Mint Oil Distillation as a Function of Mint Hay Moisture Content

https://www.mintfarm.ca/

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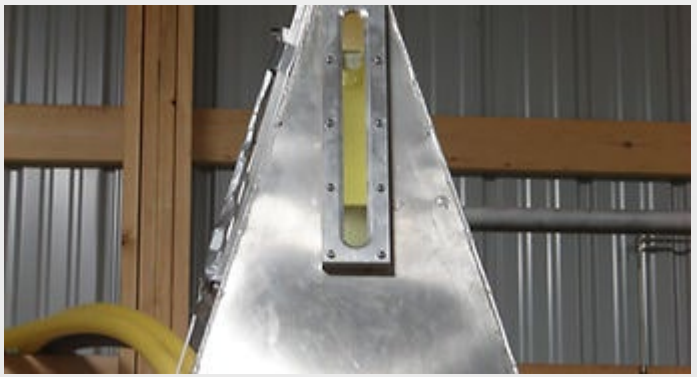
Objectives

- Work with Dale and Gavin Thacker's Existing Data Set. Gather additional data using three different steam flow rates

https://www.mintfarm.ca/



Thacker Data Set - 2014 – 2024

- Hay % moisture,
- Field of origin,
- Tub number,
- Stall,
- Acreage in the load,
- Load tonnage,
- Lbs oil from each load,
- Start time,
- Breakthrough time,
- End Time,
- Oil temperature,
- Boiler pressures,
- Steam Flow Rate,
- Oil Flow Rate,
- How these vary over time for each load of mint that is distilled.

Pearsons Correlation Coefficients r

Variable	BTDurr Min	CookDurr Min	Oil Pr Load	Moist %	BT Steam Lbs	Cook Steam Lbs	BT Steam Lbs/Hr	CkSteam Lbs/Hr	Oil/ 1000Lb TotalSteam	Oil/Ton WetHay
CookDurr Min	-0.11***	—								
Oil/Load	-0.166***	**0.789*** **	—							
Moist %	**0.598*** **	**-0.289*** **	**-0.484*** **	—						
BT_Steam Lbs	0.832***	-0.116***	-0.106***	**0.561*** **	—					
Ck_Steam Lbs	-0.102***	0.944***	**0.774*** **	-0.234***	-0.107***	—				
BTSteam Lbs/Hr	-0.049	-0.068*	0.000	0.064*	0.377***	-0.097***	—			
CookSteam Lbs/Hr	-0.024	-0.075**	-0.007	0.144***	0.012	0.211***	-0.128***	—		
Oil/1000Lb TotalSteam	-0.368***	0.454***	0.842***	**-0.627*** **	-0.378***	0.394***	-0.053	-0.17***	—	
Oil/Ton WetHay	-0.162***	0.616***	0.718***	**-0.519*** **	-0.198***	**0.567*** **	-0.091**	-0.114***	0.659***	—
Ton DryHay/Load	-0.174***	-0.177***	-0.082**	-0.071**	-0.065*	-0.139***	0.139***	0.083**	-0.027	-0.631***

* p < .05, ** p < .01, *** p < .001

Analysis of Discrete Variables

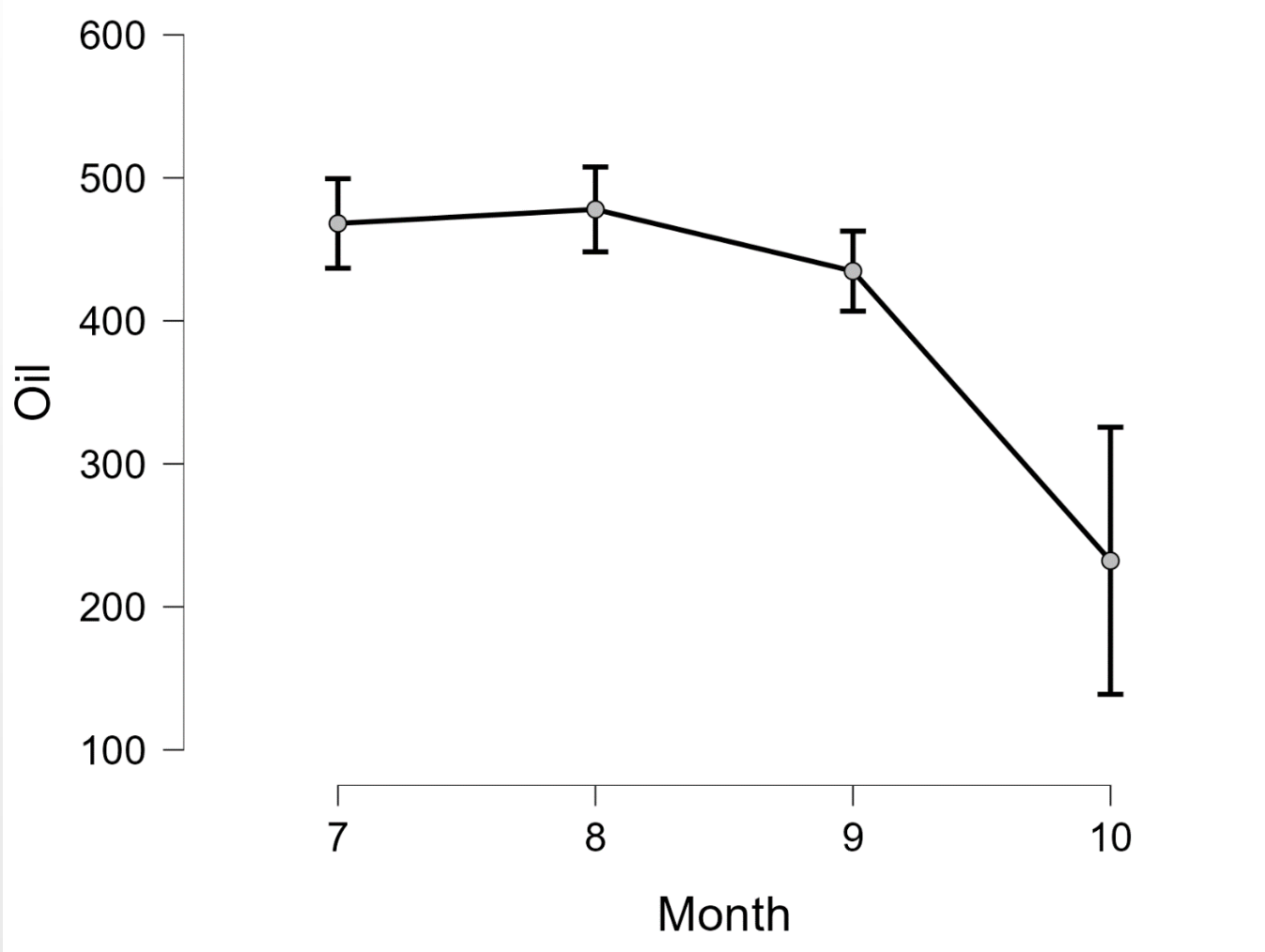
- Year is significant!
  - Dry hay / acre
  - Oil / ton of dry hay
  - Oil / load and oil/acre
  - Oil / 1000lbs of steam
  - Breakthrough times, cook times, and total duration
- Fields of origin were Significant!
  - Oil/load and oil/acre
- Tub number significant! (different tub designs)
- Stalls in the still were NOT statistically significant

Mixed Model Analysis
(controls for the differences between variables)

- Example: Year is different! Controls for that difference to look at the effects of other parameters without the additional year-to-year variability.

Mixed Model Analysis

Dependent Variable: Oil/Load



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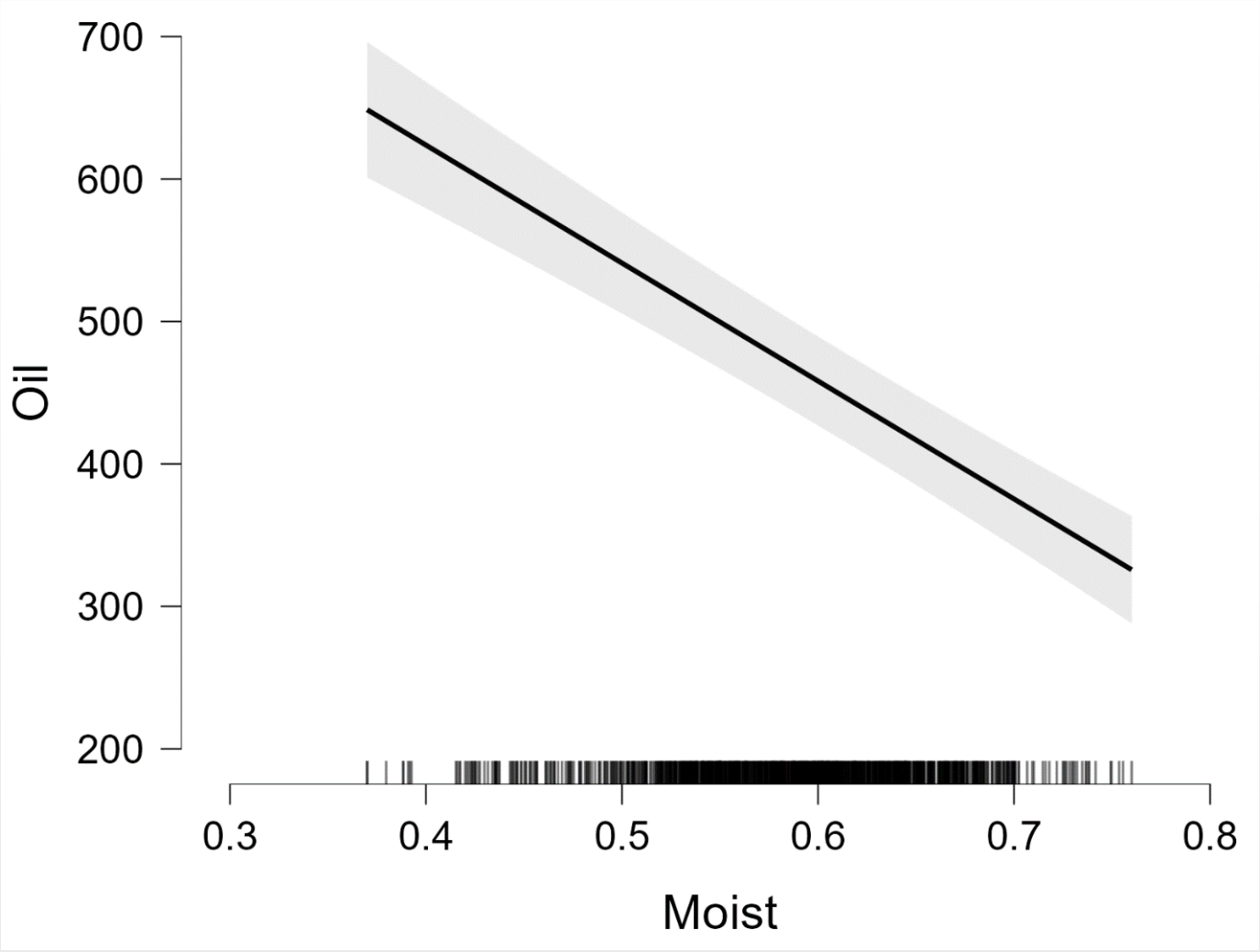

