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Create Accurate Type Wells

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Agenda

- Current practice
- What's wrong?
- Synthetic example
- 4 field examples
- Valid groups
- Auto forecasts
- Conclusions

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Why is this Important?

- The advent of unconventional resources has radically changed the gas and oil supply landscape in North America.
- Investment decisions with respect to development of unconventional resources depend to a great extent on the ability to accurately forecast future recovery.
- Analog or type wells forecasts are used extensively, especially during a well's early production period.

What are Type Wells?

- Pseudo-well meant to represent many wells
- Created by averaging the rate from many wells
- Used to determine rate based on analogous wells
- Benchmark to guide forecasts for similar wells

Industry Standard Practice

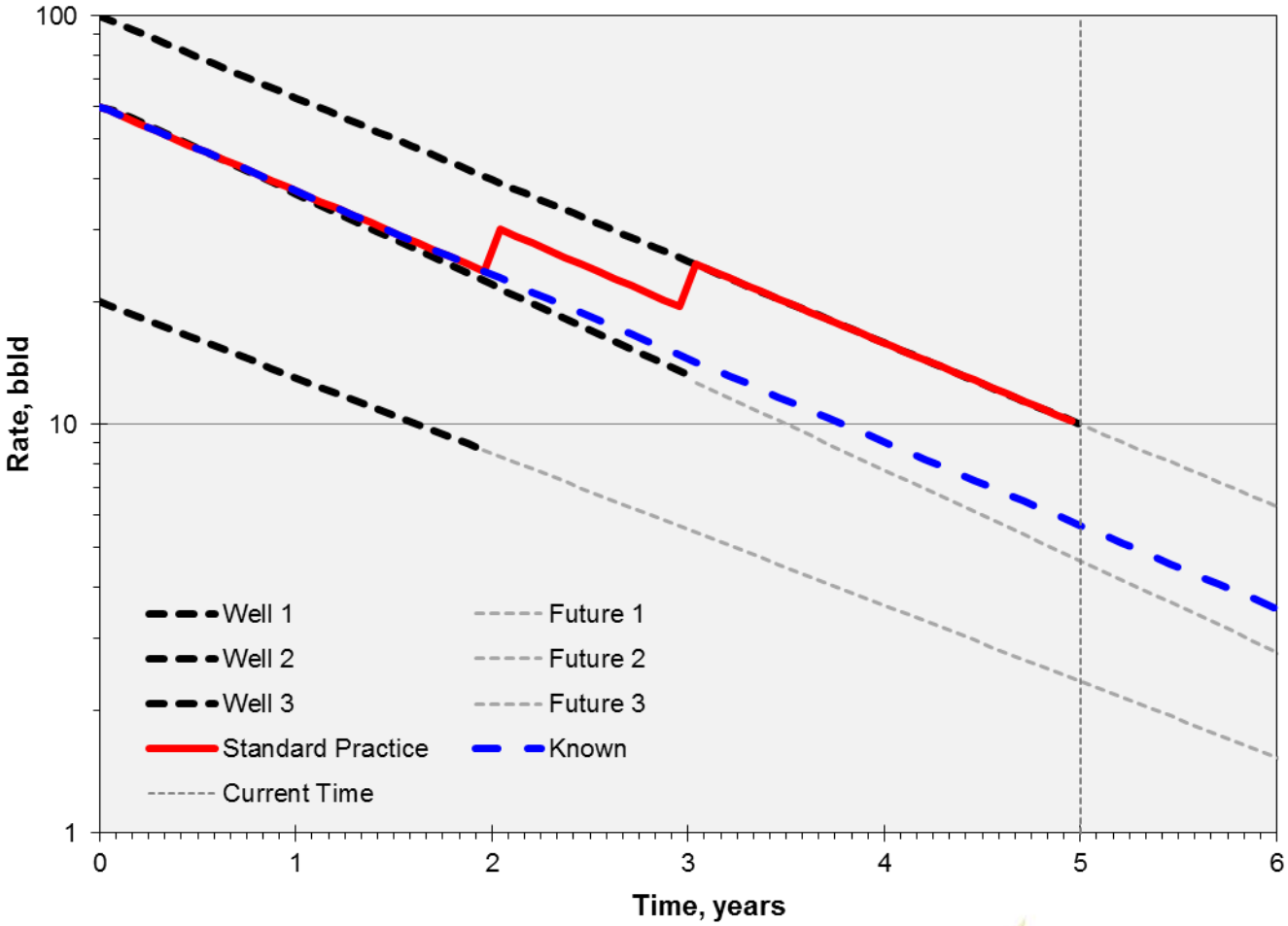
- The ***Industry Standard Practice*** (ISP) is to average the production rate from contributing wells.
- Informal process that has become a standard.
- Relies on production history.
- **Rarely** includes individual well forecasts.

Issue

- Industry Standard Practice is defective
- Type wells rarely use forecasts
- Using combined historical production with reliable production forecasts remedies the defect
- Unreliable forecasts are better than no forecasts

Theory

- Forecasts are implicit to the ISP method.
- Implicit forecasts are usually inaccurate.
- Type well quality is compromised.
- Better forecasts yield better type wells.



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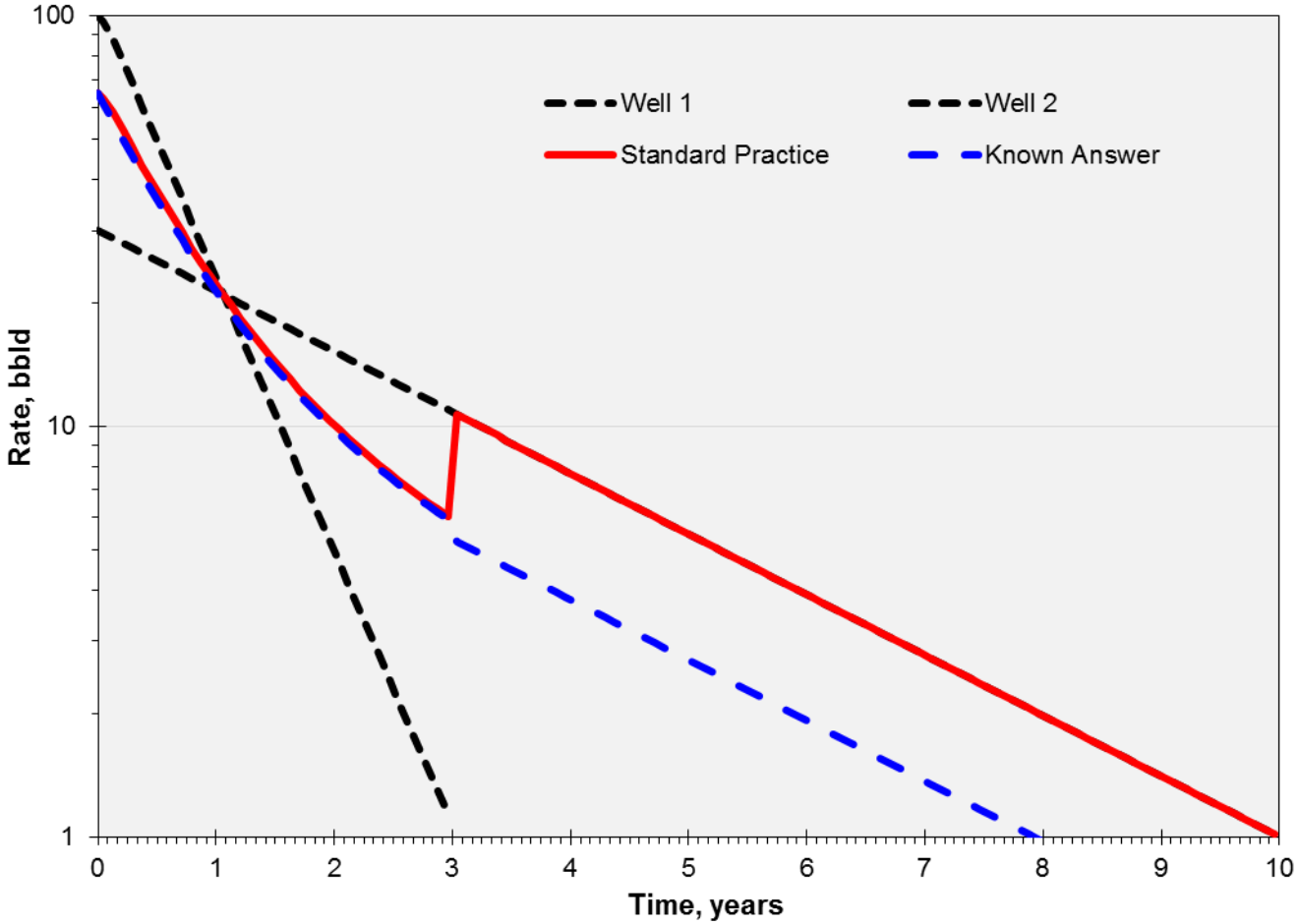
Theory

- Depleted wells must be counted.



