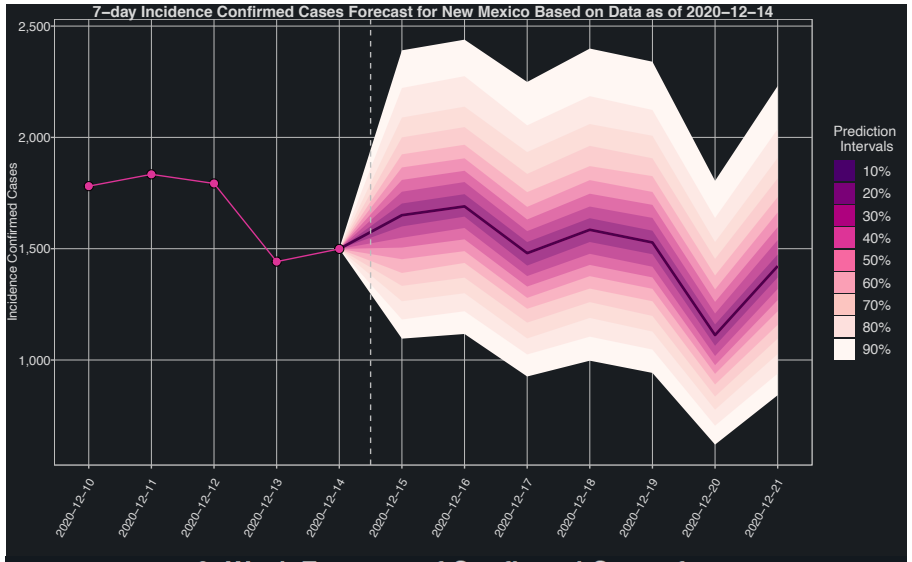
Modeling & Forecasting COVID-19 in NM

December 15, 2020

NNSA
National Nuclear Security Administration

Short- & Long-Term Forecast for NM: Cases



6–Week Forecast of Confirmed Cases for New Mexico Based on Data as of 2020–12–14

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2020–12–14		121,299*	
2020–12–21	127,898	131,810	136,973
2020–12–28	134,316	142,688	153,959
2021–01–04	140,499	154,170	172,014
2021–01–11	146,626	166,220	192,222
2021–01–18	152,751	178,938	214,212
2021–01–25	158,852	192,044	238,415

*Last reported confirmed cases count
^Closest–matching scenario

6–Week Forecast of Daily Average of Confirmed Cases for New Mexico Based on Data as of 2020–12–14

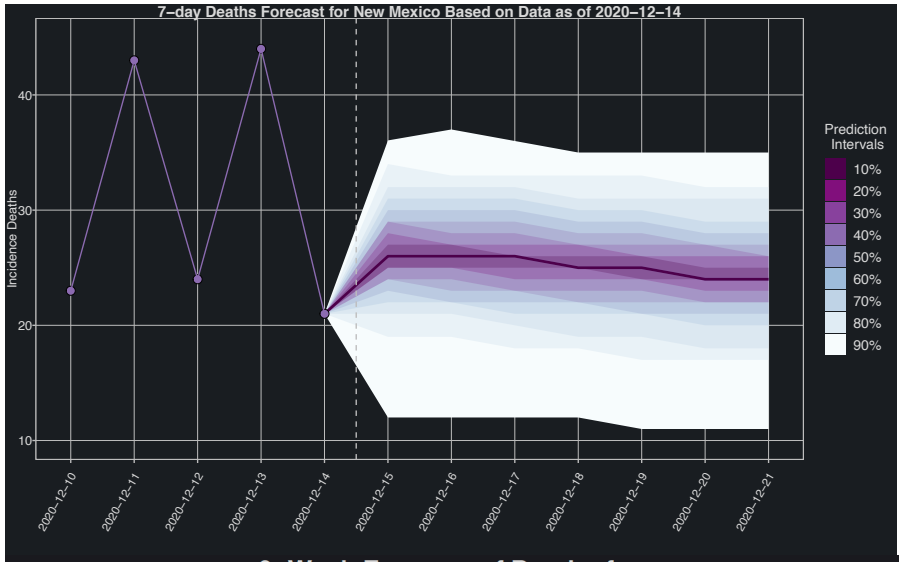
Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2020–12–14		1,622*	
2020–12–21	943	1,502	2,239
2020–12–28	917	1,554	2,427
2021–01–04	883	1,640	2,579
2021–01–11	875	1,721	2,887
2021–01–18	875	1,817	3,141
2021–01–25	872	1,872	3,458

*Last reported confirmed cases count
^Closest–matching scenario

So what?

The daily number of cases are expected to range between 900 and 2,400 in the next two weeks

Short- & Long-Term Forecast for NM: Deaths



6–Week Forecast of Deaths for New Mexico Based on Data as of 2020–12–14

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2020–12–14		1,978*	
2020–12–21	2,060	2,154	2,226
2020–12–28	2,135	2,321	2,461
2021–01–04	2,206	2,482	2,689
2021–01–11	2,280	2,643	2,921
2021–01–18	2,352	2,809	3,172
2021–01–25	2,435	2,980	3,443

*Last reported deaths count
^Closest–matching scenario

6–Week Forecast of Daily Average of Deaths for New Mexico Based on Data as of 2020–12–14

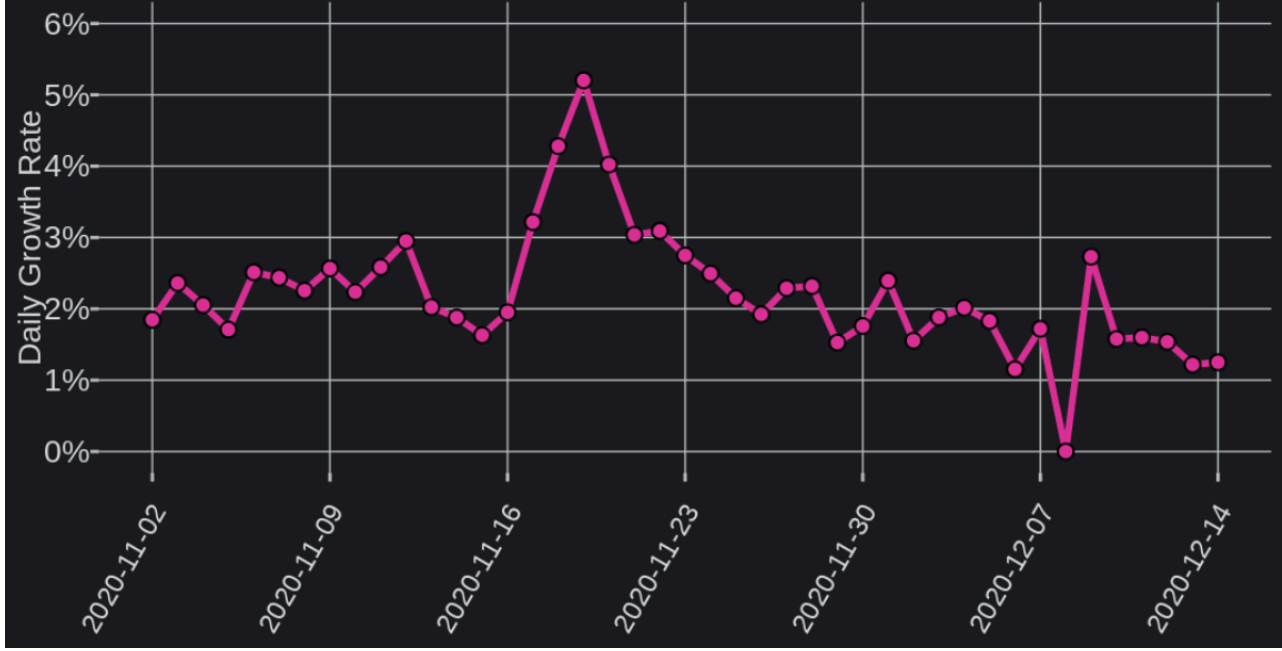
Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2020–12–14		32*	
2020–12–21	12	25	35
2020–12–28	11	24	34
2021–01–04	10	23	33
2021–01–11	11	23	33
2021–01–18	10	24	36
2021–01–25	12	24	39

*Last reported confirmed deaths
^Closest–matching scenario

So what?

The daily number of deaths are expected to range between 11 and 35 in the next two weeks

Growth Rate for NM



6-Week Forecast of the Average Weekly Growth Rate for New Mexico Based on Data as of 2020-12-14

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2020-12-14		1.4%*	
2020-12-21	0.76%	1.2%	1.8%
2020-12-28	0.70%	1.1%	1.7%
2021-01-04	0.65%	1.1%	1.6%
2021-01-11	0.61%	1.1%	1.6%
2021-01-18	0.59%	1.1%	1.6%
2021-01-25	0.56%	1.0%	1.5%

*Last weekly mean daily growth rate

^Closest-matching scenario

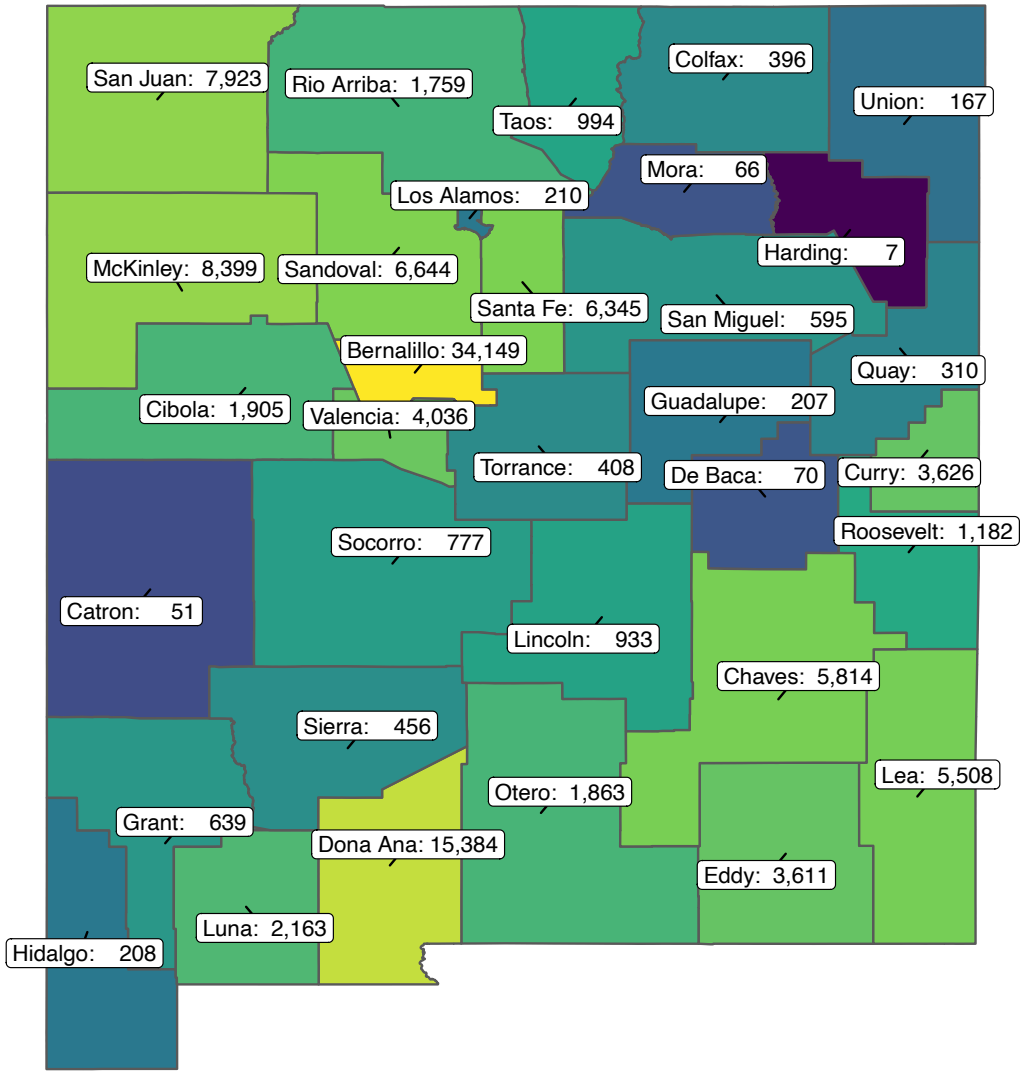
So what?

