Network Systems Science & Advanced Computing

Biocomplexity Institute & Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

July 20th, 2022

(data current to July 17th – 19th)

Biocomplexity Institute Technical report: TR BI-2022-1619

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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

Key Takeaways

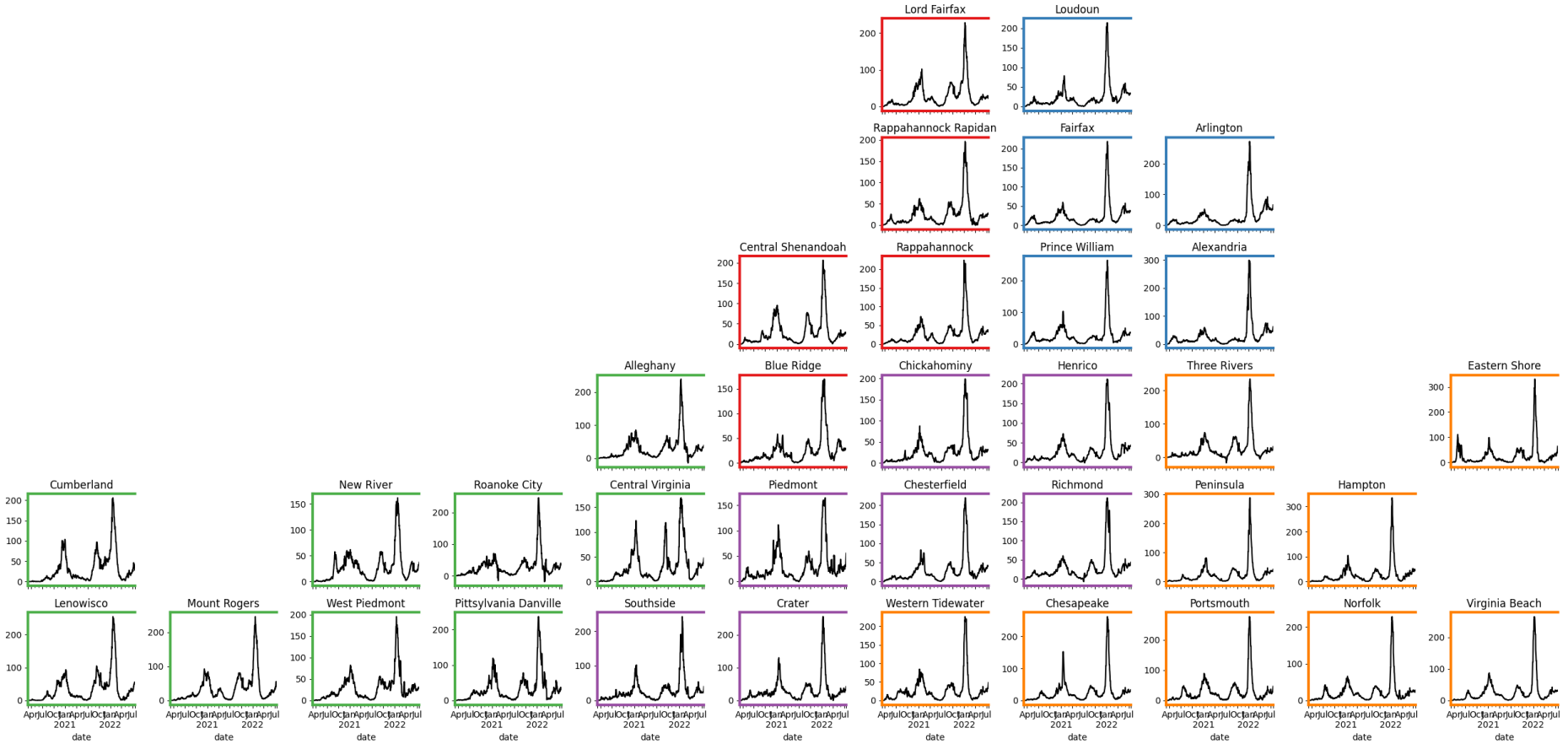
Projecting future cases precisely is impossible and unnecessary.
Even without perfect projections, we can confidently draw conclusions:

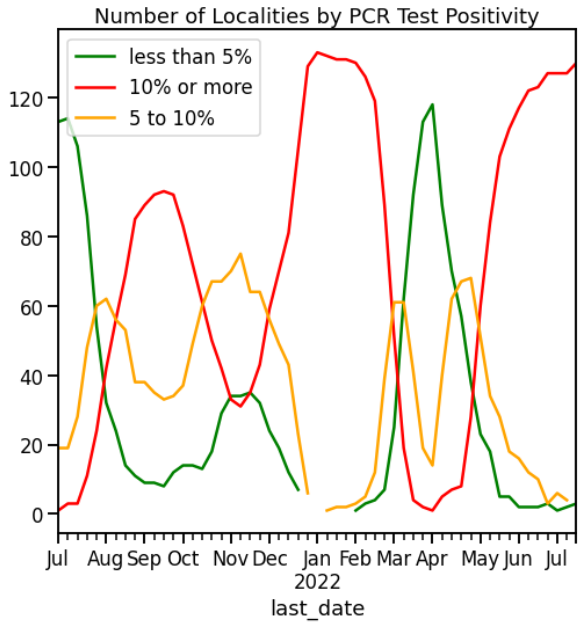
- **Case rates remain high and continue to rise as do hospitalizations**
- VA weekly case rate slightly up to 284/100K from 242/100K
  - US also slightly down to 259/100K from 233/100K
  - VA hospital occupancy (rolling 7 day mean of 670 from 641) continues to rise for past 10 days
- Omicron sub-variants BA.5 still dominates overall, however, there remains pockets where it has not yet reached which are likely to experience growth in cases
- Projections from last week remain largely on target

