short-term forecast is that, if relevant influences remain unchanged, NSW will have 12,191 prisoners by March 2017. If age-specific rates of imprisonment remain constant, we expect the NSW prison population to rise to 12,500 by June 2036. If age-specific rates of imprisonment rise in a manner commensurate with trends observed over the past decade, the prison population should reach 15,600 by June 2036. If age-specific imprisonment rates rise according to the trends observed since 1982, the prison population should reach 17,600 by June 2036.

**Conclusion:** The NSW prison population is likely to rise over both the short and long-term unless measures are taken to reduce the demand for prison accommodation.

**Keywords:** prison population, ARIMA, forecast, demography, population

### Introduction

Prison population forecasting is fraught with difficulty. Many factors affect the size of the prison population, including levels of crime, the number of arrests, the proportion of arrestees convicted, the proportion refused bail, the proportion given a prison sentence, the average length of prison sentences, the proportion of offenders released to parole at the end of their non-parole period and the rate at which parole is revoked. Most if not all of these factors are hard to predict.

In practice, to generate forecasts, assumptions have to be made about the future behaviour of factors that affect the prison population. The simplest and most commonly made assumption is that existing policing, court and correctional policies and practices will remain unchanged. This assumption becomes less and less tenable, the further into the future we attempt to forecast. The result is that the uncertainties attached to long-term forecasts are much greater than those attached to short-term forecasts.

This report provides short and long-term forecasts of the number of prisoners in NSW. Three long-term forecasts are

provided; one of which assumes no further growth in age-specific rates of imprisonment, and another two of which assume a continuation of the growth that has occurred either over the last ten years or over the history of available data (32 years), respectively. In order to provide some context for the forecasts we begin by describing long-term trends in the remand and sentenced prisoner numbers and some of the factors that have influenced growth in these populations.

### Trends in prisoner numbers

Figures 1 and 2 show the trend in remand (Figure 1) and sentenced prisoner (Figure 2) populations over the period 2004 to 2014. The remand population has grown from under 2,000 prisoners at the start of 2004 to more than 3,000 prisoners toward the end of 2014. There are noticeable peaks in the population in the first few months of each year, especially from 2009 onwards. The trend in sentenced prisoner numbers is somewhat different. This population grew rapidly until the middle of 2009. It then fell sharply until 2012, whereupon it began rising again, reaching a new peak in the middle of 2014.

## The role of seasonal factors

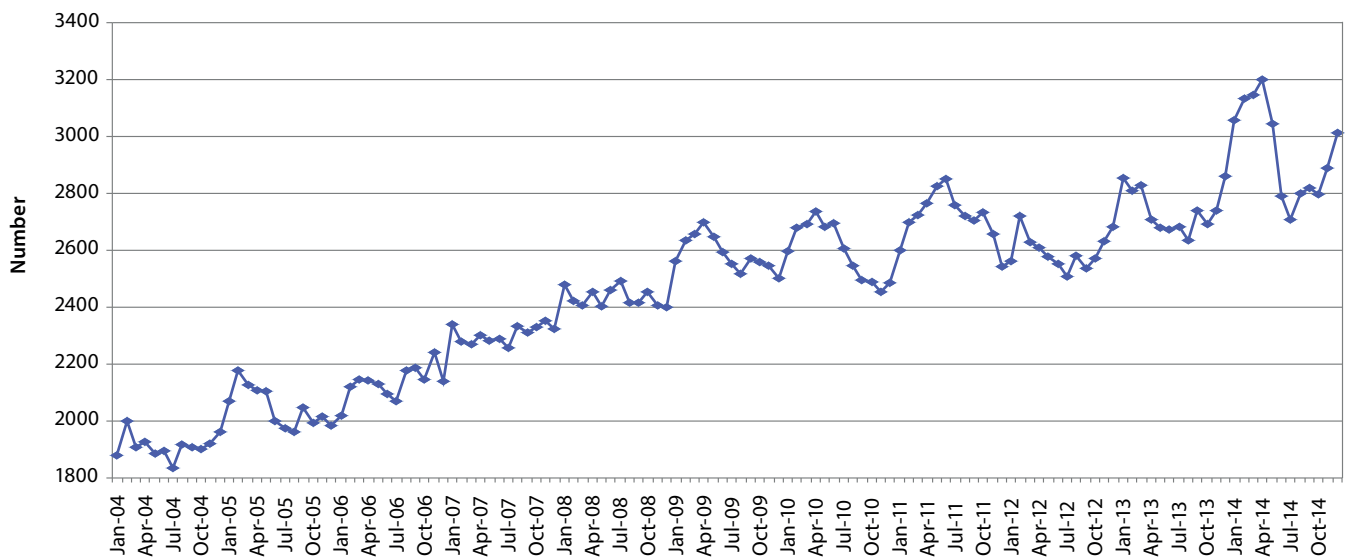
Seasonal factors account for a lot of the volatility shown in Figure 1 (remand). Figure 3 shows this by plotting the average month-to-month change in remand prisoners averaged over a 13 year period (i.e. 2001-2013).