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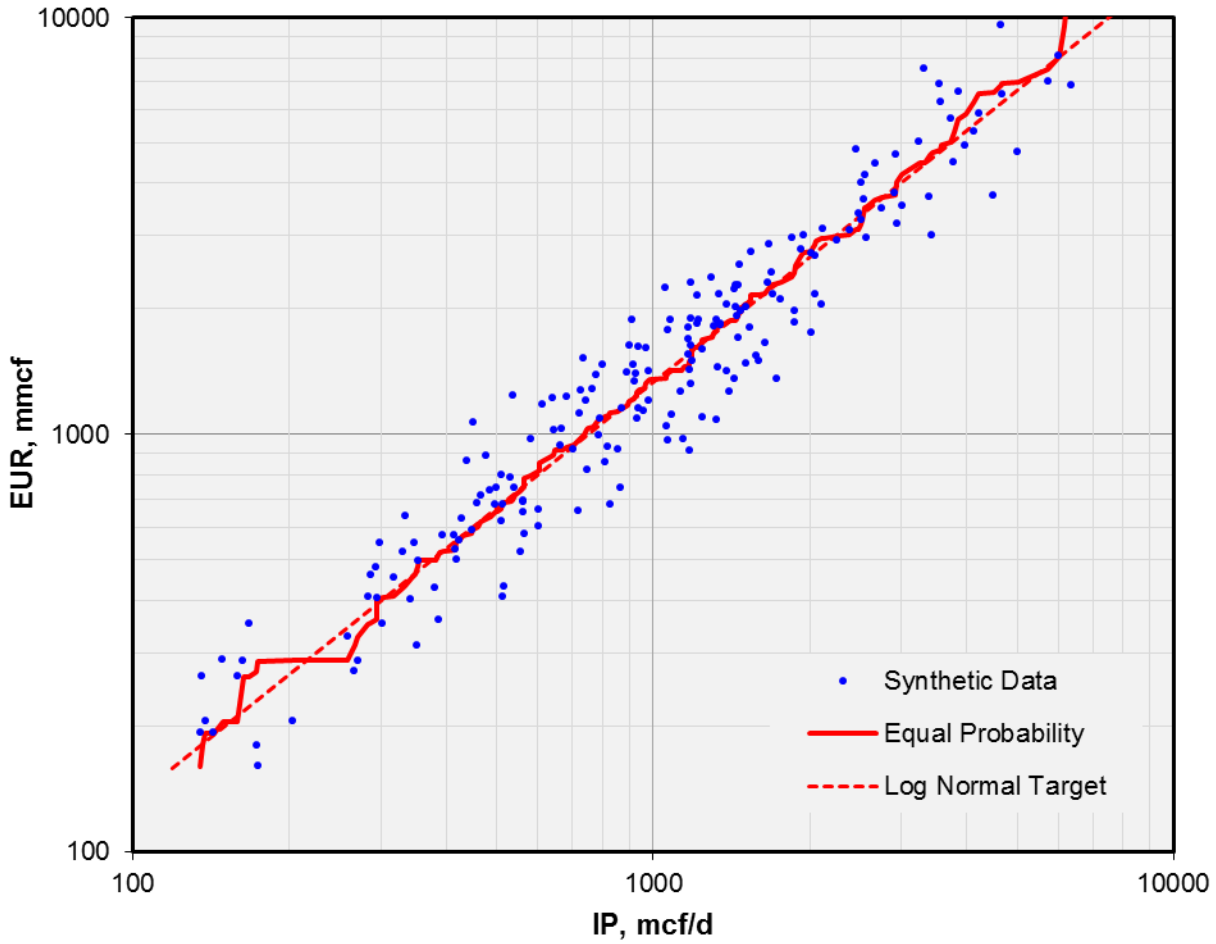
Synthetic Wells

- 199 synthetic exponential forecasts.
- IP & EUR log normal.
- Random variation +/- 30%.
- Answer is known.
- 5 year drill cycle.
- Type wells created after 10 years.



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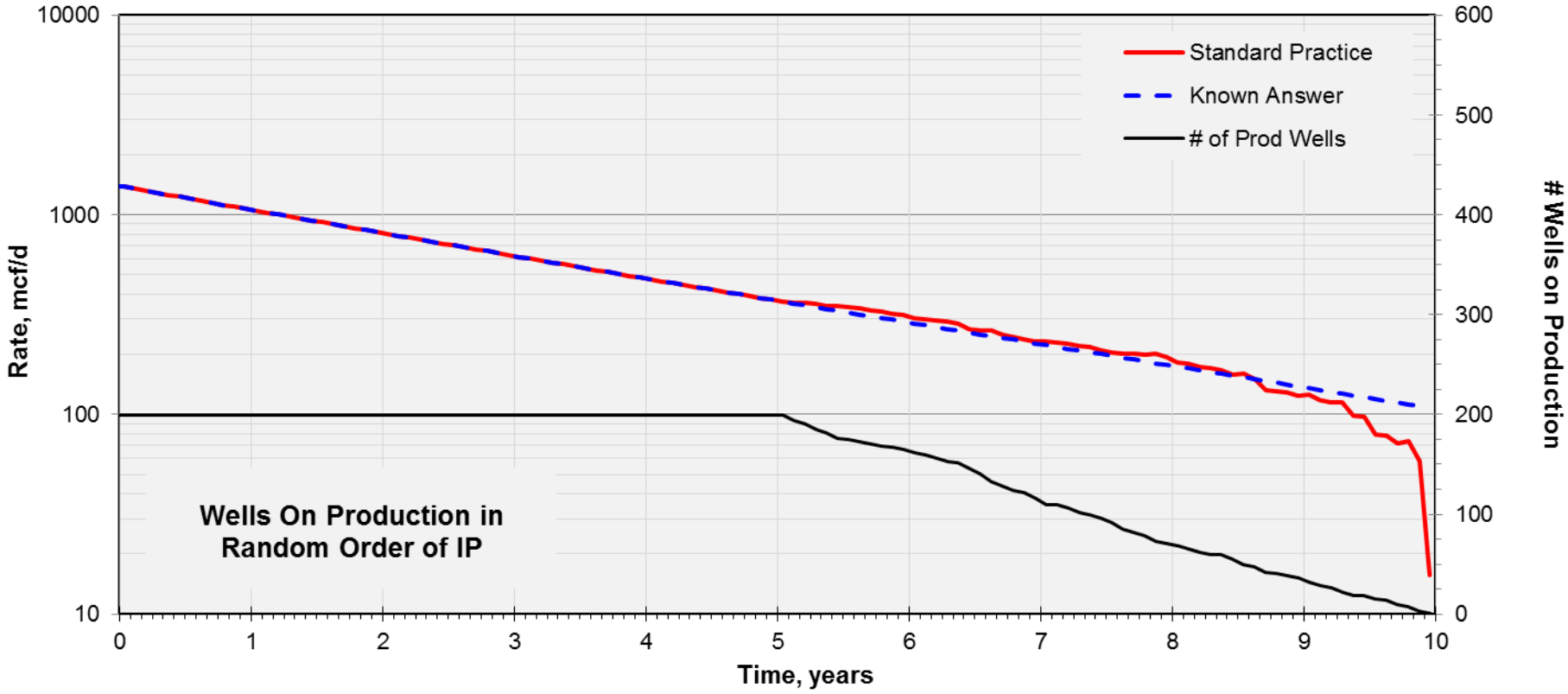
Wells Drilled in Random Order



- ISP matches the known answer.

