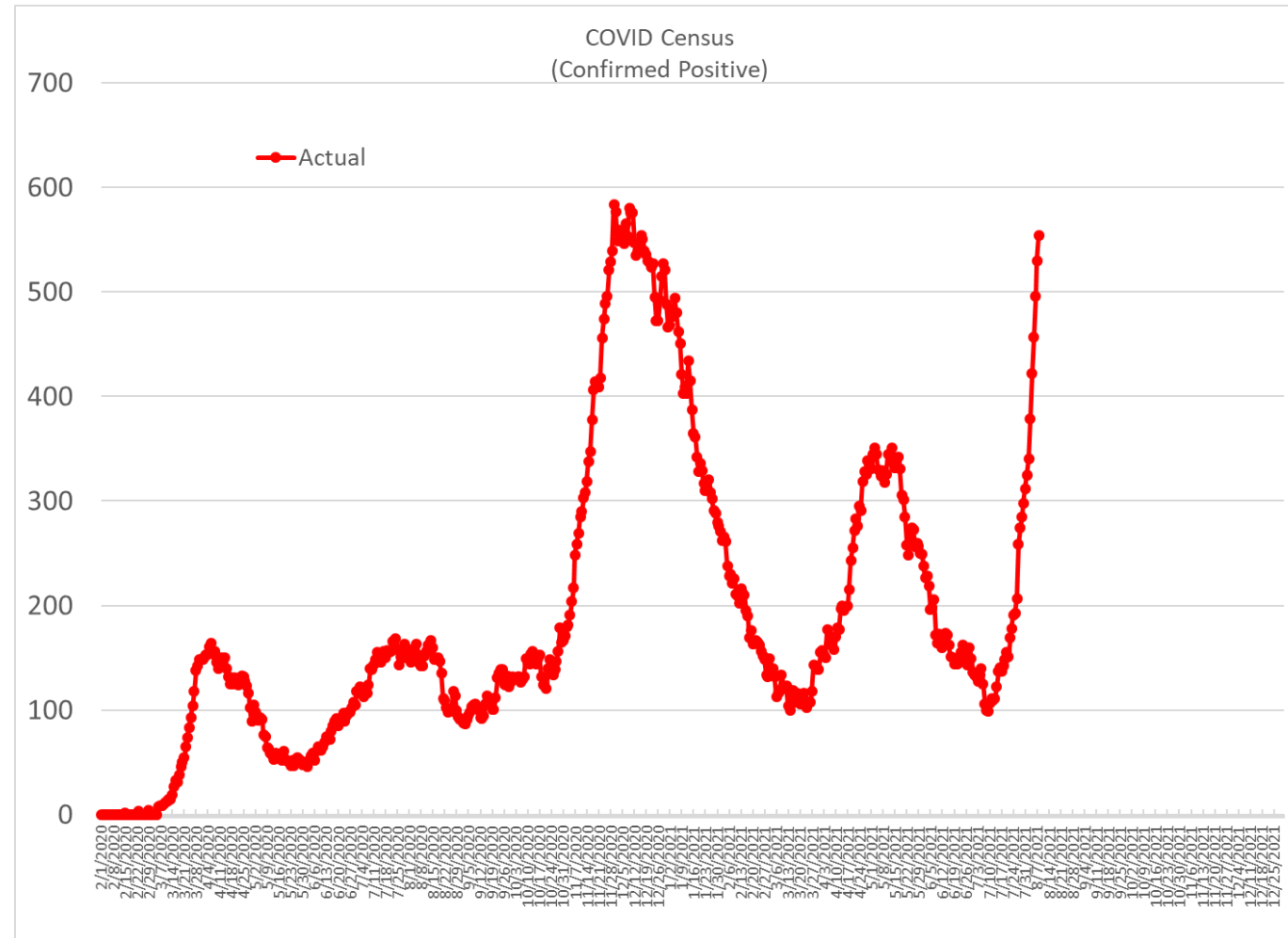# OHSU COVID Forecast
Edition: 8/10/2021

Peter Graven, PhD; Office of Advanced Analytics, BIAA, ITG

Key Outcomes

Hospitalized Patients

As of 8/8/2021, the statewide census was 554.

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonCOVID-19HospitalCapacitySummaryTables_15965754787060/HospitalizationbySeveritySummaryTable

Regional Hospital Census

Region 5 is showing dramatic increase to extremely high census levels.

All other regions are showing increases to levels at peak of winter/fall surge.
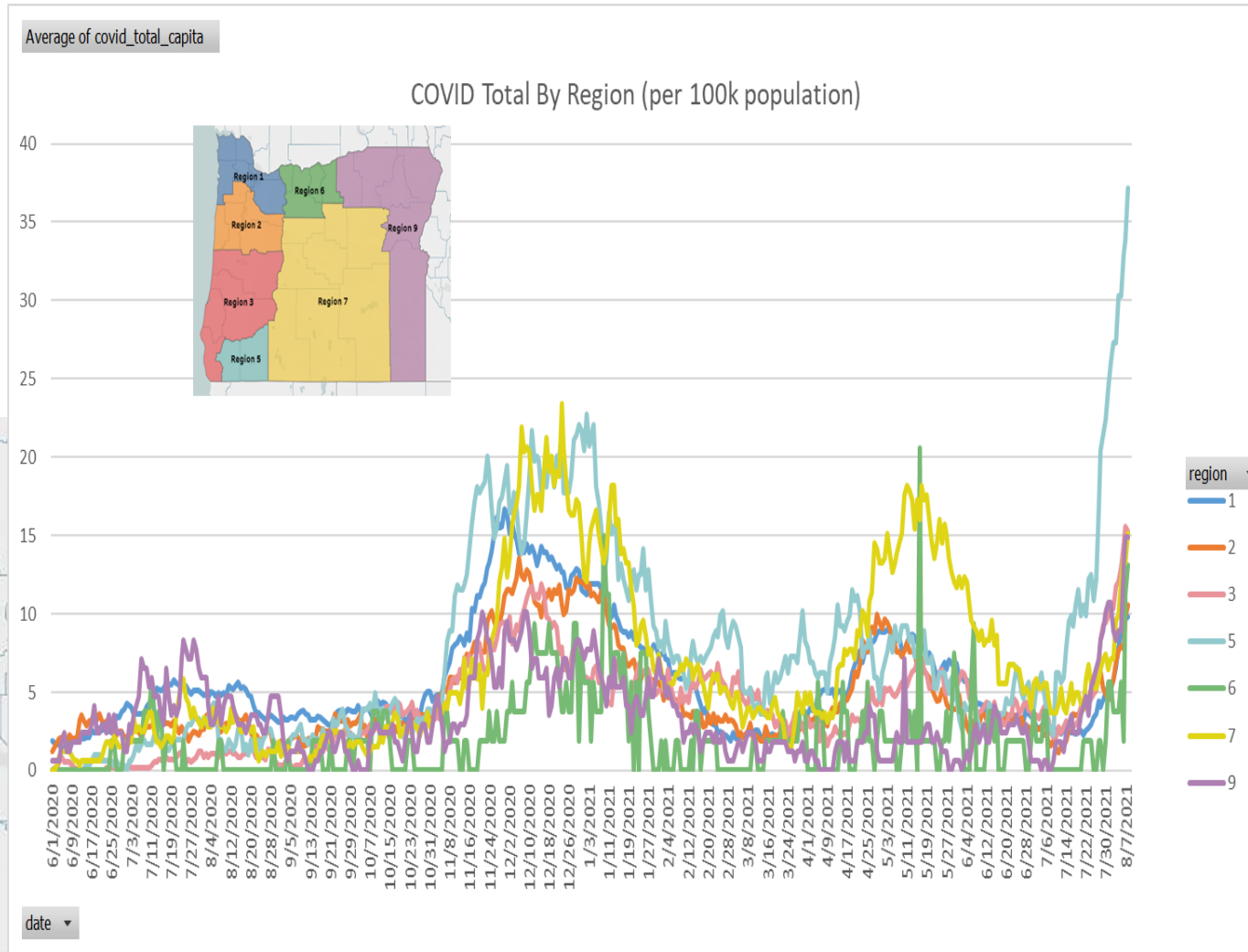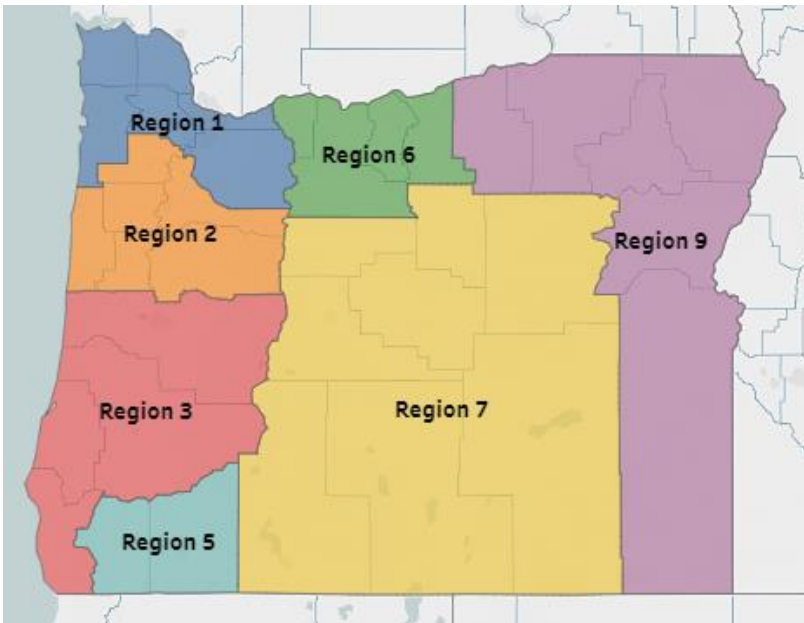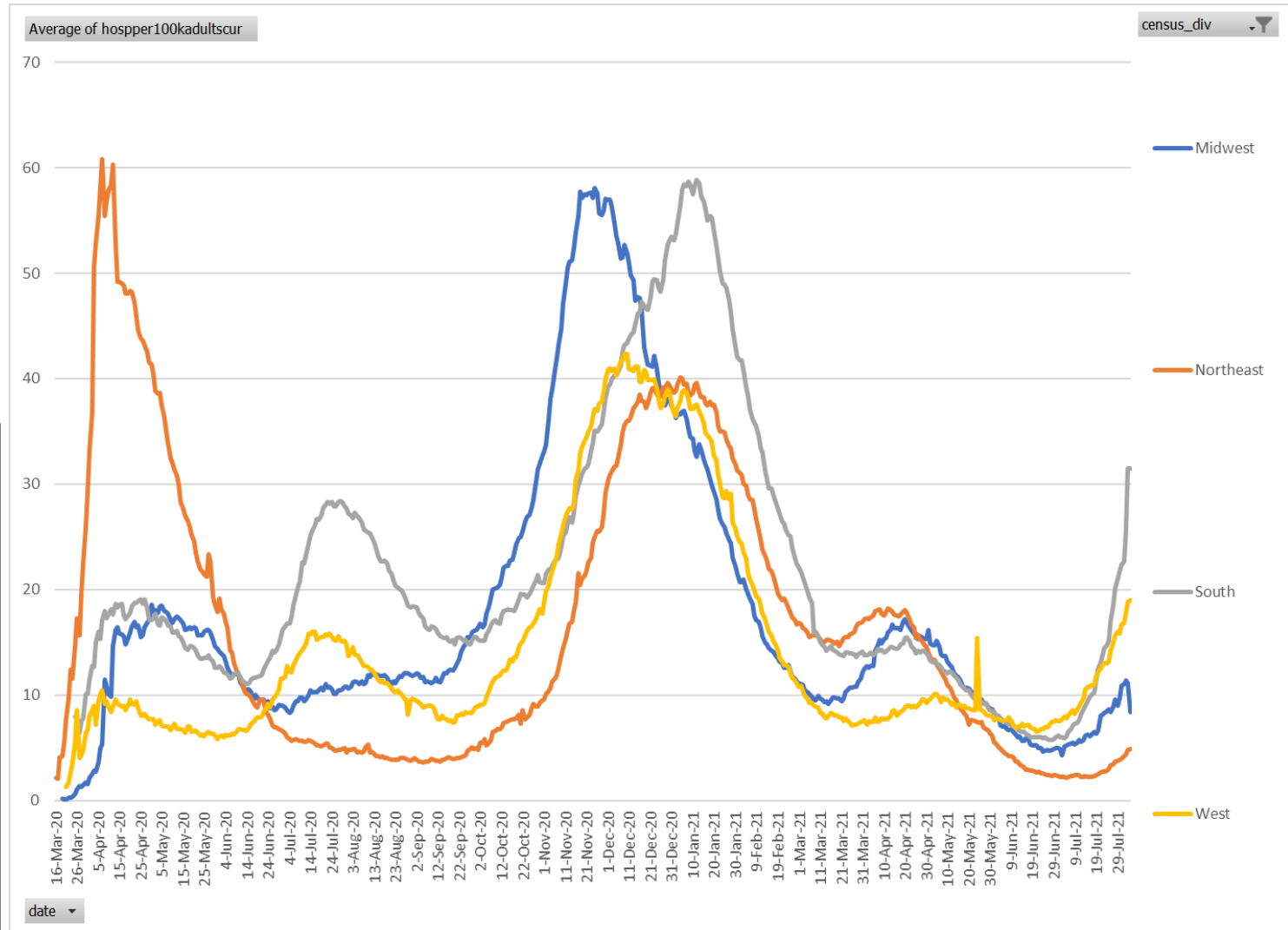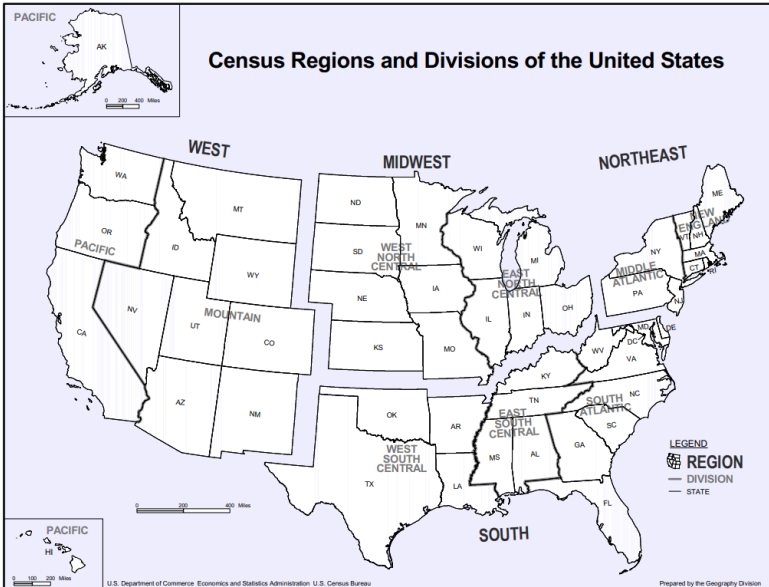
Hospital Census by US Region

The South and West are showing accelerating increase.