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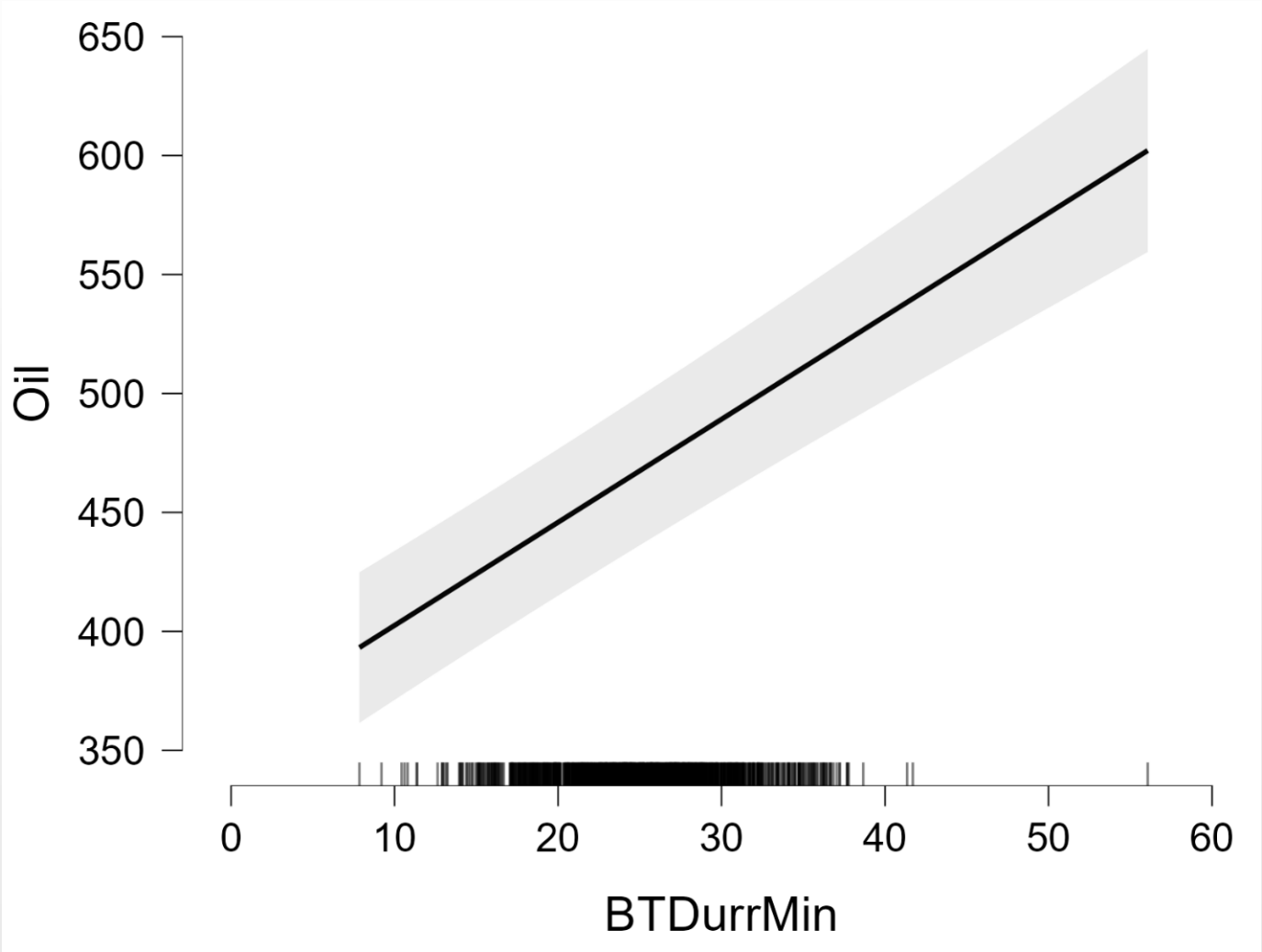

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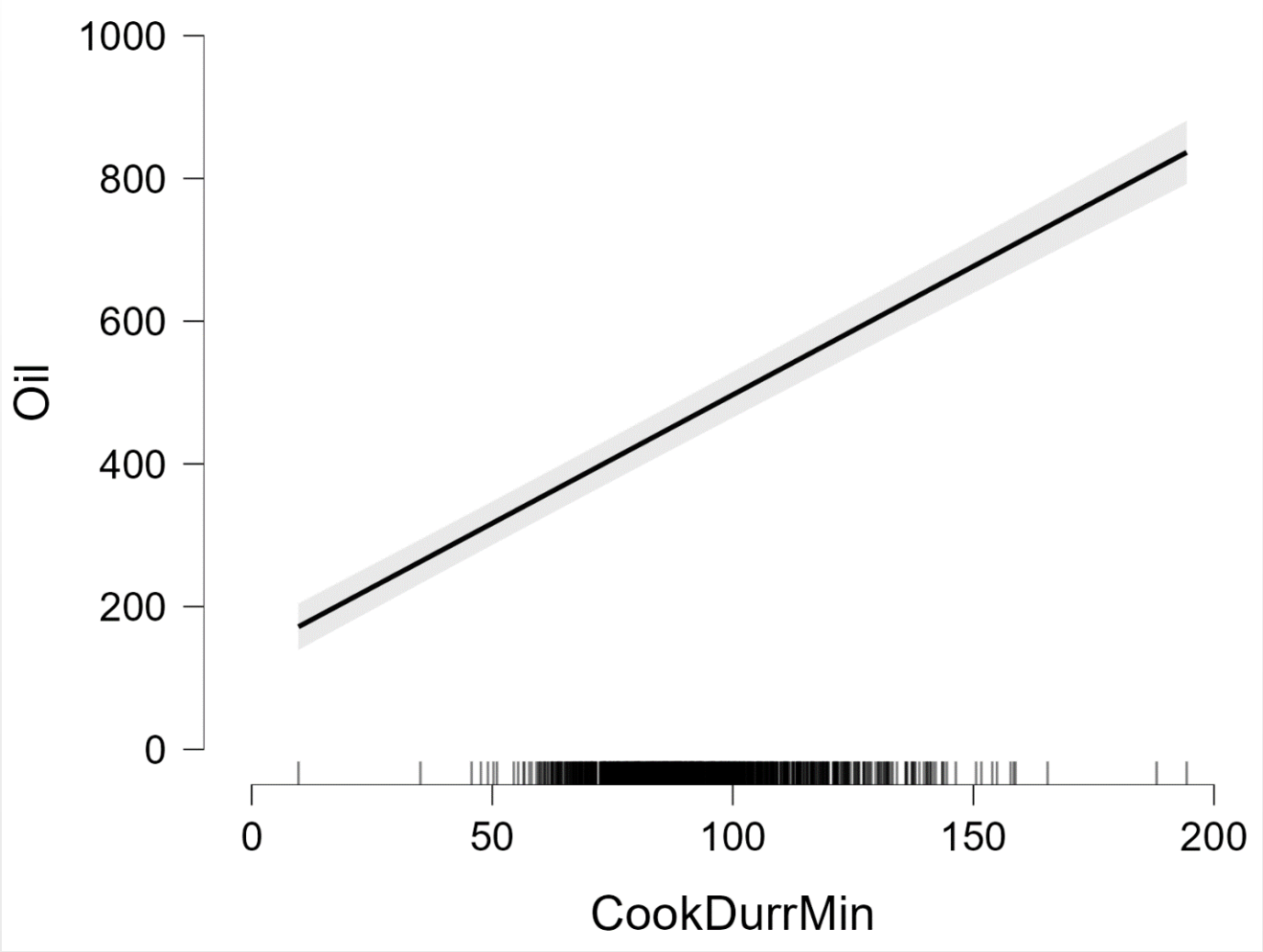

