Projecting Prison Population Growth

Stock-flow models & Utah Adoptations

Commission on Criminal & Juvenile Justice

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https://justice.utah.gov/

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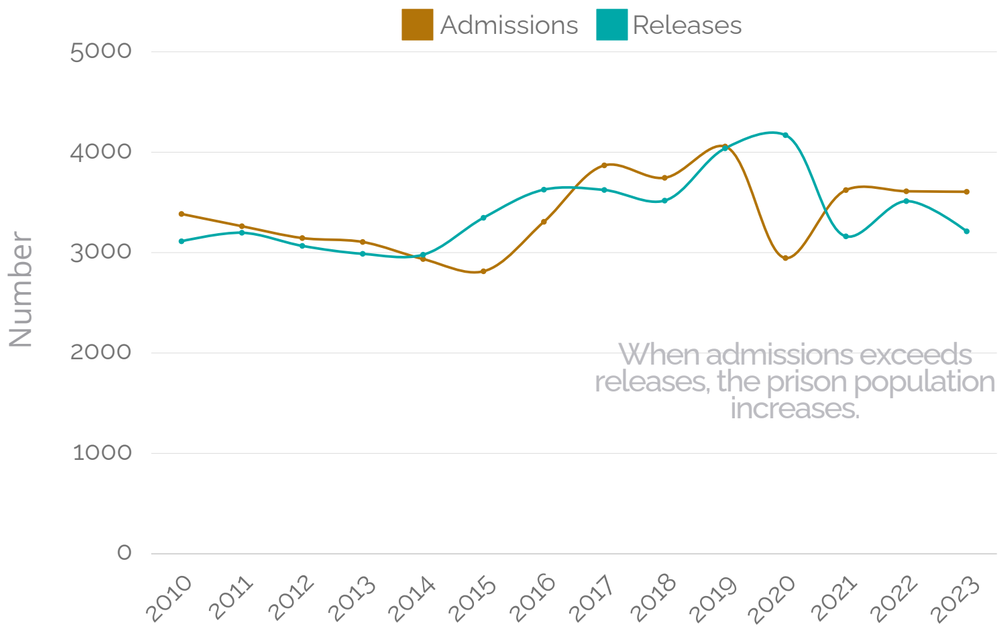
Overview

What determines the prison population?

The prison population is determined by two forces:

- **Admissions:** Individuals being admitted to prison due to a new crime or a probation/parole revocation.
- **Releases:** Individuals being released from prison into the community.

Two competing forces: Admissions & releases



What are Stock-flow models?

A stock-flow model projects the prison population over time by combining the existing stock population (prison population at time t) with the expected new admissions. Historical trends in prison admissions help estimate the “flow” of new inmates over time.

The stock population is *finite* and decreases as individuals exit the prison system while new individuals are admitted and then phased out based on their expected release date.

Takeaways: Stock-flow models

Stock population

Uses the stock population (aka prison population) at the most recent known time.

New admissions

Historical trends in prison admissions help project the flow of new inmates over time.

How it works

The stock population declines over time, while new admissions are added and phased out as they serve their sentences.

Pros & Cons of Stock-flow Models

What are the Benefits?

Stock-flow models have several benefits when used to project future prison populations, including:

- **Granular data:** Simulates an individual's path through the prison system vs relying on aggregate/univariate trends.

- **Flexibility:** By separating the prison population into 1) existing inmates and 2) expected new admissions, the model can easily incorporate the impact of new policy and legislative changes that may affect trends in new admissions and LOS.

- **Adjustments:** Because the model's mechanics are transparent (not a statistical "black box"), it's easily understood, and adaptable to new assumptions and trends.

What are the Limitations?

Like any model, stock-flow models depend on accurate data and assumptions, including reliable Length of Stay (LOS) estimates and projections for new admissions.

Expectations for new admissions are generally based on historical trends, assuming these patterns will persist over time. As with most statistical models, unexpected events, in other words "System Shocks" (e.g., COVID-19) can reduce accuracy, necessitating adjustments as new data becomes available.

Takeaways: Limitations

Accurate LOS

Relies on accurate Length of Stay (LOS) estimates to capture the flow of individuals as they enter and exit prison.

Unexpected events

Significant and unexpected events (e.g., COVID-19) can reduce accuracy, particularly over longer forecasting periods.