The Midwest is showing minor increases in hospital census.
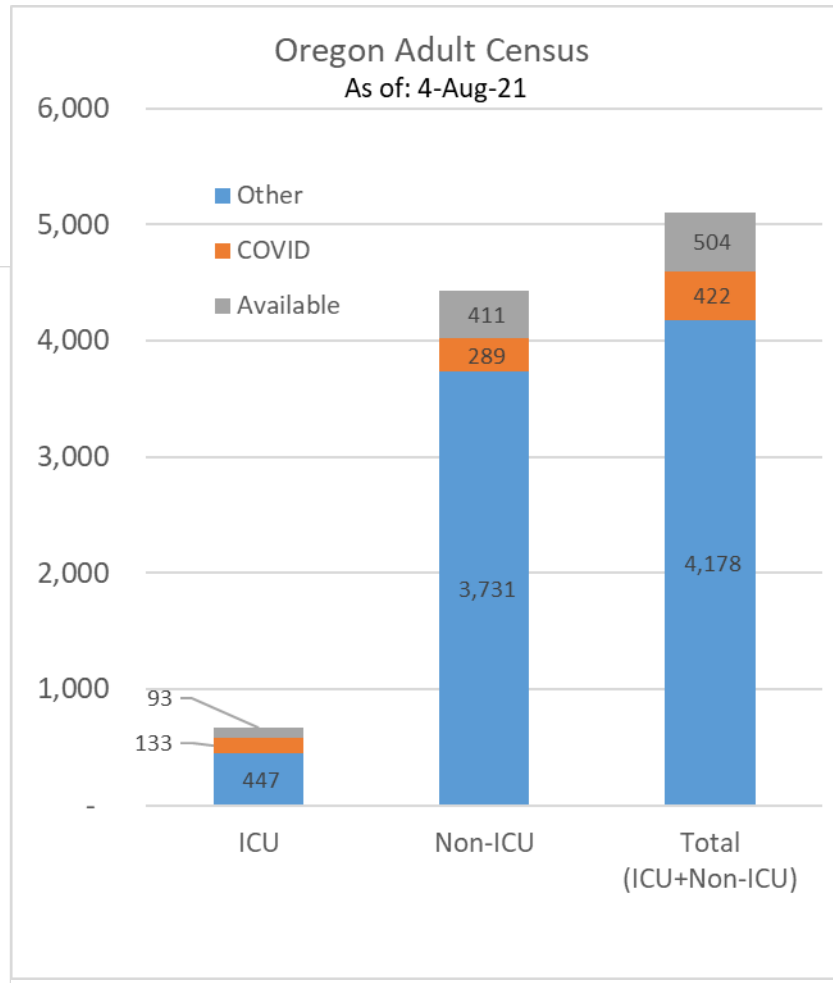
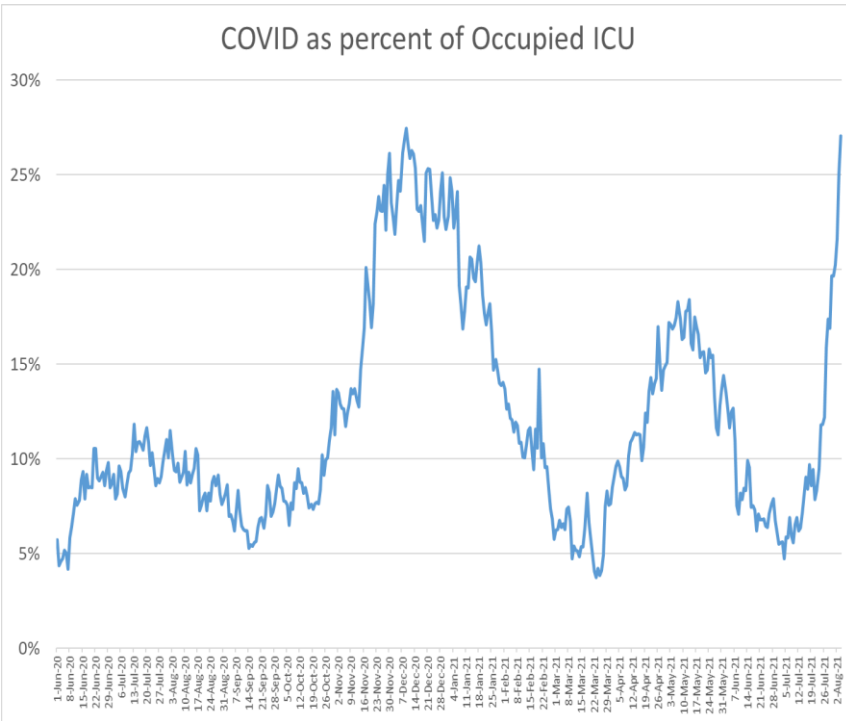The Northeast is showing slight increase at very low levels.

Census Regions and Divisions of the United States

Average of hospper100kadultscur

Source: https://carlsonschool.umn.edu/mili-misrc-covid19-tracking-project

Oregon Hospital Capacity

As of 8/4, of the 580 occupied ICU beds, 133 (23%) are filled with COVID patients.

Oregon Adult Census
As of: 4-Aug-21

- Other
- COVID
- Available

	ICU	Non-ICU	Total (ICU+Non-ICU)
Available		411	504
COVID	93 / 133	289	422
Other	447	3,731	4,178

Share of Occupied w/COVID

Region	ICU	Non-ICU	Total
1	16%	6%	7%
2	22%	6%	8%
3	29%	8%	11%
5	57%	15%	20%
6	0%	6%	5%
7	12%	6%	7%
9	45%	8%	15%
Total	23%	7%	9%

COVID as percent of Occupied ICU

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonCOVID-19HospitalCapacitySummaryTables_15965754787060/HospitalizationbySeveritySummaryTable

OHSU
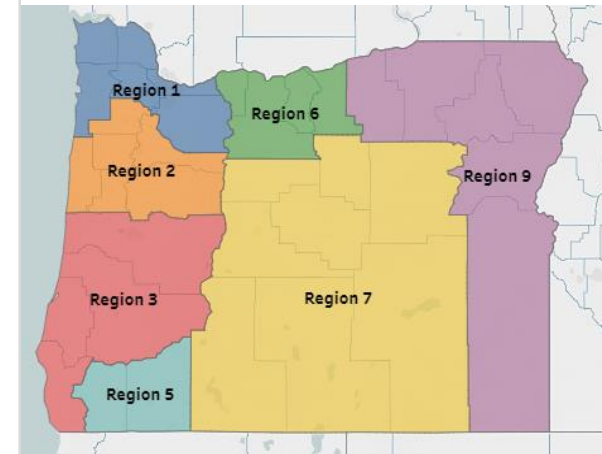
New Cases per Capita

Dramatic increase in cases.

Oregon ranks 26th in the number of new cases per day.

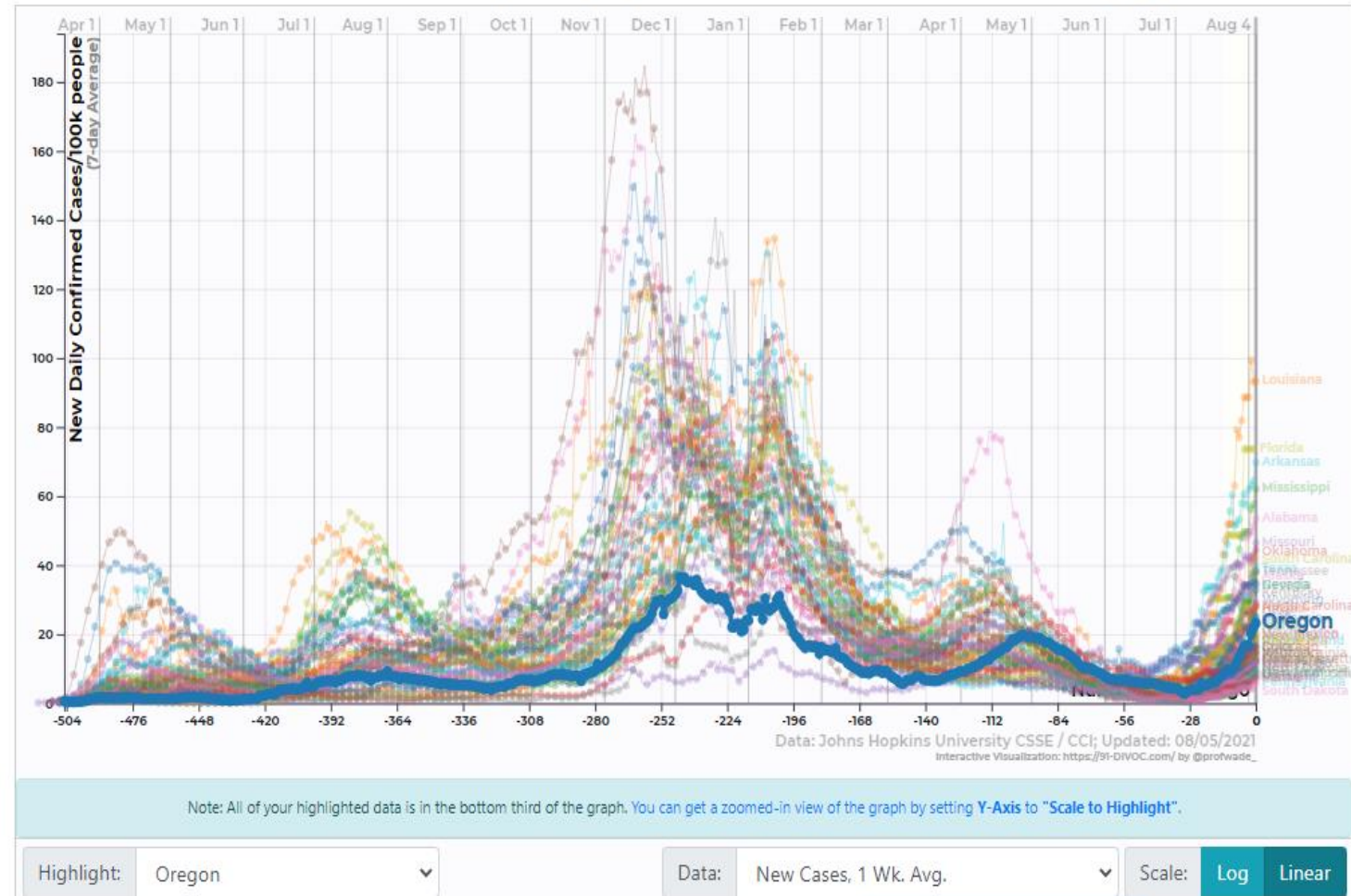Several states are showing sharp increases in cases per day.

New Confirmed COVID-19 Cases per Day by States/Territories, normalized by population

Source: http://91-divoc.com/pages/covid-visualization/

New Cases by Vax Status

In Oregon, while cases amongst vaccinated are up in the last month, the rate of cases amongst unvaccinated are 6 times higher.

Figure 3. Rate of COVID-19 cases by vaccination status

Rate of COVID-19 Cases by Vaccination Status

— Case Rate in Unvaccinated Population   — Case Rate in Vaccinated Population
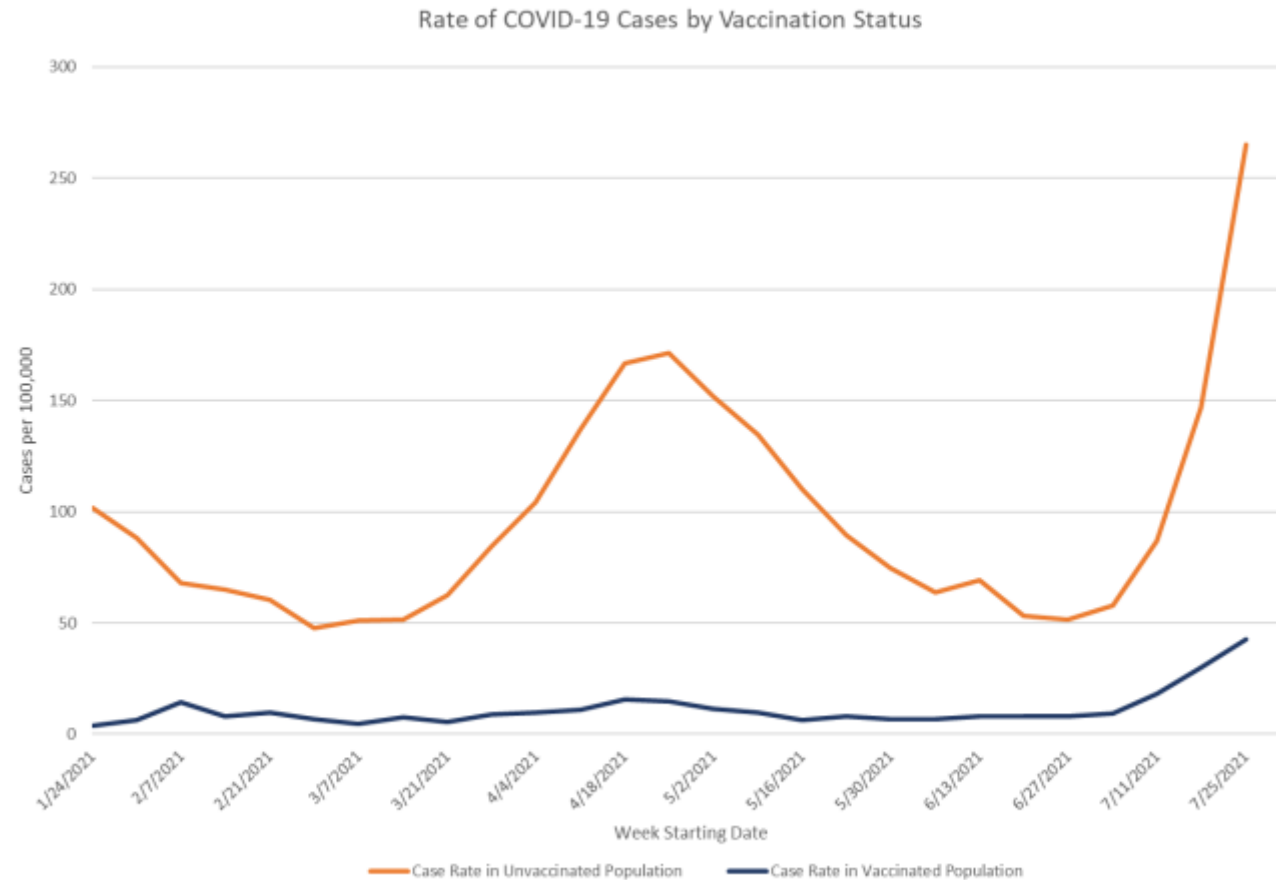
Denominators for vaccinated population are the cumulative number of Oregonians that were fully vaccinated by week

Source: https://www.oregon.gov/oha/covid19/Documents/DataReports/Breakthrough-Report-08-2021.pdf

Hospitalization Rate

For the most recent week (7/18-7/24) of complete data, the hospitalization rate is 5.0%.

This represents a return to previous rates of hospitalization.