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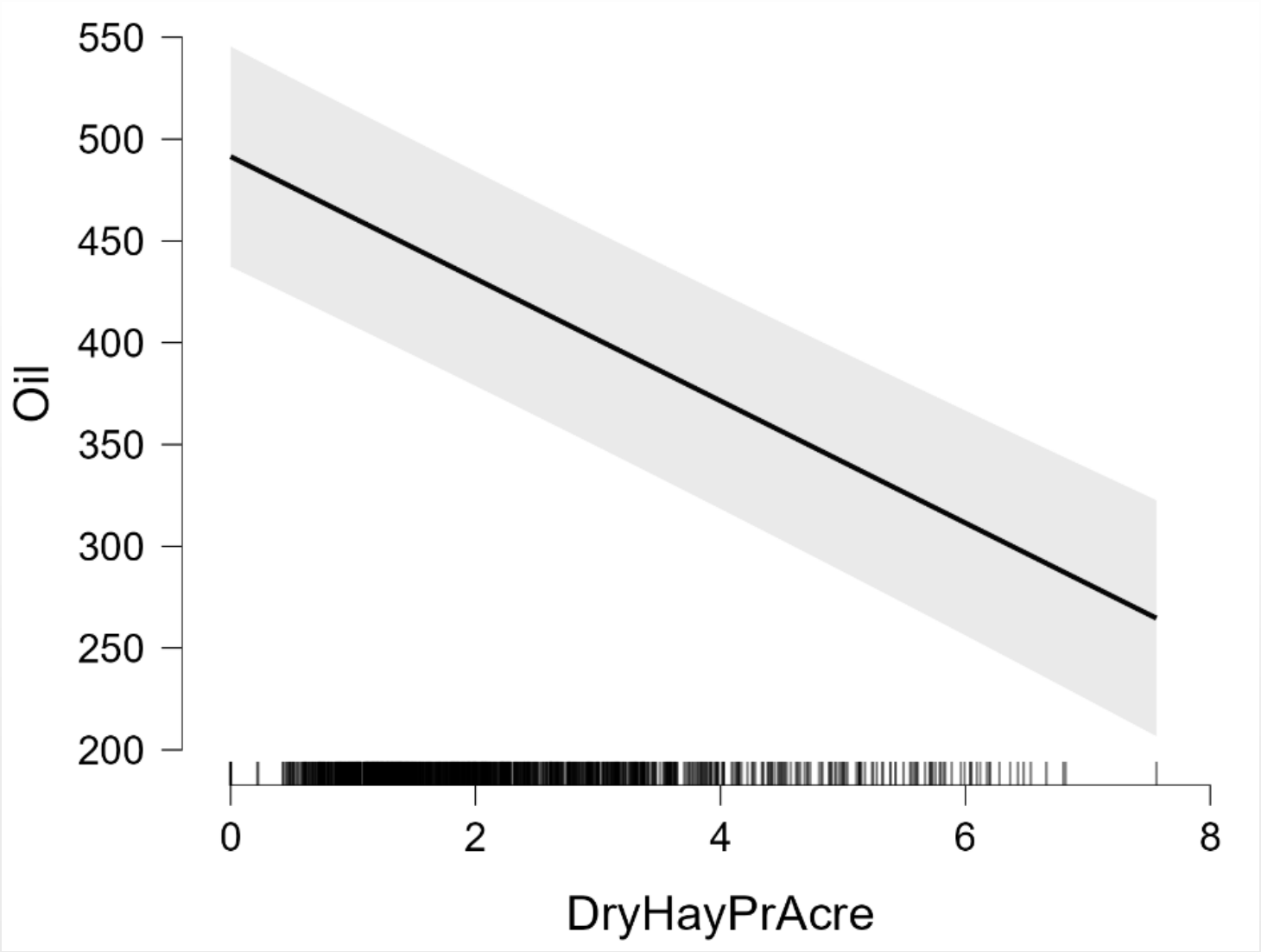

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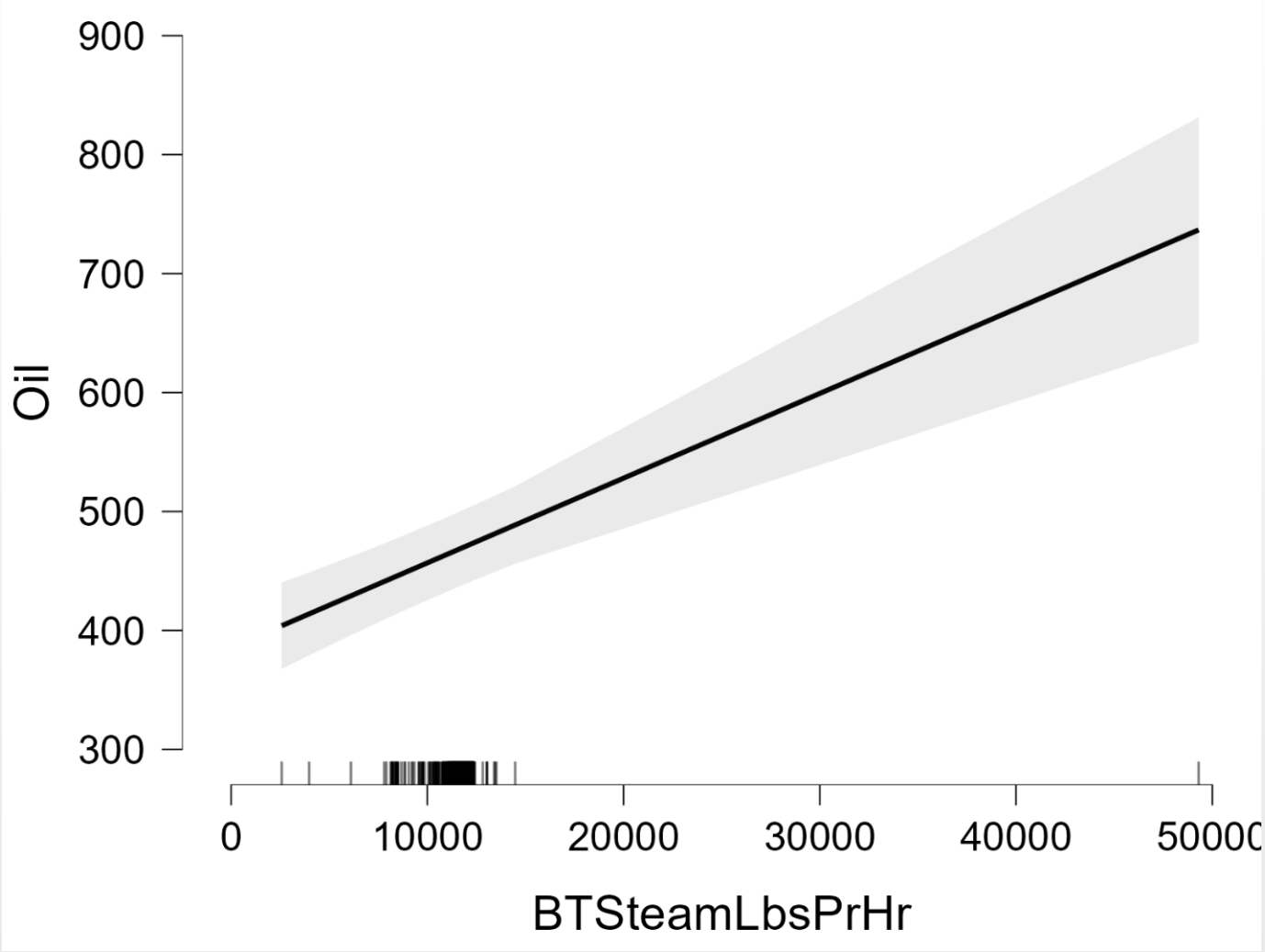

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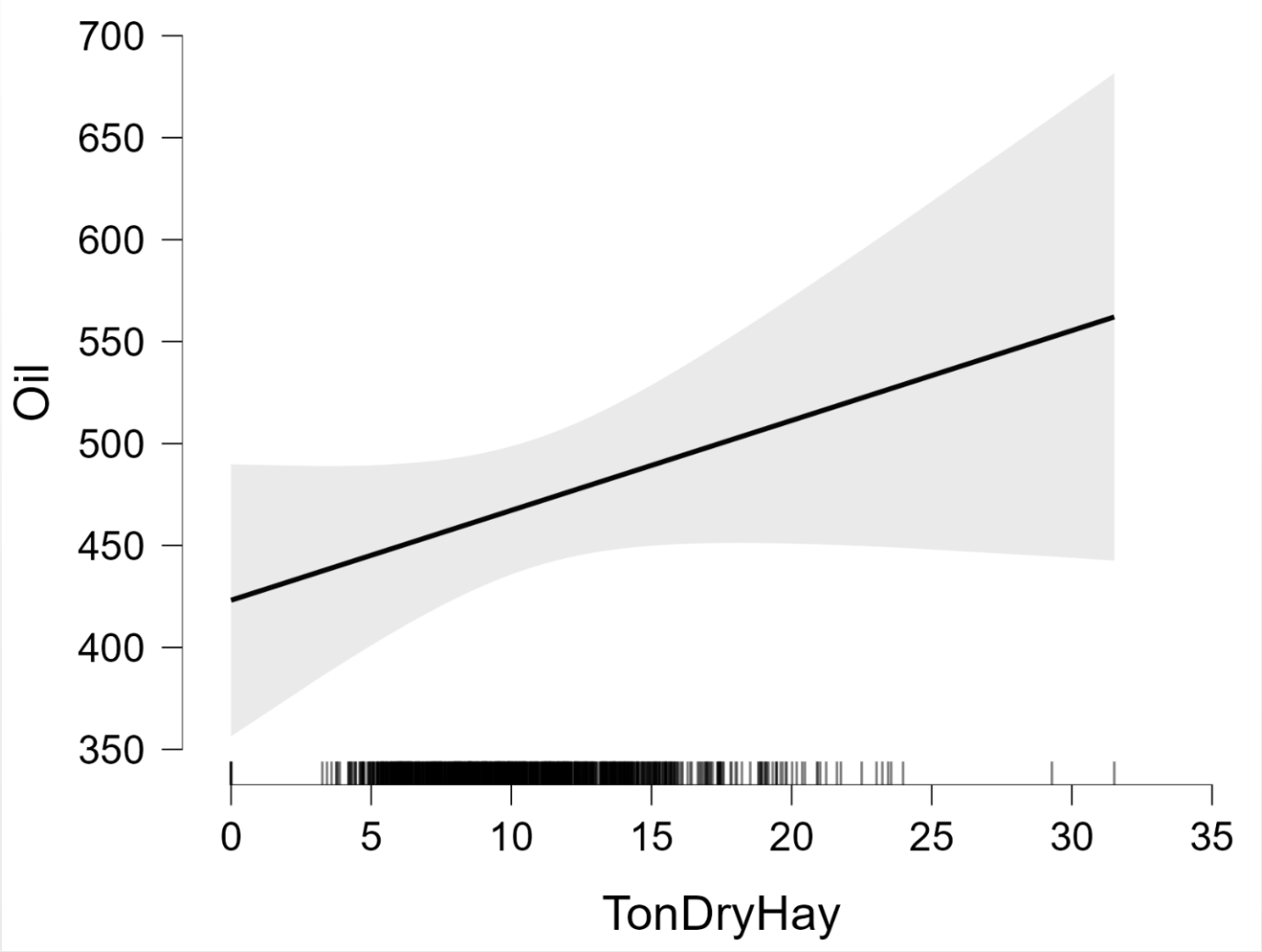