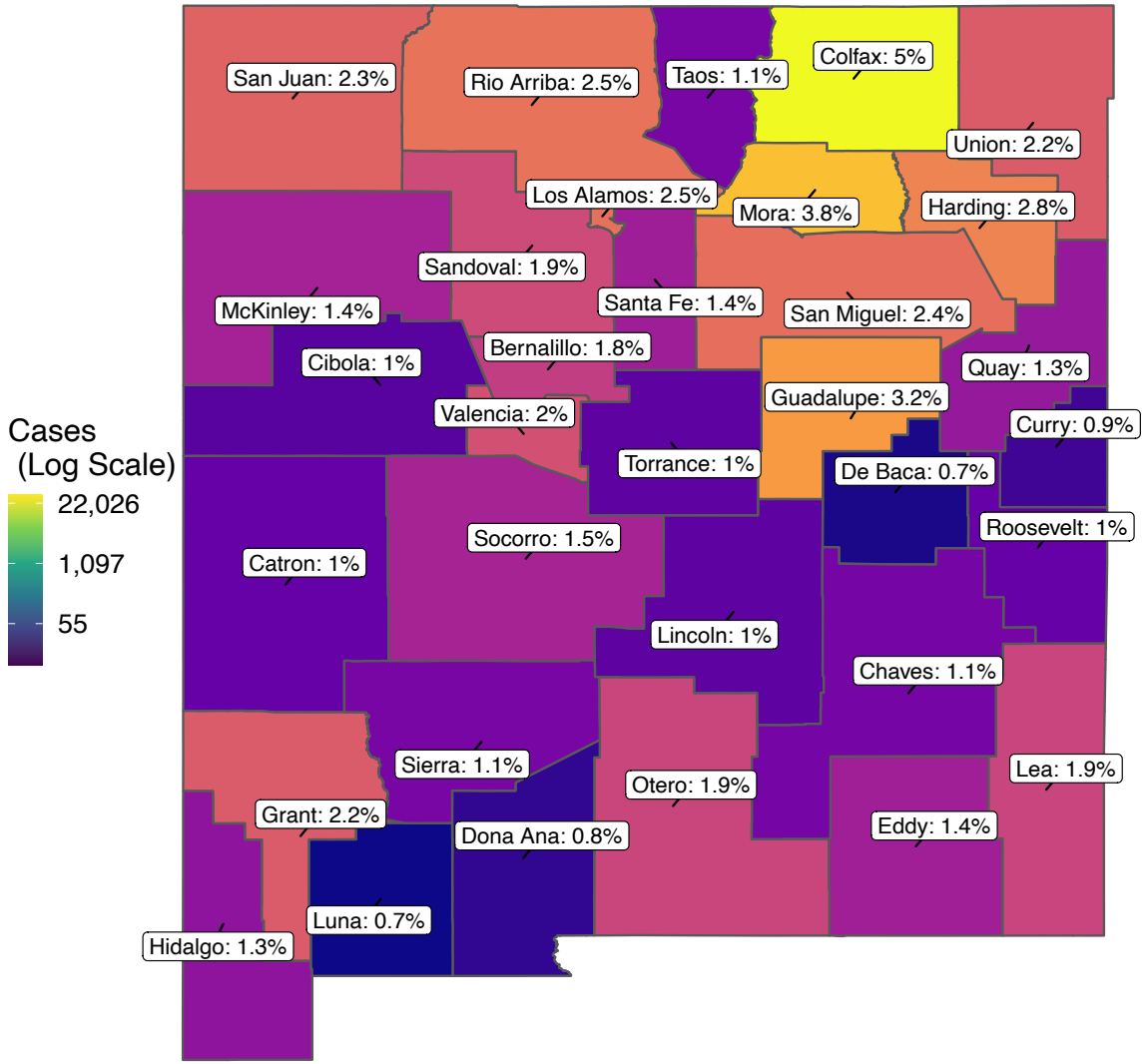
As of December 14th, the average growth rate in NM is at 1.4% (down from 1.8%)

Deaths have been increasing by an average of 1.7% per day (up from 1.6%)

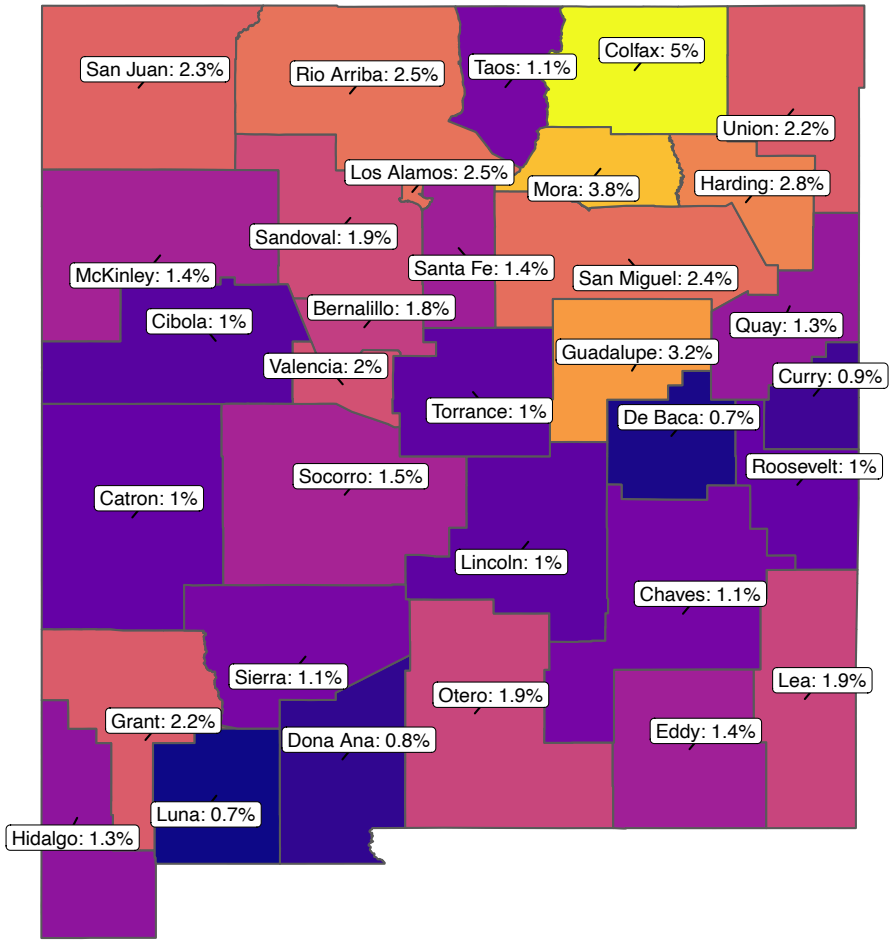
> Regional Forecasts, Growth Rates, & Hospitalizations

Cumulative Cases & Daily Growth Rate for NM: Dec 14





Daily Growth Rate for NM Dec 14



*arrows indicate more than 0.5% difference in growth rate from last week's analysis

Socorro **1.5%** =
Roosevelt **1.0%** ↓
DeBaca 0.7% ↓
Quay **1.3%** ↓
Los Alamos **2.5%** ↓
Mora **3.8%** ↓
Catron **1.0%** ↓
Union **2.2%** ↓

Hidalgo **1.3%** ↑
Colfax **5.0%** ↑

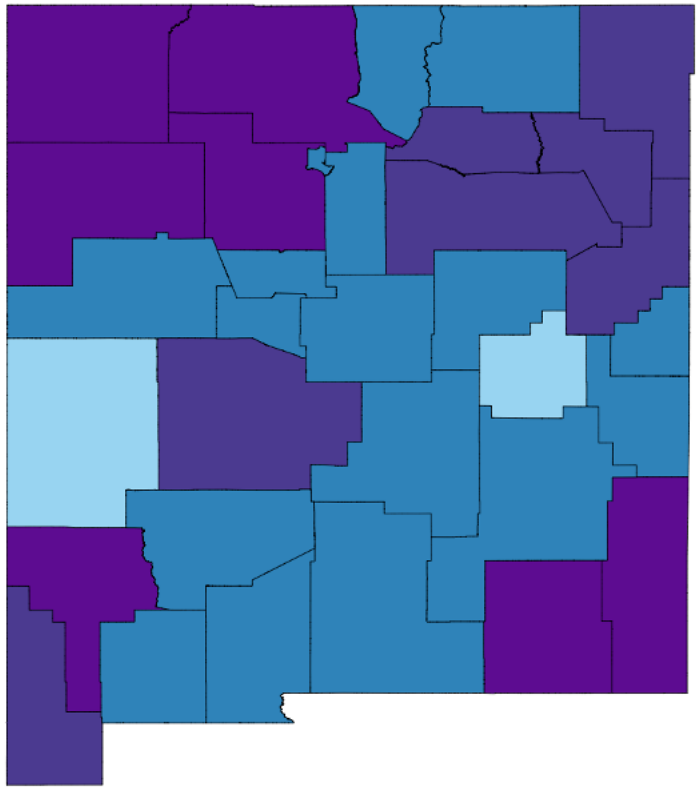
County	Daily Growth Rate	Change
San Juan	**2.3%**	=
Rio Arriba	**2.5%**	↑
Sierra	**1.1%**	↓
McKinley	**1.4%**	=
Sandoval	**1.9%**	=
Santa Fe	**1.4%**	↓
Cibola	**1.0%**	=
Bernalillo	**1.8%**	↓
Valencia	**2.0%**	↓
Torrance	**1.0%**	↓
Lincoln	**1.0%**	↓
San Miguel	**2.4%**	=
Chaves	**1.1%**	↓
Dona Ana	0.8%	↓
Otero	**1.9%**	↑
Lea	**1.9%**	=
Eddy	**1.4%**	=
Curry	0.9%	=
Grant	**2.2%**	↑
Luna	0.7%	=
Taos	**1.1%**	↓

Weekly Growth Rate for NM: Another View (Dec 14)