Hospitalization Rate (per Case)

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonHealthAuthorityCOVID-19SummaryTable_15889676399110/OregonsEpiCurveSummaryTable
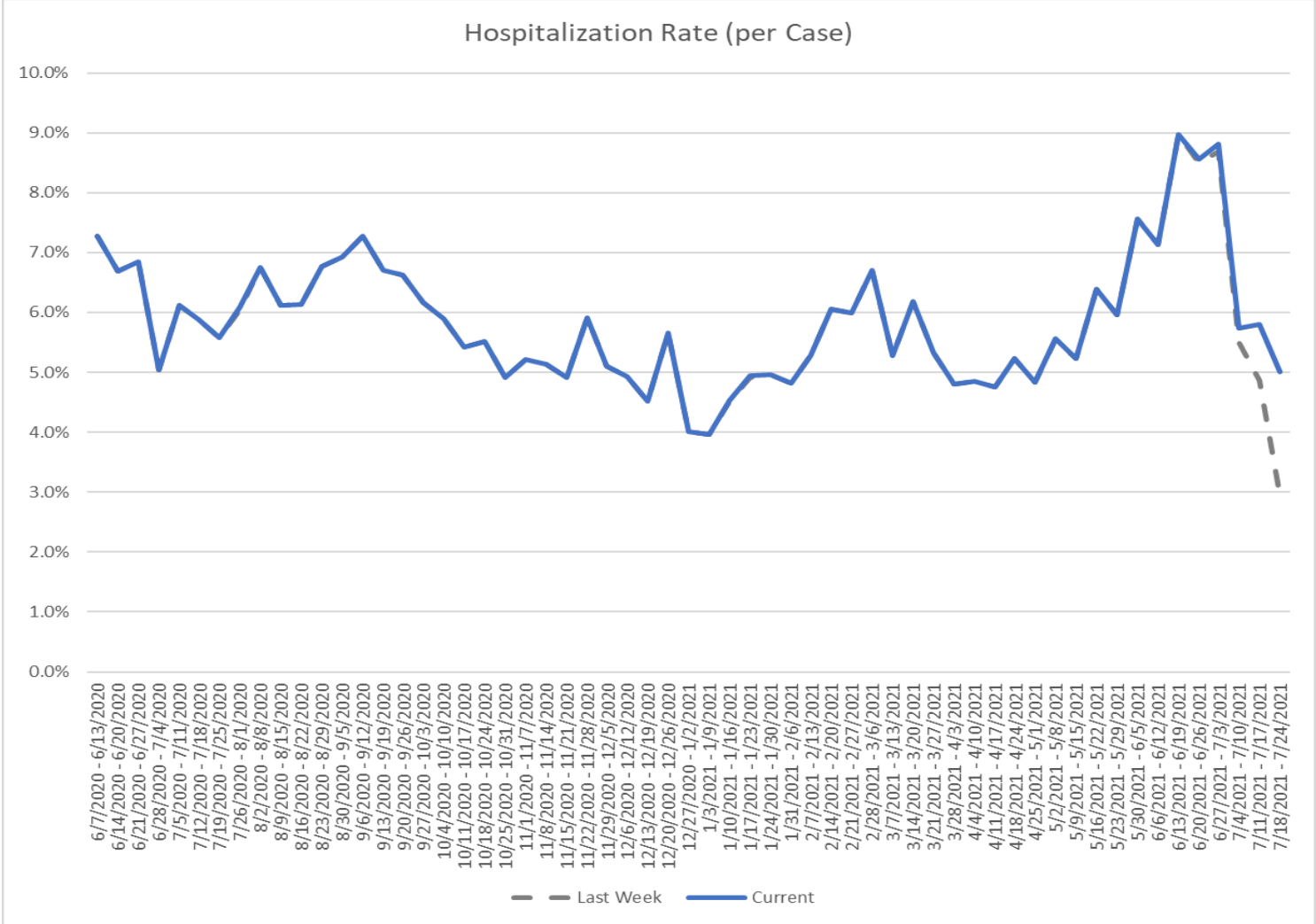
Test Positivity

A sharp rise in positivity is developing.

The most recent complete week (7/18-7/24) had a test positivity of 5.4%.

Test positivity over time - All

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonHealthAuthorityCOVID-19DataDashboard/OregonsCOVID-19ELRsOverTime
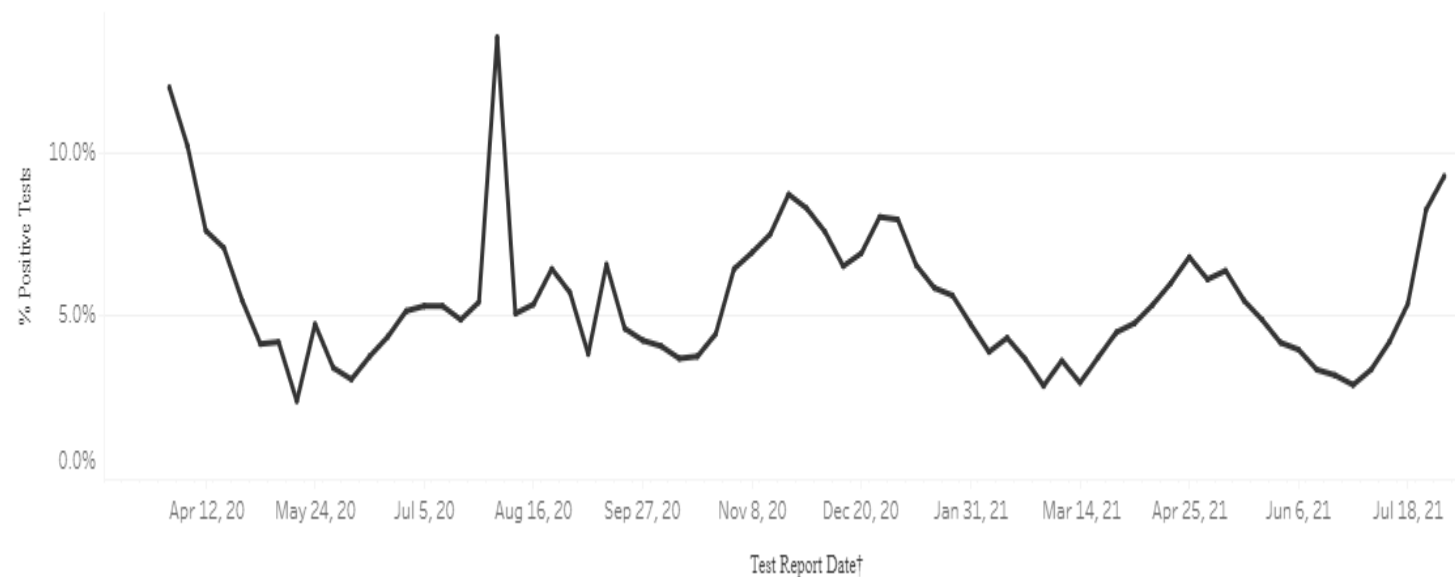
Total Tests

Testing continues to increase.

Positive and Negative COVID-19 test counts over time - All

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonHealthAuthorityCOVID-19DataDashboard/OregonsCOVID-19ELRsOverTime
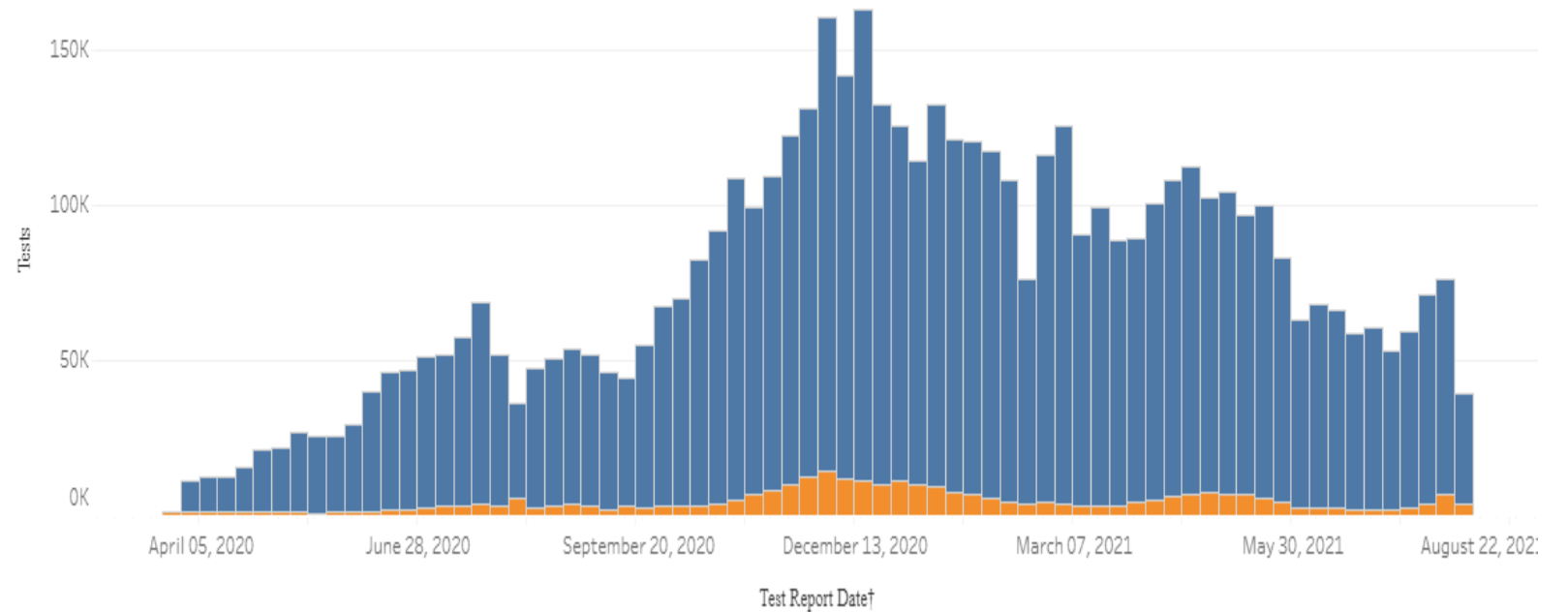
Review of Leading Indicators

Leading Indicators Comparison

Leading indicators for Oregon from google are showing continued high levels of activity.

Leading Index Comparison

Legend: Retail, Transit, Near Residence (inv), Parks, Grocery

Source: SDI from: https://data.covid.umd.edu/
DEX from https://github.com/COVIDExposureIndices/, Google mobility reports from https://www.google.com/covid19/mobility/
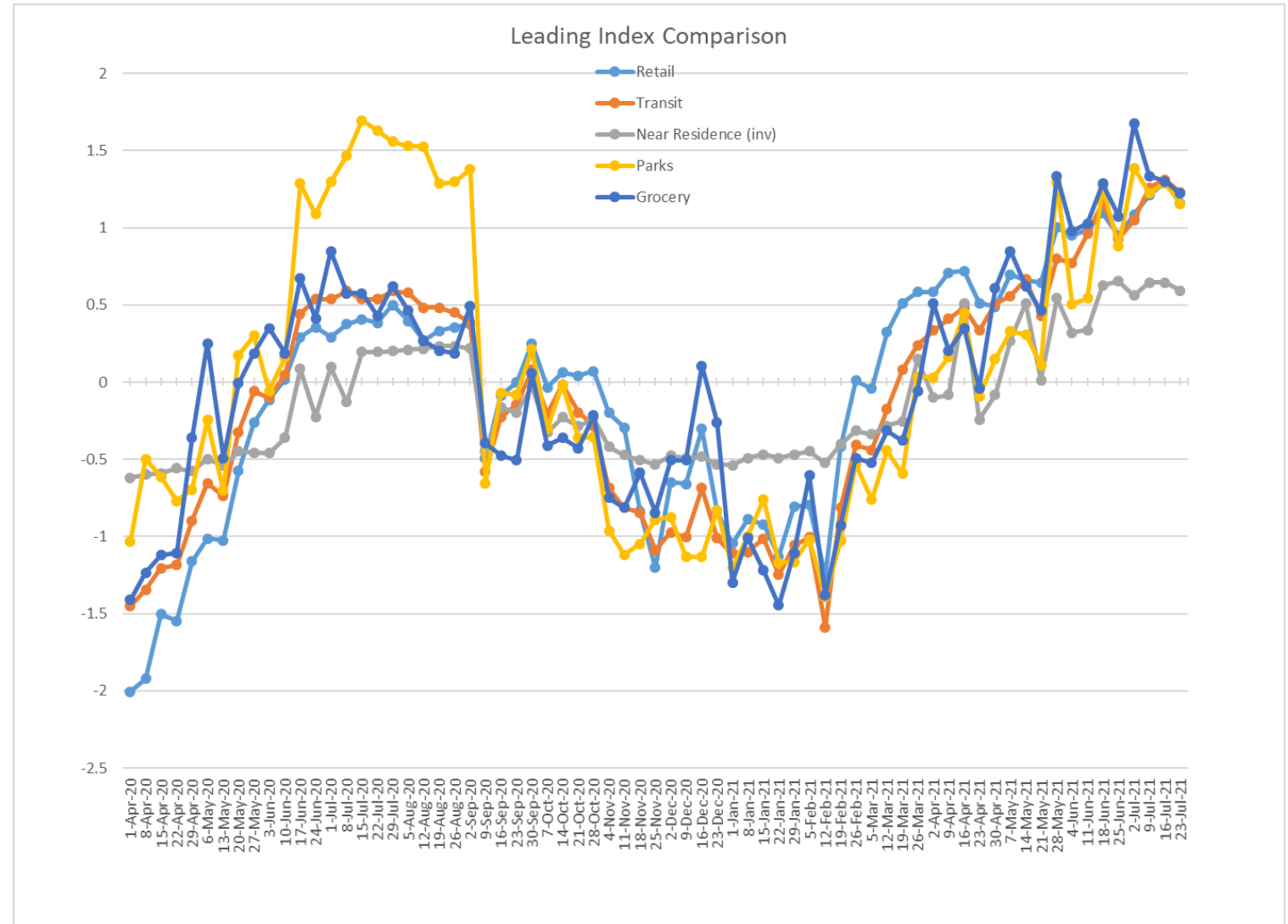
Higher Risk Behaviors

Higher risk behaviors in Oregon have leveled off and even declined somewhat in recent weeks.

Source: https://covidcast.cmu.edu/
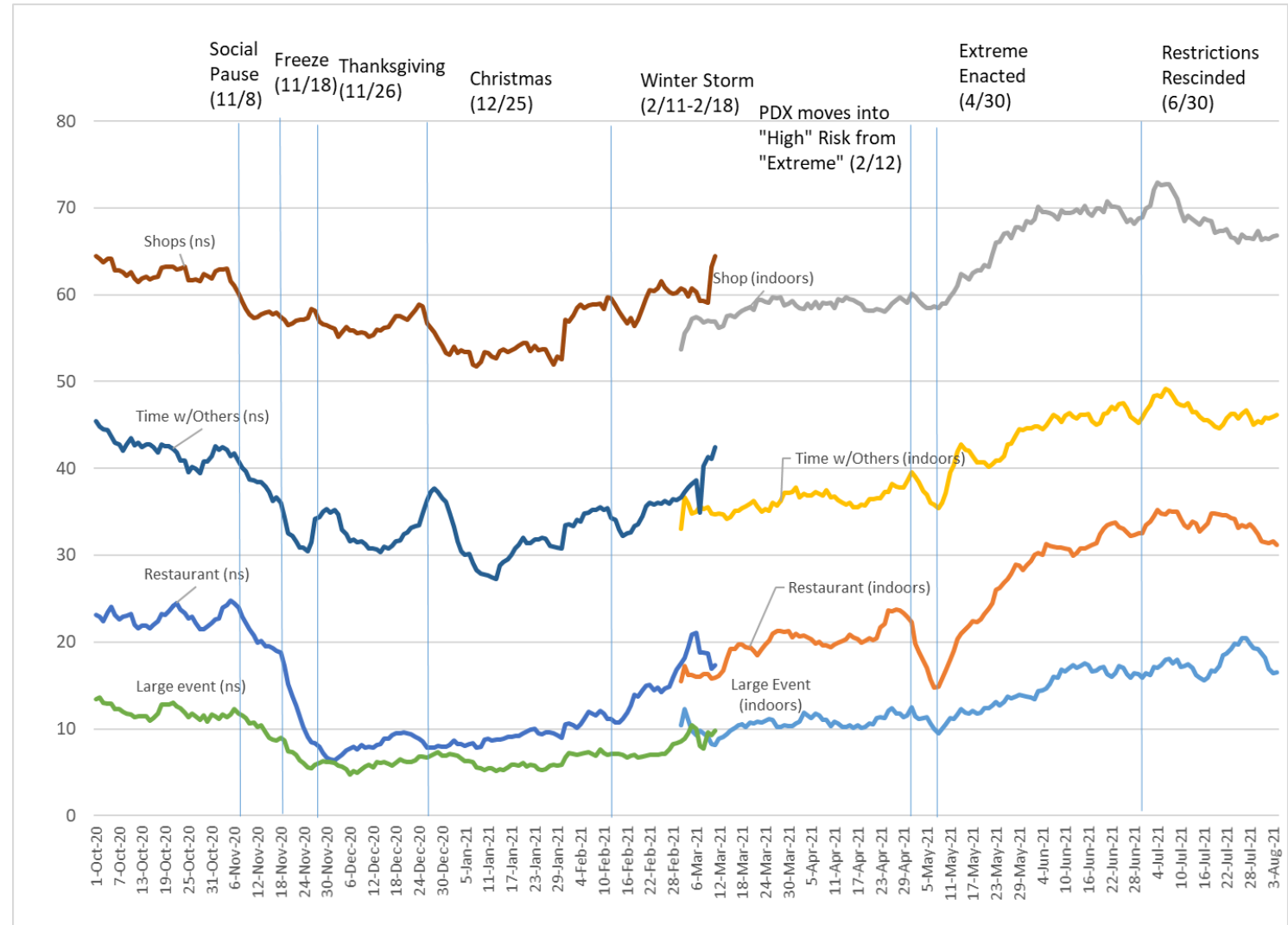
Mask Wearing

A very slight increase in mask wearing has occurred in last 10 days.