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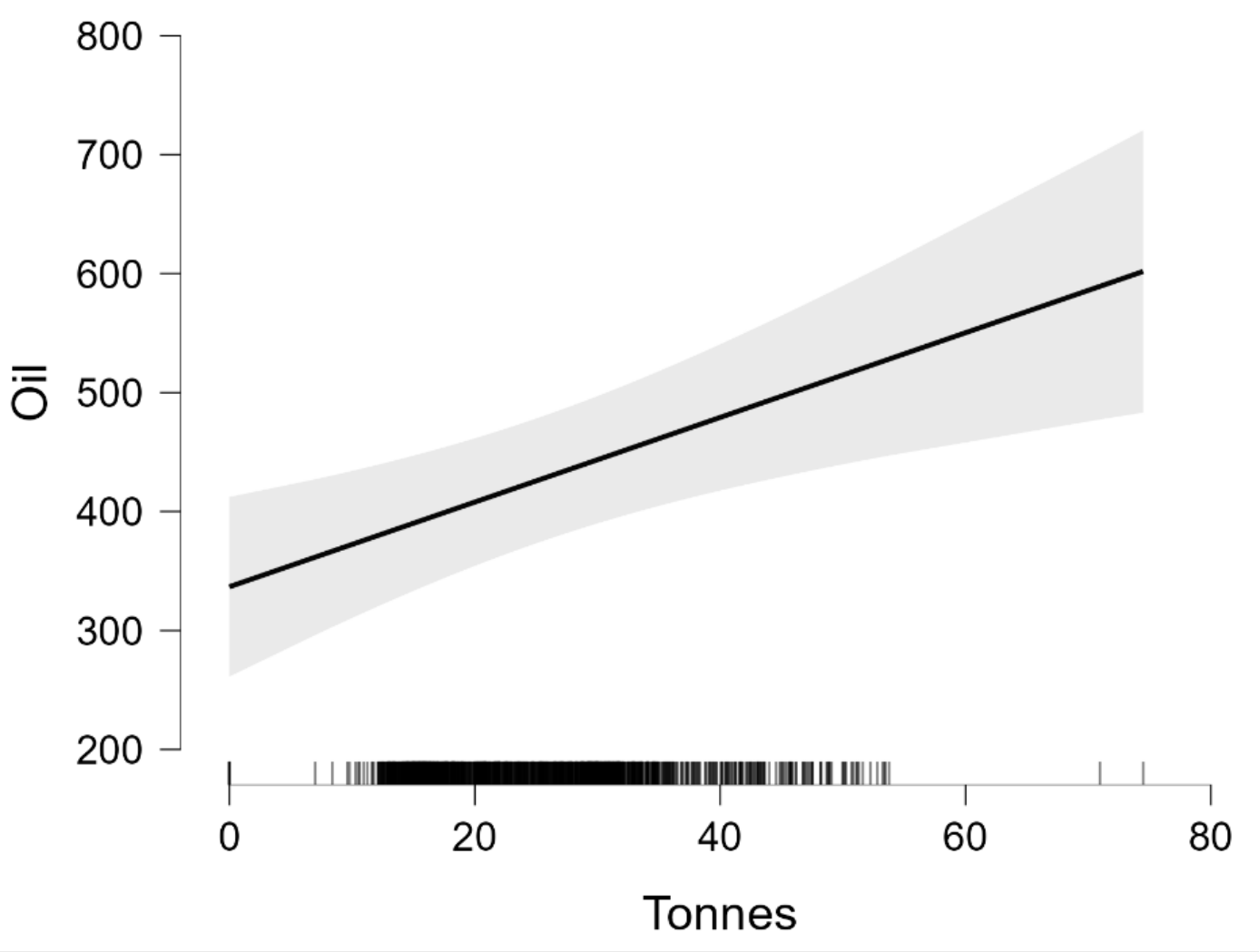

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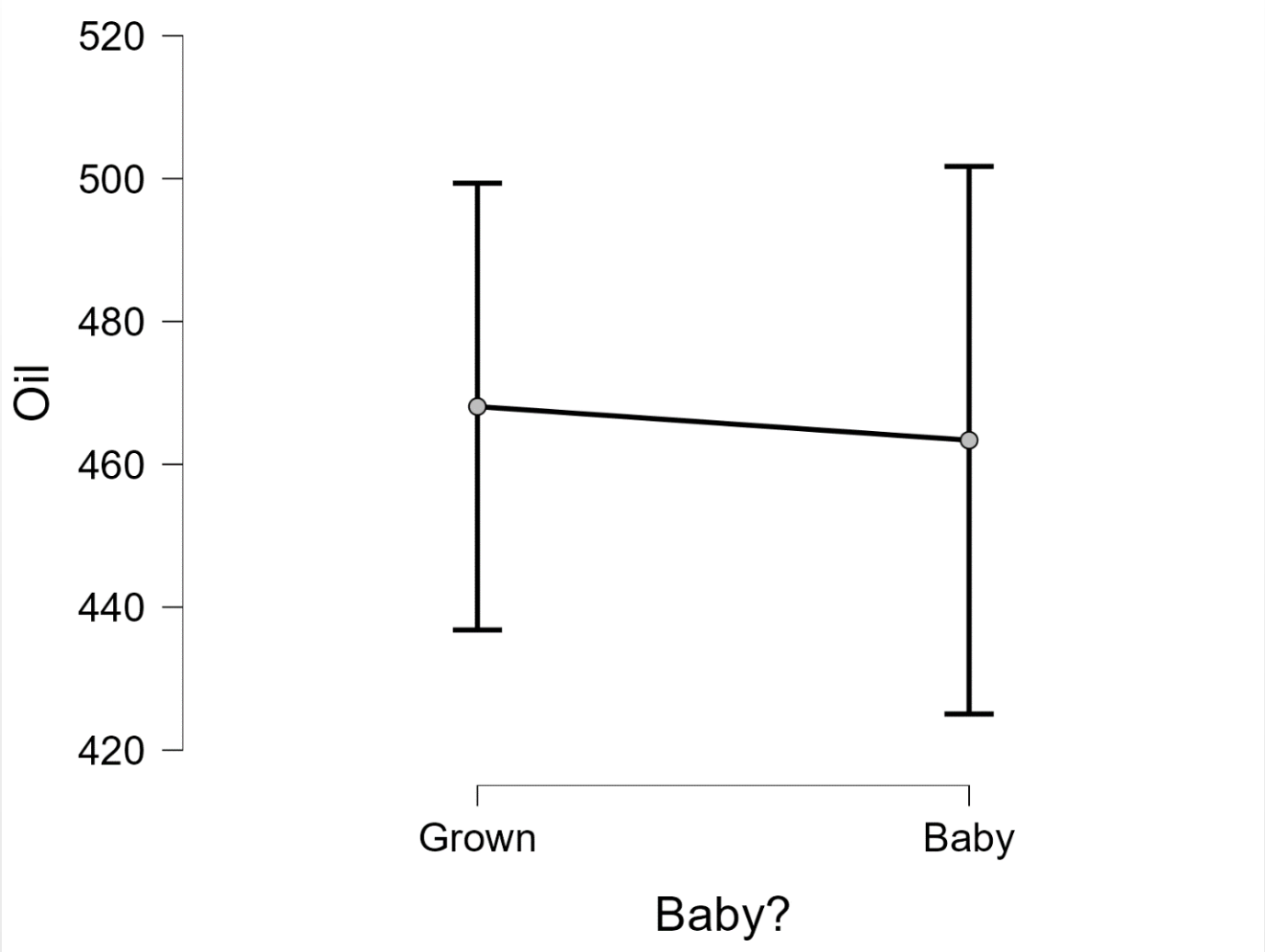

