Network Systems
Science & Advanced
Computing

Biocomplexity Institute
& Initiative

University of Virginia

# Estimation of COVID-19 Impact in Virginia

July 28th, 2021

(data current to July 25th – 27th)

Biocomplexity Institute Technical report: TR 2021-085

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biocomplexity.virginia.edu

# About Us

- Biocomplexity Institute at the University of Virginia
  - Using big data and simulations to understand massively interactive systems and solve societal problems
- Over 20 years of crafting and analyzing infectious disease models
  - Pandemic response for Influenza, Ebola, Zika, and others

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# Overview

- **Goal**:  Understand impact of COVID-19 mitigations in Virginia
- **Approach:**
  - Calibrate explanatory mechanistic model to observed cases
  - Project based on scenarios for next 4 months
  - Consider a range of possible mitigation effects in "what-if" scenarios
- **Outcomes:**
  - Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  - Geographic spread over time, case counts, healthcare burdens

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# Key Takeaways

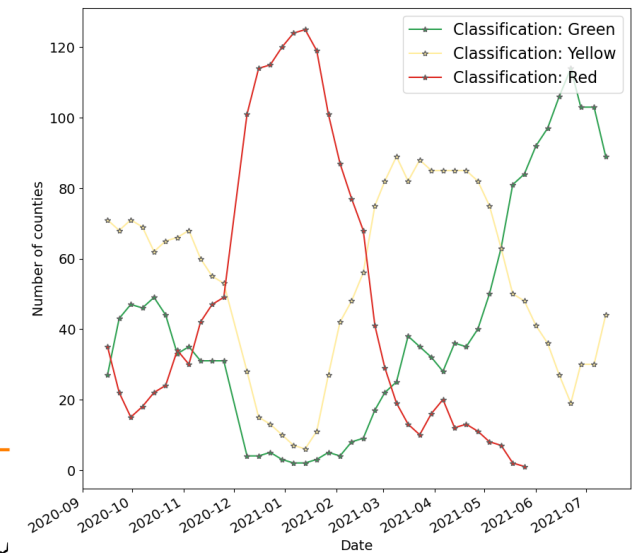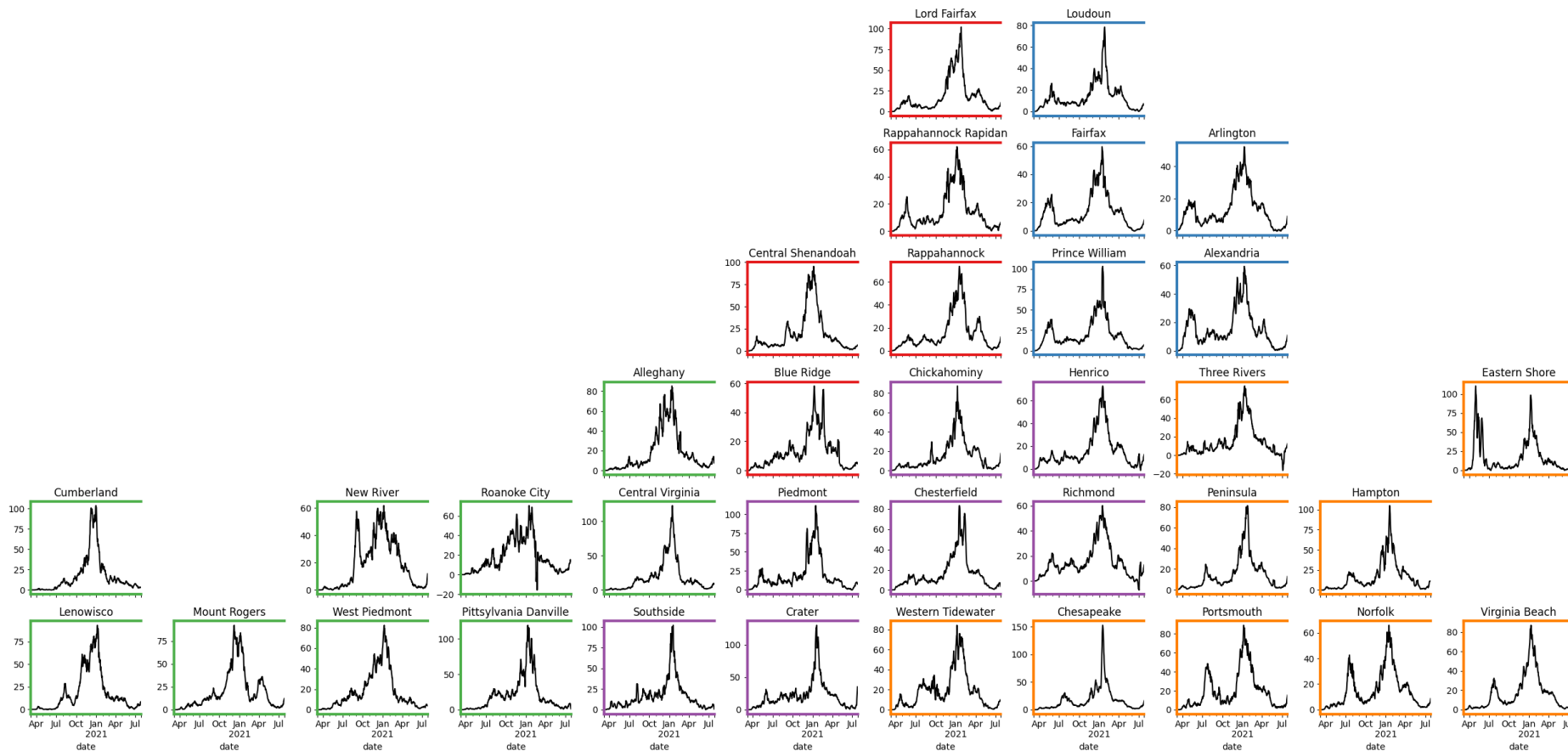Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

- **Case rates in Virginia continue to rise quickly amidst a background of surges across the nation**

- VA mean weekly incidence up to 7.8/100K from 4.4/100K, US up to 15.6/100K (from 10/100K)

- Vaccination rates experience slight rebound while acceptance among the unvaccinated persists and may be growing slightly in some regions

- Projections show significant uptick in activity, with larger growth possible fueled by Delta's increasing prevalence, even areas with high vaccination coverage

- Recent updates:
  - Added projection scenarios to examine conditions needed to control the current surges in activity
  - Delta variant dominates and has impacts on severity of disease

The situation continues to change. Models continue to be updated regularly.

# Situation Assessment

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# Case Rates (per 100k) and Test Positivity



https://data.cms.gov/stories/s/q5r5-gjyu

**County level test positivity from RT-PCR tests.**

**Green**: <5.0%
(or with <20 tests in past 14 days)

**Yellow**: 5.0%-10.0%
(or with <500 tests and <2000 tests/100k and >10% positivity over 14 days

**Red**: >10.0%
(and not "Green" or "Yellow")

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# District Trajectories

**Goal:** Define epochs of a Health District's COVID-19 incidence to characterize the current trajectory

**Method:** Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory

Hockey stick fit
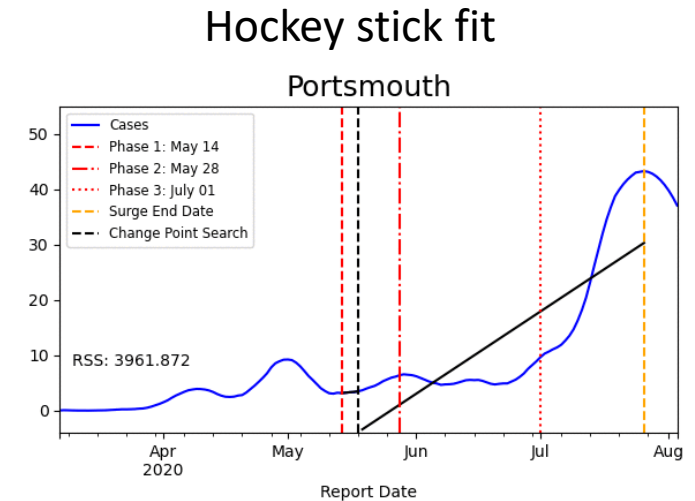


| Trajectory | Description | Weekly Case Rate (per 100K) bounds | # Districts (prev week) |
|---|---|---|---|
| **Declining** | Sustained decreases following a recent peak | below -0.9 | 1 (3) |
| **Plateau** | Steady level with minimal trend up or down | above -0.9 and below 0.5 | 1 (19) |
| **Slow Growth** | Sustained growth not rapid enough to be considered a Surge | above 0.5 and below 2.5 | 23 (12) |
| **In Surge** | Currently experiencing sustained rapid and significant growth | 2.5 or greater | 10 (1) |

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# District Trajectories – last 10 weeks

| Status | # Districts (prev week) |
|---|---|
| Declining | 1 (3) |
| Plateau | 1 (19) |
| Slow Growth | 23 (12) |
| In Surge | 10 (1) |

Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
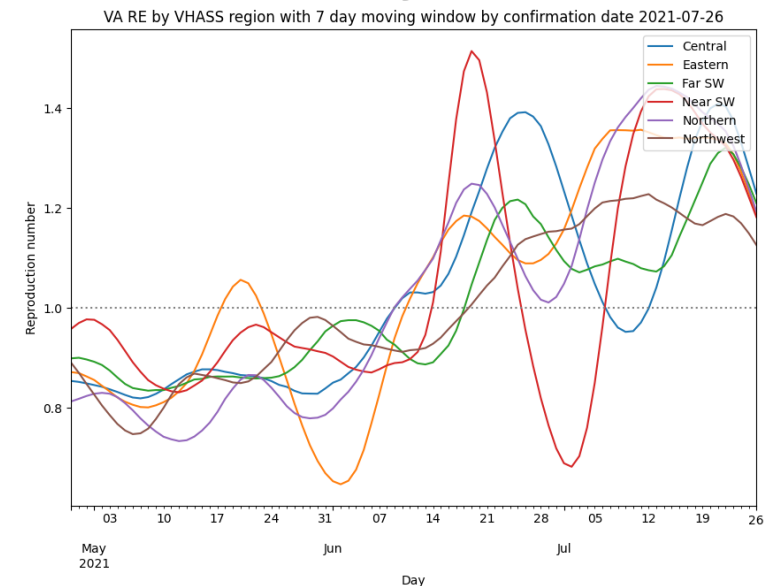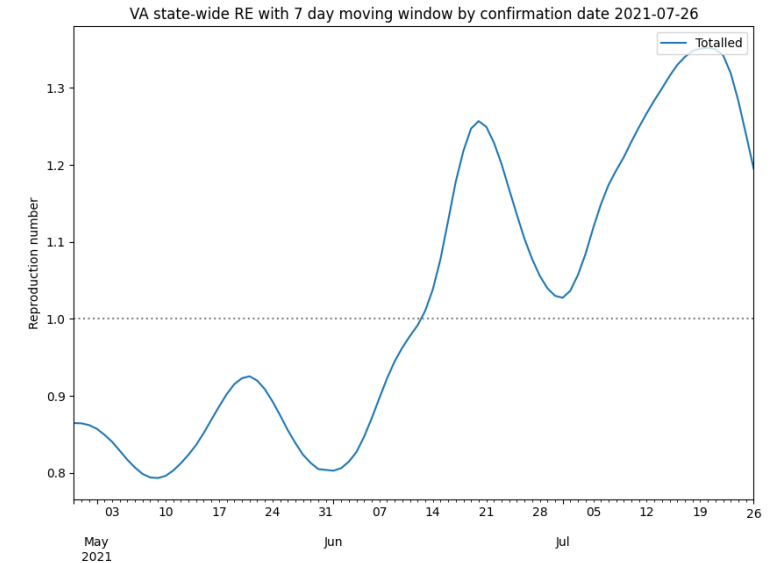Case Rate curve colored by Reproductive

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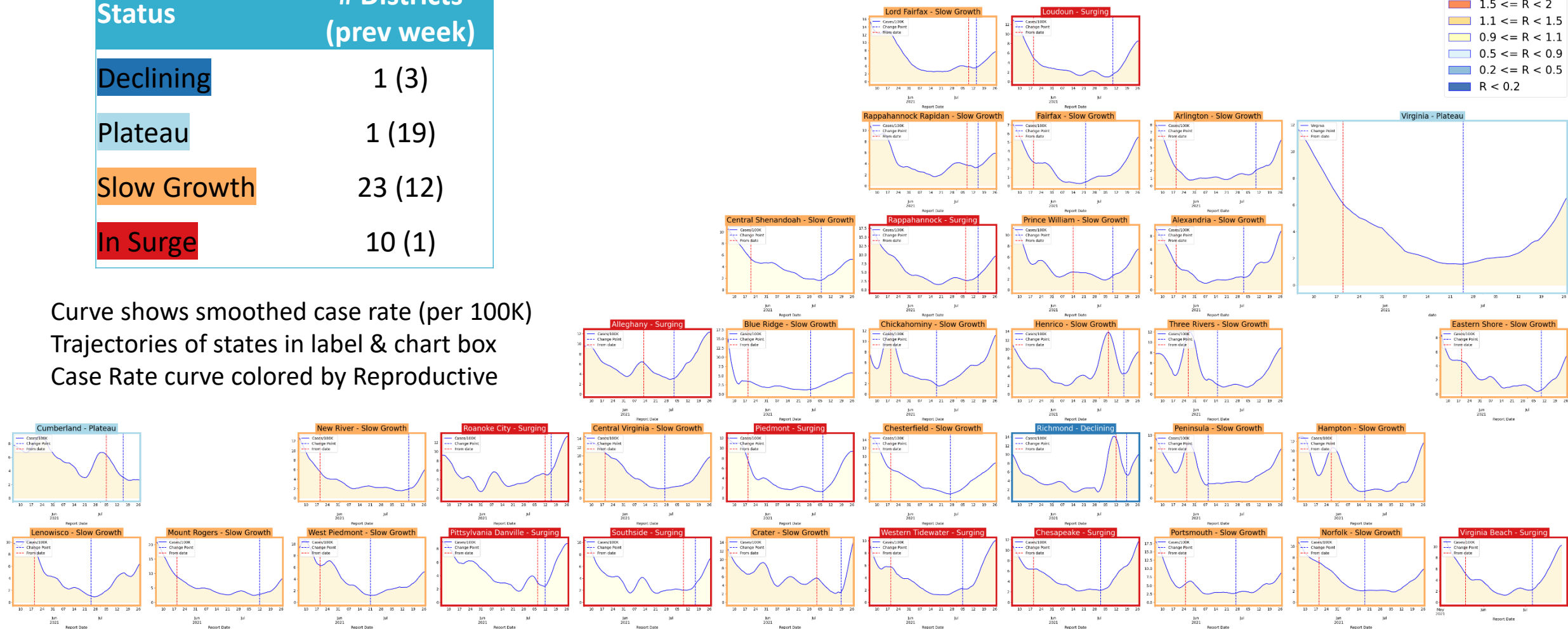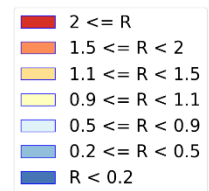
# Estimating Daily Reproductive Number

## July 26th Estimates

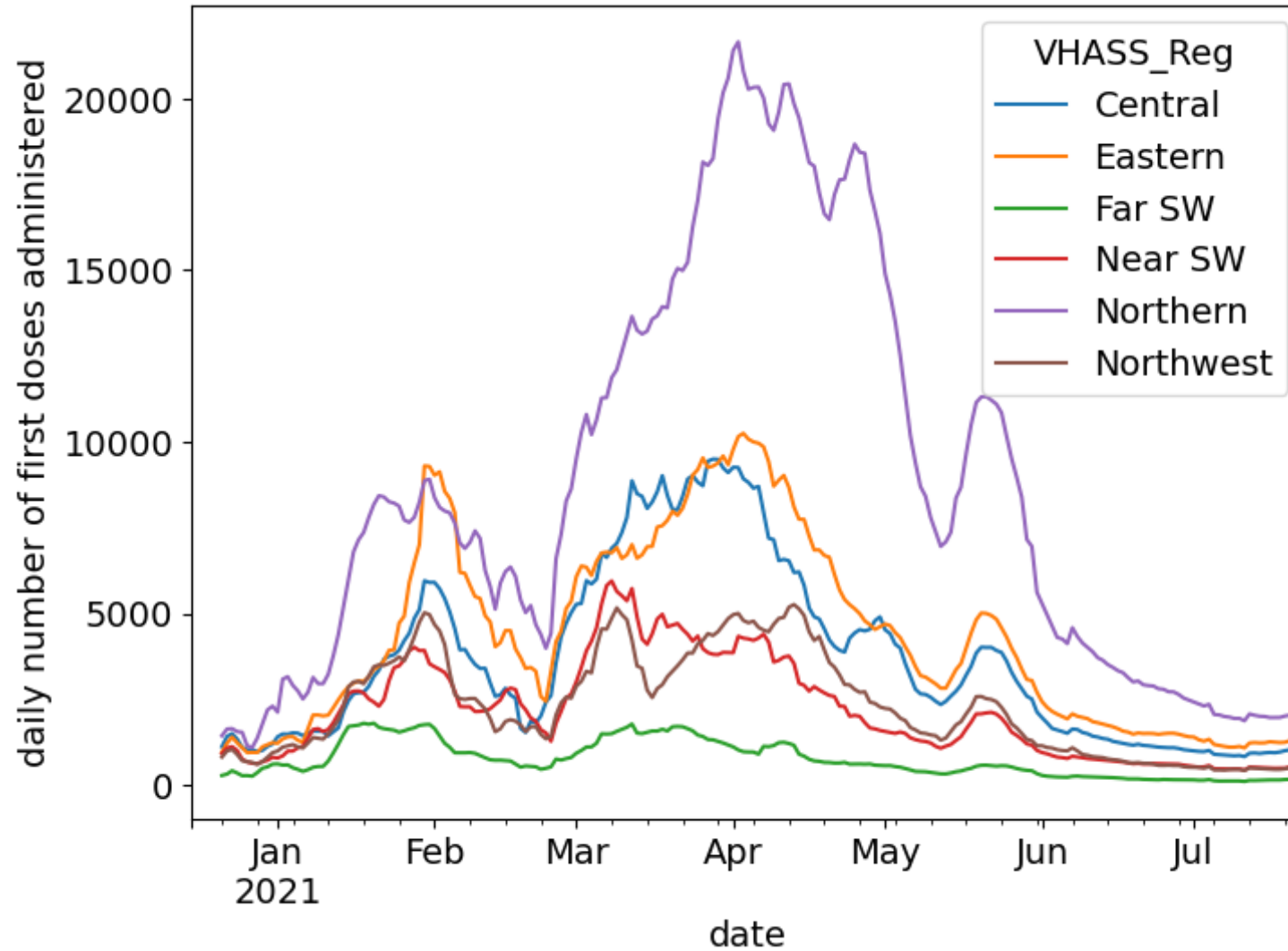| Region | Date Confirmed $R_e$ | Date Confirmed Diff Last Week |
|---|---|---|
| State-wide | 1.193 | 0.018 |
| Central | 1.231 | 0.125 |
| Eastern | 1.191 | 0.024 |
| Far SW | 1.209 | 0.220 |
| Near SW | 1.180 | -0.067 |
| Northern | 1.194 | -0.008 |
| Northwest | 1.126 | -0.041 |

**Methodology**

- Wallinga-Teunis method (EpiEstim[1]) for cases by **confirmation date**
- Serial interval: updated to discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, https://doi.org/10.1093/aje/kwt133



VA state-wide RE with 7 day moving window by confirmation date 2021-07-26



VA RE by VHASS region with 7 day moving window by confirmation date 2021-07-26

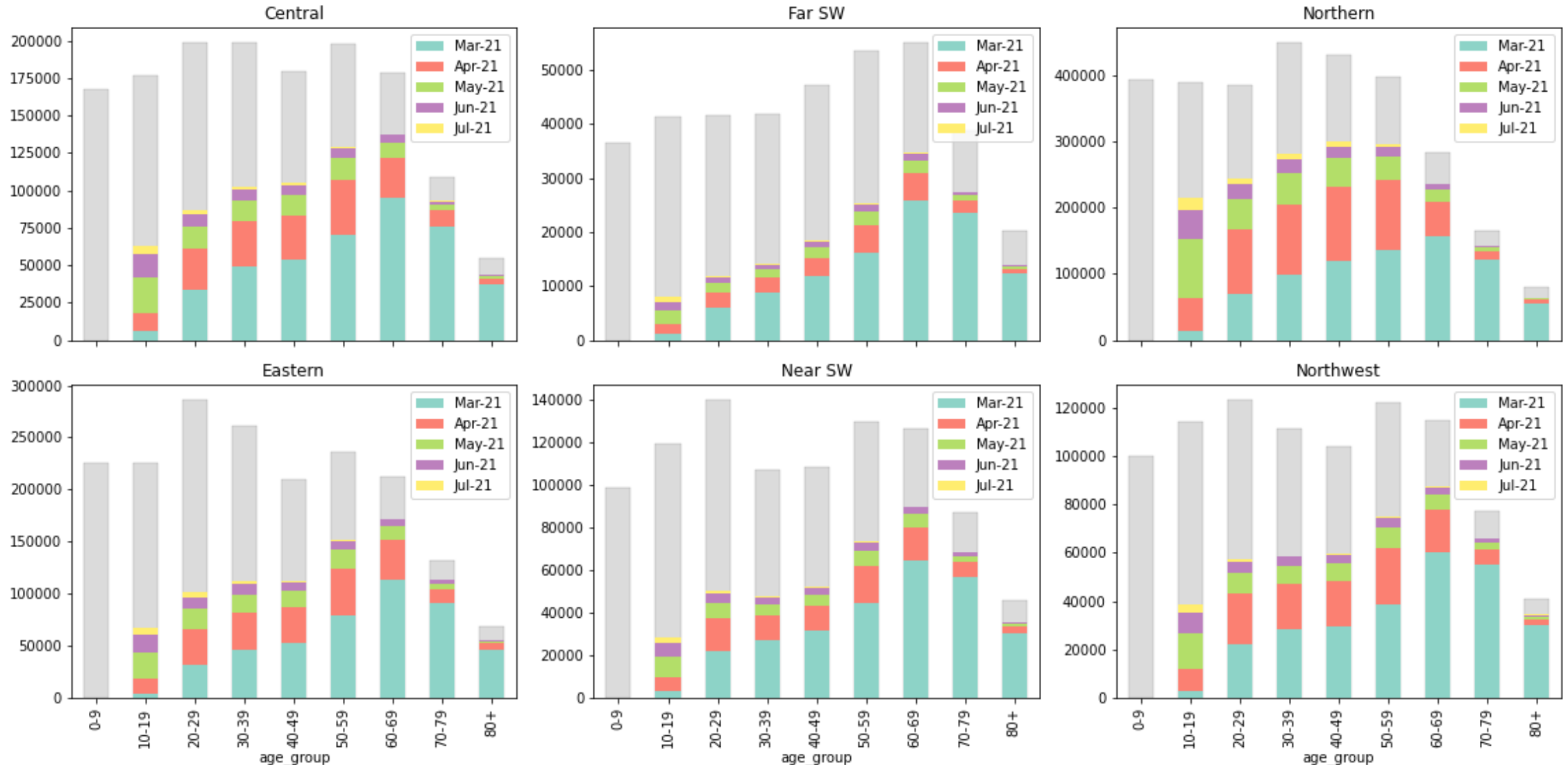# Vaccination Administration Slows



**Regional Vaccine courses initiated per day:**
- Total counts of first dose of vaccines across regions
- Very slight rise across all regions
- Reflected in 1st dose of Pfizer and Moderna uptick