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

Situation Assessment

Case Rates (per 100k) and Test Positivity





County level RT-PCR test positivity

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

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

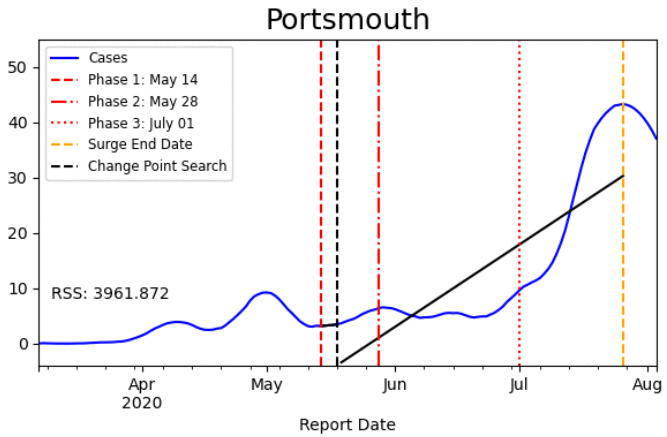
Red: >10.0% (and not "Green" or "Yellow")

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

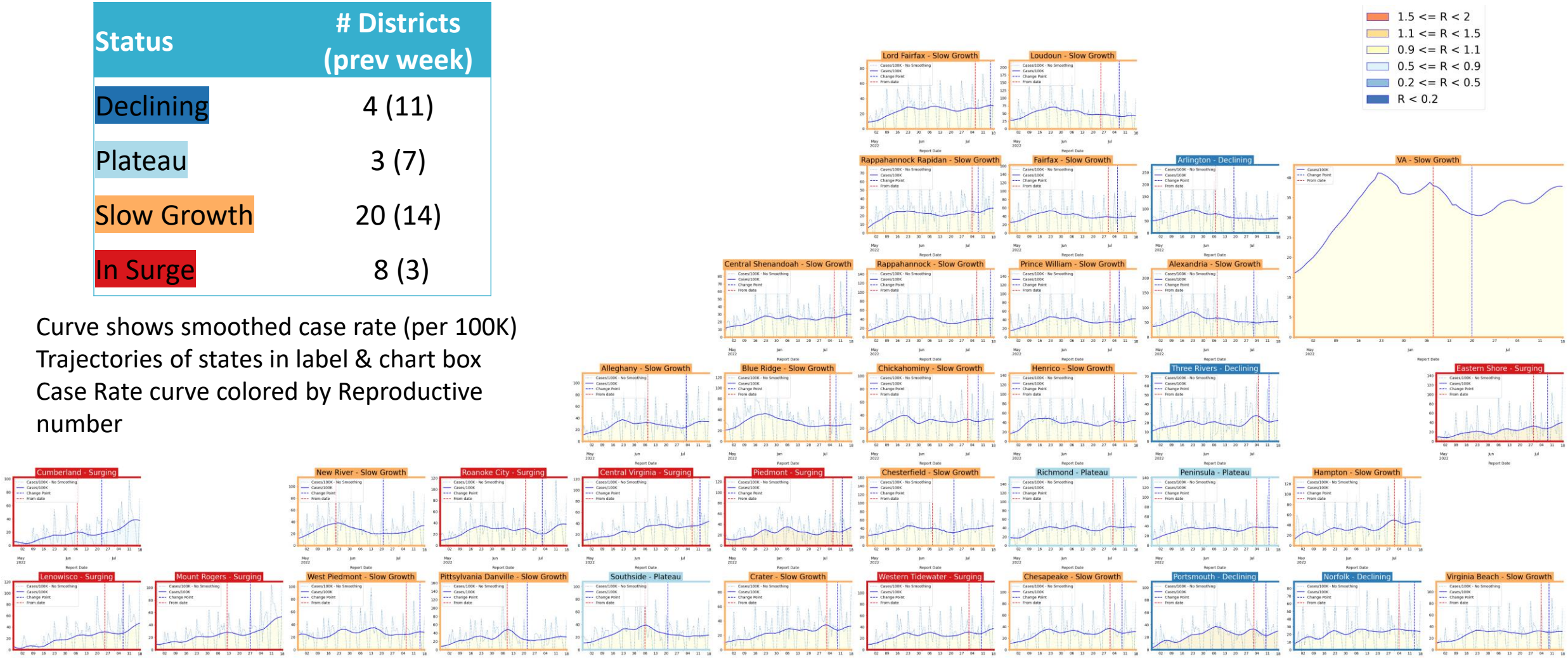


Trajectory	Description	Weekly Case Rate (per 100K) bounds
Declining	Sustained decreases following a recent peak	below -0.9
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5
In Surge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

District Trajectories – last 10 weeks

Status	# Districts (prev week)
Declining	4 (11)
Plateau	3 (7)
Slow Growth	20 (14)
In Surge	8 (3)

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



CDC's new COVID-19 Community Levels

What Prevention Steps Should You Take Based on Your COVID-19 Community Level?