As can be seen from Figure 3; the number of remand prisoners jumps by an average of 224 between December and January each year. Between January and February it jumps by an average of 37 prisoners. The seasonal increase in remand numbers has increased over the last two years, with the

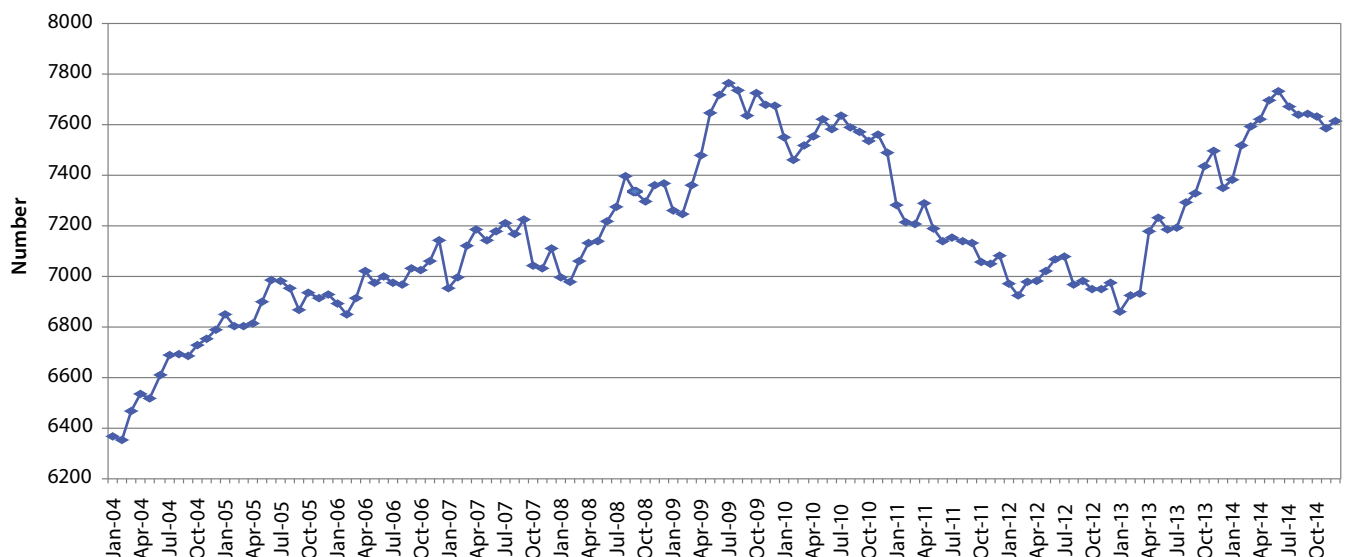
number of remand inmates increasing by 321 inmates between December 2013 and January 2014 and then increasing by 417 inmates between December 2014 and January 2015.

Figure 4 shows the average month-to-month change in the number of sentenced prisoners over the same 13 year period. The first half of each year sees small to modest month-to-month increases in the number of sentenced prisoners. During the second half of the year, the monthly number of sentenced prisoners remains fairly constant. Seasonal factors do not play a large role in the growth in sentenced prisoner numbers.