After a low of 32%, the rate has increased to 45% as of 8/8.

Source: https://covidcast.cmu.edu/
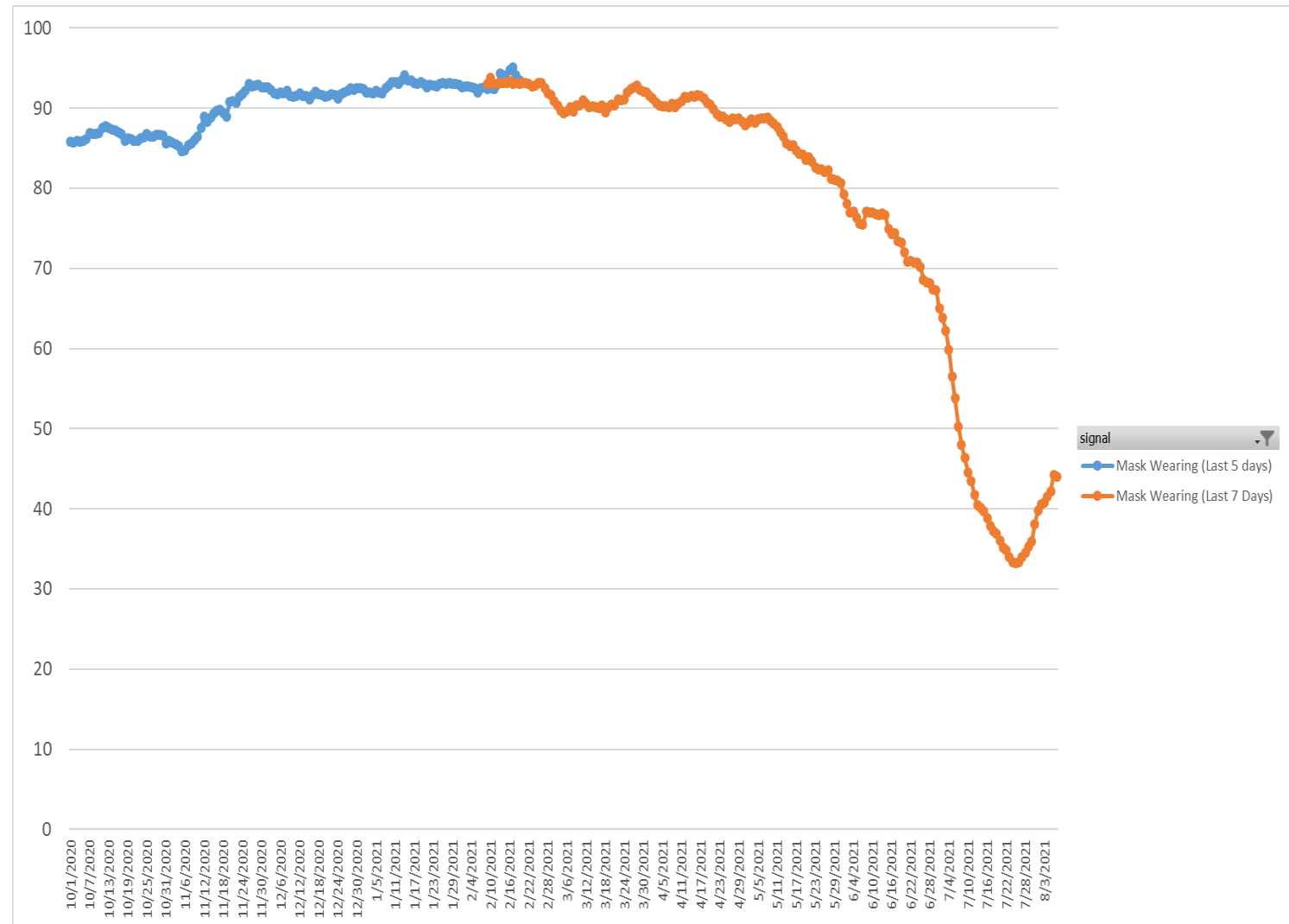
Symptoms

Symptoms are showing a sharp increase in the last week.

"Symptoms" refer to community reports of COVID-like symptoms through Facebook surveys.

Source: https://covidcast.cmu.edu/
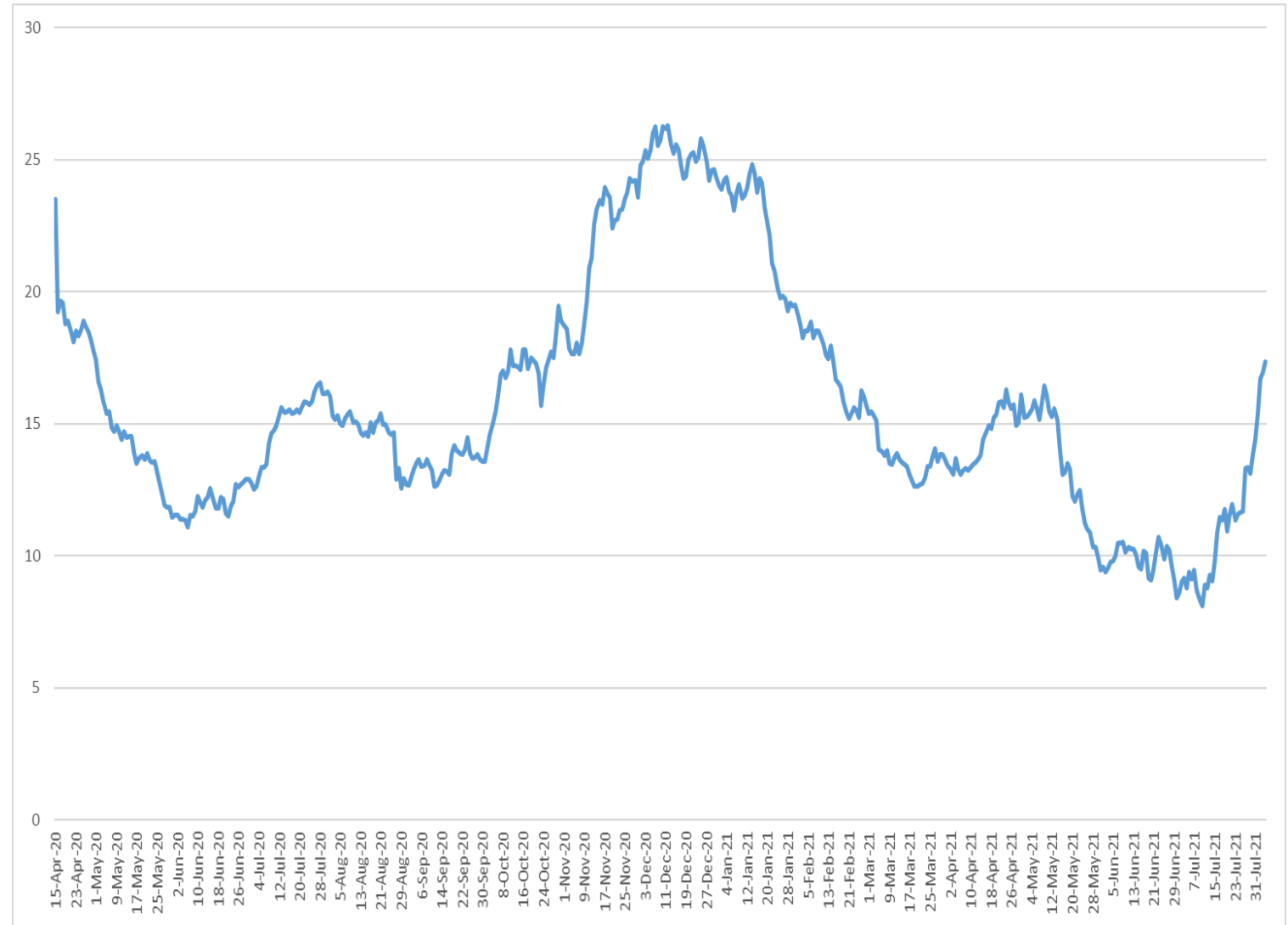
Statewide Forecast

Model Assumption-Vaccine Volume

"Fast" scenario assumes some increased vaccine rates due to attention from current surge. It also assume 5-11 become eligible in late fall.

"Slow" scenario show previous pattern of declining vaccine providing little boost to immunity levels.

First Doses Administered (per week)

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonCOVID-19VaccinationTrends/OregonStatewideVaccinationTrends, Projections by OHSU using Weekly Dose Projections from OHA.
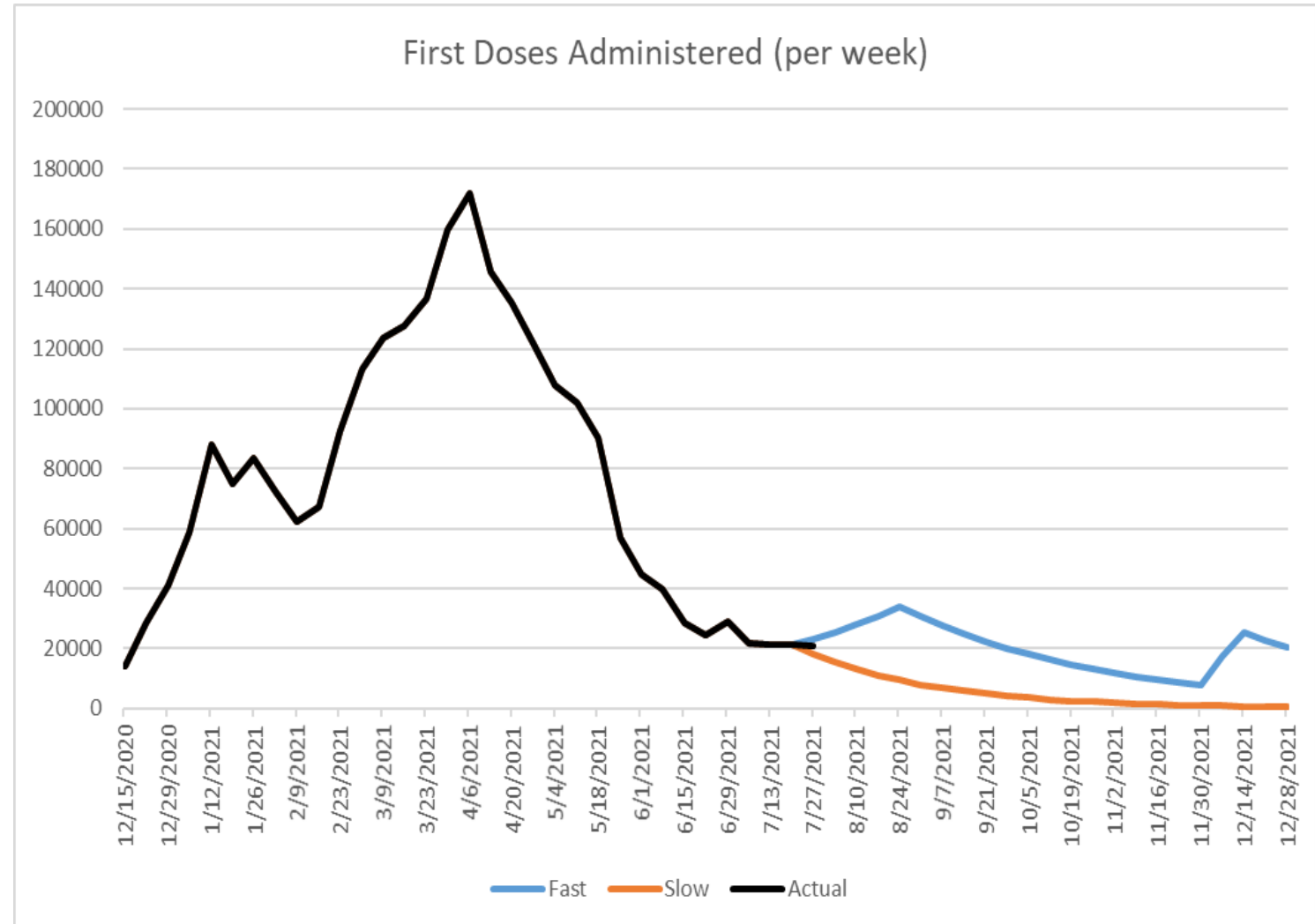
Model Assumption-Virus Spread Rate

The fast uptick in delta variant is shown by a kink in the overall R0 of circulating virus.

The "Fast" scenario assumes delta variant has an R0 of 8.0. The Slow scenario assumes the R0 is 7.0.

R0 of Circulating Virus

Source: Actuals from https://outbreak.info/location-reports?loc=USA_US-OR, Projections by Simulation by OHSU

OHSU
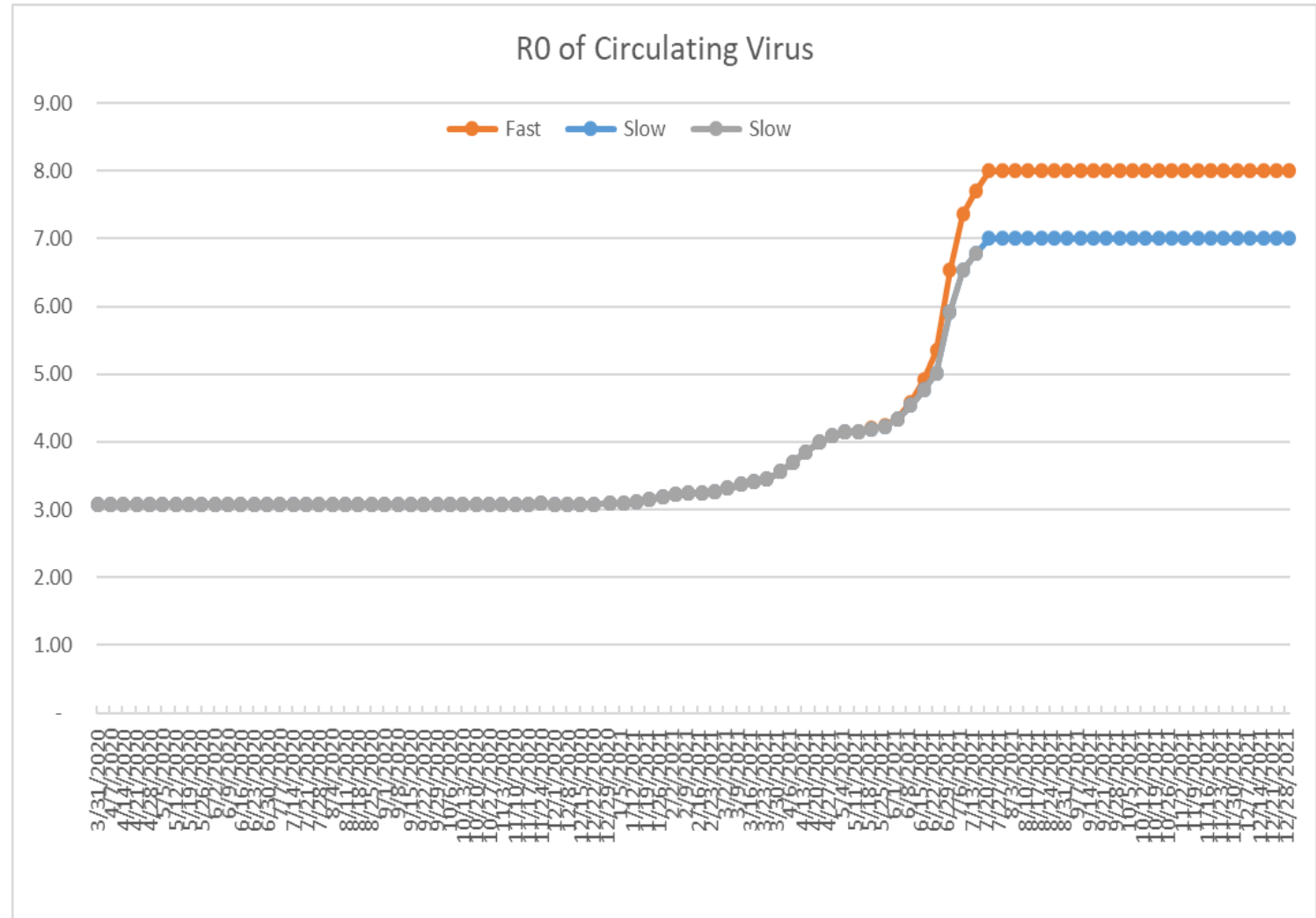
Model Assumption- Policy/Behavior

New variant prevalence data has impacted estimated intervention effectiveness. Now much more of surge is attributed to delta.