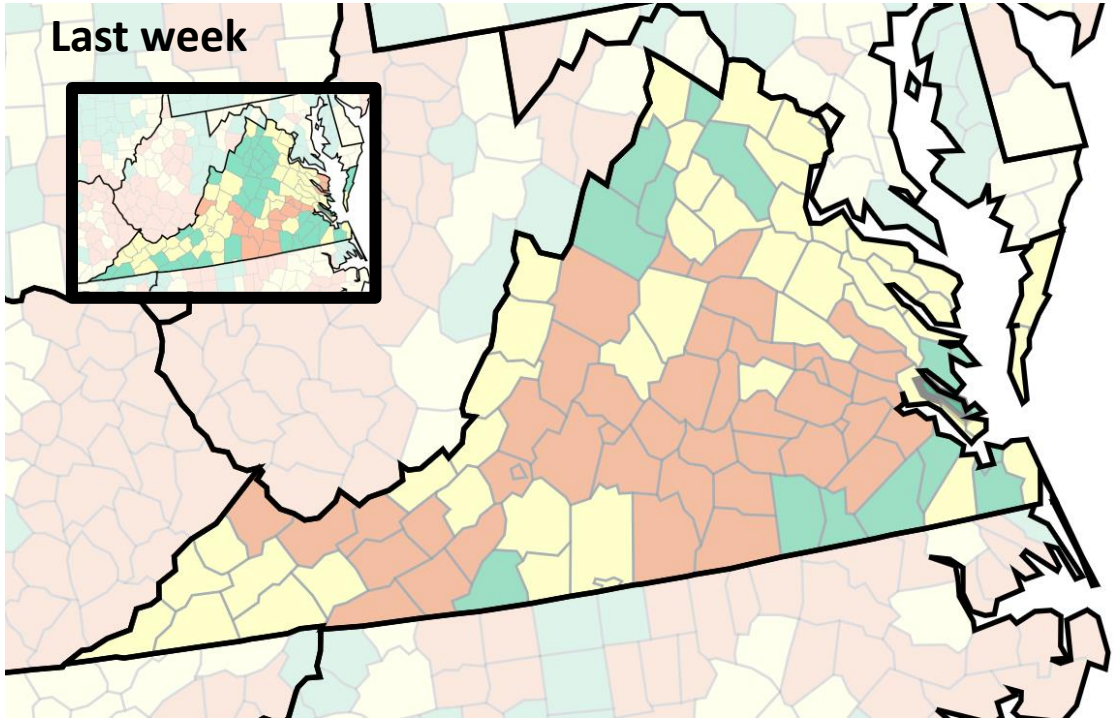
Low	Medium	High
• Stay up to date with COVID-19 vaccines • Get tested if you have symptoms	• If you are at high risk for severe illness, talk to your healthcare provider about whether you need to wear a mask and take other precautions • Stay up to date with COVID-19 vaccines • Get tested if you have symptoms	• Wear a mask indoors in public • Stay up to date with COVID-19 vaccines • Get tested if you have symptoms • Additional precautions may be needed for people at high risk for severe illness

People may choose to mask at any time. People with symptoms, a positive test, or exposure to someone with COVID-19 should wear a mask.

COVID-19 Community Levels – Use the Highest Level that Applies to Your Community

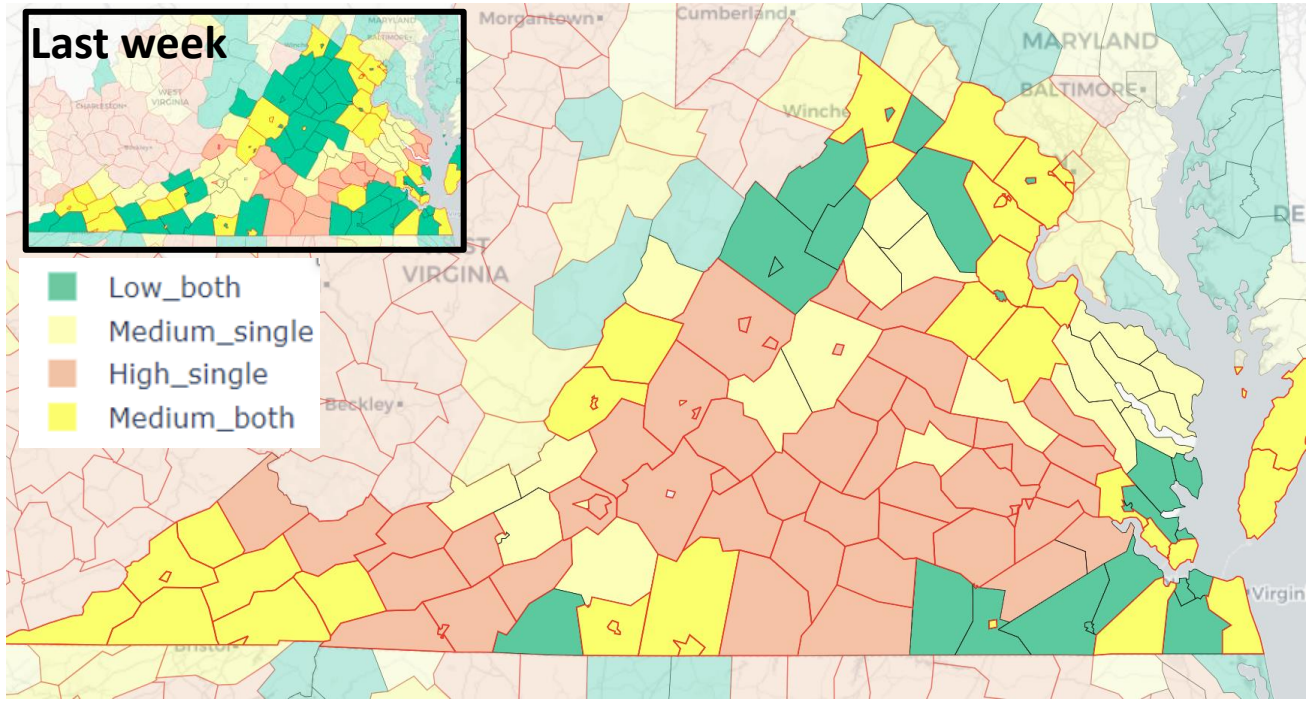
New COVID-19 Cases Per 100,000 people in the past 7 days	Indicators	Low	Medium	High
Fewer than 200	New COVID-19 admissions per 100,000 population (7-day total)	<10.0	10.0-19.9	≥20.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	<10.0%	10.0-14.9%	≥15.0%
200 or more	New COVID-19 admissions per 100,000 population (7-day total)	NA	<10.0	≥10.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	NA	<10.0%	≥10.0%

