

Sample degradation analysis

Marlin Lee and Steve Goldstein

August 3, 2021

Analysis of TimeSeriesDataforStats072321.csv from 7/23/2021 email from Kayley Janssen

One figure I am hoping to include is a time series of filtering to show decay rate or when/if a significant drop off in signal of SARS-CoV-2 and control viruses in wastewater held at 4 degrees occurs. We were provided with enough influent from 3 different wastewater treatment plants where we filtered duplicates of the sample almost every day over a 2 week period and then ran triplicates(technical replicates) of each filter on qPCR for N1, N2, BCoV, and PMMoV.

Fitting a linear model to $\log(\text{concentration N1})$ seems appropriate: the slope of the regression line estimates the exponential rate of decay of concentration N1. Figure 1 shows the results of applying a mixed-effects model, estimating a common slope for the three WWTPs and letting concentration N1 vary between the three. The p-value for the slope coefficient is not significant.

To investigate why the data don't fit this model, we fit linear models to each filter replicate independently. Figure 2 suggests that Wisconsin Rapids Filter replicate A might be an outlier. Excluding this sample from the dataset and fitting the mixed-effects model yields an estimated decay rate of $-0.041 \pm 0.016 \text{ GC}/(\text{L} \cdot \text{day})$, ($p < 0.05$), as shown in Figure 3.

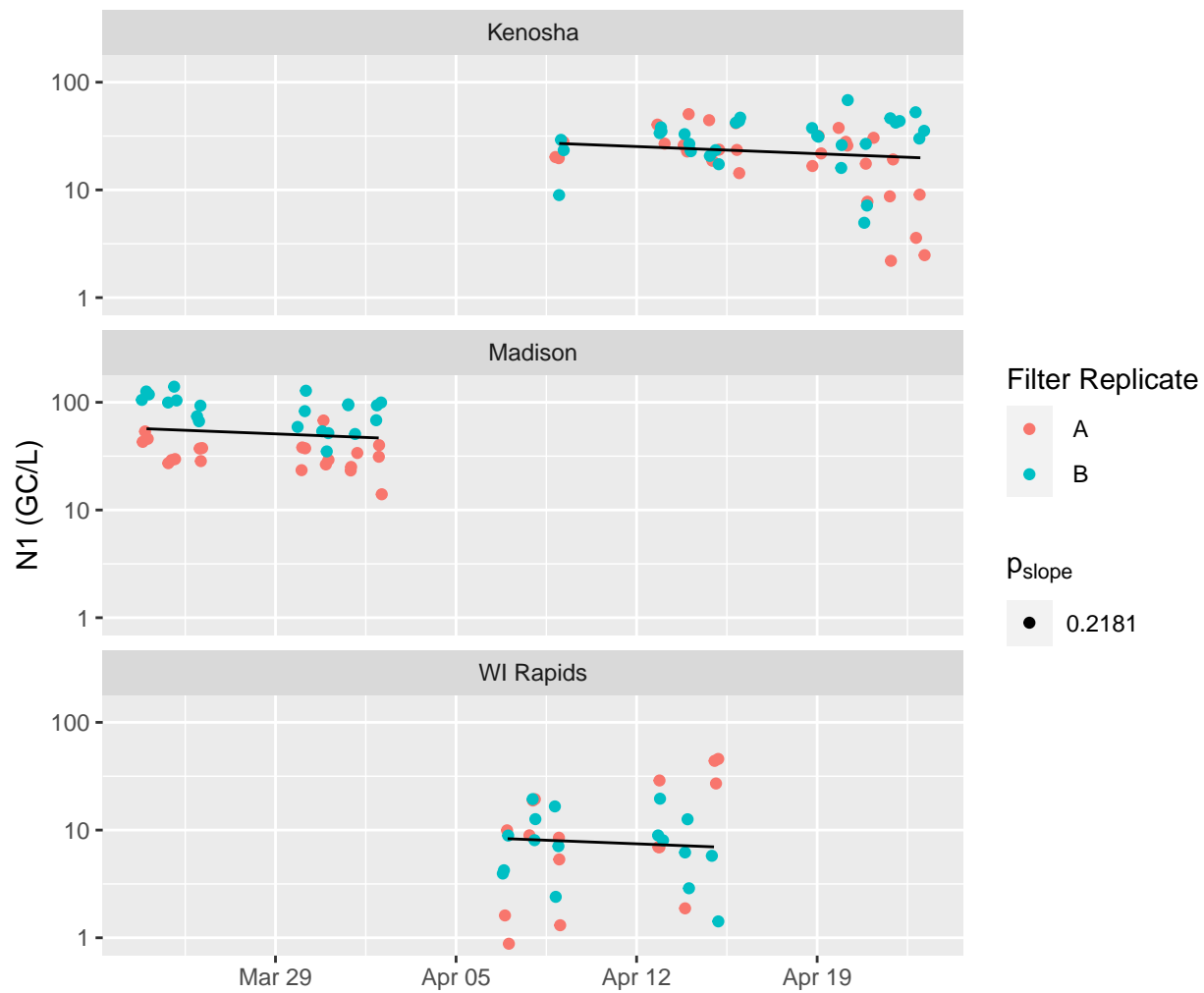


Figure 1. Mixed-effects model.