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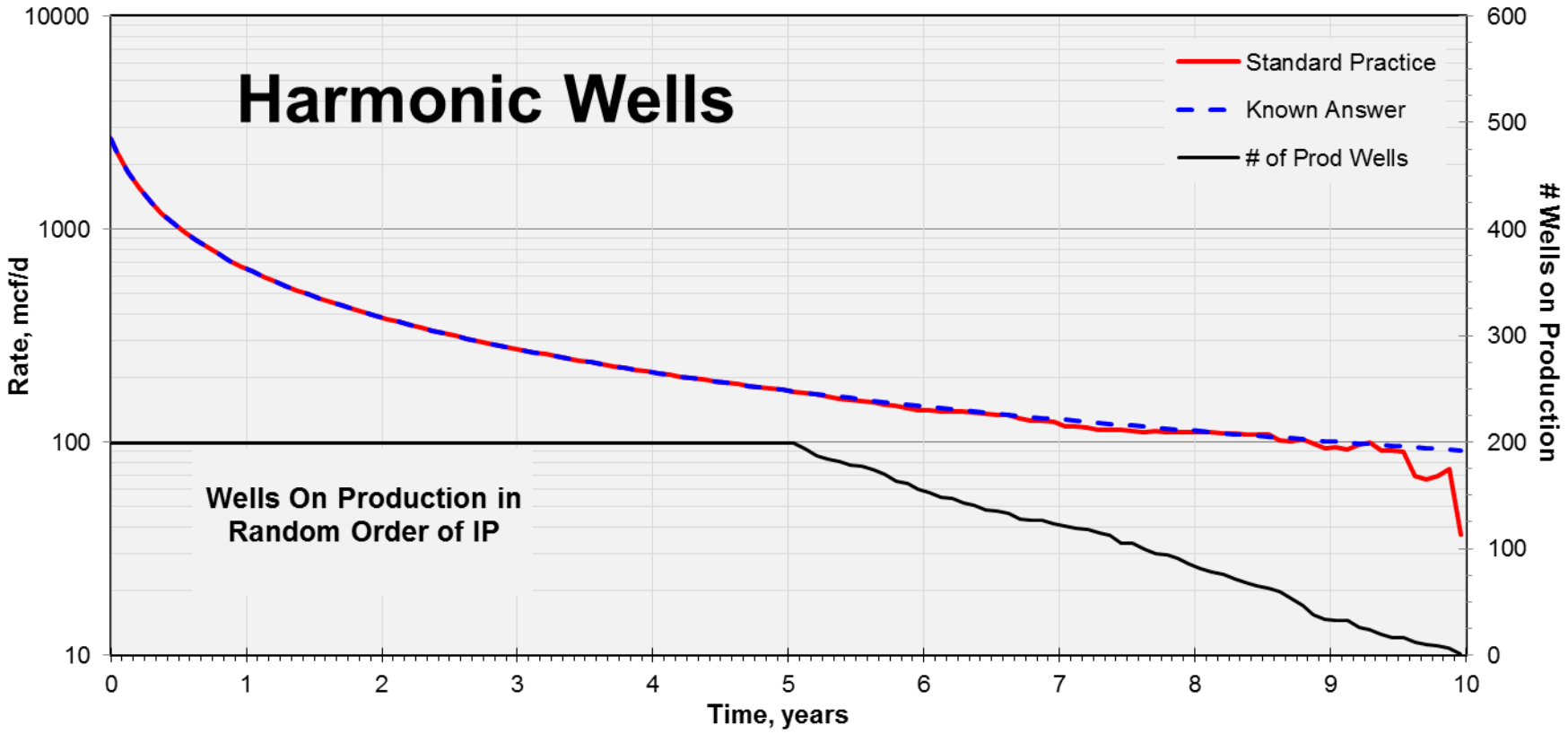

- ISP matches the known answer.

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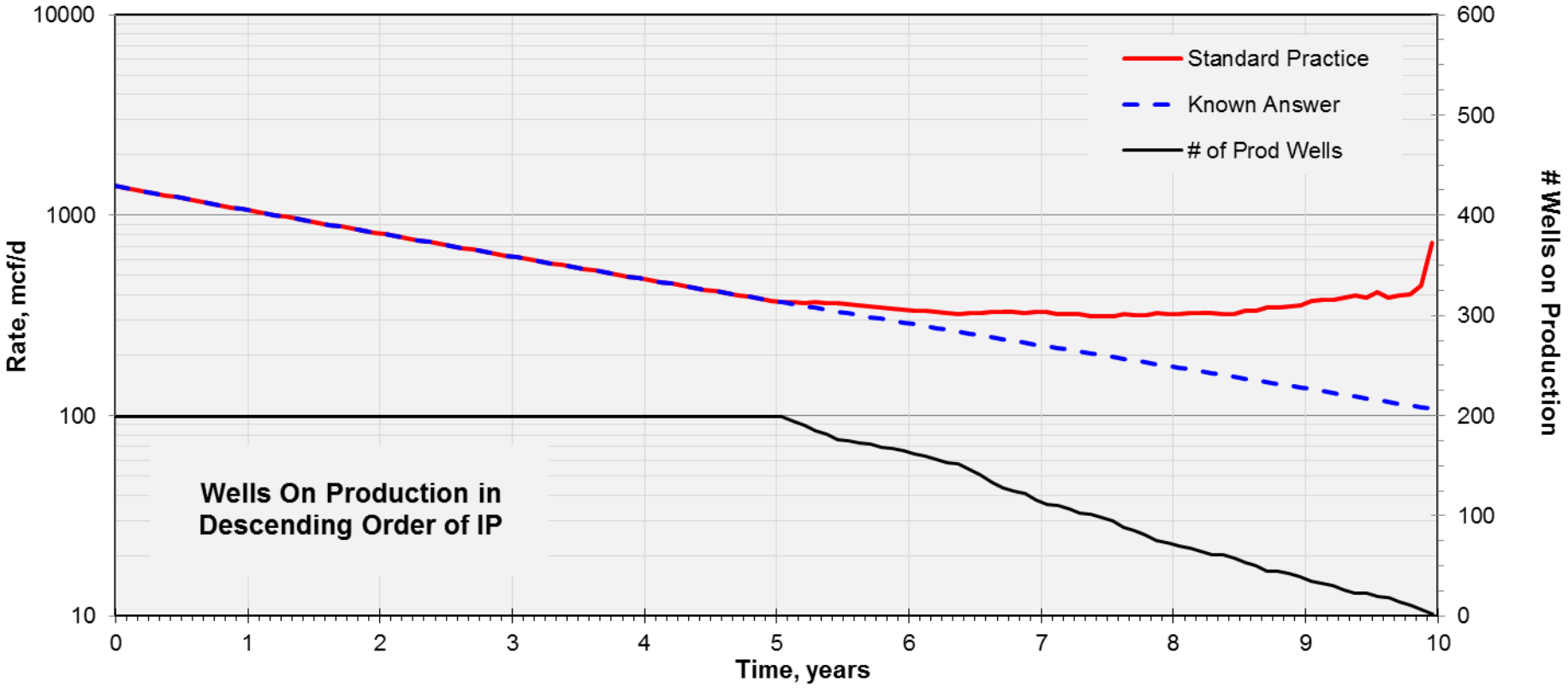
Sequence Bias

- Gaps are not filled with representative rates
- Profit Optimization
  - Best wells drilled first
  - Type wells are optimistic
  - Implicit forecasts for the newer wells created from older, better wells
- Technical Play
  - Wells improve as technology develops
  - Type wells are pessimistic
  - Implicit forecasts for the newer wells created from older, poorer wells

Best Wells Drilled First



- Best wells drilled first: ISP fails.
- Type well changes to an incline.

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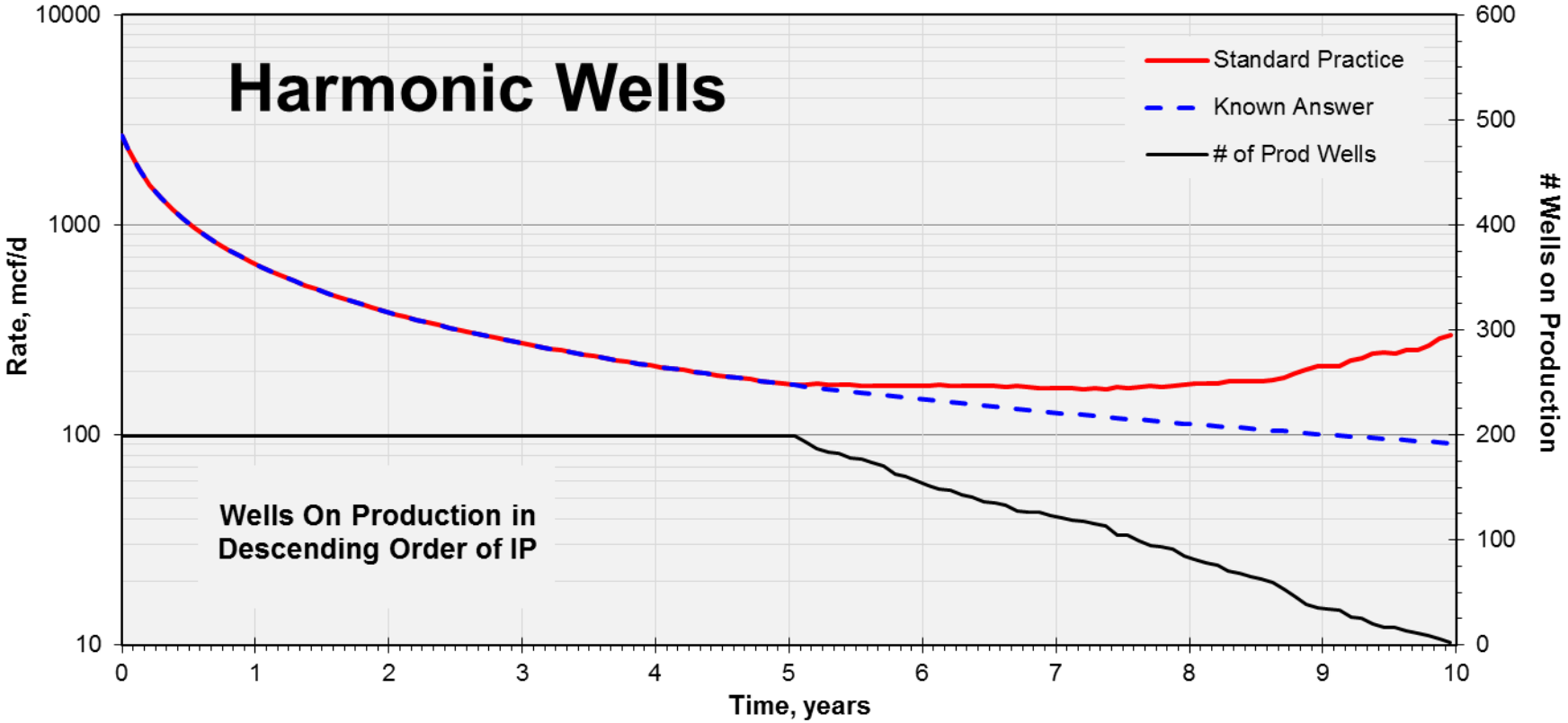
Best Wells Drilled First