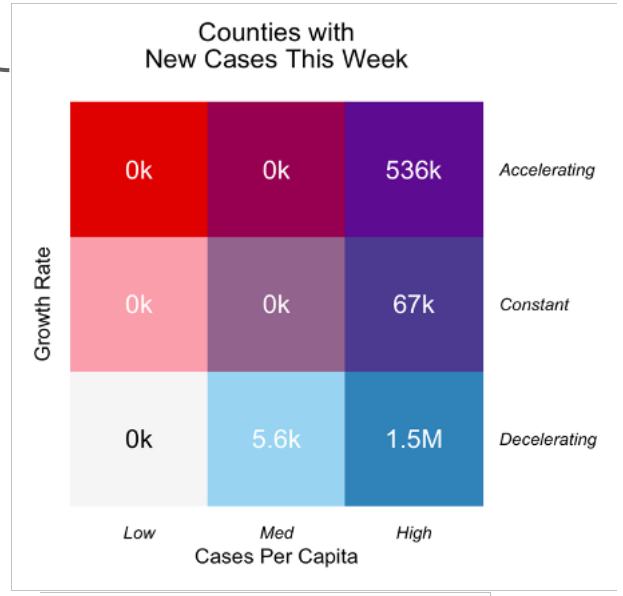
COVID-19 across New Mexico

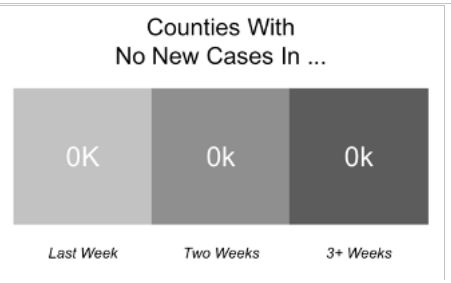
A 7-day moving window comparison

December 14, 2020



Impacted New Mexicans





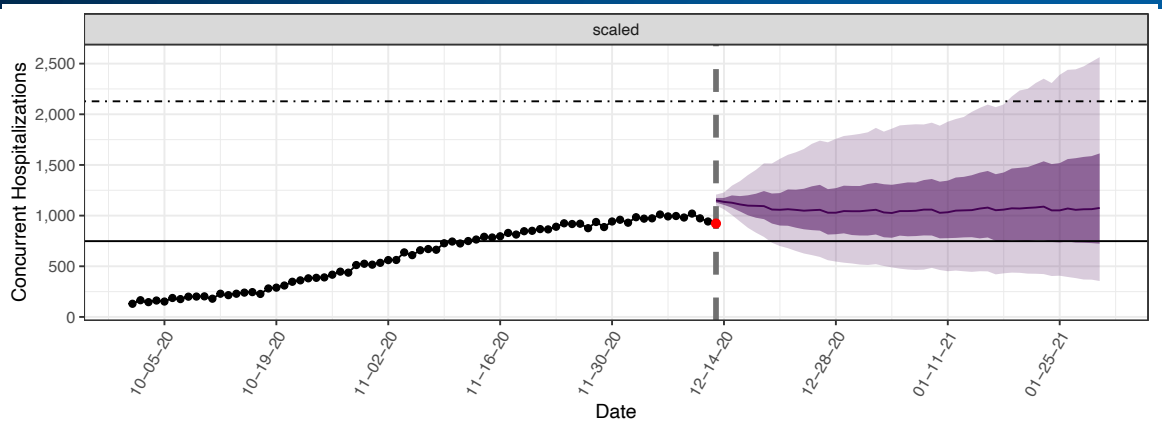
Number of New Mexicans living in regions with particular combinations of per capita case counts and 7-day growth rates

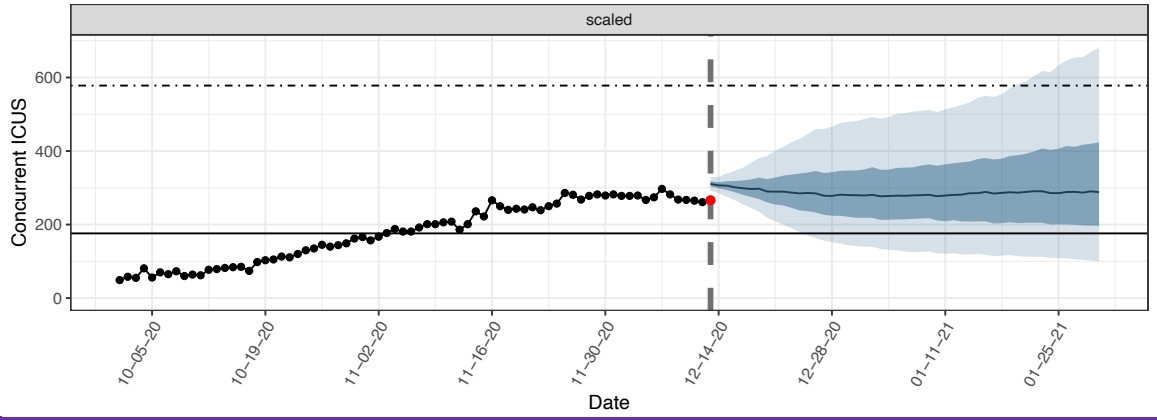
So what?

- Most people in New Mexico are living in a county that is decelerating but still high per capita case counts
- 7 counties are still accelerating: Eddy, Grant, Lea, McKinley, Rio Arriba, Sandoval, San Juan
- Counties with >500 weekly cases per 100k: Chaves, Colfax, Eddy, Guadalupe, Lea, McKinley, Rio Arriba, San Juan, Union, Valencia

Low <10 cases/100k per week
Med 10-99 cases/100k per week
High >100 cases/100k per week

Concurrent Hosp & ICU Beds Based on Forecasts – Average Stay of 8 Hosp, 15 Days for ICU/vent & 25% ICU rate





Concurrent COVID-19 ICUs beds

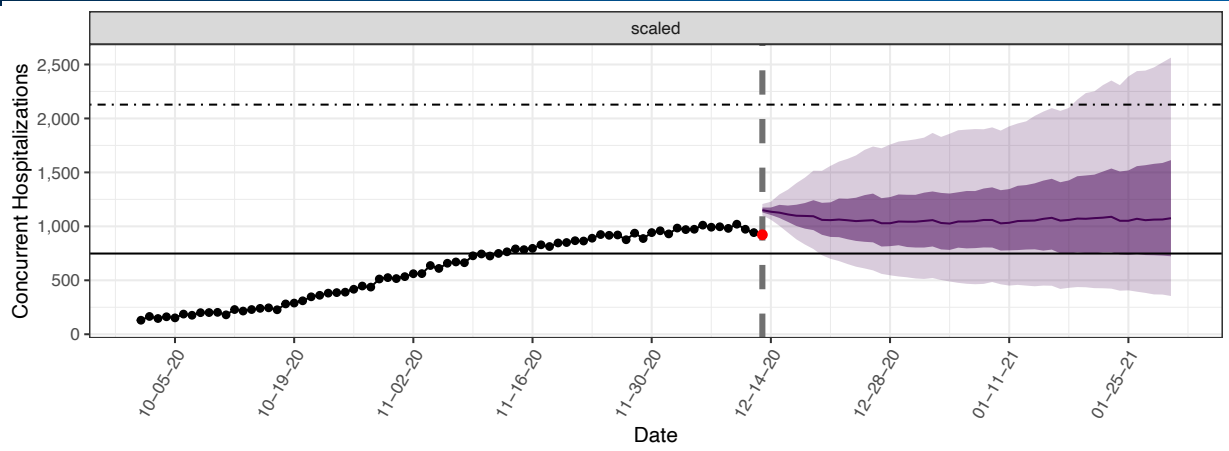
Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	219	290	387
12/27	156	278	460
1/3	134	277	488
1/10	122	277	506
1/17	114	284	547
1/24	109	286	615

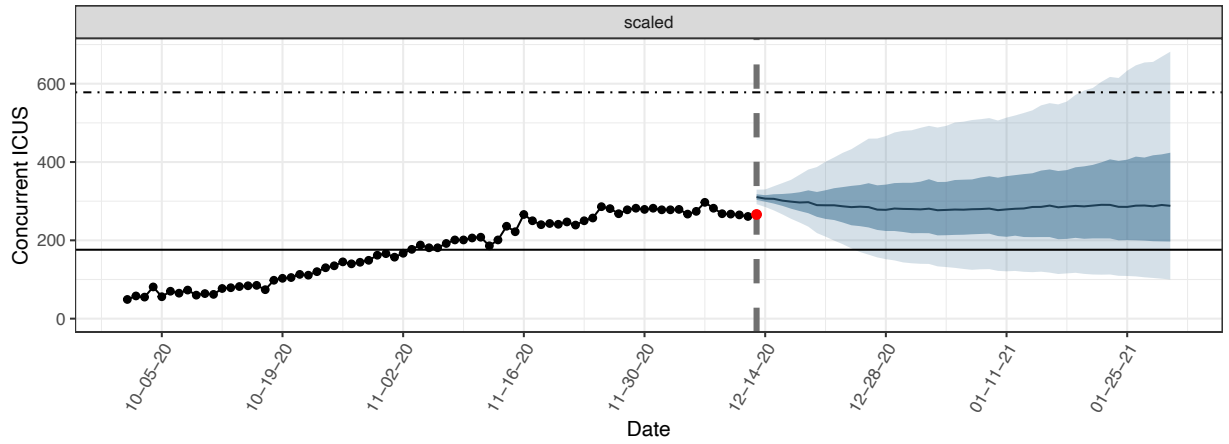
"Scaled" Scenario

So what?

We are over baseline ICU bed capacity for concurrent COVID-19 patients; our model is tracking between best and median this week. Model is predicting a very gradual decline over the next six weeks (between 134-277 concurrent COVID-19 ICU beds by December 27)

Concurrent Hosp & ICU Beds Based on Forecasts – Average Stay of 8 Hosp, 15 Days for ICU/vent & 25% ICU rate