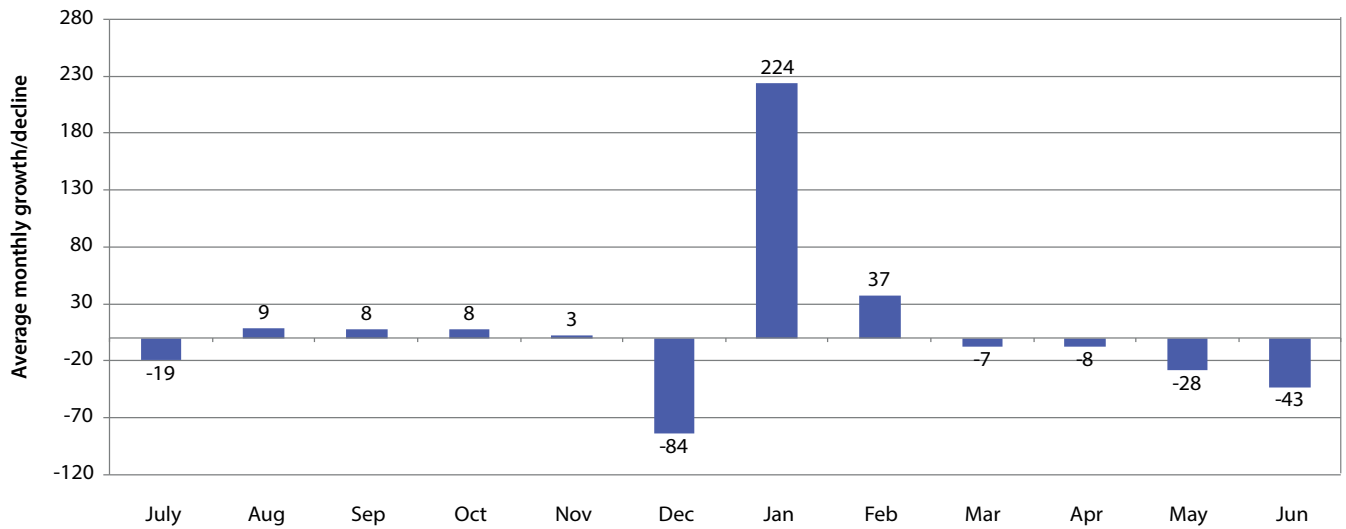
**Figure 1. Trend in remand population NSW: 2004 to 2014**



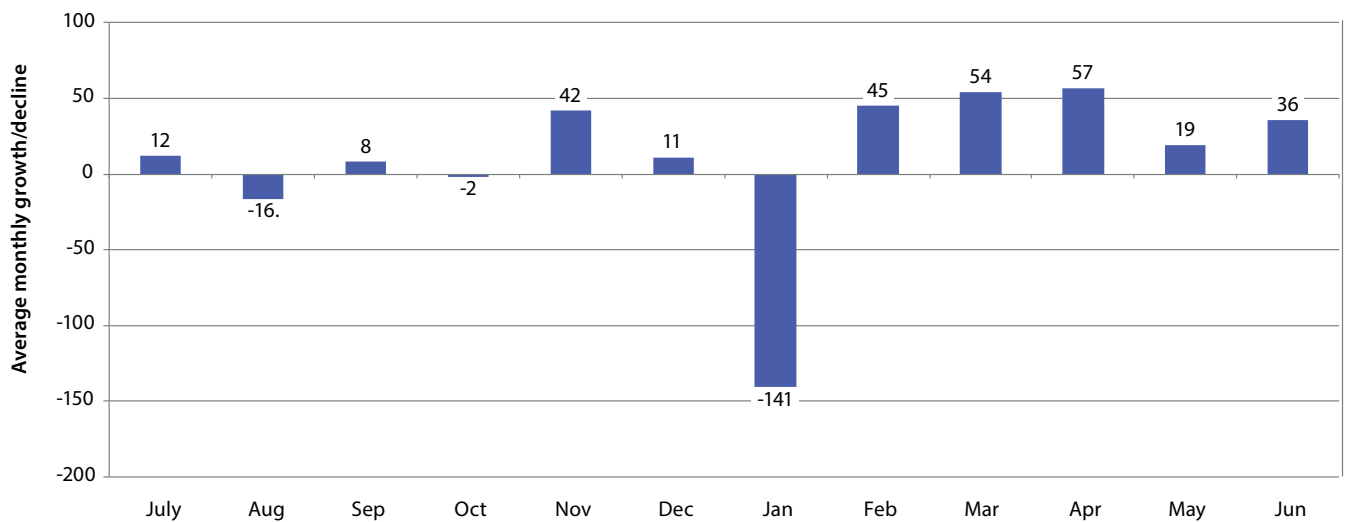
**Figure 2. Trend in sentenced prisoner population NSW: 2004 to 2014**