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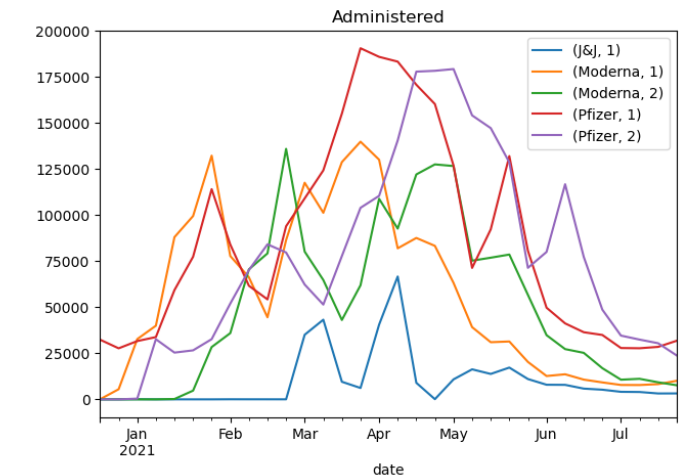
# Vaccinations Shift to Younger Populations

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# Vaccination Acceptance by Region
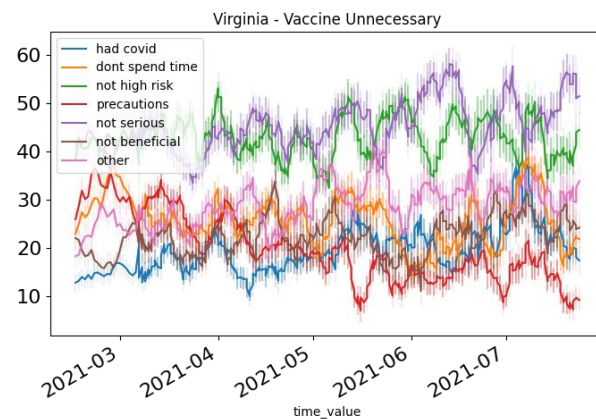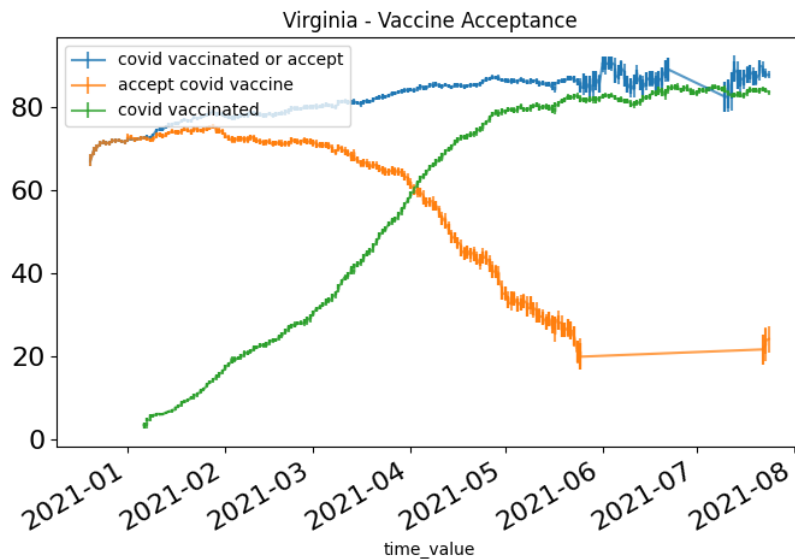
**Corrections to surveys:**

- Facebook administered survey is timely and broad, but biased by who accesses Facebook and answers the survey
- Correction approach:
  - Calculate an over-reporting fraction based on reported vaccinations compared to VDH administration data
  - Cross-validate coarse corrections against HPS survey at the state level and corrected in same manner

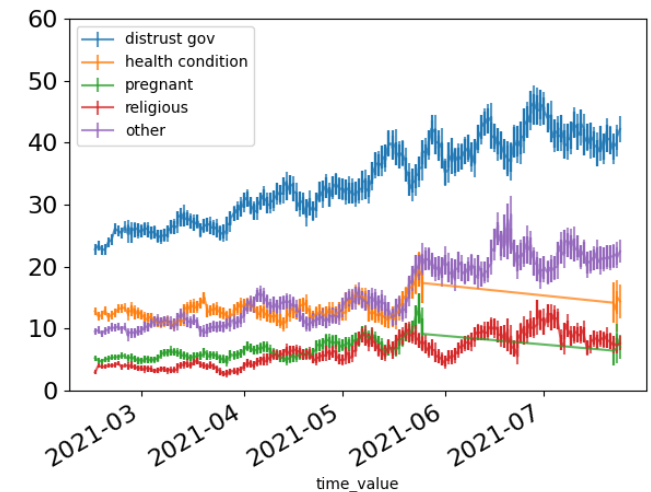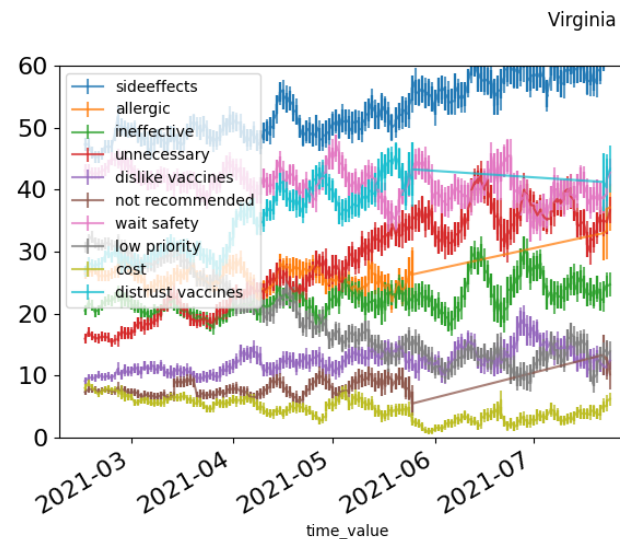| Region | COVIDcast accepting corrected | VDH proportion eligible vaccinated |
|---|---|---|
| Central | 80% | 63% |
| Eastern | 70% | 59% |
| Far SW | 53% | 49% |
| Near SW | 64% | 55% |
| Northern | 91% | 74% |
| Northwest | 77% | 63% |
| **Virginia** | **77%** | **64%** |
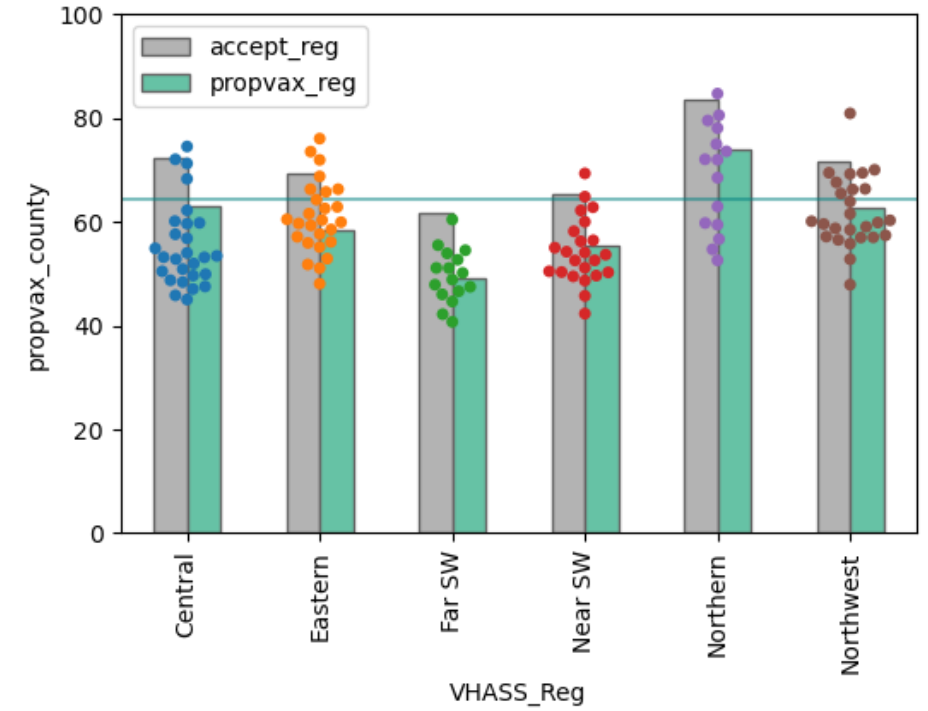


**Grey Bar**: Survey measured and corrected acceptance
**Green Bar**: Proportion of eligible population administered a vaccine
**Dots**: Proportion administered at least one dose for each county

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# Vaccine Acceptance in Virginia - COVIDcast



Virginia - Vaccine Acceptance



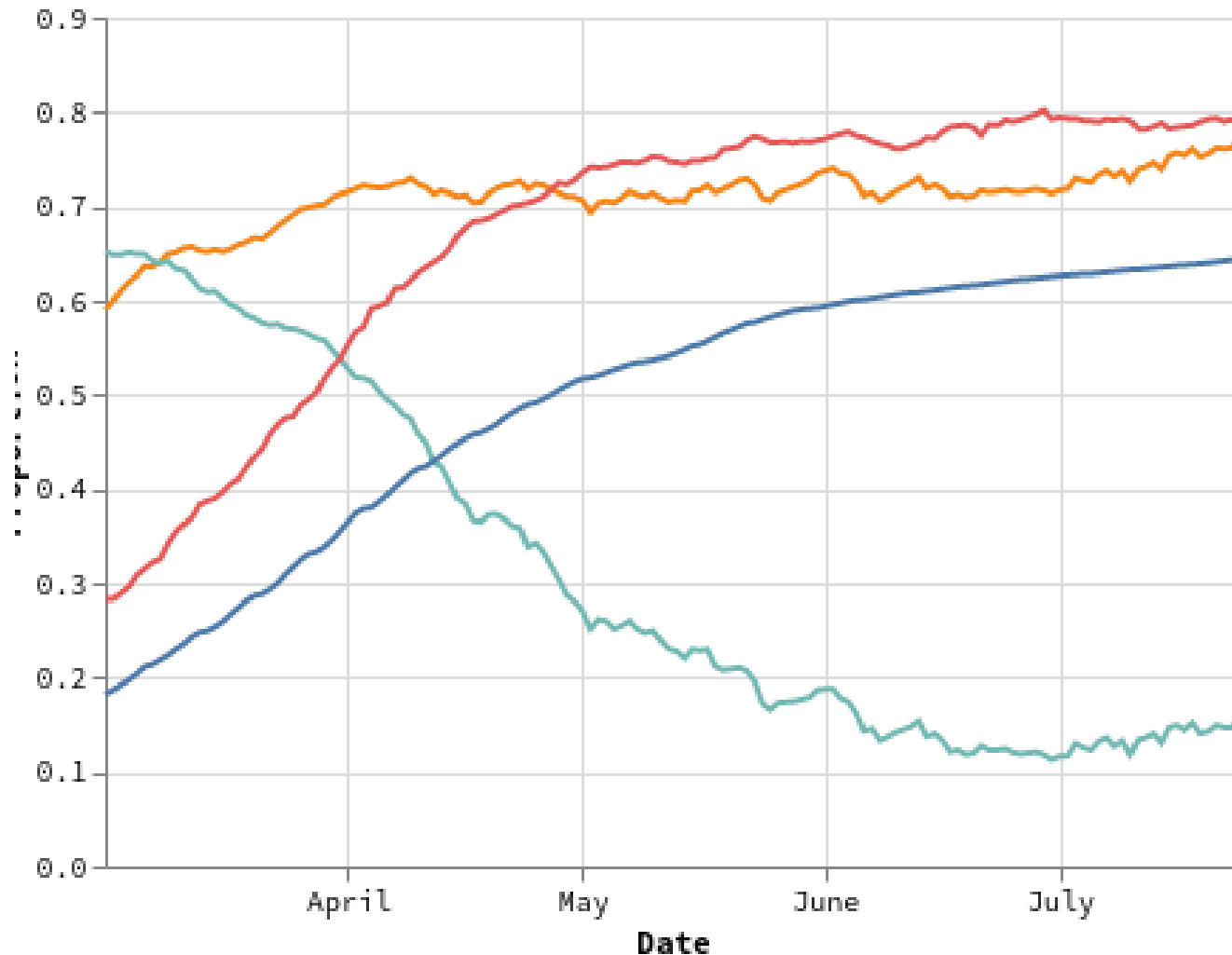Virginia - Vaccine Unnecessary

**Acceptance remains high:**

- Proportion of Virginians that have already or would definitely or probably accept vaccination if offered today
- *Survey respondents are reporting high levels of vaccination of ~80% reflecting bias of the mechanism*
- **Top reasons for hesitancy**: side effects, distrust (increasing), unnecessary (increasing)
- **More likely to take if recommended by:** doctors and friends
- **Reasons unnecessary**: Not serious, not high risk, or other

Virginia - Vaccine Hesitancy



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

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# Vaccine Acceptance Components over Time



**variable**
- Administered Vaccines
- Corrected Acceptance
- Surveyed Vaccinated
- Unvaccinated Acceptanc

**Vaccine Acceptance has risen as vaccination rates have climbed**
- Corrected Acceptance reflects the daily measured overall acceptance
- Unvaccinated Acceptance shows still ~10% of those who are unvaccinated are definitely or probably willing to be vaccinated
- Unvax acceptance has declined a bit and leveled off in last couple of weeks, final 10% may be waiting for FDA approval
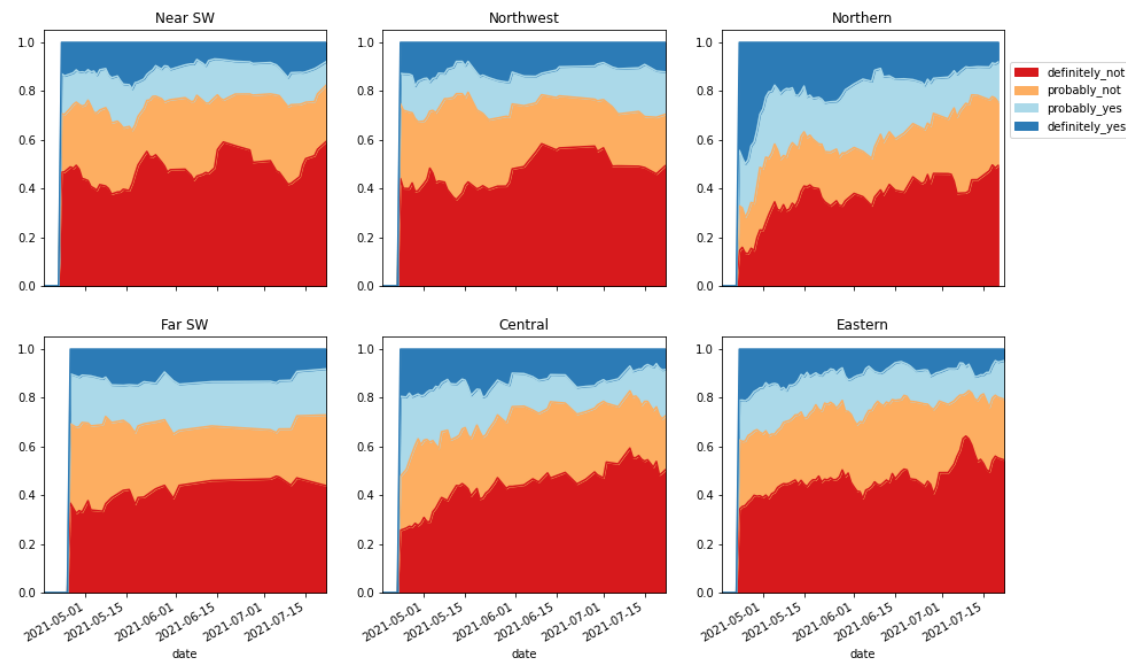
Data Source: https://covidcast.cmu.edu

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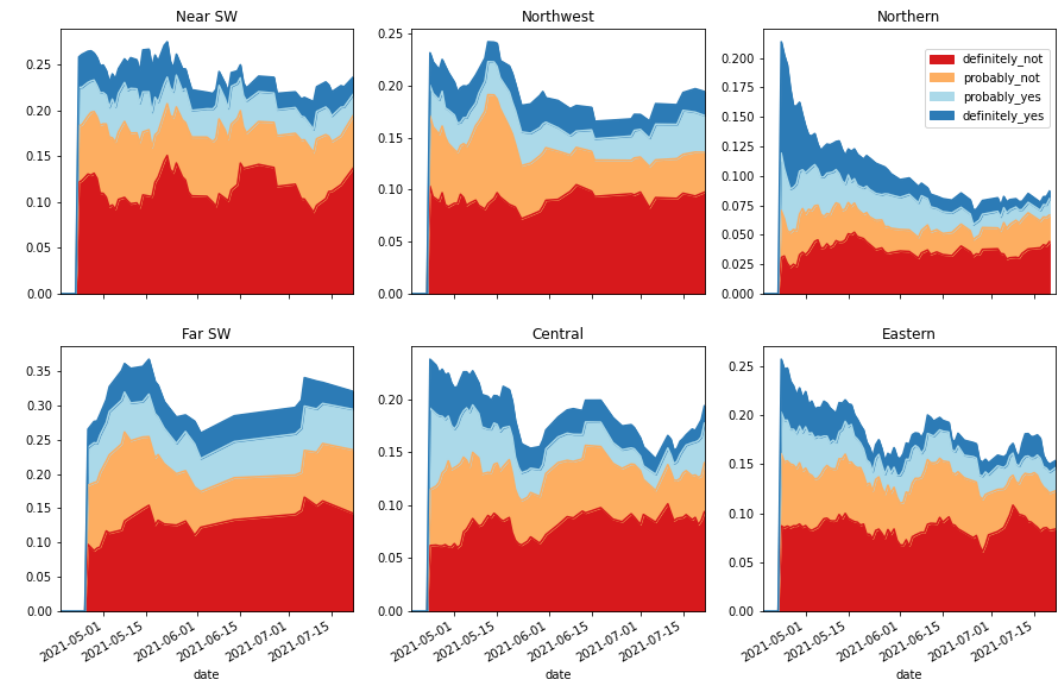
# Vaccine Acceptance by Region- COVIDcast

**Levels of Acceptance and potential acceptance in flux:**

- Nearly all the "Definitely Yes" have been vaccinated, yet there are 10-15% remaining across the regions
- Northwest and Southwest (to lesser degree) see growth in "probably not", seemingly from "definitely not"
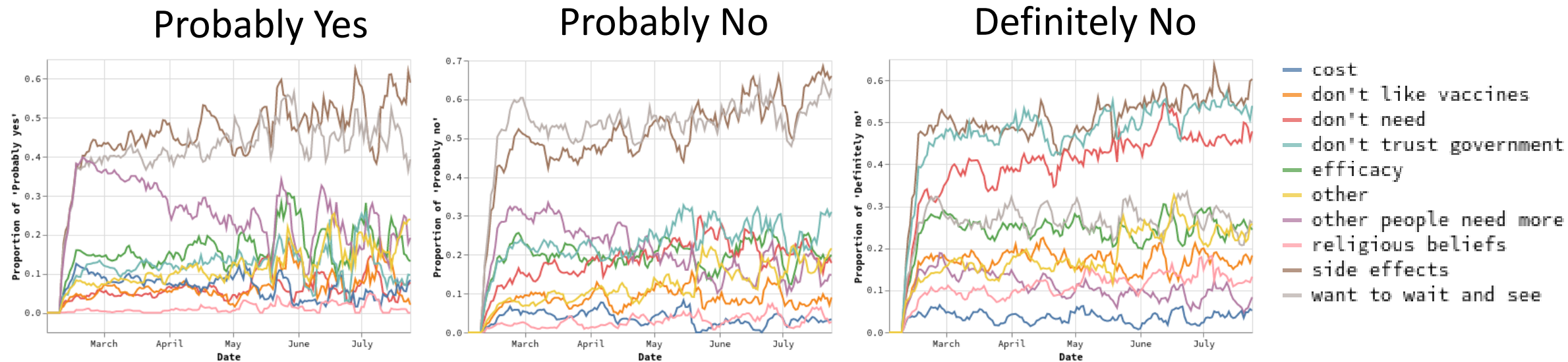
**Unvaccinated Only**
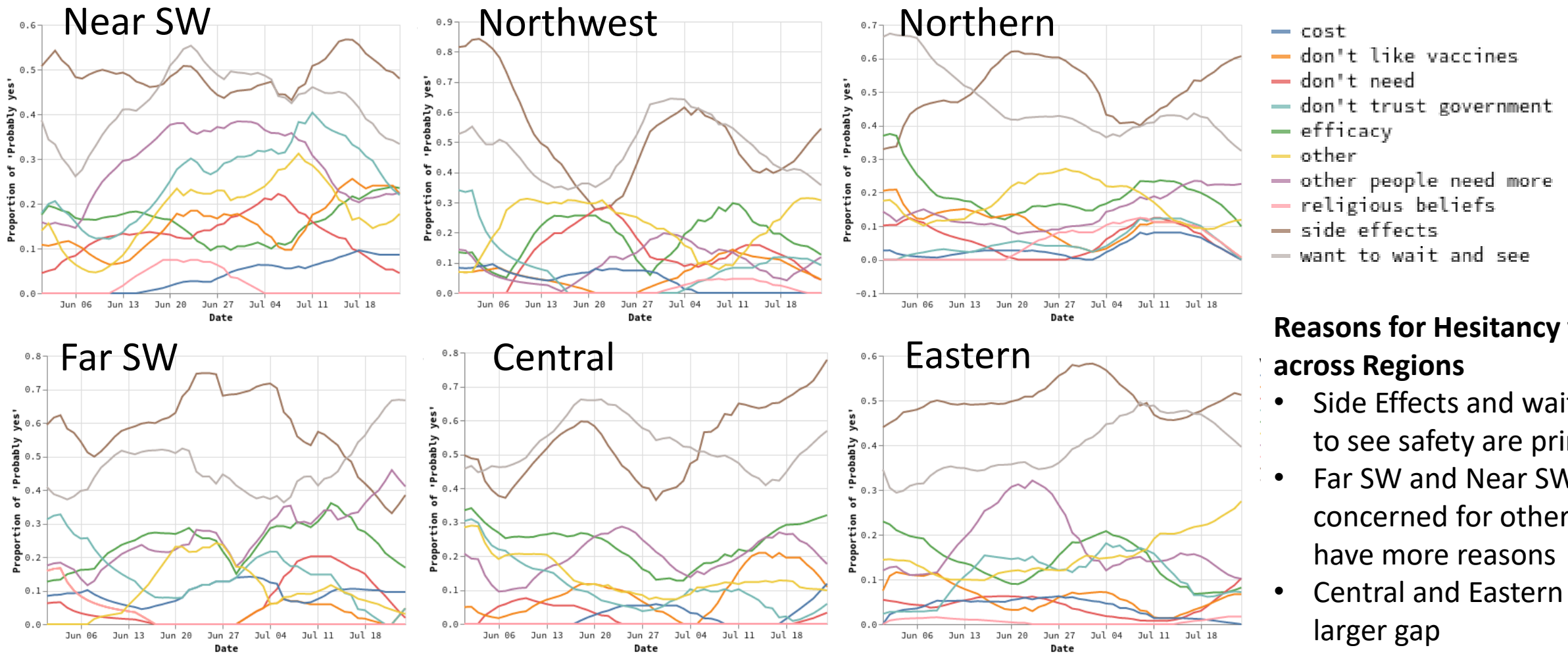
**All Respondents**