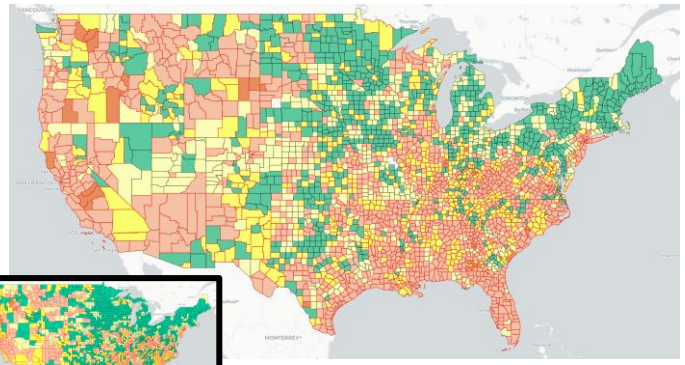
The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100,000 population in the past 7 days

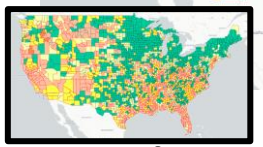


[CDC Data Tracker Portal]

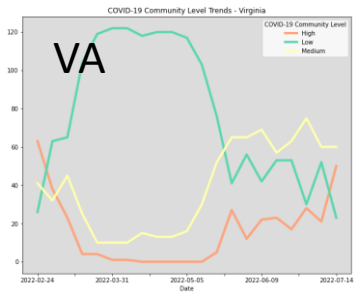
CDC's new COVID-19 Community Levels

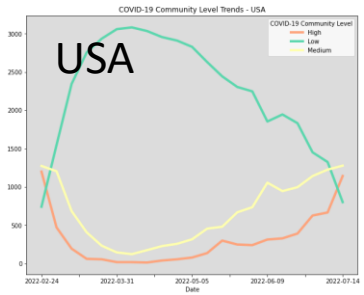






Last week





Red outline indicates county had 200 or more cases per 100k in last week

Pale color indicates either beds or occupancy set the level for this county

Dark color indicates both beds and occupancy set the level for this county

COVID-19 Community Levels – Use the Highest Level that Applies to Your Community

New COVID-19 Cases Per 100,000 people in the past 7 days	Indicators	Low	Medium	High
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The COVID-19 community level is determined by the higher of the new admissions and inpatient beds metrics, based on the current level of new cases per 100,000 population in the past 7 days

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Data from: CDC Data Tracker Portal

District Trajectories with Community Levels

Community Level (Title Color)
- High
- High-Med
- Med-High
- Medium
- Med-Low
- Low-Med
- Low

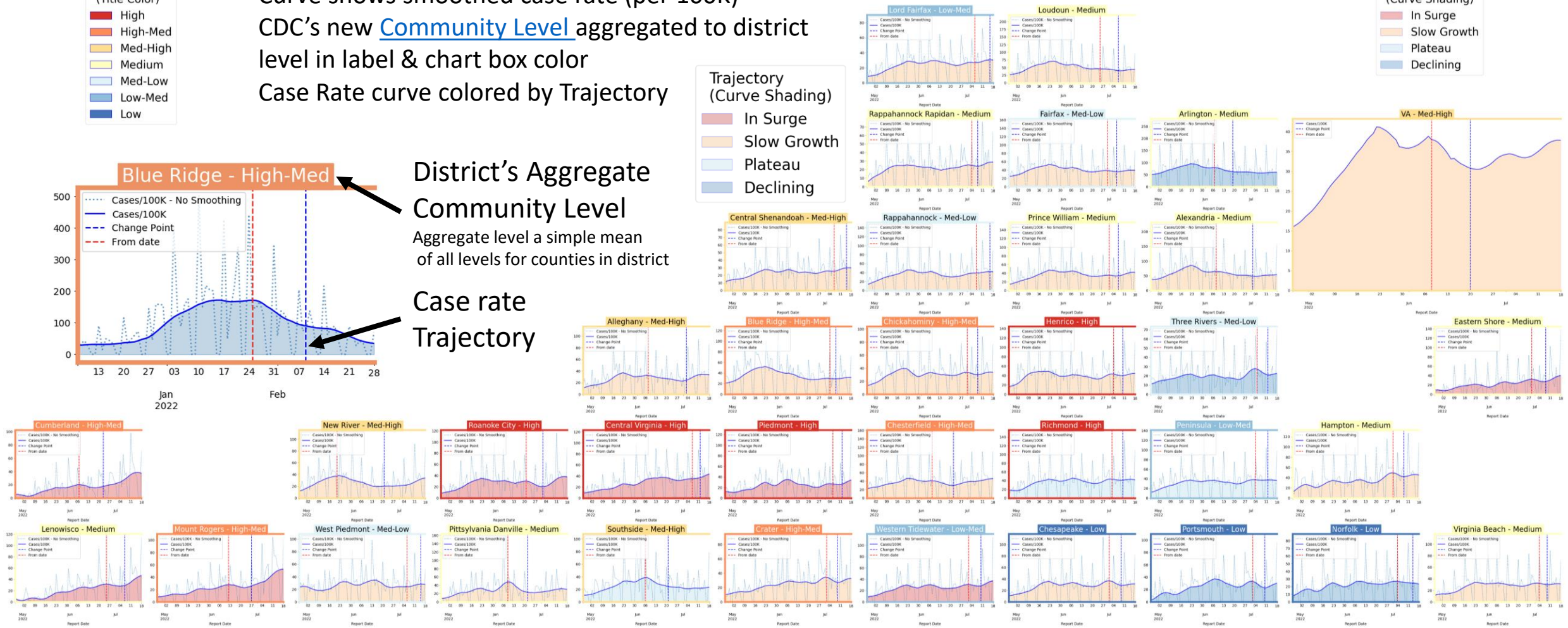
Curve shows smoothed case rate (per 100K)
CDC's new Community Level aggregated to district level in label & chart box color
Case Rate curve colored by Trajectory