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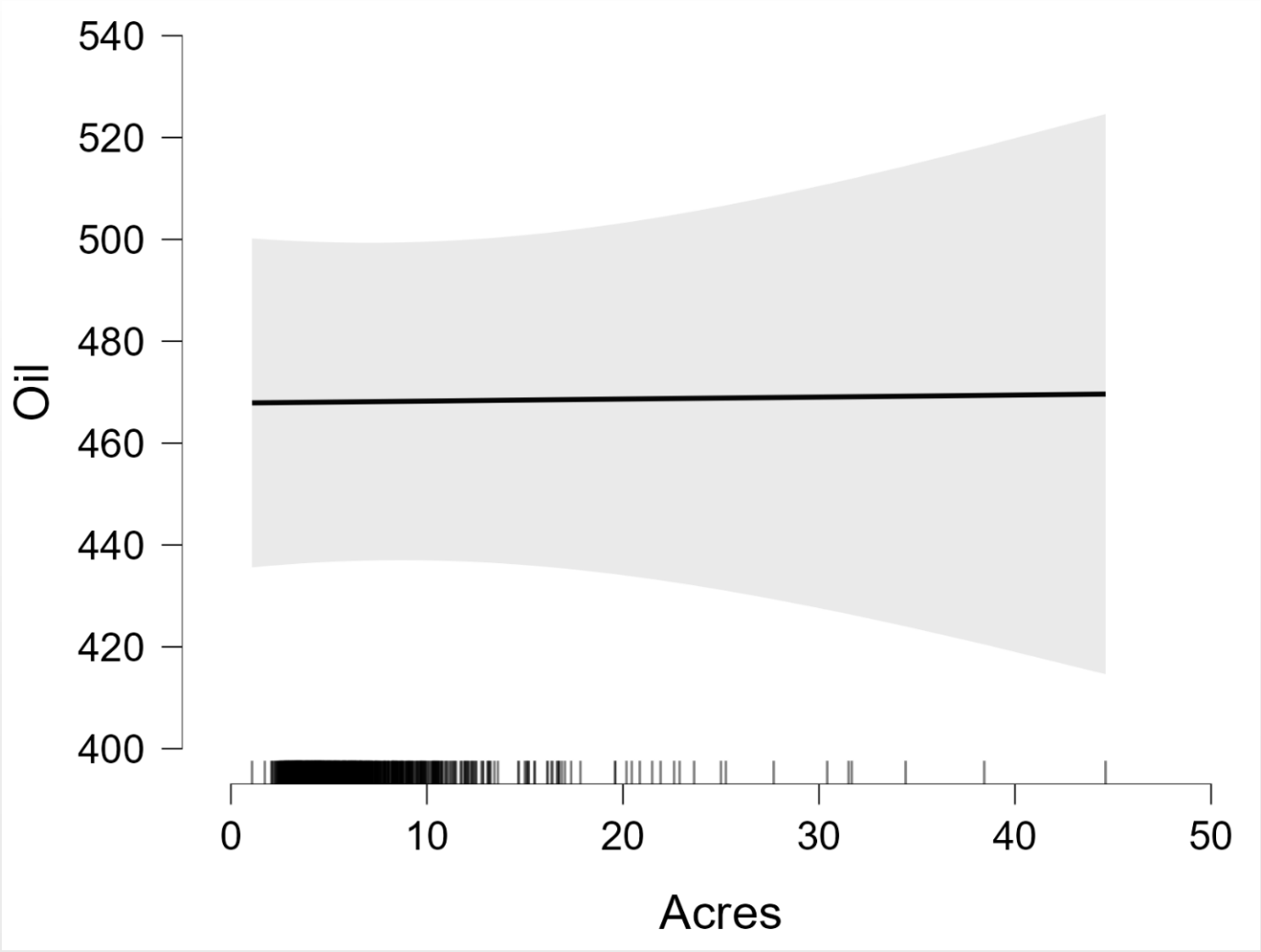
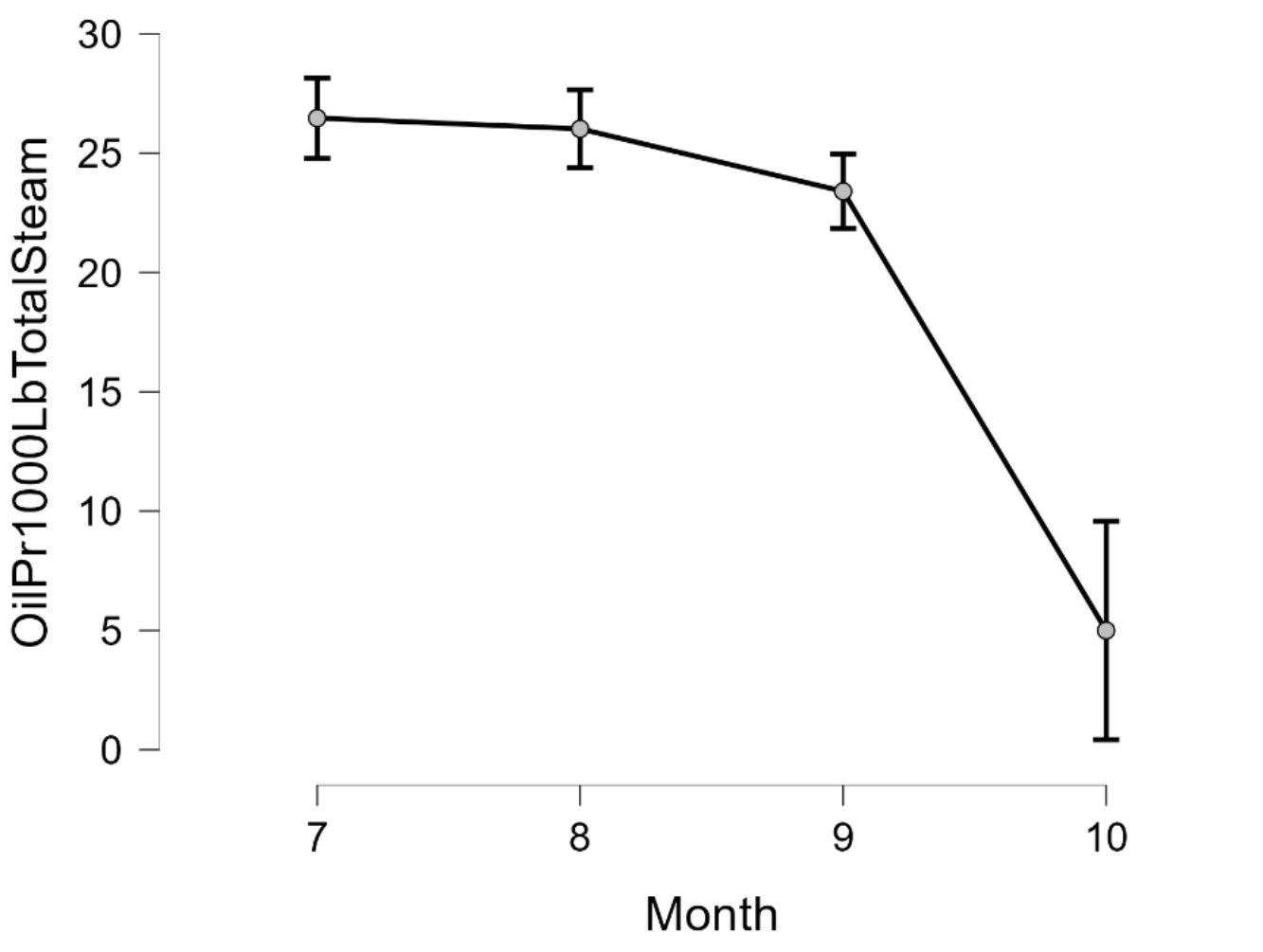


Mixed Model Analysis

Dependent Variable: Oil/1000lbs of Steam, or Steam use Efficiency



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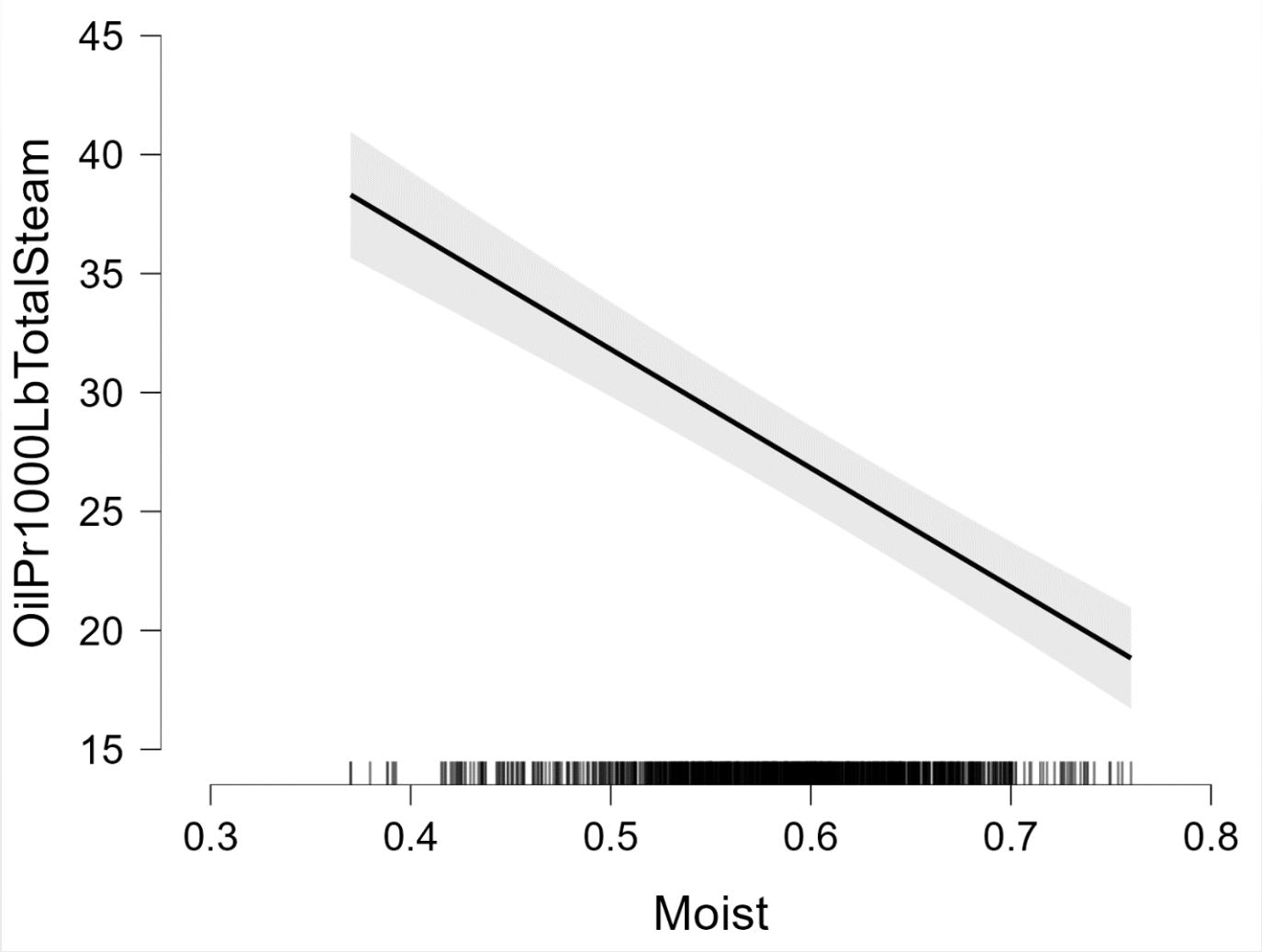