Concurrent COVID-19 non-ICU "med-surge" beds

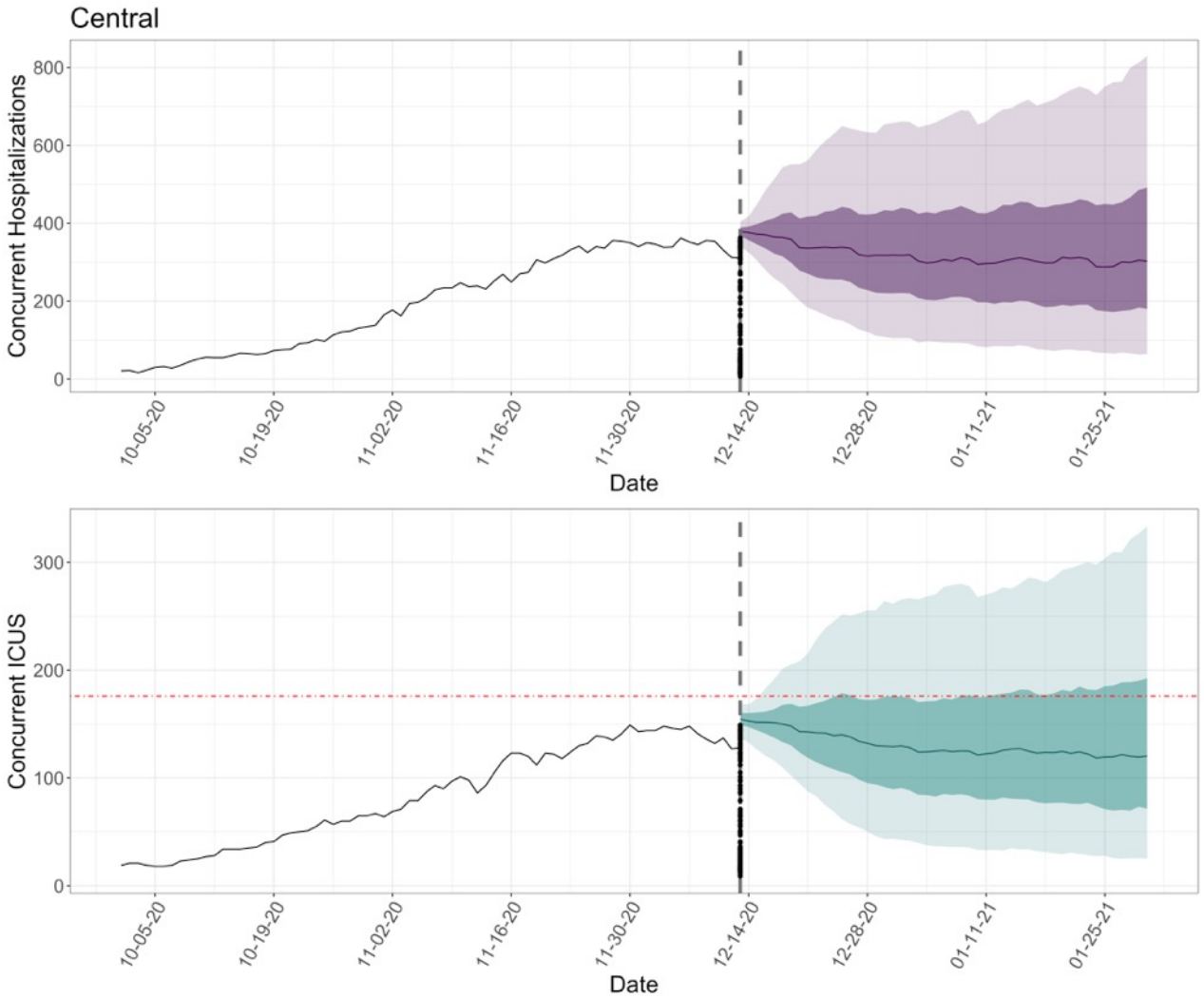
Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	514	770	1127
12/27	403	750	1263
1/3	369	754	1341
1/10	341	751	1381
1/17	306	769	1523
1/24	294	766	1694

"Scaled" Scenario

So what?

Med-surge general bed needs are tracking between best and median case scenario this week; med-surge beds predicted to gradually decline, needing between 403—750 beds by December 27

Regional Hospitalization Forecasts: Central



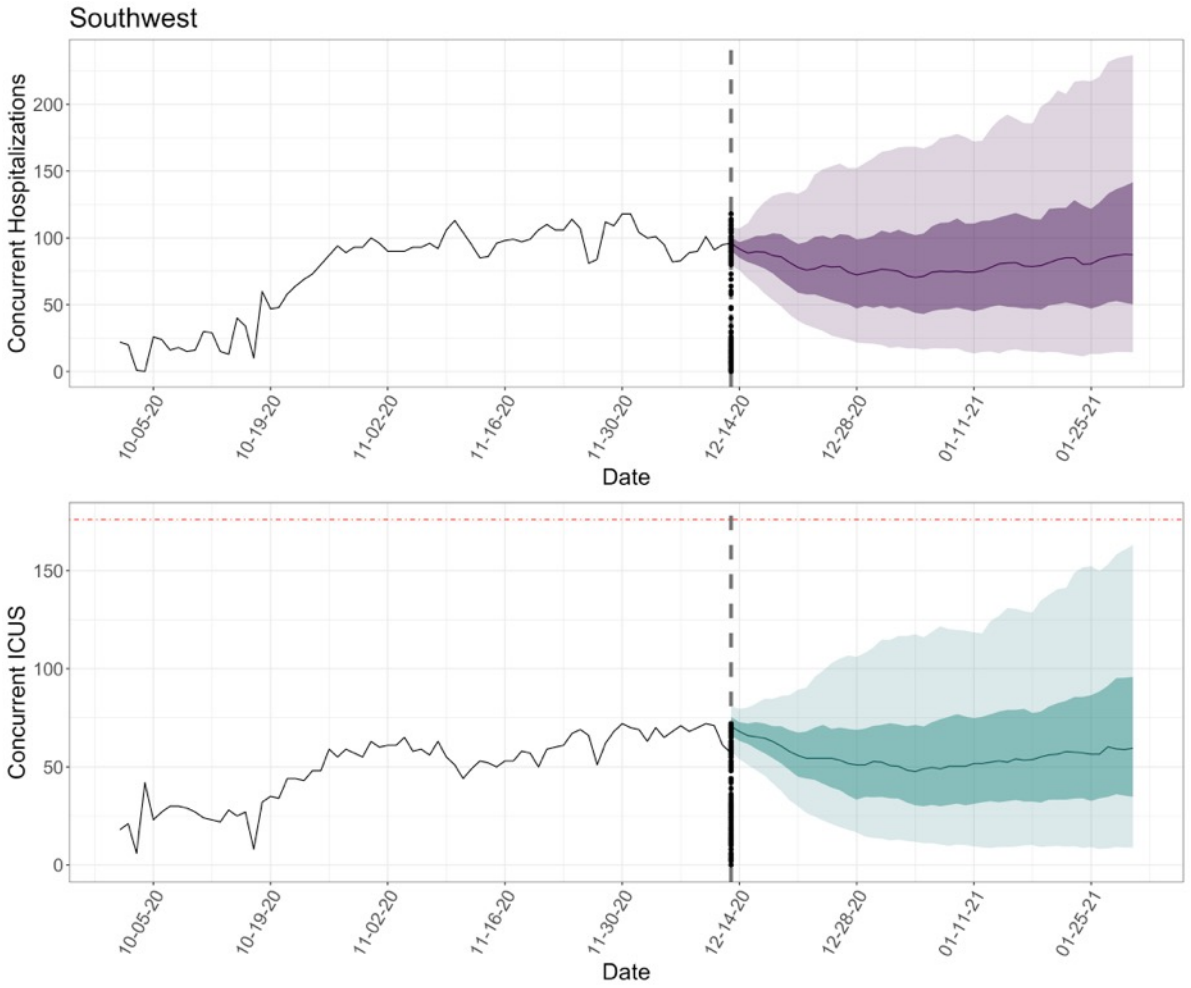
Concurrent COVID-19 ICUs beds: Central

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	95	143	208
12/27	54	134	253
1/3	40	124	266
1/10	33	121	268
1/17	32	123	285
1/24	27	119	298

So what?

ICU bed usage is expected to gradually decline in the Central region; tracking between best

Regional Hospitalization Forecasts: Southwest



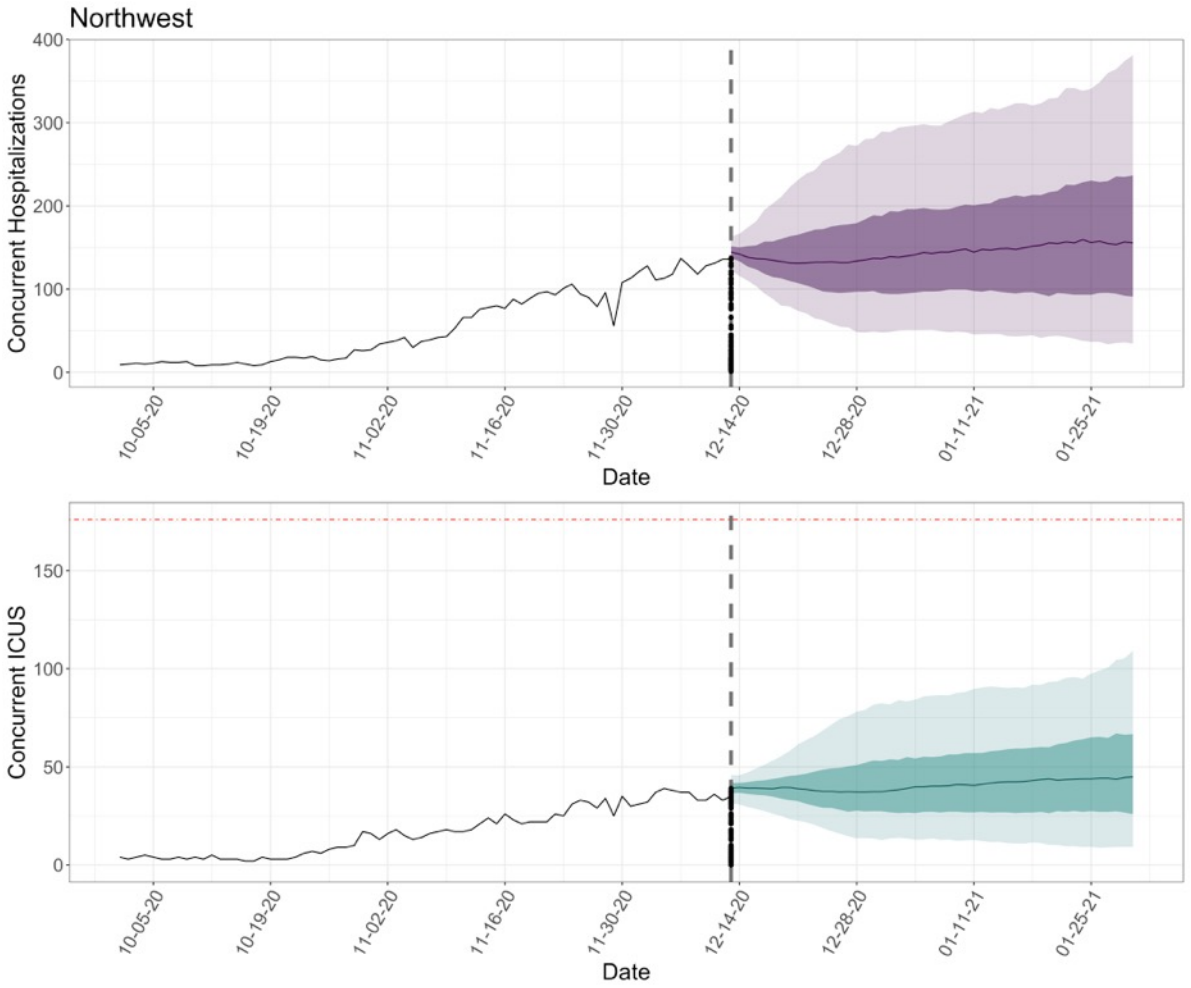
Concurrent COVID-19 ICUs beds: Southwest

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	33	58	87
12/27	18	52	107
1/3	12	48	117
1/10	10	50	119
1/17	10	53	129
1/24	9	57	152

So what?