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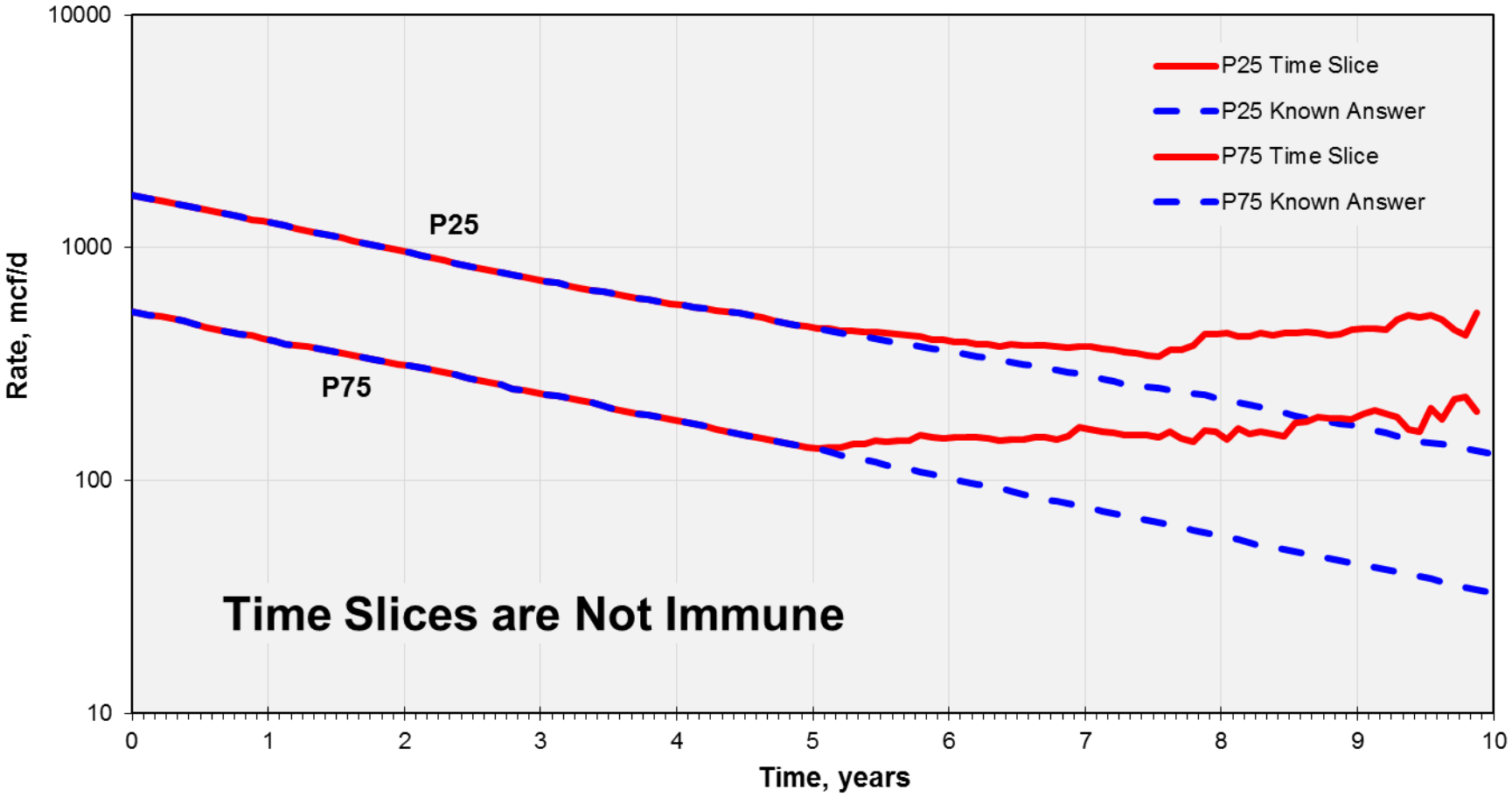
Best Wells Drilled First



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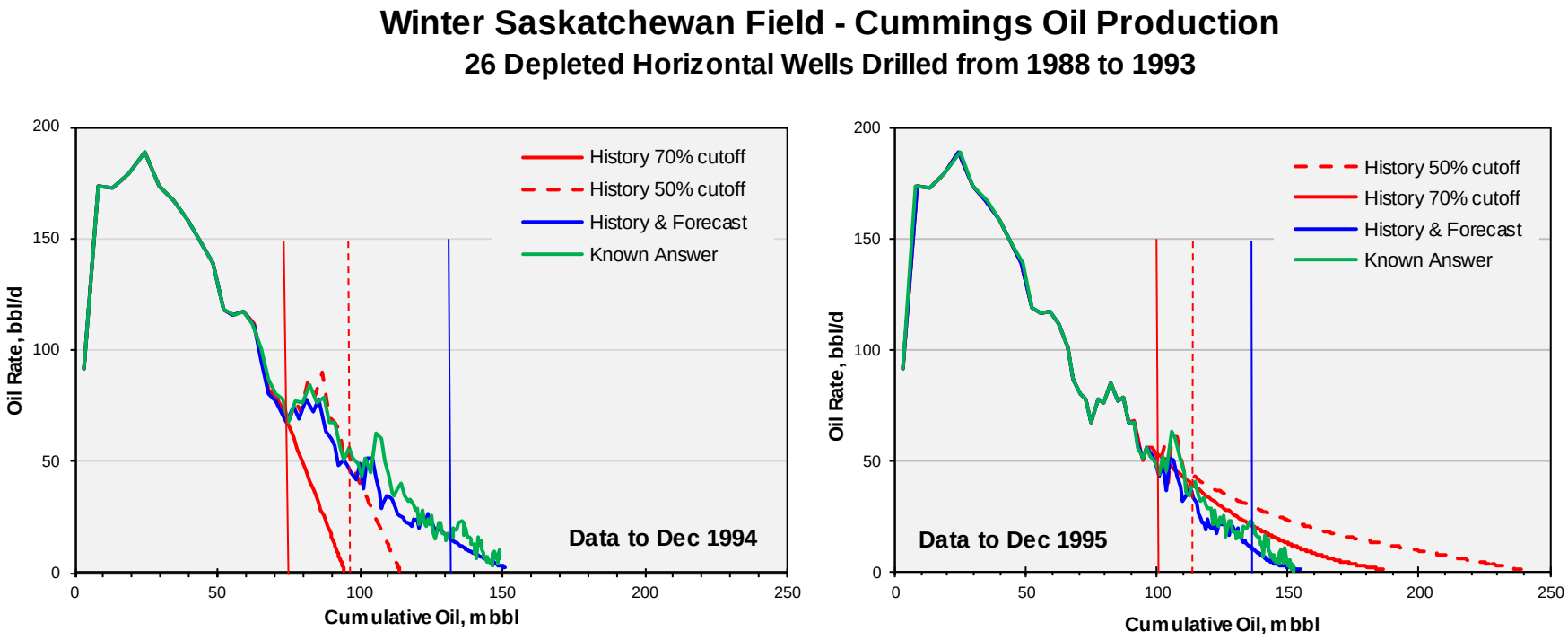
Winter Field



- History & Forecast

Results in a better type well.
Makes Better use of available data.
Does not require a perfect forecast.