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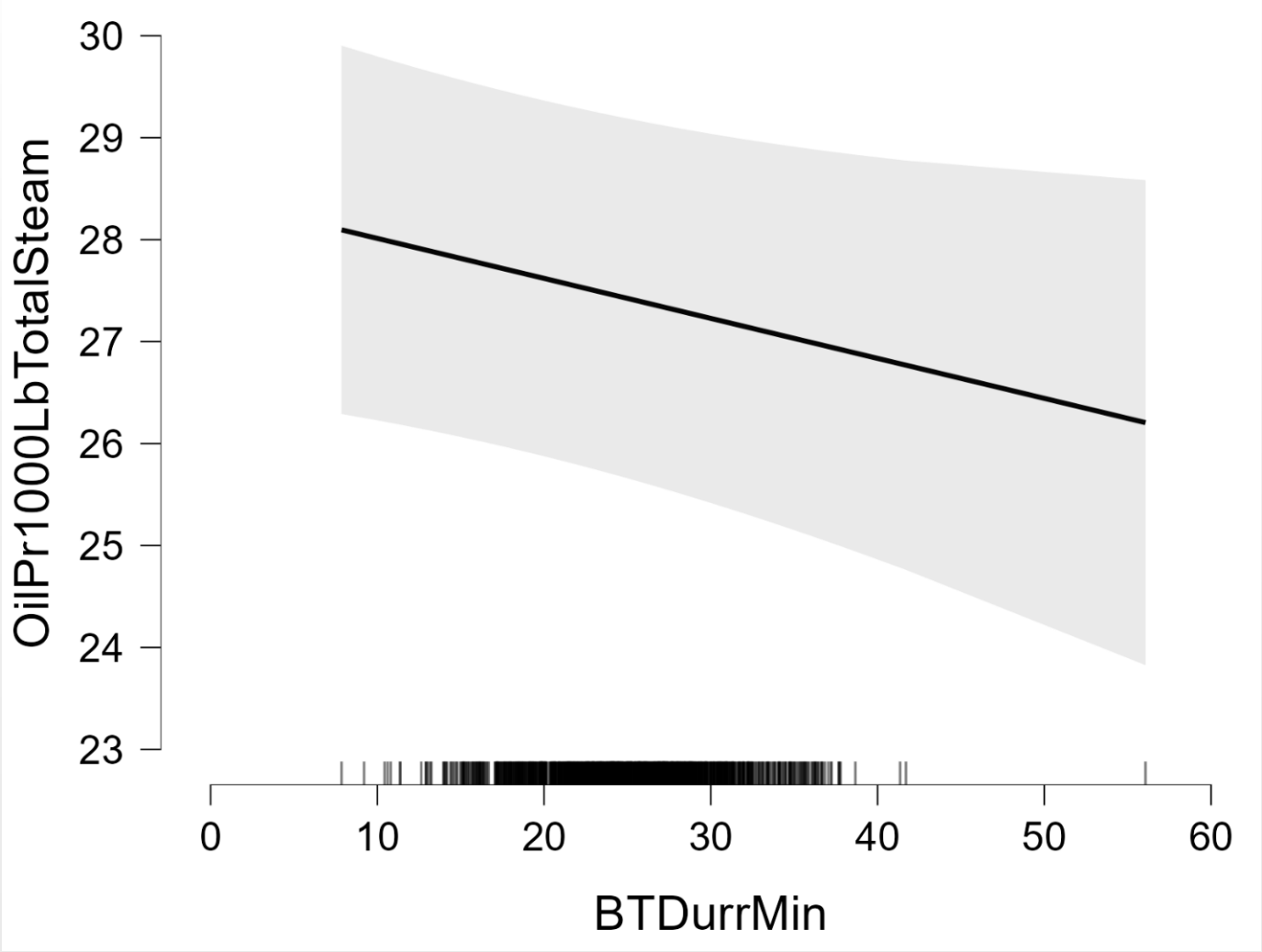

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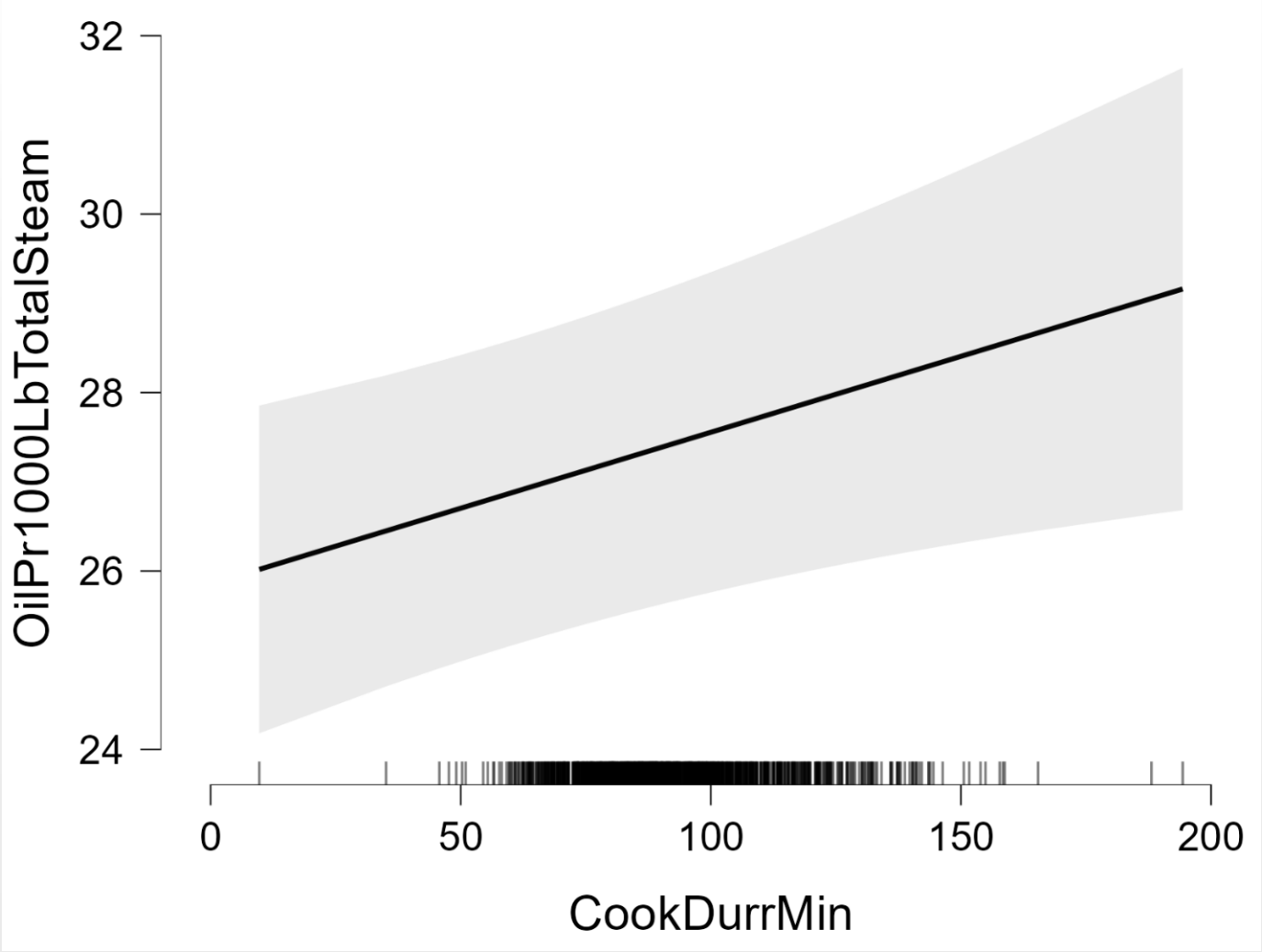

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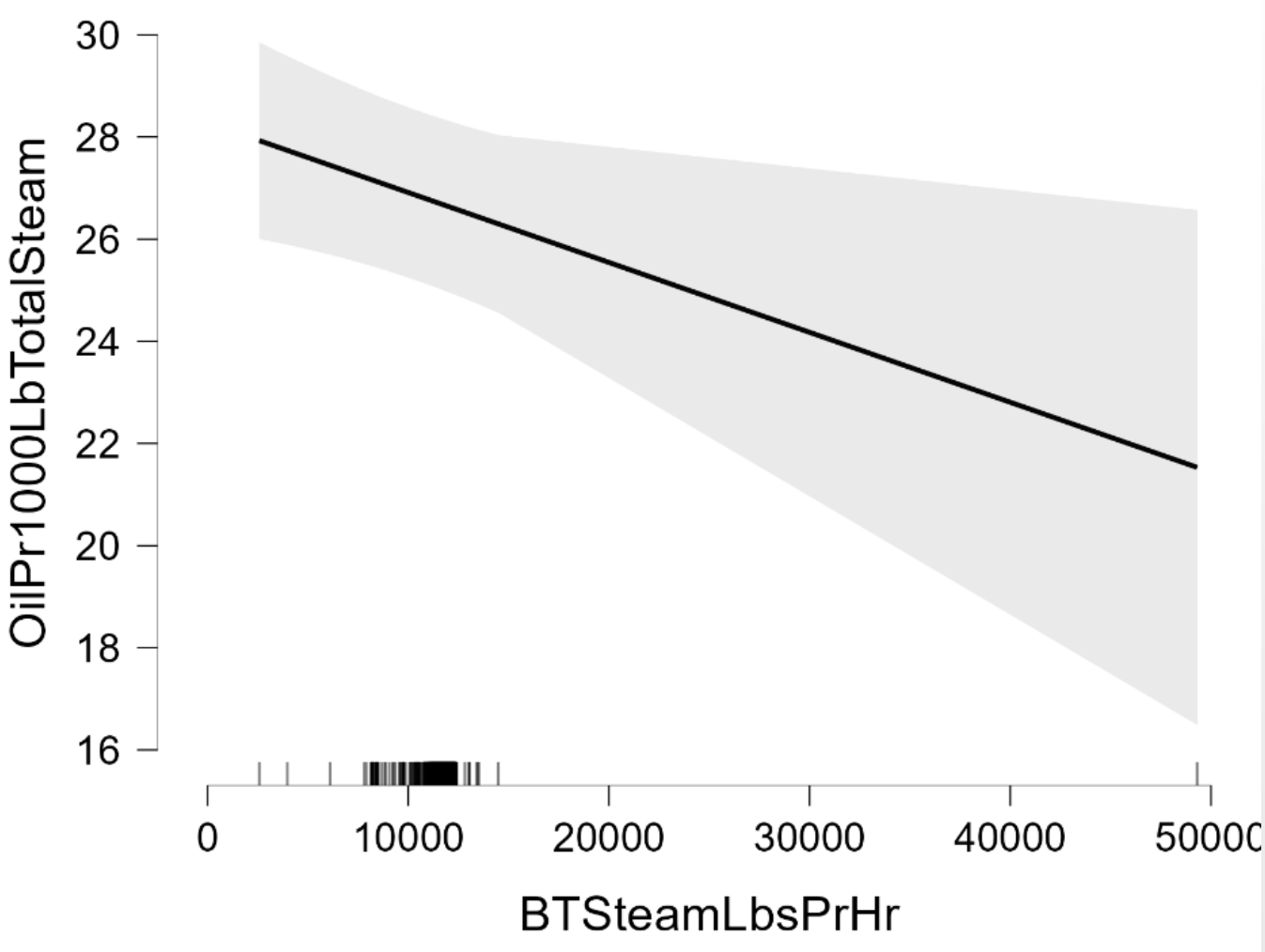

