



# **US Shale Oil Productivity Gains Since the Crash: A look at the Bakken, Rockies, and Permian over the past 2 years**

March 16, 2017





DUG Bakken and Niobrara – Denver, Colorado

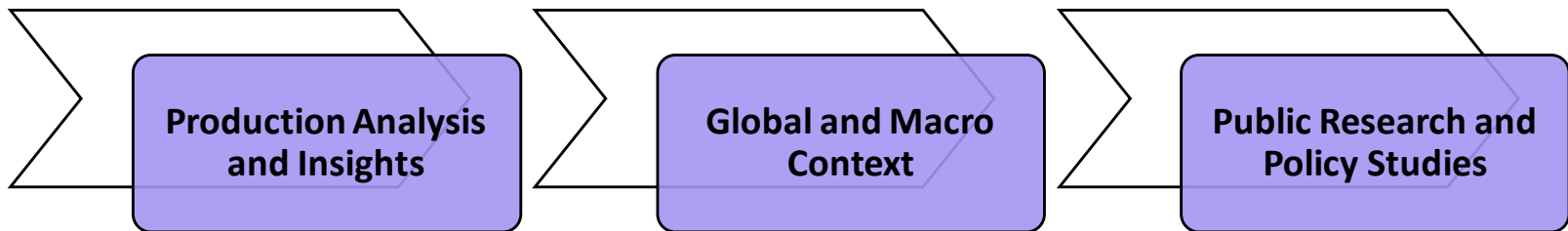
Trisha Curtis – President and Co-Founder, PetroNerds, LLC  
trisha@petronerds.com



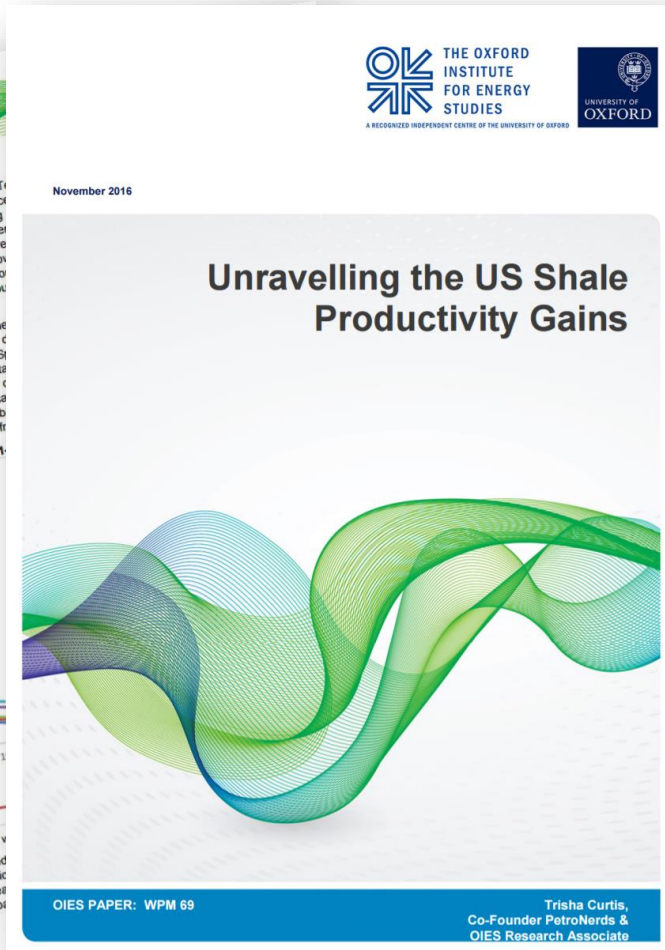
## About PetroNerds

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-  Denver-based boutique research firm specializing in US shale/unconventional/tight oil
-  Granular, data-driven analysis of production, operators, industry behavior and methodologies, and well performance
-  We translate this research into actionable results and provide global market context
-  Company analysis, asset evaluations, in-depth market analysis, infrastructure, policy impacts, global markets/OPEC



## Published Report on US Shale Productivity Gains



Oxford Institute for Energy Studies (OIES), an independent research center of Oxford University

Following the paper, PetroNerds has presented at:

- OIES, Oxford
- Chatham House, London
- KAPSARC (King Abdullah Petroleum Studies and Research Center) Riyadh, Saudi Arabia



## Nuts and Bolts of Productivity Gains

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- Productivity gains are not just about IPs but also increasing EURs
- Shifting the entire production curve upwards and flattening the decline tails
- Major step changes in completions were largely missed by analysts because they were focused on the short term impact of “high grading” and “high intensity completions”
- Initially, skeptics believed that sweet-spot acreage was limited and high proppant volumes only resulted in increasing IPs – “flash in the pan” gains
- Lower prices pushed operators to chase volume, lower costs, and create efficiencies
- Better rock analysis, precision lateral targeting, accurately placing fractures, longer laterals, and higher sand and fluid concentrations enabled substantial gains



## Conceptual Change Taking Place

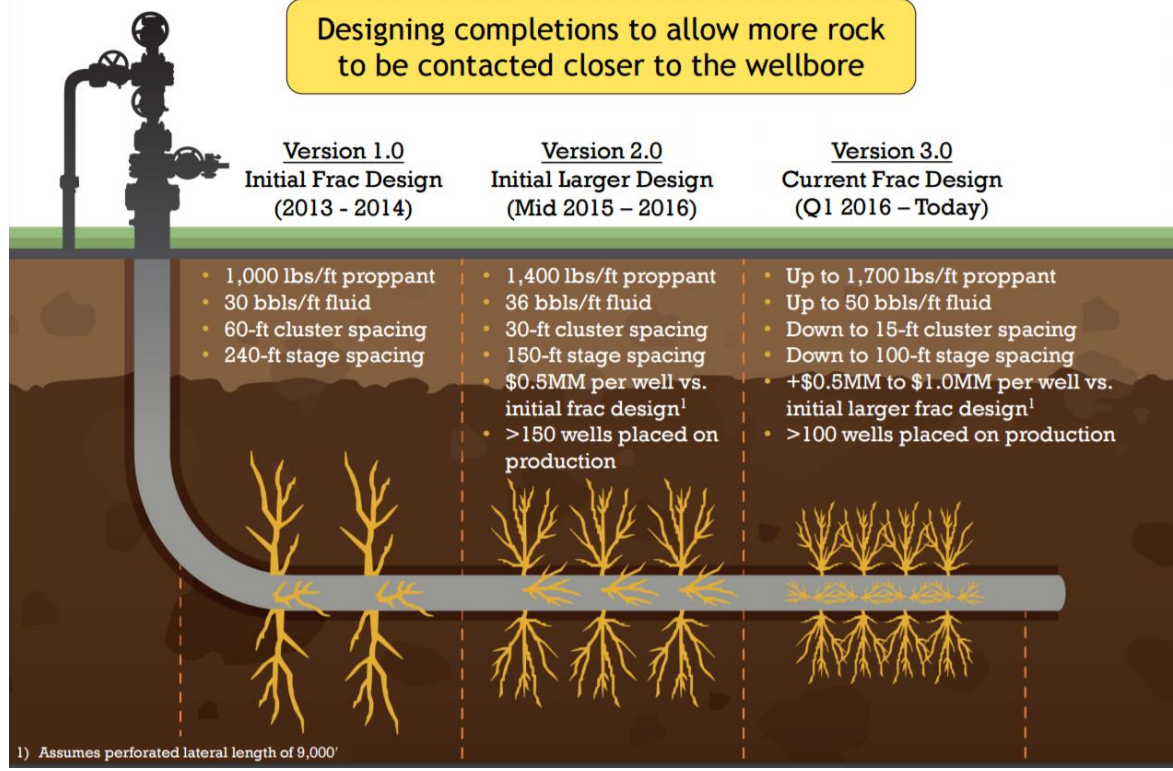
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*There is also a conceptual change taking place as operators gain more knowledge of the reservoirs and see real productivity gains by implementing new spacing, lateral placement, and frac designs. Operators no longer want their fractures to extend as far as possible, rather, they want to keep them close to the wellbore so they can better drain the oil from the reservoir and rock closest to the lateral (wellbore) and place another lateral nearby to do the same thing. This means that companies are increasing reserves and drilling locations by being able to place more laterals closer together.*

# Industry Articulated Example of Completion Changes

## COMPLETION OPTIMIZATION PROGRAM

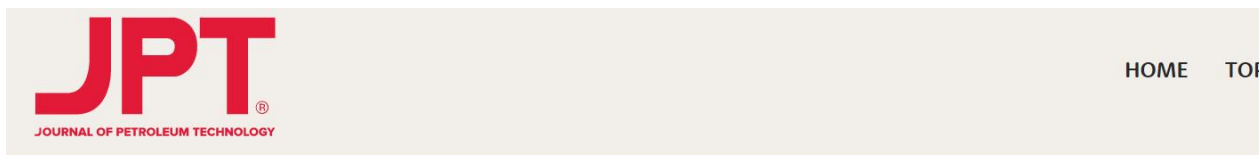
Designing completions to allow more rock to be contacted closer to the wellbore



Changes in completion designs enable the use of cheaper proppant and cheaper fluid

Source: Slide from Pioneer Natural Resources Q4 2016 Investor Presentation

## Pushing the Envelope

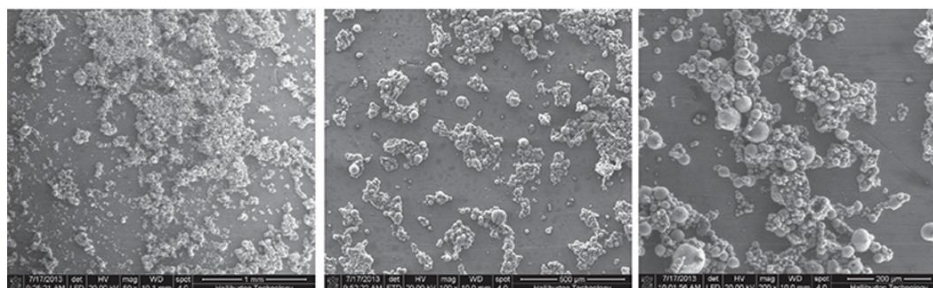


### Seeking Big Oil Production Gains By Fracturing With Microproppant

Stephen Rassenfoss, JPT Emerging Technology Senior Editor | 01 March 2017



Topics: Hydraulic fracturing



Source: Halliburton.