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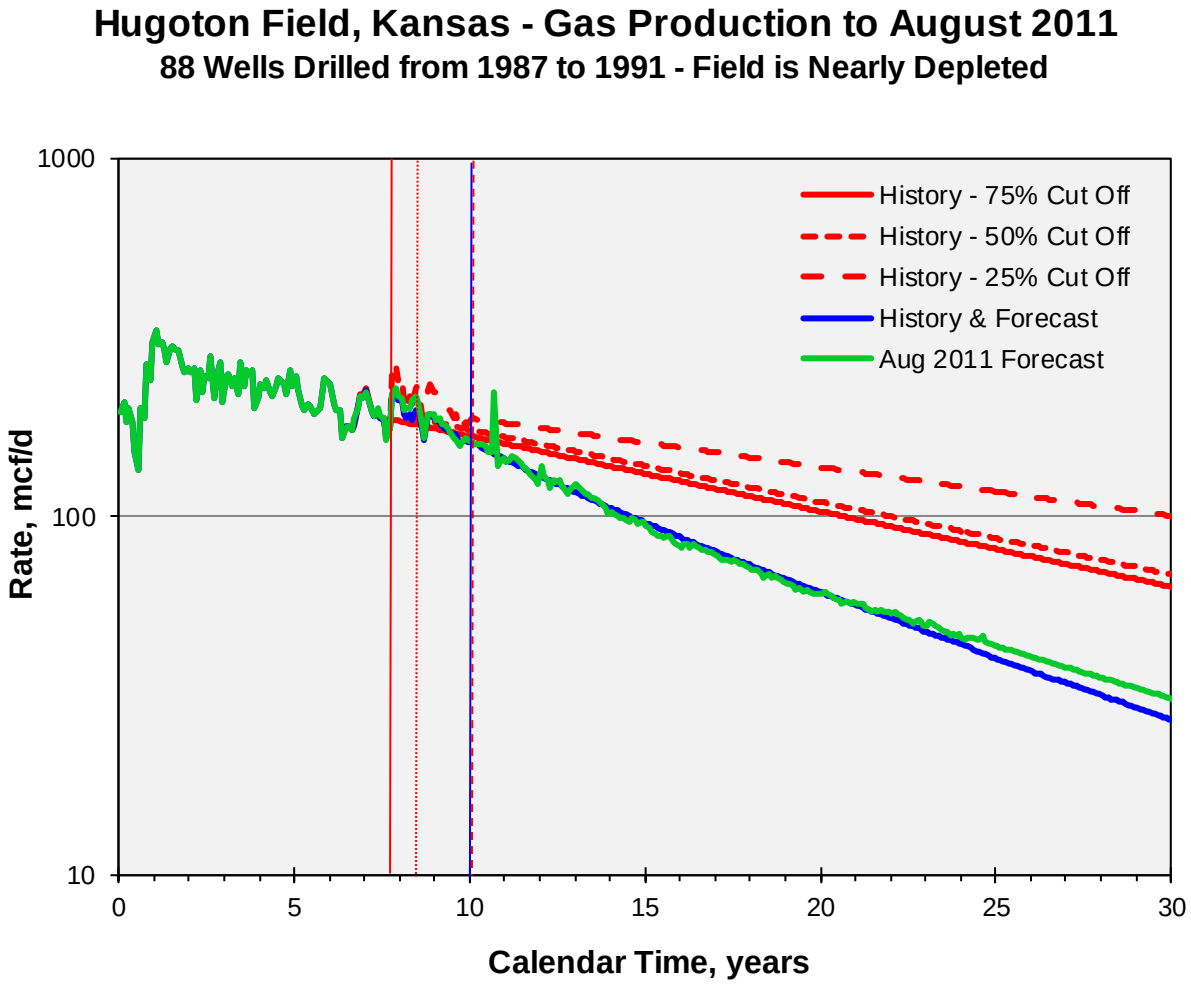
Hugoton Field

- Standard Practice has large EUR error
- Type Well is near perfect when forecast is included

	EUR mmcf	Error %
Aug 2011 Forecast	1466	
10 Years of History		
History & Forecast	1439	-2%
History - 75%	1948	33%
History - 50%	2049	40%
History - 25%	2562	75%



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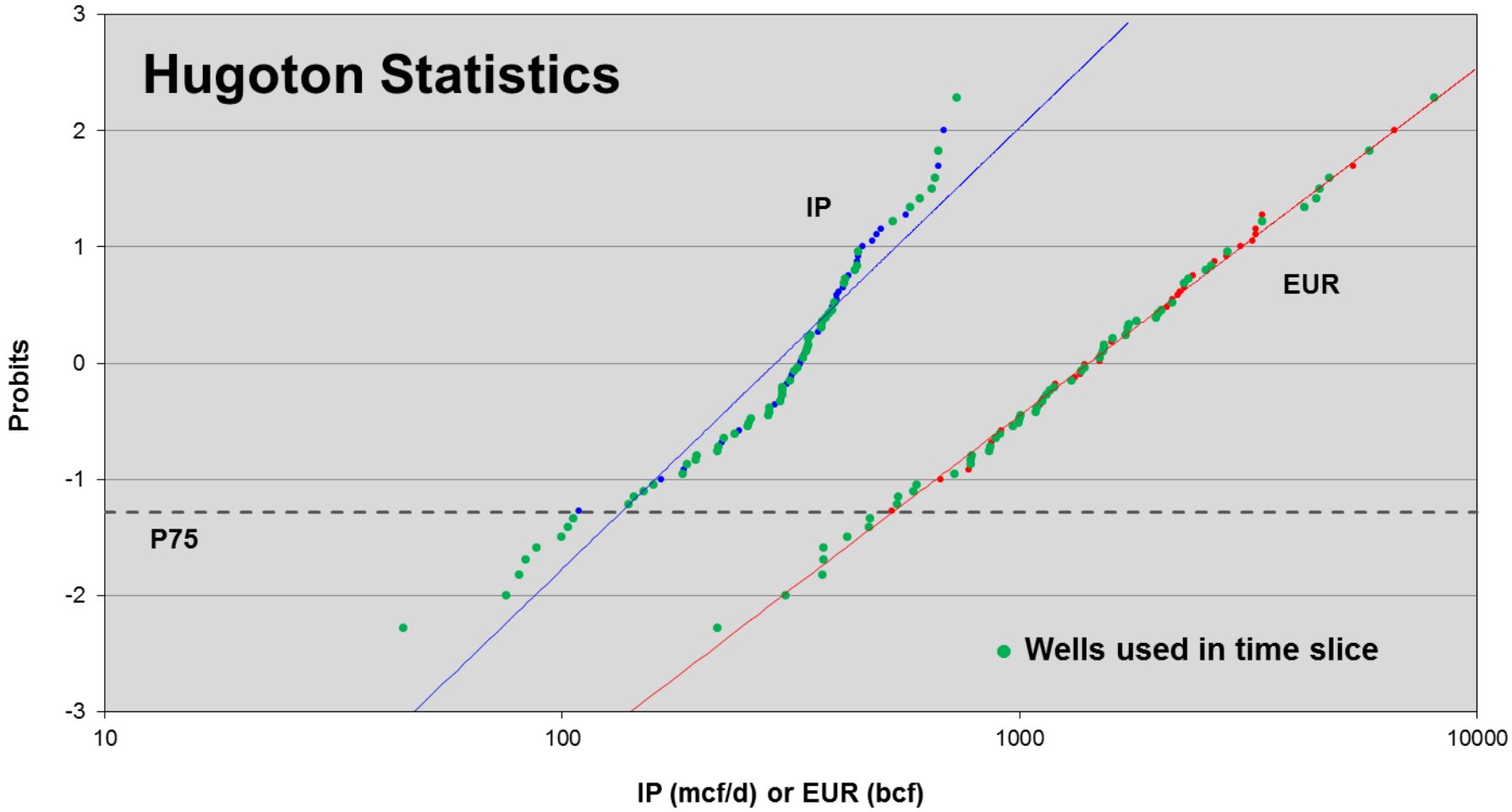
Hugoton Statistics