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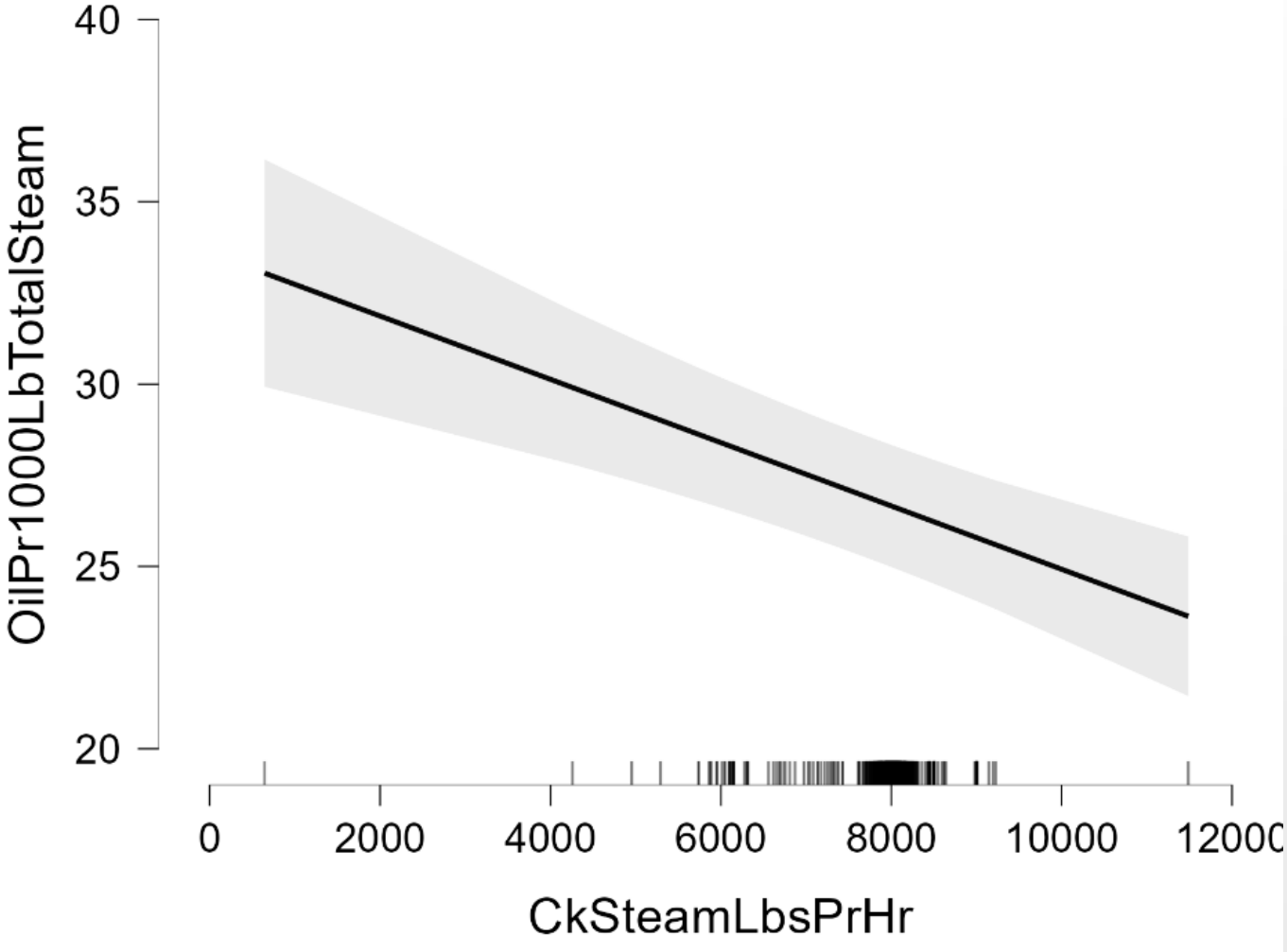

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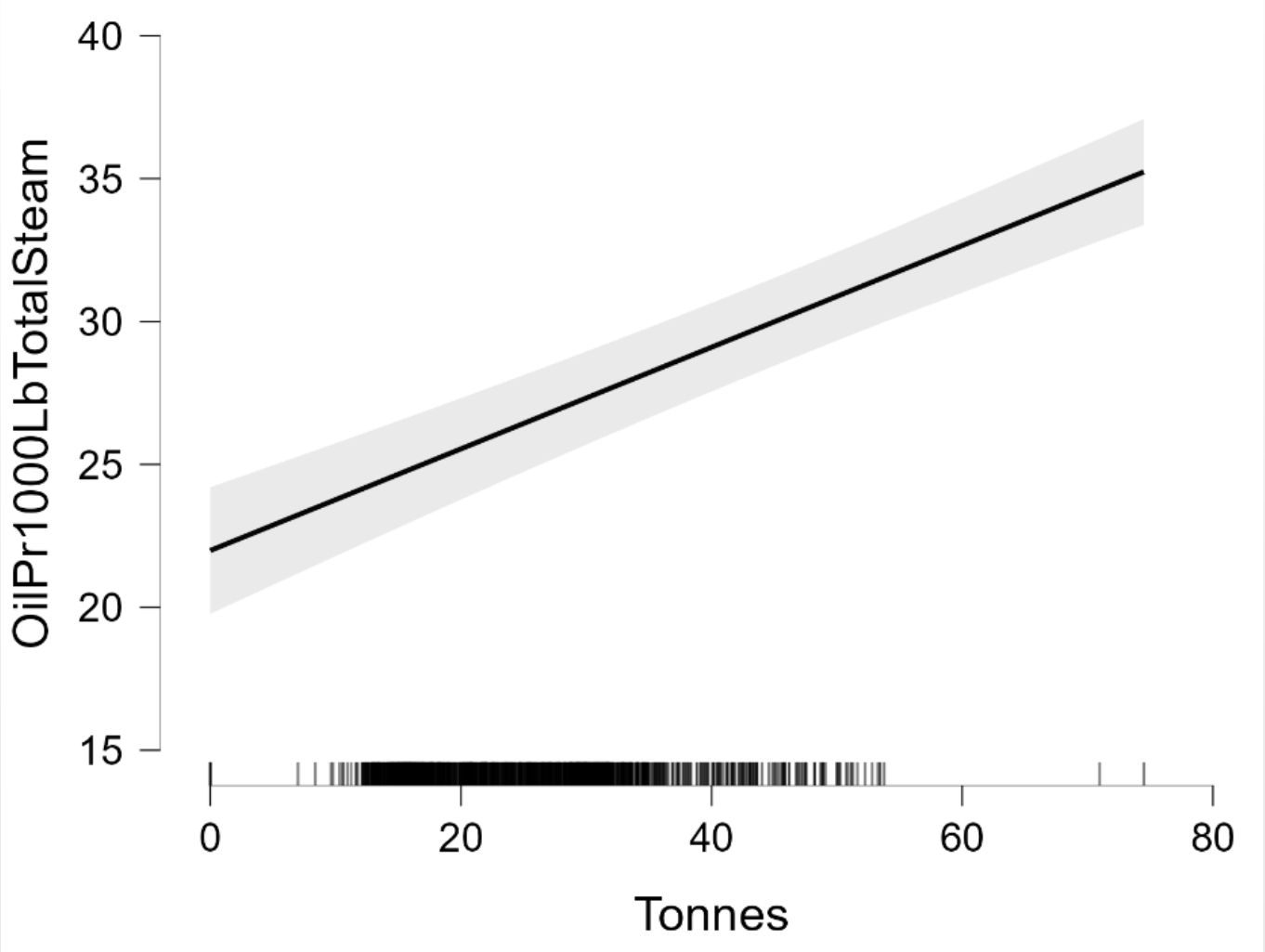

