Modeling & Forecasting COVID-19 in NM

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March 2, 2021

NNSA
National Nuclear Security Administration

Short- & Long-Term Forecast for NM: Cases

7-day Incidence Confirmed Cases Forecast for New Mexico Based on Data as of 2021-03-01

Prediction Intervals: 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%

6-Week Forecast of Confirmed Cases for New Mexico Based on Data as of 2021-03-01

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2021-03-01		185,297*	
2021-03-08	185,874	186,633	187,833
2021-03-15	186,393	187,950	190,508
2021-03-22	186,930	189,410	193,542
2021-03-29	187,511	191,144	197,090
2021-04-05	188,203	193,092	201,333
2021-04-12	188,954	195,427	206,008

*Last reported confirmed cases count
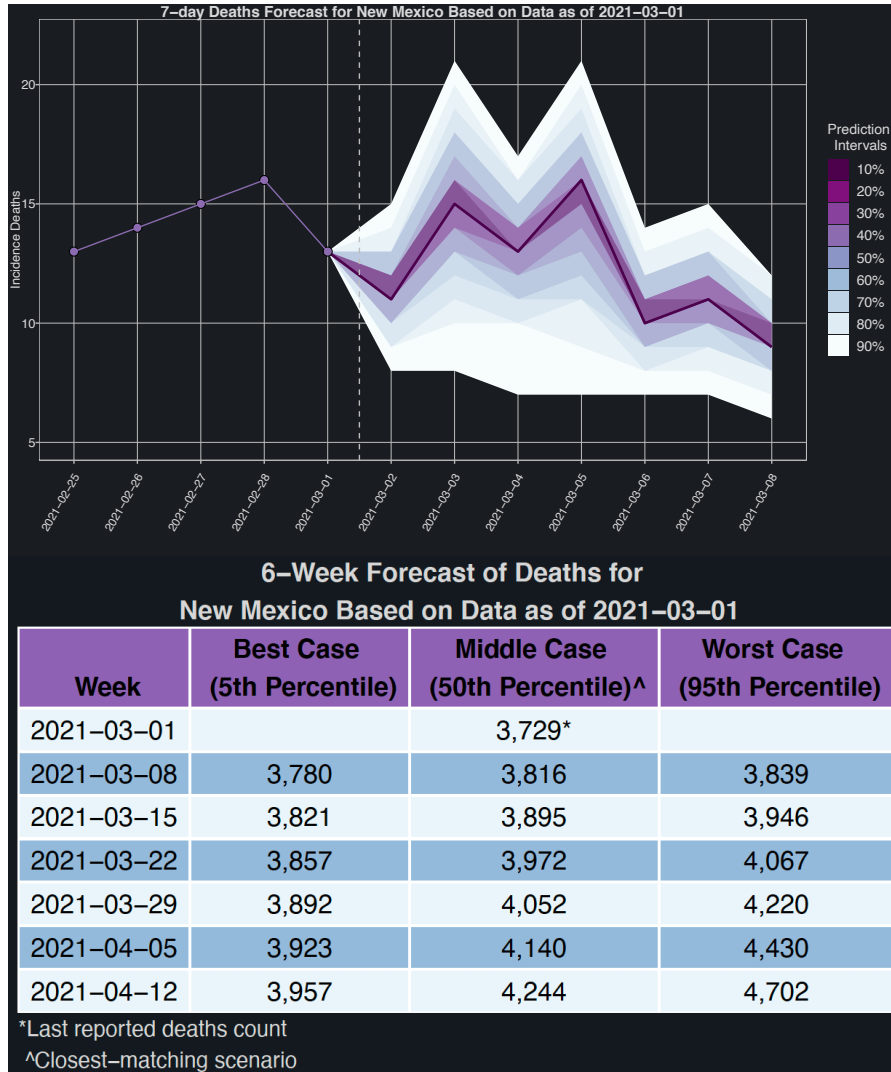^Closest-matching scenario

6-Week Forecast of Daily Average of Confirmed Cases for New Mexico Based on Data as of 2021-03-01

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2021-03-01		325*	
2021-03-08	82	191	362
2021-03-15	74	188	382
2021-03-22	77	209	433
2021-03-29	83	248	507
2021-04-05	99	278	606
2021-04-12	107	334	668

*Last reported confirmed cases count
^Closest-matching scenario

So what?
The _daily_ number of cases are expected to range between 74 and 433 in the next few weeks

Short- & Long-Term Forecast for NM: Deaths

7–day Deaths Forecast for New Mexico Based on Data as of 2021–03–01

Prediction Intervals: 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%

6–Week Forecast of Deaths for New Mexico Based on Data as of 2021–03–01

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2021–03–01		3,729*	
2021–03–08	3,780	3,816	3,839
2021–03–15	3,821	3,895	3,946
2021–03–22	3,857	3,972	4,067
2021–03–29	3,892	4,052	4,220
2021–04–05	3,923	4,140	4,430
2021–04–12	3,957	4,244	4,702

*Last reported deaths count
^Closest–matching scenario

6–Week Forecast of Daily Average of Deaths for New Mexico Based on Data as of 2021–03–01

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2021–03–01		13*	
2021–03–08	7	12	16
2021–03–15	6	11	15
2021–03–22	5	11	17
2021–03–29	5	11	22
2021–04–05	4	13	30
2021–04–12	5	15	39

*Last reported confirmed deaths
^Closest–matching scenario

So what?
The daily number of deaths are expected to range between 5 and 17 in the next few weeks

Growth Rate for NM

Daily Growth Rate for the Past Six Weeks in New Mexico as of 2021-03-01
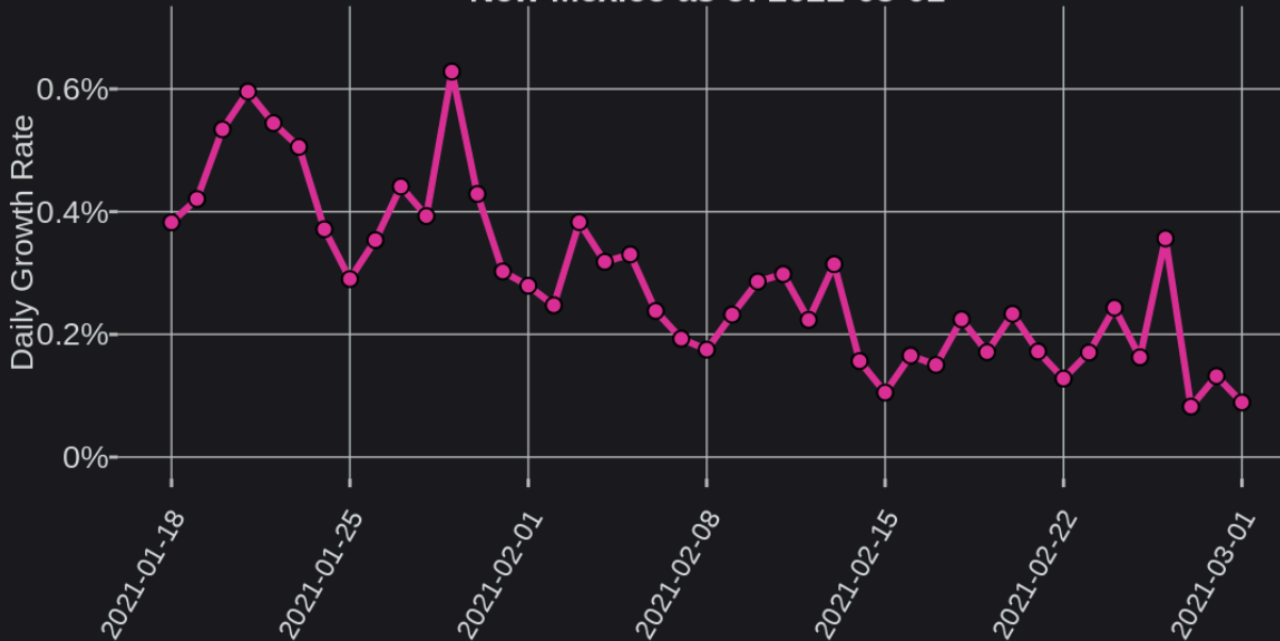
6-Week Forecast of the Average Weekly Growth Rate for New Mexico Based on Data as of 2021-03-01

Week	Best Case (5th Percentile)	Middle Case (50th Percentile)^	Worst Case (95th Percentile)
2021-03-01		0.18%*	
2021-03-08	0.044%	0.10%	0.19%
2021-03-15	0.040%	0.10%	0.20%
2021-03-22	0.041%	0.11%	0.23%
2021-03-29	0.044%	0.13%	0.26%
2021-04-05	0.053%	0.14%	0.30%
2021-04-12	0.057%	0.17%	0.33%

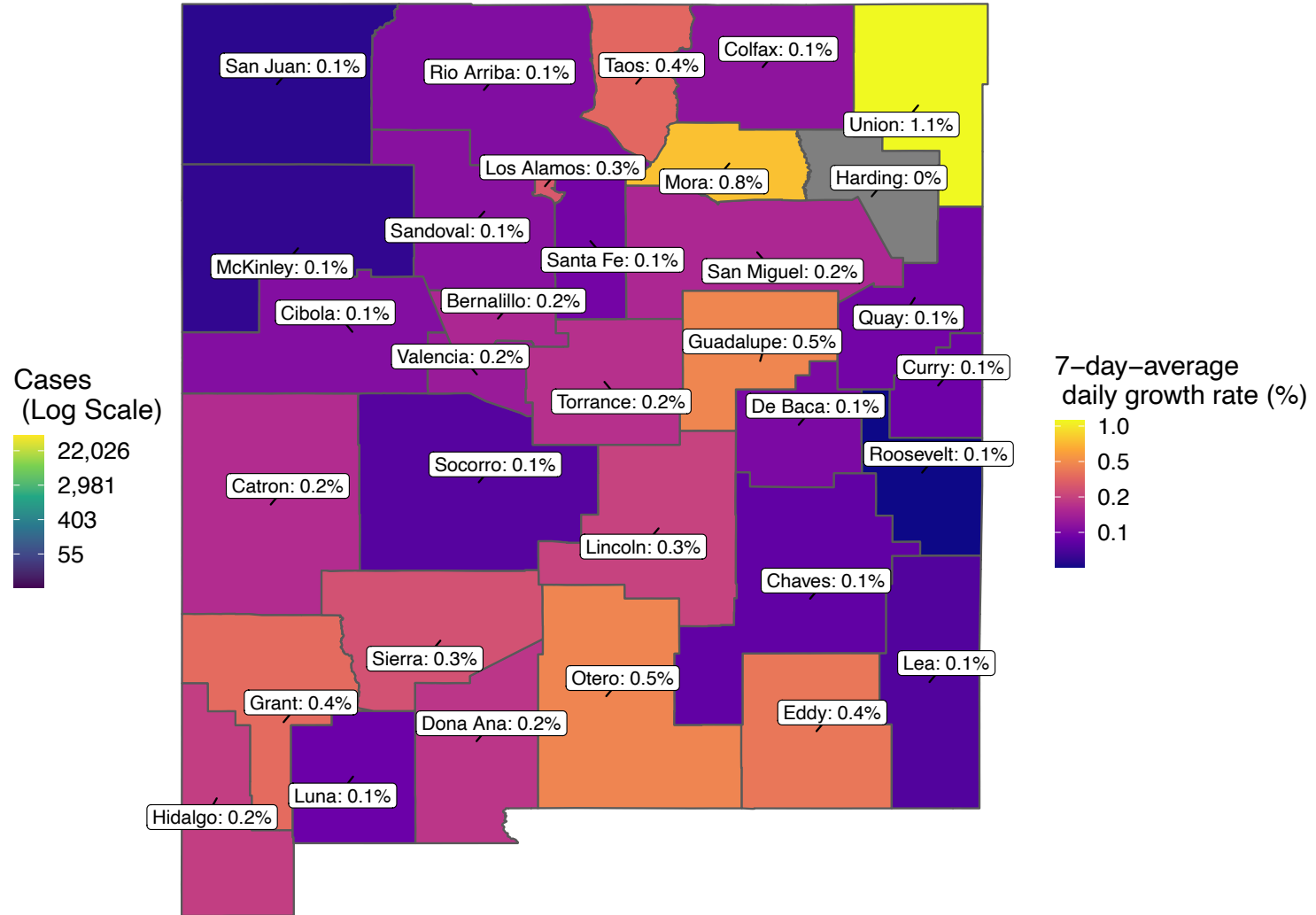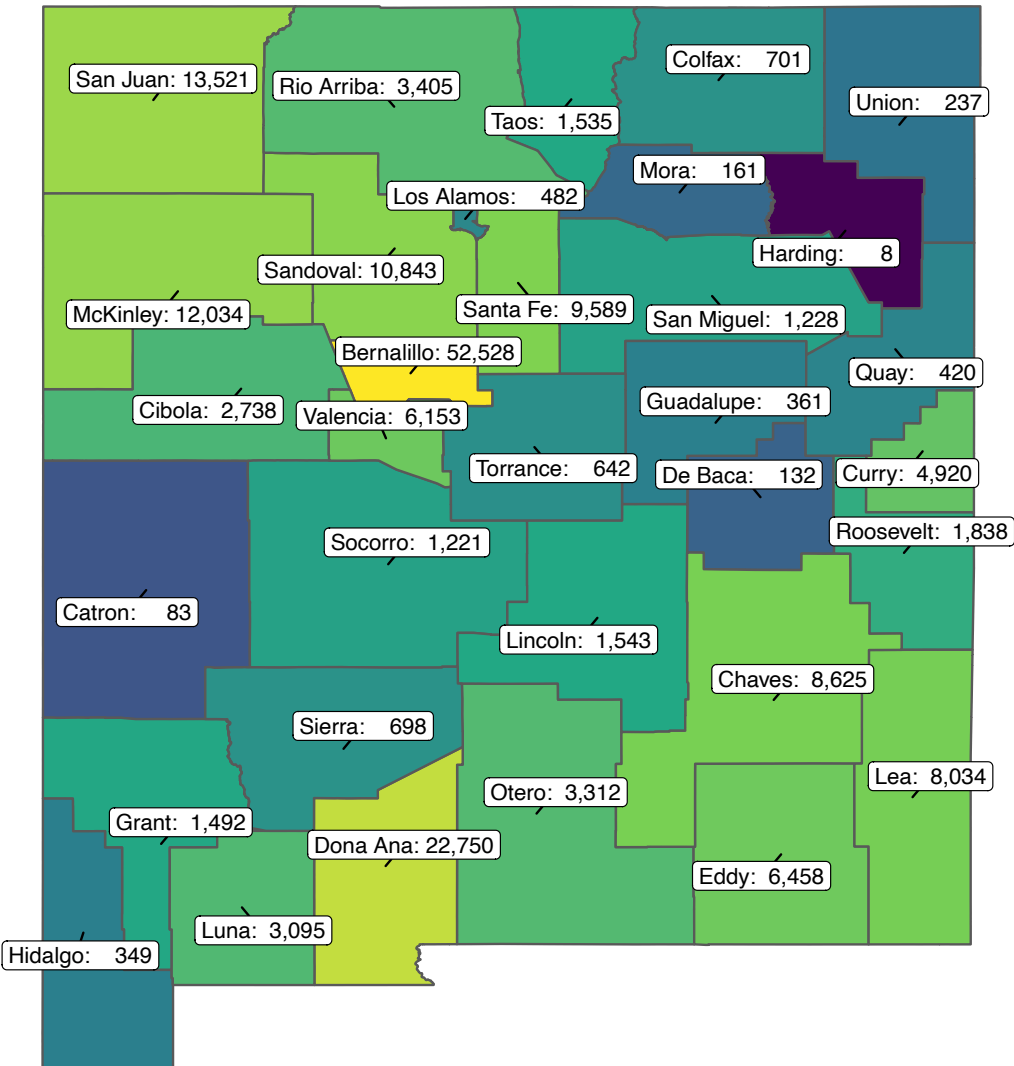*Last weekly mean daily growth rate
^Closest-matching scenario