Trajectory (Curve Shading)
- In Surge
- Slow Growth
- Plateau
- Declining

District's Aggregate Community Level

Aggregate level a simple mean of all levels for counties in district

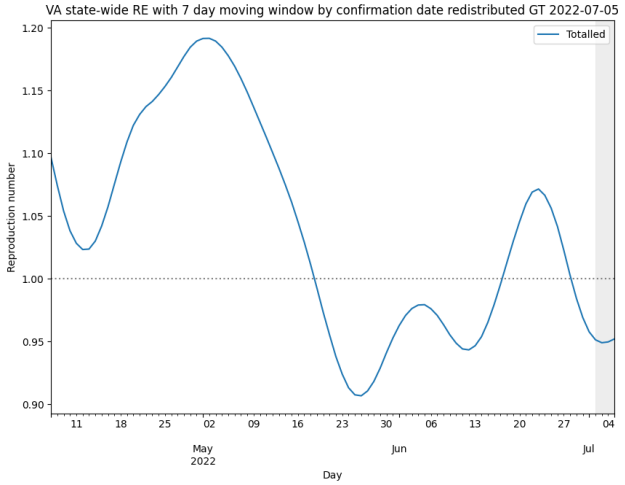
Case rate Trajectory

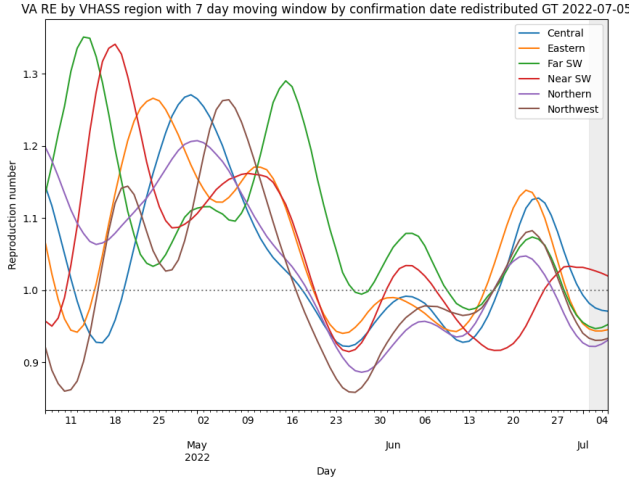


Estimating Daily Reproductive Number – Redistributed gap

July 18th Estimates

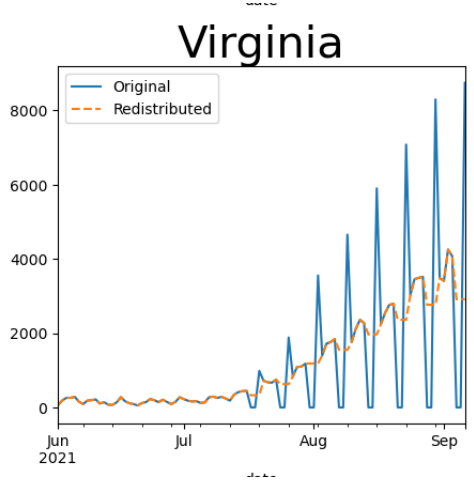
Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	0.981	-0.007
Central	1.006	0.042
Eastern	1.002	0.052
Far SW	0.981	-0.087
Near SW	0.971	-0.073
Northern	0.969	-0.034
Northwest	0.961	0.012





Skipping Weekend Reports & holidays biases estimates

Redistributed "big" report day to fill in gaps, and then estimate R from "smoothed" time series



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

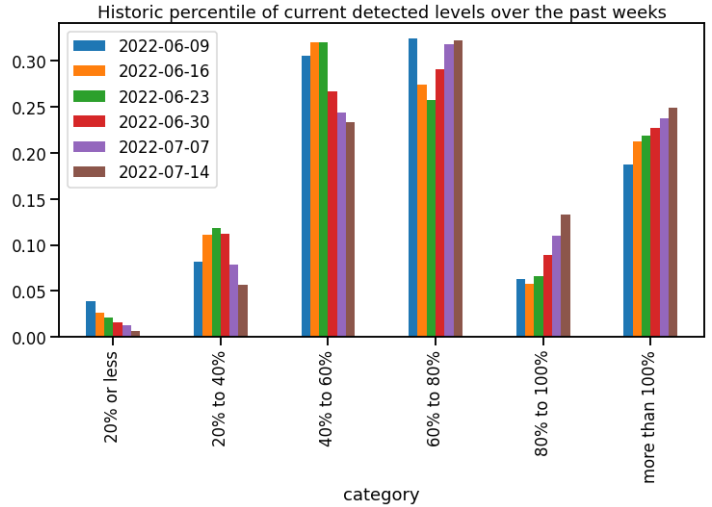
1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, https://doi.org/10.1093/aje/kwt133