This series of increasingly magnified images of micron-scale proppant from Halliburton shows the spheres on the flat surface of a core that had been split in half. The diameter of the grains is 1–130 microns with most in the 20–30 range. The core is subjected to stresses that simulate reservoir conditions in order to see how much permeability is created by the bumps and ridges formed by clusters of particulate.

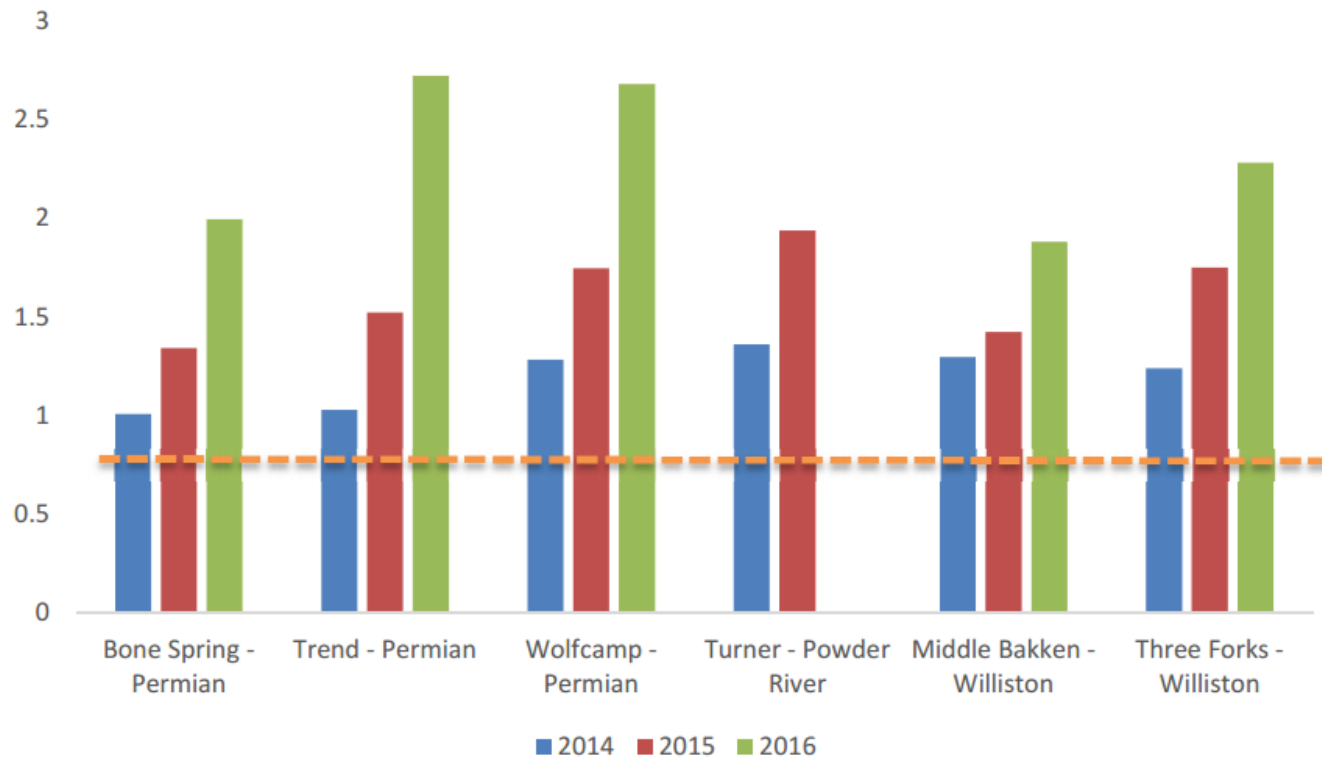
Source: Journal for Petroleum Technology



## Performance Increases of Selected Operators – Within Individual Reservoirs – 2014 - 2016

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Productivity gains are being made across a number of reservoirs



Source: PetroNerds, [Unravelling the US Shale Productivity Gains \(link to pdf\)](#)