So what?
As of February 21st, the average growth rate in NM is at 0.18% (down from 0.17%)
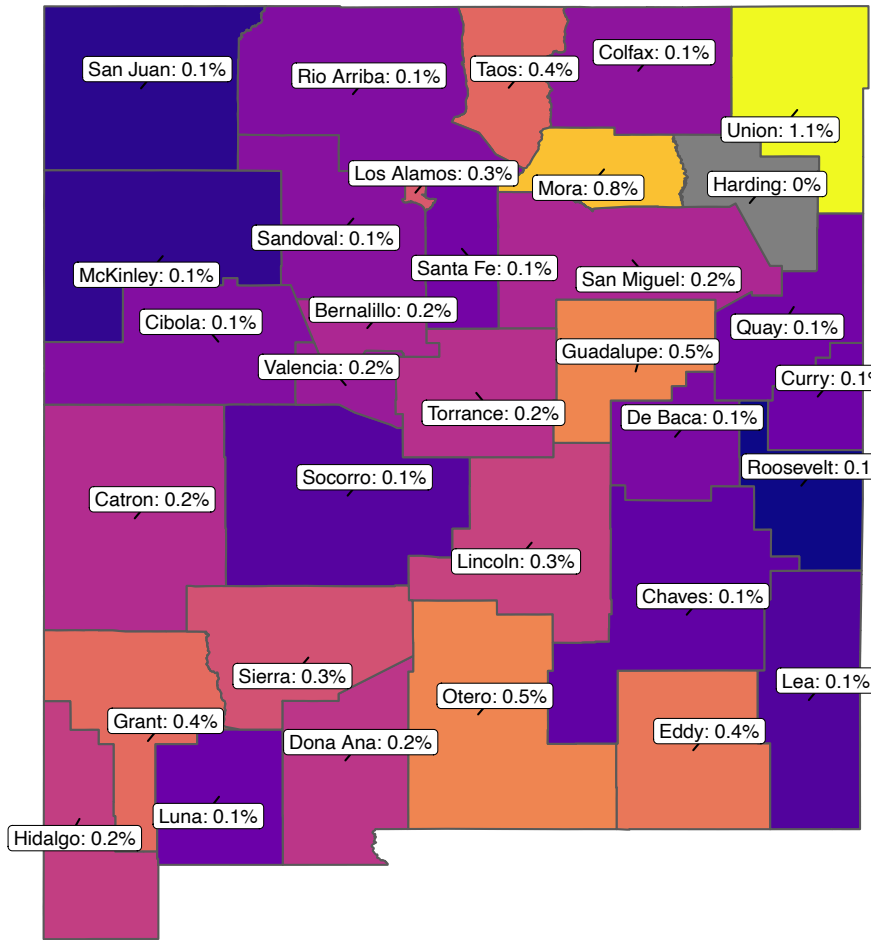
> Regional Forecasts, Growth Rates, & Hospitalizations

Cumulative Cases & Daily Growth Rate for NM: March 1

*Growth rate is in cumulative cases

Daily Growth Rate for NM Mar 1

7–day–average daily growth rate (%)
- 1.0
- 0.5
- 0.2
- 0.1

Socorro 0.1% =
Roosevelt 0.1% =
DeBaca 0.1% =
Los Alamos 0.3% =
Quay 0.1% =
Colfax 0.1% =
Harding 0.0% =
Hidalgo 0.2% =
Guadalupe 0.5% =
Catron 0.2% =

Union 1.1% ↑
Mora 0.8% ↑

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

Los Alamos National Laboratory

County	Daily Growth Rate	Change
San Juan	0.1%	=
Rio Arriba	0.1%	=
Sierra	0.3%	=
McKinley	0.1%	=
Sandoval	0.1%	=
Santa Fe	0.1%	=
Cibola	0.1%	=
Bernalillo	0.2%	=
Valencia	0.2%	=
Torrance	0.2%	=
Lincoln	0.3%	=
San Miguel	0.2%	=
Chaves	0.1%	=
Dona Ana	0.2%	=
Otero	0.5%	=
Lea	0.1%	=
Eddy*	0.4%	=
Curry	0.1%	=
Grant	0.4%	=
Luna	0.1%	=
Taos*	0.4%	=

COVID-19 across New Mexico

A 7-day moving window comparison
March 1, 2021
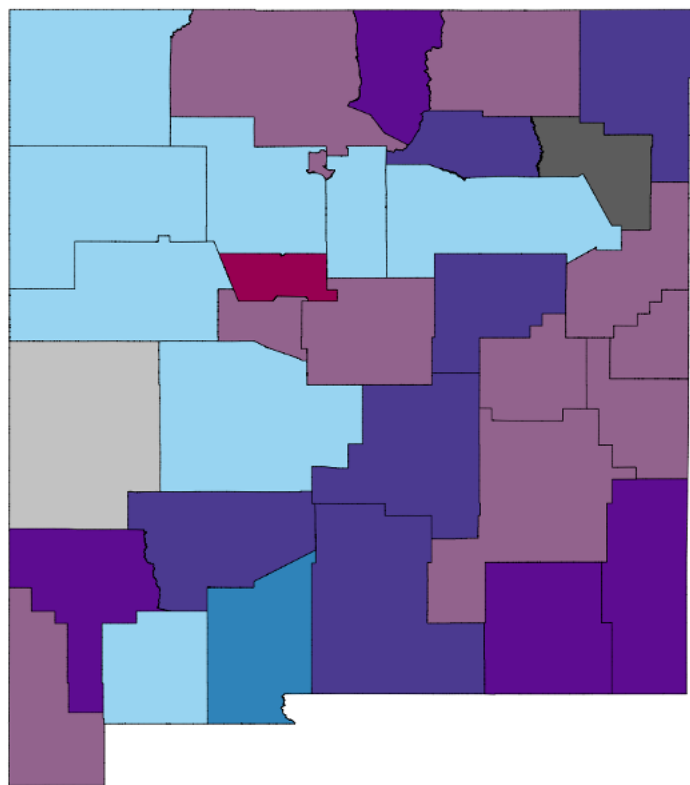
Impacted New Mexicans

Counties with New Cases This Week

	Low	Med	High	
	0k	680k	190k	Accelerating
Growth Rate	0k	310k	110k	Constant
	0k	590k	215k	Decelerating

Cases Per Capita

Counties With No New Cases In ...

Last Week	Two Weeks	3+ Weeks
3.5k	0k	459

So what?

- **Most people in New Mexico are living in a county that is decelerating with high per-capita case counts**

- **Counties with higher per capita case counts: Dona Ana, Eddy, Grant, Lea, Lincoln, Otero, Taos**

- **Taos, Eddy, Lea, Grant are accelerating; Bernalillo is on border between constant and accelerating**
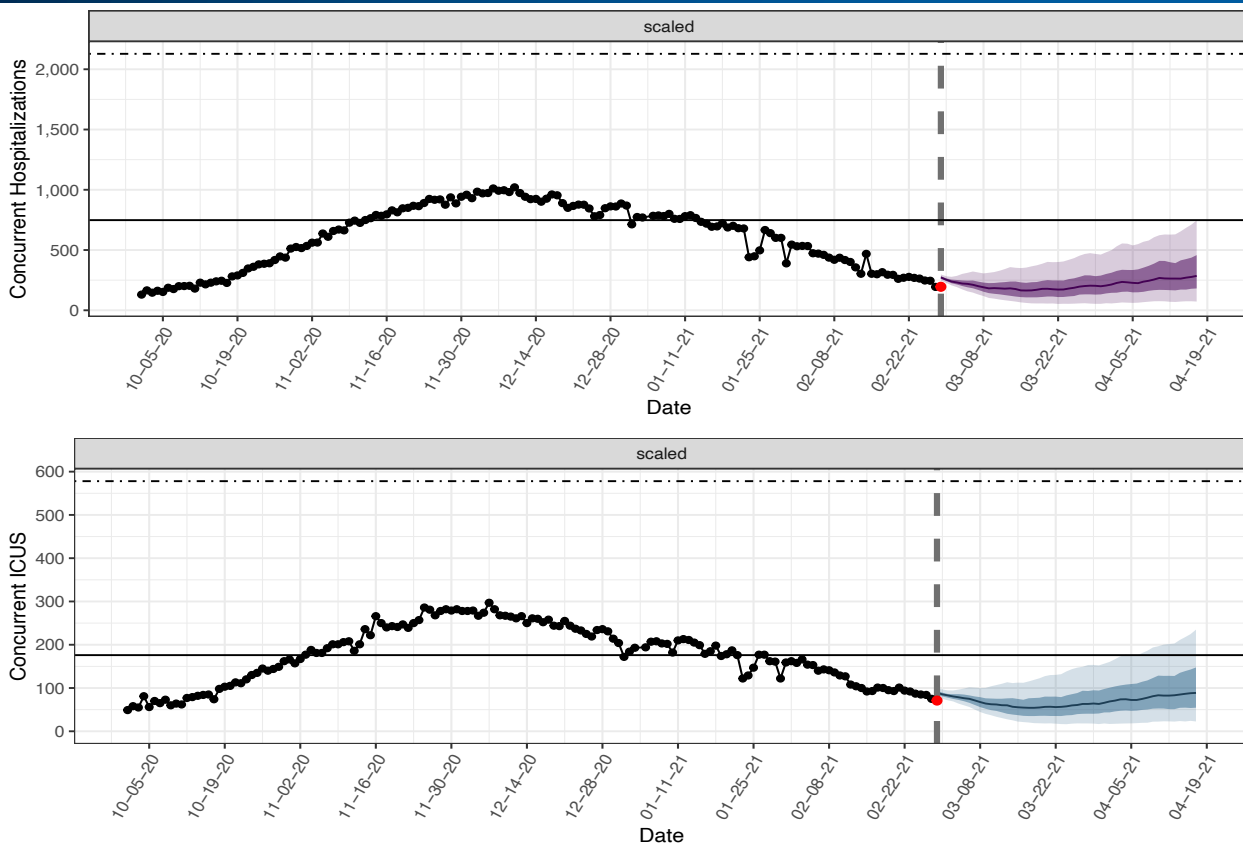
Number of New Mexicans living in regions with particular combinations of per capita case counts and 7-day growth rates