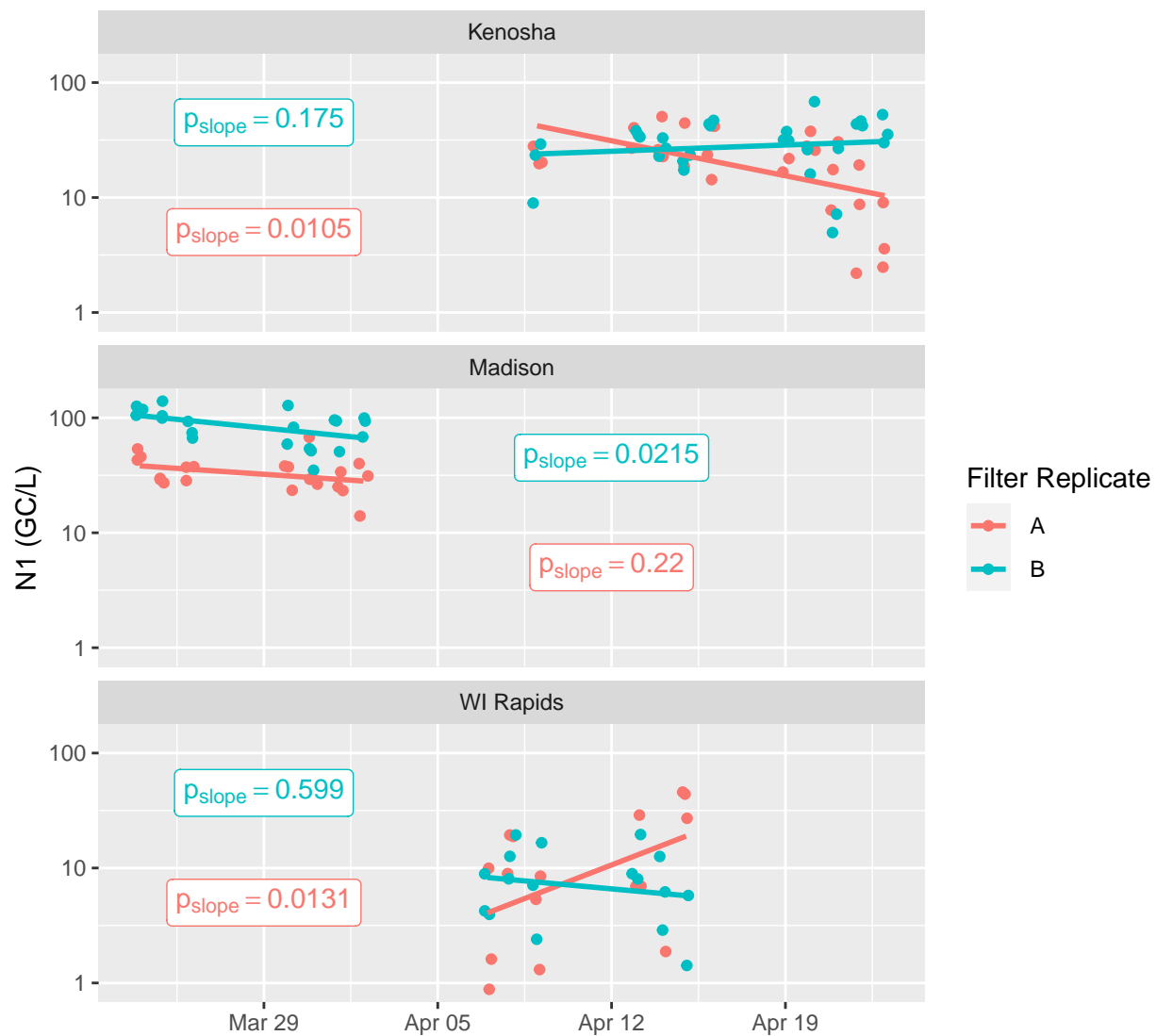


Figure 2. Six independent linear regressions.

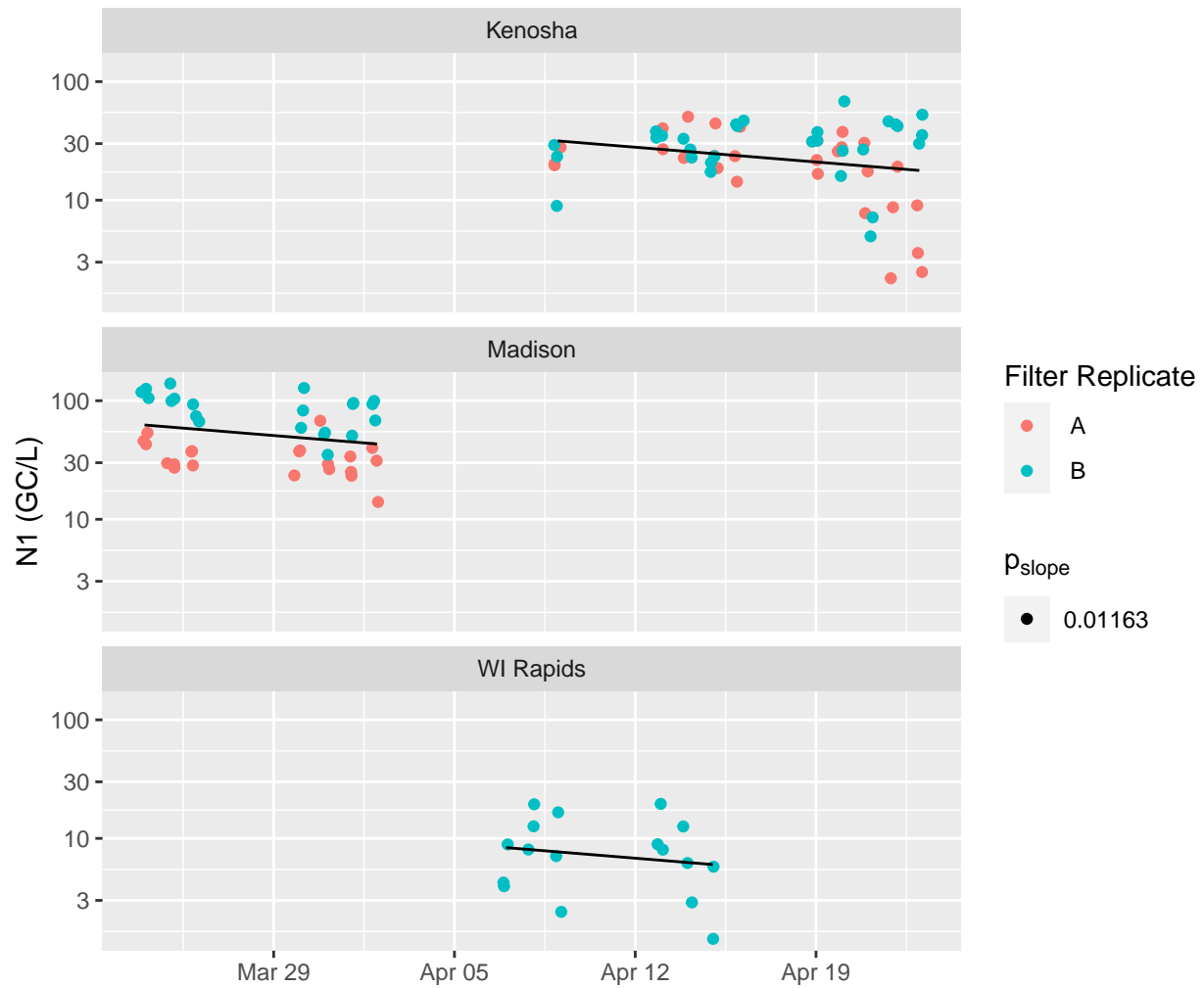


Figure 3. Mixed-effects model excluding WI Rapids filter replicate A

This process was repeated with N2 with no significance.