ICU bed usage is expected to <u>decrease</u> slowly in the Southwest region. Estimates are tracking

Regional Hospitalization Forecasts: Northwest



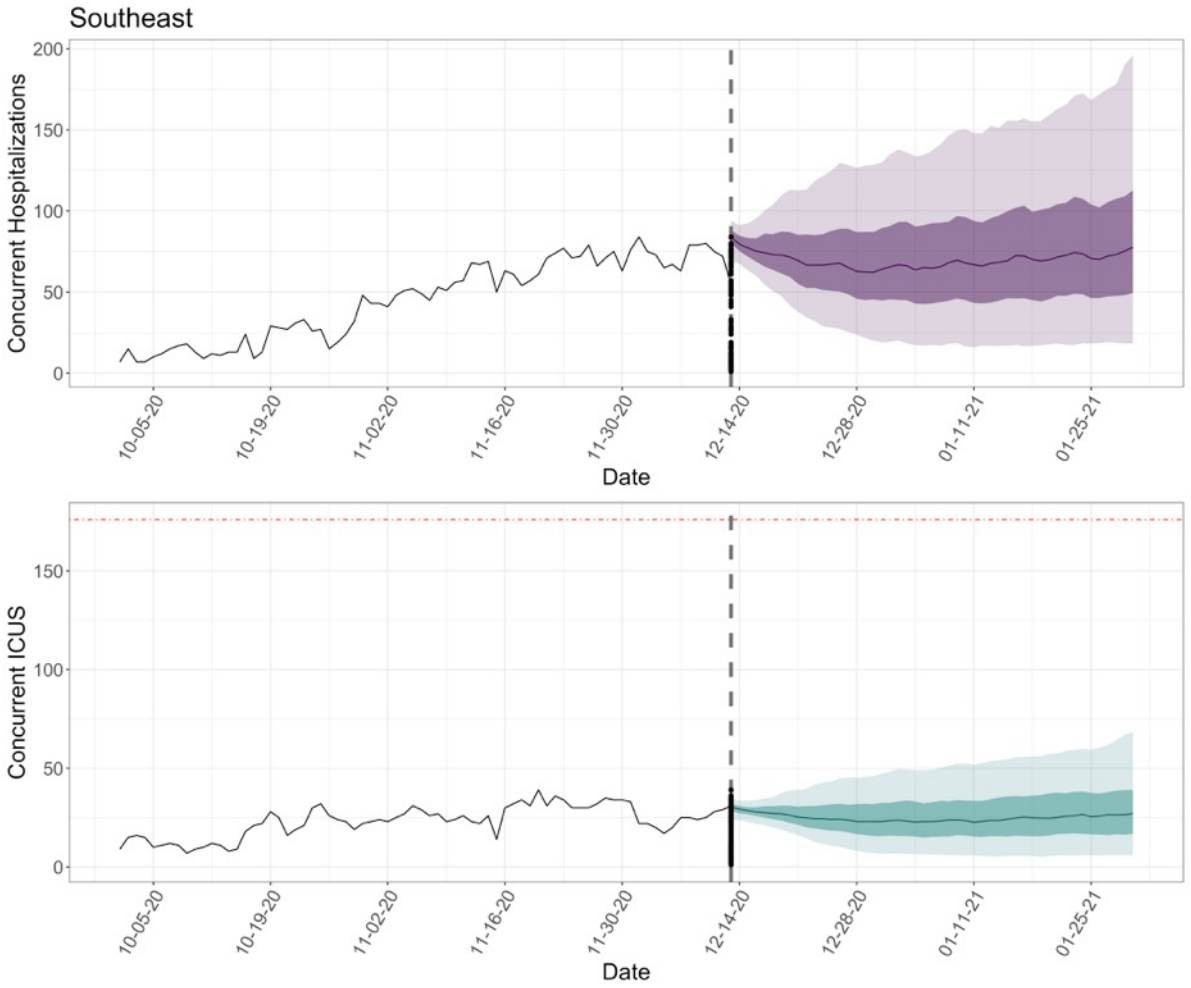
Concurrent COVID-19 ICUs beds: Northwest

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	23	40	58
12/27	15	37	76
1/3	14	39	83
1/10	13	41	88
1/17	11	43	90
1/24	9	44	95

So what?

ICU bed usage is expected to slowly decrease or remain steady in the Northwest region;

Regional Hospitalization Forecasts: Southeast



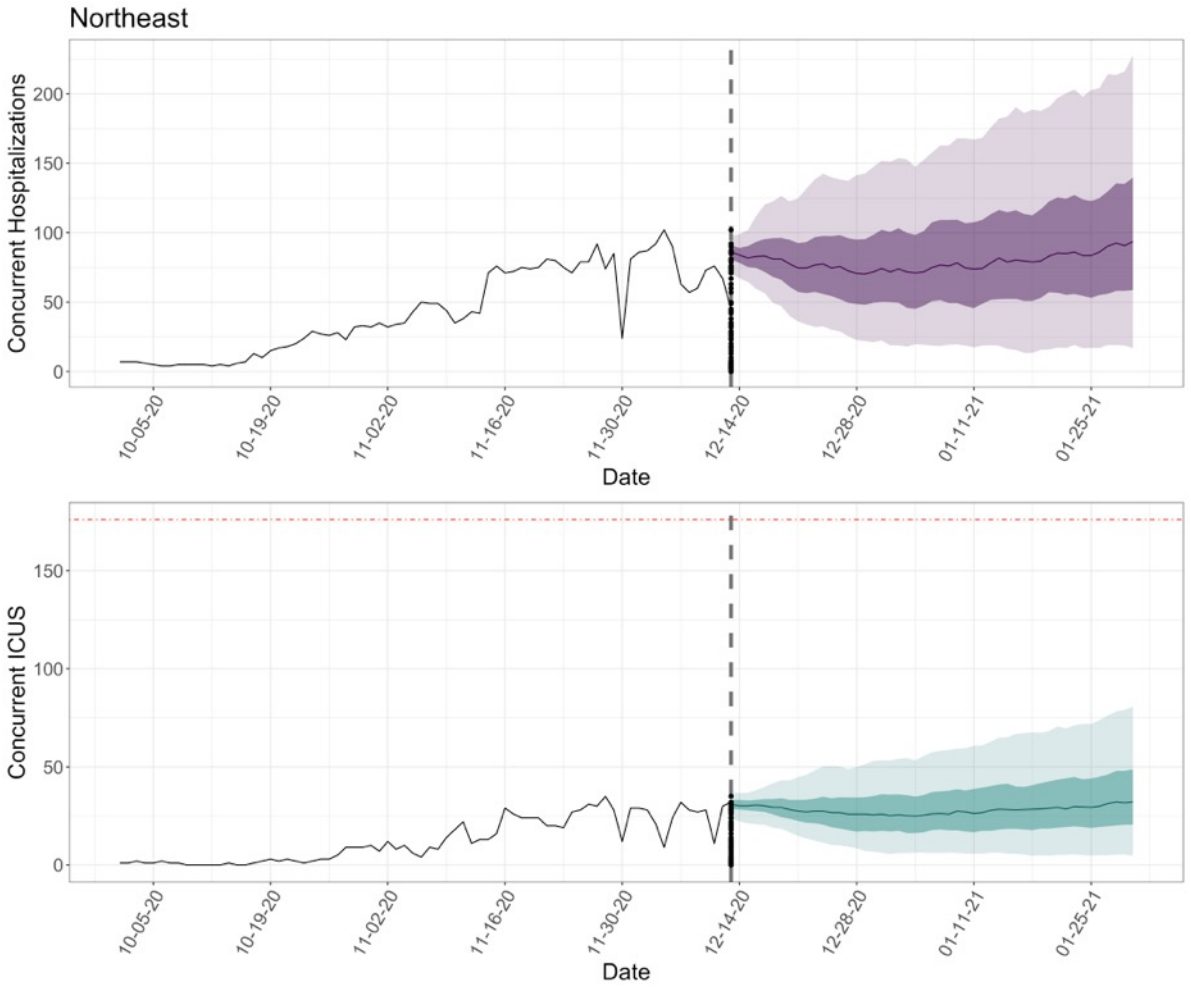
Concurrent COVID-19 ICUs beds: Southeast

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	17	26	39
12/27	9	24	45
1/3	7	23	49
1/10	6	23	52
1/17	6	25	56
1/24	6	27	60

So what?

ICU bed usage is expected to slowly decrease in the Southeast region; tracking between best

Regional Hospitalization Forecasts: Northeast



Concurrent COVID-19 ICUs beds: Northeast

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
12/20	17	28	43
12/27	9	26	49
1/3	6	25	55
1/10	6	27	59
1/17	5	28	67
1/24	5	30	72

So what?

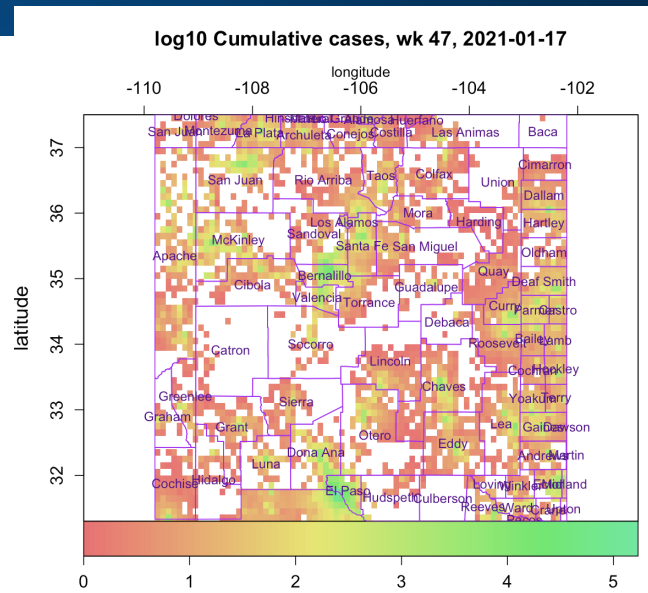
ICU bed usage is expected to slowly decrease in the Northeast region; tracking between best

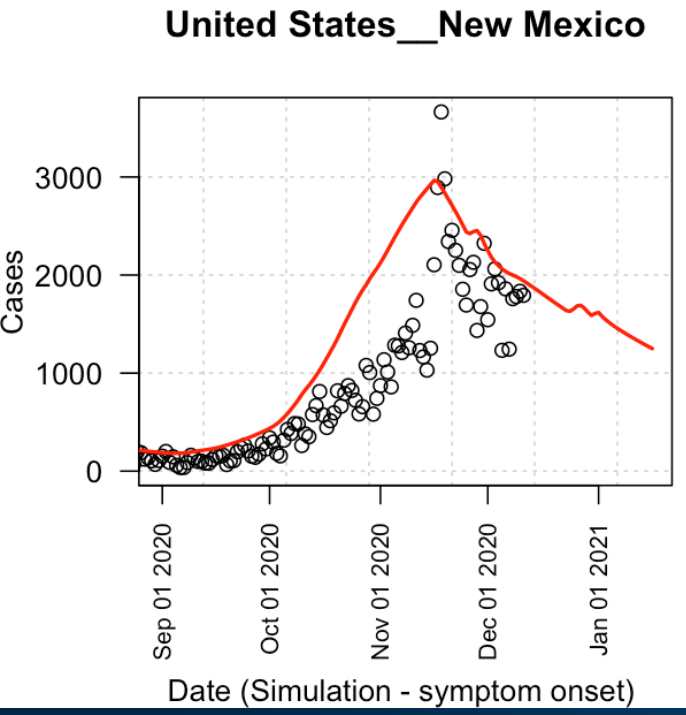
15 Dec 2020: EpiGrid modeling

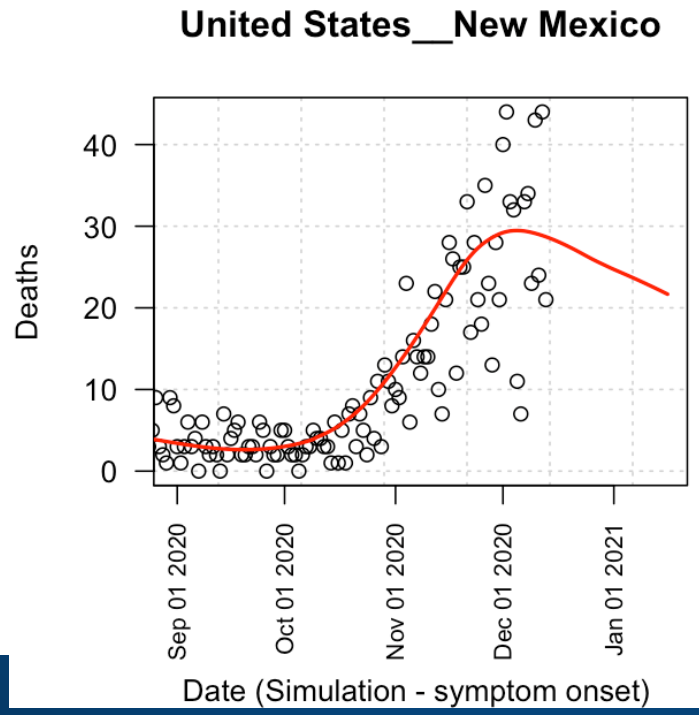
- Assumes all counties remain in their current (almost all “red”) category under the new county-by-county system. (More precisely we assume that transmission parameters stay as they are.)