**Figure 3: Average monthly difference in remand population (2001-2013)**



**Figure 4. Average monthly difference in the sentenced prisoner population (2001-2013)**



## The growth in age-specific imprisonment rates

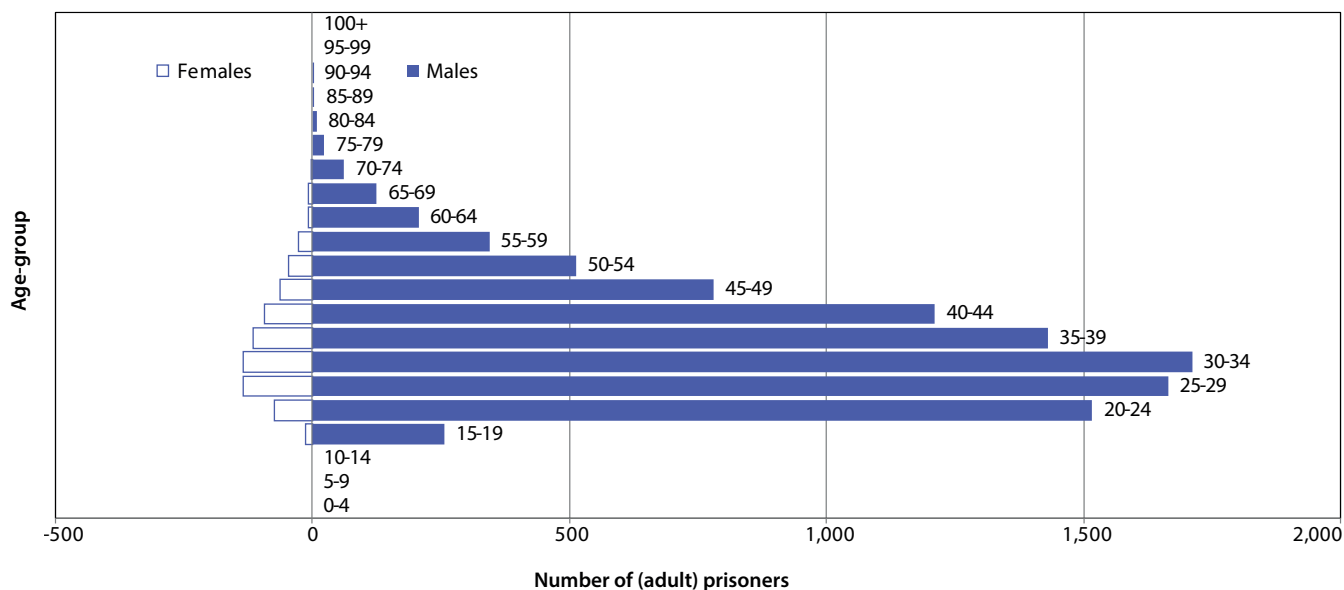
Figure 5 shows the prison population disaggregated by gender and age-group as at 30 June 2014. It is obvious that males comprise the majority of people imprisoned, with most aged between 20 and 45 years.