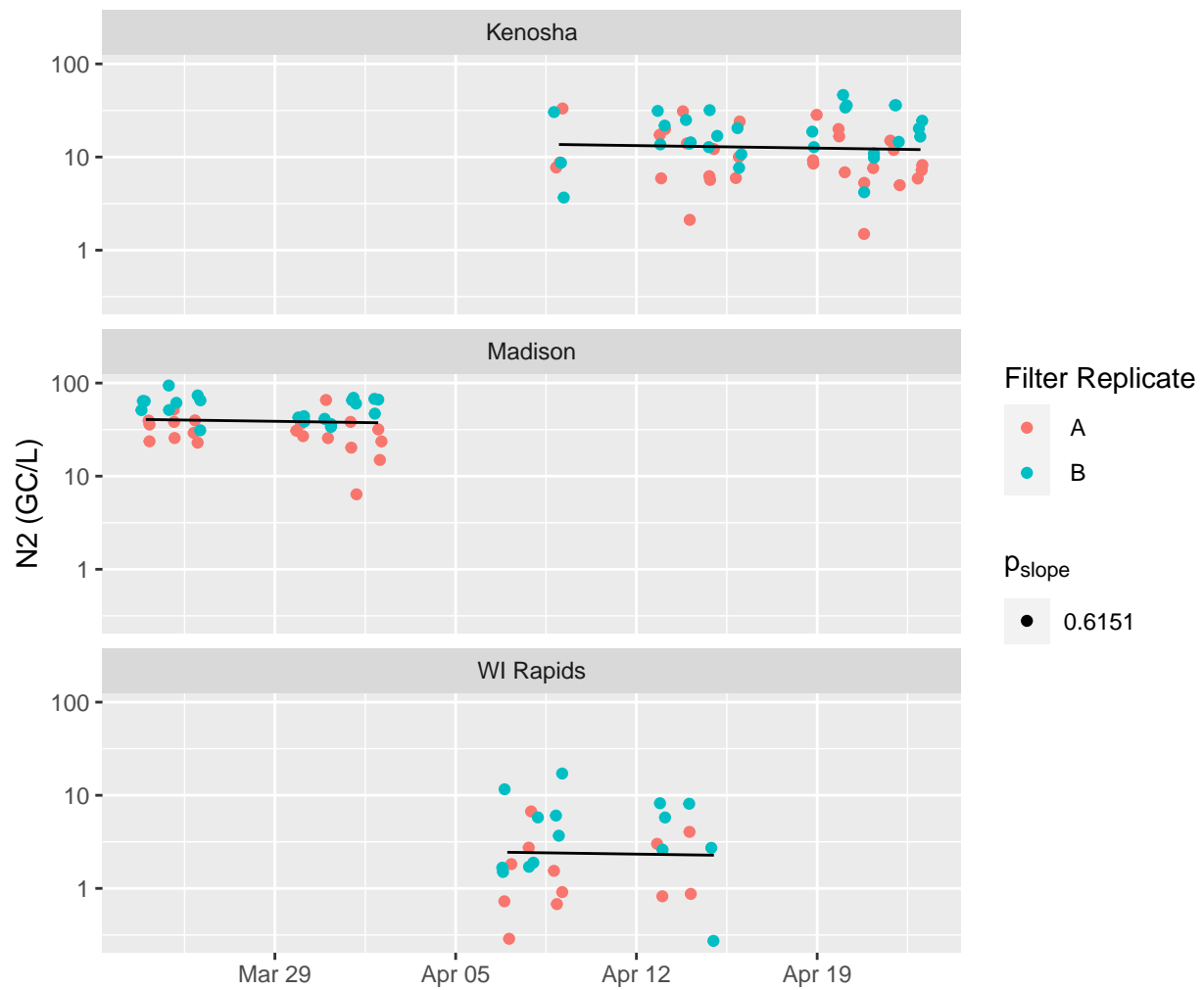


Figure 1. Mixed-effects model.