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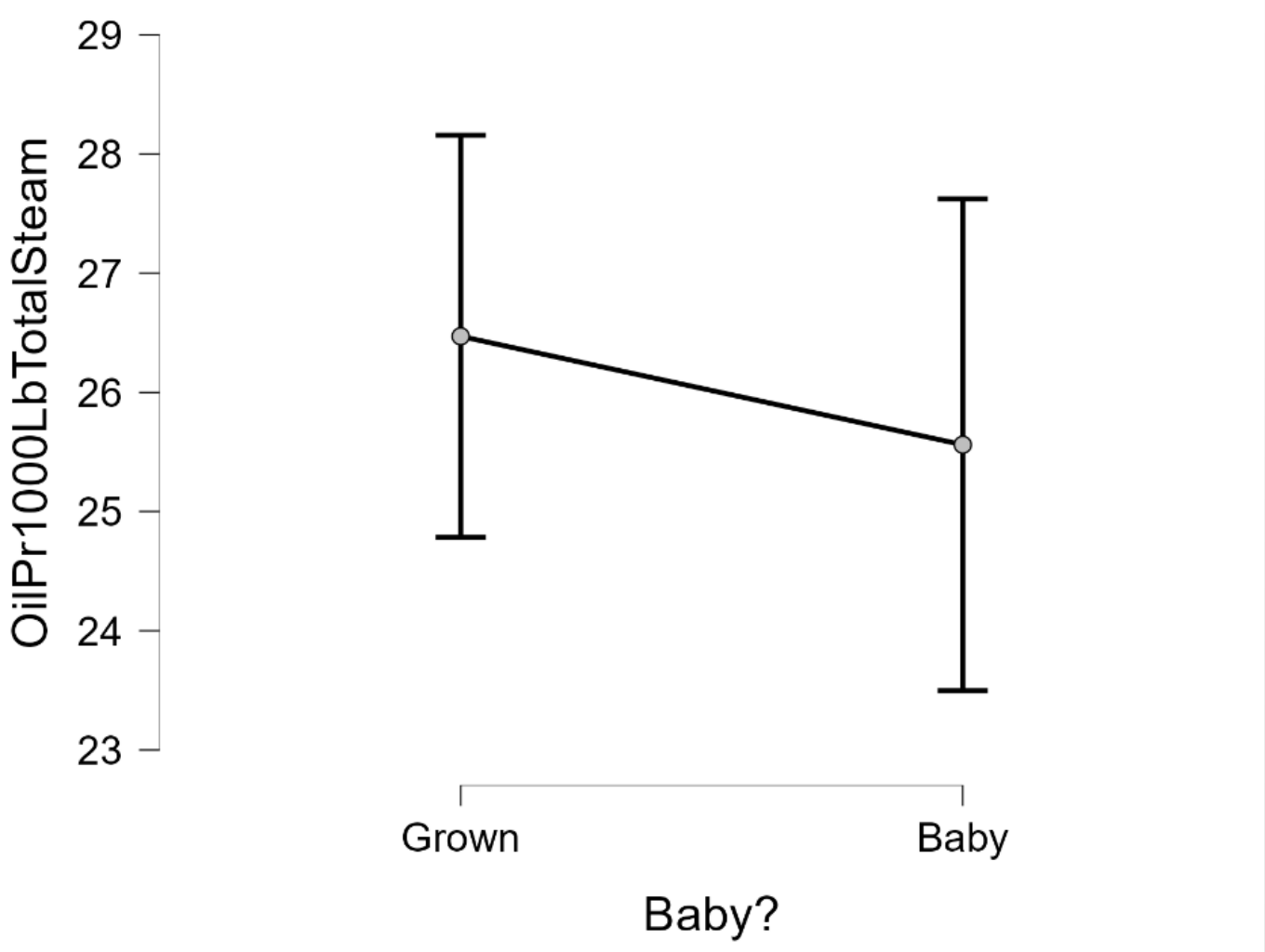
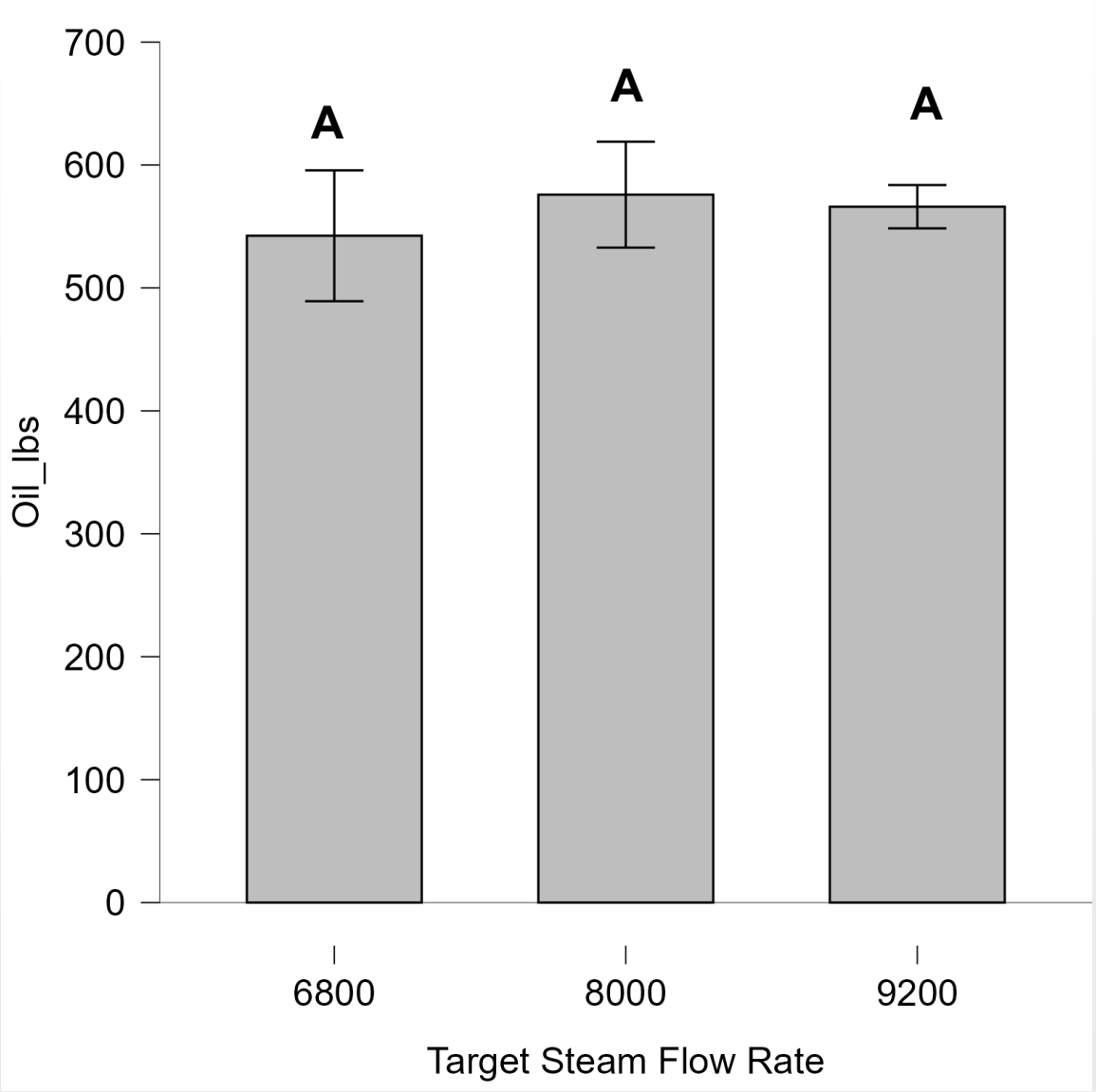


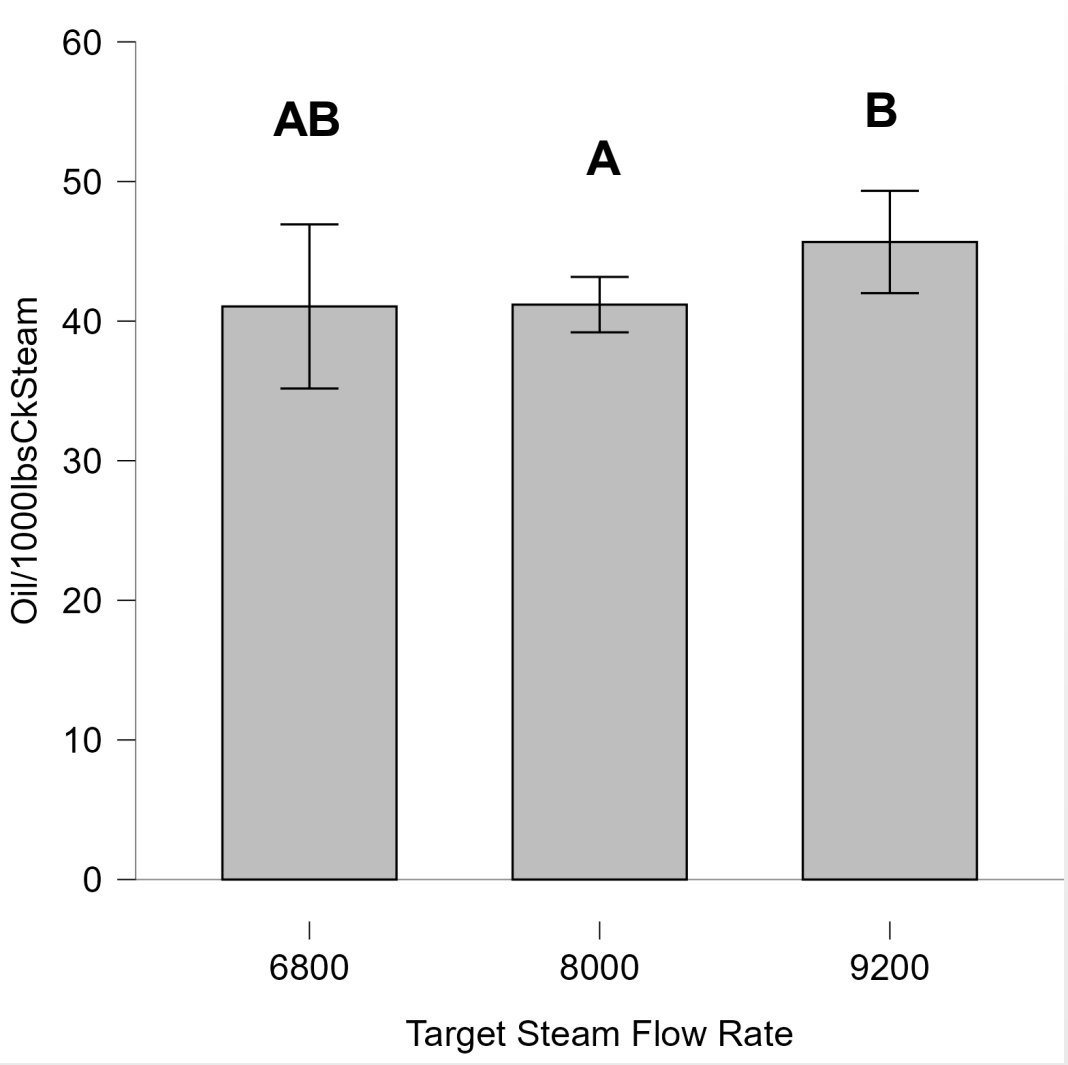
Vary Cook Steam Flow Rate

- Same Field
- Same Date
- Same Steam Flow Rate Until Breakthrough (12500 lbs/hr)
- 3 Different Steam Flow Rate in the Cook
  - 6800 lbs/hr: – 10%
  - 8000 lbs/hr: Control
  - 9200 lbs/hr: +10%

No Signficant Difference In Oil/Load



Statistically Signficant Difference In Oil/1000lbs Steam (steam use efficiency)



Conclusions

- Oil/load decreased the later it was harvested in the year.
- Wetter hay = less oil per load
- Longer breakthrough times resulted in more oil per load. Or, loads with more oil in them may take longer to breakthrough.
- Loads with more oil took longer to cook out, Or, longer cook times resulted in greater oil yields per load.
- High hay yielding acreage had less oil per load.

Conclusions

- Higher flow rates during the breakthrough period are desirable. However, this effect is not strong.
- Higher flow rates of steam seemed to result in overall more oil. However, this effect was not strong.
- The dry matter content in the load had almost no effect on the oil content per load when everything else was controlled for.
- Whether the load consisted of baby mint or mature mint seemed to have no effect on the total oil per load.
- The number of acres that were harvested and included in the load had almost no overall effect on the oil per load.

Conclusions

- The dryer the hay, the more efficient the distillation process.
- Hay harvested later in the year used steam less efficiently.
- Steam flow rate during the breakthrough period did not have a significant effect on the steam use efficiency.
- Higher steam flow rates during the cook used steam less efficiently.
- The more hay in the load, the more efficient the steam use.
- Baby mint used steam slightly less efficiently than mature mint.