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

# Reasons for Hesitancy by Likeliness to Accept



**Probably Yes**     **Probably No**     **Definitely No**

Legend:
- cost
- don't like vaccines
- don't need
- don't trust government
- efficacy
- other
- other people need more
- religious beliefs
- side effects
- want to wait and see

**Reasons for Hesitancy vary across tiers of likeliness to accept the vaccine**
- Probably Yes and Probably No mainly concerned about side effects and are waiting to see
- Definitely No are concerned about side effects but also don't think they need the vaccine and don't trust the government
- Most other reasons are below 30% within these tiers of likeliness

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

# Reasons for Hesitancy by Region



**Reasons for Hesitancy vary across Regions**

- Side Effects and waiting to see safety are primary
- Far SW and Near SW concerned for others and have more reasons
- Central and Eastern show larger gap

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

# SARS-CoV2 Variants of Concern

**Emerging new variants will alter the future trajectories of pandemic and have implications for future control**

- Emerging variants can:
  - Increase transmissibility
  - Increase severity (more hospitalizations and/or deaths)
  - Limit immunity provided by prior infection and vaccinations

- Genomic surveillance remains very limited
  - Challenges ability to estimate impact in US to date and estimation of arrival and potential impact in future



United States / Virginia

Outbreak Info

| | New WHO Name | Transmissibility | Immune Evasiveness | Vaccine Effectiveness^ |
|---|---|---|---|---|
| Ancestral | | — | — | ✓ |
| D614G | | + | — | ✓ |
| B.1.1.7 | Alpha | +++ | — | ✓ |
| B.1.351 | Beta | + | ++++ | ✓ |
| P.1 | Gamma | ++ | ++ | ✓ |
| B.1.429 | Epsilon | + | + | ✓ |
| B.1.526 | Iota | + | + | ✓ |
| B.1.617.2 | Delta | ++++* | ++# | ✓ |

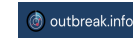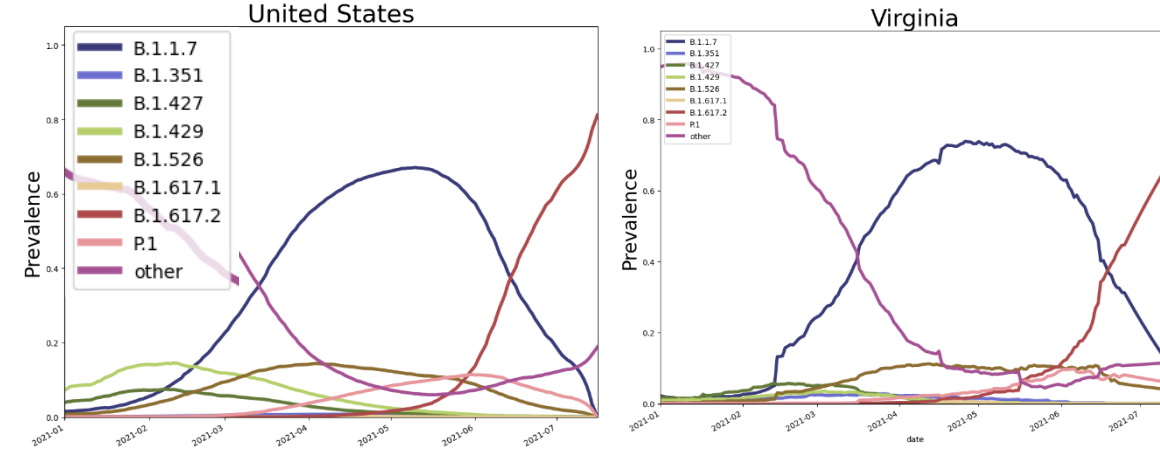*Relative transmissibility to B.1.1.7 yet to be fully defined
^Effectiveness from real world evidence vs. severe illness, not all vaccines are effective vs all variants, and importance of 2-doses, especially for B.1.617.2 for which 1 dose of mRNA or AZ is only ~30% effective # May carry more immune escape than P.1, to be determined
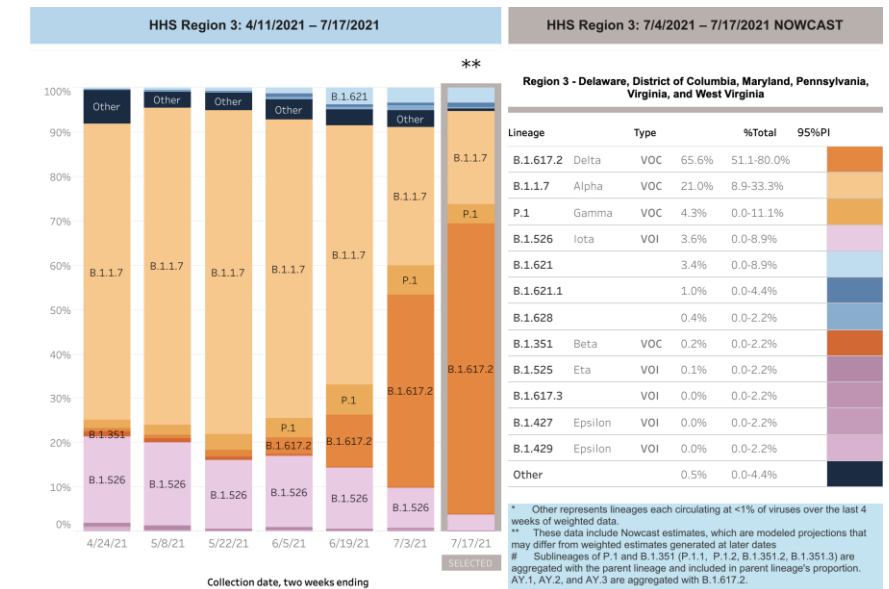
World Health Organization
WHO and Eric Topol



HHS Region 3: 4/11/2021 – 7/17/2021        HHS Region 3: 7/4/2021 – 7/17/2021 NOWCAST

Region 3 - Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia

| Lineage | | Type | %Total | 95%PI |
|---|---|---|---|---|
| B.1.617.2 | Delta | VOC | 65.6% | 51.1-80.0% |
| B.1.1.7 | Alpha | VOC | 21.0% | 8.9-33.3% |
| P.1 | Gamma | VOC | 4.3% | 0.0-11.1% |
| B.1.526 | Iota | VOI | 3.6% | 0.0-8.9% |
| B.1.621 | | | 3.4% | 0.0-8.9% |
| B.1.621.1 | | | 1.0% | 0.0-4.4% |
| B.1.628 | | | 0.4% | 0.0-2.2% |
| B.1.351 | Beta | VOC | 0.2% | 0.0-2.2% |
| B.1.525 | Eta | VOI | 0.1% | 0.0-2.2% |
| B.1.617.3 | | VOI | 0.0% | 0.0-2.2% |
| B.1.427 | Epsilon | VOI | 0.0% | 0.0-2.2% |
| B.1.429 | Epsilon | VOI | 0.0% | 0.0-2.2% |
| Other | | | 0.5% | 0.0-4.4% |

\* Other represents lineages each circulating at <1% of viruses over the last 4 weeks of weighted data.
\*\* These data include Nowcast estimates, which are modeled projections that may differ from weighted estimates generated at later dates
\# Sublineages of P.1 and B.1.351 (P.1.1, P.1.2, B.1.351.2, B.1.351.3) are aggregated with the parent lineage and included in parent lineage's proportion. AY.1, AY.2, and AY.3 are aggregated with B.1.617.2.

CDC
CDC Variant Tracking

# SARS-CoV2 Variants of Concern

## Alpha α - Lineage B.1.1.7

**Prevalence:** Levels have stalled and are now dropping in most states; flat in VA

**Transmissibility:** Estimated increase of 50% compared to previous variants. B.1.1.7's mutations boost its overall levels of viremia; study from Public Health England shows contacts of B.1.1.7 cases are more likely (50%) to test positive

**Severity:** Increased risk of hospitalization (60%) and mortality (60%). Danish study shows B.1.1.7 to have a 64% higher risk of hospitalization, while Public Health Scotland studies showed a range of 40% to 60%; Study in Nature estimates 60% higher mortality

## Beta β - Lineage B.1.351

**Prevalence:** Levels have remained low, as this variant's transmissibility can't compete with B.1.1.7, however, as more of the population becomes immune it may gain an advantage

**Immune Escape:** Many studies show that convalescent sera from previously infected individuals does not neutralize B.1.351 virus well which is predictive of protection, however, vaccine induced immunity shows signs of effectiveness

## Gamma γ - Lineage P.1

**Prevalence:** Nationally at 10%, slow increase in VA at 9%

Study estimates 17-32% of all infections in Manaus in 2021 were reinfections, which helps explain data from Brazil demonstrating P.1's continued dominance in Rio despite presence of B.1.1.7
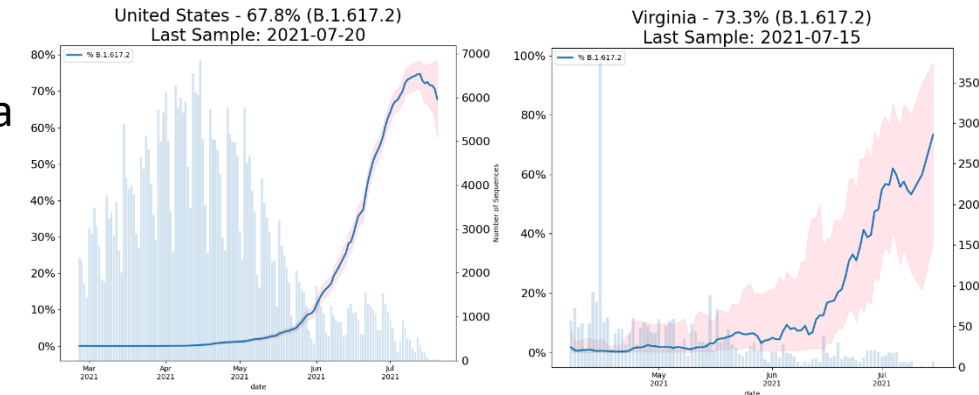


United States - 4.3% (B.1.1.7) Last Sample: 2021-07-20 / Virginia - 6.7% (B.1.1.7) Last Sample: 2021-07-15

Outbreak Info

United States - 0.0% (B.1.351) Last Sample: 2021-07-20 / Virginia - 0.0% (B.1.351) Last Sample: 2021-07-15

United States - 1.4% (P.1) Last Sample: 2021-07-20 / Virginia - 20.0% (P.1) Last Sample: 2021-07-15

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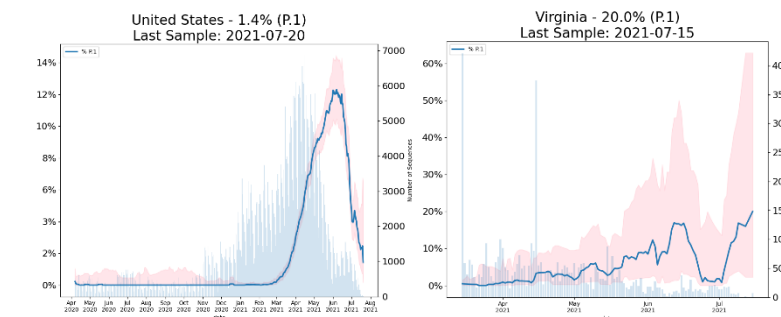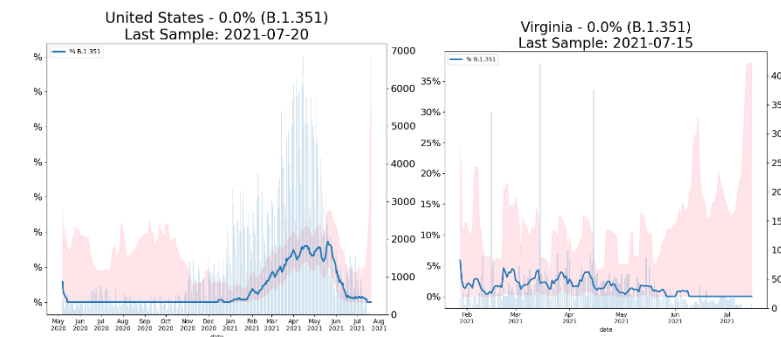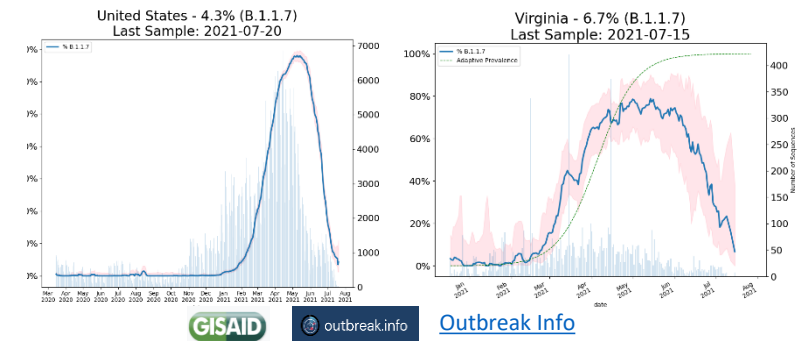
# SARS-CoV2 Variants of Concern

**Delta δ - Lineage B.1.617.2 and related subvariants**

- Delta plus δ+ lineage which contains the K417N mutation is emerging as a sub-variant that is even more transmissible; declared a VoC in India

- Delta variant now dominates most of Europe and US

- CDC recommends resumption of mask wearing indoors due to reports of breakthrough infections of the vaccinated possibly being transmissible

- Delta prevalence has dropped significantly in several European countries that previously had 100% prevalence

- More reports describe time Delta variant escapes vaccine immunity, with recent Israeli study showing a 64% efficacy against infection, however, remains highly effective against hospitalization and death

- Public Health Scotland study in Lancet suggests Delta is 2x more likely to cause hospitalization than Alpha

- Recent Lancet study shows vaccinations continue to show reduced infectiousness even in breakthrough cases



United States - 67.8% (B.1.617.2) Last Sample: 2021-07-20

Virginia - 73.3% (B.1.617.2) Last Sample: 2021-07-15

Delta variant prevalence has dropped rapidly in some countries that reached ~100% prevalence

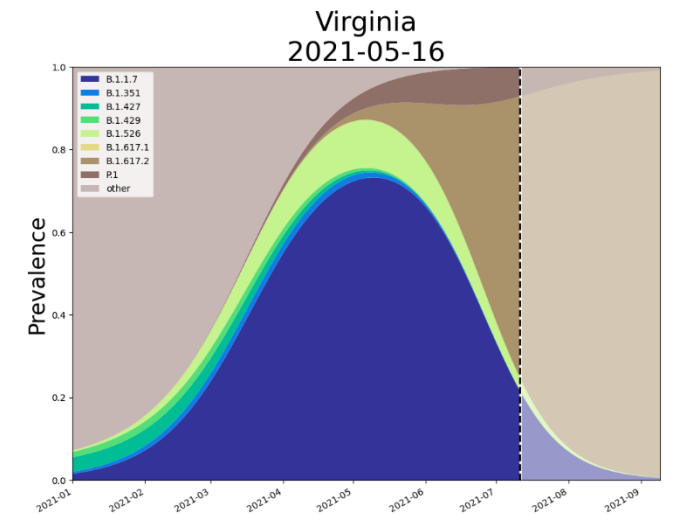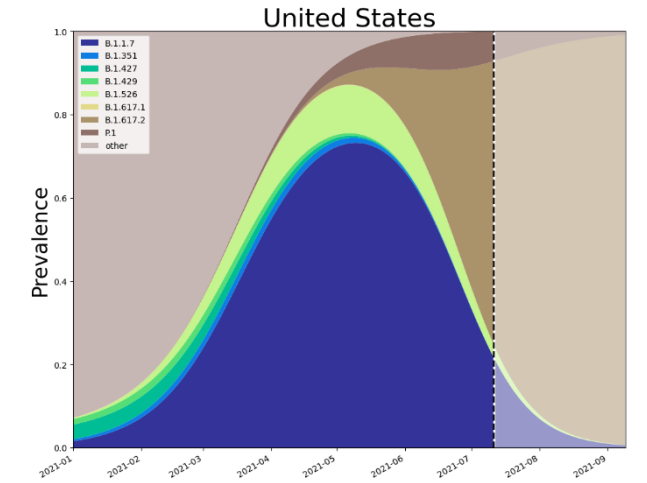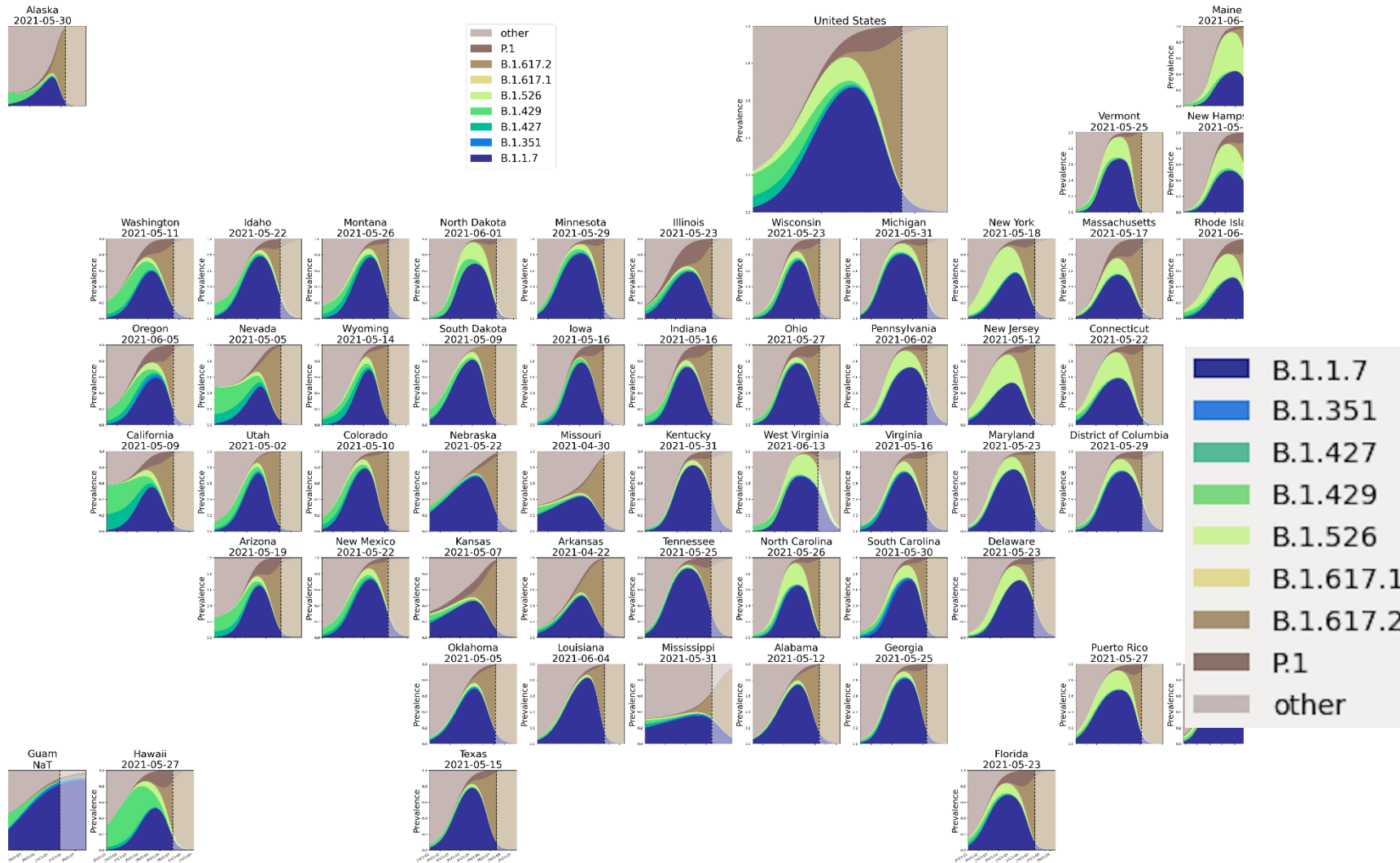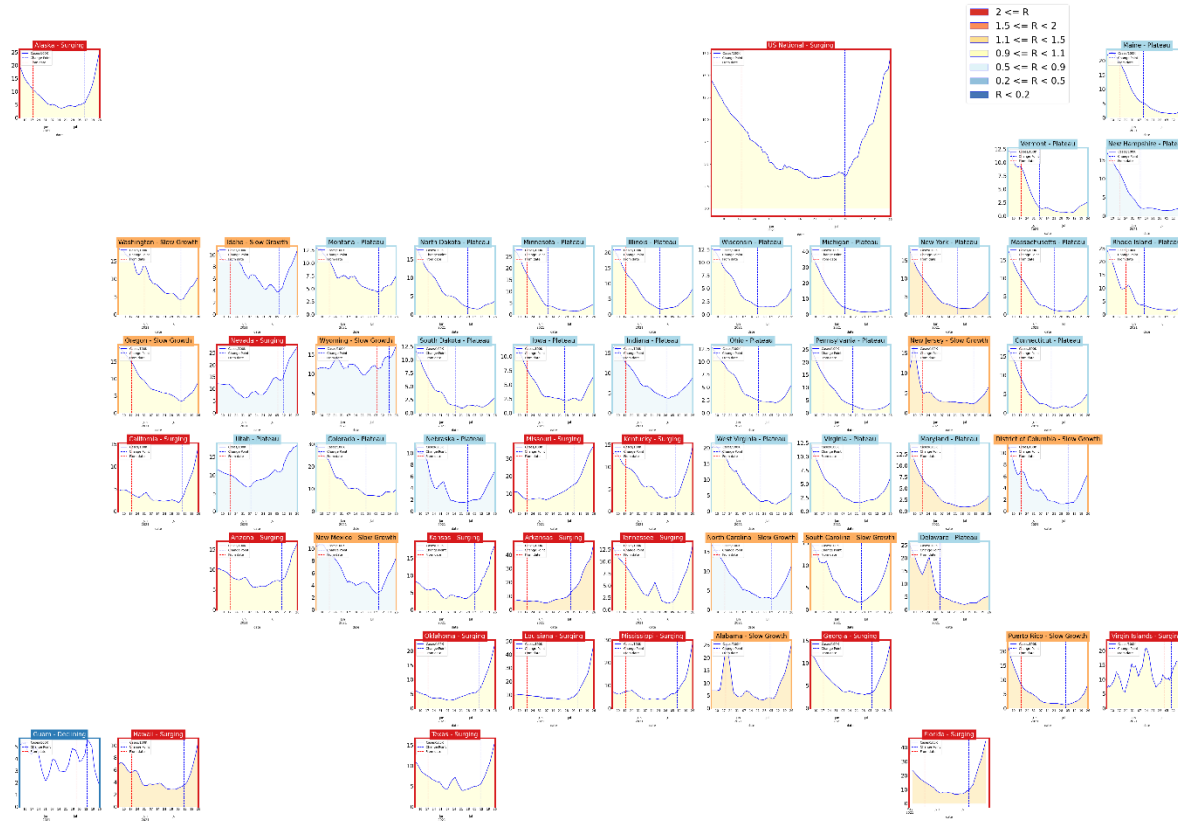Eric Topol / OurWorldinData/Covariants.org