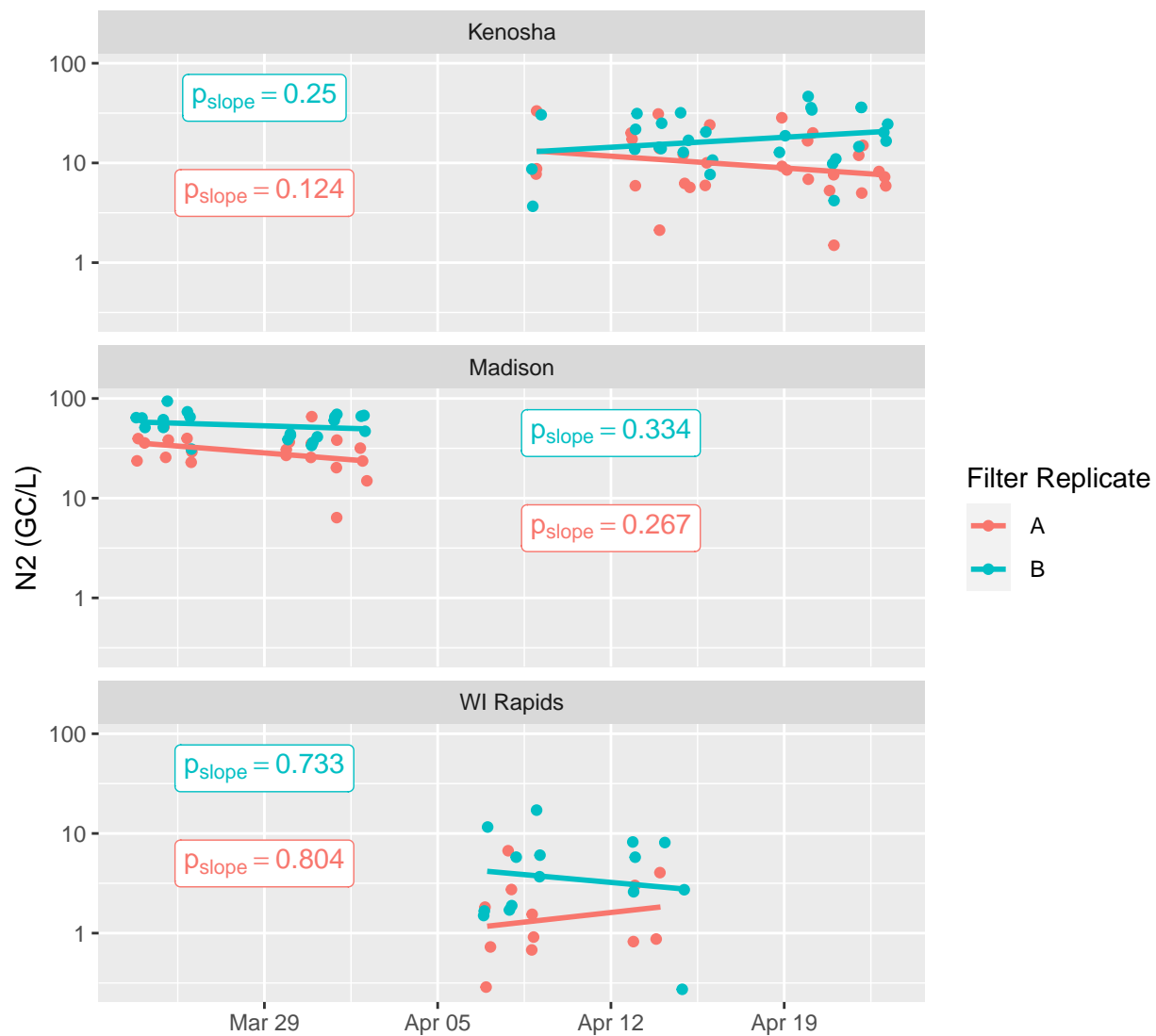


Figure 2. Six independent linear regressions.

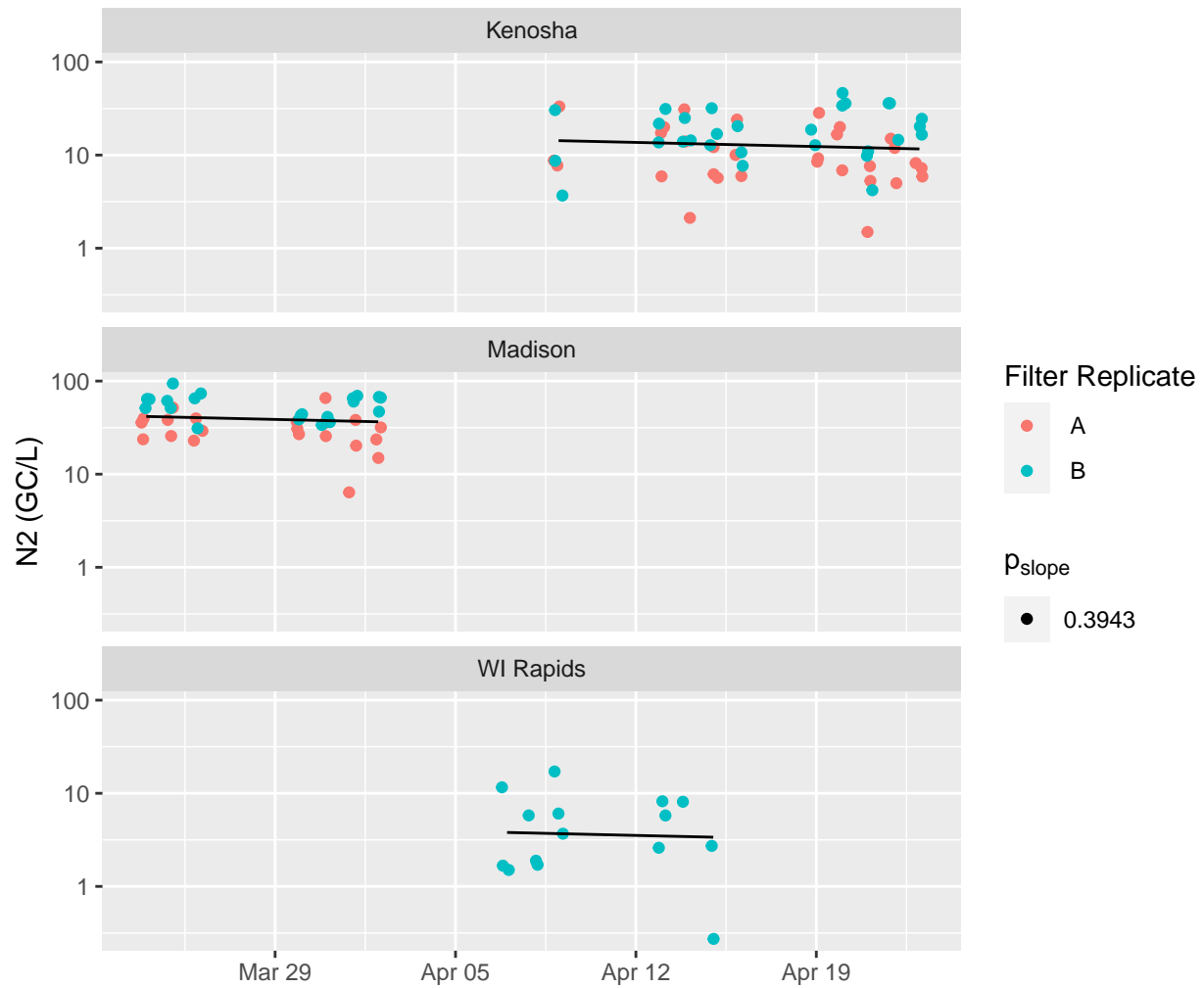


Figure 3. Mixed-effects model excluding WI Rapids filter replicate A

When the mixed model is fitted for PMMoV we find a much stronger picture indicating an exponential decay relationship.