"Current" Scenario represents maintaining our current performance.

"Lowest Policy" shows what happens with our least amount of intervention effectiveness.

"Fear/Fatigue Cycle" shows a pattern of effectiveness from our history.

Intervention Effectiveness (Amongst Susceptible)

Legend:
- Policy/Behavior Effectiveness
- Current
- Lowest Policy
- Fear/Fatigue Cycle

Effectiveness needed to keep virus from growing (ie. R_0-1). (Note: Does not include reductions due to vaccinations.)

Fast Variant

Slow Variant

Intervention Effectiveness Value=R_0-R_t
Where: R_0=3.08 then transitions upwards with variant prevalence, R_t estimated by data

Note: The fear and fatigue cycle is shifted upwards to account for the increased transmissibility of the virus.

Census Forecast-Primary Scenario

The fifth wave is updated to be much more severe than previous forecasts.

Its resolution is driven by future infections getting closer to herd immunity.
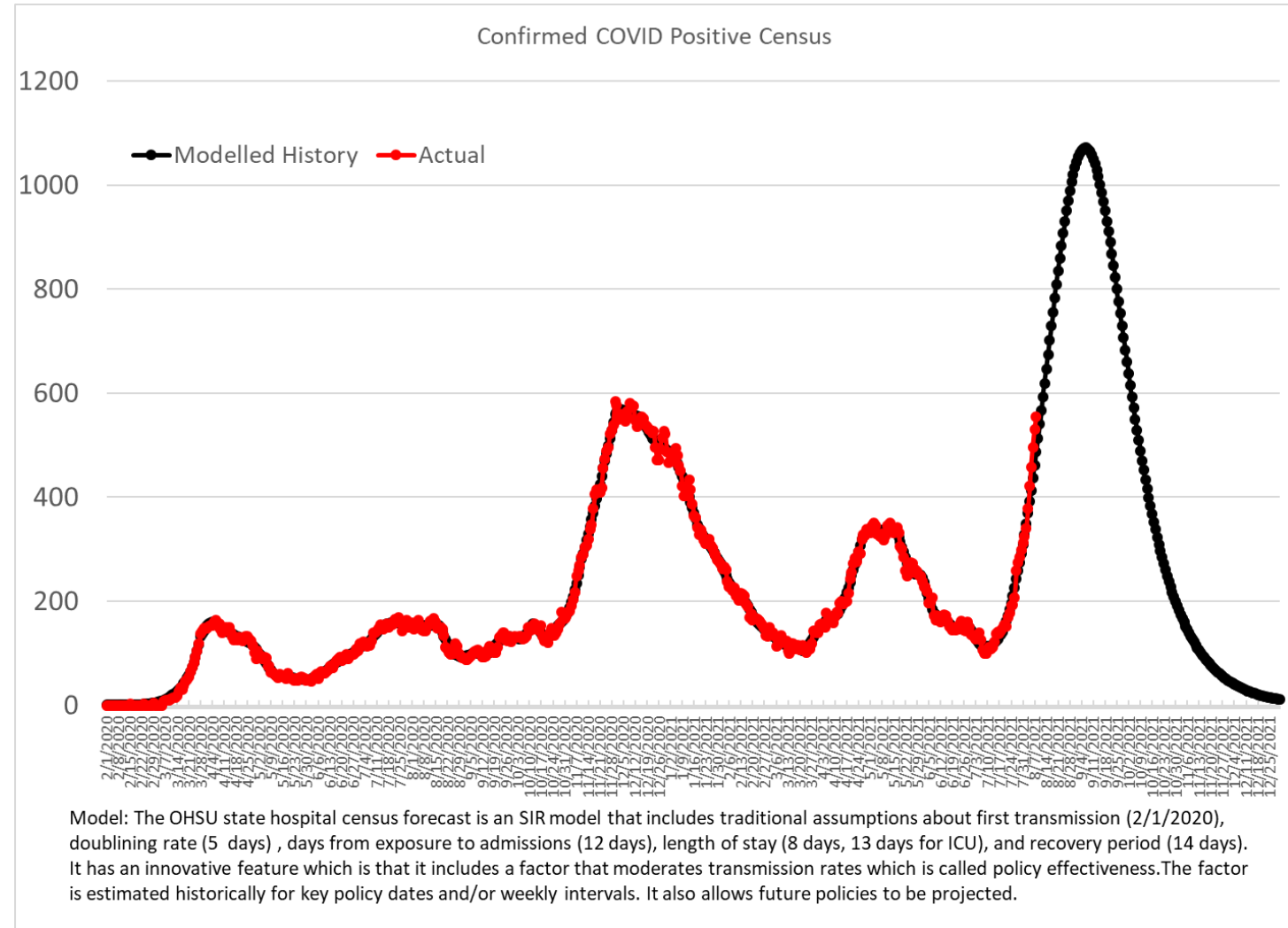
Current intervention effect level is not able to slow down the variant.

The primary scenario is

- "Current" intervention effect
- Fast Variant (Delta R_0=8.0)
- Slow Vaccine

Confirmed COVID Positive Census

Modelled History   Actual

Model: The OHSU state hospital census forecast is an SIR model that includes traditional assumptions about first transmission (2/1/2020), doublining rate (5 days), days from exposure to admissions (12 days), length of stay (8 days, 13 days for ICU), and recovery period (14 days). It has an innovative feature which is that it includes a factor that moderates transmission rates which is called policy effectiveness. The factor is estimated historically for key policy dates and/or weekly intervals. It also allows future policies to be projected.

Source: OHSU COVID Forecast Model

Census with Key Policy Interventions

Oregon's policies have directly contributed to changing the trajectory of occupied hospital beds.

Confirmed COVID Positive Census

Legend: Modelled History, Actual

Policy markers: Stay Home, Mask Mandate, Freeze, Back to Extreme

Model: The OHSU state hospital census forecast is an SIR model that includes traditional assumptions about first transmission (2/1/2020), doublining rate (5 days), days from exposure to admissions (12 days), length of stay (8 days, 13 days for ICU), and recovery period (14 days). It has an innovative feature which is that it includes a factor that moderates transmission rates which is called policy effectiveness. The factor is estimated historically for key policy dates and/or weekly intervals. It also allows future policies to be projected.

Source: OHSU COVID Forecast Model

Census Comparisons

Other states have not been as aggressive and the impact on hospital census compared to Oregon's has been notable.

As you can see, when Oregon's census spike was flattened by the Freeze, other states continue to increase to levels 3 or 4 times higher.

Source: OHSU COVID Forecast Model
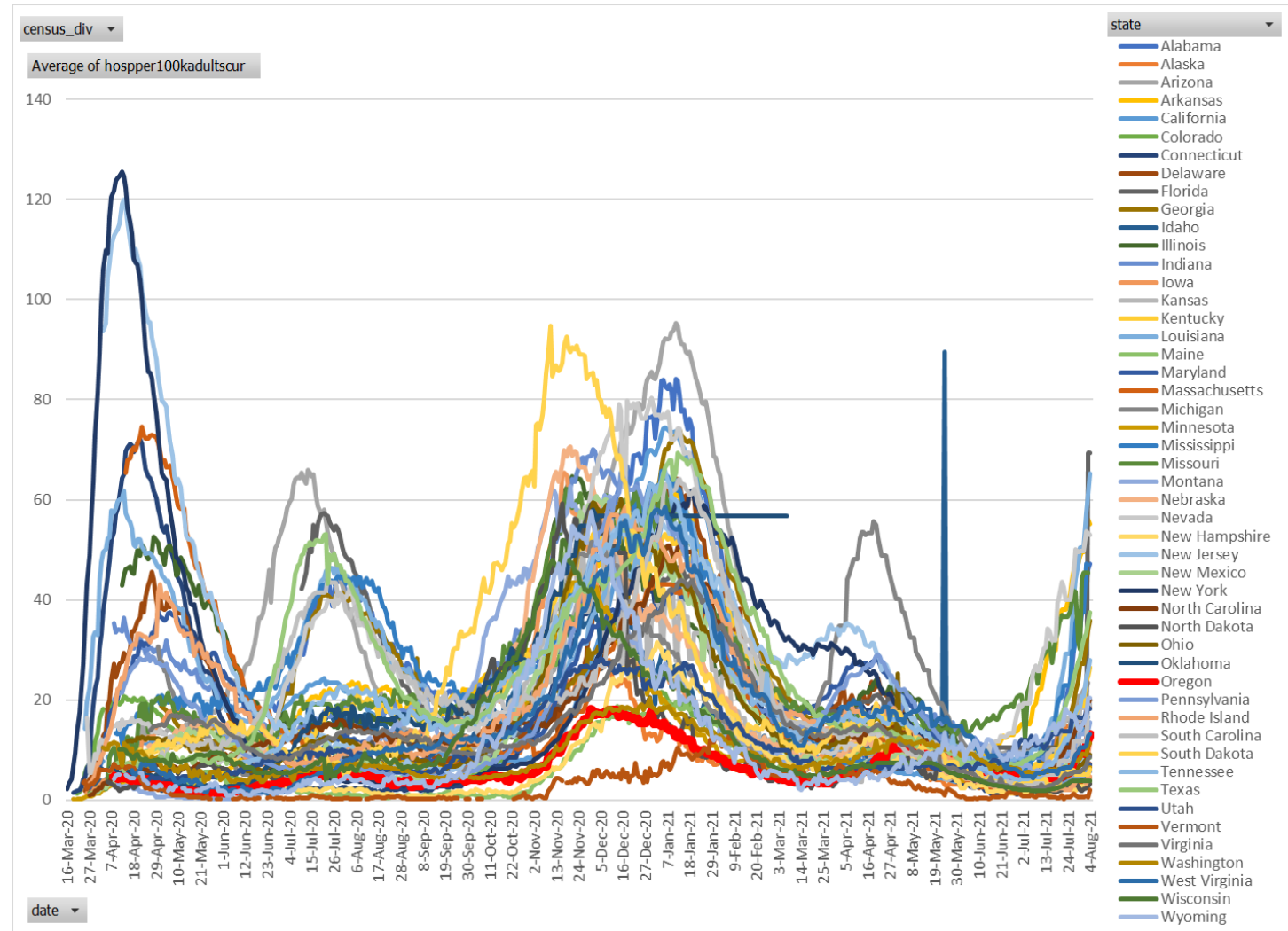
Census Forecast-Alternative Scenarios

Scenarios:

Variant

a) Fast (ie. Delta R_0=8.0)

b) Slow (ie. Delta R_0=7.0)

Policy/Behavior:
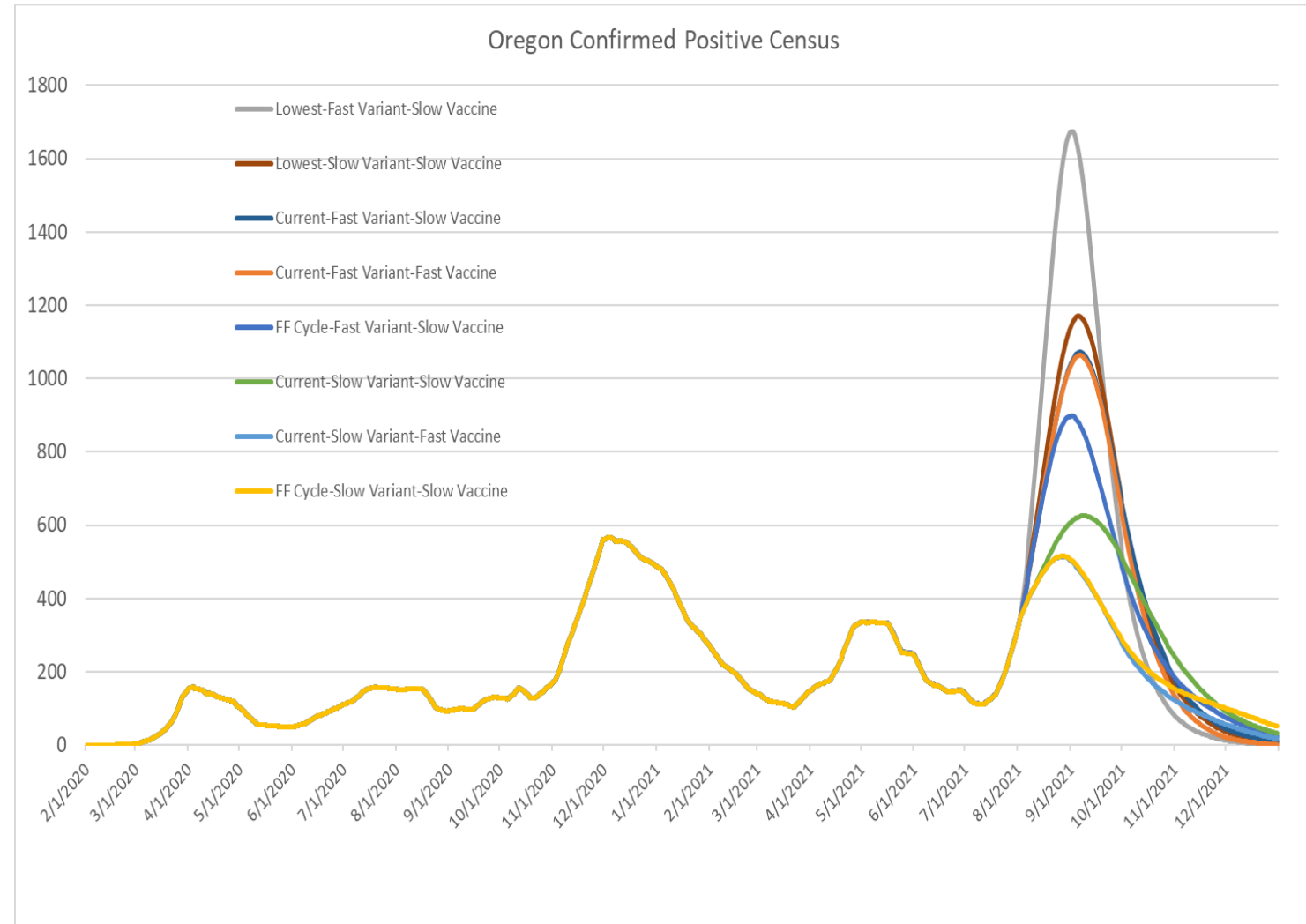
a) Current effectiveness level