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
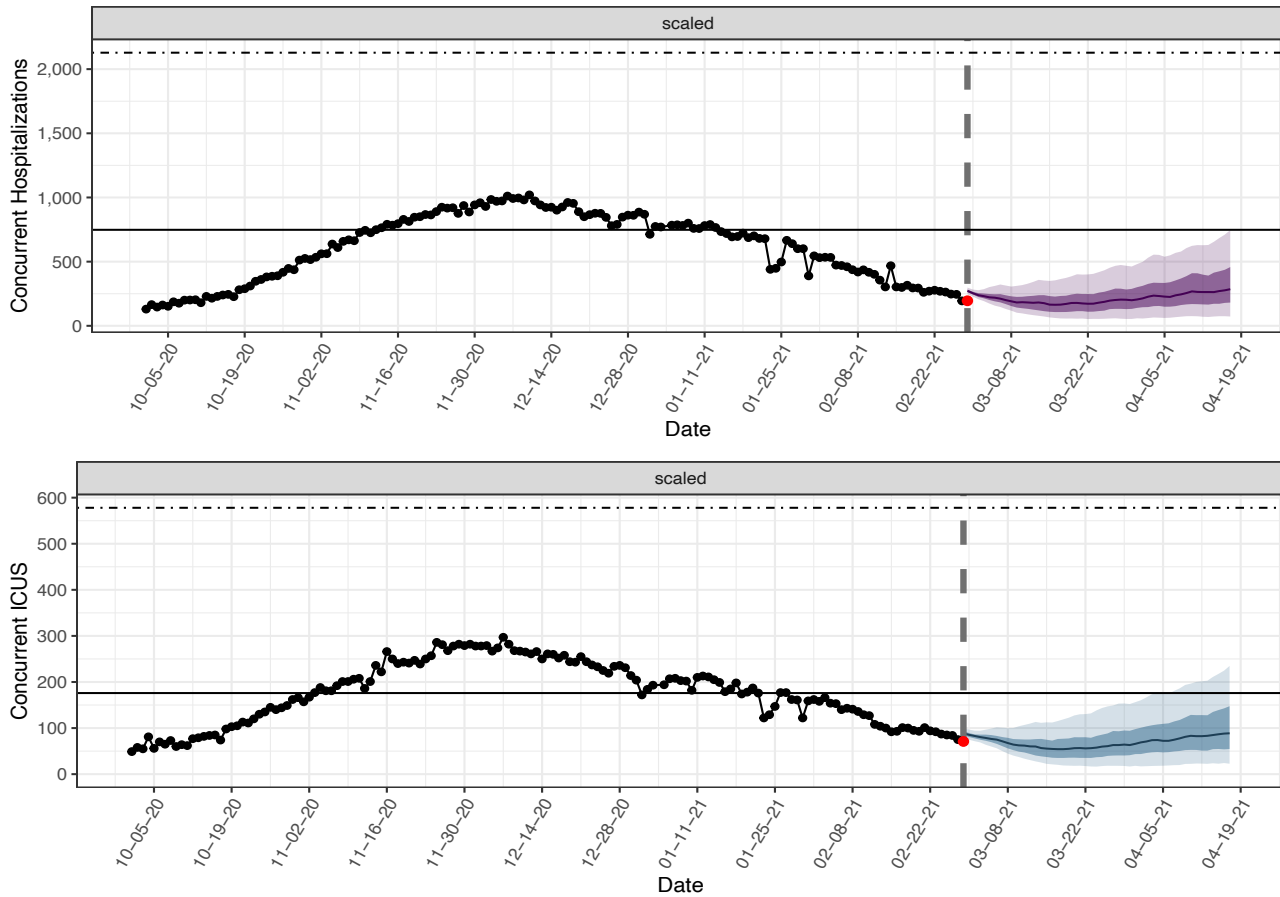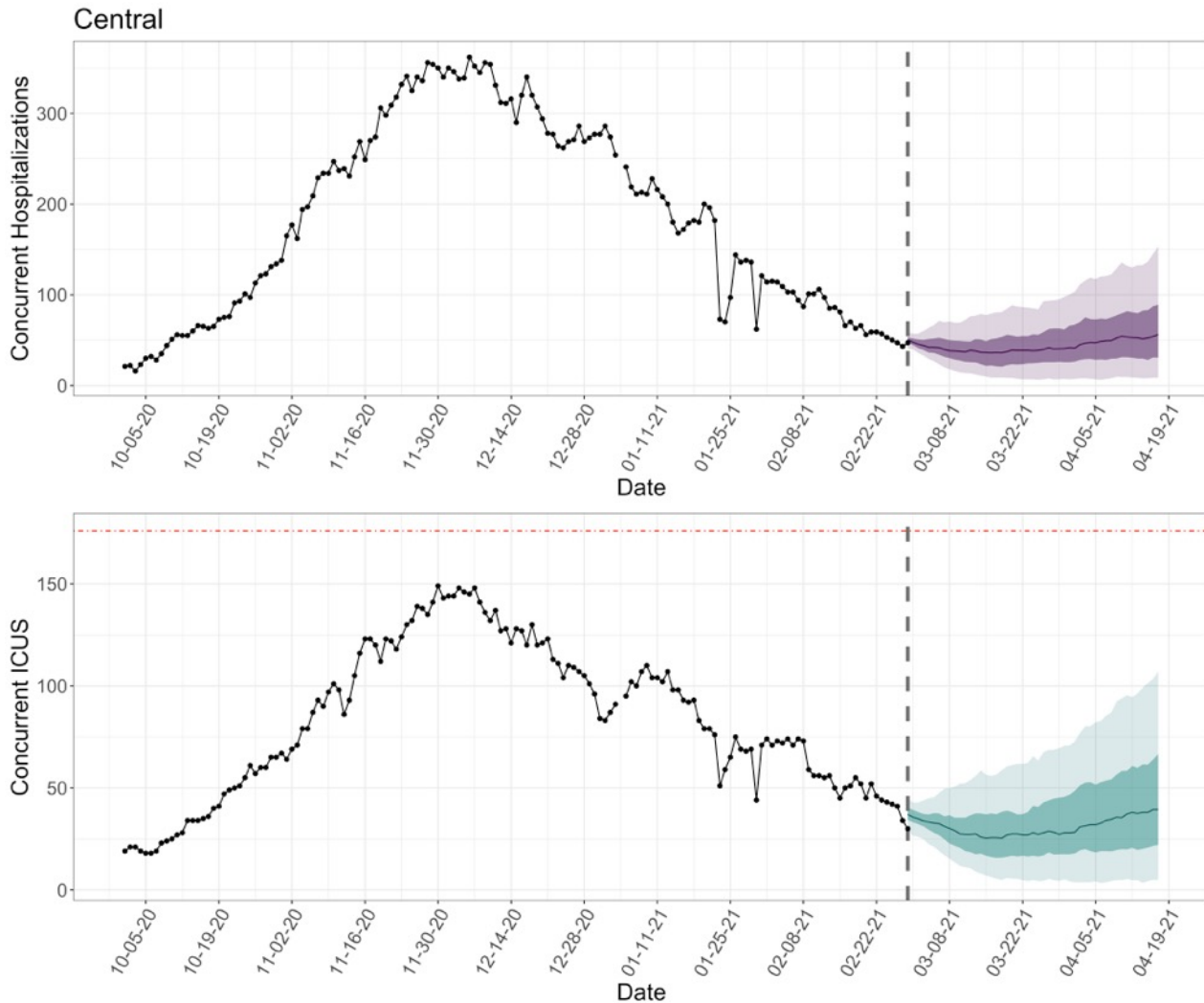

Concurrent COVID-19 ICU beds

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	50	71	101
3/14	25	57	111
3/21	18	57	130
3/28	18	63	153
4/4	18	74	177
4/11	23	82	200

"Scaled" Scenario

at?

t COVID-19 patients. Model is predicting a <u>slow</u>

Concurrent COVID-19 <u>non-ICU "med-surge"</u> beds

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	81	129	213
3/14	47	120	241
3/21	38	118	269
3/28	37	141	321
4/4	45	158	376
4/11	51	182	429

"Scaled" Scenario

...hat?

...o <u>decrease</u> during the next 3 weeks

Regional Hospitalization Forecasts: Central

Central

Concurrent COVID-19 ICUs beds: Central

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	17	31	50
3/14	8	26	58
3/21	5	27	62
3/28	5	28	69
4/4	4	32	80
4/11	5	37	95

So what?

ICU bed usage is expected to decrease and level off
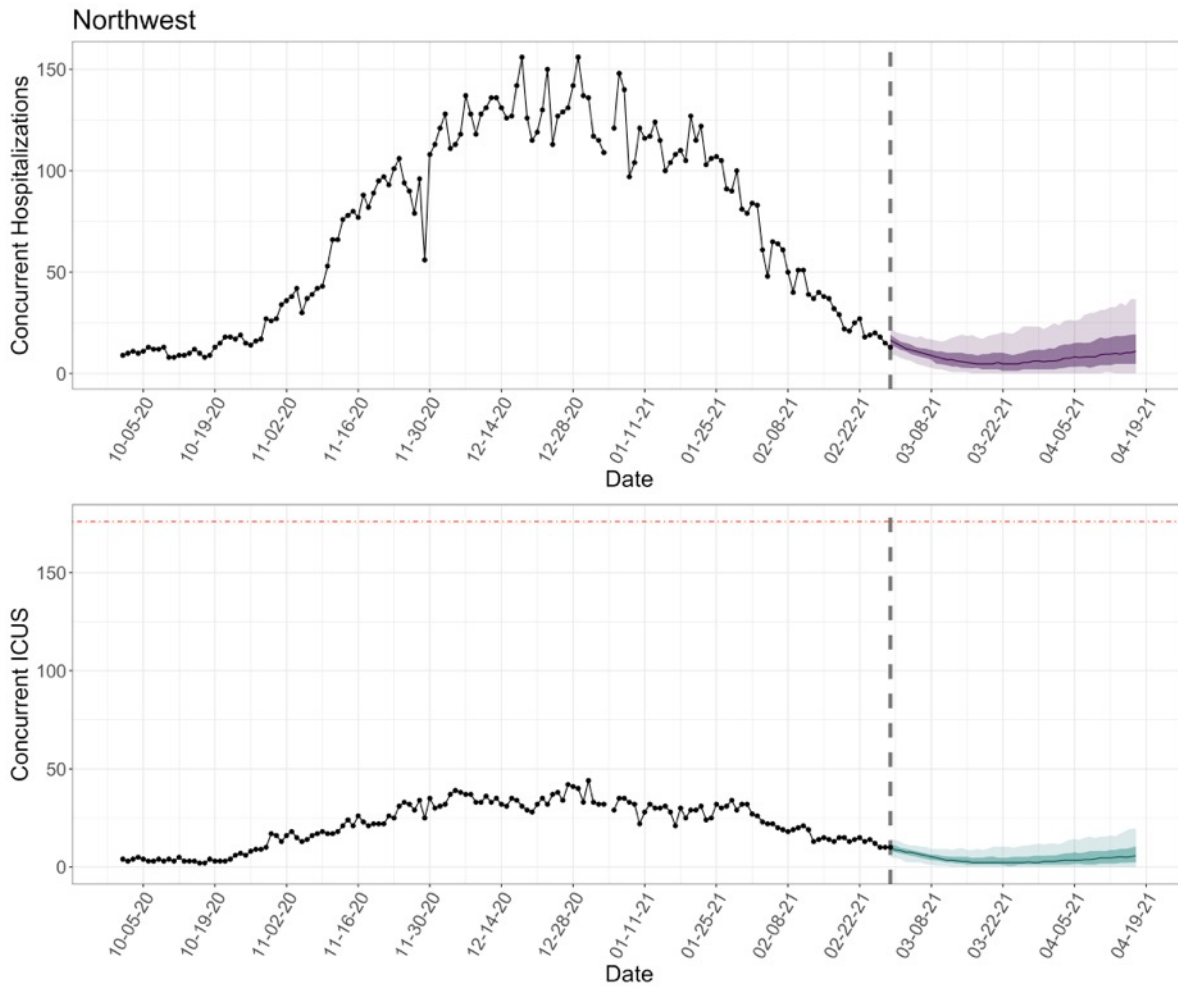
Regional Hospitalization Forecasts: Southwest
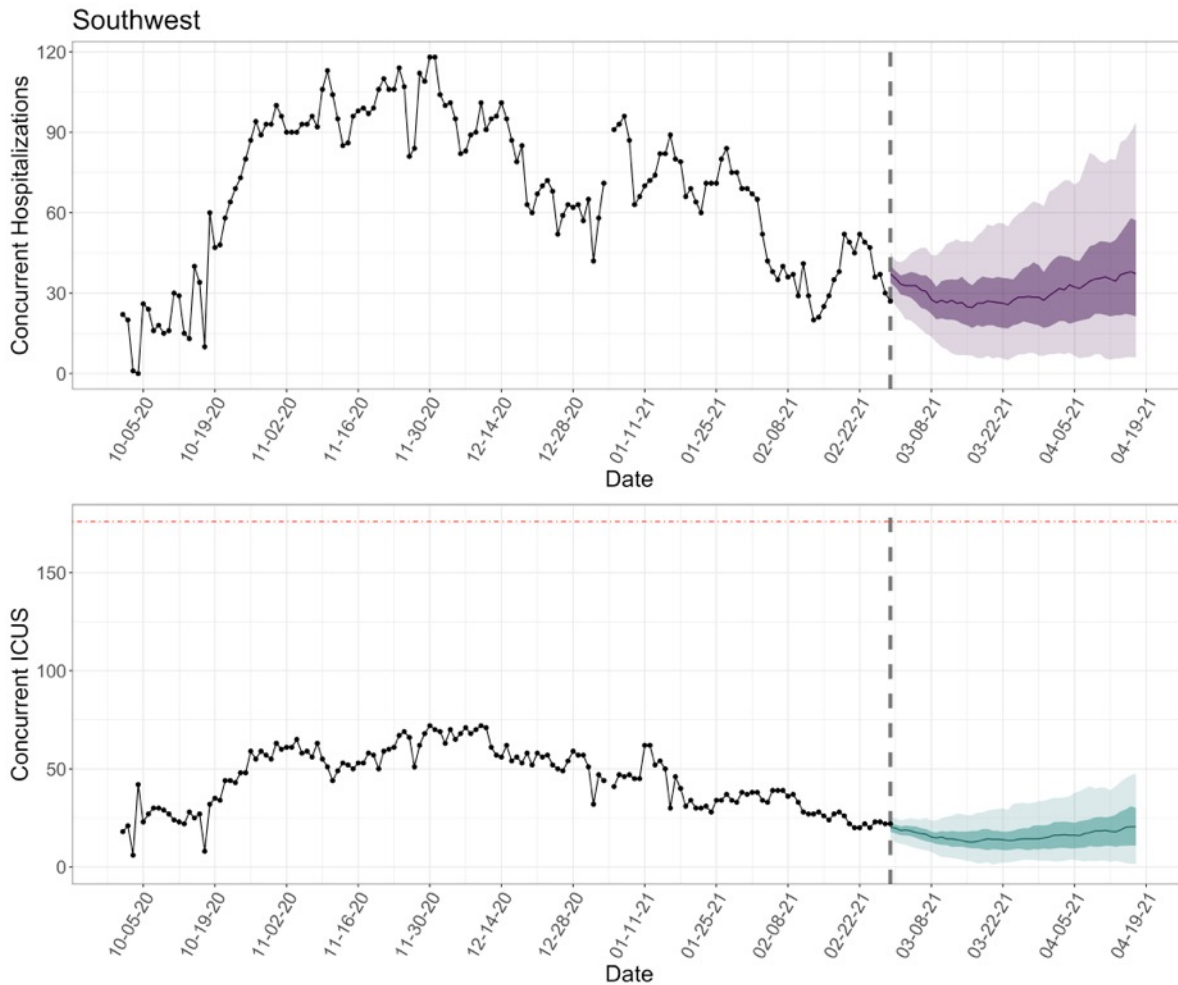
Concurrent COVID-19 ICUs beds: Southwest

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	9	17	25
3/14	4	13	27
3/21	2	14	30
3/28	4	14	33
4/4	4	16	36
4/11	3	19	40

So what?

ICU bed usage is expected to <u>decline and level off</u> in the Southwest region.