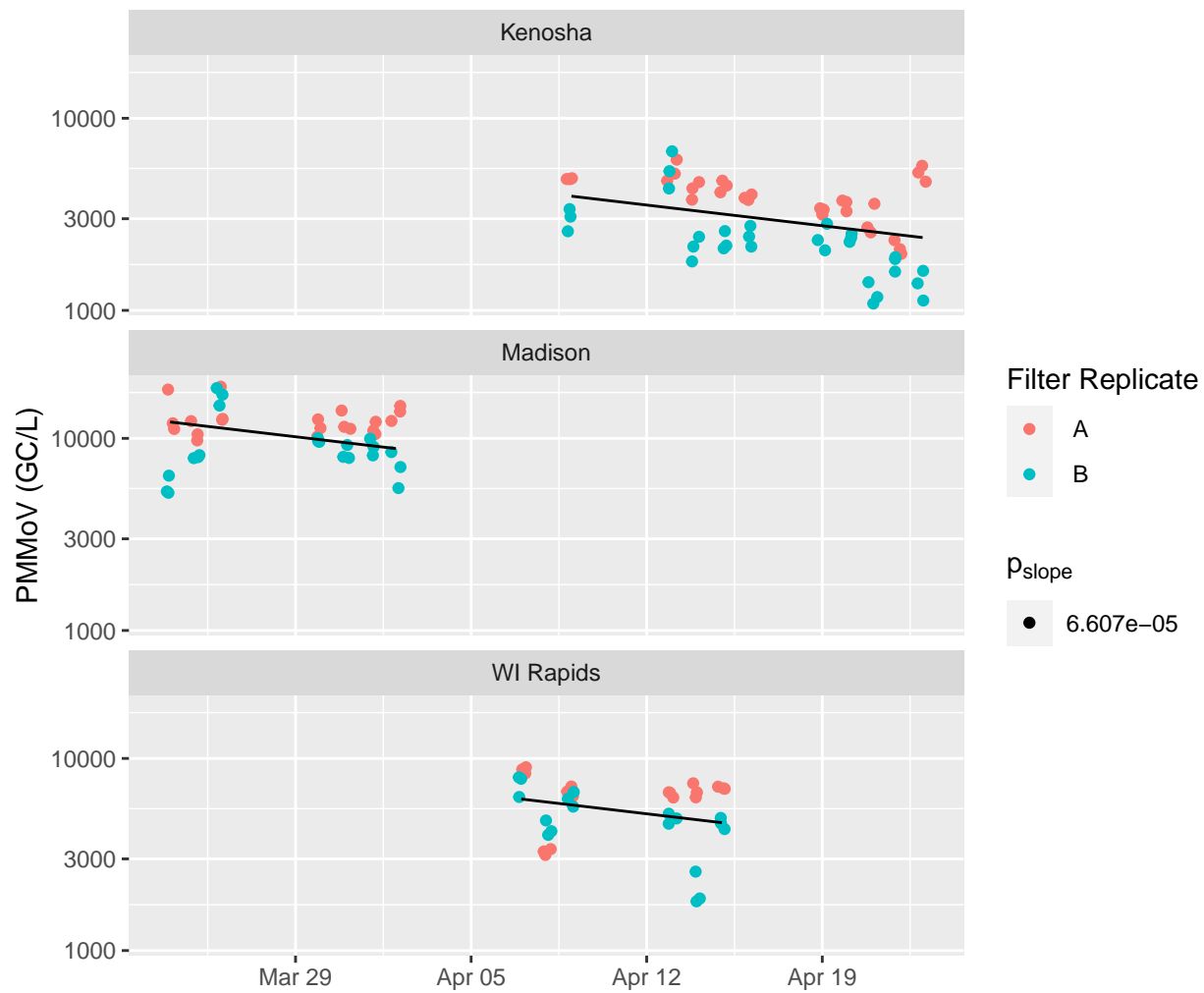


Figure 1. Mixed-effects model.