A Simple Example

With made-up data

Simple stock-flow model example

- **Example Data:** Let's assume we have the data as seen in Table 1, showing the prison population between 2020 and 2024. We are interested in projecting the population for 5-years in moving forward (2025-2029).

- **Stock population:** Highlighted in gold is our current prison population (200 inmates). We will use an expected release date/LOS estimate to project how many individuals we expect to be released over this 5-year period.

- **New Admissions:** For simplicity, we assume a constant number of new admissions equal to 20 each year. These admissions will later be phased out based on LOS.

Table 1 - Example Data

Year	Prison population	Forecast	New Admissions
2020	100		
2021	125		
2022	150		
2023	175		
2024	**200**		
2025		?	**20**
2026		?	20
2027		?	20
2028		?	20
2029		?	20

Counting the number of persons leaving by length of stay

- **LOS 2024 stock:** We assume that two persons had a LOS of zero years starting in 2024, hence they will not move forward to the 1st 2025 forecast, similarly by year 2026, we have lost 8 additional persons as their LOS has expired and so the logic continues.

- **LOS new admissions:** Out of the 20 new admissions yearly that starts in 2025, we assume that one person had a LOS of zero years, hence they will not move forward to the 2026 forecast. similarly by year 2027, we have lost three additional persons as they only had a LOS of one year.

Table 2 - Distribution of LOS

LOS in years	Number of persons (stock)	Number of persons (new admissions)	Corresponding yearly forecast (stock)
0	2	1	2025
1	8	3	2026
2	5	4	2027
3	20	5	2028
4	30	3	2029
5	135	4	-

Calculating remaining persons left

- **Remaining 2024 stock:** As part of the first forecasting year of 2025, we now have the original 2024 stock-population minus the two people we lost. We are left with a total of 200 - 2 = 198 from the 2024 stock.

- **New & Remaining admissions:** The first forecast year has only 20 new admissions. Following years add 20 new admissions plus remaining individuals from prior cohorts based on their LOS. For example, 2026 has 39 people: 20 new admissions + 19 remaining from the 2025 cohort (one person left with an LOS of zero). This iterative process continues, with each year's forecast building on the remaining population from previous years.

Table 3 - Final Forecast

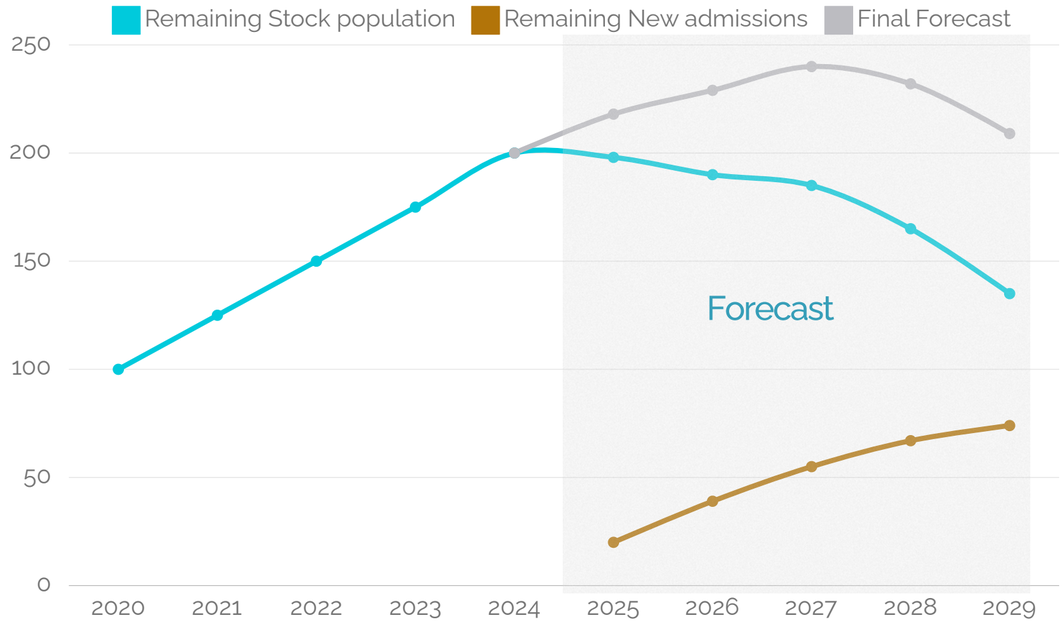
Forecasting year	Persons left (2024 stock)	Persons left (new admissions)	Total persons left (final forecast)
2025	**= 200 - 2 = 198**	**20**	218
2026	190	**= 20 + 19 = 39**	229
2027	185	55	240
2028	165	67	232
2029	135	74	209

The final forecast for each year is the sum of persons left from the original stock plus new and remaining admission cohorts.