Pfizer and Moderna showed modest neutralization resistance against Beta, Delta, Delta plus and Lambda variants whereas J&J from a significant fraction of vaccinated individuals were of low neutralizing titer (IC50<50)  BioRxiv and NyTimes



B

**Natural** Convalescent

**Pfizer** BNT162b2

**Moderna** mRNA-1273

**J&J** Ad26.COV2.S

28-Jul-21
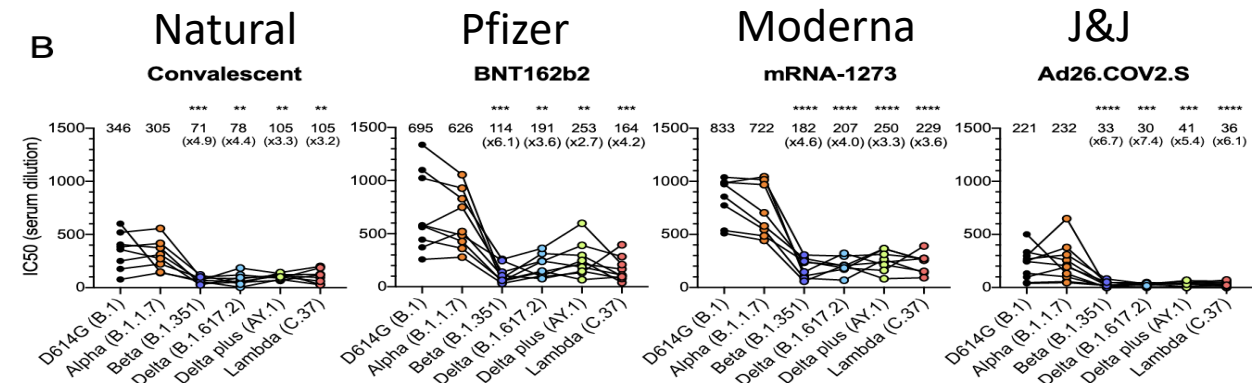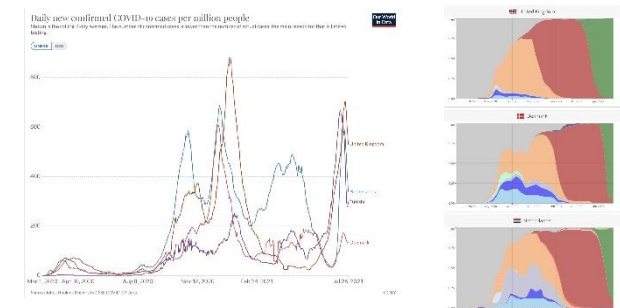
# Variant of Concern Trajectories

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# Other State Comparisons

Trajectories of States



Virginia and her neighbors



- Early surges still show no signs of slowing
- Surges that started in the Plains and South have expanded
- Over half of jurisdictions in Surge or Slow Growth
- Most of the Plateaus are increasing slowly
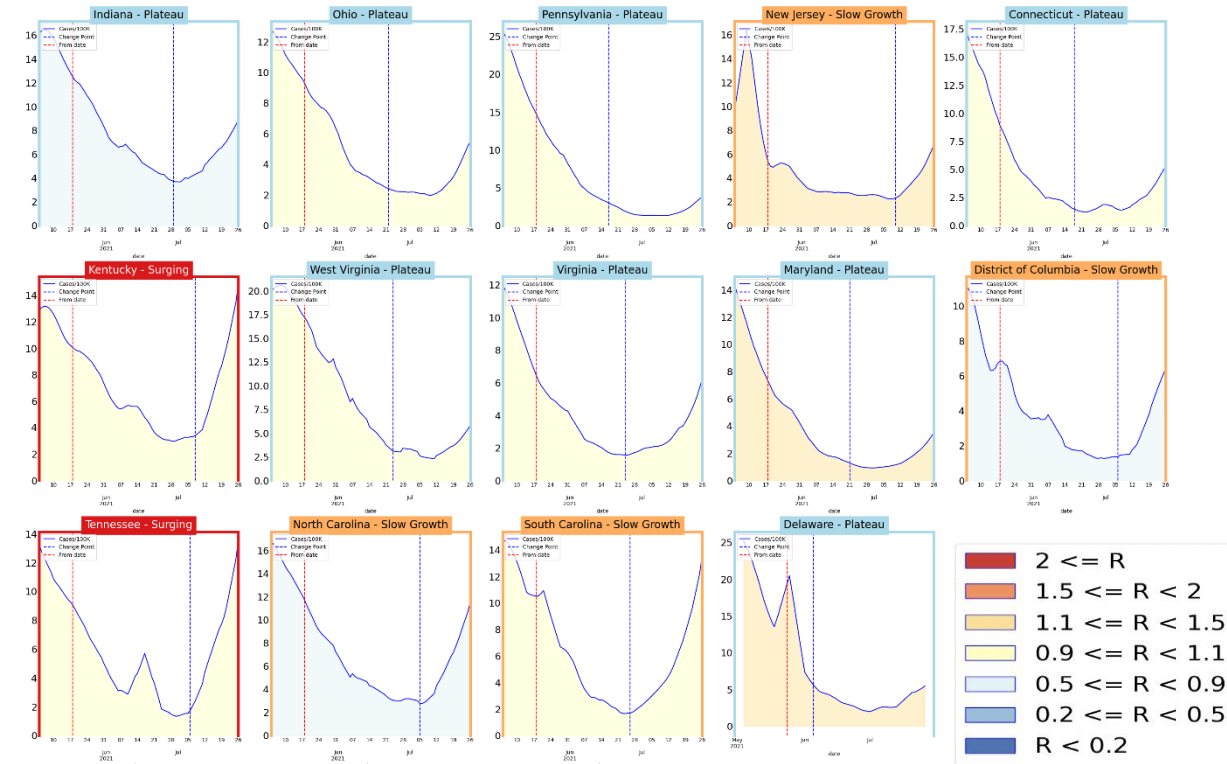
- VA and many neighbors show slight upward trends
- Many neighbors are in surge and/or have returned to rates above 10/100K

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# Recent Cases Correlate with Delta and Low Vax
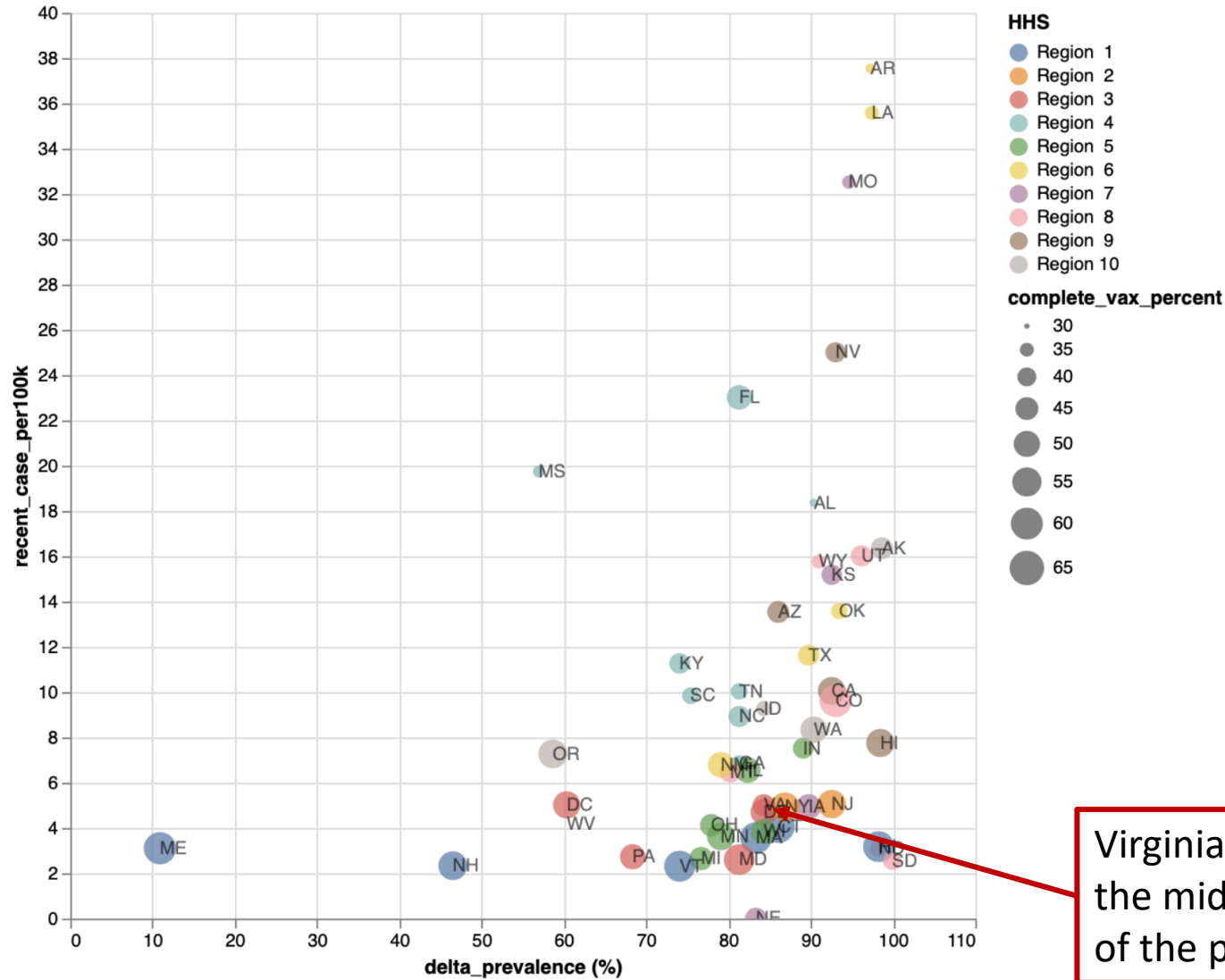


**Mean cases per 100K vs. Delta prevalence, sized by vaccine coverage**

- Mean case rate in last month correlates with the current levels of Delta prevalence
- States with smaller "size" are least vaccinated and most susceptible to high case rates
- Virginia currently low case rate despite moderate Delta prevalence

Virginia in the middle of the pack

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# Recent Cases Correlate with Delta and Low Vax
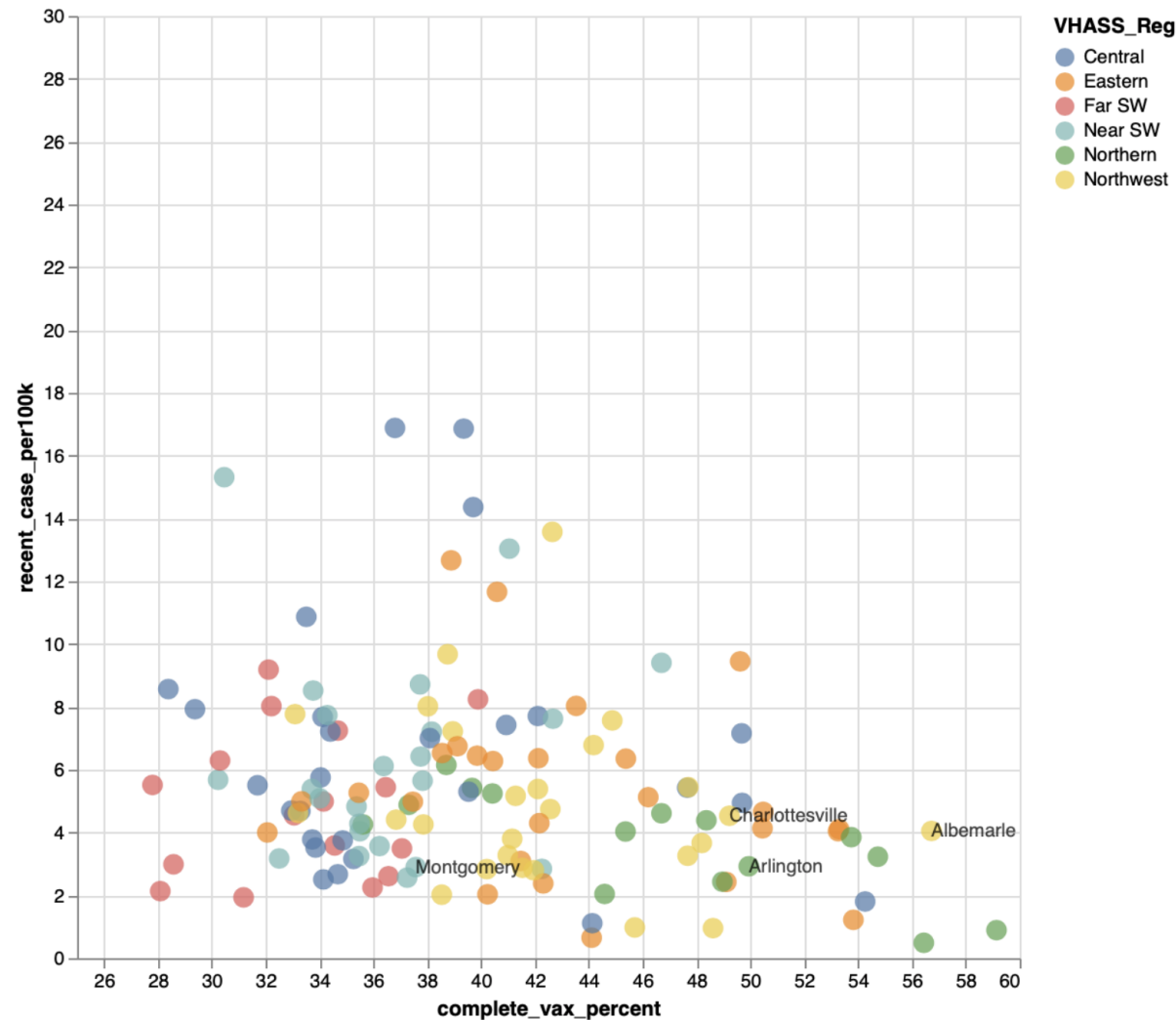


**Mean cases per 100K vs. vaccinations for Virginia Counties**

- Counties with higher vax coverage are maintaining lower case rates
- Many counties with low vax coverage continue to enjoy low case rates as well, though this may not hold

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# Race and Ethnicity cases per 100K
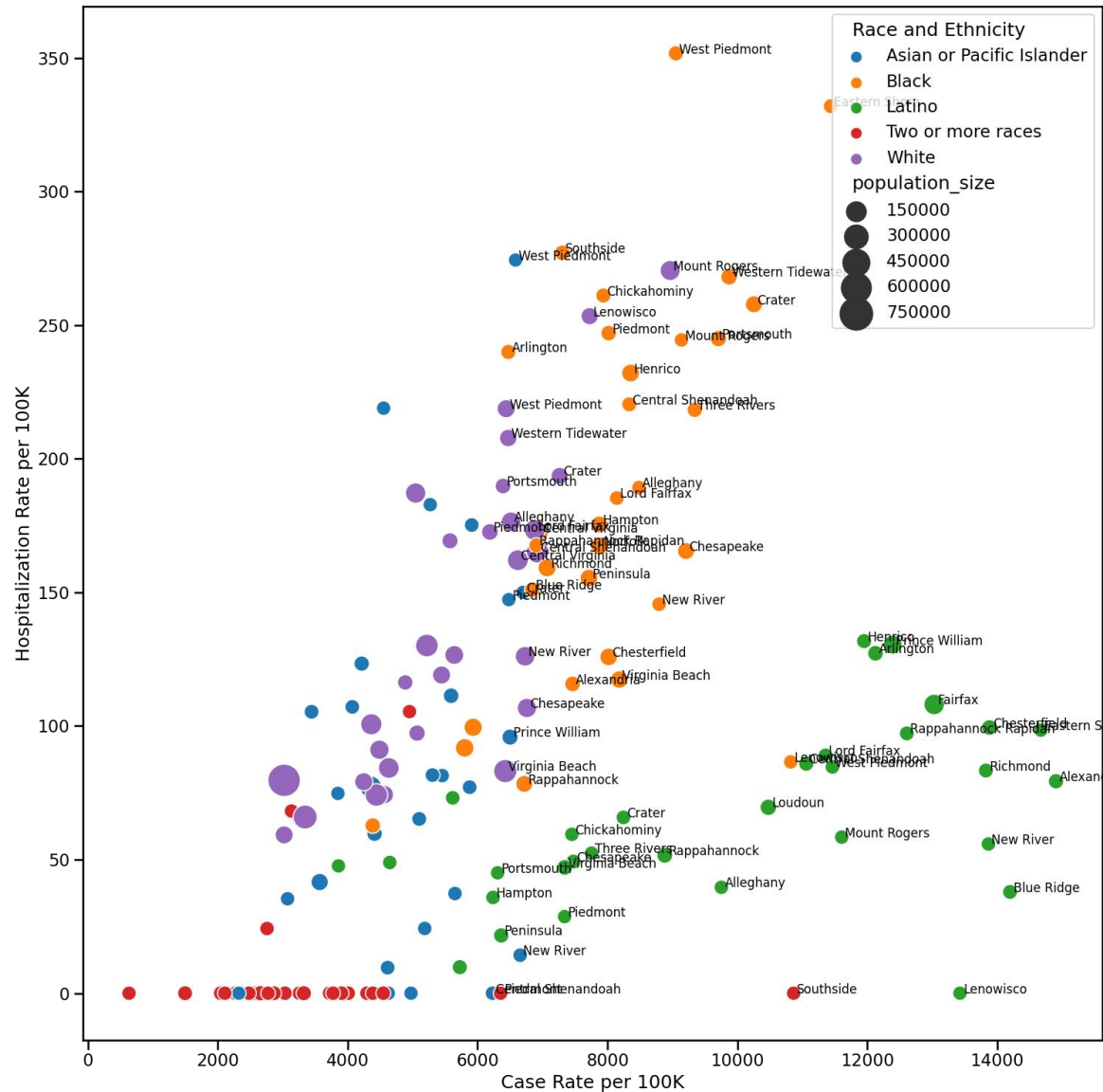


**Rates per 100K of each Racial-Ethnic population**
- Each Health District's Racial-Ethnic population is plotted by their Hospitalization and Case Rate
- Points are sized based on their overall population size (overlapping labels removed)
- Change in rates over the last 2 weeks