b) Fear and Fatigue in policy restrictions
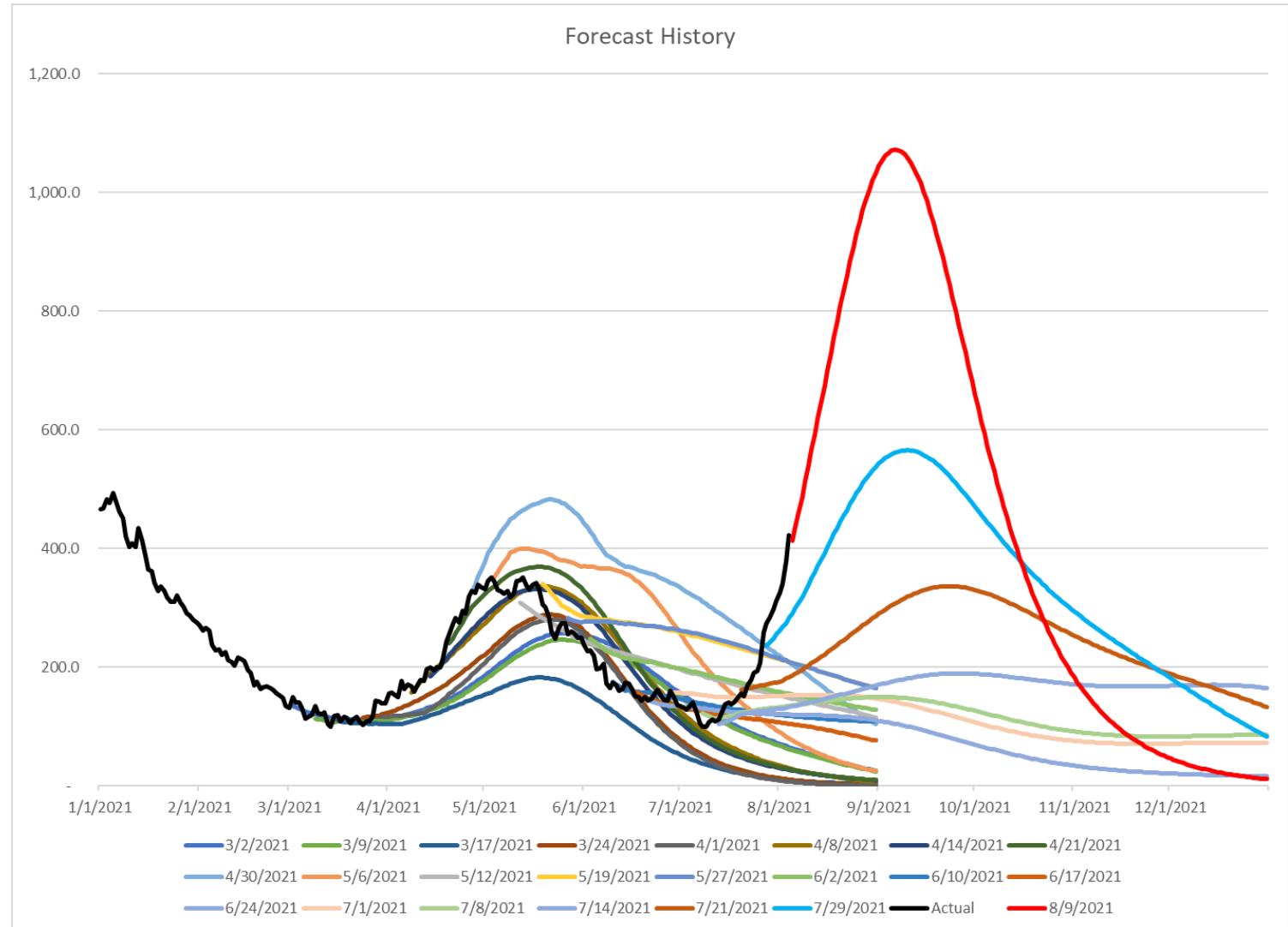
c) Lowest policy effectiveness

Vaccine:

a) Fast (quicker distribution)

b) Slow (slower distribution)

Oregon Confirmed Positive Census

- Lowest-Fast Variant-Slow Vaccine
- Lowest-Slow Variant-Slow Vaccine
- Current-Fast Variant-Slow Vaccine
- Current-Fast Variant-Fast Vaccine
- FF Cycle-Fast Variant-Slow Vaccine
- Current-Slow Variant-Slow Vaccine
- Current-Slow Variant-Fast Vaccine
- FF Cycle-Slow Variant-Slow Vaccine

Previous Forecasts

Previous forecasts can help assess accuracy of the model.

Forecast History

Source: Primary scenario for each week is used
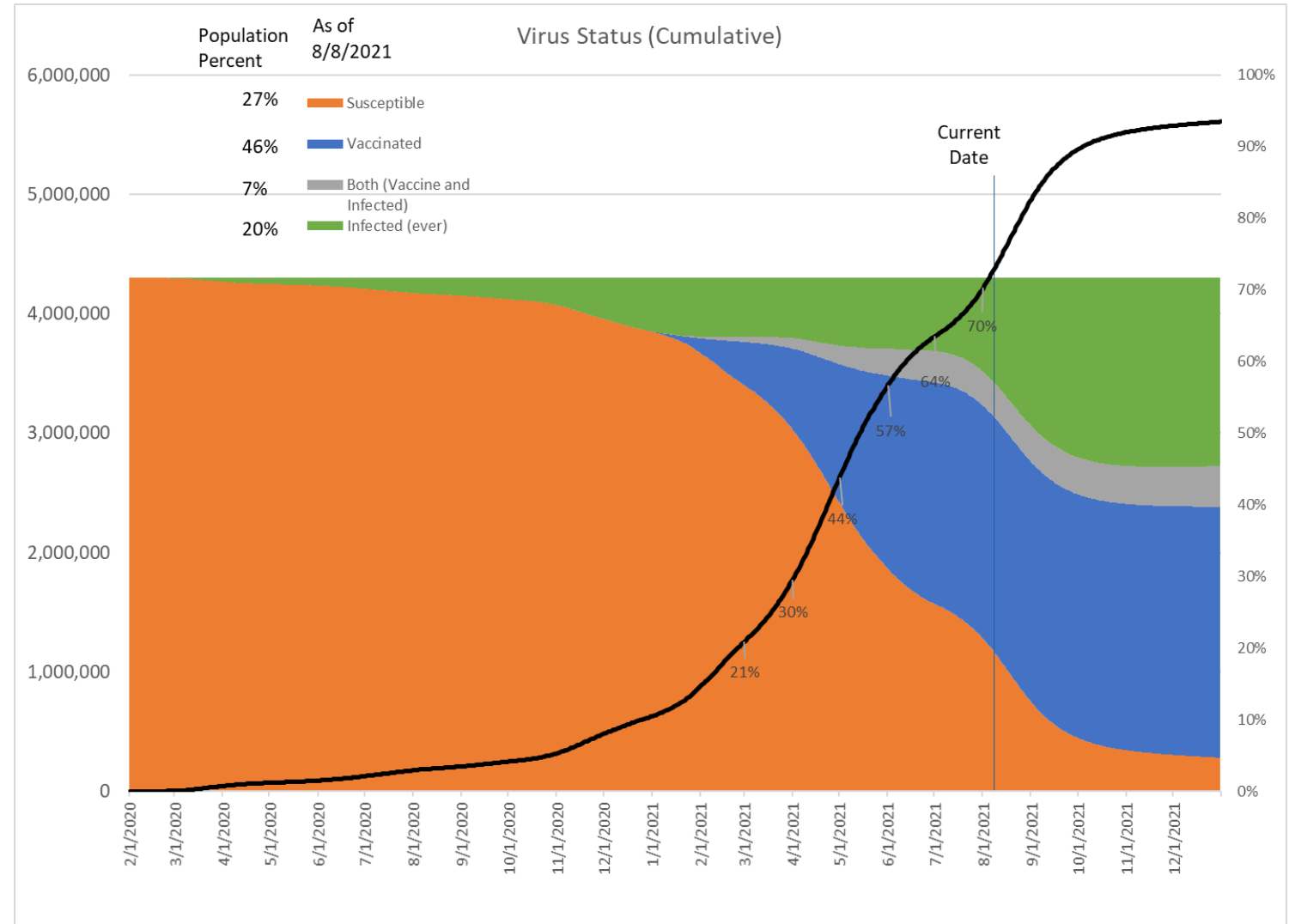
Model-Herd Chart

As of 8/8, the estimated population proportions are:

Susceptible: 27%

Vaccinated: 46%

Infected: 20%

Vaccinated & Infected: 7%
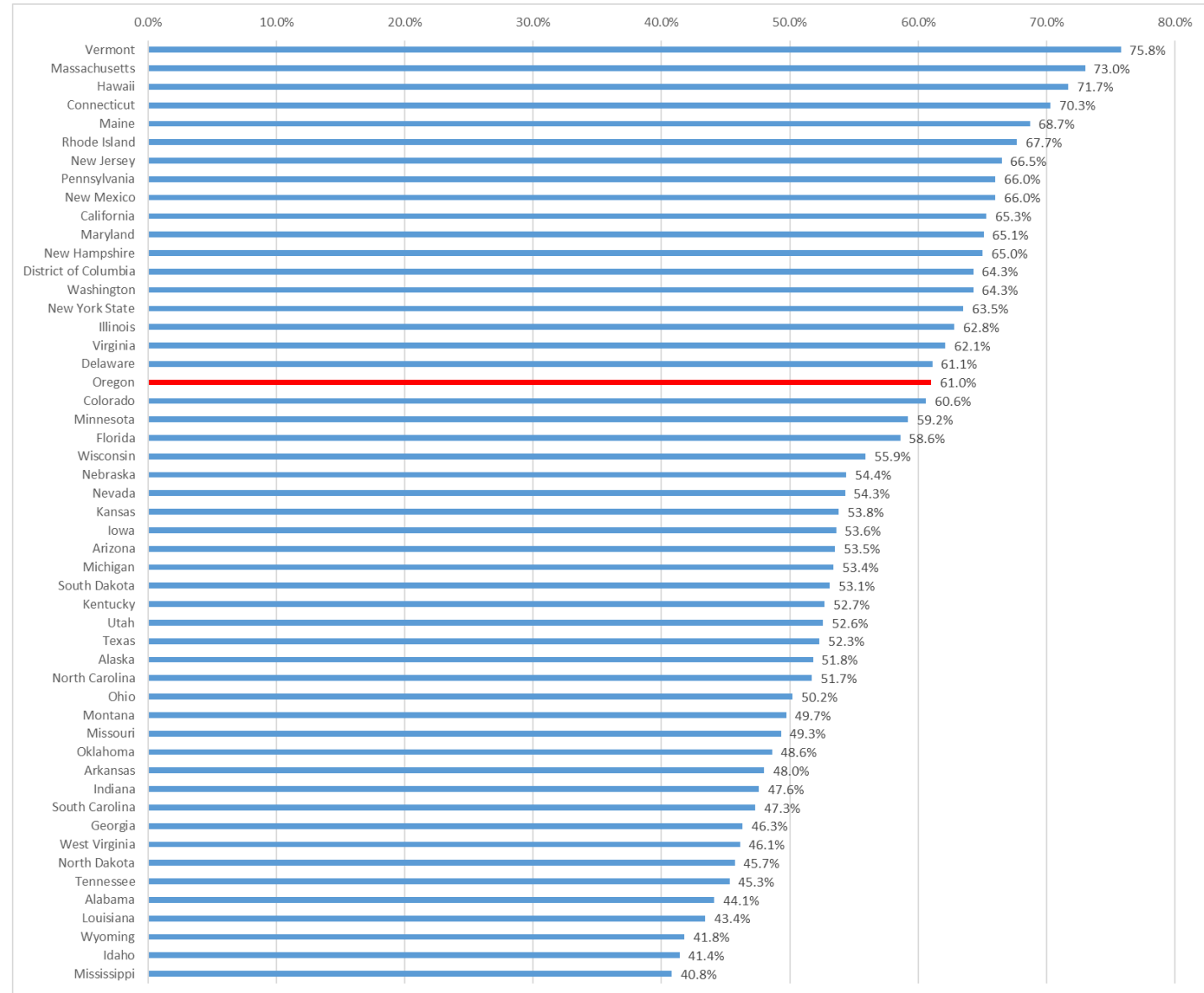
Projection uses primary scenario.

Source: OHSU COVID Forecast Model

Policy Issues

Vaccination Rates

Oregon has given a first dose to 61.0% of population (not just eligible).

This rate ranks 19th in the US.

Source: https://covid.cdc.gov/covid-data-tracker/#vaccinations

| State	Rate
Vermont	75.8%
Massachusetts	73.0%
Hawaii	71.7%
Connecticut	70.3%
Maine	68.7%
Rhode Island	67.7%
New Jersey	66.5%
Pennsylvania	66.0%
New Mexico	66.0%
California	65.3%
Maryland	65.1%
New Hampshire	65.0%
District of Columbia	64.3%
Washington	64.3%
New York State	63.5%
Illinois	62.8%
Virginia	62.1%
Delaware	61.1%
Oregon	61.0%
Colorado	60.6%
Minnesota	59.2%
Florida	58.6%
Wisconsin	55.9%
Nebraska	54.4%
Nevada	54.3%
Kansas	53.8%
Iowa	53.6%
Arizona	53.5%
Michigan	53.4%
South Dakota	53.1%
Kentucky	52.7%
Utah	52.6%
Texas	52.3%
Alaska	51.8%
North Carolina	51.7%
Ohio	50.2%
Montana	49.7%
Missouri	49.3%
Oklahoma	48.6%
Arkansas	48.0%
Indiana	47.6%
South Carolina	47.3%
Georgia	46.3%
West Virginia	46.1%
North Dakota	45.7%
Tennessee	45.3%
Alabama	44.1%
Louisiana	43.4%
Wyoming	41.8%
Idaho	41.4%
Mississippi	40.8%

Mask Wearing in Outbreak States

The chart shows the mask wearing rate of the 7 states with the highest rate of cases per day per capita (FL, LA, OK, AR, MS, AL, MO) compared to all other states.

The trend shows dramatic reduction in mask wearing beginning in May.

High case count states started with lower rates than other states.