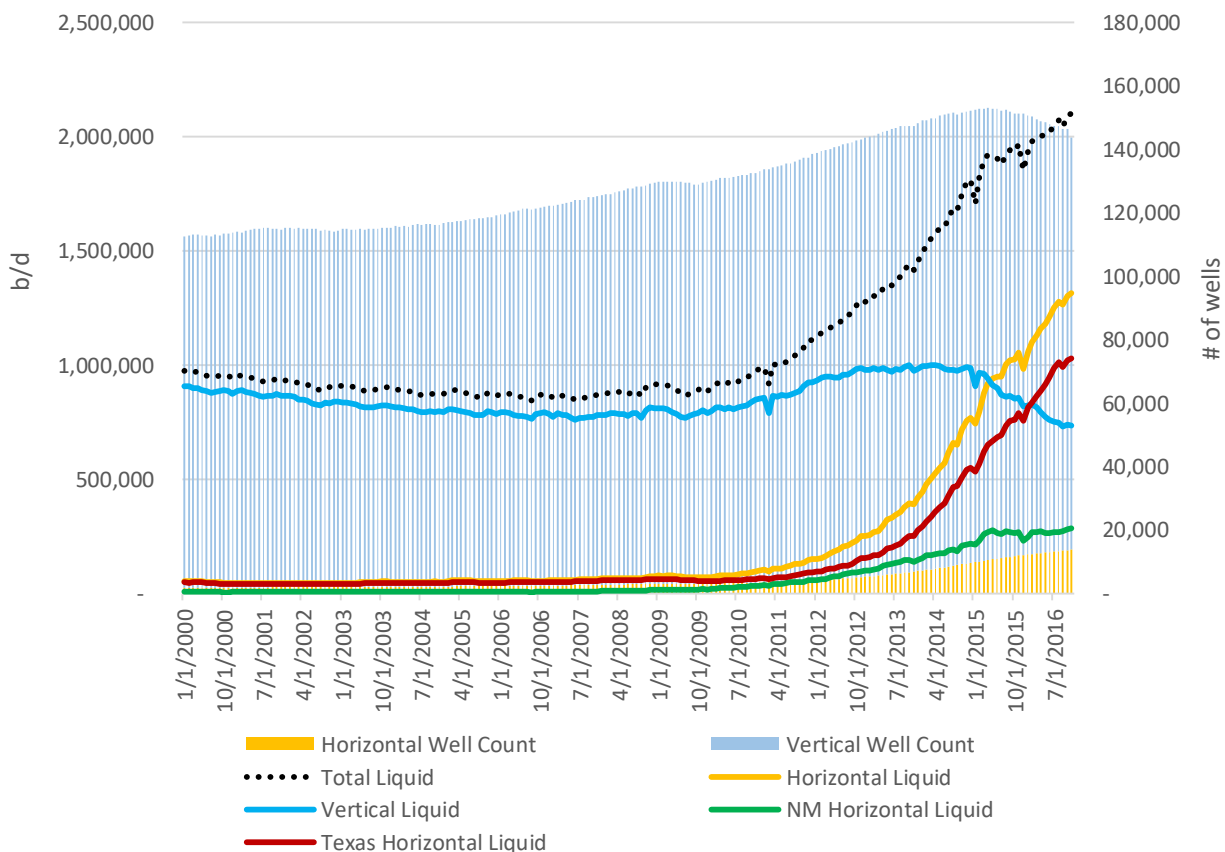




# Texas Sized Productivity Gains (and New Mexico)

# Permian Basin Production Breakout

Permian Basin Production by Well Orientation



2.1 Mbd Nov 2016

New Mexico: Bone Spring, Delaware, and some Wolfcamp

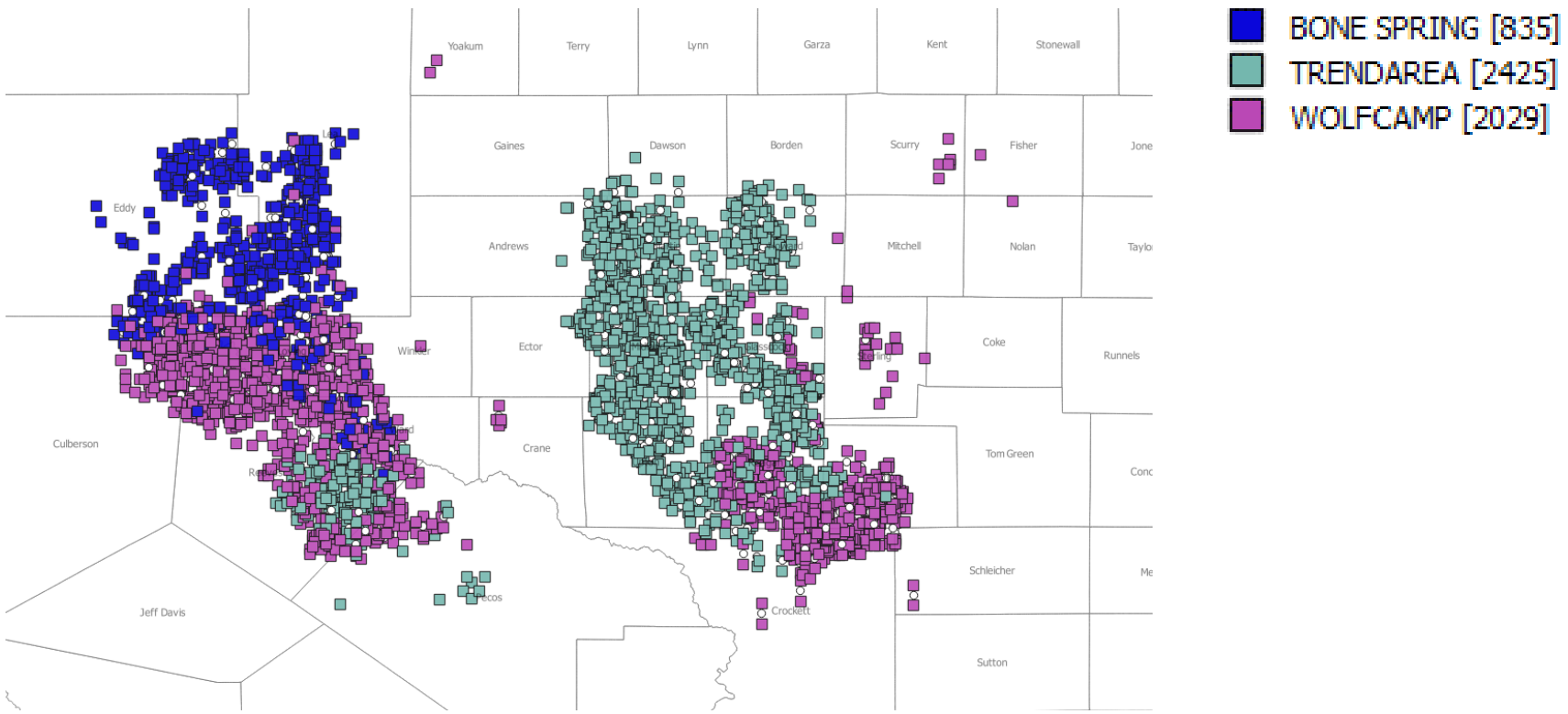
Texas: Trend Area, Wolfcamp and some Bone Spring

Permian production is far less concentrated in the hands of top producers than many other tight oil plays

Acreage HBP

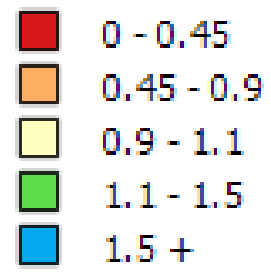
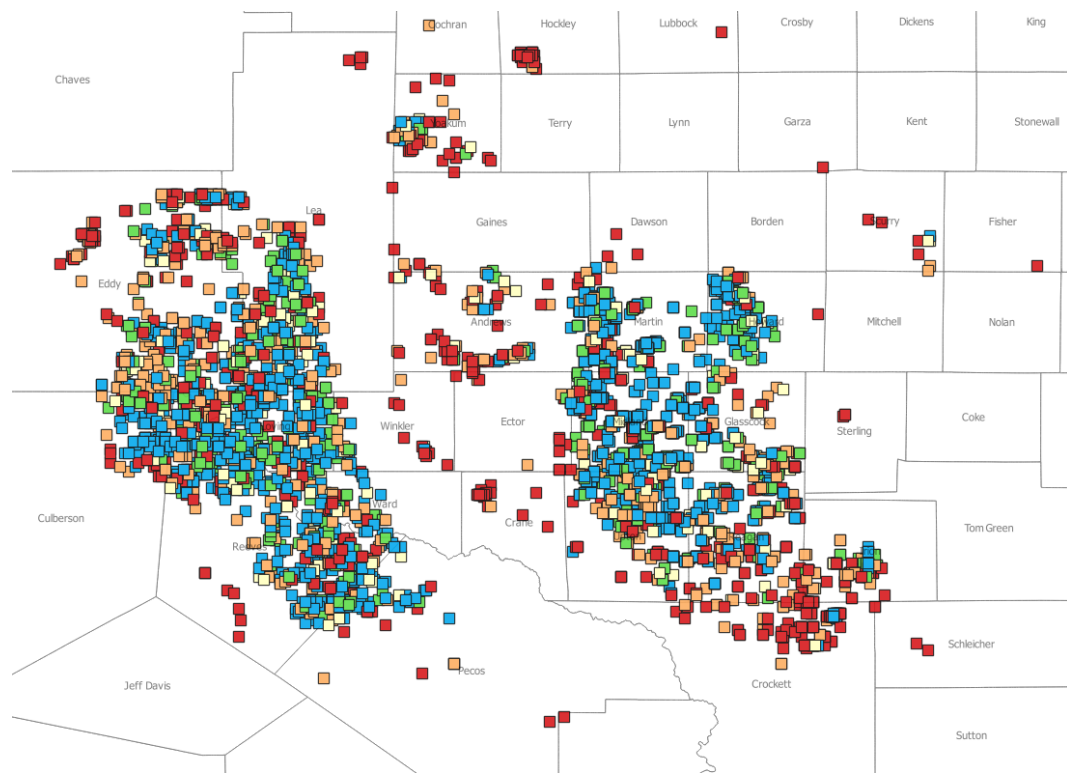


# Primary Permian Reservoirs – H Wells added since 2014

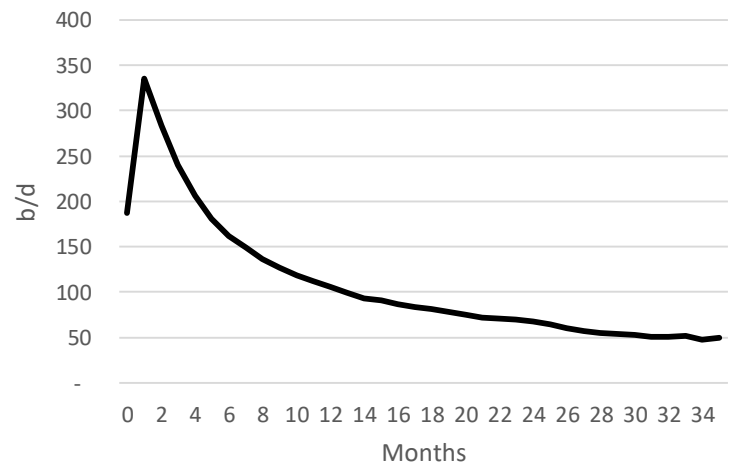


Source: PetroNerds

# Permian Basin Productivity



Permian 2014 Decline Curve

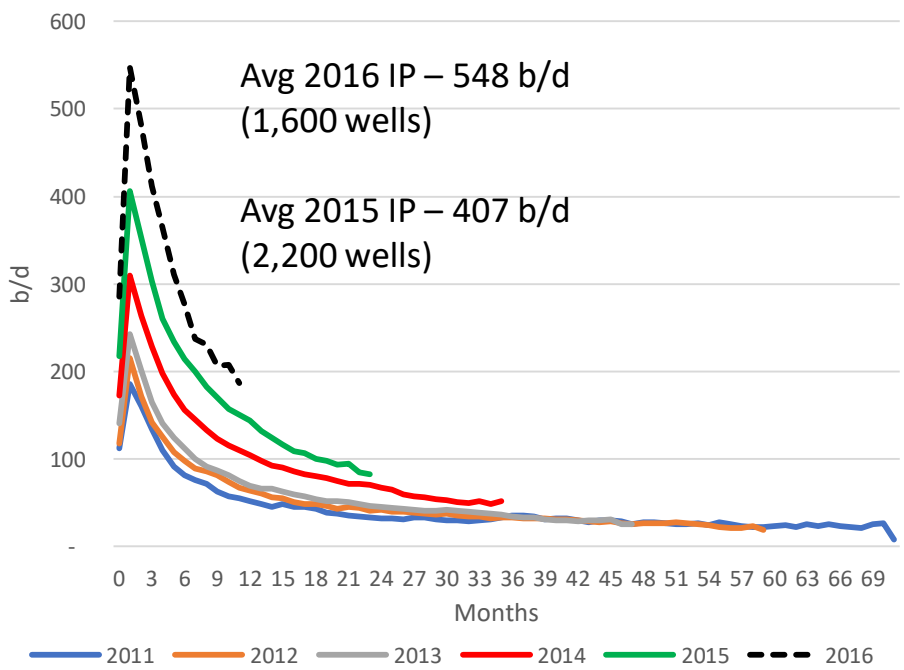


Source: PetroNerds, raw data DrillingInfo, Productivity: wells are indexed to the average 2014 horizontal well for each basin, which = 1, and adjusted for age.