**Case Rate Change in last 14 days**
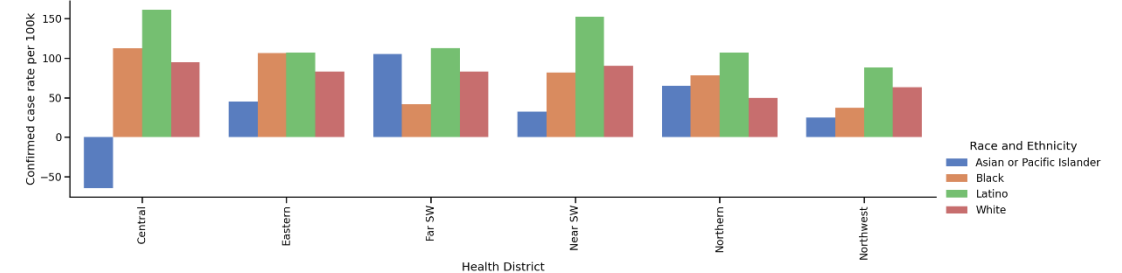
**Death Rate Change in last 14 days**
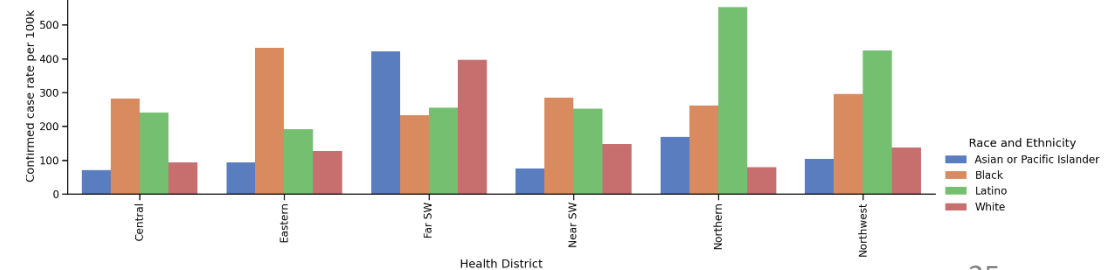
# Recent Incidence Compared to Summer 2020

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 0.89; Median: 0.64; IQR: 0.4-0.99

**Ratio of Recent Case Rate compared to mean Case Rate during Summer 2020**
- Ratio has climbed slightly
- VA: 24% of counties above average of last summer (11% last week)
- US: 46% this week, 25% last week



Proportion of Last Week's Incidence to that of Weekly Summer Mean
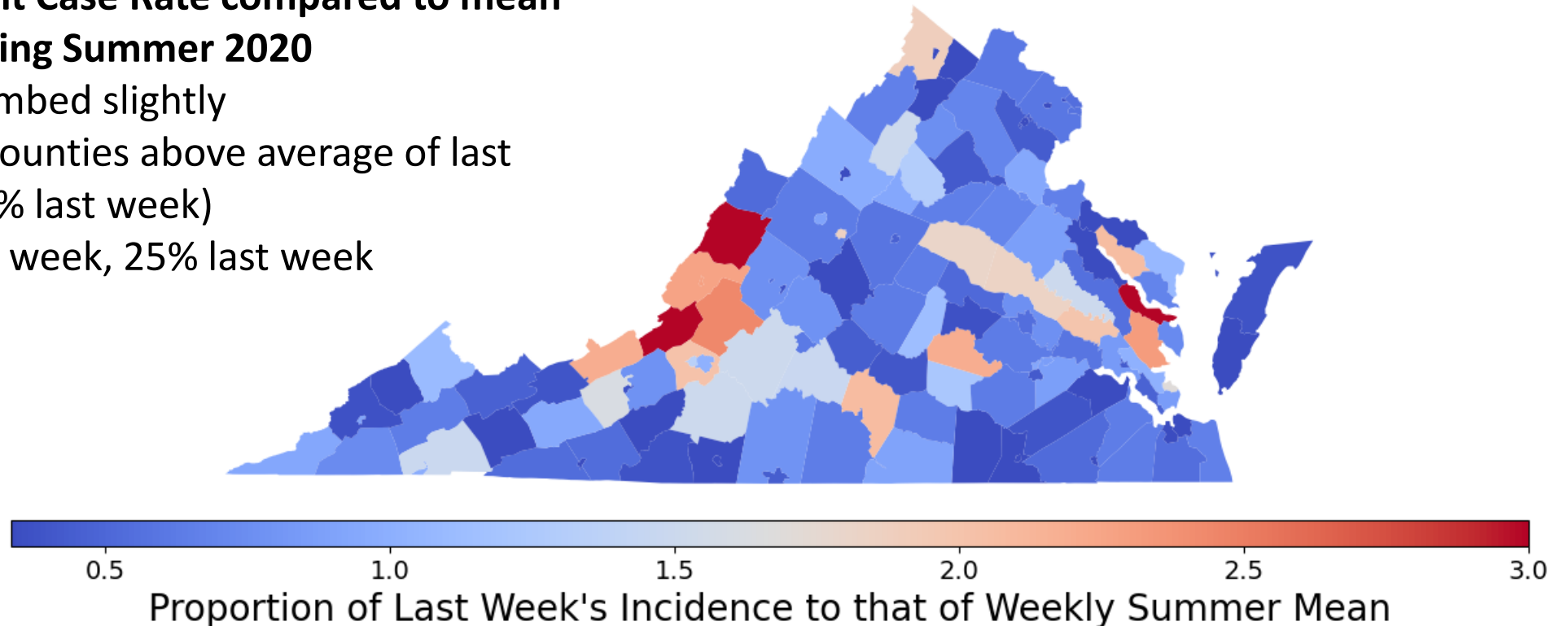
# Model Update – Adaptive Fitting

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# Adaptive Fitting Approach

**Each county fit precisely, with recent trends used for future projection**

- Allows history to be precisely captured, and used to guide bounds on projections

**Model:** An alternative use of the same meta-population model, PatchSim

  - Allows for future "what-if" Scenarios to be layered on top of calibrated model
  - Eliminates connectivity between patches, to allow calibration to capture the increasingly unsynchronized epidemic

**External Seeding:** Steady low-level importation

  - Widespread pandemic eliminates sensitivity to initial conditions
  - Uses steady 1 case per 10M population per day external seeding
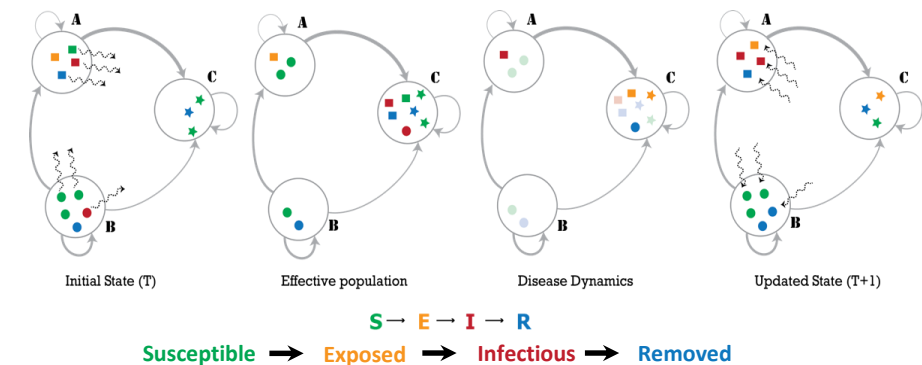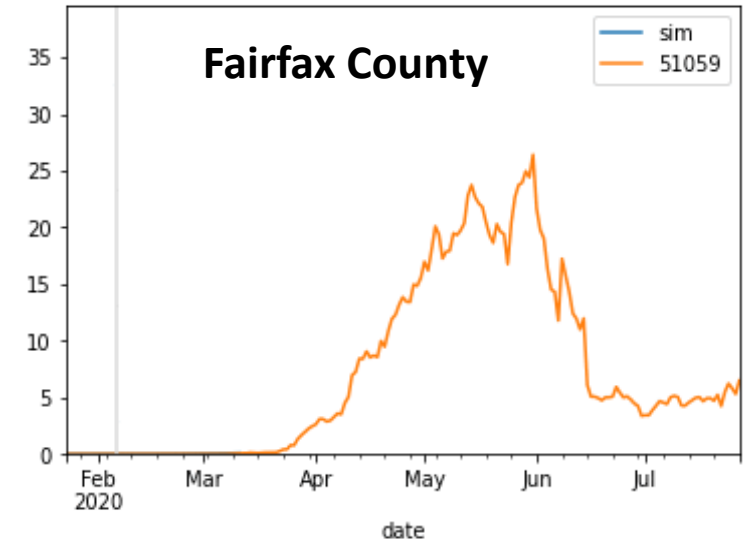
# Using Ensemble Model to Guide Projections

Ensemble methodology that combines the Adaptive with machine learning and statistical models such as:

- Autoregressive (AR, ARIMA)

- Neural networks (LSTM)

- Kalman filtering (EnKF)

Weekly forecasts done at county level.

Models chosen because of their track record in disease forecasting and to increase diversity and robustness.

Ensemble forecast provides additional 'surveillance' for making scenario-based projections.
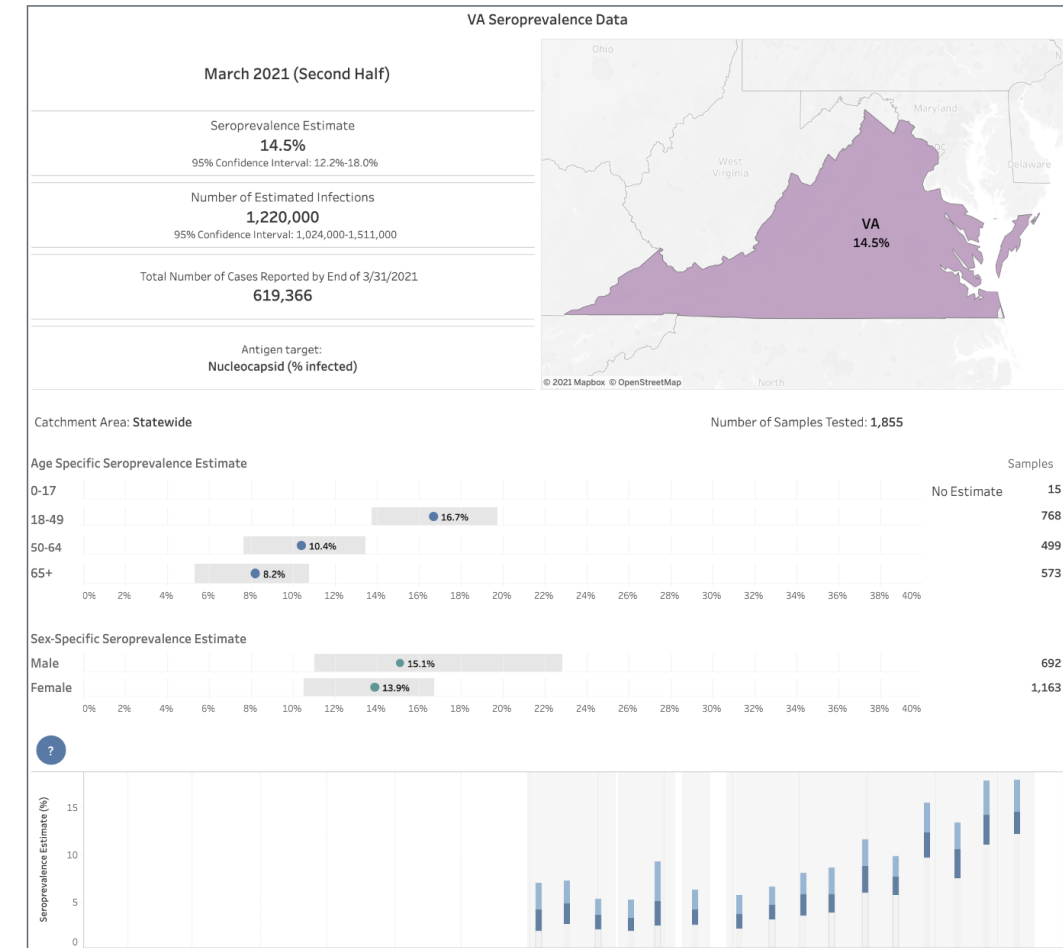
Also submitted to CDC Forecast Hub.

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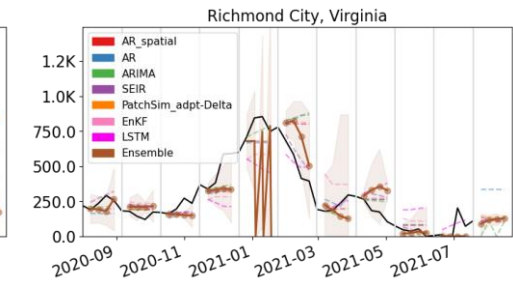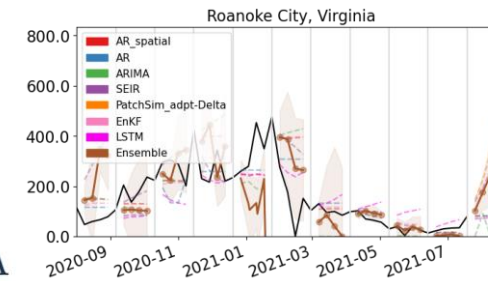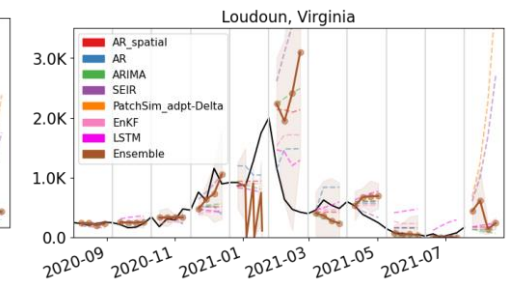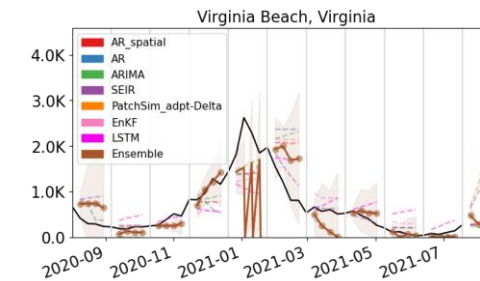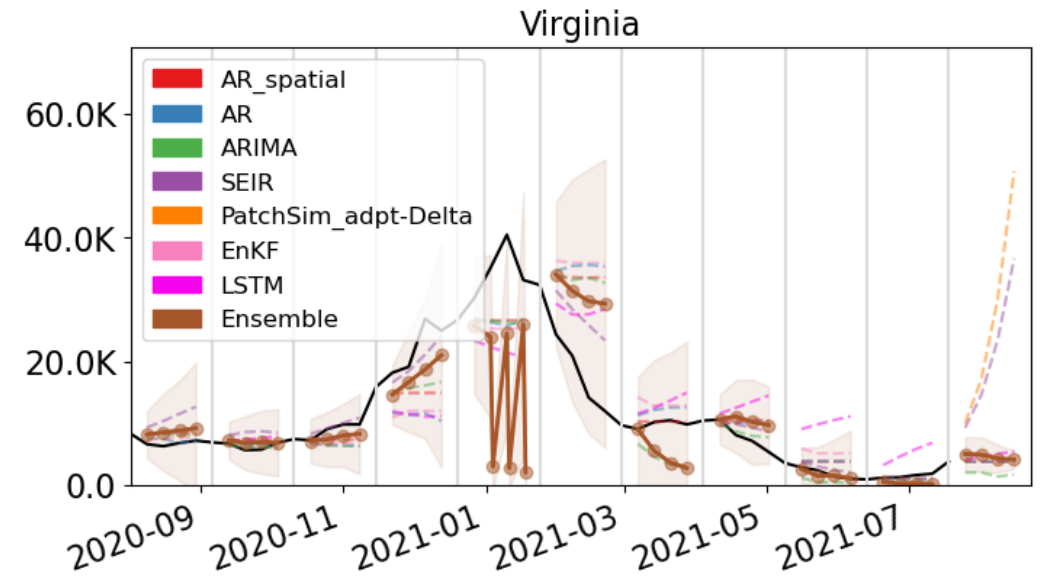
# Seroprevalence updates to model design

**Several seroprevalence studies provide better picture of how many actual infections have occurred**

- CDC Nationwide Commercial Laboratory Seroprevalence Survey estimated 14.5% [12% – 18%] seroprevalence as of March 4th – 17th up from 10.5% a month earlier

**These findings are equivalent to an ascertainment ratio of ~2x in the future, with bounds of (1.3x to 3x)**

- Thus for 2x there are 2 total infections in the population for every confirmed case recently

- This measure now fully tracks the estimated ascertainment over time

- Uncertainty design has been shifted to these bounds (previously higher ascertainments as was consistent earlier in the pandemic were being used)



VA Seroprevalence Data

March 2021 (Second Half)

Seroprevalence Estimate
14.5%
95% Confidence Interval: 12.2%-18.0%

Number of Estimated Infections
1,220,000
95% Confidence Interval: 1,024,000-1,511,000

Total Number of Cases Reported by End of 3/31/2021
619,366

Antigen target:
Nucleocapsid (% infected)

VA
14.5%

© 2021 Mapbox © OpenStreetMap

Catchment Area: **Statewide**          Number of Samples Tested: **1,855**

Age Specific Seroprevalence Estimate                Samples

| | | Samples |
|---|---|---|
| 0-17 | No Estimate | 15 |
| 18-49 | 16.7% | 768 |
| 50-64 | 10.4% | 499 |
| 65+ | 8.2% | 573 |

Sex-Specific Seroprevalence Estimate

| | | Samples |
|---|---|---|
| Male | 15.1% | 692 |
| Female | 13.9% | 1,163 |

https://covid.cdc.gov/covid-data-tracker/#national-lab

*University of Virginia*

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# Calibration Approach

- **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting

- **Calibration:** fit model to observed data and ensemble's forecast
  - Tune transmissibility across ranges of:
    - Duration of incubation (5-9 days), infectiousness (3-7 days)
    - Undocumented case rate (1x to 7x) guided by seroprevalence studies
    - Detection delay: exposure to confirmation (4-12 days)
  - Approach captures uncertainty, but allows model to precisely track the full trajectory of the outbreak

- **Project:** future cases and outcomes generated using the collection of fit models run into the future
  - **Mean trend from last 7 days of observed cases and first week of ensemble's forecast used**
  - Outliers removed based on variances in the previous 3 weeks
  - 2 week interpolation to smooth transitions in rapidly changing trajectories

## COVID-19 in Virginia:

Dashboard Updated: 7/28/2021
Data entered by 5:00 PM the prior day.

### Cases, Hospitalizations and Deaths

| Total Cases* | Total Hospitalizations** | Total Deaths |
|---|---|---|
| 692,105 | 31,241 | 11,522 |
| (New Cases: 1,087)^ | | |

| Confirmed† | Probable† | Confirmed† | Probable† | Confirmed† | Probable† |
|---|---|---|---|---|---|
| 536,663 | 155,442 | 29,610 | 1,631 | 9,727 | 1,795 |

\* Includes both people with a positive test (Confirmed), and symptomatic with a known exposure to COVID-19 (Probable).
\*\* Hospitalization of a case is captured at the time VDH performs case investigation. This underrepresents the total number of hospitalizations in Virginia.
^New cases represent the number of confirmed and probable cases reported to VDH in the past 24 hours.
† VDH adopted the updated CDC COVID-19 confirmed and probable surveillance case definitions on August 27, 2020. Found here: https://wwwn.cdc.gov/nndss/conditions/coronavirus-disease-2019-covid-19/case-definition/2020/08/05/

### Outbreaks

| Total Outbreaks* | Outbreak Associated Cases |
|---|---|
| 3,773 | 77,881 |

\* At least two (2) lab confirmed cases are required to classify an outbreak.

### Testing (PCR Only)

| Testing Encounters PCR Only* | Current 7-Day Positivity Rate PCR Only** |
|---|---|
| 7,946,025 | 4.7% |

\* PCR" refers to "Reverse transcriptase polymerase chain reaction laboratory testing."
\*\* Lab reports may not have been received yet. Percent positivity is not calculated for days with incomplete data.