Wastewater Monitoring

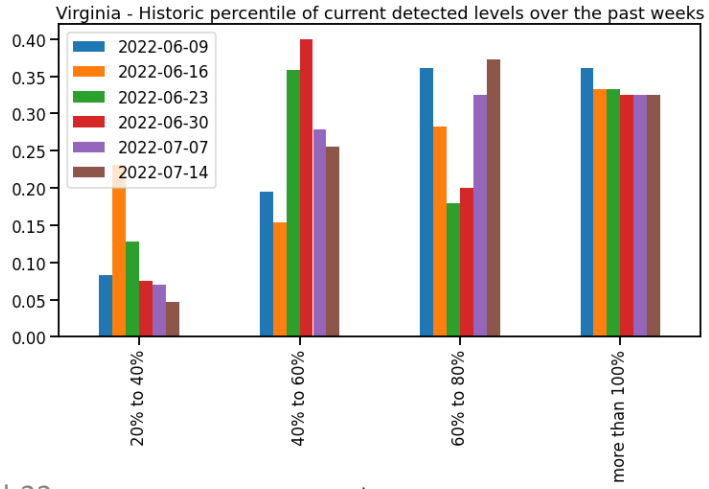
Wastewater provides a coarse early warning of COVID-19 levels in communities

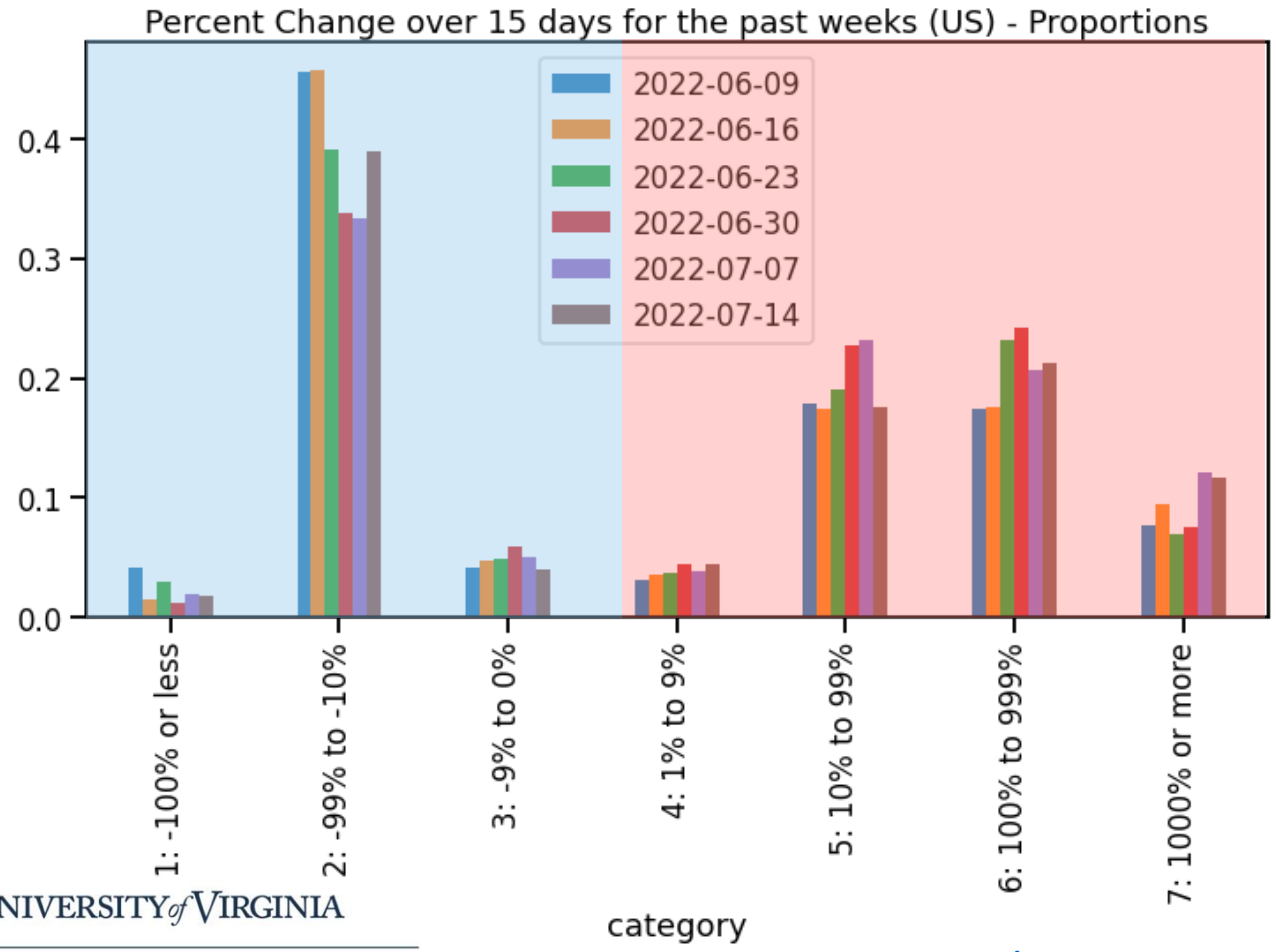
- Overall in the US, there is an increase in sites with increased levels of virus compared to 15 days ago
- Current virus levels are at or exceeding max of previous historical levels, has slowed, though more sites are entering upper quintiles