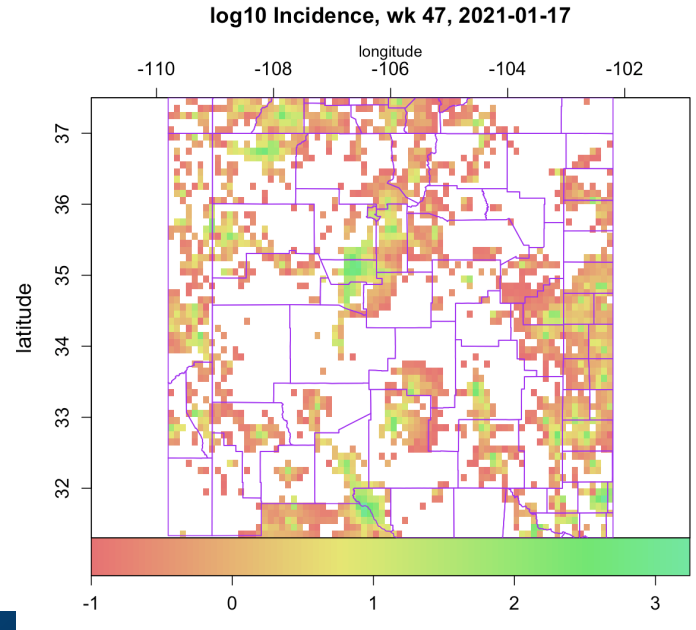
- Quarantine modeled at 42%.

- Small increases in transmission are parameterized for Thanksgiving, and assumed for Christmas and New Year’s.









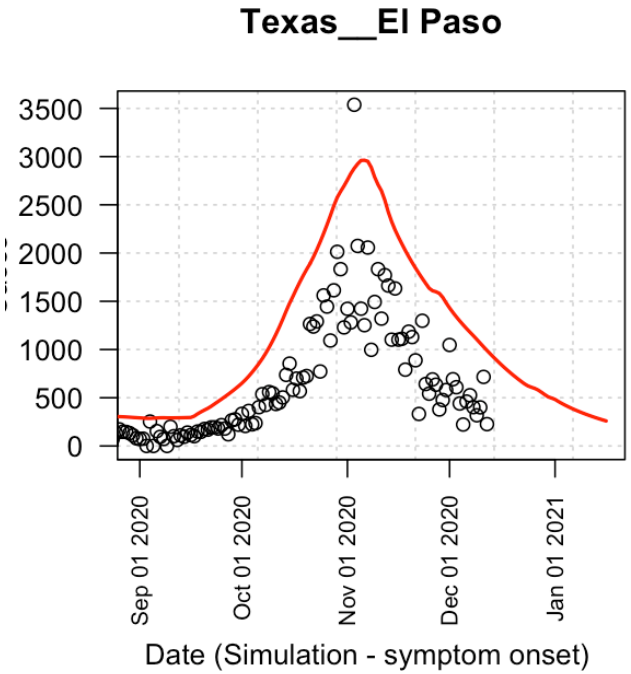
08 December 2020 Model (EpiGrid) – more details and information

- **Reported cases in El Paso are still decreasing; positivity dropped to 12.5%.**

- **Transmission is based on mobility with modifications due to PHO's.**
  - Modeling of public reaction and public health orders (PHO) is similar to previous models.
  - Geographical heterogeneity of mobility accounts for the majority of variations in the force of infection from county-to-county.

- **Death rates now include more of the inhomogeneity by-county**
  - Counties with higher-risk populations have higher death rates.

- **Isolation and quarantine rates are assumed to be stable.**
  - Swab to results times: Assuming 1-3 days
  - Base isolation rate is 0.42 for NM.
  - The rate of effective quarantine state-wide is rising slowly.

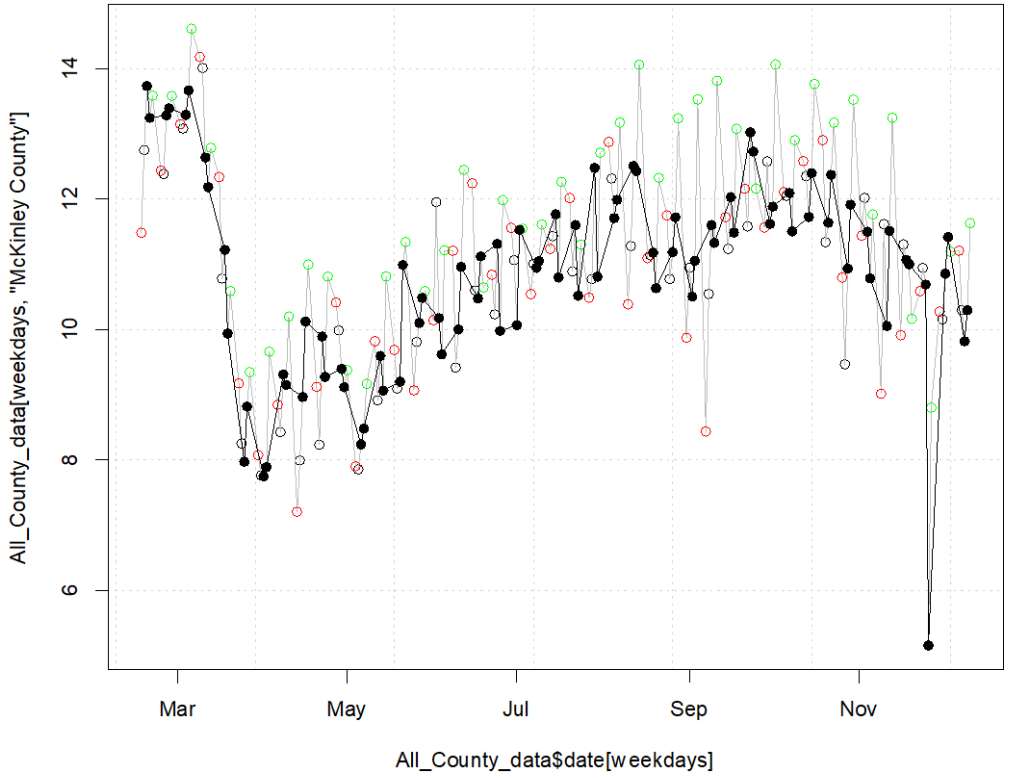


T-80 Mobility – northern counties (Data only).

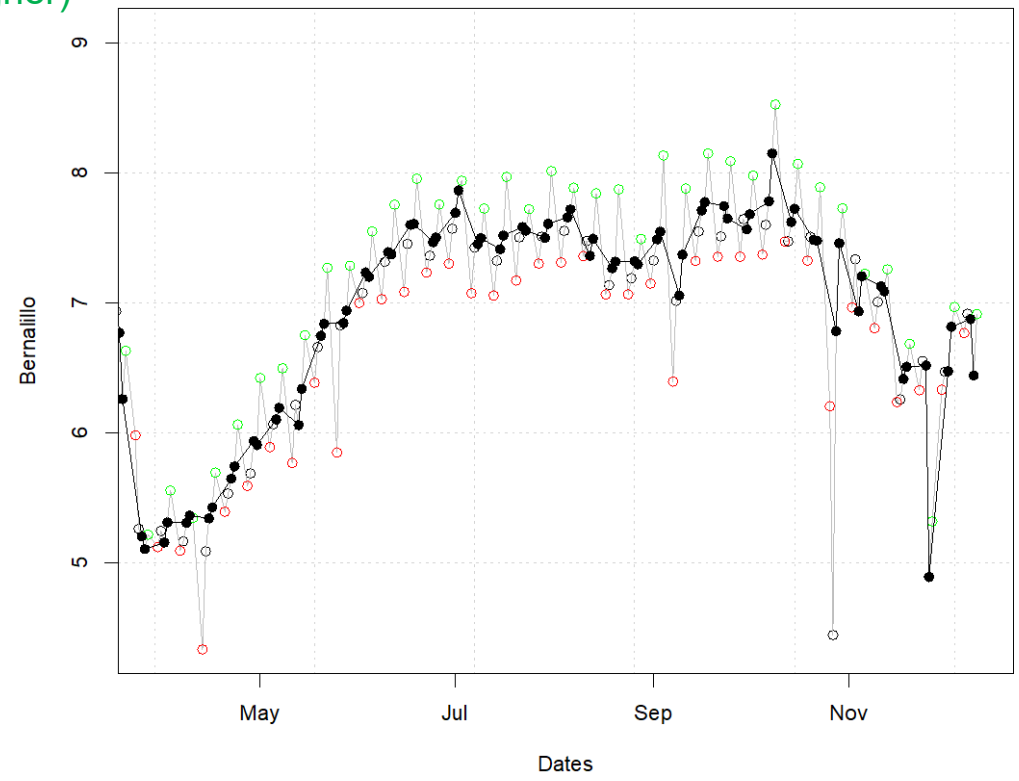
Bernalillo, McKinley, Rio Arriba, Sandoval, San Juan, Santa Fe, and Taos all at similar levels or slightly higher than immediately pre-Thanksgiving.