### Multisystem Inflammatory Syndrome in Children

| Total Cases* | Total Deaths |
|---|---|
| 78 | 0 |

\*Cases defined by CDC HAN case definition: https://emergency.cdc.gov/han/2020/han00432.asp

Accessed 10:00am July 28, 2021
https://www.vdh.virginia.gov/coronavirus/

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# Scenarios – Transmission Conditions

- Variety of factors continue to drive transmission rates
  - Seasonal impact of weather patterns, travel and gatherings, fatigue and premature relaxation of infection control practices

- Plausible levels of transmission can be bounded by past experience
  - Assess transmission levels at the county level from May 1, 2020 – Sept 1, 2020 or current, whichever is highest

- Projection Scenario:
  - **Adaptive:** Control remains as is currently experienced into the future
  - **Adaptive-Surge Control:** 2 weeks from now behaviors and mitigation efforts ramp up over a 2-week period culminating in a 25% reduction in transmission
  - **Adaptive-SpringControl:** Immediate return to the mean levels of transmission experienced in May 2021
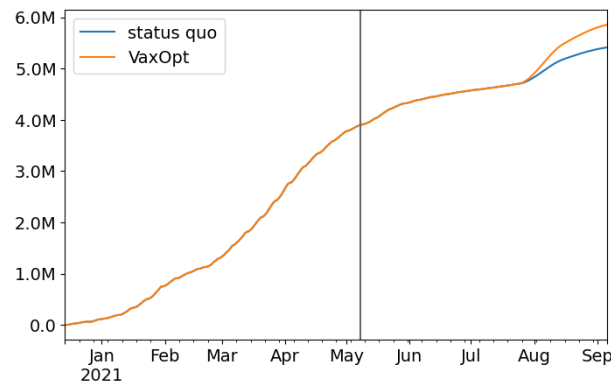
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# Scenarios – Vaccination Conditions

## Vaccine Characteristics

- **Pfizer/Moderna**: 50% after first dose, 95% after second dose (3.5 week gap)
- **J & J** : 67% efficacy after first (and only) dose
- Delay to efficacy from doses is 14 days, immunity lasts at least 7m (NEJM study)
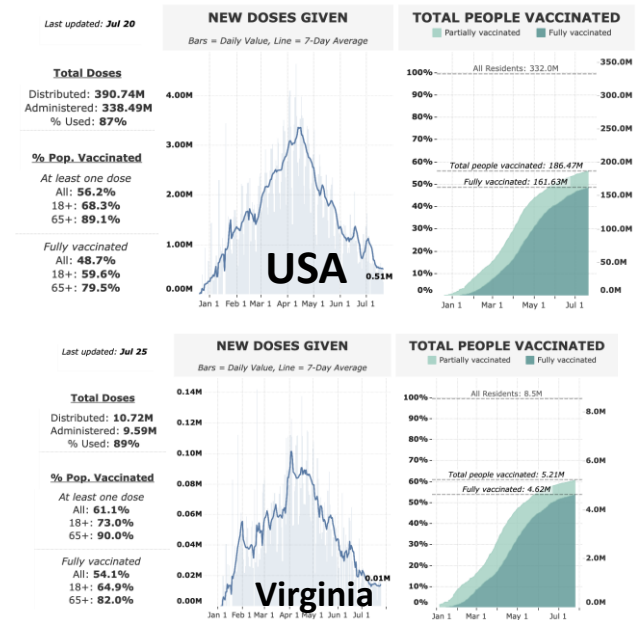
## Vaccine Administration Scenarios

- **Status quo (no label):** COVIDcast corrected acceptance estimates (statewide mean is ~73%) reached by Labor Day.
- **Optimistic (VaxOpt):** Expand VA mean acceptance to ~85% (with all counties reaching a minimum of 65%, max of 95%).
- Acceptance at county level = regional acceptance +/- relative current vax
- Front-loaded rollout (two-thirds of the remaining in half the time)

Source: https://ckelly17.github.io/vaccine_dashboard.html

**Weekly VA doses administered by manufacturer**

| Monthly first doses | status quo | VaxOpt |
| --- | --- | --- |
| Date | | |
| 2020-12-31 | 108.4K | 108.4K |
| 2021-01-31 | 642.0K | 642.0K |
| 2021-02-28 | 555.0K | 555.0K |
| 2021-03-31 | 1.3M | 1.3M |
| 2021-04-30 | 1.2M | 1.2M |
| 2021-05-31 | 570.9K | 570.9K |
| 2021-06-30 | 240.5K | 240.5K |
| 2021-07-31 | 238.3K | 296.5K |
| 2021-08-31 | 564.1K | 923.3K |
| 2021-09-30 | 43.6K | 70.6K |

| Cumulative | status quo | VaxOpt |
| --- | --- | --- |
| Date | | |
| 2020-12-31 | 108.4K | 108.4K |
| 2021-01-31 | 750.4K | 750.4K |
| 2021-02-28 | 1.3M | 1.3M |
| 2021-03-31 | 2.6M | 2.6M |
| 2021-04-30 | 3.8M | 3.8M |
| 2021-05-31 | 4.3M | 4.3M |
| 2021-06-30 | 4.6M | 4.6M |
| 2021-07-31 | 4.8M | 4.9M |
| 2021-08-31 | 5.4M | 5.8M |
| 2021-09-30 | 5.4M | 5.9M |

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# Scenarios – Delta δ Variant Condition

Variant Delta δ has exhibited ability to outcompete other variants and now is dominant in the US and most states

**Transmissibility:** Delta's relative transmissibility compared to Alpha is better understood (60% more transmissible) and its weighted growth fits a 60% growth advantage well

**Immune Escape:** Delta has been observed to evade immunity, both natural and vaccine-induced, however, uncertainty remains high thus this is **NOT** factored into the model

**Severity**: Delta, similar to Alpha, appears to cause more severe illness with estimates ranging from 50% to 200%, at the moment assume 60%

## Delta Variant Scenario:

- Continues to grow on 60% more transmissible trajectory, reached 50% prevalence on June 29th and is also 60% more severe than Alpha



Outbreak Info

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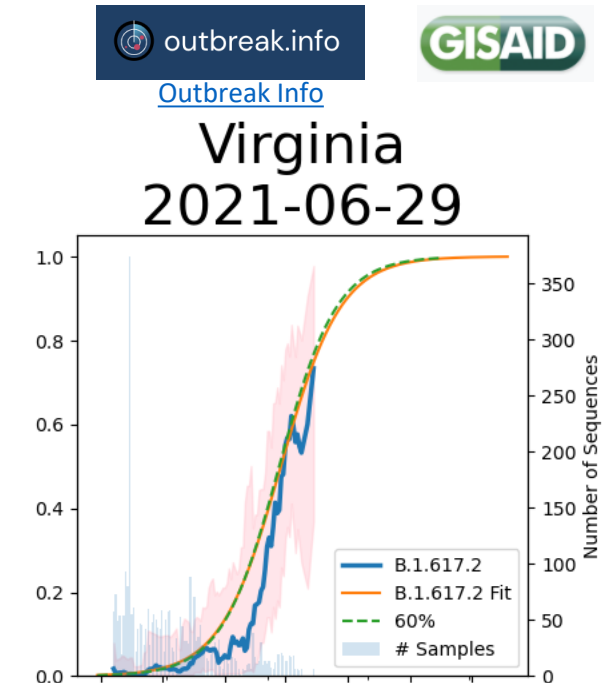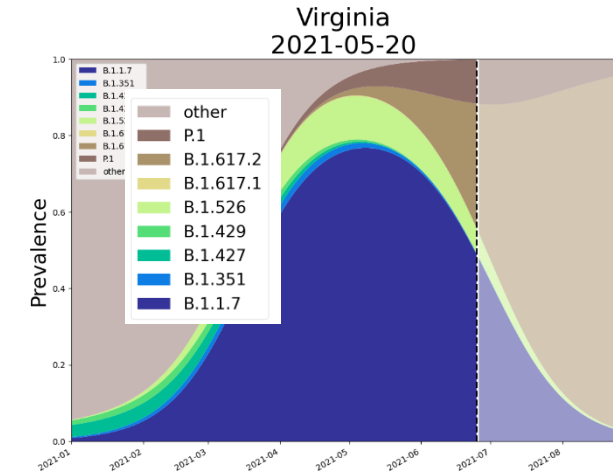
# Projection Scenarios – Combined Conditions

| Name | Txm Controls | Variant Boosting | Vax | Description |
|------|------|------|------|------|
| Adaptive | C | None | SQ | Likely trajectory based on conditions remaining similar to how they are now |
| Adaptive-VaxOpt | C | None | VO | Vaccination through Labor Day reaches an optimistically high level of expanded coverage (85%) |
| Adaptive-Delta | C | 60% | SQ | Likely trajectory based on conditions remaining similar to now, but with increasing prevalence of Delta variant |
| Adaptive-Delta-VaxOpt | C | 60% | VO | Vaccination through Labor Day reaches an optimistically high level of expanded coverage (85%), with increasing prevalence of Delta variant |
| Adaptive-SurgeControl | 25% | 60% | SQ | Transmission rates in the next month reduced through increased control from non-pharmaceutical interventions, with status quo vax and Delta |
| Adaptive-SpringControl | Spring | 60% | SQ | Transmission rates return the rates experienced in May 2021 with status quo vaccination and increasing prevalence of Delta |

**Transmission Controls:** C = Current levels persist into the future

25% = Transmission rates are reduced by 25% with a gradual introduction, concluding in 4 weeks

Spring = Transmission rates return to May 2021 levels

**Variant Boosting:** None = Variety of variants, no future txm boosting, but with severity impacts from current levels

60% = Prevalence of Delta ramps up according to logistic growth and is 60% more transmissible

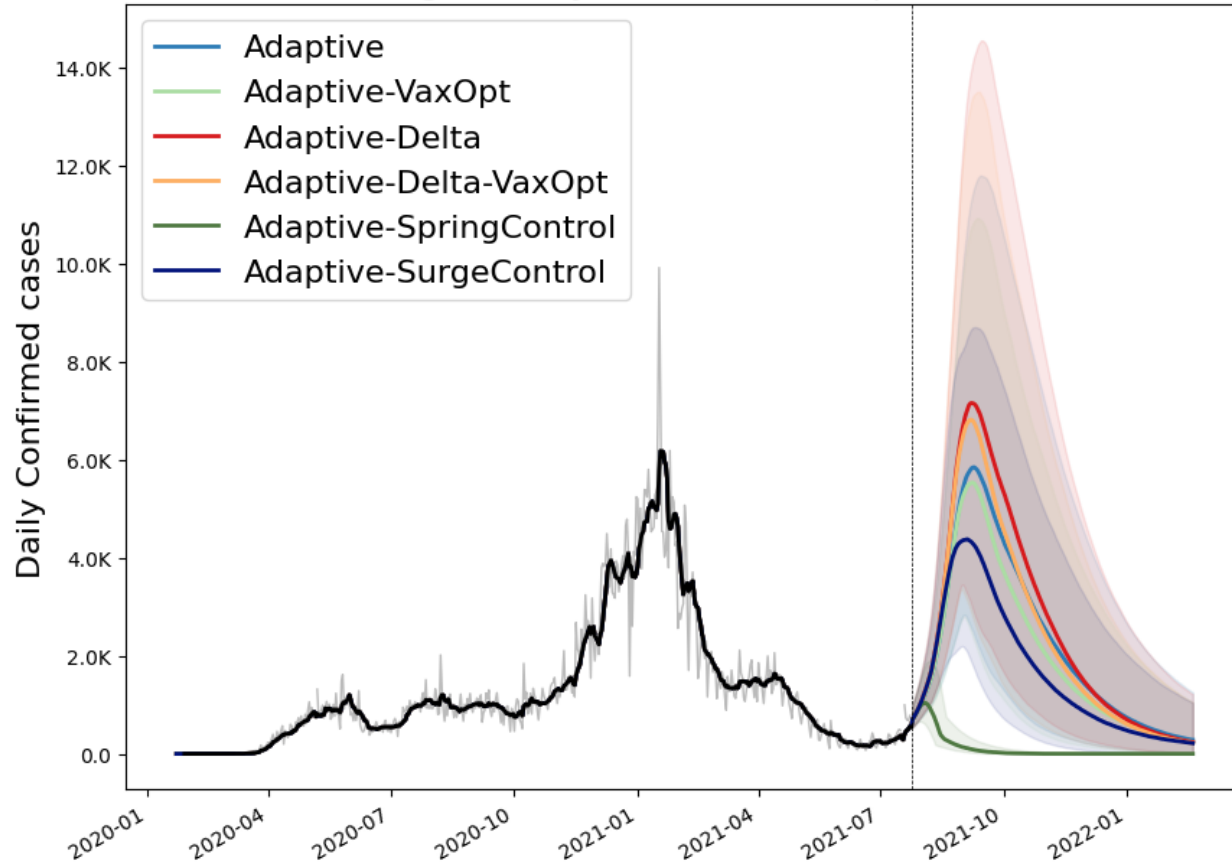**Vaccinations:** SQ = Status quo acceptance leads to low rates of vaccination through the summer

VO = Vaccination acceptance optimistically expands with increased rates through the summer
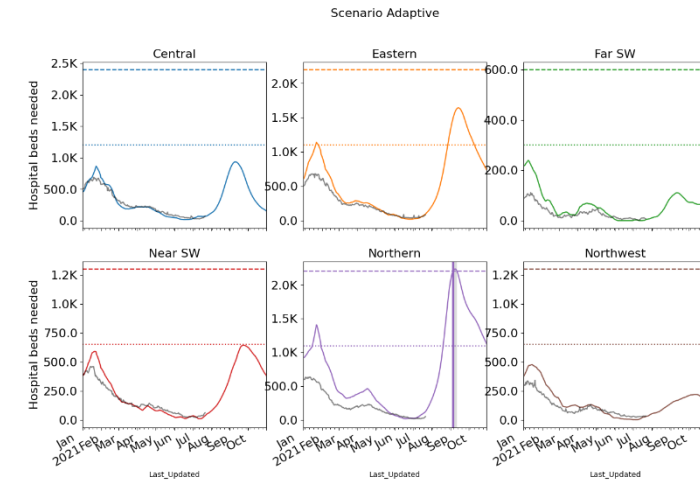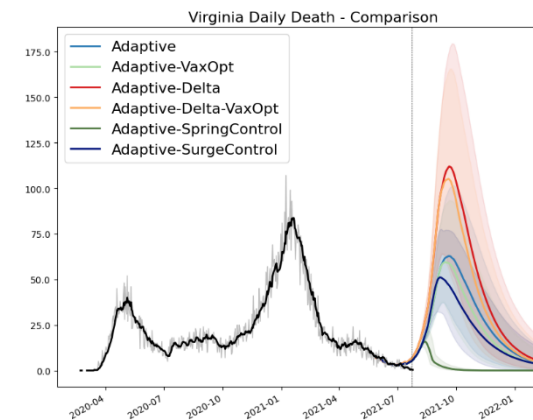
# Model Results

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# Outcome Projections

## Estimated Hospital Occupancy



## Confirmed cases



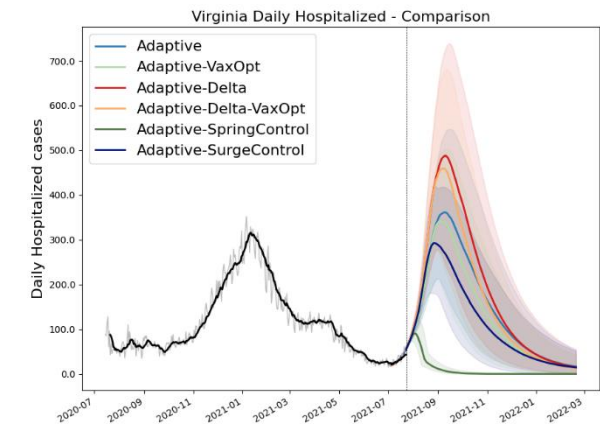## Daily Deaths



Death ground truth from VDH "Event Date" data, most recent dates are not complete

## Daily Hospitalized



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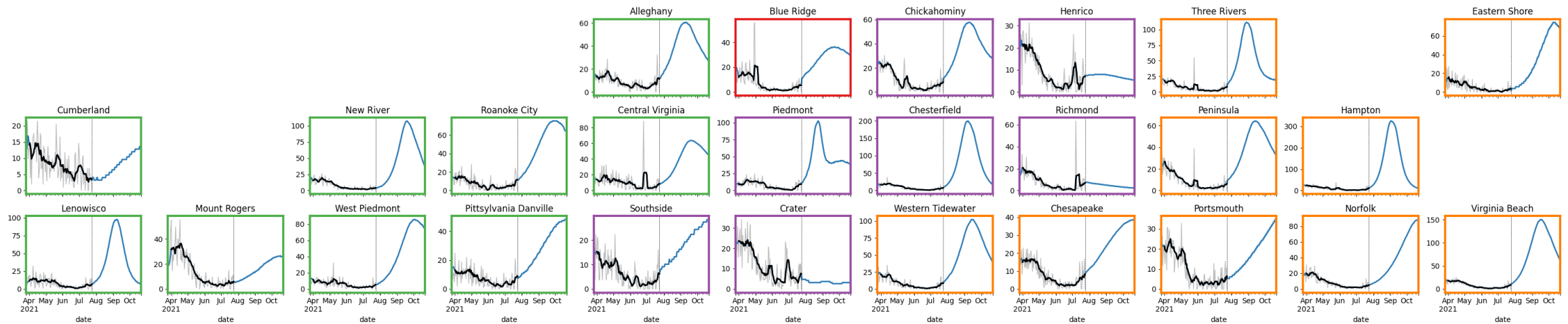
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# District Level Projections: Adaptive
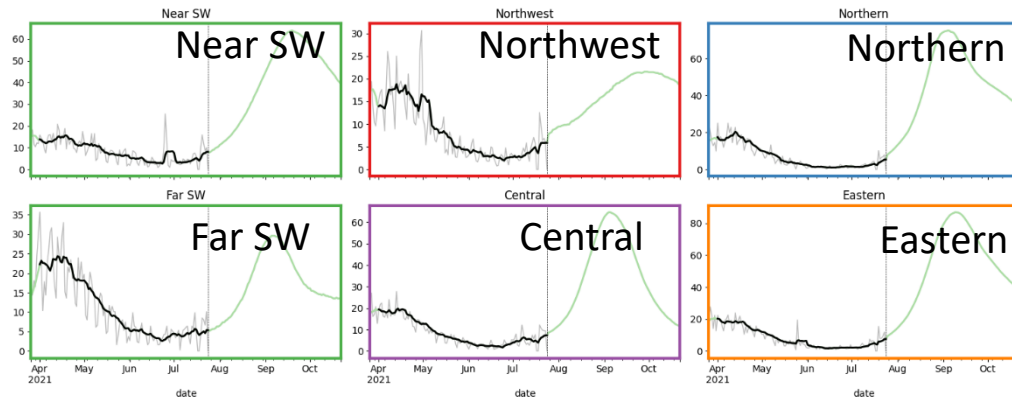


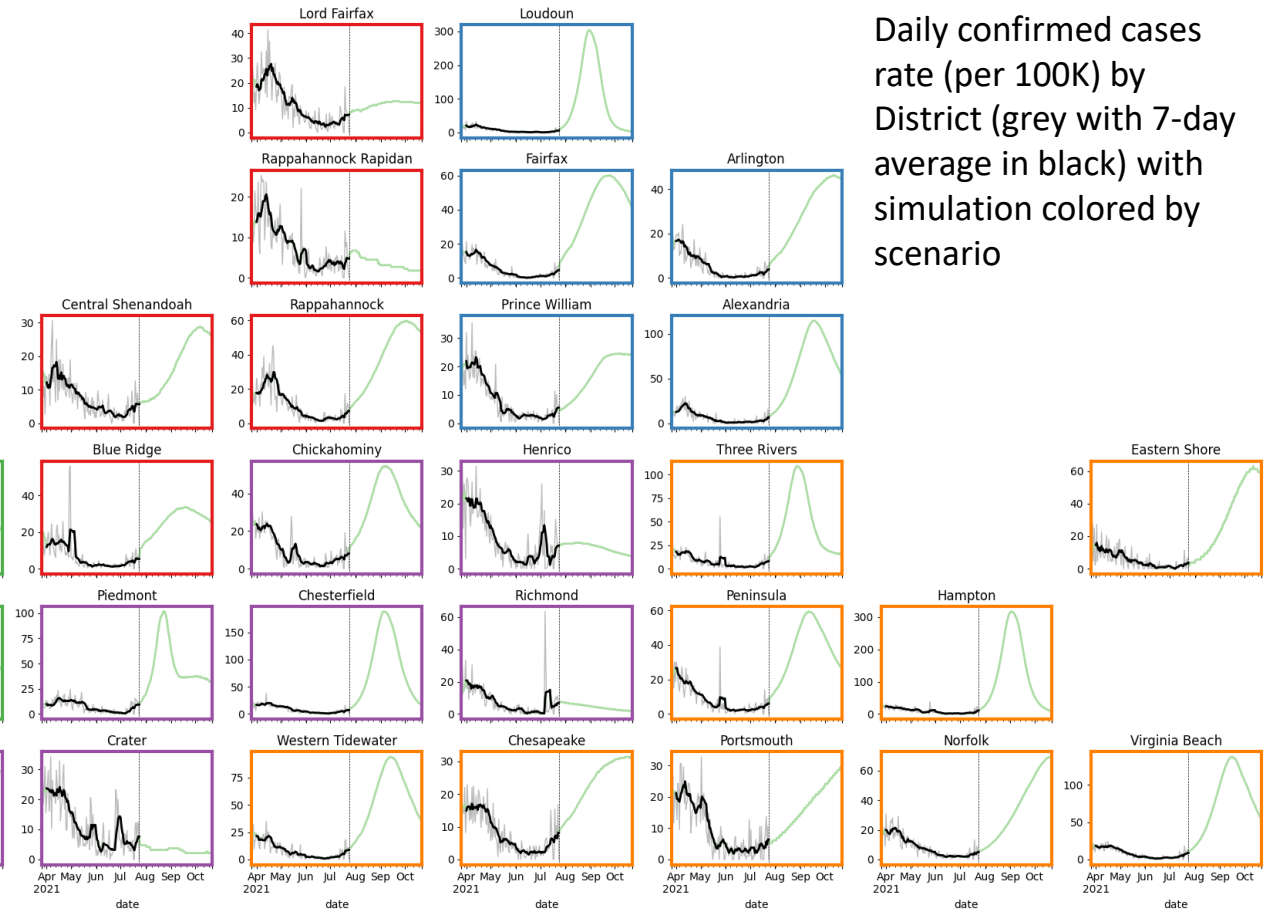**Projections by Region**
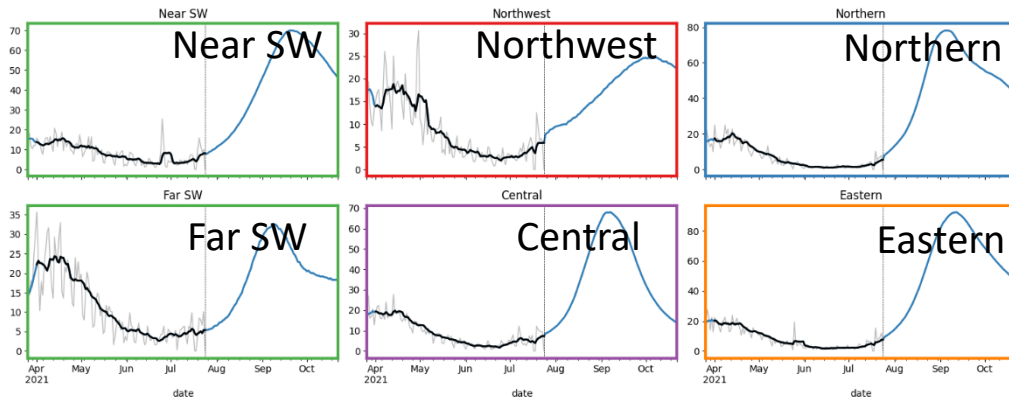
**Projections by District**

Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

# District Level Projections: Adaptive-VaxOpt

## Projections by Region



## Projections by District



Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

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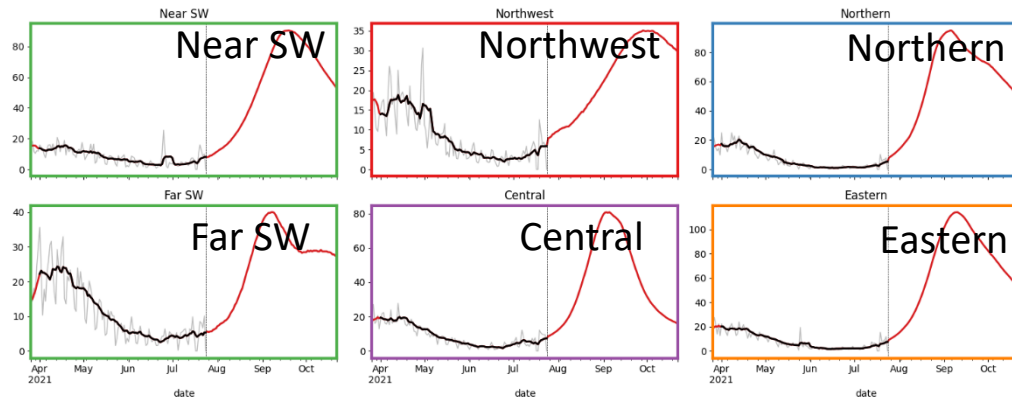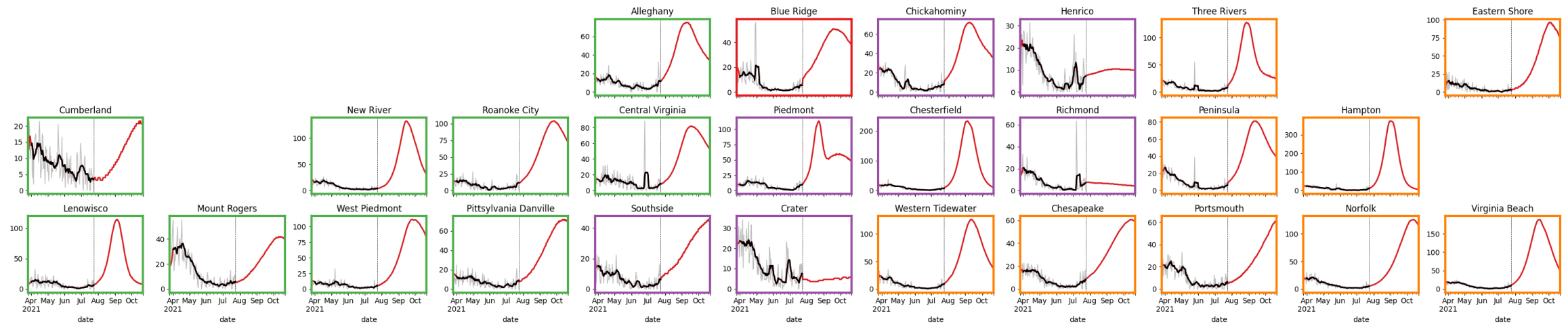# District Level Projections: Adaptive-Delta

## Projections by Region



## Projections by District



Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

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# District Level Projections: Adaptive-Delta-VaxOpt
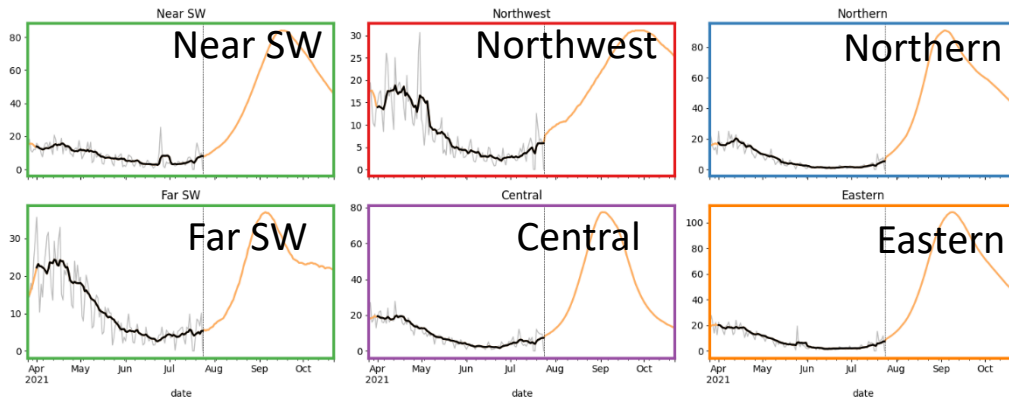
## Projections by Region



## Projections by District



Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

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# District Level Projections: SurgeControl

## Projections by Region



## Projections by District
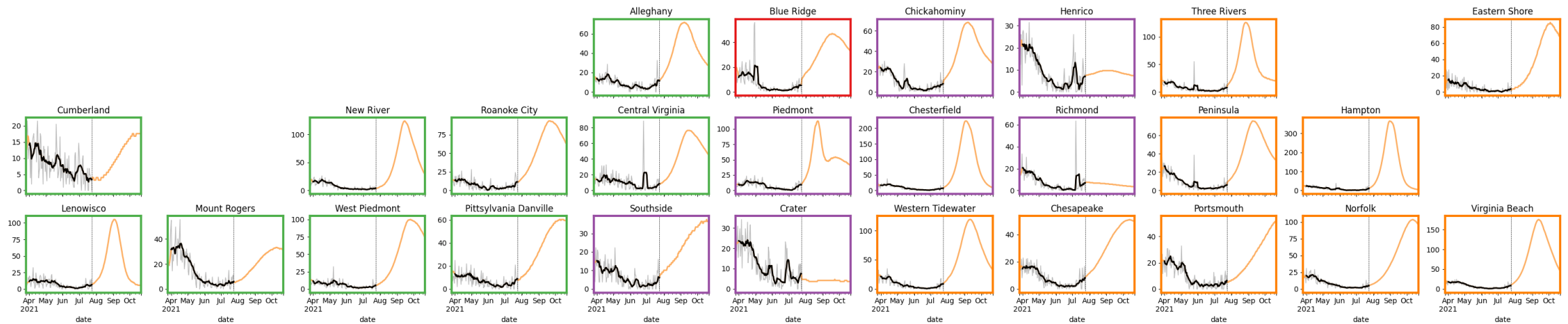


Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

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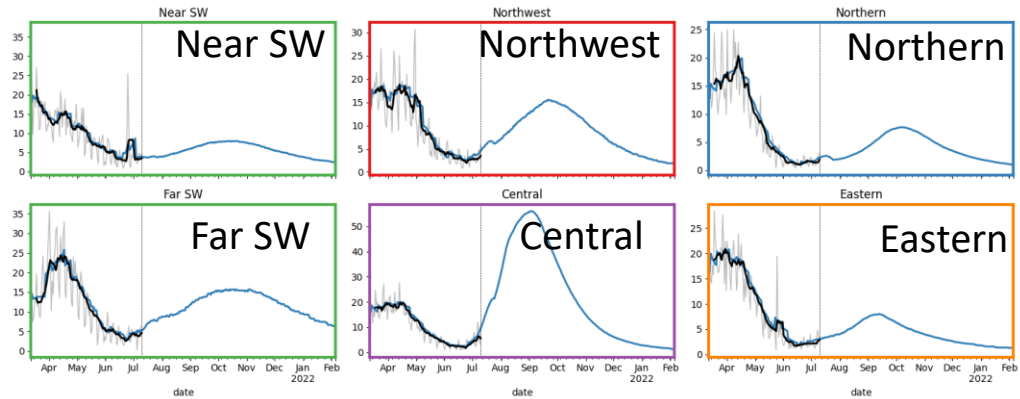# District Level Projections: SpringControl
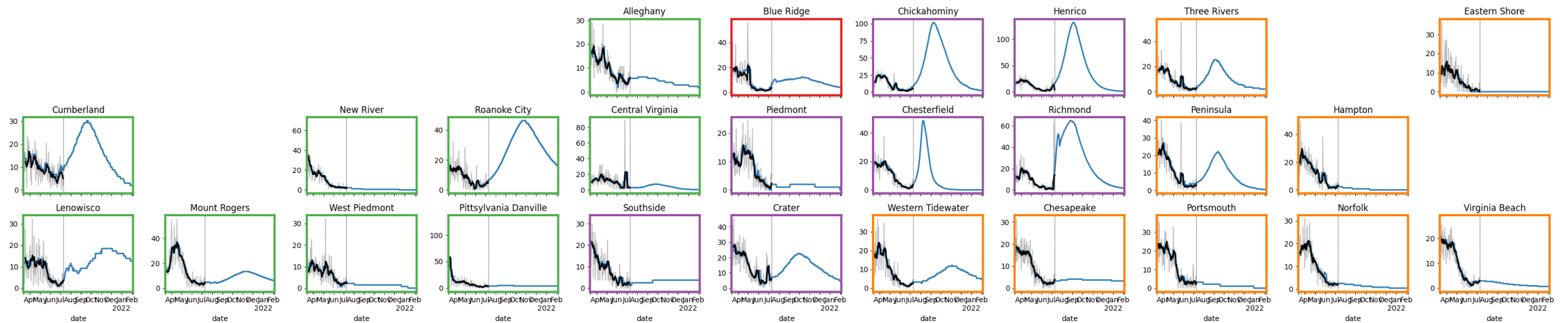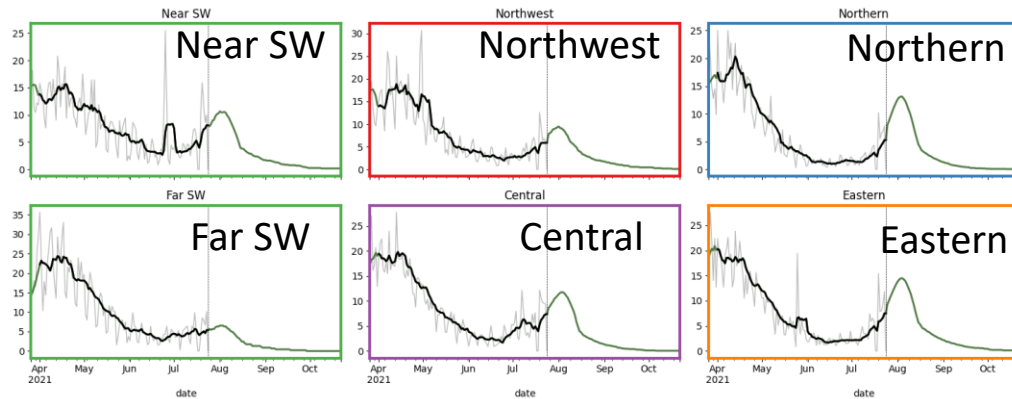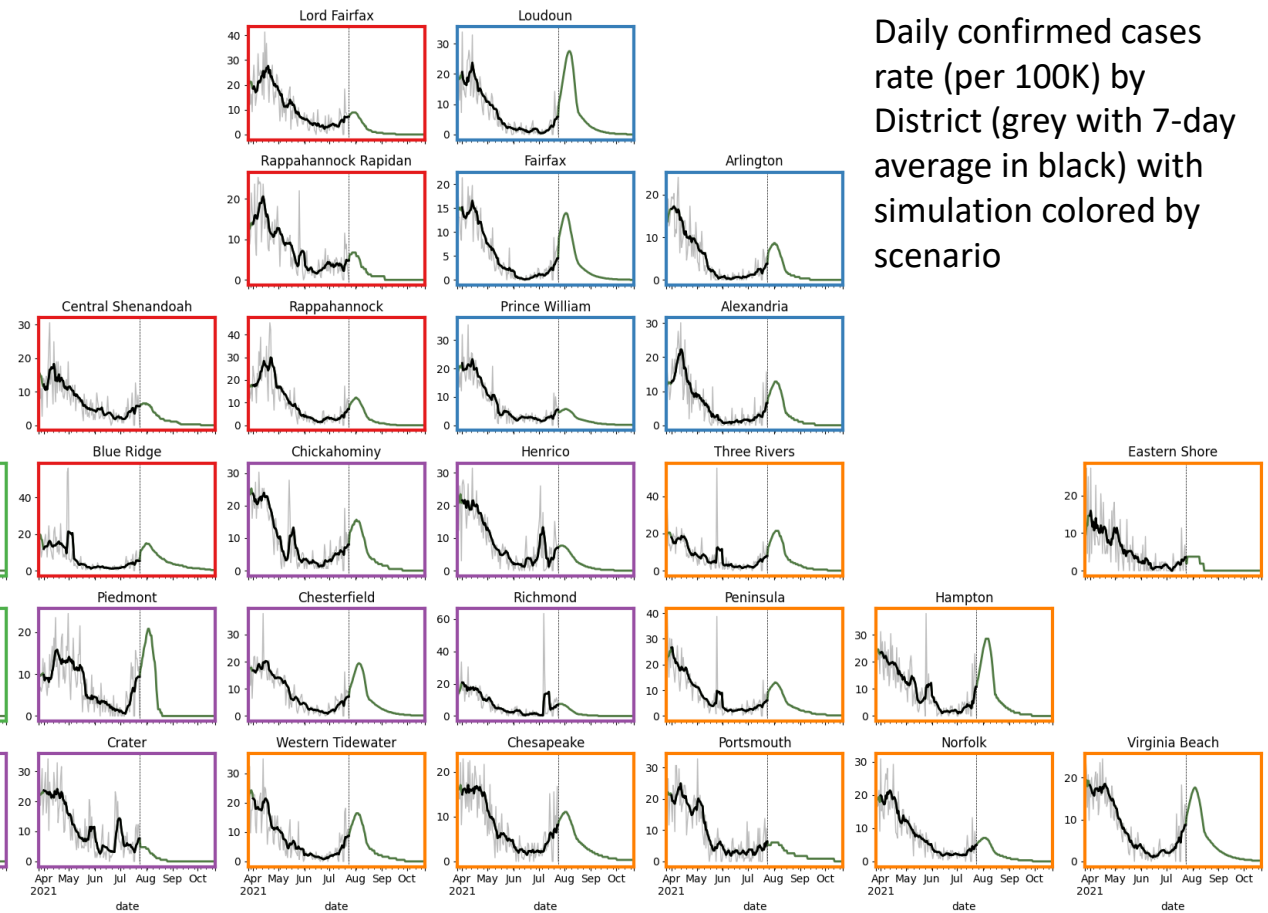
## Projections by Region



## Projections by District



Daily confirmed cases rate (per 100K) by District (grey with 7-day average in black) with simulation colored by scenario

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# Hospital Demand and Bed Capacity by Region

**Capacities\* by Region – Adaptive-Delta**

COVID-19 capacity ranges from 80% (dots) to 120% (dash) of total beds



https://nssac.bii.virginia.edu/covid-19/vmrddash/
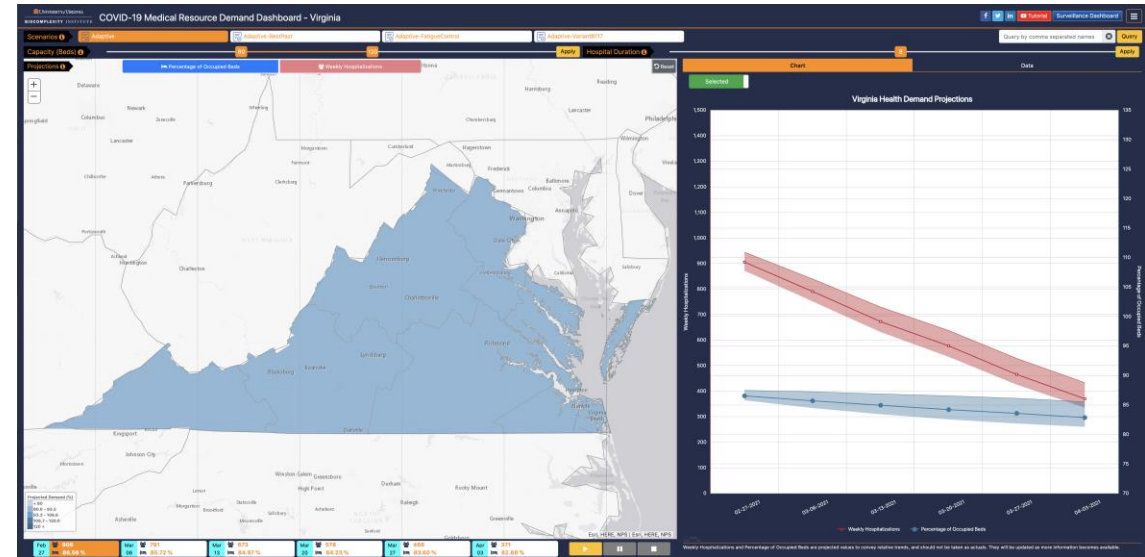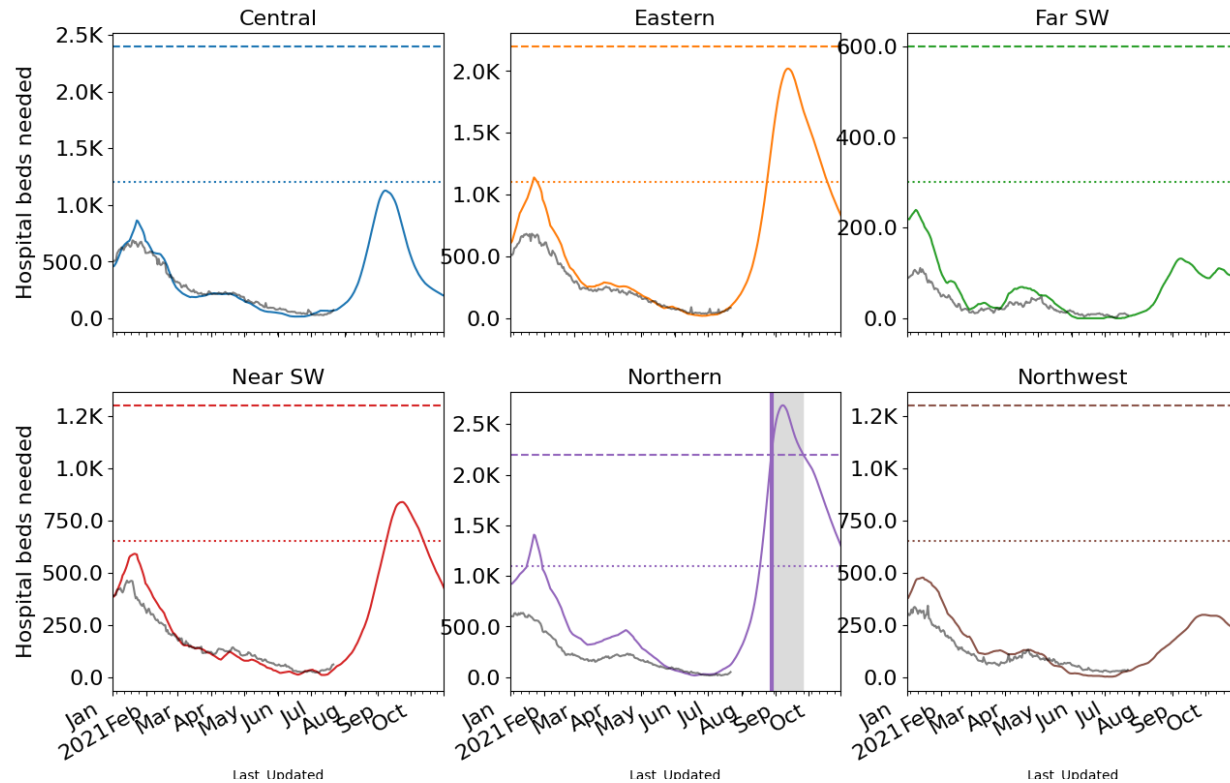
**Adaptive-Delta scenario shows that if the Delta fueled surge continues unabated:**

- Central could approach and Near SW and Eastern could exceed initial capacity
- Northern could exceed surge capacity

\* Assumes average length of stay of 8 days

# Virginia's Progress on Population Immunity

**Natural Immunity and Vaccines combine to produce a population level of immunity**

- Duration of immunity from infection with SARS-CoV2 still not well understood
  - We assume a conservative 6 month period of protection for these calculations
  - Do **not** factor in variant immune escape
  - Natural immunity is well calibrated to recent seroprevalence surveys

- Vaccine induced immunity is likely to last longer, we assume indefinite protection
  - This also assumes that all administered vaccines remain protective against current and future variants

- Population immunity depends on a very high proportion of the population getting vaccinated
  - Current models track measured seroprevalence
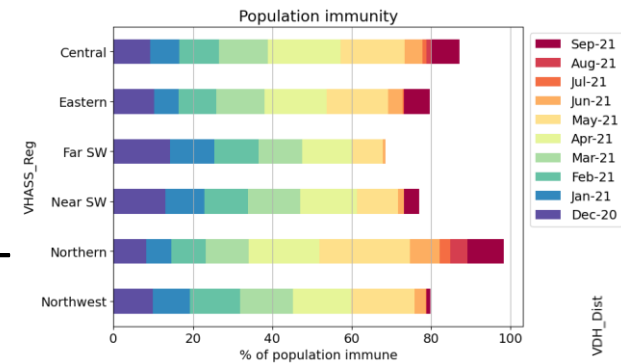


| Region | % adult immune (est.)* |
|--------|------------------------|
| Central | 78% |
| Eastern | 72% |
| Far SW | 64% |
| Near SW | 71% |
| Northern | 85% |
| Northwest | 78% |
| **Virginia** | **78%** |

\* As of July 25, 2021

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# Additional Analyses

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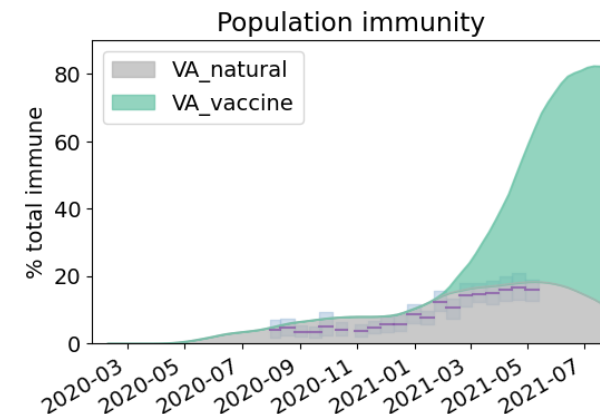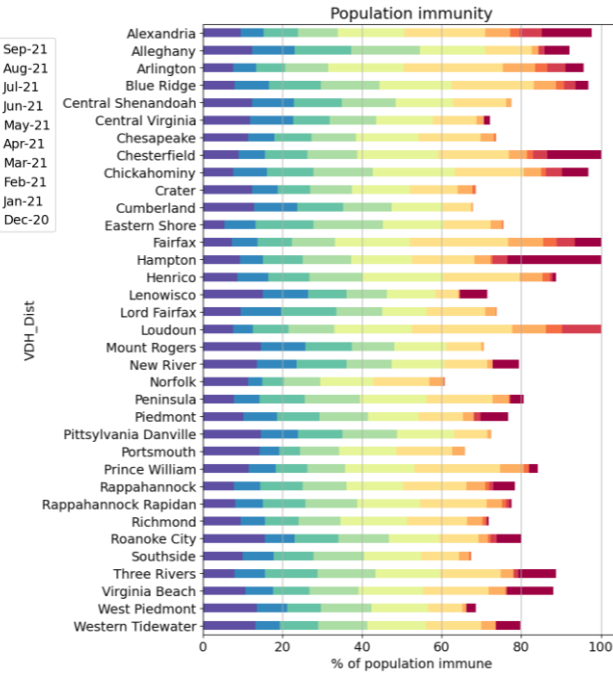
# Overview of relevant on-going studies

Other projects coordinated with CDC and VDH:

- **Scenario Modeling Hub:** Consortium of academic teams coordinated via MIDAS / CDC to that provides regular national projections based on timely scenarios

- **Genomic Surveillance:** Analyses of genomic sequencing data, VA surveillance data, and collaboration with VA DCLS to identify sample sizes needed to detect and track outbreaks driven by introduction of new variants etc.