USA



VA





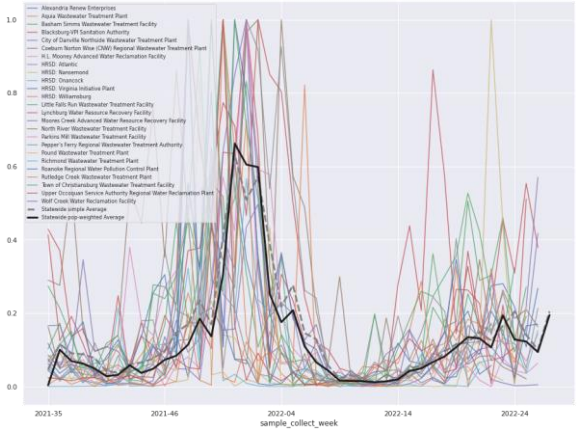
Data Source: CDC Data Tracker

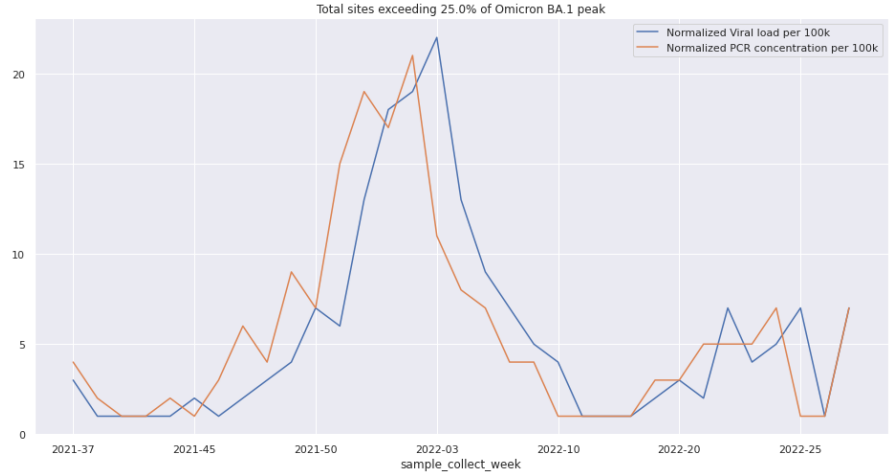
Prelim VDH Wastewater Analysis

Wastewater provides a coarse early warning of COVID-19 levels in communities

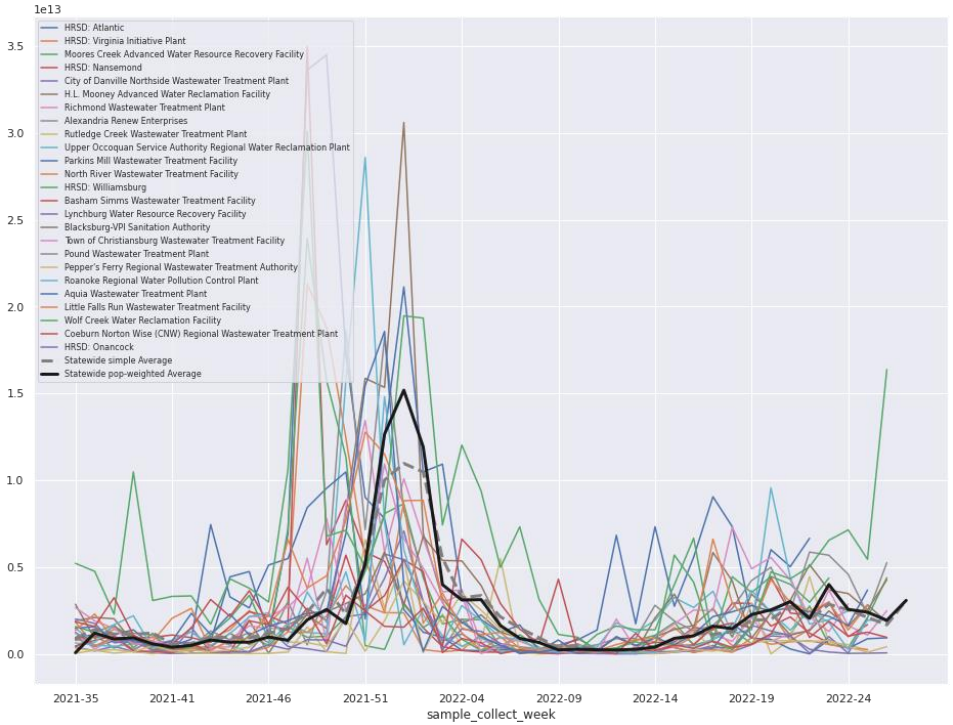
- **Viral Load per 100k**: Adjust raw viral RNA by population served (per 100k)
- **Normalized PCR concentration**: Adjust PCR concentration by population served, and further normalized against max reading per site