Phasing out current stock while phasing in new admissions

Starting in 2025, the stock population is gradually reduced based on LOS, while new admissions begin. The total forecast is the sum of the remaining existing population and the new admissions seen in grey and more prominently on the next slide.

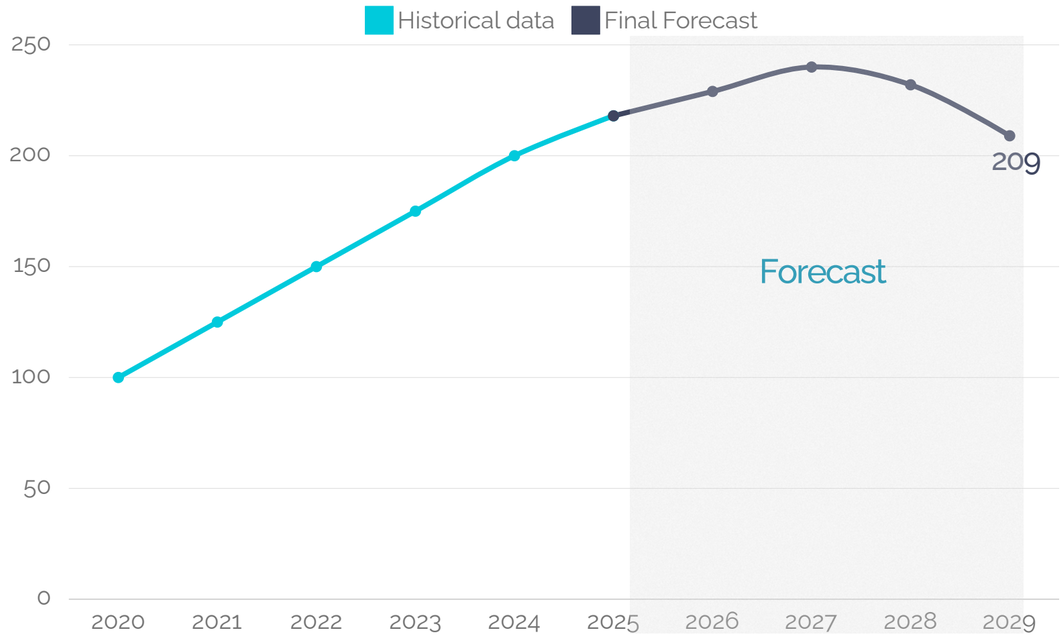
Phasing out of the 2024 stock population while phasing in new admissions



The Final Forecast

The final forecast is then the simply the sum of the stock left at time t, plus new admissions at time t, plus any remaining admissions from prior admission cohorts. It is an iterative process.