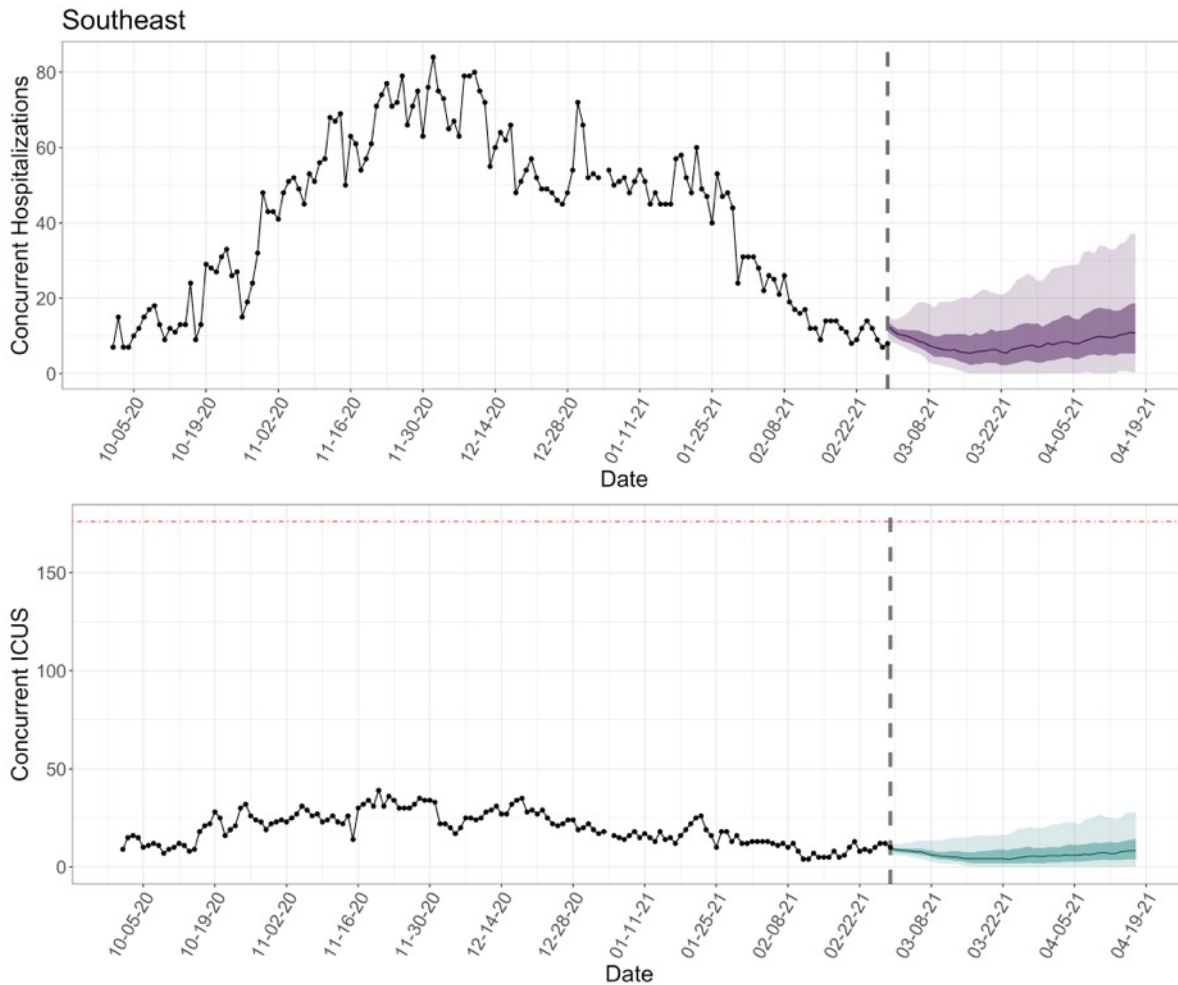# Regional Hospitalization Forecasts: Northwest

Northwest

Concurrent COVID-19 ICUs beds: Northwest

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	1	6	10
3/14	0	3	10
3/21	0	2	10
3/28	0	2	11
4/4	0	3	14
4/11	0	5	15

So what?

ICU bed usage is expected to <u>decrease</u> in the Northwest region
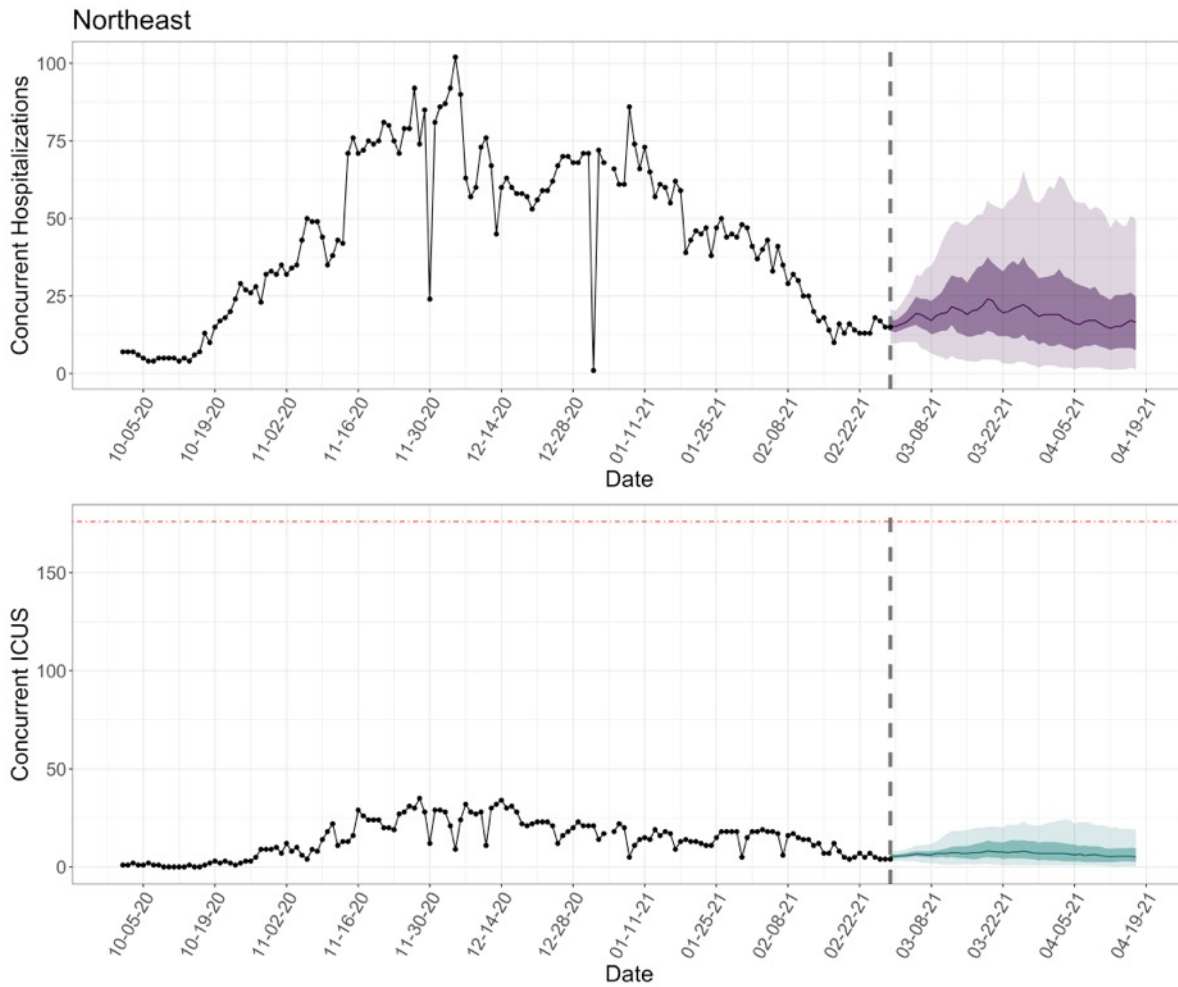
Regional Hospitalization Forecasts: Southeast

Concurrent COVID-19 ICUs beds: Southeast

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	4	7	13
3/14	1	4	15
3/21	0	4	16
3/28	0	6	20
4/4	0	6	23
4/11	0	7	26

So what?

ICU bed usage is expected to be low in the Southeast region

Regional Hospitalization Forecasts: Northeast

Northeast

Concurrent COVID-19 ICUs beds: Northeast

Week	Qu. 5% (best case)	Qu. 50% (median)	Qu. 95% (worst case)
3/7	2	6	11
3/14	1	7	18
3/21	1	8	20
3/28	1	7	21
4/4	1	7	24
4/11	0	5	21

So what?

### ICU bed usage is expected to <u>be low </u>in the Northeast region

> Non-Congregational Shelter Forecast

Non-Congregate Shelter Forecast

- Our goal is to inform the capacity of shelters for forecasting the need of additional rooms
- We calculate a ratio between the mean number of daily new cases over the previous two weeks to current occupied rooms
  - We apply this ratio to the forecast of COVID-19 cases from the LANL COFFEE model to estimate the number of rooms needed
- We use the spread in the case forecast to report a subsequent spread in the shelter forecast
- We calculate the number of new rooms need by applying the ratio of occupied rooms:new cases to the number of cases forecasted in each county

- NEW AS OF 2/7/21: We added a second forecast method for comparison by averaging the shelter forecast with current shelters in use to smooth the forecast

Non-Congregate Shelter Forecast: Bernalillo

Number of cases as of 2/28/21: **52,528**
Number of shelter rooms available: **221**
Total number of patients/medical workers (including specialty): **41**
Number of patients: **38**
Number of medical workers: **3**
Occupied rooms:new cases ratio: **0.43**
2-week avg. new cases per day: **96**

Bernalillo County
Cumulative COVID-19 cases and 6-week forecast
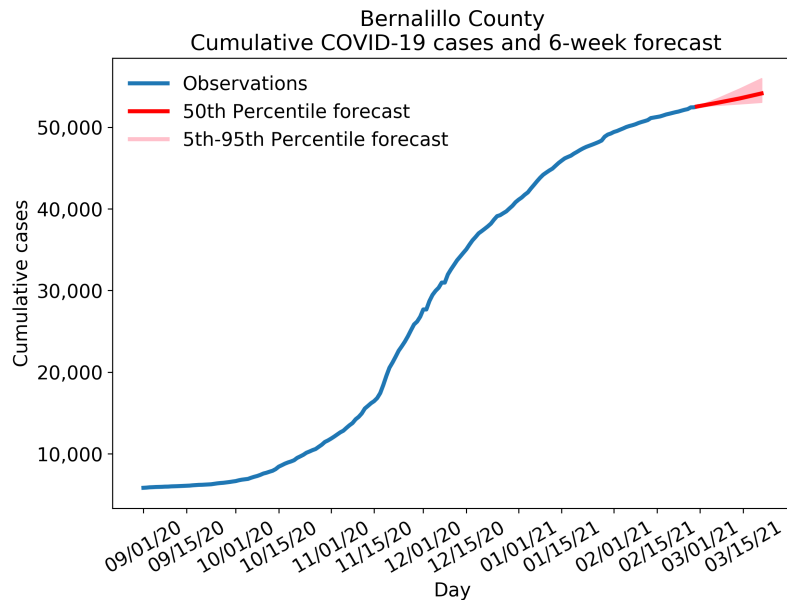
	2/28/21	3/7/21	3/14/21
Total cases	53,012 (52,701-53,560)	53,528 (52,876-54,709)	54,131 (53,064-55,955)
# of rooms needed	30 (11-63)	31 (11-70)	37 (11-76)
Deficit (-) or surplus of rooms	191	190	184
# of rooms needed (new forecast method)	35	34	35

2-week avg. new cases per day decreased from 114 last week to 96 this week

Last week we forecasted 24 (8-55) rooms in use, 35 rooms with the adjustment; there are 41 actually in use, so we are under forecasting

Non-Congregate Shelter Forecast: Santa Fe

Number of cases as of 2/28/21: **9,589**
Number of shelter rooms available: **52**
Total number of patients/medical workers (including specialty): **24**
Number of patients: **24**
Number of medical workers: **0**
Occupied rooms:new cases ratio: **2.22**
2-week avg. new cases per day: **11**
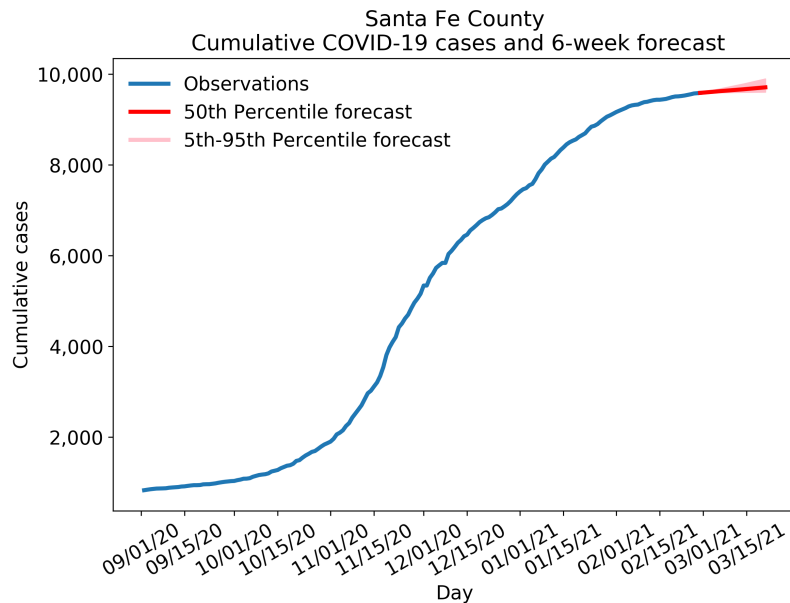
	2/28/21	3/7/21	3/14/21
Total cases	9,631 (9,598-9,688)	9,669 (9,605-9,787)	9,711 (9,611-9,897)
# of rooms needed	13 (3-31)	12 (2-31)	13 (2-35)
Deficit (-) or surplus of rooms	39	40	39
# of rooms needed (new forecast method)	19	16	16

Santa Fe County
Cumulative COVID-19 cases and 6-week forecast

- Observations
- 50th Percentile forecast
- 5th-95th Percentile forecast

(Cumulative cases vs. Day, 09/01/20 – 03/15/21)

2-week avg. new cases per day decreased from 13 last week to 11 this week

Last week we forecasted 5 (0-18) rooms in use, 11 rooms with the adjustment; there are 24 actually in use, so we are under forecasting