- Weekends NOT shown
- Monday
- Wednesday/Thursday
- Friday (usually higher)

McKinley



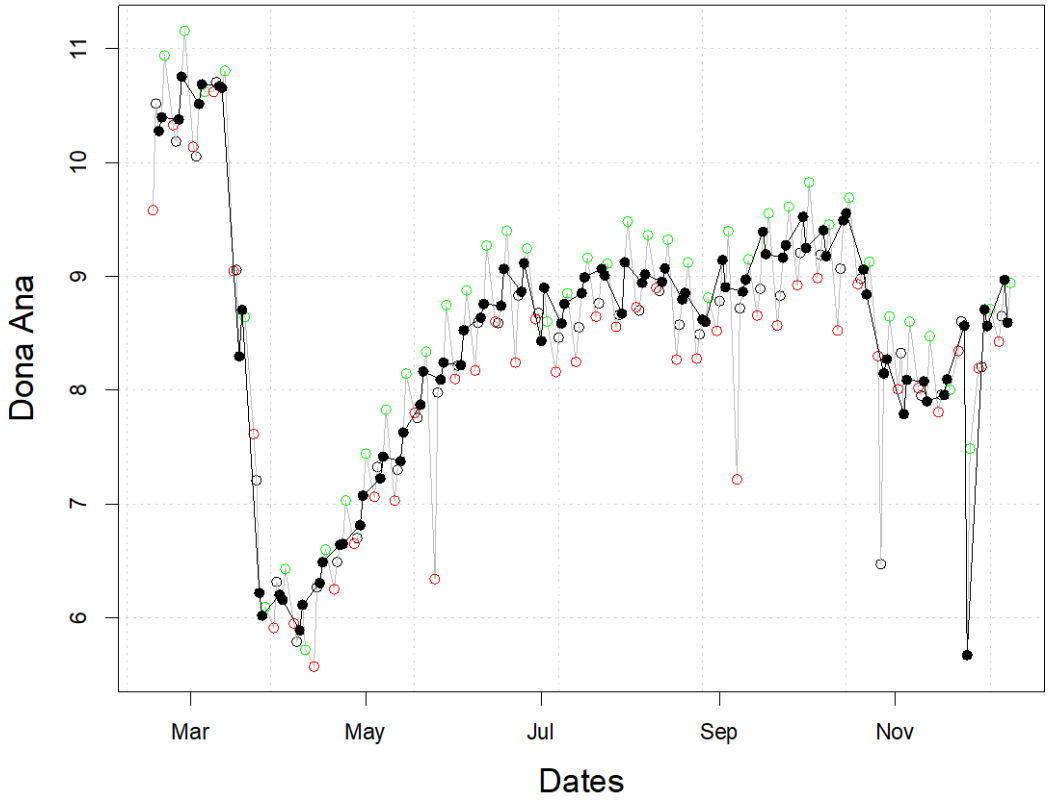
Bernalillo



T-80 Mobility – southern counties (and Curry) (Data only)

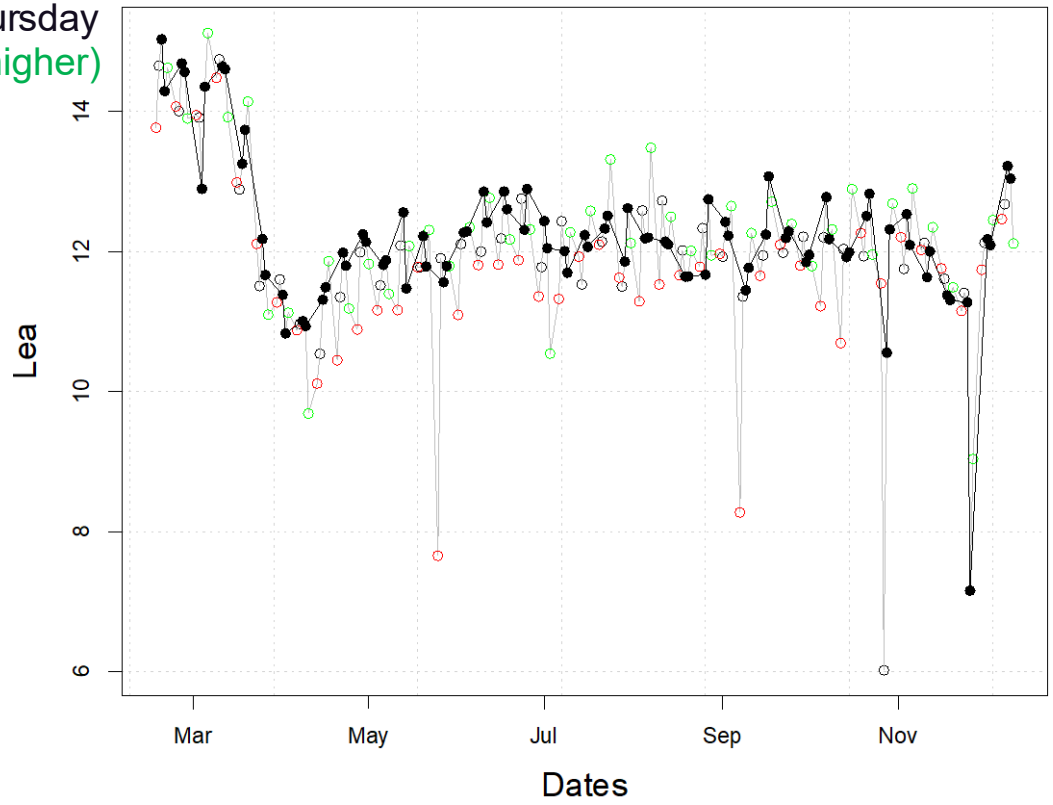
Lea, Eddy and possibly Dona Ana have increasing mobility.
Eddy, Chaves, Curry, Luna, Roosevelt are fairly stable at levels similar to immediately preceding Thanksgiving.

Dona Ana



- Weekends NOT shown
- Monday
- Wednesday/Thursday
- Friday (usually higher)

Lea



Fundamental Considerations for Vaccination Objectives. Effects Modeled.

0. Not a single objective! Multiple, *complementary* objectives.

- Contagious diseases have multiple effects. All are amenable to remediation though vaccination.
- Three objectives below can likely be achieved by over-lapping progression through the numbered ordering below.

1. Reduce the death rate. Time frame ~4 weeks to initial effects with Pfizer.

- Early administration to high-risk populations and individuals at elevated risk of mortality.
  - Pueblos & Navajo Nation at-risk residents in congregated multi-generation housing, etc.
  - People living with ESRD, DMII, COPD, etc.
  - Over-N years (depends on number of available doses to-date), but N > 65 most likely.
- High risk-for-mortality populations are *widely distributed* and preferential administration is unlikely to inhibit other objectives.
- These populations are at-risk for hospitalization; *this objective will help control hospital load.*

2. Lower the rate of spread. Connectivity-based, and geographically-based. Time frame ~3 weeks to see initial effects with Pfizer.

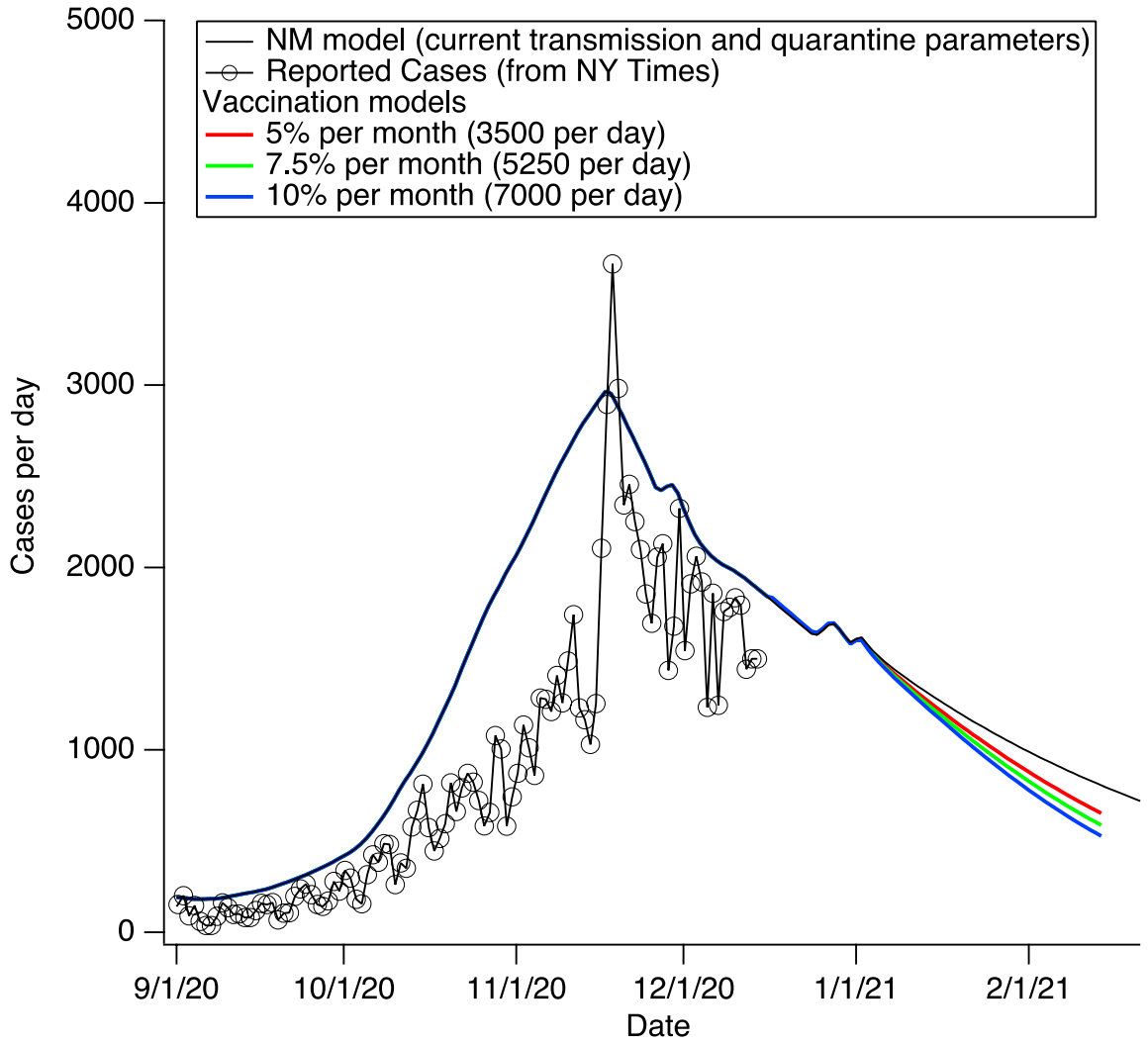
- The existence of geographical hot-spots (N.B. Top 10 Zip Code list) allows classical ring-type vaccination in those limited number of areas.
  - Runs not complete, but 10 ZIP Codes account for 1/3 of daily state-wide incidence. Lowers hospital load.
- Employment description is correlated with daily contact rate and associated demographic risk factors (i.e. income, etc.).
  - Has the potential to radically improve contact-tracing efficiency, will lower hospital load.
  - Only easily-foreseen complexity is that vaccination of risky job categories in low-incidence areas does not immediately modify the epidemic.

3. Achieve vaccine-mediated herd immunity. Time frame determined by integrated vaccine production and administration.

- Because vaccine-mediated herd immunity can go well beyond the extinction threshold, this creates an opportunity for the elimination of COVID.
- Likely beneficial to keep vaccination and case investigation, contact tracing, quarantine, testing objectives aligned.