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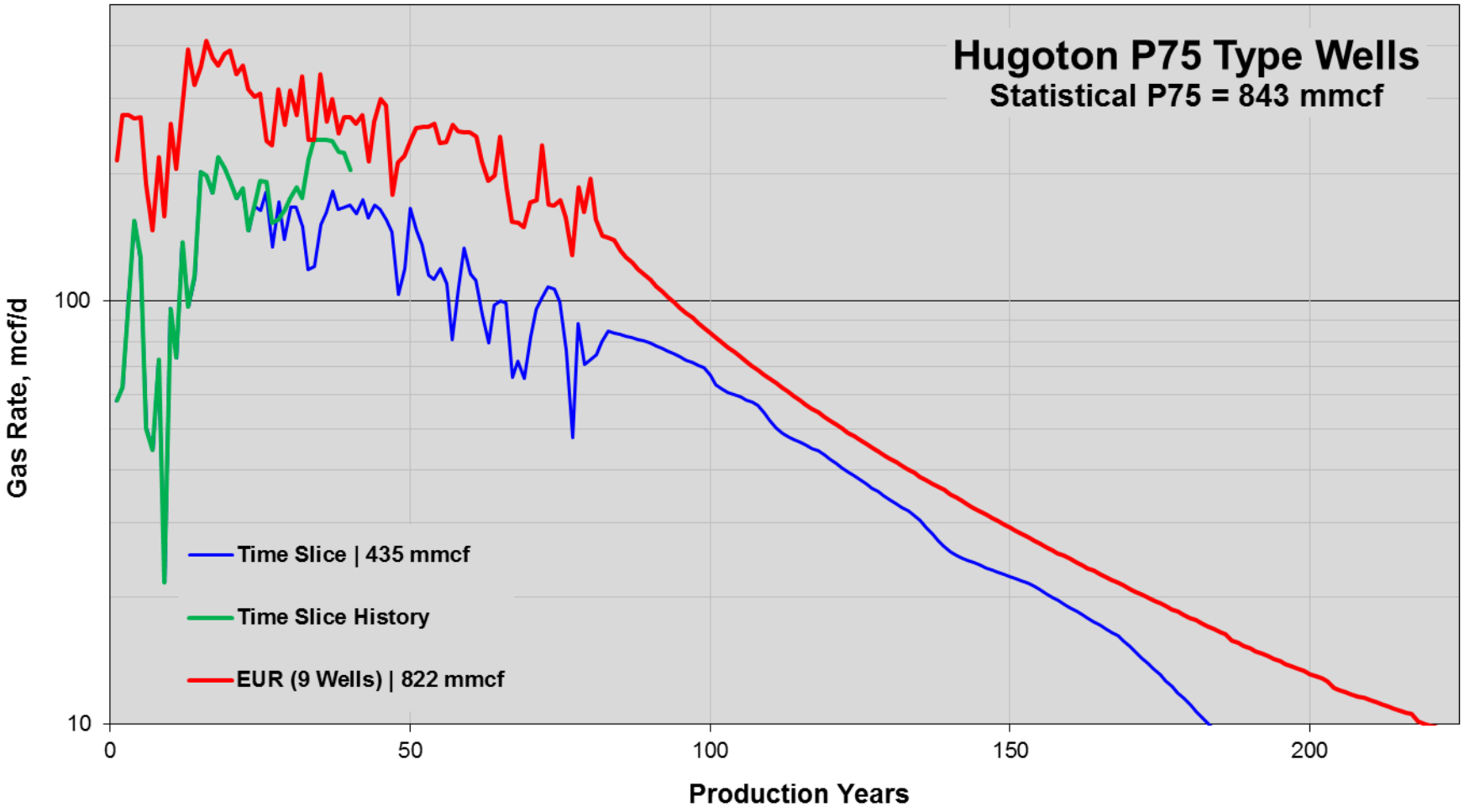
Hugoton Time Slice



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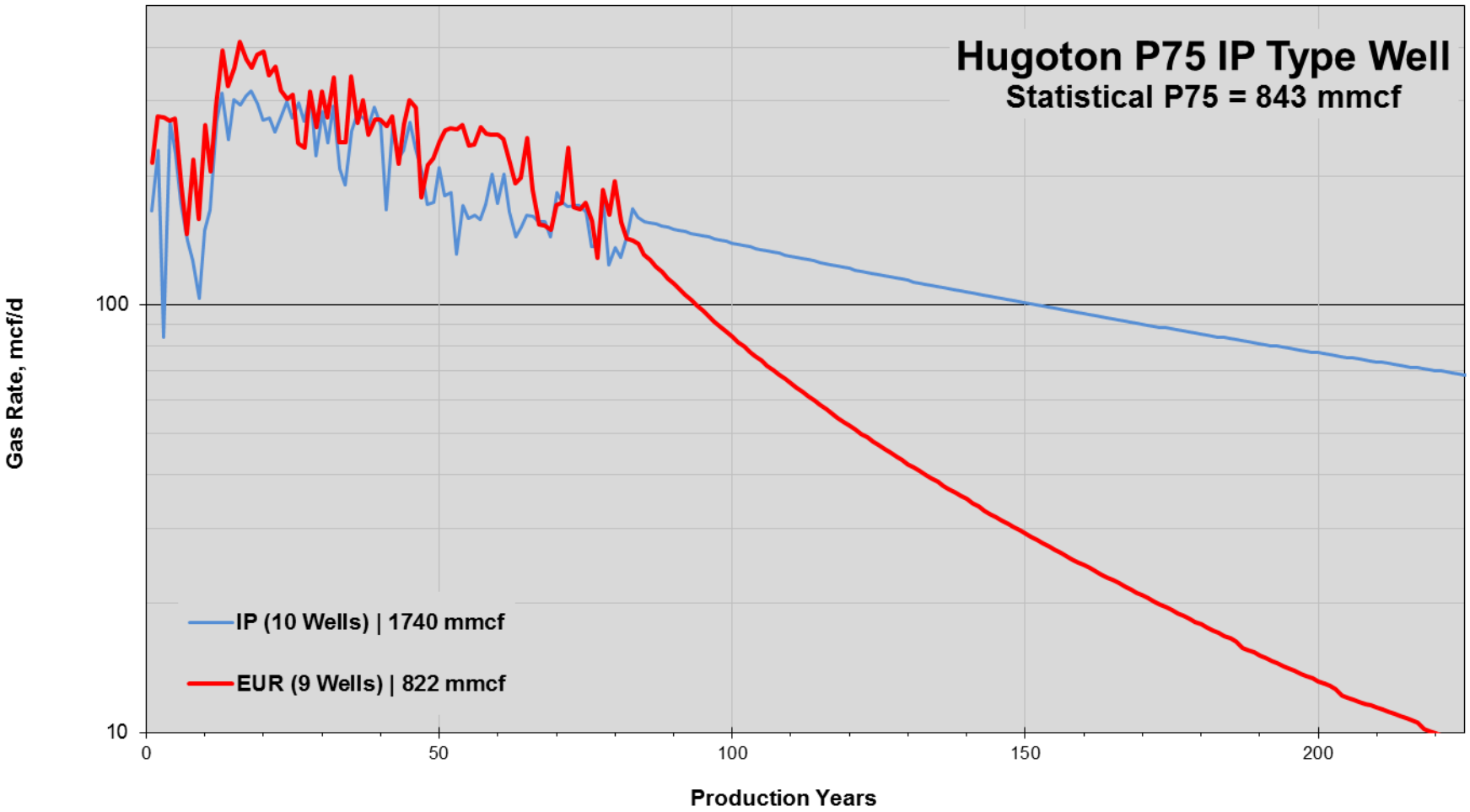
Hugoton P75 Wells



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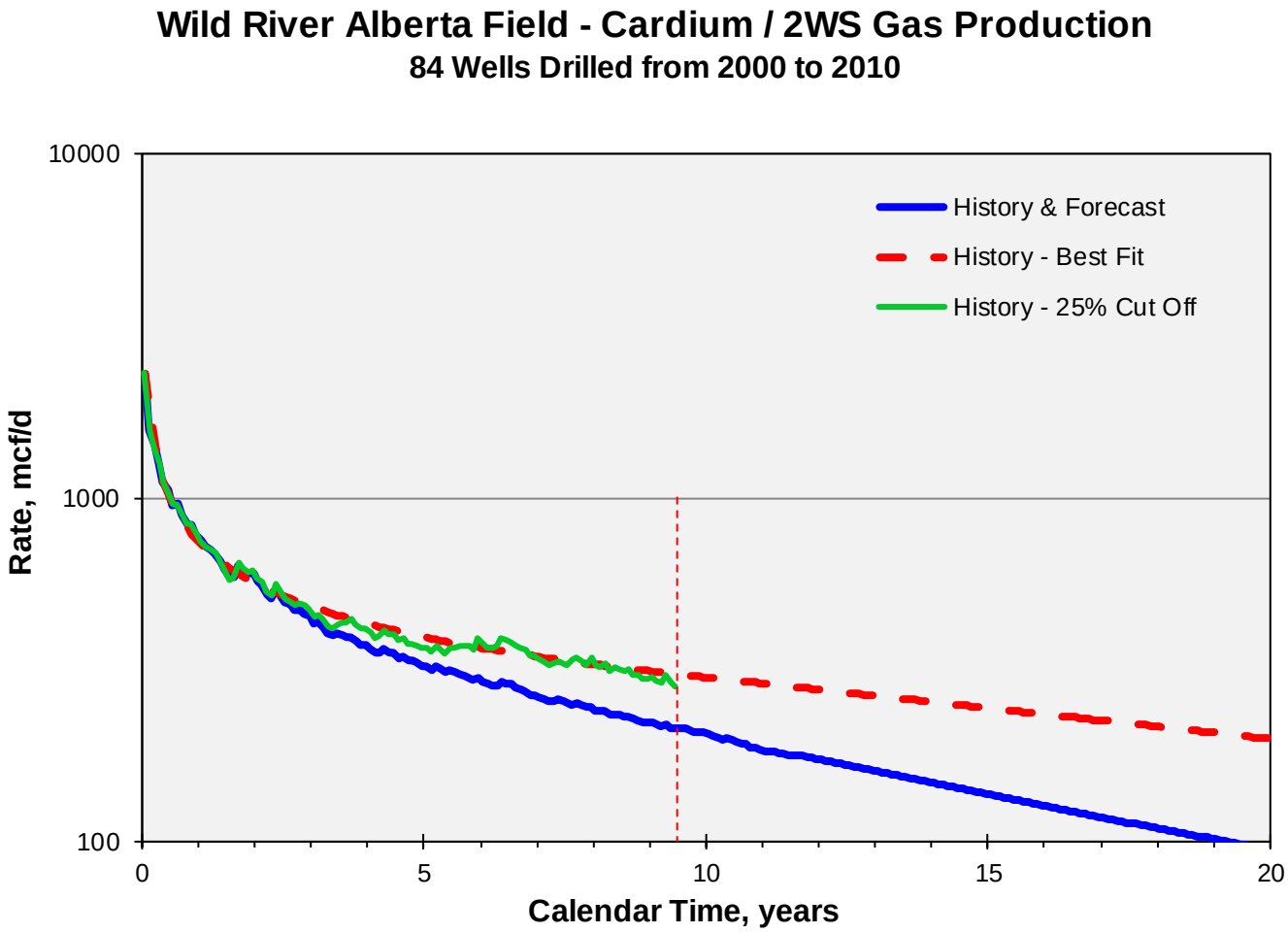
Wild River