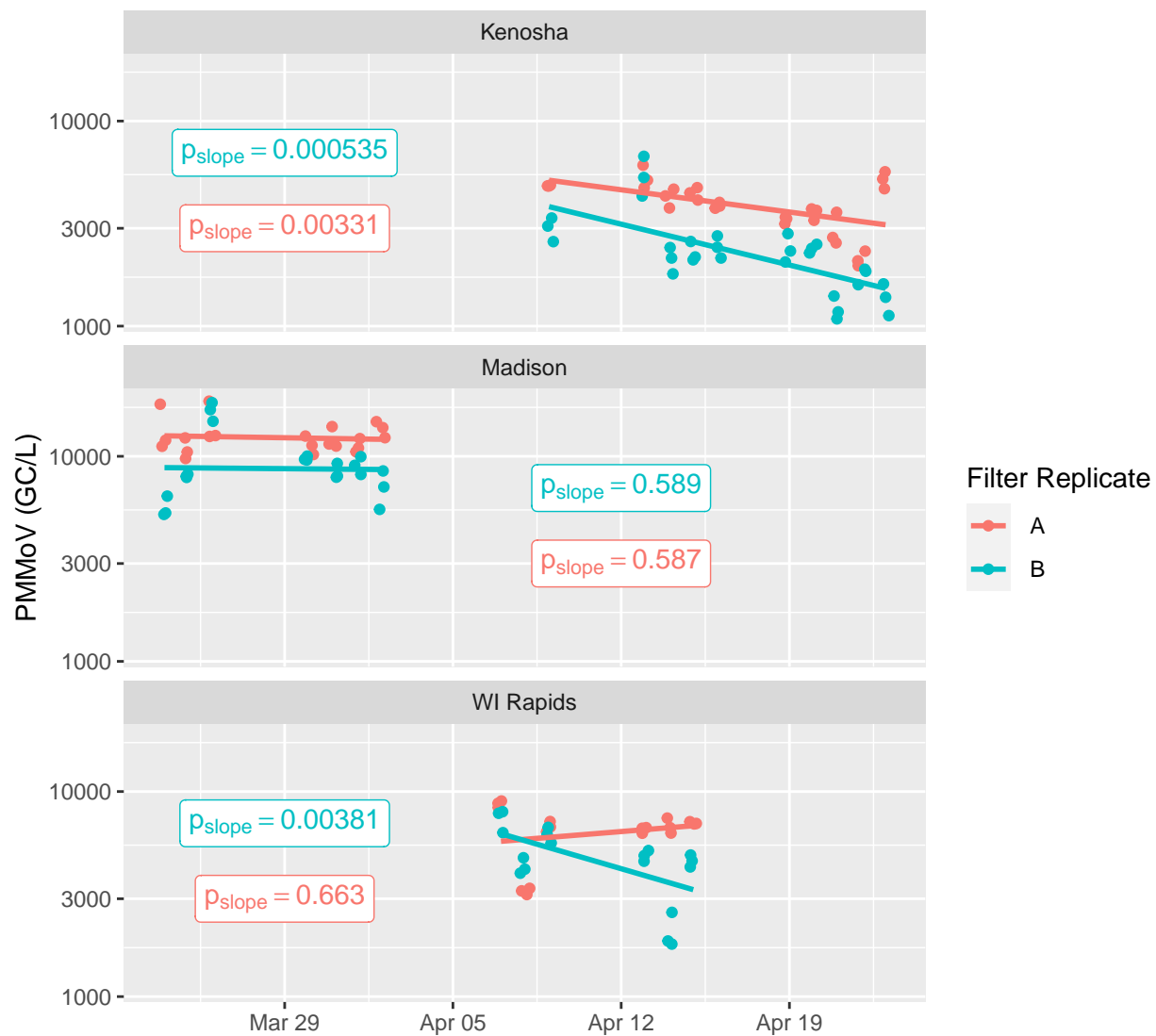


Figure 2. Six independent linear regressions.