Simple stock-flow model projection example

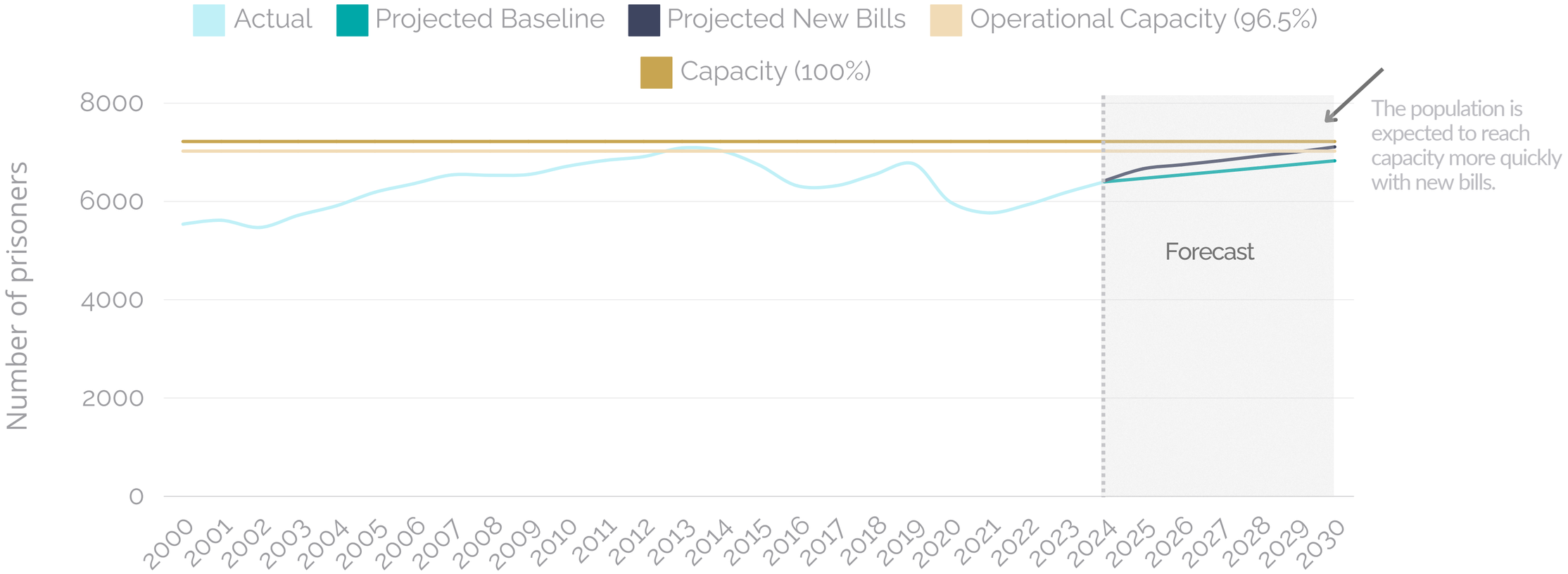


New Policy Scenarios

E.g., a new set of Criminal Justice related bills

New Legislation Scenario

A stock-flow model lends itself to compare a baseline projection (e.g., things stay as they are) to a set of policy changes that may impact the prison population and as seen below:



Requirements

Required data & information

Data & System Expertise

Stock-flow models benefit from individual-level data on the stock population and new admissions, drawn from a census for the relevant time period and forms the foundation of the model.

In addition, software tools like R, SAS or Excel are used for calculation and iteration. Finally, local expertise from data experts and system stakeholders is critical to address Utah-specific challenges and ensure the data is modeled effectively.

Takeaways: Data & system expertise

Individual data

Individual level data on prison and admissions data.

Software

Common software applications include: SAS, Excel, and R.

Local expertise

Consult with local stakeholders to address Utah-specific requirements.