Beginning in July those rankings flipped and high case count states now have higher masking rates (though still well below winter and spring levels).
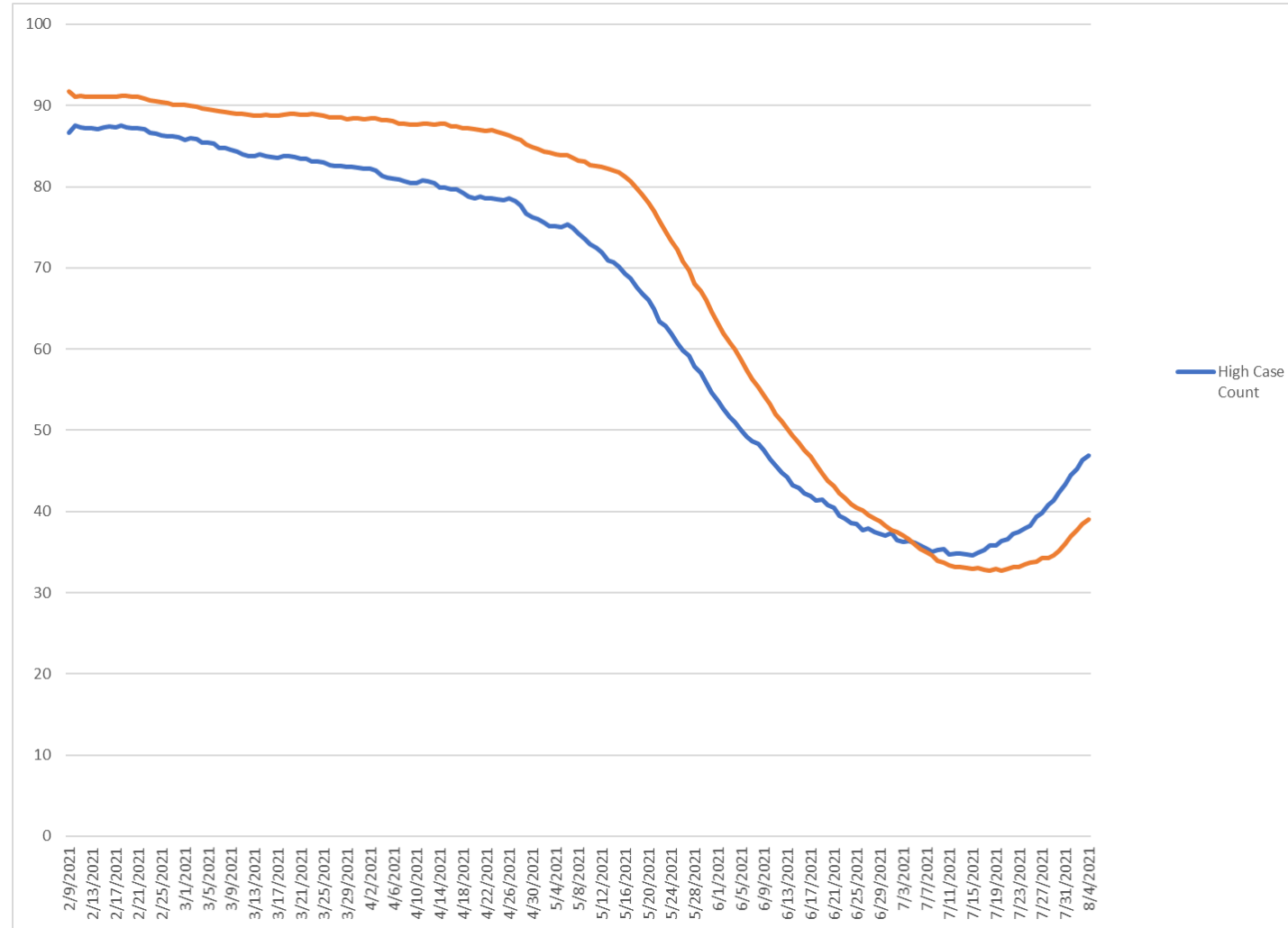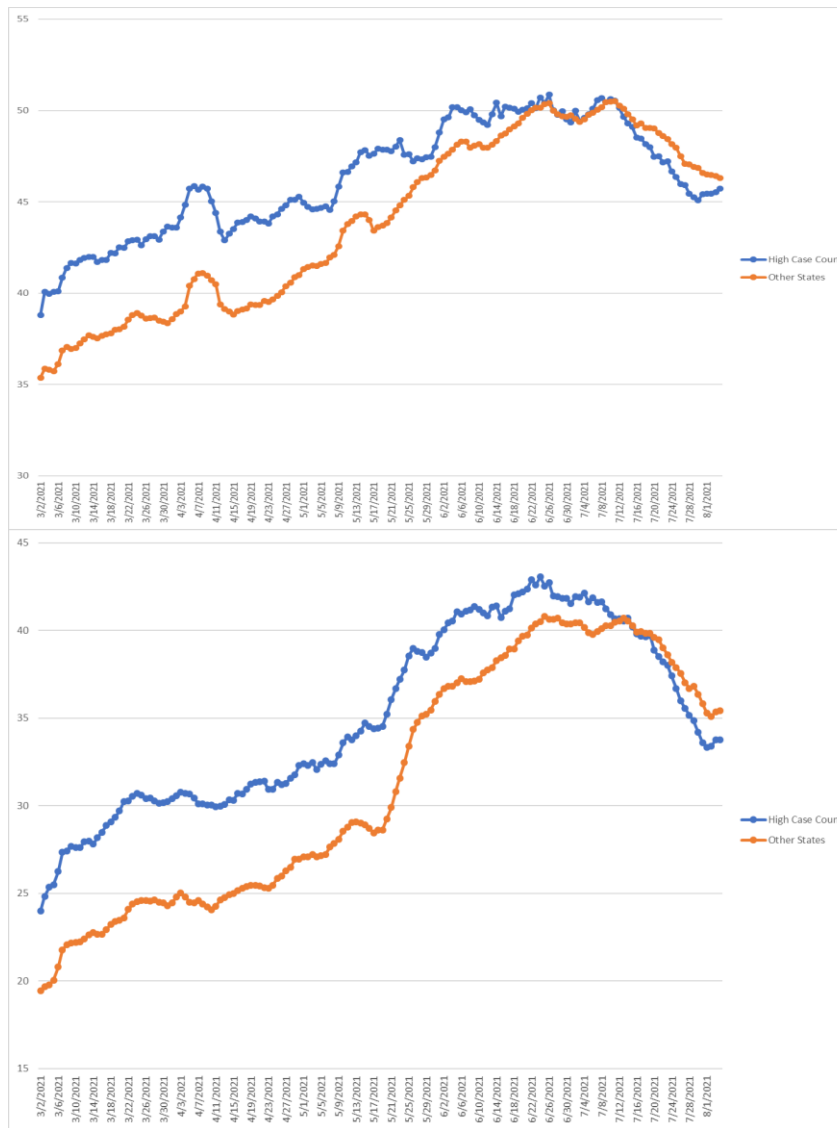
Source:
https://delphi.cmu.edu/covidcast/?level=county&region=42003&signalType=value

High Risk Behaviors in Outbreak States

These charts shows the percent of people engaging in types of behaviors between the 7 states with the highest rate of cases per day per capita (AL, LA, MO, AR, MS, OK, FL) and all other states.

The trend shows high risk behaviors increasing into June and displaying a mild decrease in July.

High case count states had higher rates prior to July and then have shown stronger declines since.


Indoor Time w/Others (not from household)

Restaurant Indoors

Source:
https://delphi.cmu.edu/covidcast/?level=county&region=42003&signalType=value

Vaccine Rates in Outbreak States

These charts shows the number of new vaccines administered in the 5 states with the highest rate of cases per day per capita compared with other states.

The trend shows that outbreak states (LA, MO, AR, AL, MS, OK,, FL) had lower vaccine rates but have increased and now have a higher daily rate of vaccines administered per capita.
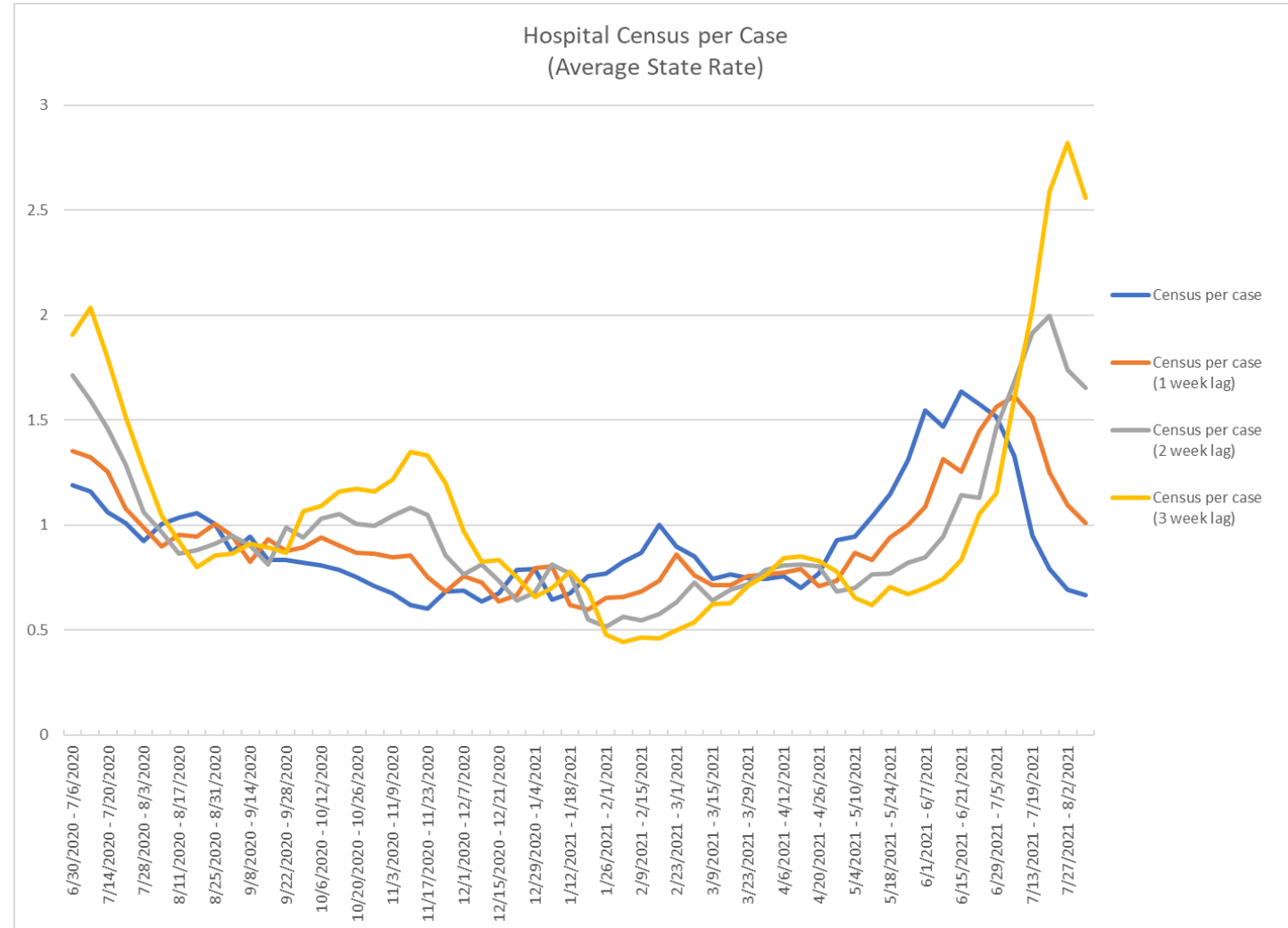

Vaccines administered (per 100k)

High Case Count
Other States

Source: https://91-divoc.com/pages/covid-visualization/

OHSU
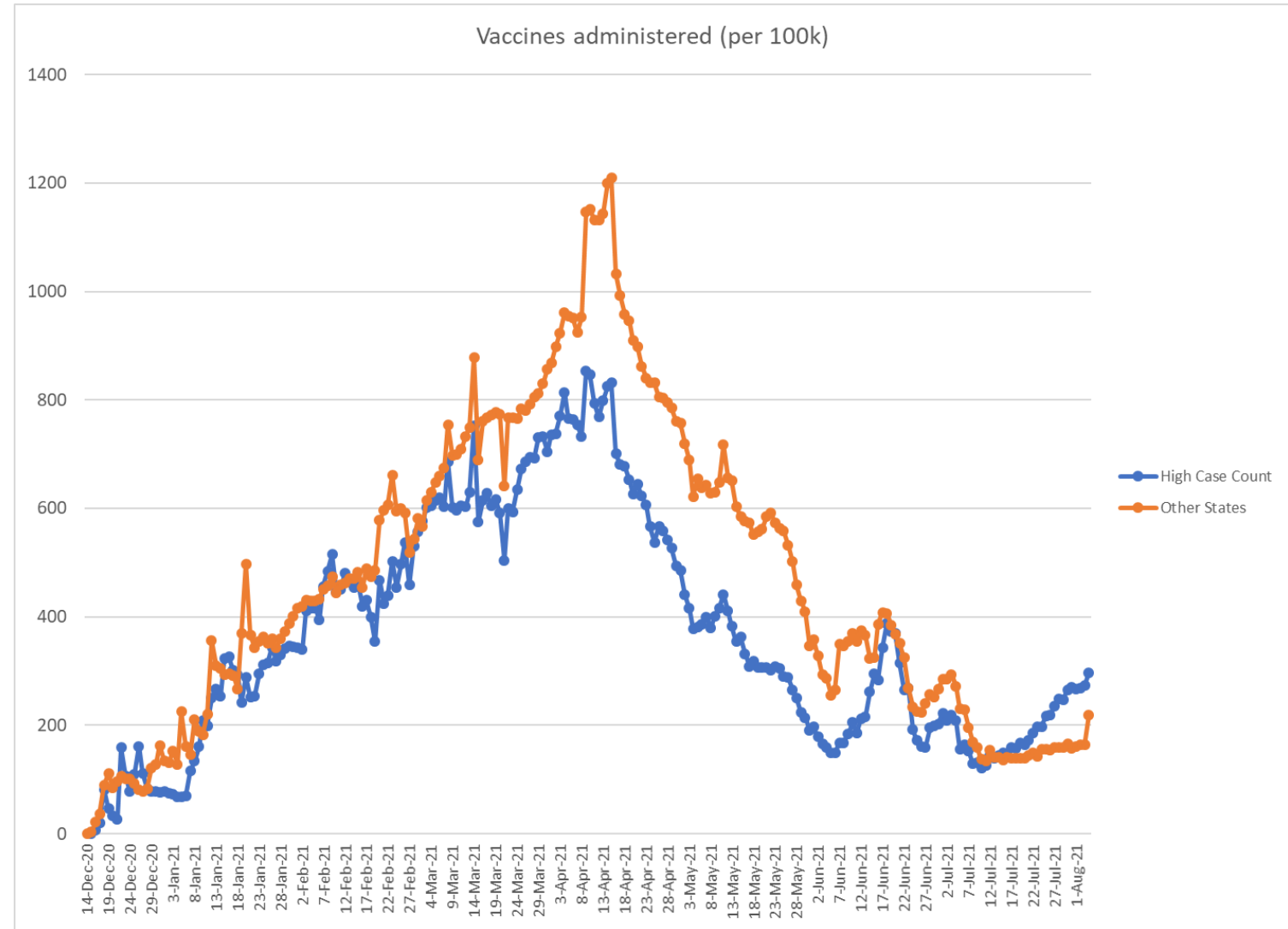
Hospital Census per Case

Using data about hospital census and number of cases per day, it is possible to look at trends in the hospital census per case. The chart shows the average rate across all states.
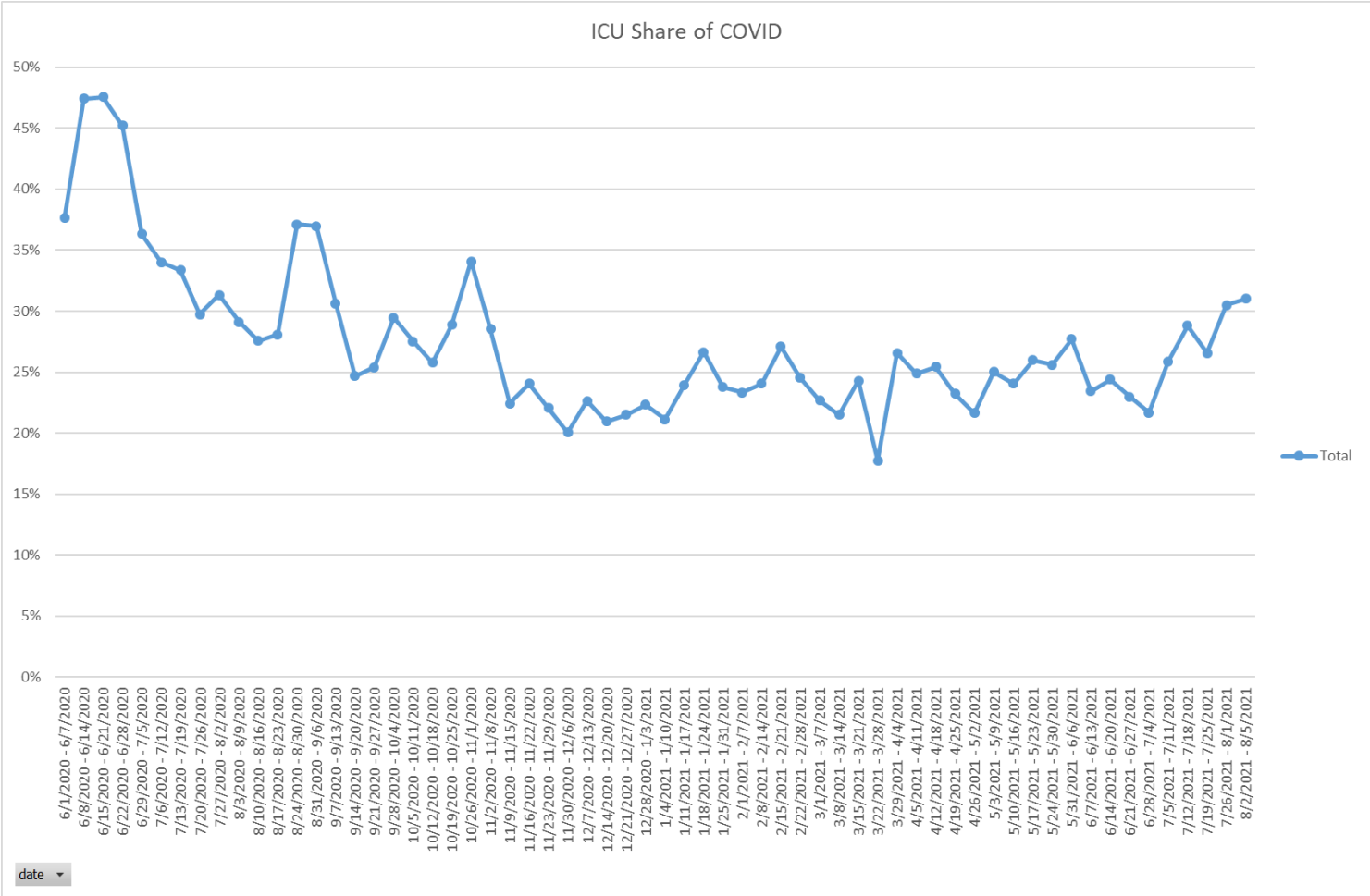
Because hospitalizations occur after cases (in many cases) various lags are provided. (i.e. hospital census today divided by case count 1 week ago).