Figure 6 shows age-specific rates of imprisonment (essentially; the percentage in each age-group in prison at any one time) for key age-groups of males over the past three decades. In general, imprisonment rates have risen considerably over this period—though the pace of change varies. Over the most recent 10-year period, while the imprisonment rate has trended

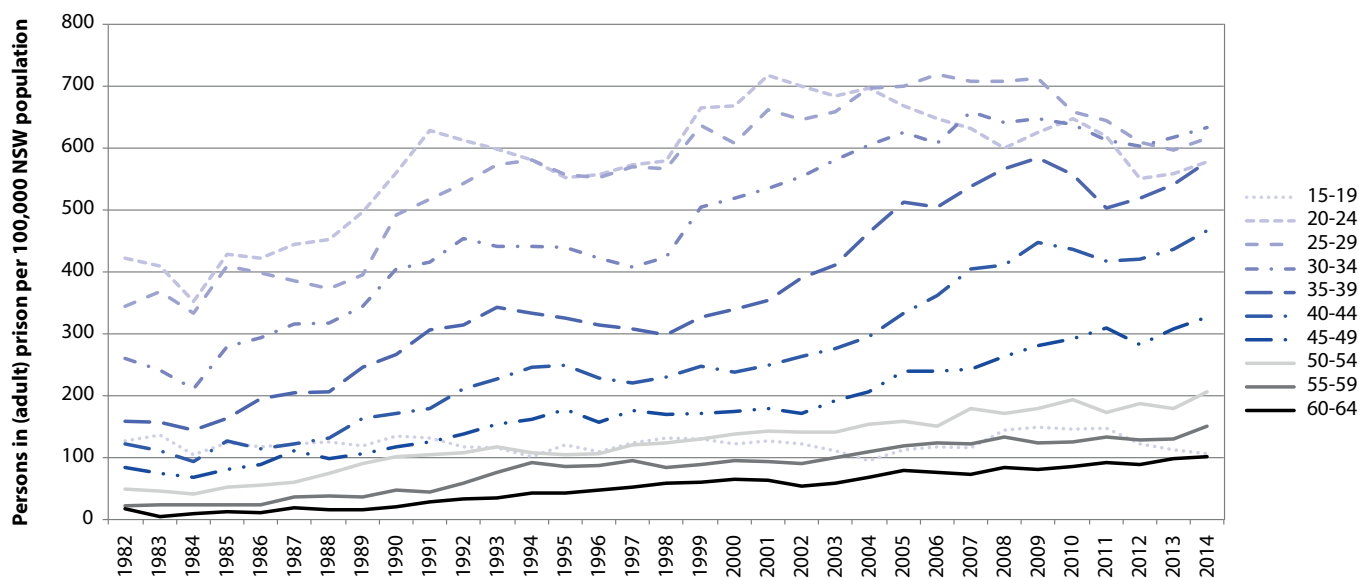
higher for more mature-aged males (aged 30 and over), there has been some decline in the rate for younger males (aged 20-29 years).

Imprisonment rates for females (not shown here) are much lower (e.g. for every 100,000 females aged 20-24 in NSW, 29 were in prison as at 30 June 2014; while for every 100,000 males, 578 were in prison). However, the trends in imprisonment rates evidenced over time amongst the male and female populations are similar. In particular, over the past 10 years, the proportion of younger females (aged 20-29) in prison at any one point in time has declined, while the imprisonment rate for older age-groups of females has risen.