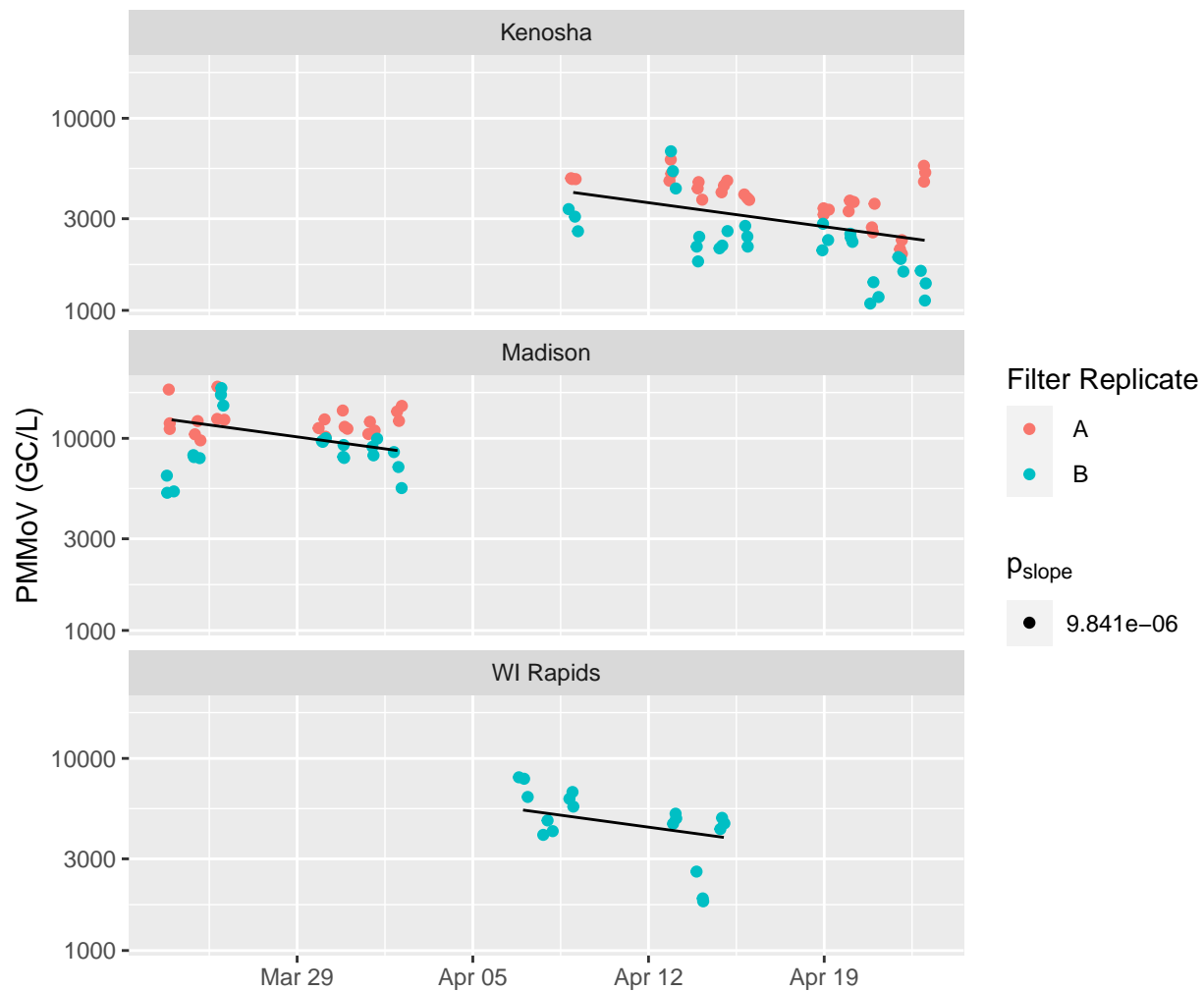


Figure 3. Mixed-effects model excluding WI Rapids filter replicate A

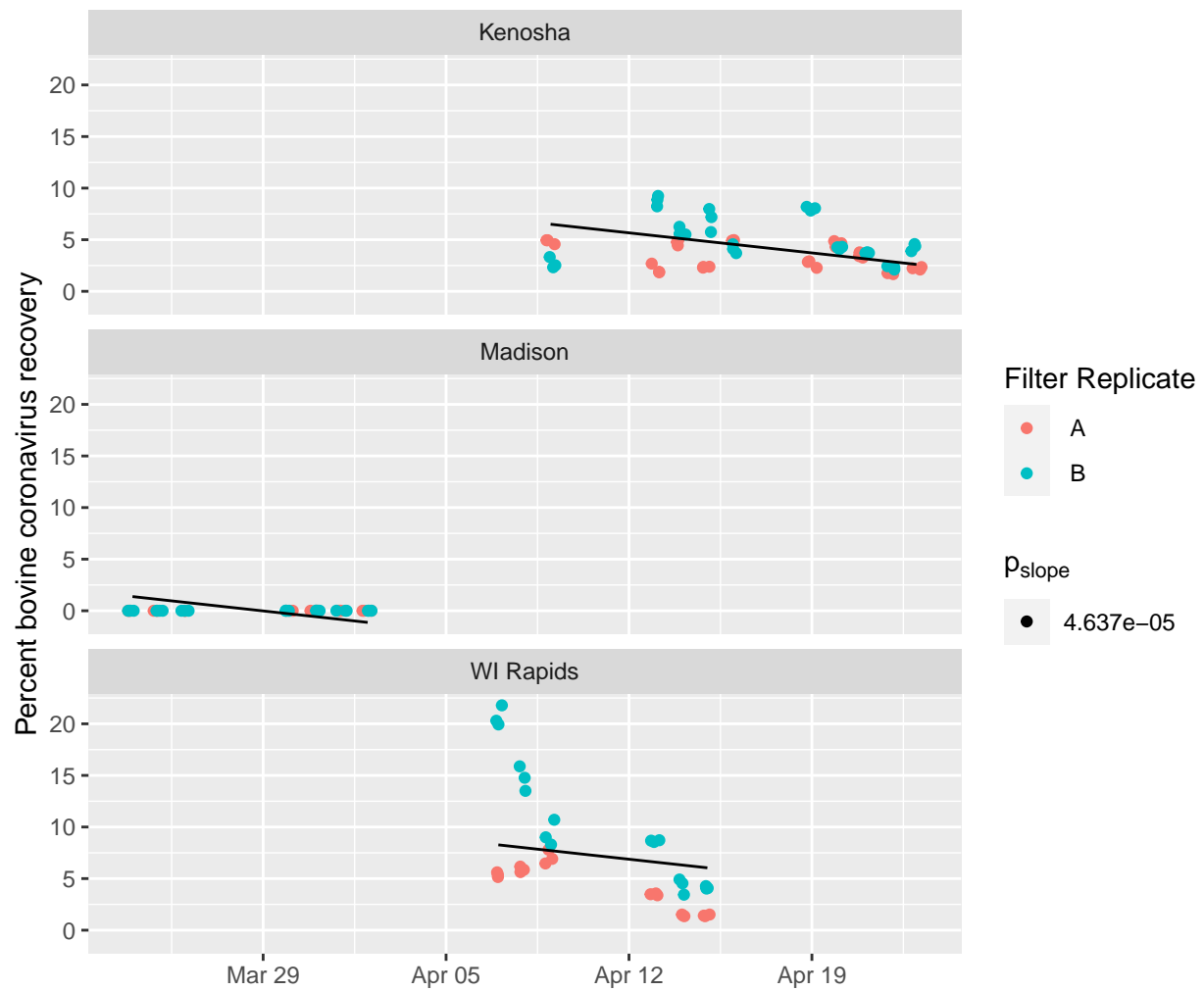


Figure 1. Mixed-effects model.