Non-Congregate Shelter Forecast: McKinley

Number of cases as of 2/28/21: **12,034**
Number of shelter rooms available: **160**
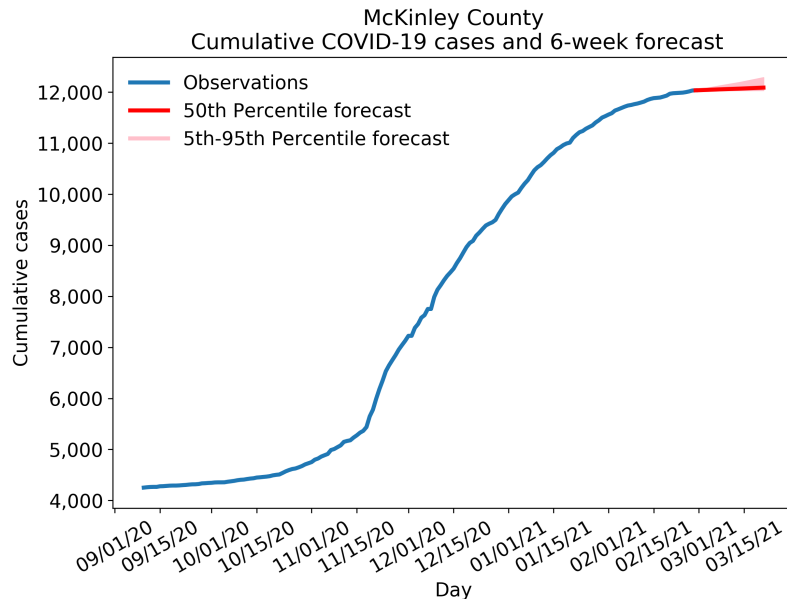Total number of patients/medical workers (including specialty): **19**
Number of patients: **14**
Number of medical workers: **5**
Occupied rooms:new cases ratio: **1.6**
2-week avg. new cases per day: **12**

McKinley County
Cumulative COVID-19 cases and 6-week forecast

|	2/28/21	3/7/21	3/14/21
Total cases	12,052 (12,034-12,116)	12,068 (12,034-12,192)	12,087 (12,035-12,282)
# of rooms needed	4 (0-19)	4 (0-17)	4 (0-20)
Deficit (-) or surplus of rooms	156	156	156
# of rooms needed (new forecast method)	12	9	8

2-week avg. new cases per day decreased from 17 last week to 12 this week

Last week we forecasted 5 (0-15) rooms in use, 10 rooms with the adjustment; there are 19 actually in use, so we are under forecasting

Non-Congregate Shelter Forecast: San Juan

Number of cases as of 2/28/21: **13,521**
Number of shelter rooms available: **21**
Total number of patients/medical workers (including specialty): **1**
Number of patients: **1**
Number of medical workers: **0**
Occupied rooms:new cases ratio: **0.07**
2-week avg. new cases per day: **14**

San Juan County
Cumulative COVID-19 cases and 6-week forecast

	2/28/21	3/7/21	3/14/21
Total cases	13,557 (13,528-13,611)	13,588 (13,531-13,700)	13,621 (13,533-13,801)
# of rooms needed	0 (0-1)	0 (0-1)	0 (0-1)
Deficit (-) or surplus of rooms	21	21	21
# of rooms needed (new forecast method)	1	1	1
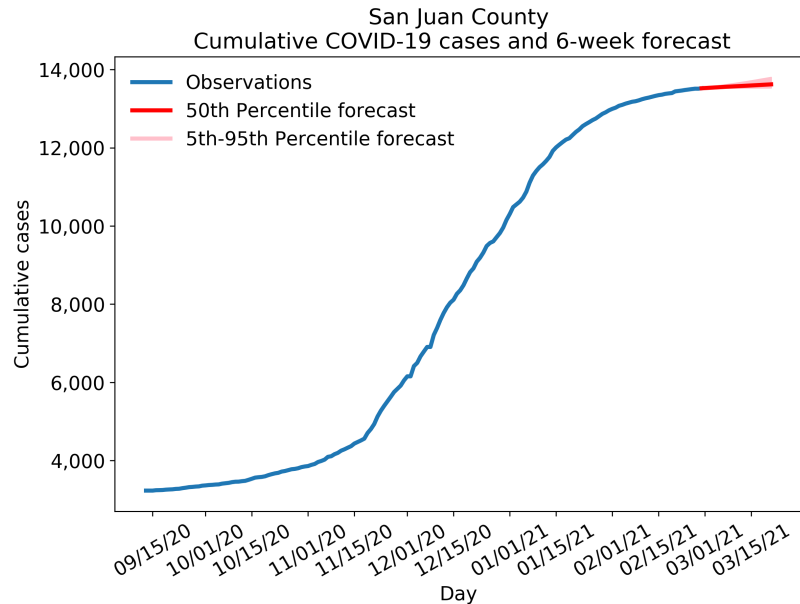
2-week avg. new cases per day decreased from 20 last week to 14 this week.

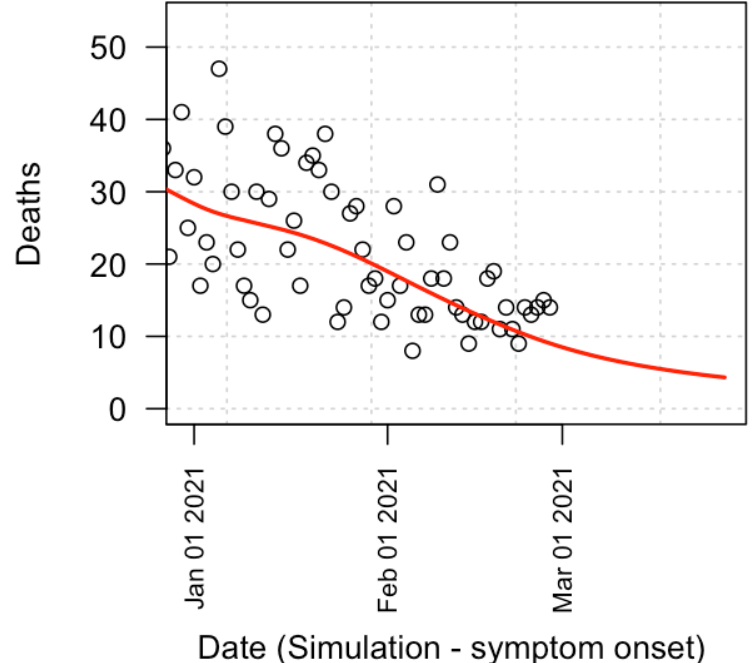Last week we forecasted 0 (0-1) rooms in use, 1 room with the adjustment; there is 1 actually in use

02 Mar 2021: Mechanistic modeling

- Current model is likely too "optimistic"
  - Underpredicts deaths in the last week.
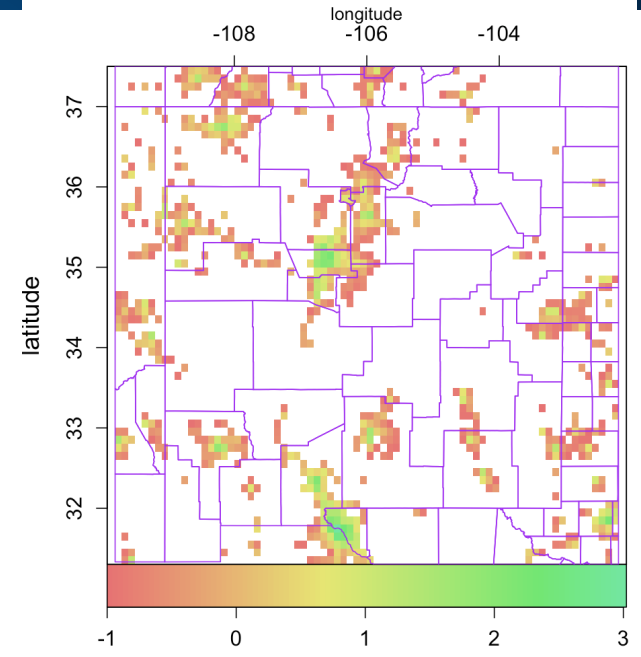 - Case multiplier may be a little low this week.
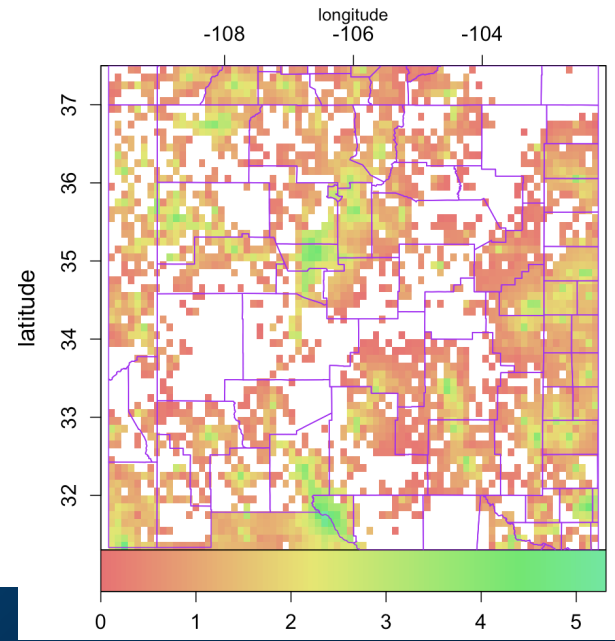

United States__New Mexico
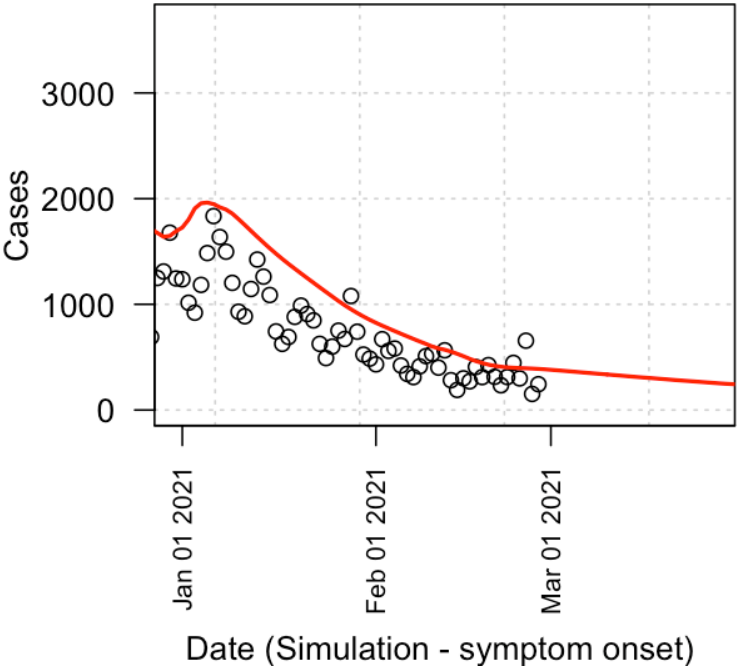
United States__New Mexico
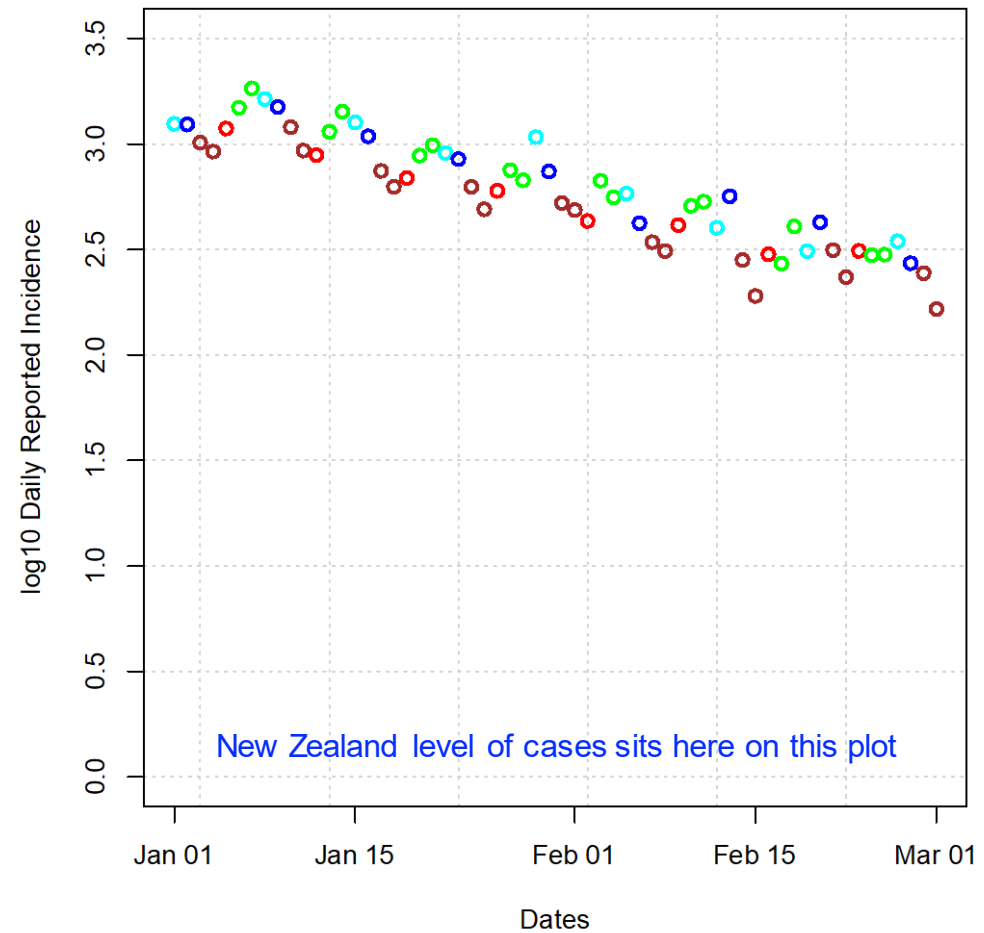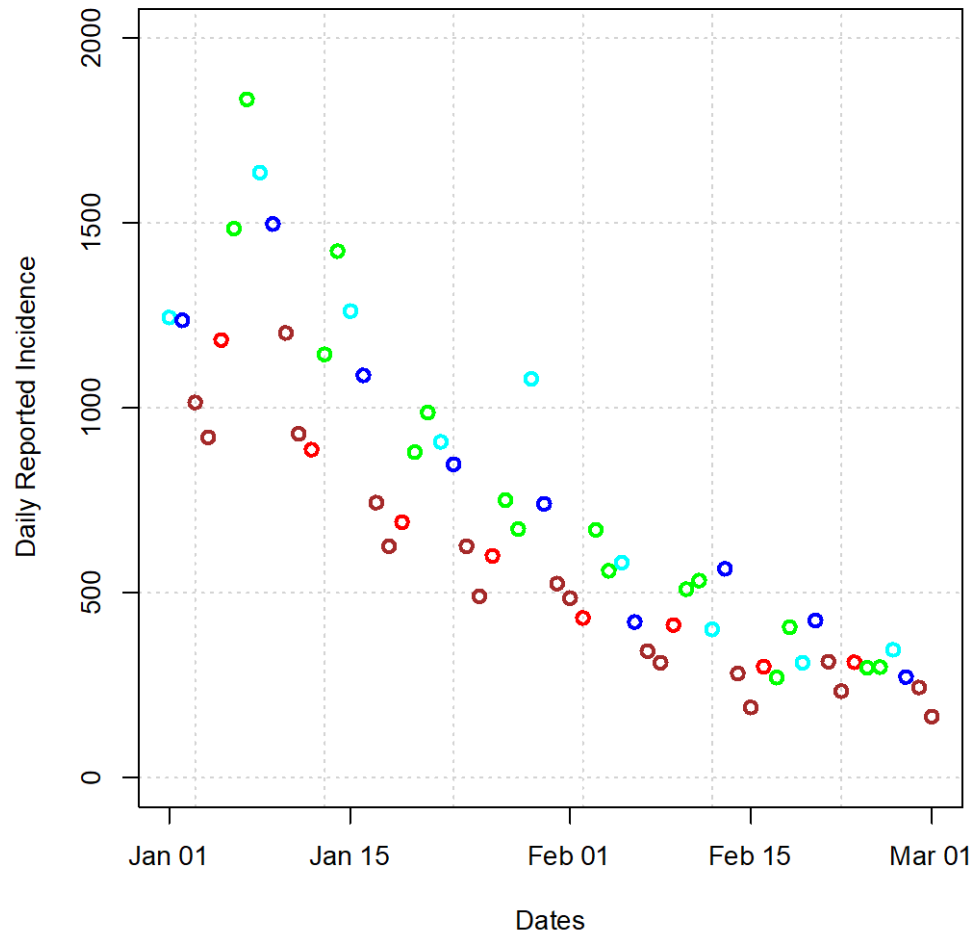