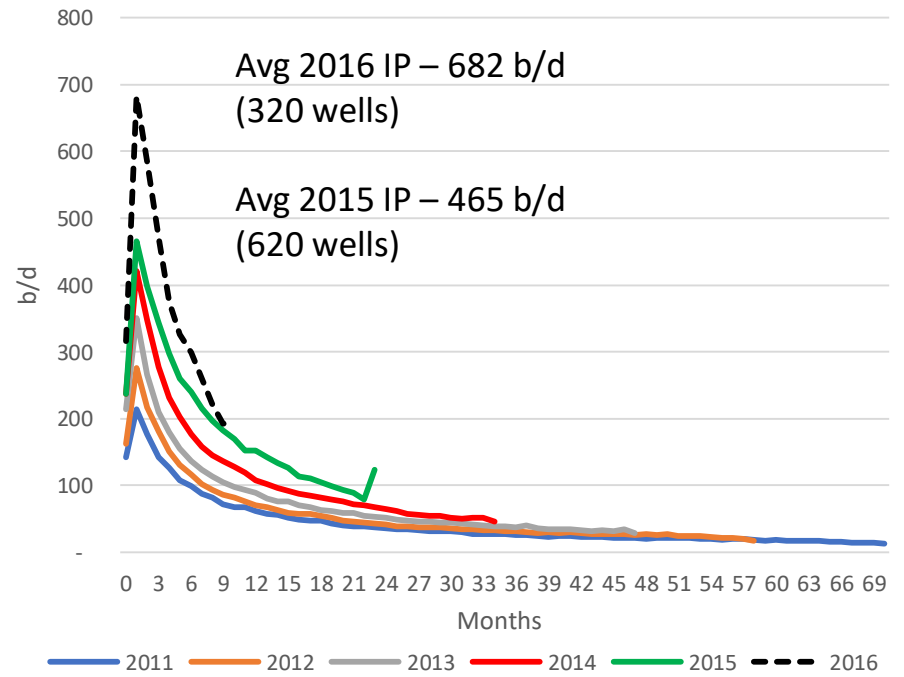
# Permian Basin Horizontal Well Performance by State

Texas Decline Curve



Texas - prominent reservoirs: Trend Area, Wolfcamp, Bone Spring

New Mexico Decline Curve

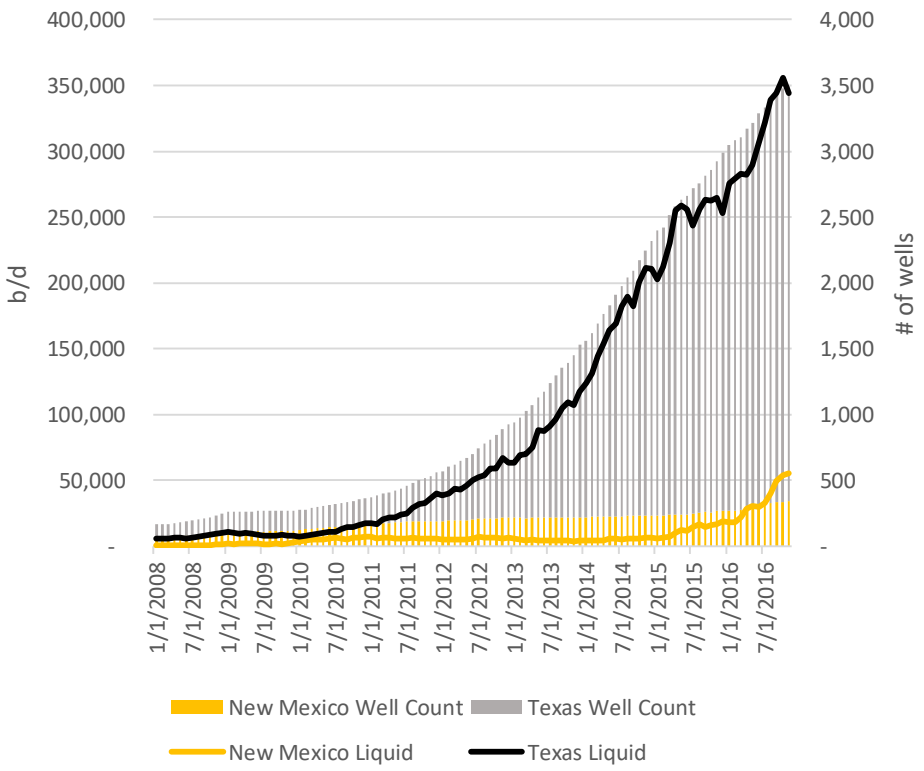


New Mexico - prominent reservoirs: Bone Spring, Wolfcamp, Delaware

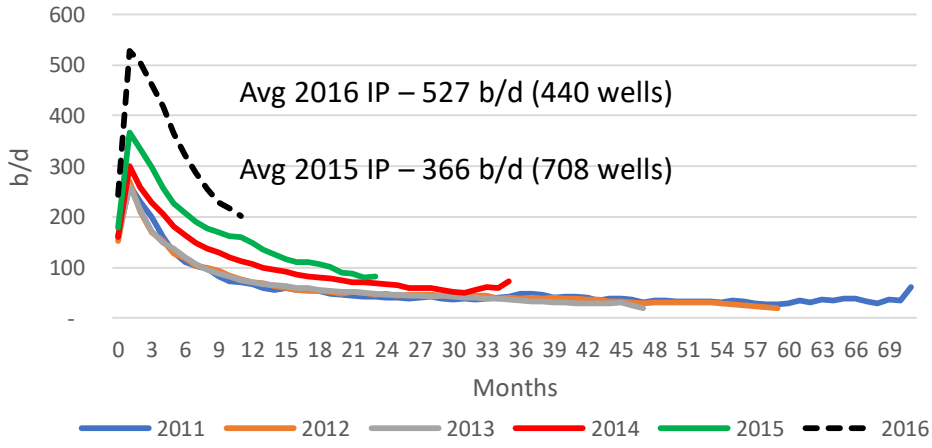
Source: PetroNerds, Raw data DrillingInfo, Mar 7, 2017

# Wolfcamp Horizontal Reservoir Production and Well Performance

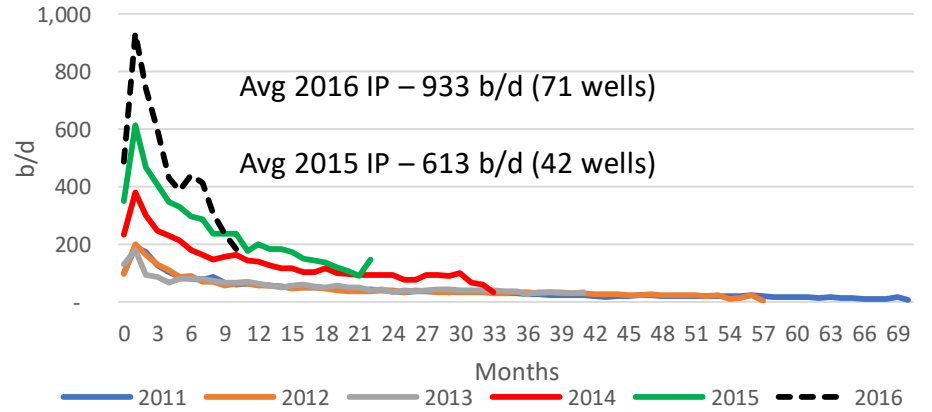
Texas and New Mexico Wolfcamp Production