- Apparent Sequence Bias
- Standard Practice gives no guidance for cut off
- Data is reliable, forecast good
- Double EUR without forecast



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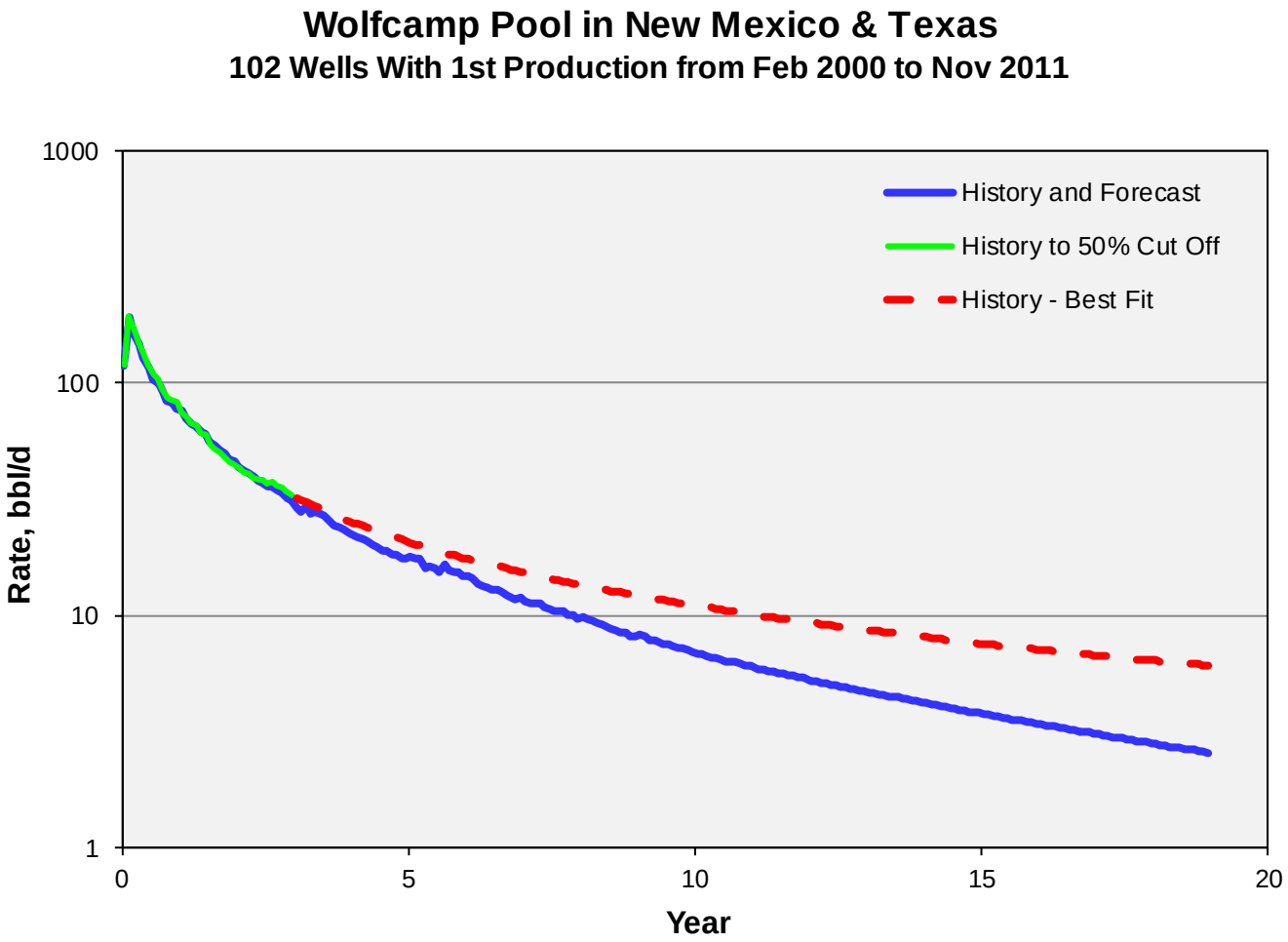
Wolfcamp Pool

- Apparent Sequence Bias
- Standard Practice gives no guidance for cut off
- Auto forecast for all wells
- 40% greater EUR without forecast



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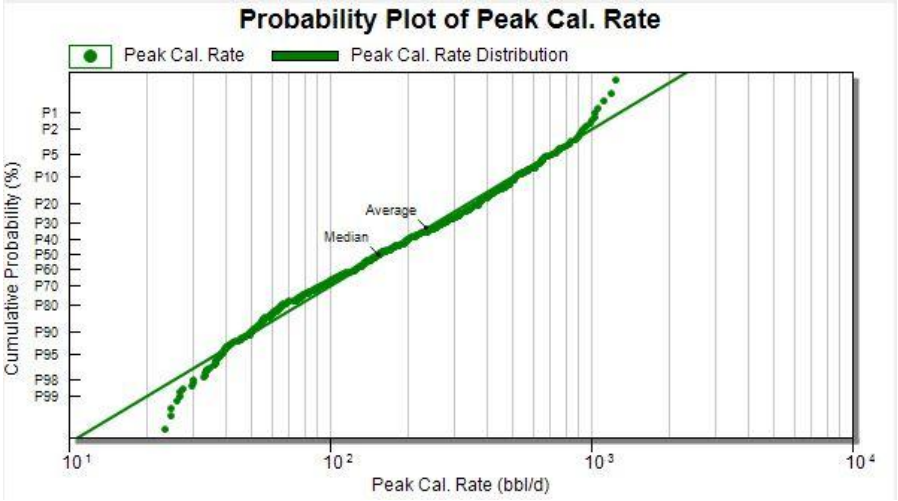
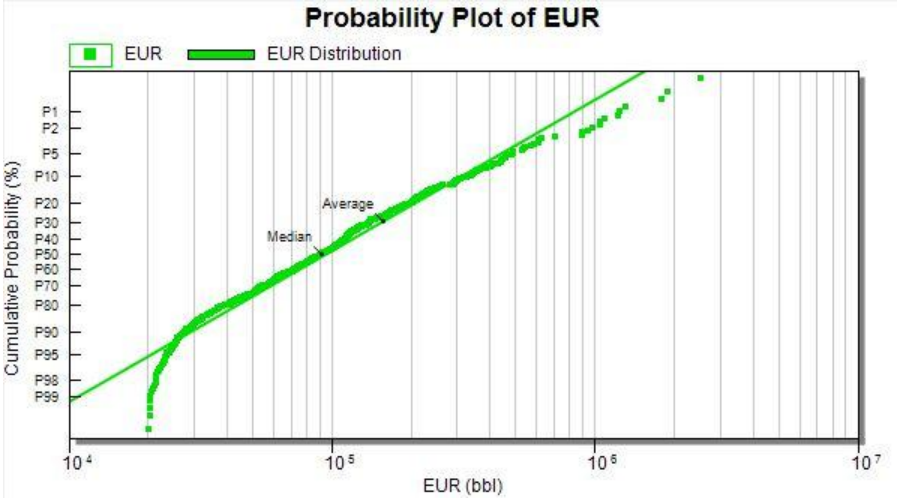
Creating Valid Groups

- Requires statistically valid and significantly similar wells.
- Many factors need to be considered for grouping.
  - Vintage.
  - Fracture size and fracture fluid type.
  - Completion technique.
  - Well location and spacing.
  - Operator.
  - And many others …
- Vintage should always be one of the groups

Use Of Cross Plots





- Valid groups have log normal distribution
  - Initial Production
  - Expected Ultimate Recovery
- Use cross plots to validate groups
- r^2 is for statisticians – visually find and remove wells that don't fit
- Create type wells from valid groups.

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HOW DO YOU FORECAST?

- Resource plays **are** statistical
- Need to forecast 1000's of wells accurately.
- Manual forecasts are not practical – too time consuming and subjective.
- Not so easy, especially in unconventional plays with lots of *super-hyperbolic's.*

Require accurate auto-forecasting!