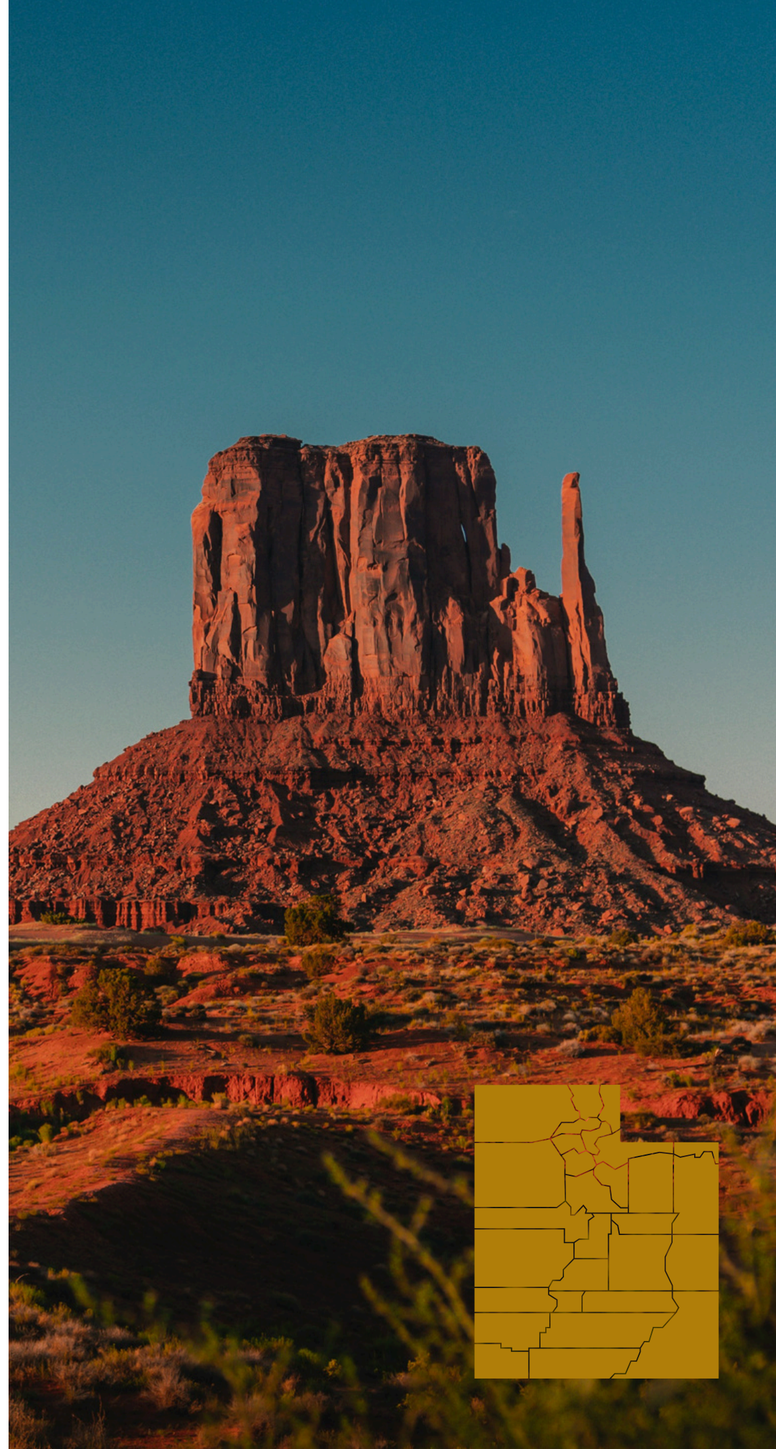
Utah Considerations

Best practices for applying stock-flow models to Utah's prison population include careful consideration of:

Indeterminate Sentencing: Unlike states with determinate sentencing, Utah largely uses indeterminate sentencing, making it challenging to estimate accurate LOS. Options include:

1) Using the Sentencing Guideline Release date
2) Applying a LOS estimate using data on prior release cohorts or
3) A combination of these approaches

Population, Crime & Economic Factors: Utah's relatively high population growth can be factored in, along with other factors (e.g., crime rates, trends in court filings, economic conditions) that may influence the prison population over time.



How can we incorporate uncertainty?

Sensitivity analyses come in many forms and are aimed at assessing how “sensitive” our assumptions are to the forecasting outcome. In using stock-flow models, this may involve:

Different LOS estimates: Examining how the forecast may change as different LOS estimates are used in phasing individuals in and out of the system. If the Sentencing Guidelines Release date is used, then the error distribution (the difference between the actual release date and the guideline release date) can be used to estimate a range of plausible values of where the forecast may lie.

Low, Moderate, & High Scenarios: Simulations can be run to assess how low, moderate, and high scenarios may impact prison beds and capacity over time.

Presentation Takeaways

Stock-flow and simulation models are widely used in criminal justice and projection work due to their ability to analyze trends, forecast future populations, and adapt to changes in the underlying population and policy shifts while accounting for uncertainty.

While simulation models can improve accuracy, they have limitations and are inherently dependent on accurate Length of Stay estimates and the assumptions built into the model.

Stock-flow models can range from simple to more sophisticated versions, incorporating seasonal adjustments and weighted parameters for more refined projections.

Presentation Takeaways:

Adaptable

Stock-flow models are adaptable to a wide set of requirement, data and scenarios.

Policy Scenarios

Can accommodate policy changes that may impact the prison population.

Limitations

No model is perfect, stock-flow models are sensitive to los estimates and system shocks.

Related Literature & Acknowledgments

- **A Comprehensive Review:** This report provides a historical and current overview of common methods used in modeling prison populations over time, while highlighting best practices and selected state examples.

- We would like to thank the states of: **Oregon, North Carolina, and Colorado** who shared their time and expertise and whose work inspired this presentation.

Thank you

Thank you!

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