log10 Incidence, wk 56, 2021-03-21

log10 Cumulative cases, wk 56, 2021-03-21
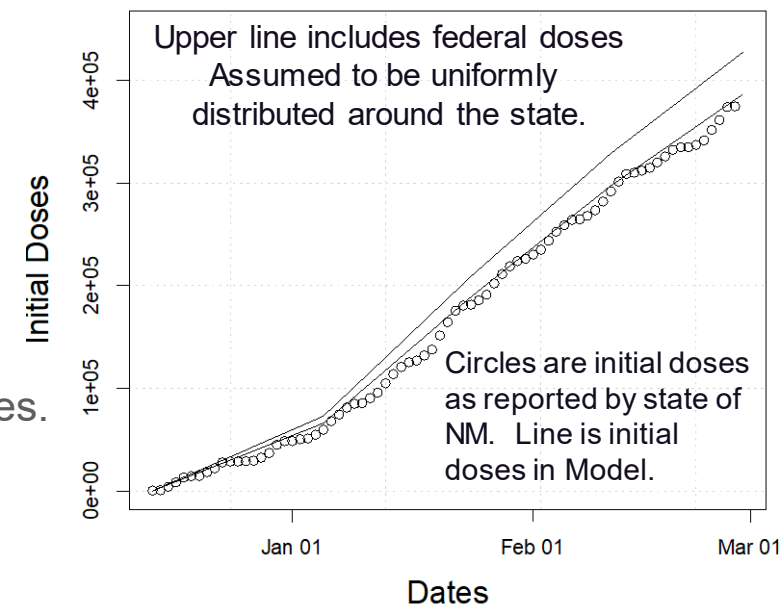
A look at the raw incidence data

- Sunday, Monday
- Tuesday
- Wednesday/Thursday
- Friday
- Saturday

The 190 cases in the Lea county correctional facility are removed from data reported on the 26th. The 1/3 of reported cases that were > 2 wks prior were removed from the 24th.

02 March 2021 Model (Mechanistic) – more details and information

- **See Figure for historical prime-dose vaccinations.**
  - Some Federal doses are uniformly distributed around the state, the rest are in McKinley, Cibola, and San Juan.
  - State vaccination rate is still assumed to be slightly lower than peak rate.
- **Transmission is based on mobility with modifications due to PHO's and the red/yellow/green/turquoise (RYGT) framework.**
  - Public health orders (PHO) and public behavior similar to previous models. Human choices.
  - Using current RYGT assignments. No extrapolations to more open conditions.
- **Daily reported cases in El Paso may be rising.**
- **Death rates include some of the inhomogeneity by-county.**
  - Counties with larger at-risk populations have higher death rates. Not a human choice.
  - Starting to model the expected change in death rate due to vaccination of older population. Partly a human choice.
- **Isolation and quarantine rates are assumed to be stable based on state-reported quarantine times.**
  - Base isolation rates mostly modeled as 50% Dec. 8th-22nd,45% until Jan 10th then are increased to 55%. Mostly human choice.
- **Baseline results reflect novel variants of SARS-CoV-2. The effect is possibly non-small at this time.**
  - Potential for a 50% increase in contagion/force of infection. Not a human choice *per se,* this is *biology*.
  - Epidemiological evidence cannot discount strain replacement in New Mexico.
  - Without vaccination, an increased daily incidence would likely be underway.


Upper line includes federal doses Assumed to be uniformly distributed around the state.

Circles are initial doses as reported by state of NM. Line is initial doses in Model.
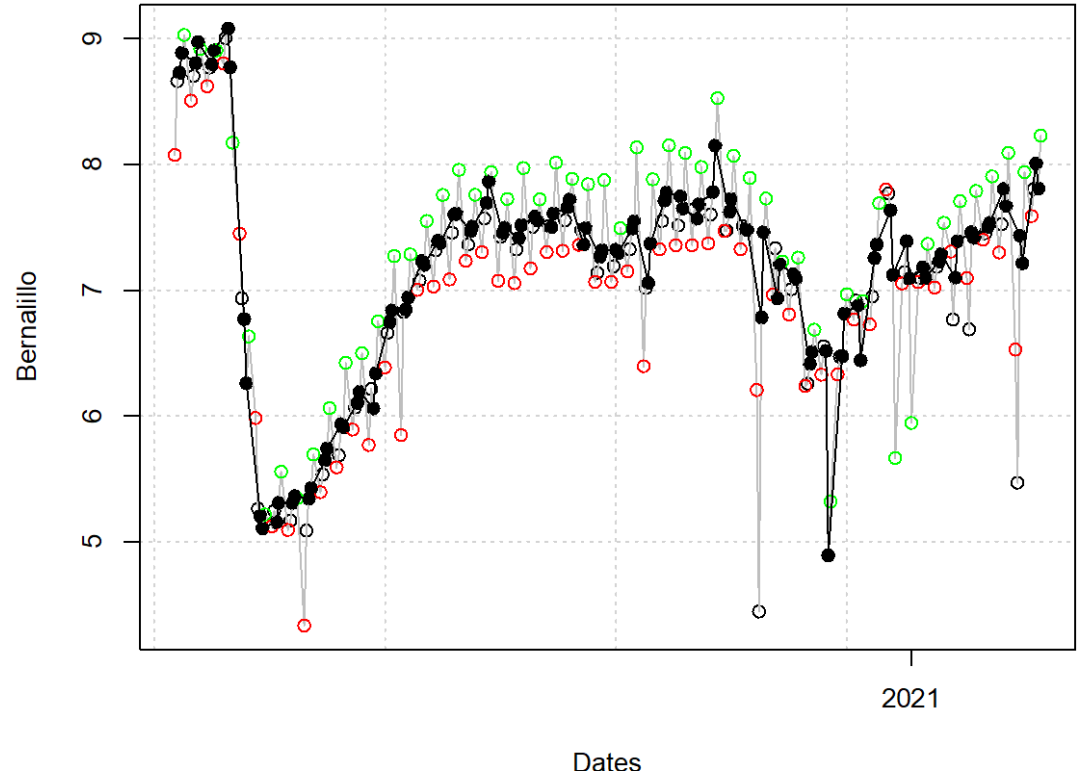
T-80 Mobility – northern counties (Data only)

- **All counties have increased mobility over previous week (which included rain/snow).**
- Bernalillo, Sandoval , San Juan, Santa Fe have strongly increasing trend in mobility over past several weeks.
- McKinley, Sante Fe, Valencia have a slowly increasing trend in mobility over past several weeks.
- Los Alamos, Taos , Rio Arriba have fairly stable mobility over past several weeks.

- Weekends not shown
- Monday
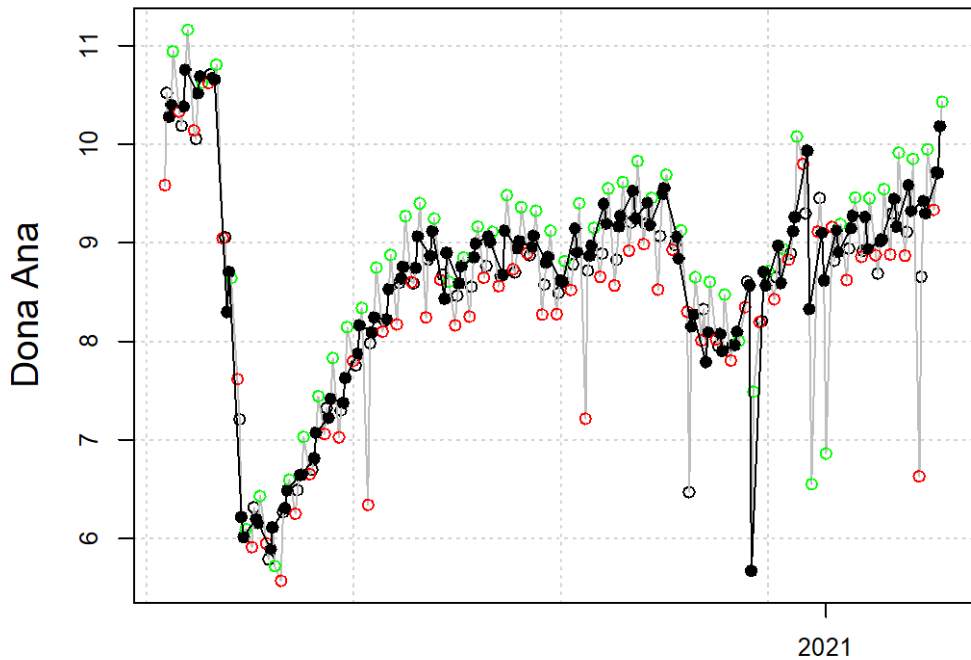- Wednesday/Thursday
- Friday (usually higher)
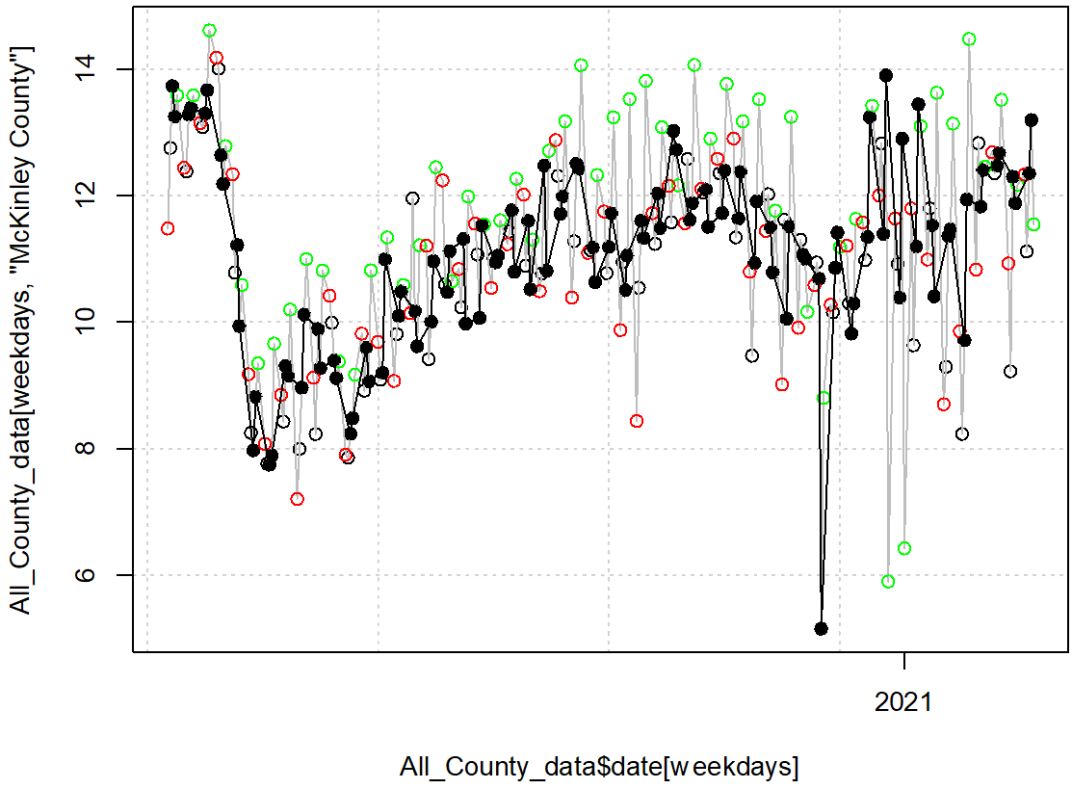
T-80 Mobility – southern counties and Curry (Data only)

- Most counties have increasing mobility.
- Dona Ana , Grant, Chaves, Curry , Eddy, Lea, Lincoln are increasing.
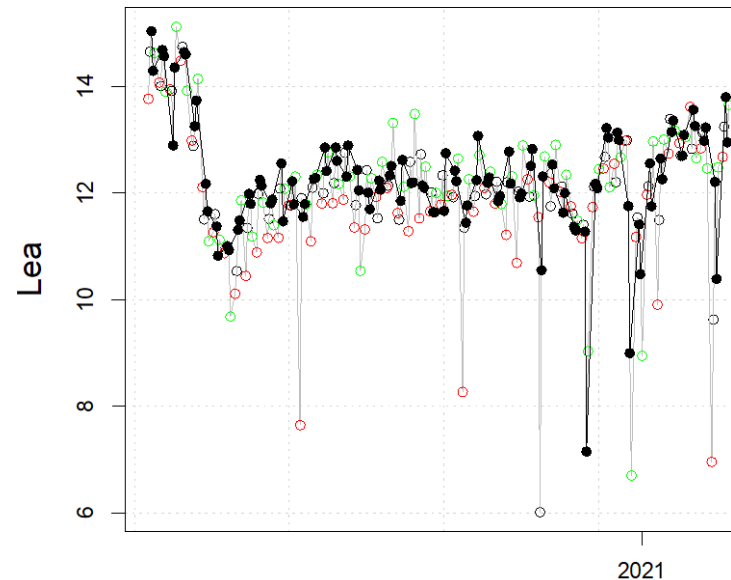- Luna, Otero, Roosevelt , Socorro have been relatively flat over that last ~4 weeks.