Texas Wolfcamp Decline Curve



New Mexico Wolfcamp Decline Curve

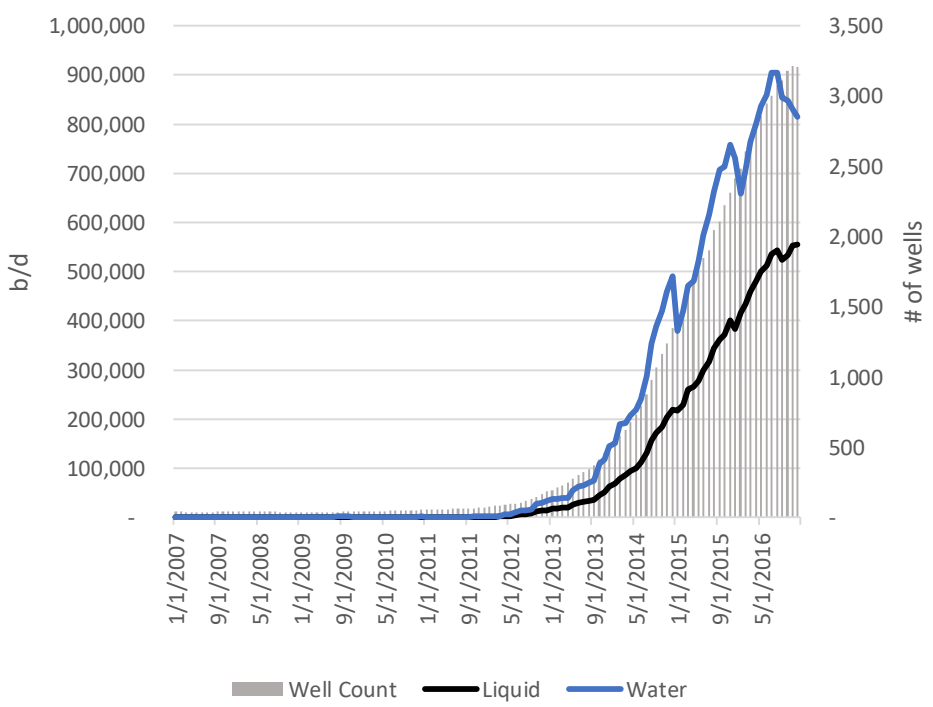


Source: PetroNerds, Raw data DrillingInfo, Mar 8, 2017

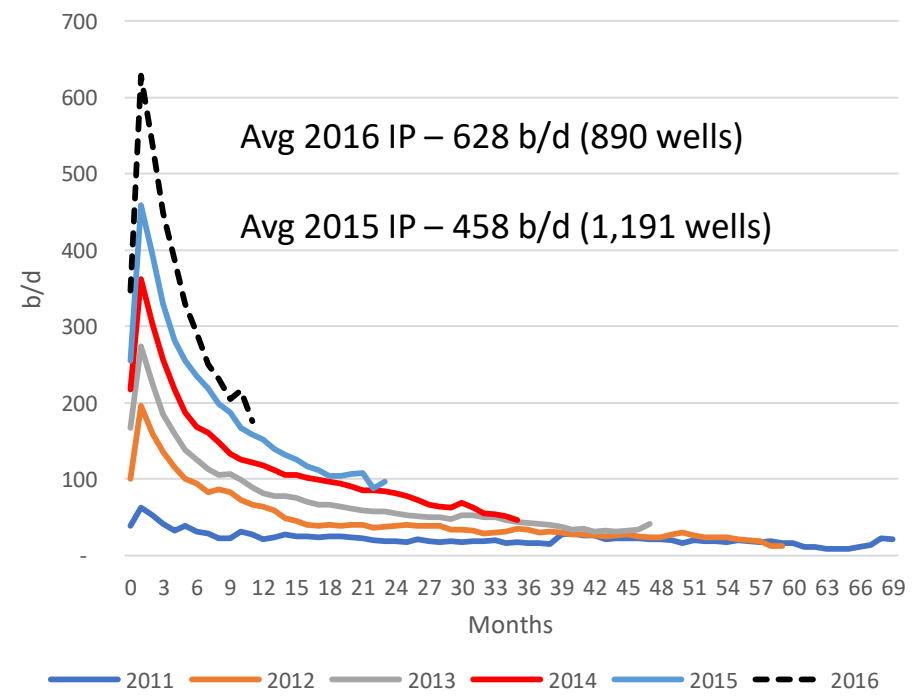


# Texas Trend Area Reservoir Horizontal Production and Well Performance

Texas Trend Area Reservoir



Trend Area Decline Curve



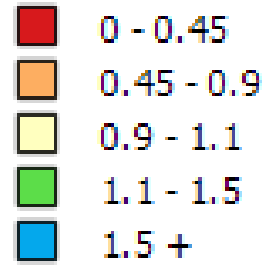
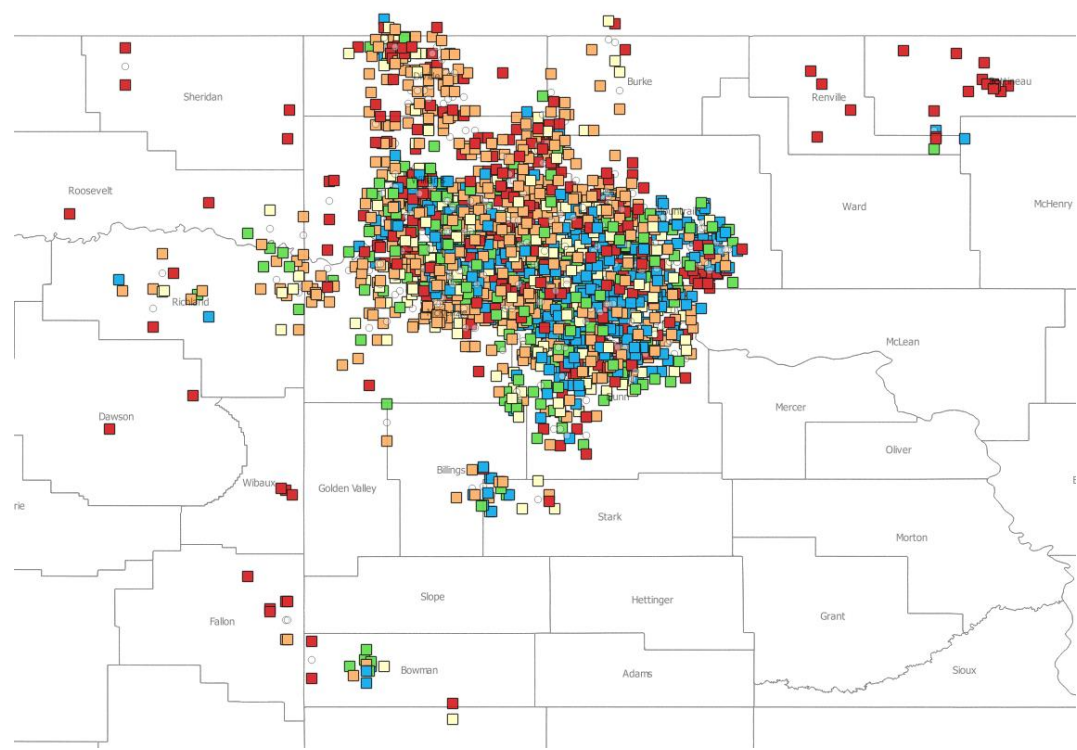
Source: PetroNerds, Raw data DrillingInfo, Mar 7, 2017