All measures are showing much higher levels than previous waves. This may be indicative of more severe disease or less thorough testing.

Hospital Census per Case
(Average State Rate)

- Census per case
- Census per case (1 week lag)
- Census per case (2 week lag)
- Census per case (3 week lag)

Source: https://carlsonschool.umn.edu/mili-misrc-covid19-tracking-project, https://github.com/nytimes/covid-19-data/raw/master/us-states.csv

Hospital Census by ICU Status

ICU patients have made up a slightly larger share of all COVID patients in Oregon in the last month.

ICU Share of COVID

Source: https://public.tableau.com/profile/oregon.health.authority.covid.19#!/vizhome/OregonCOVID-19HospitalCapacitySummaryTables_15965754787060/HospitalizationbySeveritySummaryTable

OHSU

Appendix

IDM/OHA Projection

The most recent forecast was issued on 7/29.
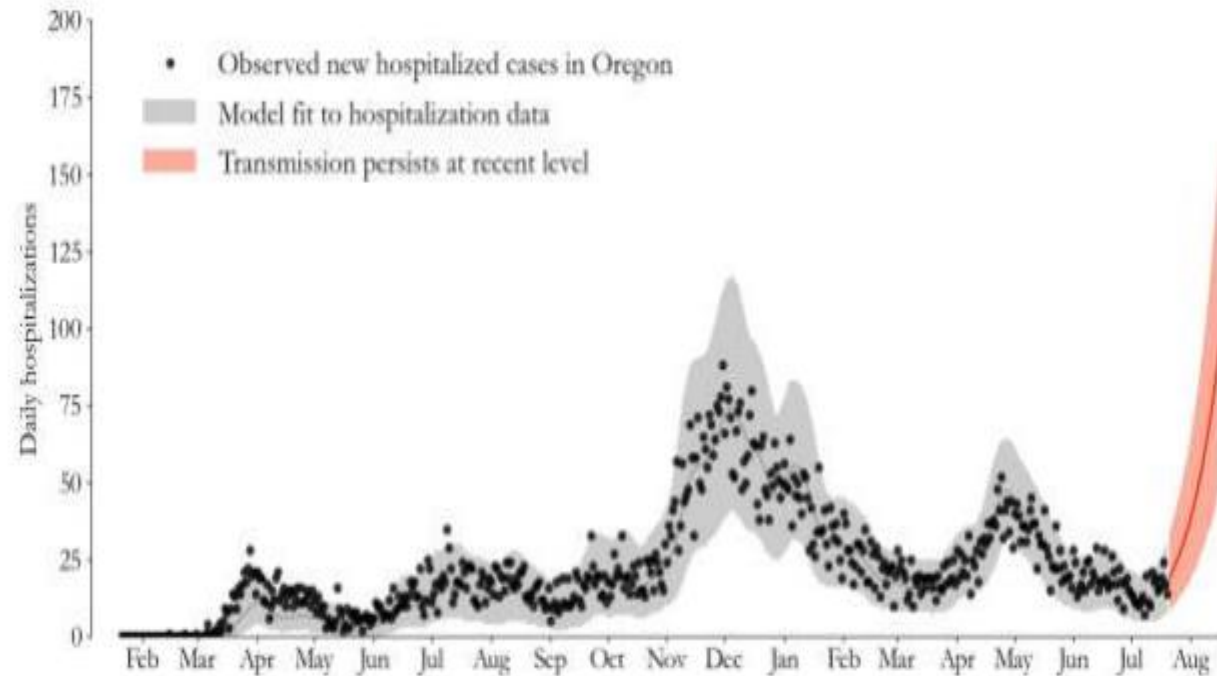
The model shows a dramatic increase over the next 3-4 weeks.

Figure 6: Observed hospitalized cases for Oregon and projection scenario. Black dots show observed daily counts, while the grey line shows model fit. The red line shows hospitalizations projected if the transmission rate estimated for the week ending July 14 persists. Shaded areas: 2.5th-97.5th percentile ranges.

Source: https://www.oregon.gov/oha/covid19/Documents/DataReports/Epidemic-Trends-and-Projections.pdf
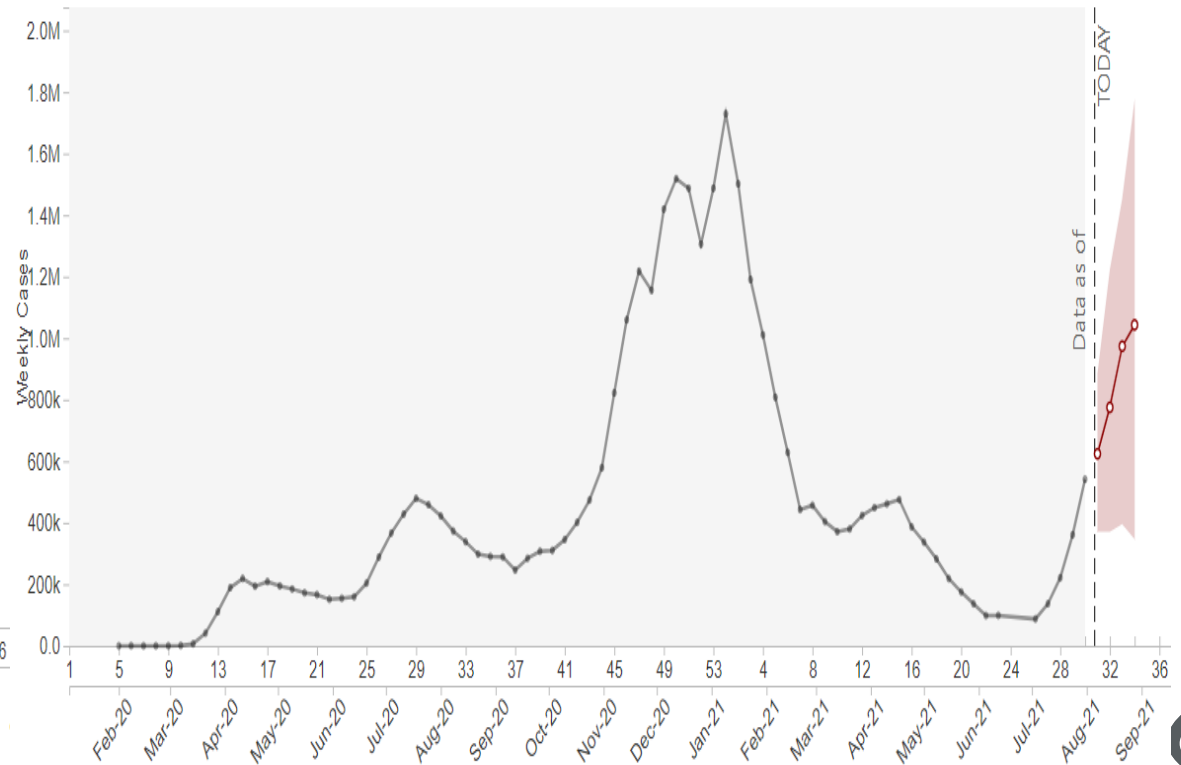
CDC Forecast-Ensemble

CDC forecasts show dramatic increase in infections in many

Observed and forecasted weekly COVID-19 cases in the United States

Observed and forecasted weekly COVID-19 cases in the United States
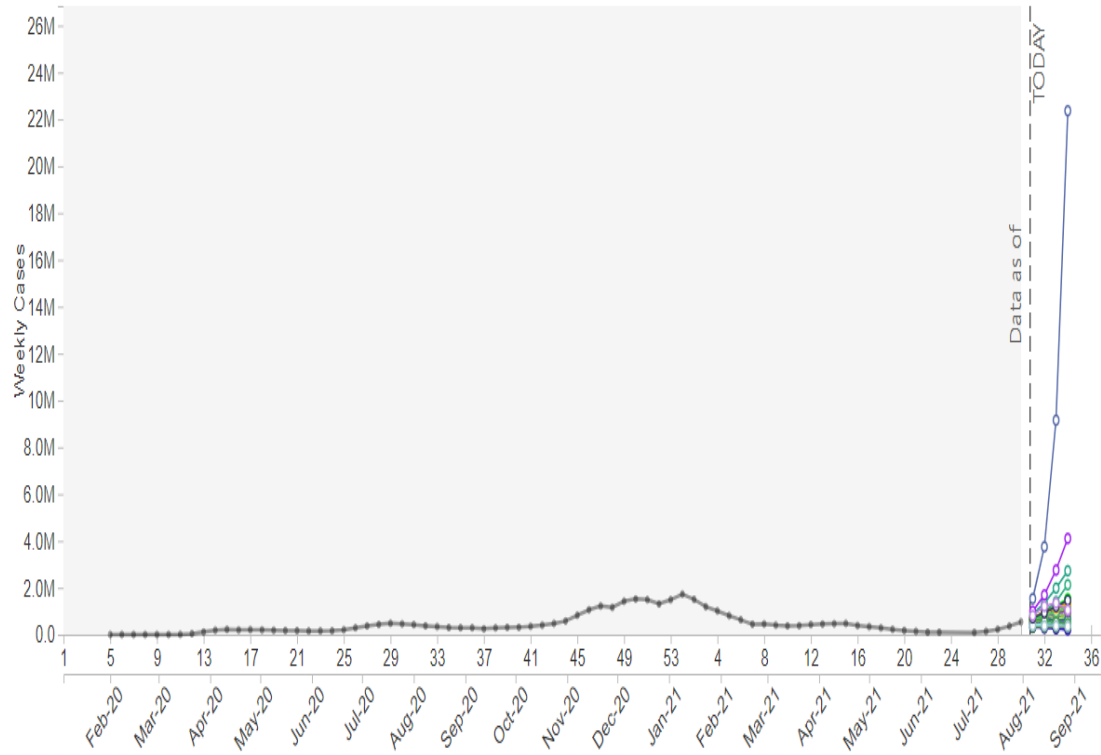
Source: https://covid.cdc.gov/covid-data-tracker/#forecasting_weeklycases

IHME Forecast

As of 7/30, the IHME model is shown below.

Projections and scenarios We produce three scenarios when projecting COVID-19. The reference scenario is our forecast of what we think is most likely to happen: • Vaccines are distributed at the expected pace. • Governments adapt their response by re-imposing social distancing mandates for 6 weeks whenever daily deaths reach 8 per million, unless a location has already spent at least 7 of the last 14 days with daily deaths above this rate and not yet re-imposed social distancing mandates. In this case, the scenario assumes that mandates are re-imposed when daily deaths reach 15 per million. • Variants B.1.1.7 (first identified in the UK), B.1.351 (first identified in South Africa), and P1 (first identified in Brazil) continue to spread from locations with (a) more than 5 sequenced variants, and (b) reports of community transmission, to adjacent locations following the speed of variant scale-up observed in the regions of the United Kingdom. The worse scenario modifies the reference scenario assumptions in two ways: • First, it assumes that variants B.1.351 or P.1 begin to spread within three weeks in adjacent locations that do not already have B.1.351 or P.1 community transmission. • Second, it assumes that all those vaccinated increase their mobility toward pre-COVID-19 levels. The universal masks scenario makes all the same assumptions as the reference scenario but also assumes 95% of the population wear masks in public in every location.

Figure 22. Daily COVID-19 infections until November 01, 2021 for three scenarios

Source: http://www.healthdata.org/sites/default/files/covid_briefs/560_briefing_Oregon.pdf
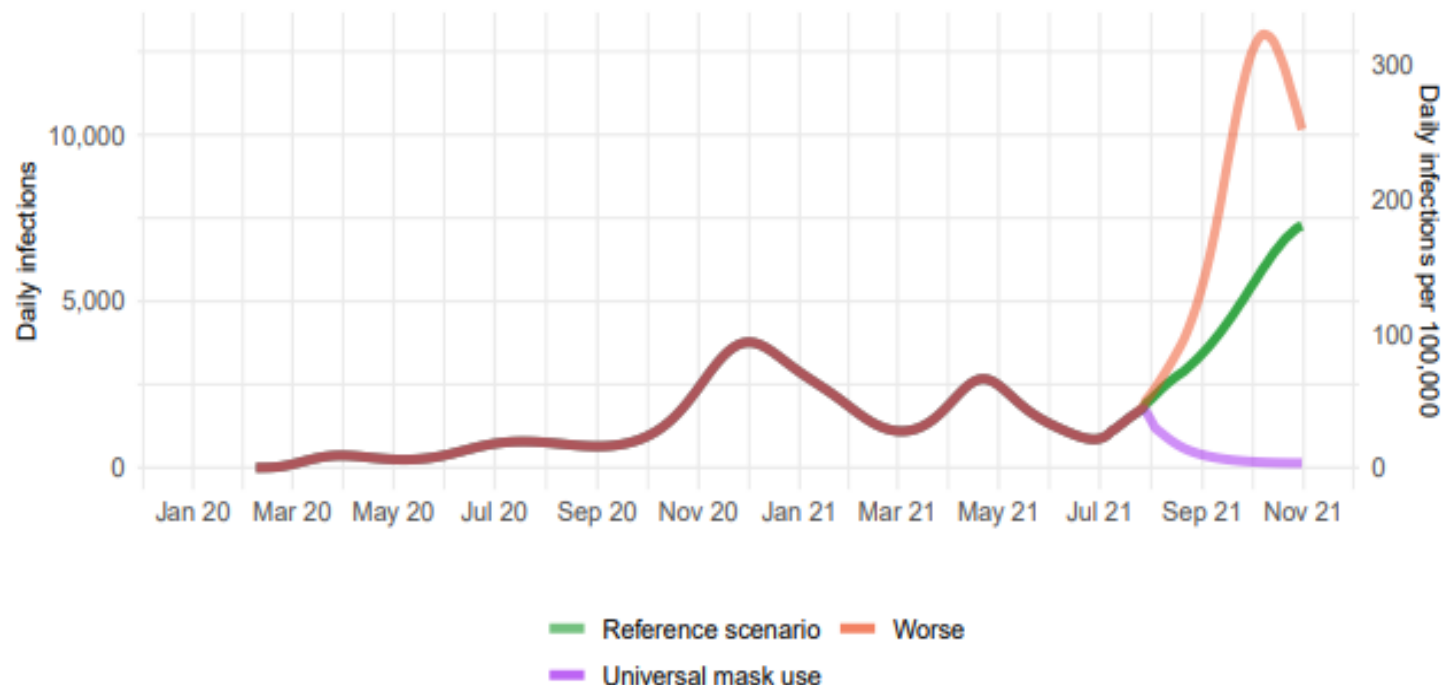
Acknowledgements

Each week this model requires updates, input and expertise from many people.

I would like to thank Alexandra Nielsen for developing a multi-strain simulation model, Brian O'Roak and Xuan Qin, at OHSU, for their expertise to understand genetic sequencing information, and the hospital forecasting workgroup for their feedback on weekly forecasts, including collaboration with Julie Maher and Erik Everson at Multnomah County PDES.

I would also like to give a special thank you to Michael Johnson from St. Charles Health who helped develop an early version of the model that has proven to be a good structure to handle the many twists and turns the problem has required.

Thank you!