Vaccination

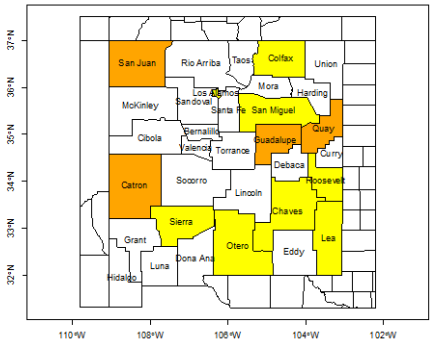
- Vaccination allocation algorithm prioritizes locations were there are covid-19 cases
  - currently a relatively small effect
- Current transmission and quarantine parameters are extended to future dates in these models
  - Assumes people's behavior does not change and that there are no PHO modifications that increase transmission
- Base model attempts to account for under-reporting of cases and delayed reporting of cases.
- ~1 month delay to larger effects in these curves

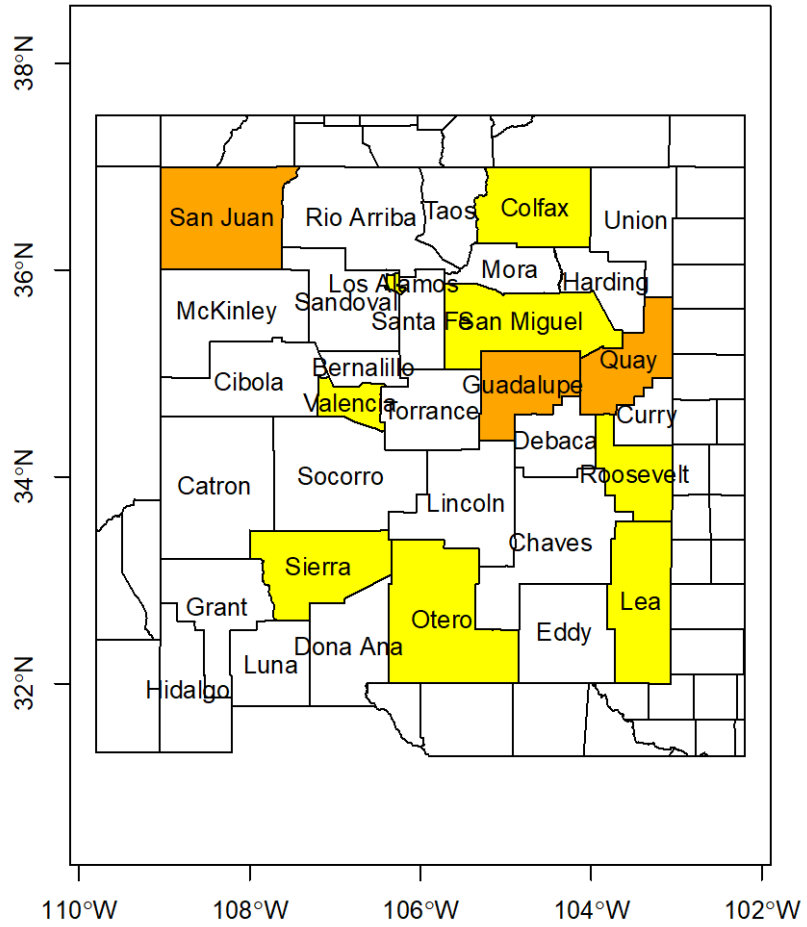


Situational Awareness:
Some counties may not be slowing down as fast as others

- Guadalupe, Quay, San Juan appear to not yet have decreasing daily case counts
- DeBaca , Colfax, Lea, Lincoln, Los Alamos, Otero, San Miguel, Sierra and Valencia also may not have decreasing daily case counts or have anomalously high transmission

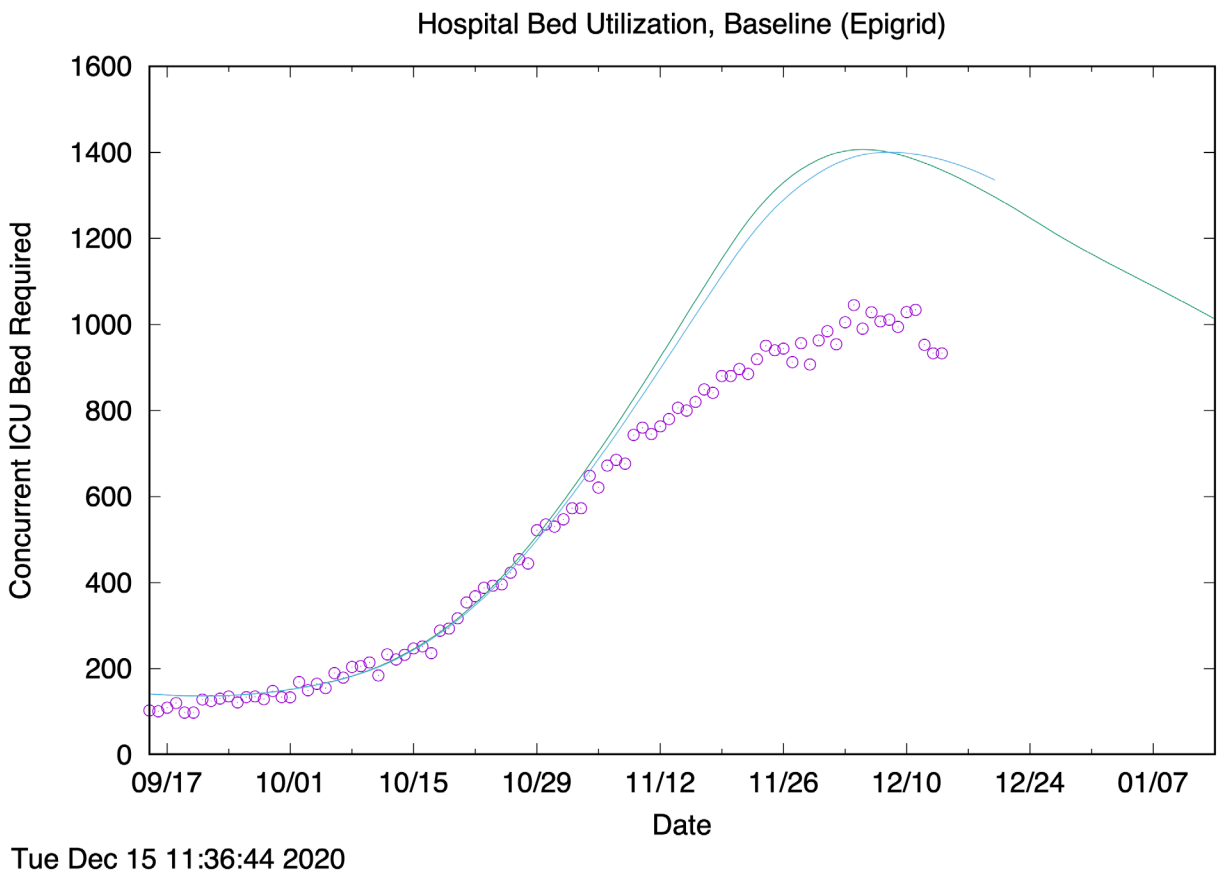
Last week

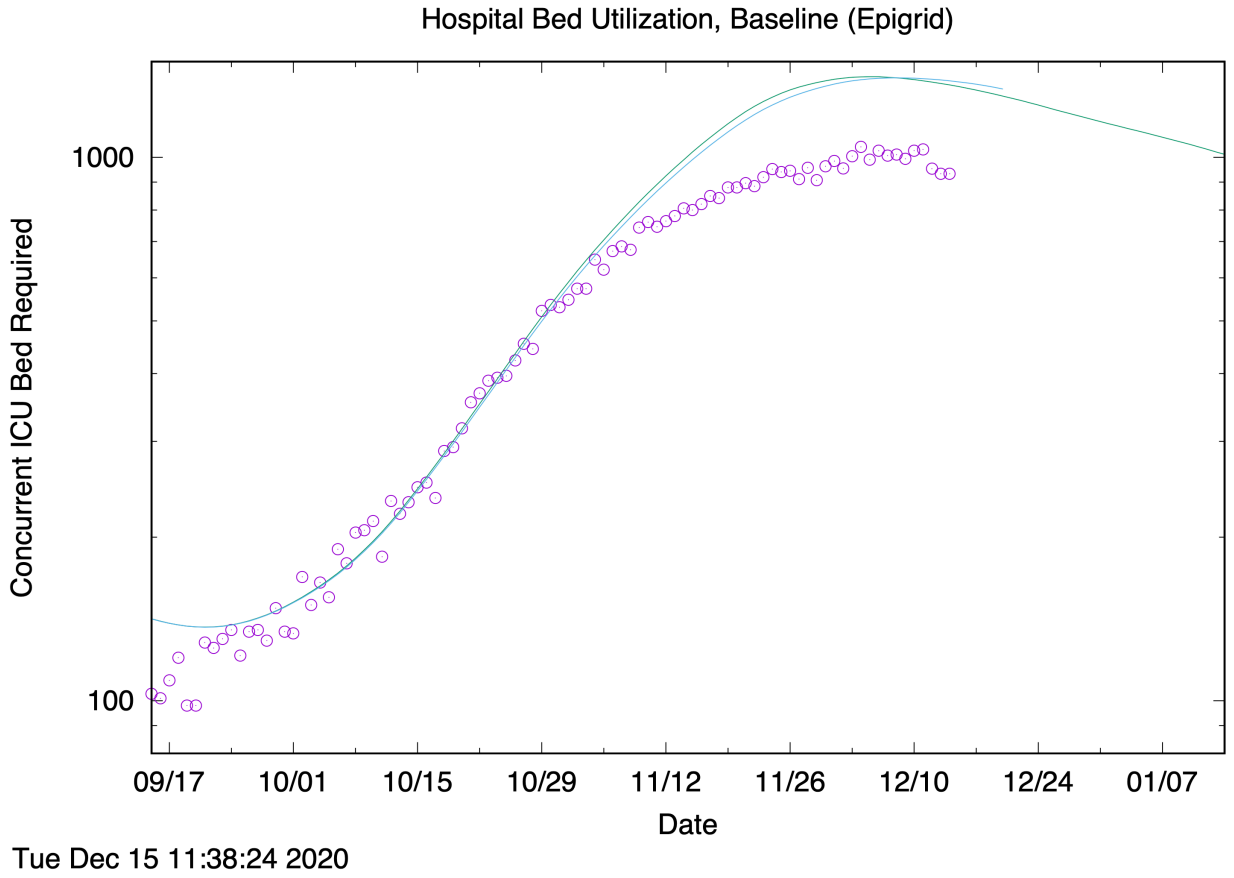




Hospital bed concurrent usage by COVID-19 patients

- Left panel: Linear vs. time shows hospital utilization and capacity. Current week's and previous week
- Right panel: Log vs. time, same data and models.
- November 16th PHO and Thanksgiving are now parameterized, Christmas and New Year's are included.
- Out-patient care is lowering hospital bed requirements.





Conclusions and Discussion

- **Thanksgiving Day Holiday bump appears mild, but New Mexico's epidemic spread is improving *very* slowly. Probably unstable to any significant perturbation.**
- **The New Mexico epidemic is geographically dispersed for the foreseeable future.**
- **Nationwide geographical dispersion requires that state-to-state travel plays an important role.**
- ***Bernalillo likely plays a substantial role driving ICU need/requirements.***
- **NM Test positivity remains well above 7%. >~12% recently.**
- **El Paso's daily incidence continues to decline. Testing positivity suggests a substantial undercount of cases even in the context of falling incidence.**
- **Due to well-understood time-to-reach immunity, vaccination will begin substantially affecting these curves in mid- to late-January.**
- **Targeting high-mortality rate areas and populations will likely be reflected first in these calculations.**
- **At-home oxygen supplementation appears to be a substantial lowering to the general bed load in New Mexico as compared with July.**
- **Discussion:**
  - For re-opening: low-risk activities first. Higher risk later.
  - Schools are highly mitigated, and elementary school provides little evidence for in-school spread?
  - School staff as a boost to case investigation and tracing? Guam is using cell phone apps.
  - Indoor, un-masked activities are inherently risky. How to mitigate? Airflow in addition to distance? For re-opening…
  - Changes in terminology? "Pre-existing conditions" are present for what fraction of the middle-aged population?
  - Qualitatively higher testing rates (i.e. 10x) can substantially offset local epidemics (i.e. South Korea) by facilitating tracing. This will take time to plan and execute, but candidate technologies exist. Bar-coded sequencing with high-through put sequencing of viral clinical samples. Multiple 10k/day approaching 100k/day?