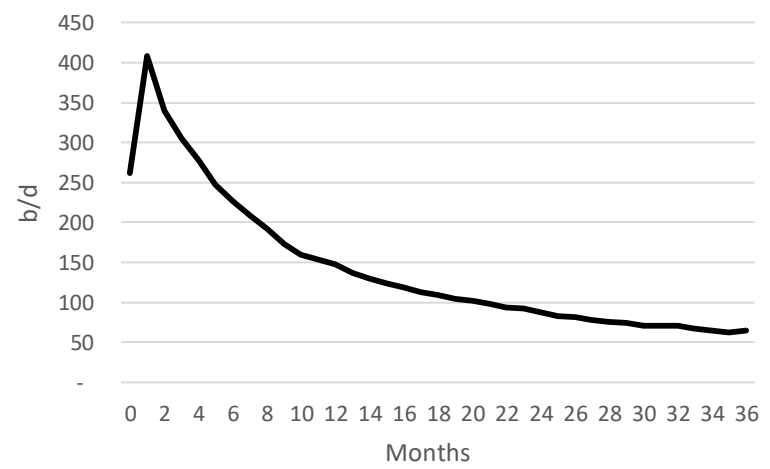
# Bringing it Home: Bakken and Rockies



# Williston Basin Productivity



Williston 2014 Decline Curve

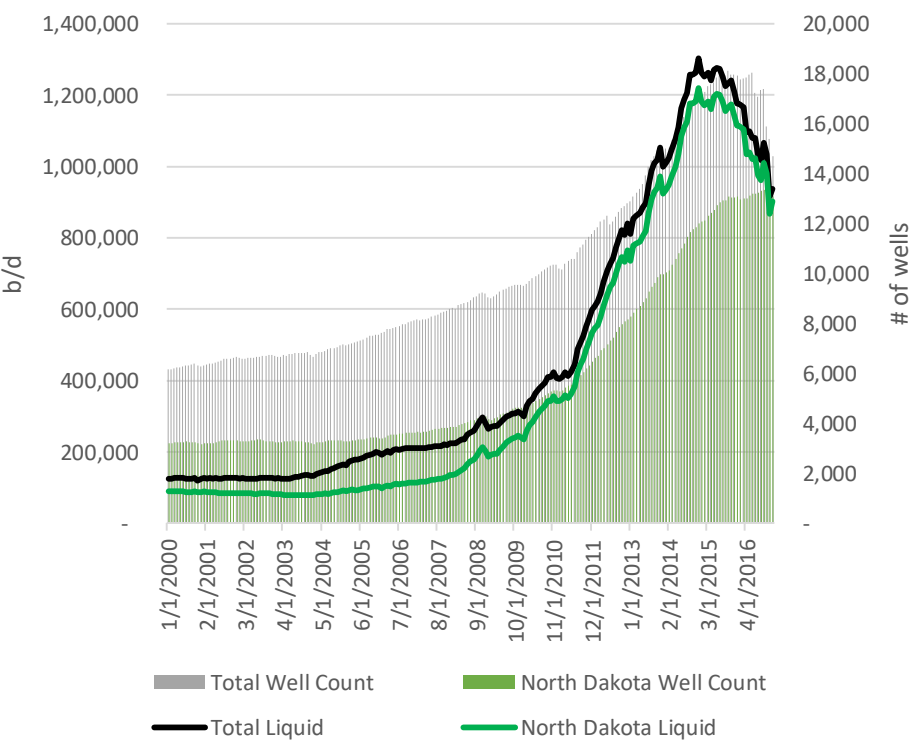


Source: PetroNerds raw data DrillingInfo

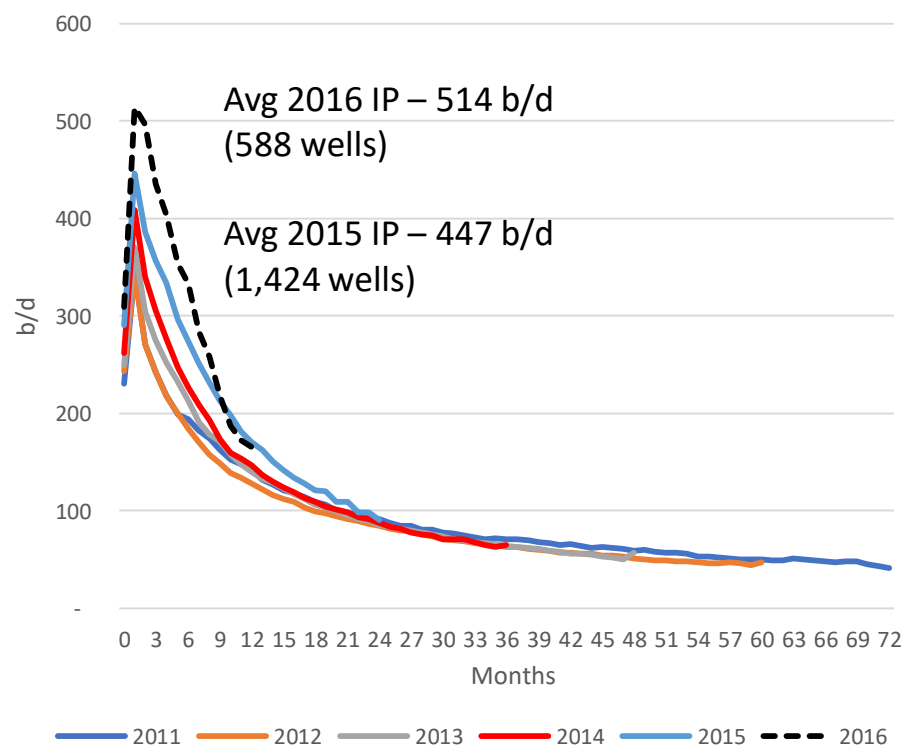


# Williston Basin Production and Well Performance

Williston Basin Production



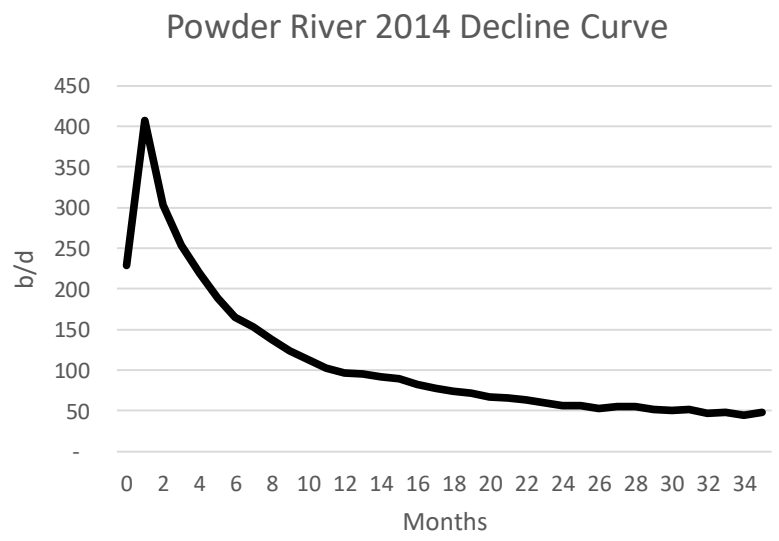
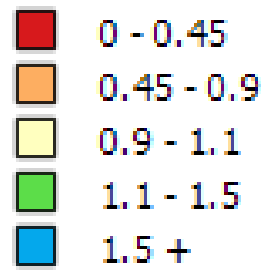
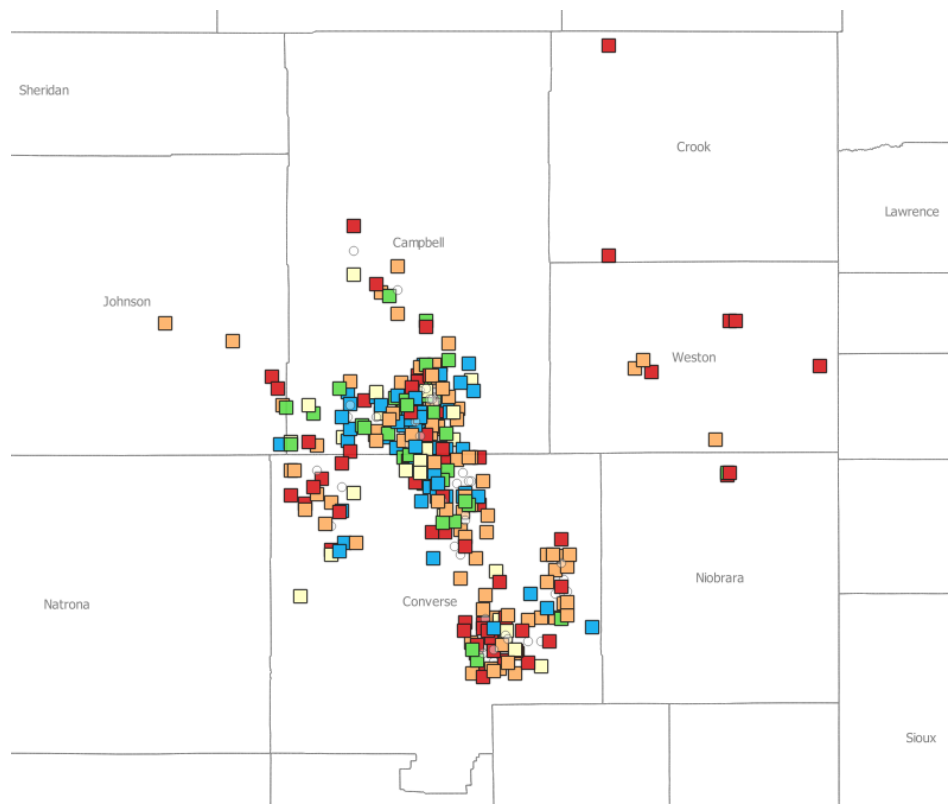
Williston Basin Decline Curve



Source: PetroNerds, Raw data DrillingInfo, Mar 12, 2017



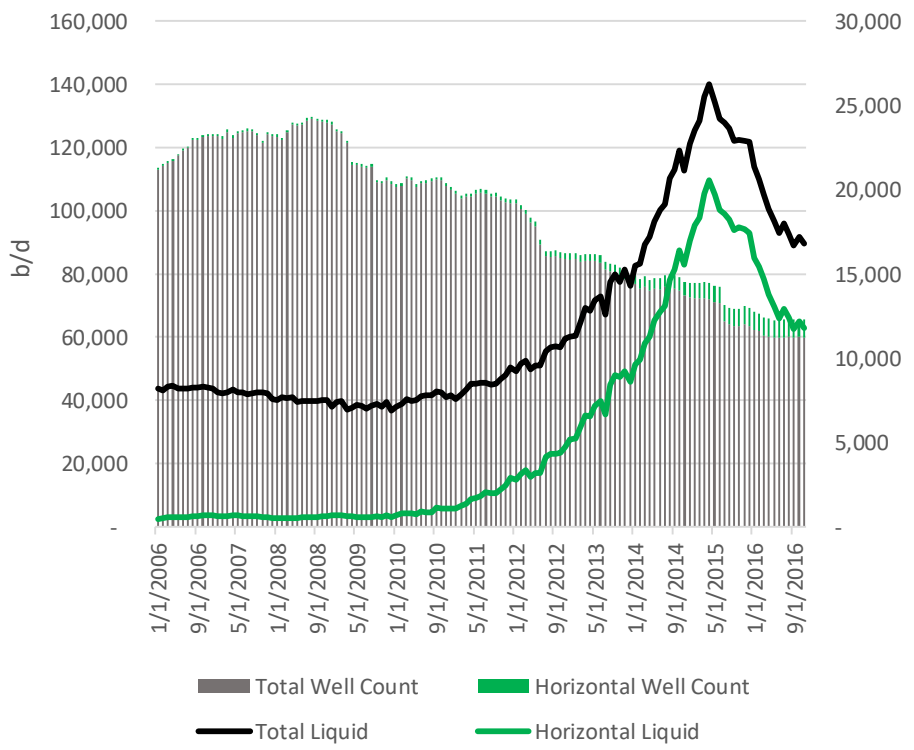
# Powder River Basin Productivity



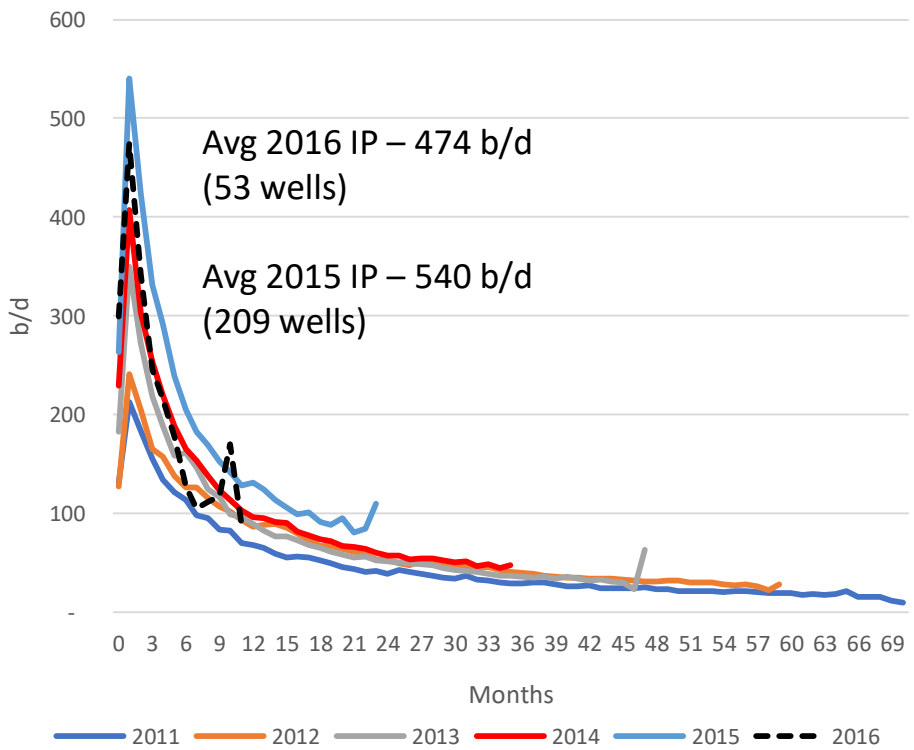
Source: PetroNerds raw data DrillingInfo