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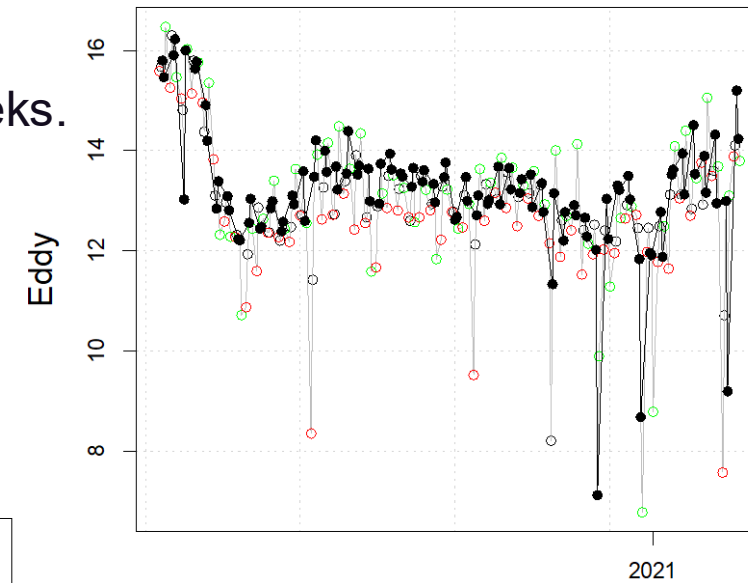- Monday
- Wednesday/Thursday
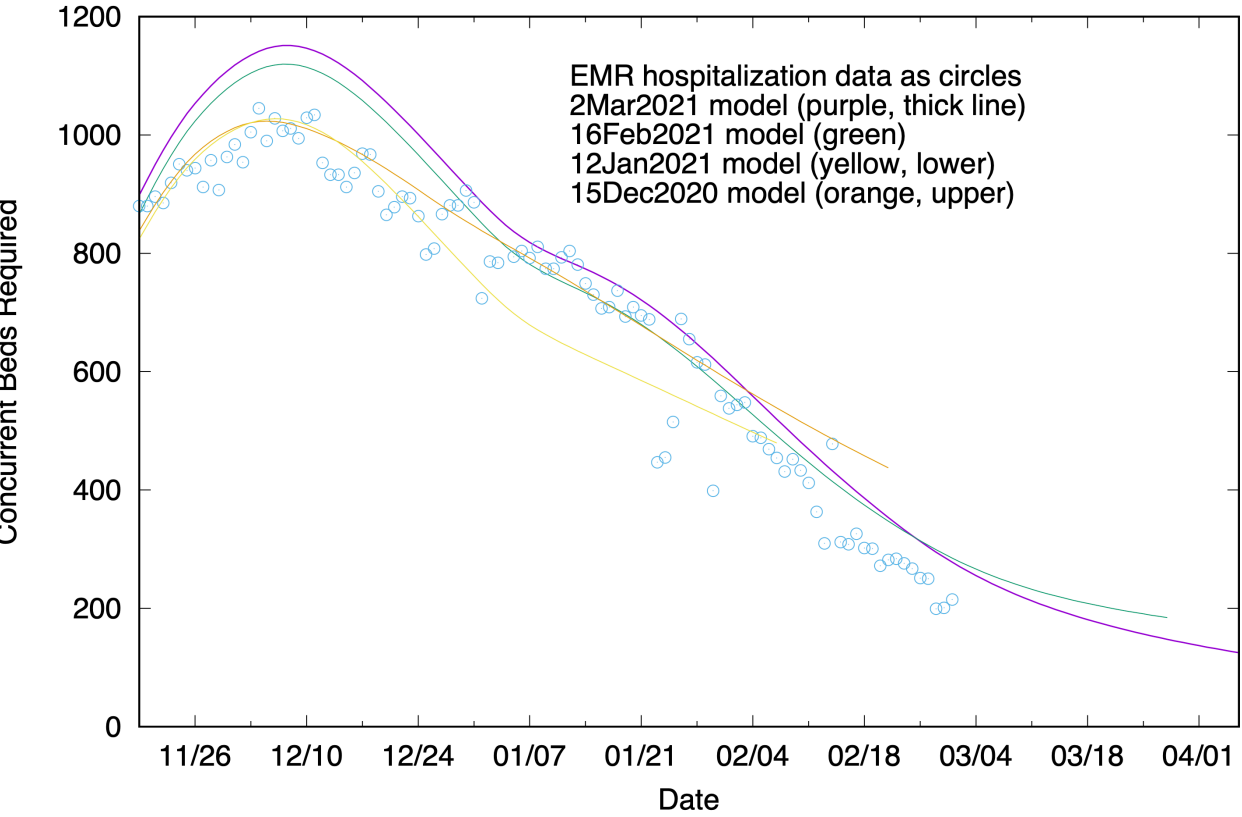- Friday (usually higher)

Eddy

Dona Ana

Lea

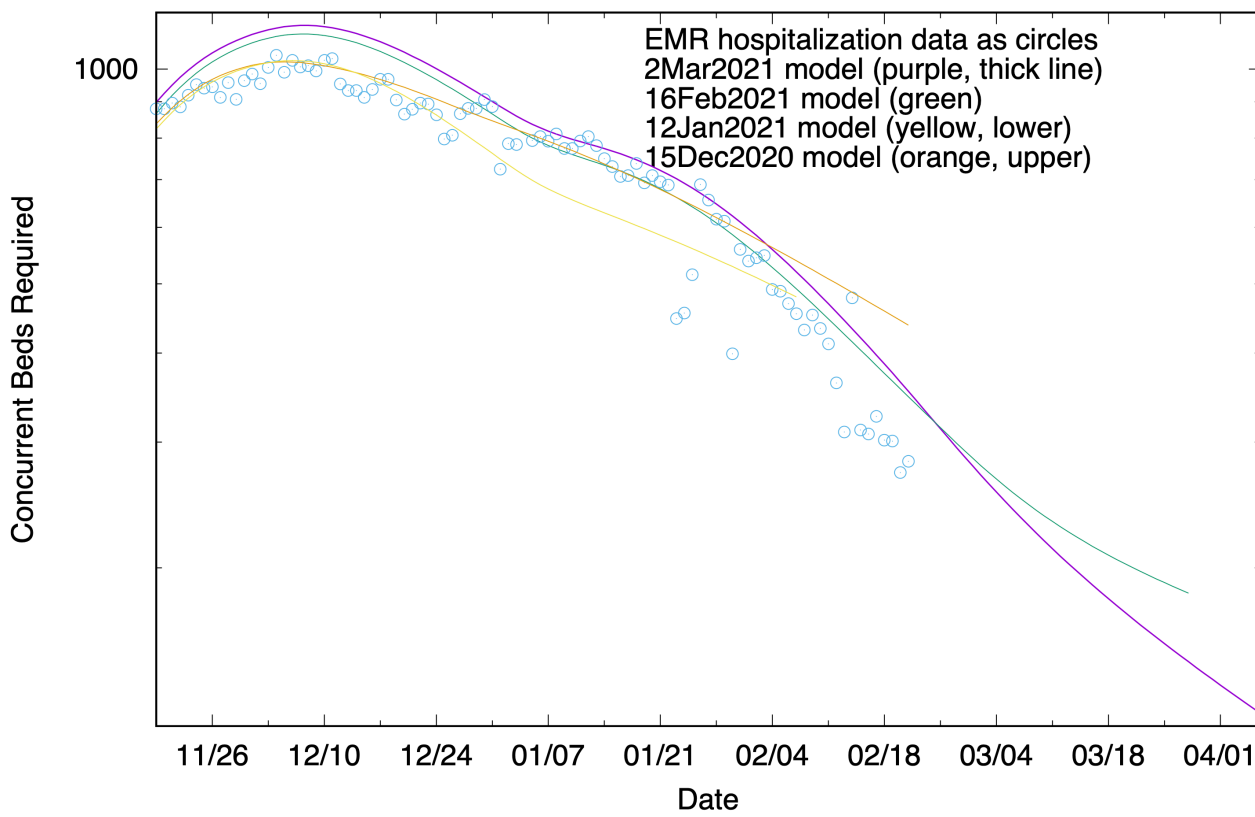# Hospital bed concurrent usage by COVID-19 patients (Statewide)

- Left panel: Linear vs. time (y-scale=0:1200) shows hospital beds.
- Right panel: Log vs. time, same data and models (y-scale = 120:1200, 10x).
- Divergence between 15Dec2020 model, subsequent EMR data, and later EG models reflects the impact of vaccination.
- Deviation below the most recent model *might* reflect avoided severe outcomes.

Hospital Bed Utilization (EpiGrid)

EMR hospitalization data as circles
2Mar2021 model (purple, thick line)
16Feb2021 model (green)
12Jan2021 model (yellow, lower)
15Dec2020 model (orange, upper)

Tue Mar 02 11:18:07 2021

Hospital Bed Utilization (EpiGrid)

EMR hospitalization data as circles
2Mar2021 model (purple, thick line)
16Feb2021 model (green)
12Jan2021 model (yellow, lower)
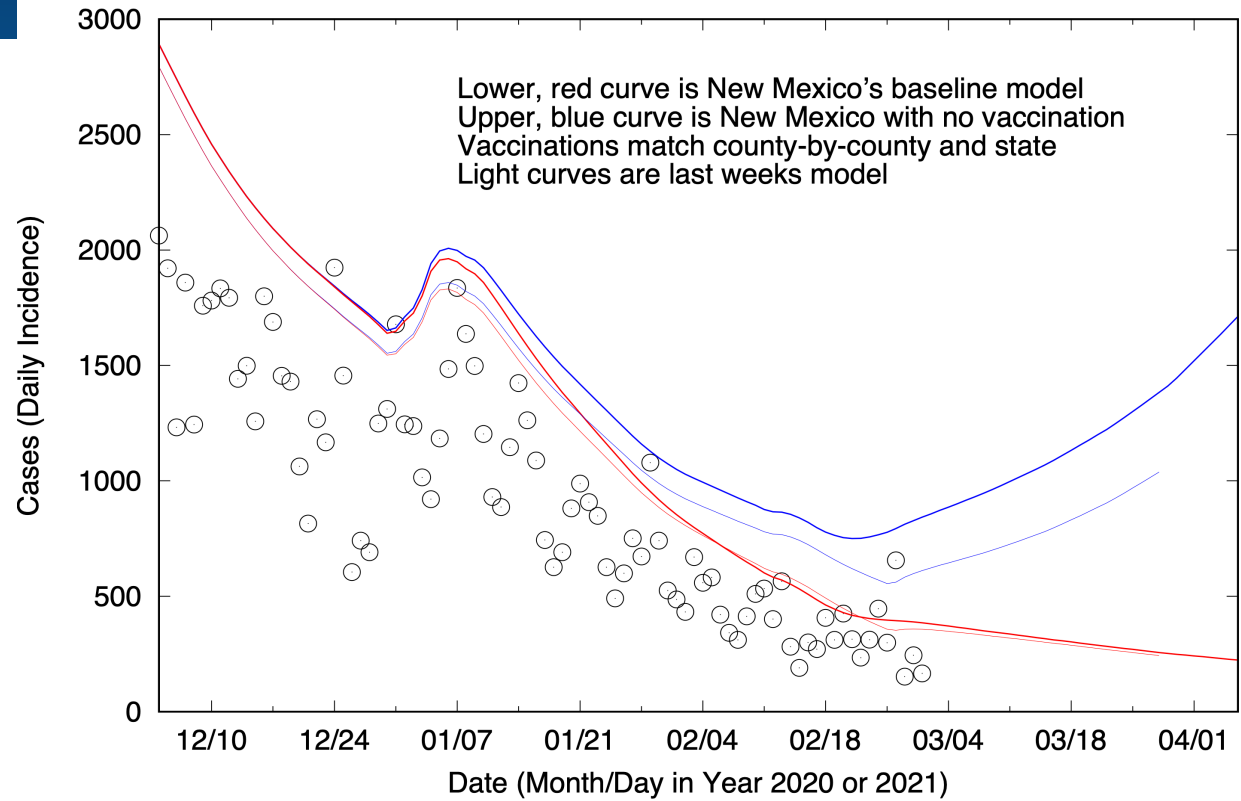15Dec2020 model (orange, upper)

Tue Mar 02 11:20:52 2021
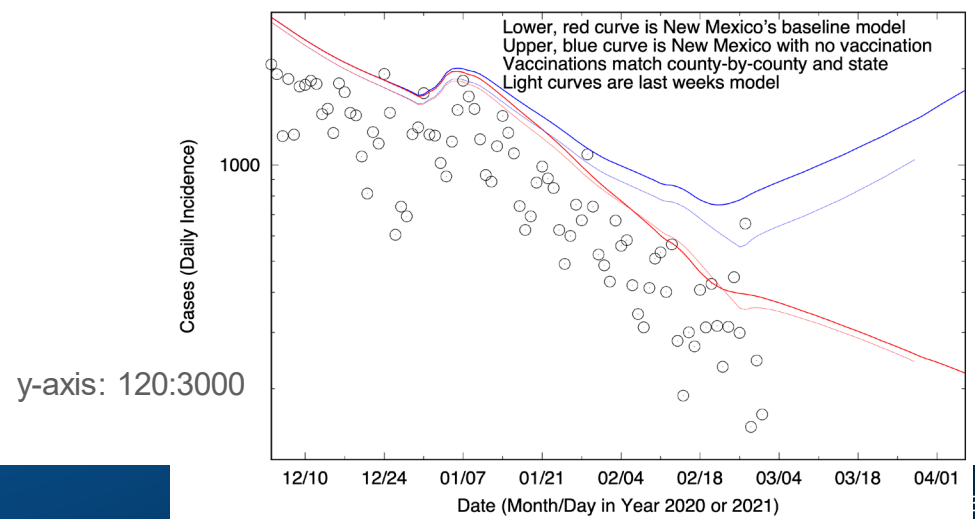
Effect of Vaccination on Incidence

- Vaccination is lowering daily incidence >30%.
- Quarantine *currently* plays a larger role in epidemic control than vaccination.
- Infection control appears to be comparable to vaccination.
- Currently modeling 90% vaccine effectiveness.
- Mar 2nd model: ~420k people vaccinated (1 or 2 doses).
- NM reports 375,100 people vaccinated. Additional Federal doses contribute too, with improved fidelity.
- By-county matching to vaccination.
- Johnson & Johnson vaccine doses will be included in this model when data are available.
- Flattening of daily incidence is the anticipated effect of red to green counties and increased mobility. Easily confused with variant virus replacement.
- NM is currently trading relaxed infection control for vaccination. This sets a "speed limit" to relaxation!
- Assuming only susceptible people are vaccinated.
- Unchanged quarantine effectiveness assumed in all cases.