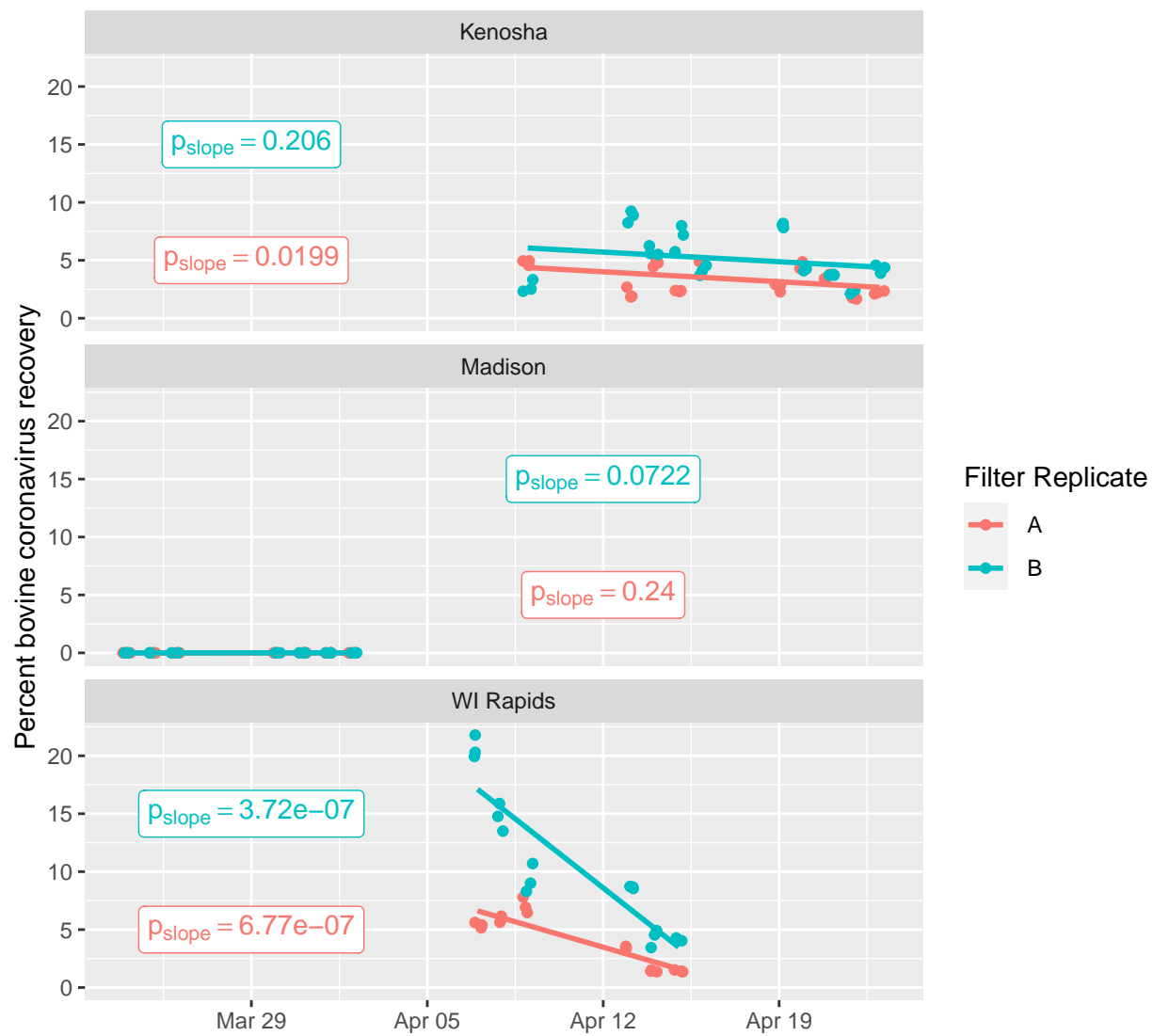


Figure 2. Six independent linear regressions.

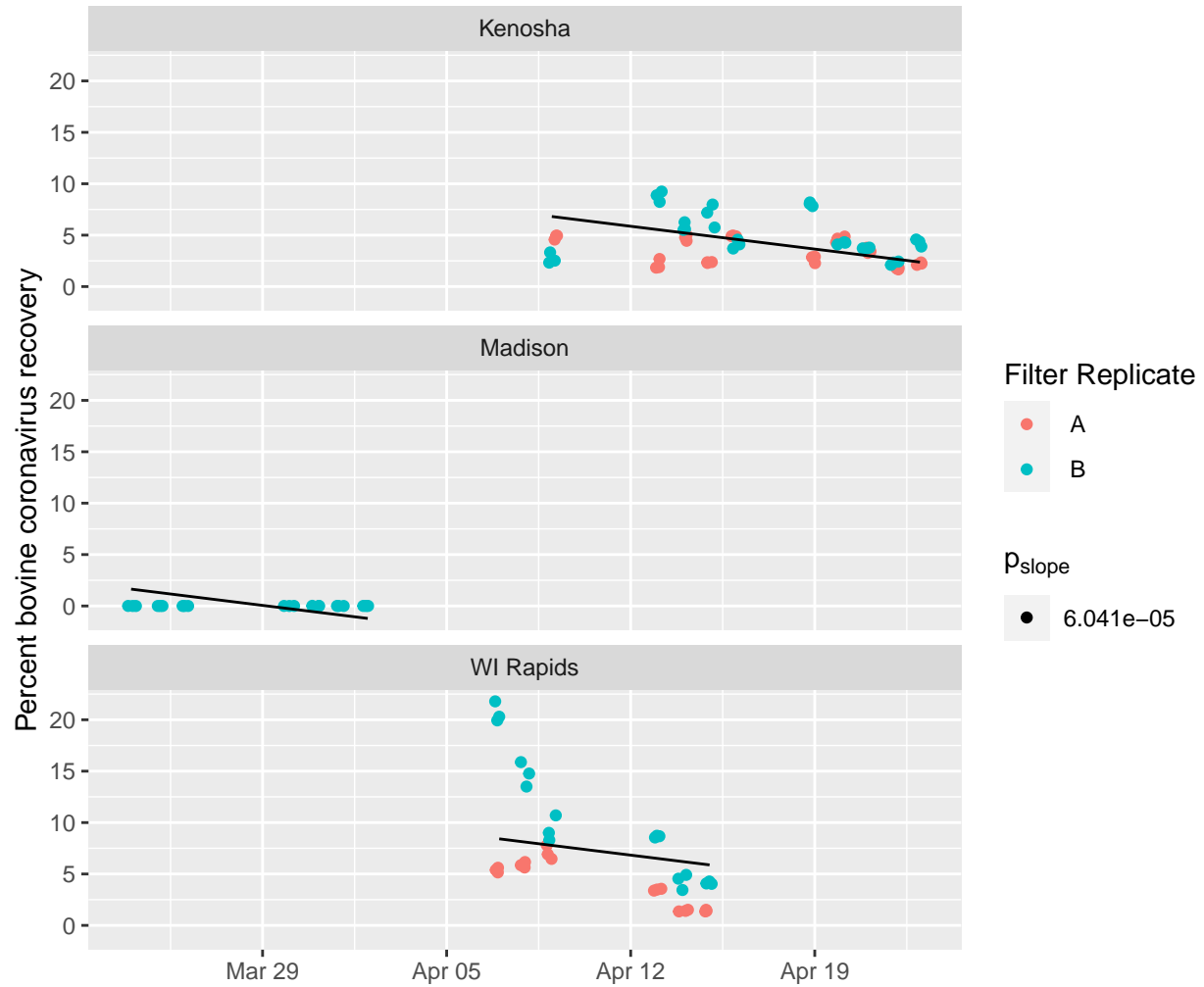


Figure 3. Mixed-effects model excluding WI Rapids filter replicate A

Table 1: Summary of models

	Estimate	Std. Error	Pr(> t)
N1 using six replicates	-0.02180	0.01760	2.18e-01
N1 excluding WI Rapids rep A	-0.04100	0.01600	1.16e-02
N2 using six replicates	-0.00897	0.01780	6.15e-01
N2 excluding WI Rapids rep A	-0.01460	0.01710	3.94e-01
PMMoV using six replicates	-0.03540	0.00860	6.61e-05
PMMoV excluding WI Rapids rep A	-0.04100	0.00886	9.80e-06
BCoV using six replicates	-0.27800	0.06600	4.64e-05
BCoV excluding Madison rep A	-0.24500	0.06050	9.21e-05