**Figure 5. Demographic composition of the NSW (adult) prison population, 30 June 2014**



**Figure 6. Male age-specific imprisonment rates over time**



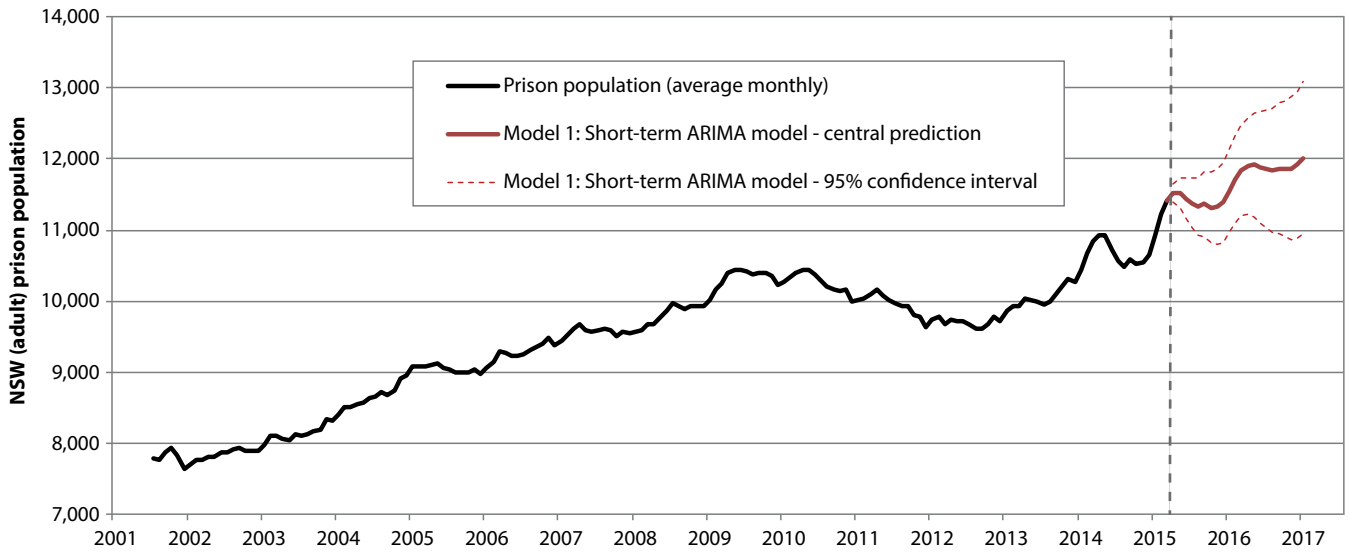
## The prisoner population forecast

In light of what we have just discussed, we now present a near-term forecast, and a number of long-term forecasts. The first forecast covers the short-term period up to the start of 2017. It was generated by fitting an ARIMA model to the observed trend in prisoner numbers between July 2001 and March 2015. There are three longer term forecasts covering the period up to 2036. These were generated by combining assumptions on age and gender-specific rates of imprisonment with information drawn from the NSW Department of Planning website on forecast changes to the level and age structure of the NSW population. The difference between the three longer-term projections is that the first

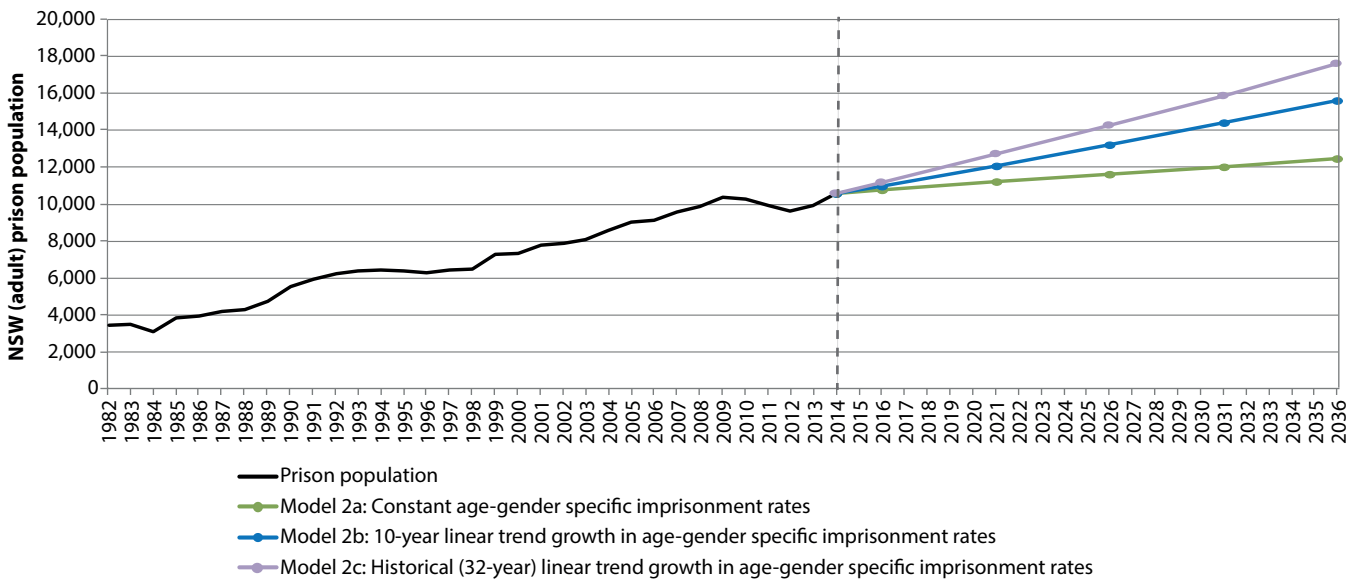
is based on the assumption that there is no further growth in age-specific rates of imprisonment, while the second and third are based on the assumption that age-specific rates continue to increase at the pace with which they have grown over the past ten years or over the history of available data (32 years), respectively.