Mechanistic Model and Data (New Mexico, Incidence)

Lower, red curve is New Mexico's baseline model
Upper, blue curve is New Mexico with no vaccination
Vaccinations match county-by-county and state
Light curves are last weeks model

Tue Mar 02 11:04:44 2021

Mechanistic Model and Data (New Mexico, Incidence)

Lower, red curve is New Mexico's baseline model
Upper, blue curve is New Mexico with no vaccination
Vaccinations match county-by-county and state
Light curves are last weeks model

y-axis: 120:3000

Tue Mar 02 11:06:00 2021

New Mexico Daily Incidence over Time

Lower, red curve is New Mexico's baseline model
Upper, blue curve is New Mexico with no vaccination
Vaccinations match county-by-county and state

Cases (Daily Incidence, log10)

Date (Month/Day in Year 2020 or 2021)

New Mexico Daily Incidence over Time

Lower, red curve is New Mexico's baseline model
Upper, blue curve is New Mexico with no vaccination
Vaccinations match county-by-county and state

Cases (Daily Incidence)
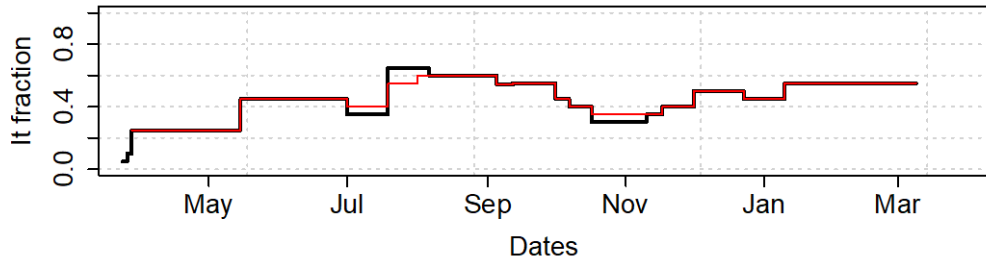
Date (Month/Day in Year 2020 or 2021)
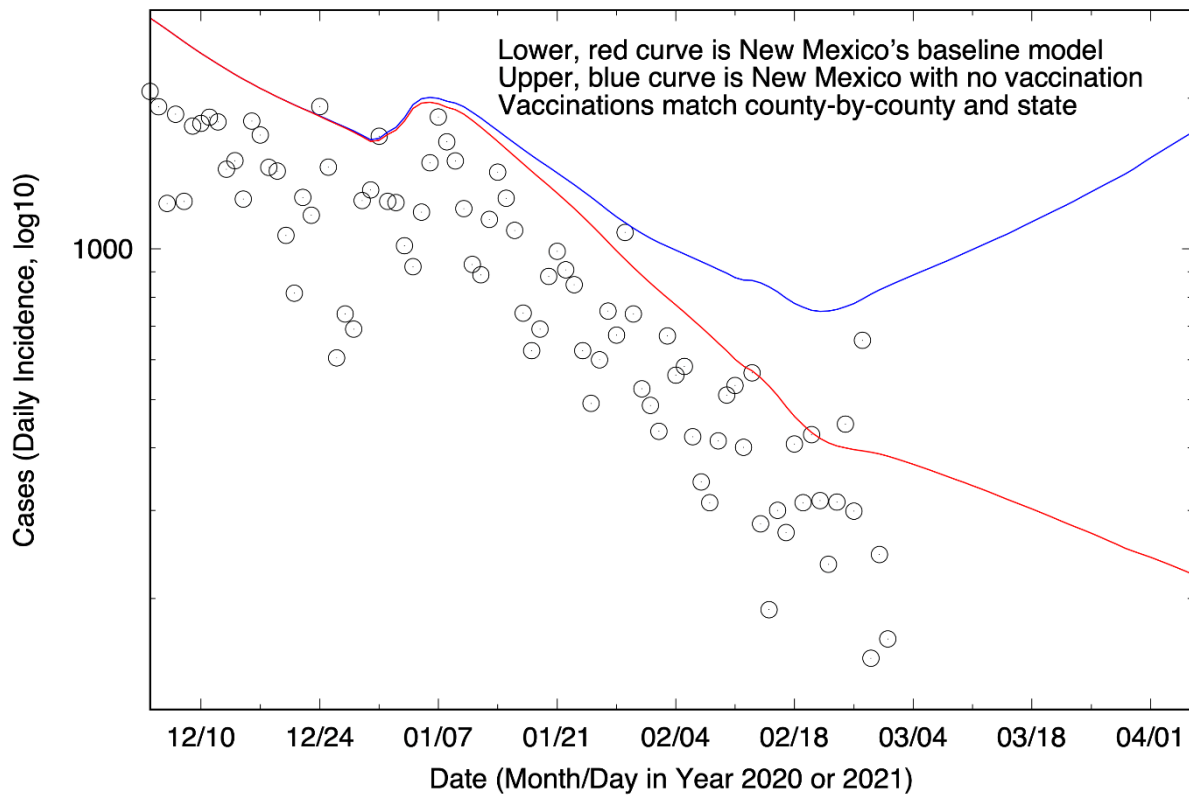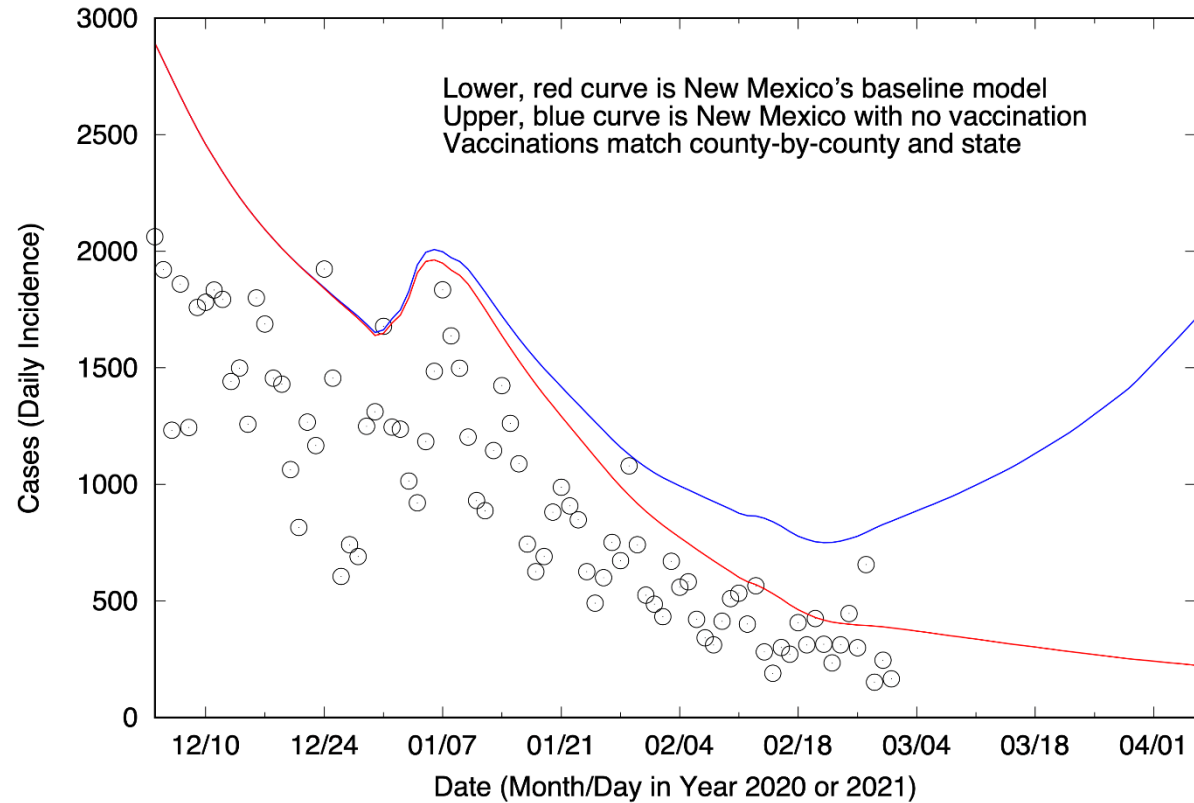
Situational Awareness:

- Cases appear to no longer be decreasing in some of the more populace counties:
  - Bernalillo, Dona Ana, Santa Fe and Valencia

- Statewide there is no evidence of cases continuing to decrease in the last week.

Separating mechanistic effects: Captured effects of mitigations
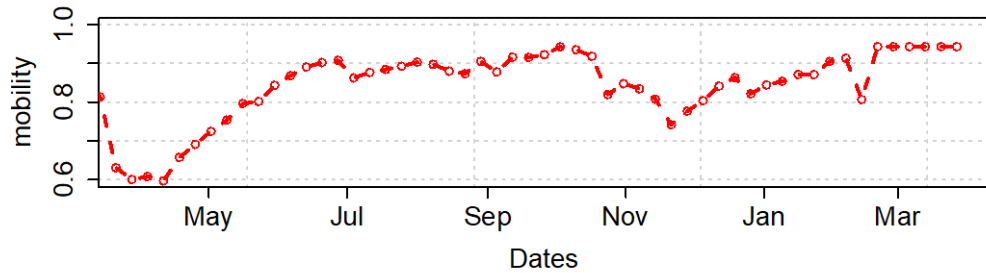

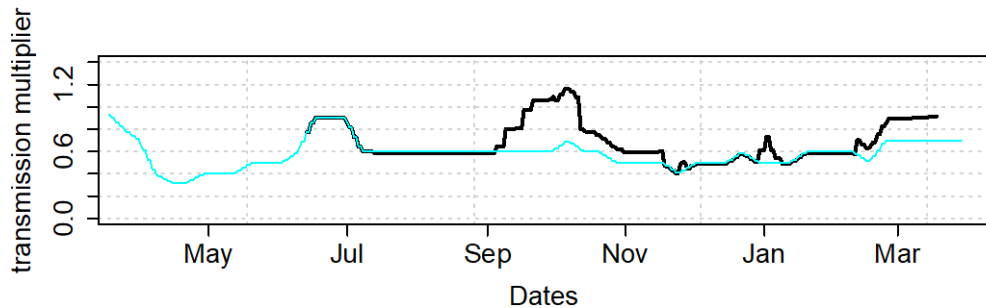**New Mexico__Bernalillo**

Quarantine
Red is base value
Black is values used for Bernalillo
~50% relative to unmitigated

Mobility data: an input
Last 5 points are extrapolation

Fractional change in person-to-person transmission
Cyan - mobility based value without PHO modifications (Aug. on)
Black – modified for PHO's, values used for Bernalillo
~20% improvement relative to unmitigated
Has been as large as ~60% in the past (rel. to unmitigated)
Cyan-black difference requires thought and/or more data for interpretation

Conclusions and Discussion

- **New Mexico's daily incidence is not increasing, possibly declining.**
- **This model's contagion modulation/community infection control is not inconsistent with strain replacement.**
- **Increased vaccine supply and administration and/or improved effective quarantine are needed.**
- **COVID-19 vaccination reported by the State is responsible for an >30% reduction in daily incidence.**
- **Infection control and quarantine play comparable roles to vaccination in epidemic control.**
- **National and State monitoring for strain emergence is likely improving. Model is *assuming* about 1:1000 variant cases in late January, assumed <~10:1000 currently. If this is several weeks behind reality, model may be more self-consistent.**
- **El Paso's daily incidence consistent with constant or rising cases.**
- **Nationwide geographical dispersion is seeding some local transmission and variants.**
- **Within-week variation in testing results suggests that situational awareness may be fair.**
- **Shift the vaccination strategy toward contagion-control in weeks?**
- **Discussion:**
  - Vaccinating high risk-of-mortality populations appears to be lowering hospital loads.
  - Good infection control in schools appears to be well-correlated with improved outcomes. Improved PPE may be required in response to viral variant emergence. Meal times, busses, and passing periods are likely the riskiest school-related activities.
  - *Epidemiological* evidence does not rule out a more contagious variant of SARS-CoV-2 in New Mexico.
  - Qualitatively higher testing rates (i.e. 10x) can substantially offset local epidemics (i.e. South Korea) by facilitating tracing and quarantine. Sequencing can provide diagnostics, and provides variant-level information that is likely to become important in the near future, and is compatible with high testing rates.
  - Elimination of COVID-19 removes or reduces the risk of novel variant emergence.