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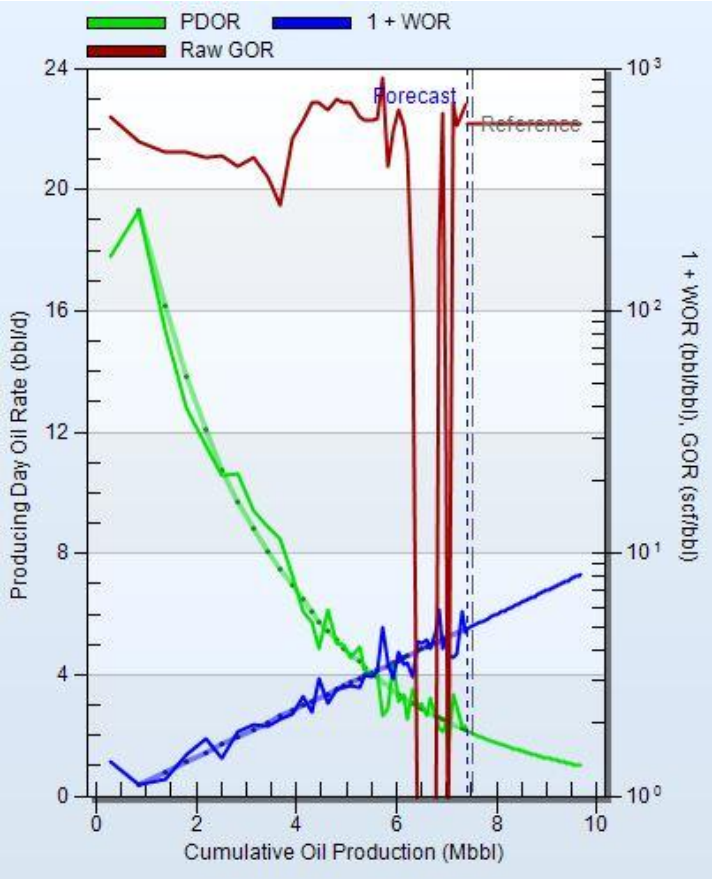
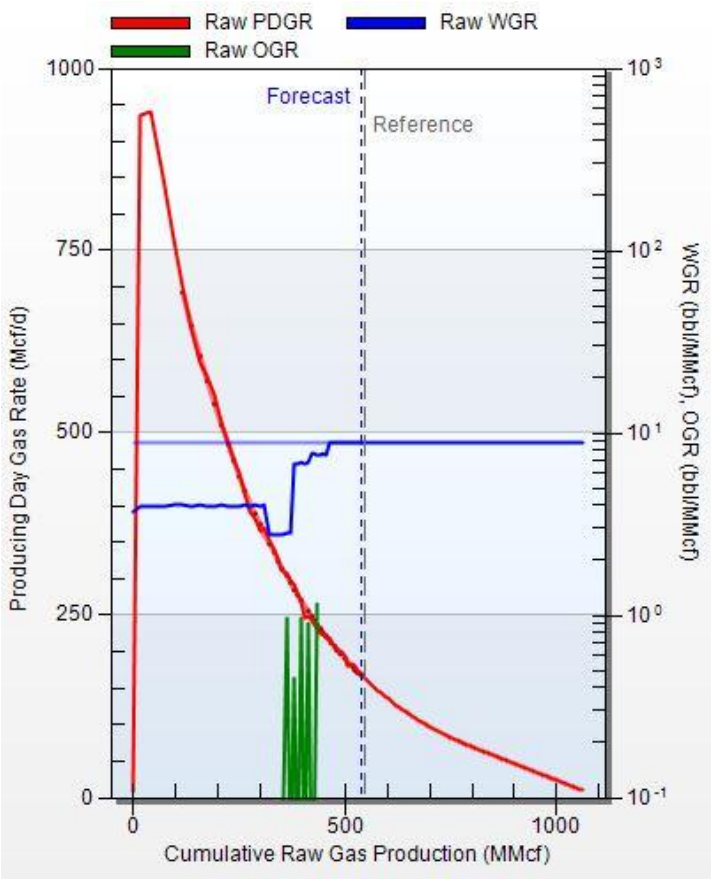
Auto-forecasting

Easy!





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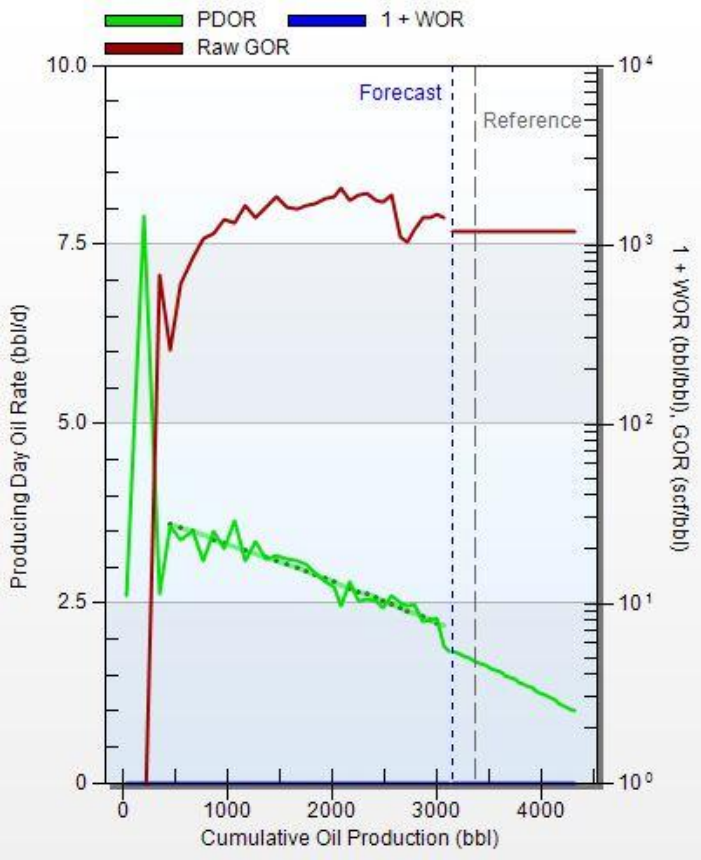
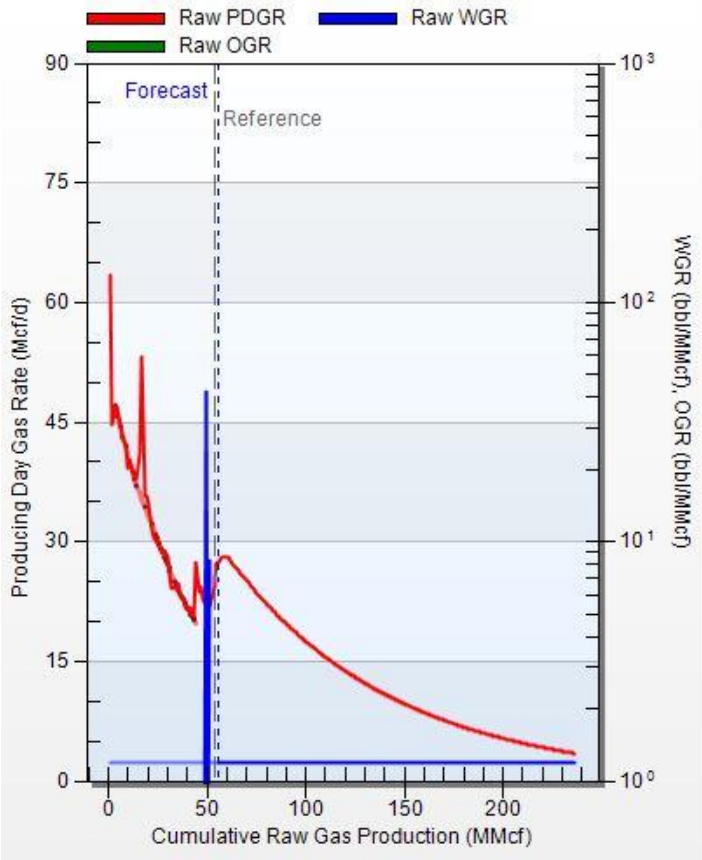
Auto-forecasting

Not so Easy!





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Conclusion

- ISP type wells are defective
  - Forecasts are implicitly created for Gap Wells
  - Implicit forecasts are usually inaccurate
  - Often no guidance when to stop averaging
  - Sequence bias may be too subtle to detect
  - Sequence bias impairs quality – too high or too low
  - Only use when drilling sequence completely random
- Combine history & forecast to create type wells
  - Accurate – Quality improves with forecast
  - Flexible – Use some or all of data to build type well
  - More Data – Extends useful period of historical data
- Use the right tools
  - Statistics to validate grouping and well selection
  - Reliable auto fitting
  - Forecast recent wells using type wells, then update the type well

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Conclusion

Forecasts are inevitable

The best forecast will include the benefit of knowledge and experience, not serendipity.