Figure 7 presents the short-term forecasts in relation to actual prisoner numbers up until March 2015. The ARIMA (short-term) forecast to 2017 is the red line to the immediate right of the vertical line. The dashed lines on either side are the confidence intervals surrounding this forecast. The short-term forecasts plotted in Figure 7 were obtained from an ARIMA model which is shown in the Appendix. Methodological details are also provided.

**Figure 7. Short-term NSW prison population projection**



**Figure 8. Long-term NSW prison population projection (June levels)**



From the ARIMA regression model the predicted monthly averages were 10,032 for the 2013 calendar year and 10,651 for the 2014 calendar year. Over the forecast period the predicted monthly averages continue to increase reaching 11,329 during the 2015 calendar year and 11,835 during the 2016 calendar year. Our short-term forecast is that, if all else remains constant, NSW will have 12,191 prisoners by March 2017.

Figure 8 presents projections for the longer term horizon. Underlying data are provided in tabular form in the Appendix, as are the methodological details. If age-specific rates of imprisonment remain constant, we expect the NSW prison population to rise to 12,500 by June 2036 (shown in the green

line of Figure 8). The blue line shows what we expect if age-specific rates of imprisonment rise or fall by a fixed amount each year, commensurate with trends observed over the past decade. In this case the prison population should reach 15,600 by June 2036. Note that the net effect of aggregating across age-groups leads to higher prisoner numbers under this scenario, notwithstanding the decline in imprisonment rates for younger age cohorts (as observed in Figure 6). The lilac line shows what we expect if age-specific imprisonment rates rise according to the trend observed since 1982 (the earliest point available). In this case, the prison population should reach 17,600 by June 2036.

## Summary and conclusion

Other things being equal, NSW appears likely to experience further significant increases in the size of its prison population both in the short/medium-term and over the longer term. This outcome is likely even if age-specific rates of imprisonment remain constant at current levels, instead of steadily increasing as they have over the last 30 odd years (see Figure 6). It is important to understand, however, that this conclusion is based on the assumption that nothing occurs or is done to alter the factors that influence prisoner numbers. Whether and how long this assumption will hold true is impossible to say, in large part because it will depend on how policy-makers respond to the trends shown in this report.

Some factors that influence imprisonment rates are hard if not impossible to control (e.g. illegal drug use). There are a variety of ways, however, in which governments can influence the demand for prison accommodation. They include reducing the number of juvenile offenders who progress to the adult criminal justice system, creating new alternatives to imprisonment, reducing the time taken to finalise criminal cases, reducing the proportion of offenders who breach court and parole orders and implementing more effective rehabilitation programs. The future trend in prisoner numbers in NSW will depend on whether and to what extent the Government is successful in reducing the demand for prison capacity.

## Appendix

### Short-term ARIMA model

Analyses were conducted to identify a time series model of monthly average total prisoner numbers in NSW from July 2001 to March 2015. These analyses were conducted using SPSS (Version 20). An ARIMA model was identified which included serial differencing of the monthly total prisoner numbers, autoregressive parameters at lags of one month (AR1) and 12 months (AR12) and a moving average parameter at a lag of eight months (MA8). The parameters from this model are shown in Table A1.

Serial differencing of the prisoner numbers data made the series stationary. Examination of the residuals using ACF and PACF plots found that this ARIMA model had removed all statistically significant autocorrelation including those at lags one, eight and 12. This was confirmed by the Ljung-Box test for

**Table A1. Time series model of NSW prison population, July 2001 - March 2015**  
**ARIMA (1,1,8) (1,0,0)<sub>12</sub>**

	Estimate	Standard Error	p value
<b>Constant</b>	22.717	13.688	= .099
<b>Autoregressive Serial (AR1)</b> Lag 1	0.387	0.073	< .001 *
<b>Moving Average (MA8)</b> Lag 8	0.170	0.079	= .033 *
<b>Autoregressive Seasonal (AR12)</b> Lag 12	0.548	0.074	< .001 *

the first 18 lags ( $p = .582$ ). The normalised BIC equalled 8.463. The parameters from this ARIMA model were forecast over a 24 month period to produce predicted total prisoner numbers over the period April 2015 through March 2017. Confidence intervals for these predicted values were also calculated as shown in Figure 7.