# Powder River Basin Horizontal Production and Well Performance

Powder River Production

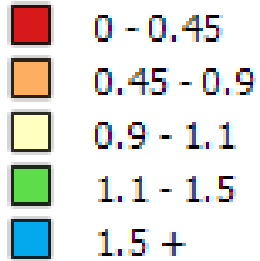
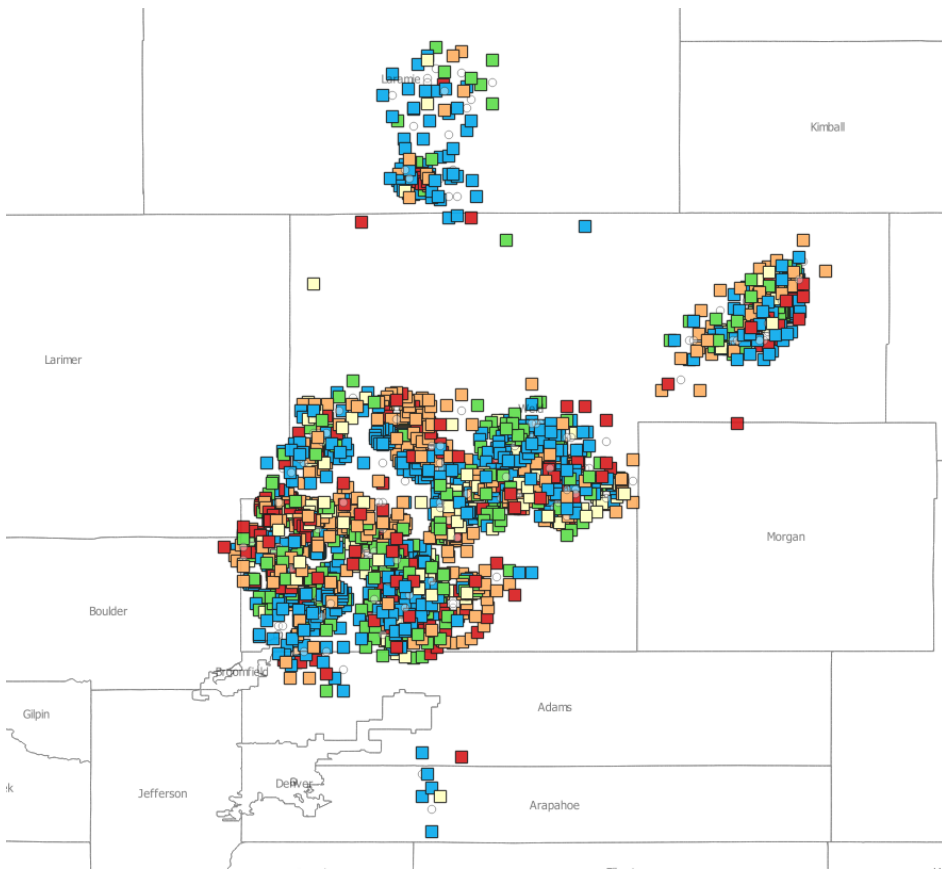