- **Mobility Data driven Mobile Vaccine Clinic Site Selection:** Collaboration with VDH state and local, Stanford, and SafeGraph to leverage anonymized cell data to help identify

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# COVID-19 Scenario Modeling Hub

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios that vary vaccine rates (high – low) and impact of the Delta variant (high and low)

- Round 8 in planning
- Round 7 now available
- Round 6 similar to

*Round 4 Results were published May 5th, 2021 in MMWR*



https://covid19scenariomodelinghub.org/viz.html

Projected Incident Cases by Epidemiological Week and by Scenario for Round 7
( - Projection Epiweek; -- Current Week)
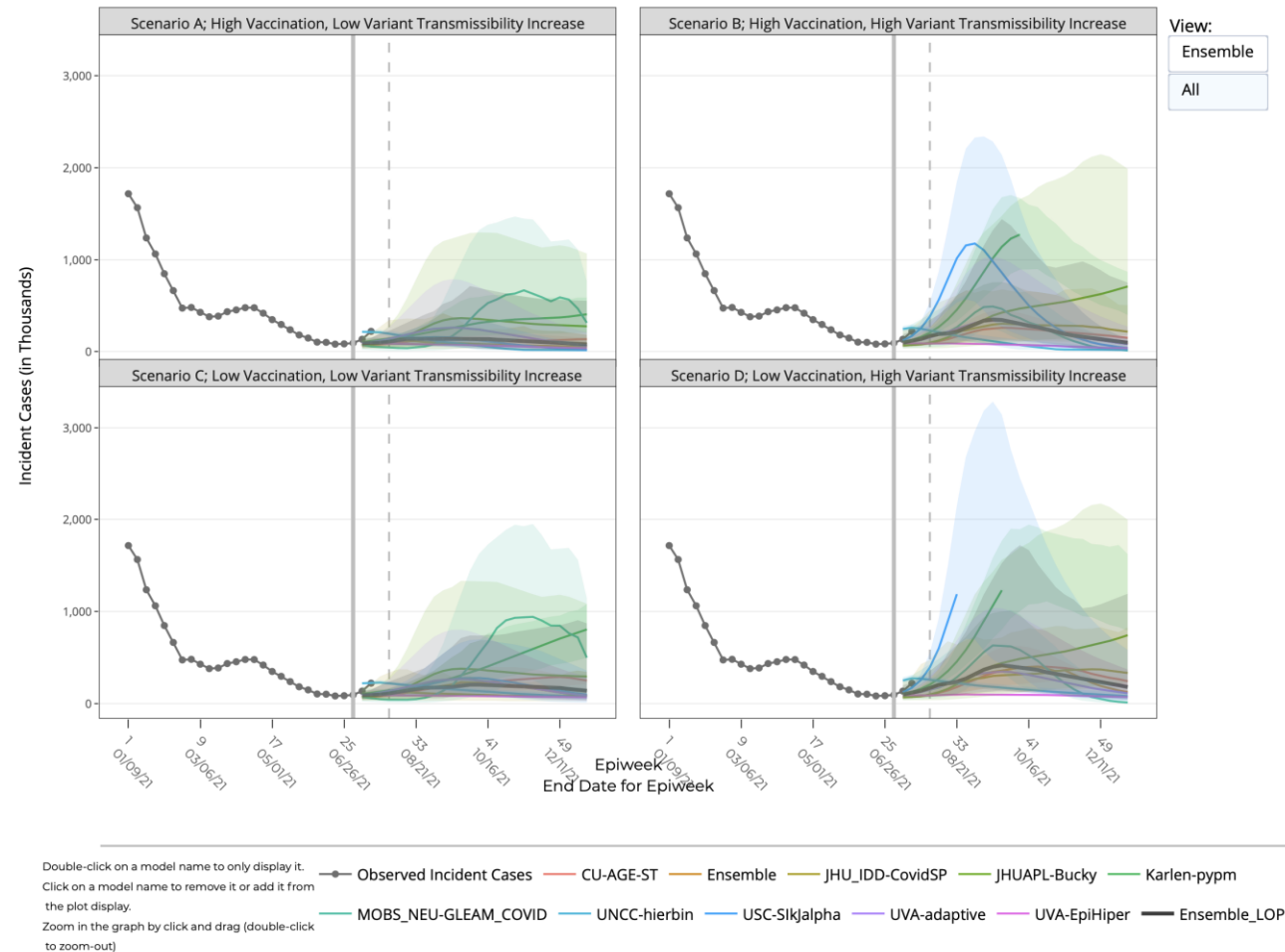
# COVID-19 Scenario Modeling Hub – Round 6

Round 7 scenarios explore the effects of a variant similar to Delta (B.1.617.2) against different backgrounds of vaccination.  Includes some vax escape

**Vaccinations by Nov 30**

- LowVacc – 70% overall coverage

- HighVacc – 80% overall coverage

**Emerging Variant Impact** (5% prevalence on May 29th)

- LowVar – 40% more transmissible

- HighVar – 60% more transmissible

https://covid19scenariomodelinghub.org/viz.html

28-Jul-21
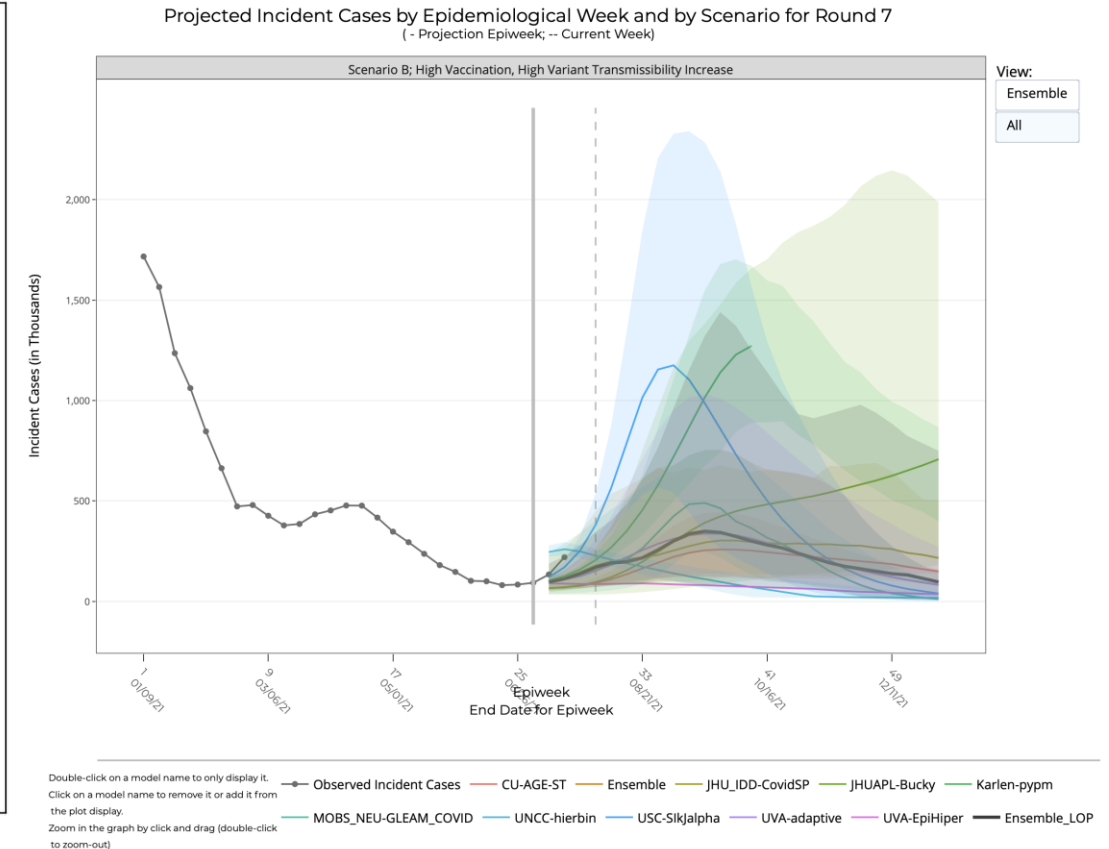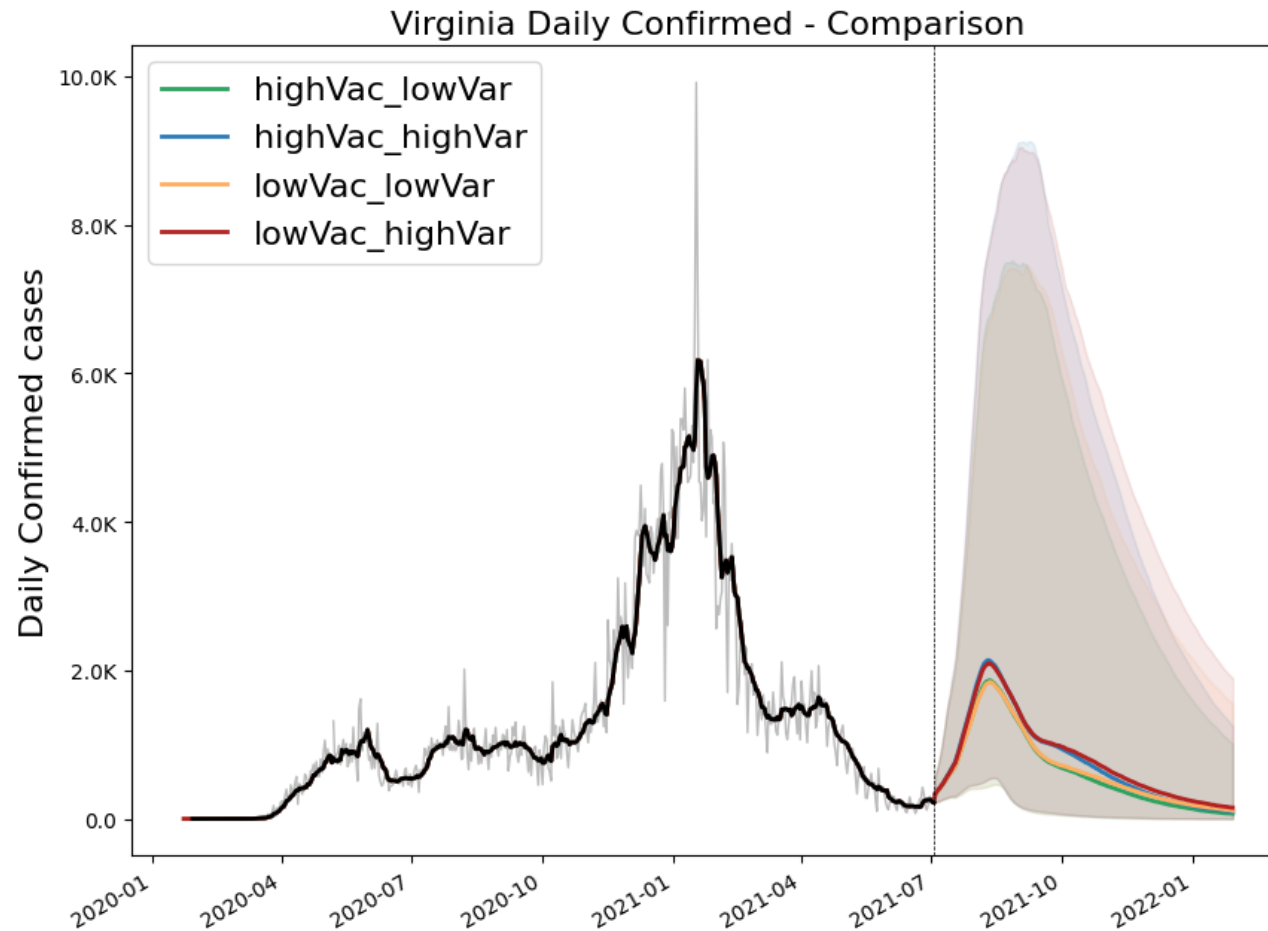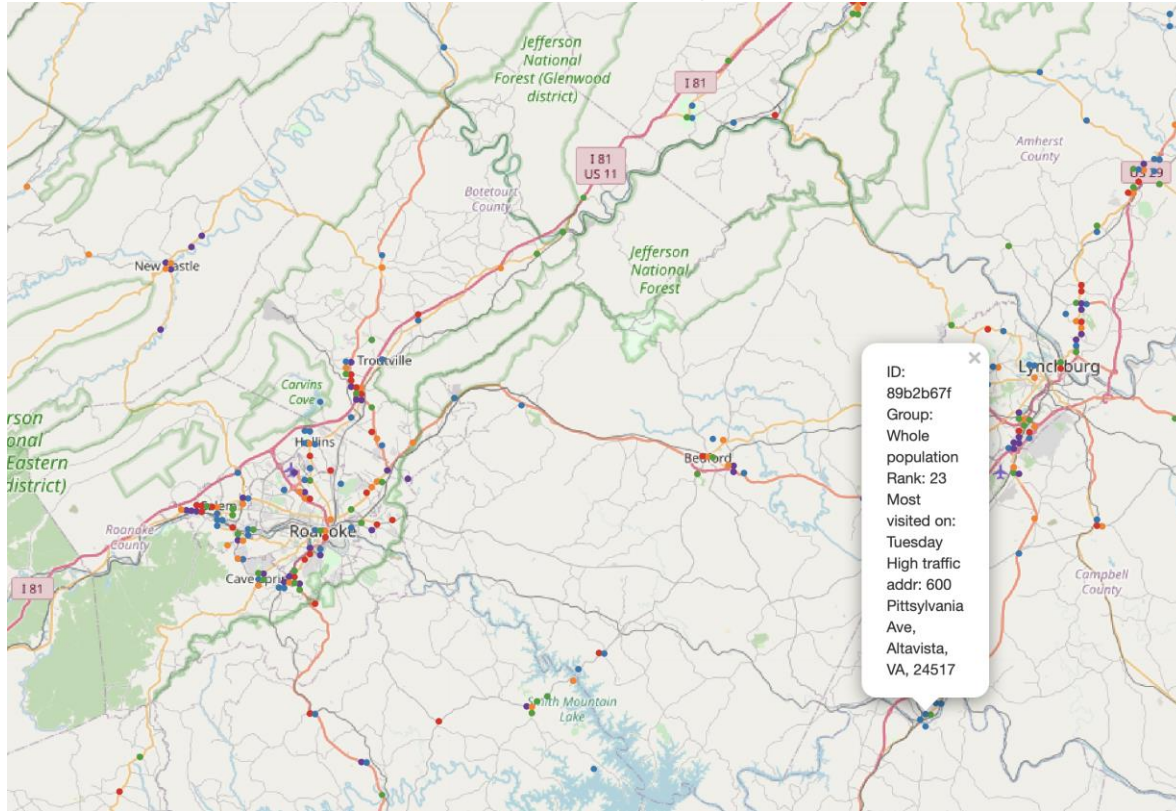
| | **LowVar** | **HighVar** |
|---|---|---|
| **See more detailed notes for each scenario below** | **Low Impact Variant** *(low transmissibility increase, no immune escape)* | **High Impact Variant** *(high transmissibility increase, no immune escape)* |
| **High Vaccination** *(Low hesitancy)*<br><br>**HighVacc** | ***Scenario A***<br><br>Vaccination:<br>- Coverage saturates at **80% nationally** among the vaccine-eligible population* by December 31, 2021**<br>- VE is **50%/90%** for Pfizer/Moderna against the Delta variant, against symptoms (1st /2nd dose)<br>- J&J no longer used<br><br>Variant:<br>- **40% increased transmissibility** as compared with Alpha for Delta variant. Initial prevalence estimated at state-level by teams. | ***Scenario B***<br><br>Vaccination:<br>- Coverage saturates at **80% nationally** among the vaccine-eligible population* by December 31, 2021**<br>- VE is **35%/85%** for Pfizer/Moderna against the Delta variant, against symptoms (1st /2nd dose)<br>- J&J no longer used<br><br>Variant:<br>- **60% increased transmissibility** as compared with Alpha for Delta variant. Initial prevalence estimated at state-level by teams. |
| **Low Vaccination** *(High hesitancy)*<br><br>**LowVacc** | ***Scenario C***<br><br>Vaccination:<br>- Coverage saturates at **70% nationally** among the vaccine-eligible population* by December 31, 2021**<br>- VE is **50%/90%** for Pfizer/Moderna against the Delta variant, against symptoms (1st /2nd dose)<br>- J&J no longer used<br><br>Variant:<br>- **40% increased transmissibility** as compared with Alpha for Delta variant. Initial prevalence estimated at state-level by teams. | ***Scenario D***<br><br>Vaccination:<br>- Coverage saturates at **70% nationally** among the vaccine-eligible population* by December 31, 2021**<br>- VE is **35%/85%** for Pfizer/Moderna against the Delta variant, against symptoms (1st /2nd dose)<br>- J&J no longer used<br><br>Variant:<br>- **60% increased transmissibility** as compared with Alpha for Delta variant. Initial prevalence estimated at state-level by teams. |

# Modeling Hub – Round 7 Prelim Results

https://covid19scenariomodelinghub.org/viz.html

# Data Recommended Mobile Vax Clinic Sites

## Detailed and Timely Locations



ID: 89b2b67f
Group: Whole population
Rank: 23
Most visited on: Tuesday
High traffic addr: 600 Pittsylvania Ave, Altavista, VA, 24517

**Data Delivered and Disseminated to Locals**
Provides a list of areas most visited by a given demographic group based on SafeGraph mobility data that links visits to specific sites and the home Census Block Group of the anonymized visitors

**Demographic Groups**: Black, Lantinx, Young Adults (20-40), Unvaccinated, and Whole Population

**Data Included**: Rank, Weight, most visited Day of Week, Highly Visited Address, and Lat-Long of area

**Goal:** Provide frequently visited locations based on populations and vaccination levels one desires to reach
**Example:** List of location in the Southside frequented by 20-40 year olds

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# Data Recommended Mobile Vax Clinic Sites

Overlap of locations between groups



**State Level**

**Within VDH Health Districts**

**Different groups visit different areas**

- Least overlap between Black and Latinx
- Overlap in ages highest, but drops with large gap
- Districts have different overlap patterns

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# Key Takeaways

Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

- **Case rates in Virginia continue to rise quickly amidst a background of surges across the nation**

- VA mean weekly incidence up to 7.8/100K from 4.4/100K, US up to 15.6/100K (from 10/100K)

- Vaccination rates experience slight rebound while acceptance among the unvaccinated persists and may be growing slightly in some regions

- Projections show significant uptick in activity, with larger growth possible fueled by Delta's increasing prevalence, even areas with high vaccination coverage

- Recent updates:
  - Added projection scenarios to examine conditions needed to control the current surges in activity
  - Delta variant dominates and has impacts on severity of disease

- The situation continues to change. Models continue to be updated regularly.

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Biocomplexity page for data and other resources related to COVID-19: https://covid19.biocomplexity.virginia.edu/

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# Questions?

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# Supplemental Slides

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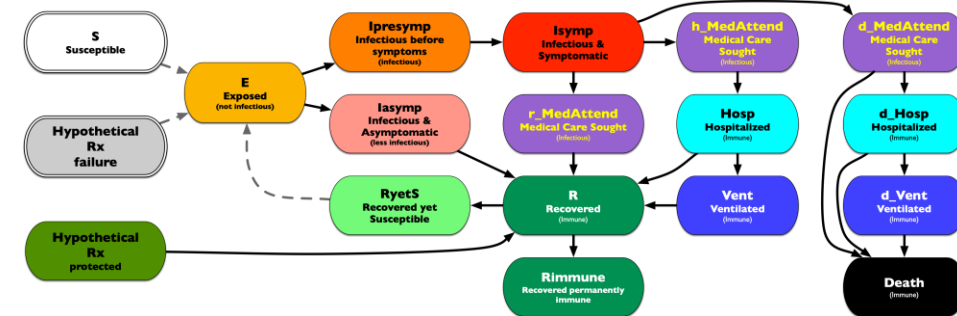
# Agent-based Model (ABM )

## EpiHiper: Distributed network-based stochastic disease transmission simulations

- Assess the impact on transmission under different conditions

- Assess the impacts of contact tracing
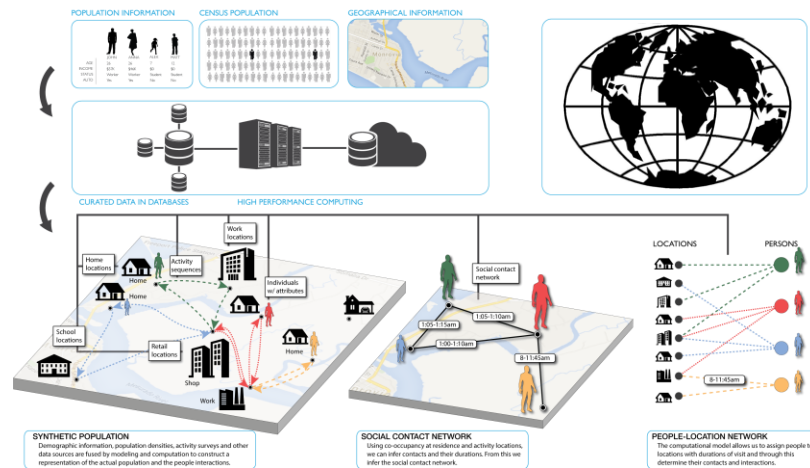


**Synthetic Population**
- Census derived age and household structure
- Time-Use survey driven activities at appropriate locations



**Detailed Disease Course of COVID-19**
- Literature based probabilities of outcomes with appropriate delays
- Varying levels of infectiousness
- Hypothetical treatments for future developments

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