### Long-term demographic model

Table A2 presents three long-term projections of the June-level NSW (adult) prison population at five-year intervals from 2016 to 2036 (as illustrated in Figure 8). These should be interpreted in conjunction with the evidence of an annual seasonal boost to prisoner numbers in the late summer months (recall Figures 3 and 4).

These projections are underpinned by NSW Department of Planning (DOP) forecasts of the level and demographic composition of the NSW resident population (benchmarked to June levels) at five-year intervals from 2016 to 2036.<sup>1</sup> There are several reasons why population projections provide a useful anchor for thinking about long-term prisoner numbers. First, imprisonment rates vary markedly amongst different demographic groups (recall Figures 5 and 6). Secondly, relatively reliable information is currently available on the future size and structure of the adult population in NSW (e.g. the number of babies born in NSW over the past five years provides a strong signal of how many people there will be in the 20-24 year old cohort in NSW in twenty years' time).

Three alternative long-term projections of prisoner numbers are constructed to reflect different assumptions around age-gender specific imprisonment rates in future years. The first (Model 2a) assumes age-gender specific imprisonment rates will remain constant over the forecast horizon. The second (Model 2b) assumes age-gender specific imprisonment rates will continue to grow according to linear trends observed over the past ten years (that is, either increasing or decreasing by some fixed amount in percentage points each year). The third (Model 2c) assumes age-gender specific imprisonment rates will continue to grow according to linear trends observed over the whole 32 year history of readily available data (covering the period from 1982 to 2014). The projected age-gender specific imprisonment rates are then applied to the DOP forecasts for the NSW resident population to derive implied prisoner numbers over the forecast horizon.

Age-specific imprisonment rates – the percentage of the NSW population imprisoned at any one time – are estimated, forecast, and applied to the DOP population projections in five-year age-groups by gender. To calculate historical imprisonment rates, demographic data collected in the prison census at 30 June each year are used in the numerator,<sup>2</sup> and Australian Bureau of Statistics (ABS) estimates of the composition of the NSW resident population in June each year are used in the denominator.<sup>3</sup> The 10-year linear trend in each age-gender specific imprisonment rate is estimated by a simple calculation: one-tenth of the change in each imprisonment rate observed between 2004 and 2014. An analogous formula is used to calculate trends since 1982.<sup>4</sup>

**Table A2. Long-term NSW prison population projections, 2016-2036, June levels**

		Model 2a	Model 2b	Model 2c
		Assumption on age-gender specific imprisonment rates		
	Year	Constant	10-year linear-trend growth	Historical linear-trend growth
Actual (30 June)	2014	10,578	10,578	10,578
Projection <sup>a</sup>	2016	10,800	11,000	11,200
	2021	11,200	12,100	12,700
	2026	11,600	13,200	14,300
	2031	12,000	14,400	15,900
	2036	12,500	15,600	17,600

<sup>a</sup> Figures for June levels, rounded to the nearest 100 prisoners

## Notes

1. Forecasts published in 2014, and sourced from the NSW Department of Planning website: <http://www.planning.nsw.gov.au/en-au/deliveringhomes/populationandhouseholdprojections/data.aspx>.
2. Data provided by Corrective Services NSW.
3. ABS catalogue number 3101.0 Australian Demographic Statistics, Table 51. Estimated Resident Population By Single Year Of Age, New South Wales.
4. Least squares methods could alternatively be employed to estimate historical linear trends in imprisonment rates. These methods would reduce the influence of the most recent observation on the projections. However, the predicted values implied by least squares models can be out of step with observed prisoner numbers at any one time. The differencing approach was employed here in order to anchor the projections at current (June 2014) prisoner numbers.