Powder River Basin Horizontal Decline Curve

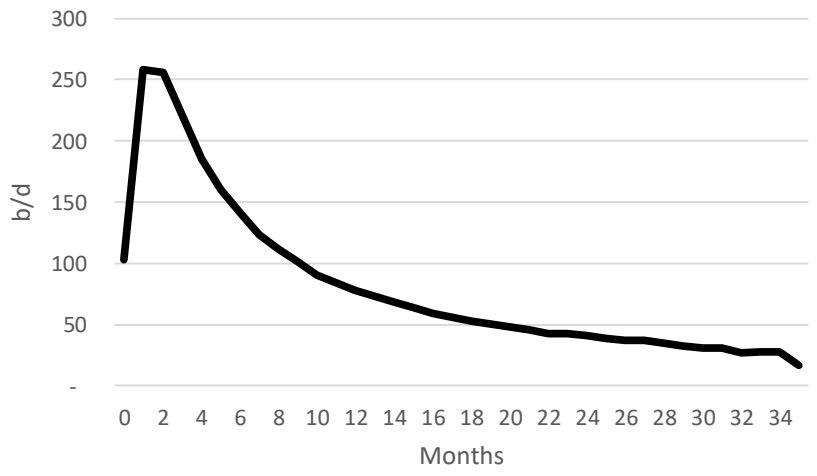


Source: PetroNerds, Raw data DrillingInfo, Mar 1, 2017

# DJ Basin Productivity



DJ 2014 Decline Curve

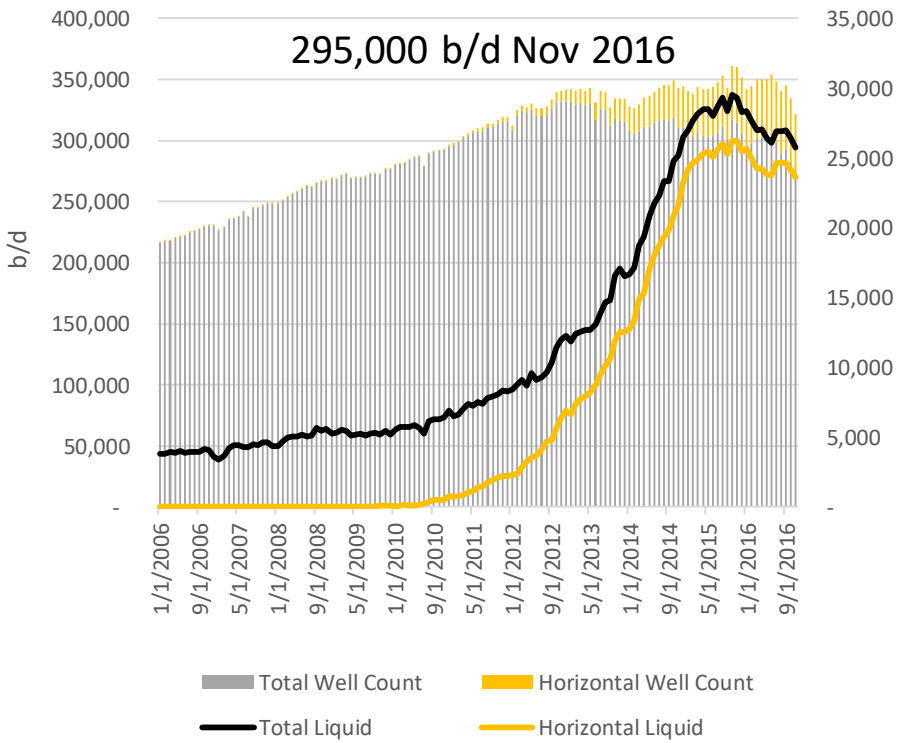


Source: PetroNerds raw data DrillingInfo

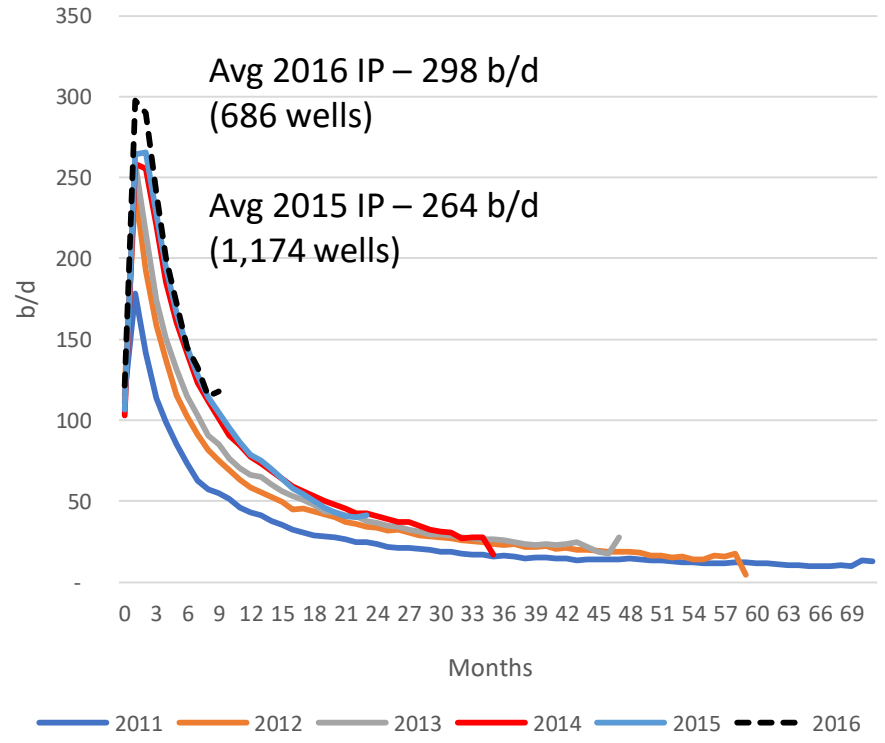


# Denver Julesburg Basin – Beginning to See Some Gains

DJ Basin Production



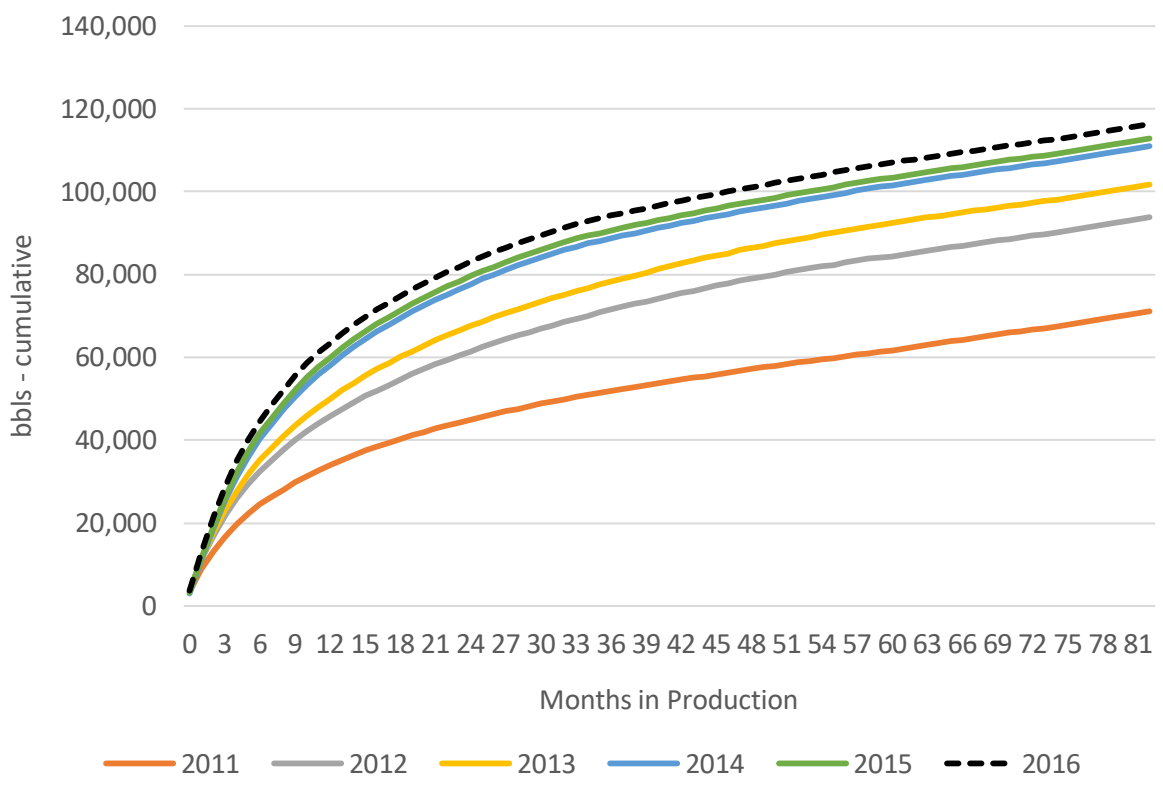
DJ Horizontal Decline Curve



Source: PetroNerds, Raw data DrillingInfo, Mar 1, 2017

## DJ Basin Cum - EUR Growth Stagnating

Cumulative 7 Year Oil Production Estimates



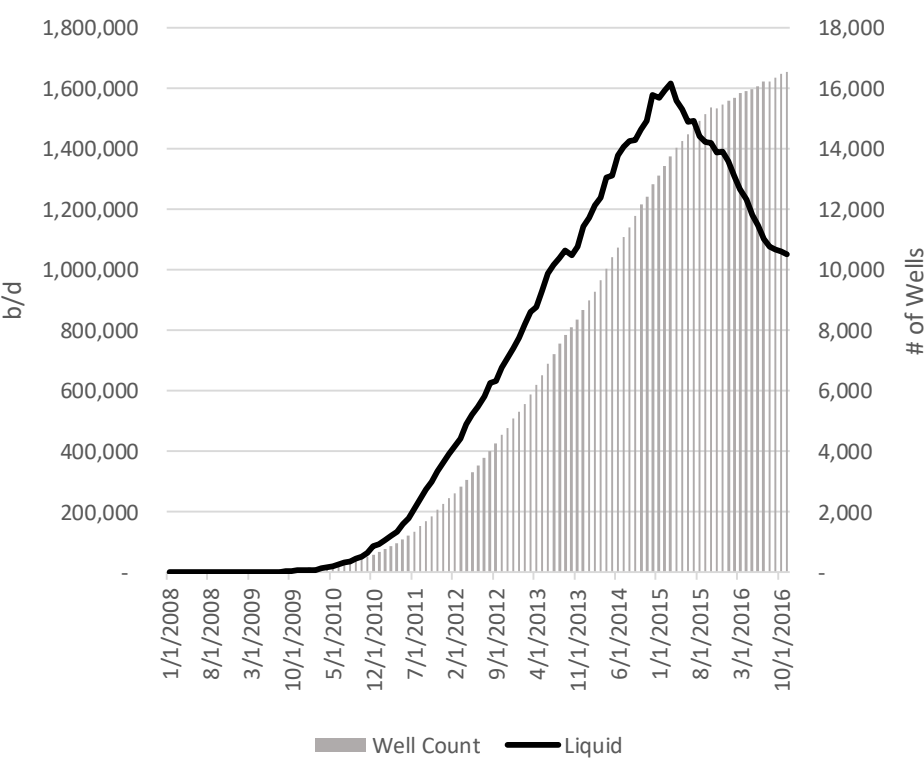
Oil EUR growth has largely stagnated since 2014

Source: PetroNerds, Raw data DrillingInfo

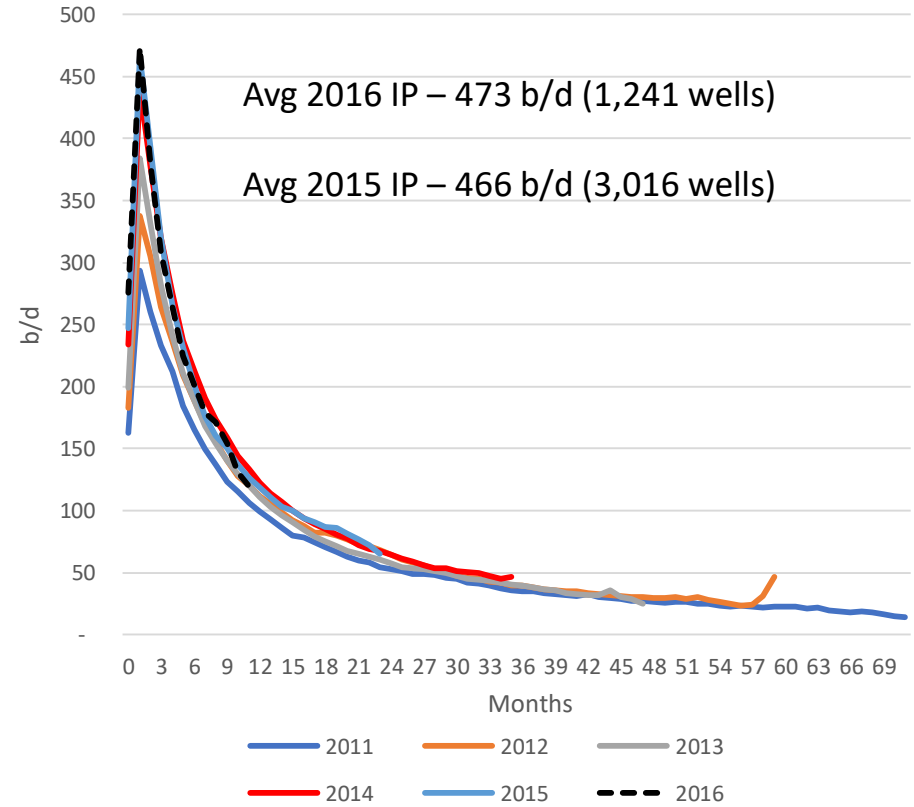


# Eagle Ford Production and Well Performance

Eagle Ford Production and Well Count



Eagle Ford Reservoir Decline Curve



Source: PetroNerds, Raw data DrillingInfo, Mar 13, 2017





## Permian and DJ Cross Pollination

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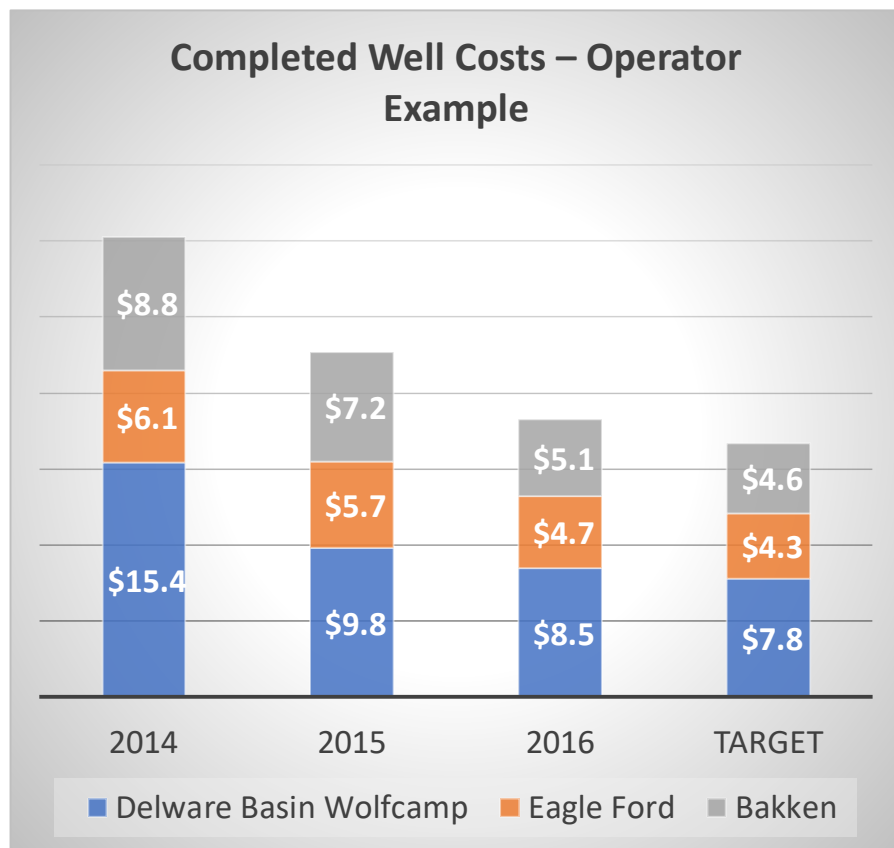
*Our development plan in 2017 will continue to shift towards higher proppant intensity completions, targeting an average of around 1,800 pounds per foot while continuing to test some wells with over 2,000 pounds per foot.*

*...enhanced completions in the Delaware....tested a range of proppant concentrations between 3,000 and 5,000 pounds per foot.*

*Similar to the DJ, it will be important to see what production rates are after 60, 90 and 120 days...we're definitely controlling flowback on those wells. And I would say, they're staying flatter for longer under that control of flowback than what we've modeled for a typical type curve.*

Noble Energy, Q4 2016 Earnings Call, Feb 14, 2017, Seeking Alpha

## Shorter Cycle, Lower Costs, and Rising Productivity



Source: EOG figures from Q4 2016 Earnings Call Feb 28, 2017 slide deck, CWC includes drilling, completion, wellsite facilities and flowback

- Rising costs for higher proppant loads, fluids, and pressure pumping
- Some cost cuts are temporary (service sector), but productivity improvements should not be underestimated (increasing output and lowering long-term costs)
- Spud to TD days have been dramatically reduced (less than a week in Eagle Ford and Bakken)
- Efficiency savings in water handling, faster drilling and completion times, and better facilities management
- US shale/tight/unconventional oil now 5% of global supply