Normalized PCR concentration





Viral load per 100k



Data Source: VDH Environmental Health

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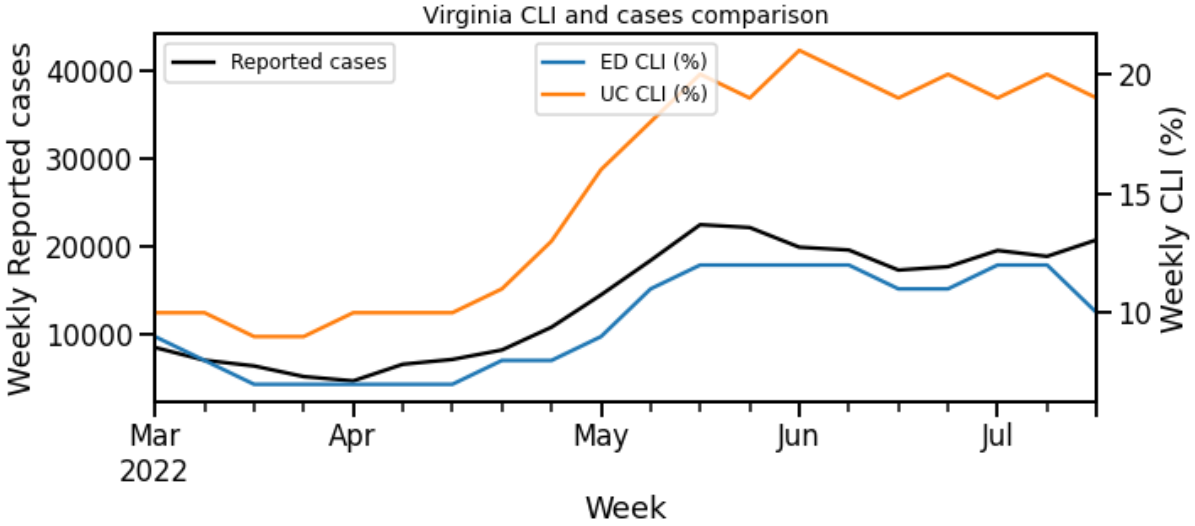
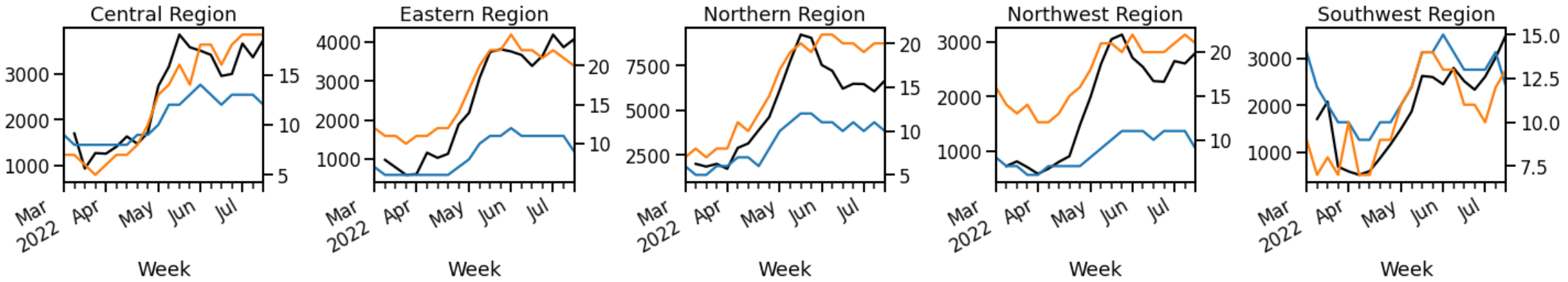
COVID-like Illness Activity

COVID-like Illness (CLI) gives a measure of COVID transmission in the community

- Emergency Dept (ED) based CLI is more correlated with case reporting
- Urgent Care (UC) is a leading indicator but prone to some false positives
- **Current trends in UC CLI have plateaued for last 8 weeks state-wide, mixed by region**





SARS-CoV2 Variants of Concern

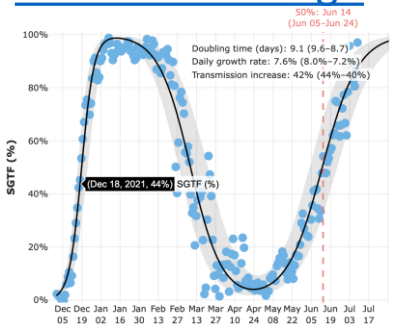
Emerging new variants will alter the future trajectories of pandemic and have implications for future control

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

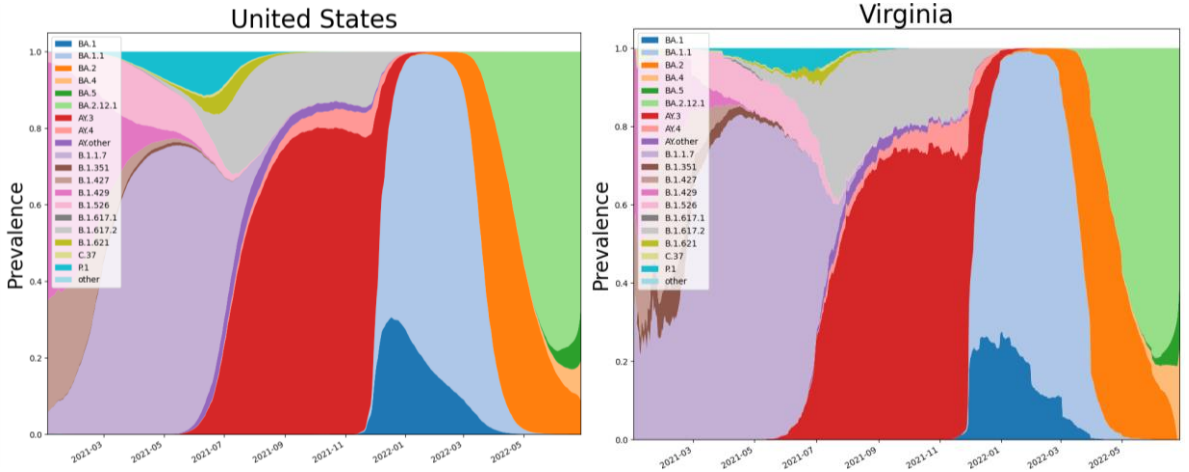
Omicron Updates (Region 3)

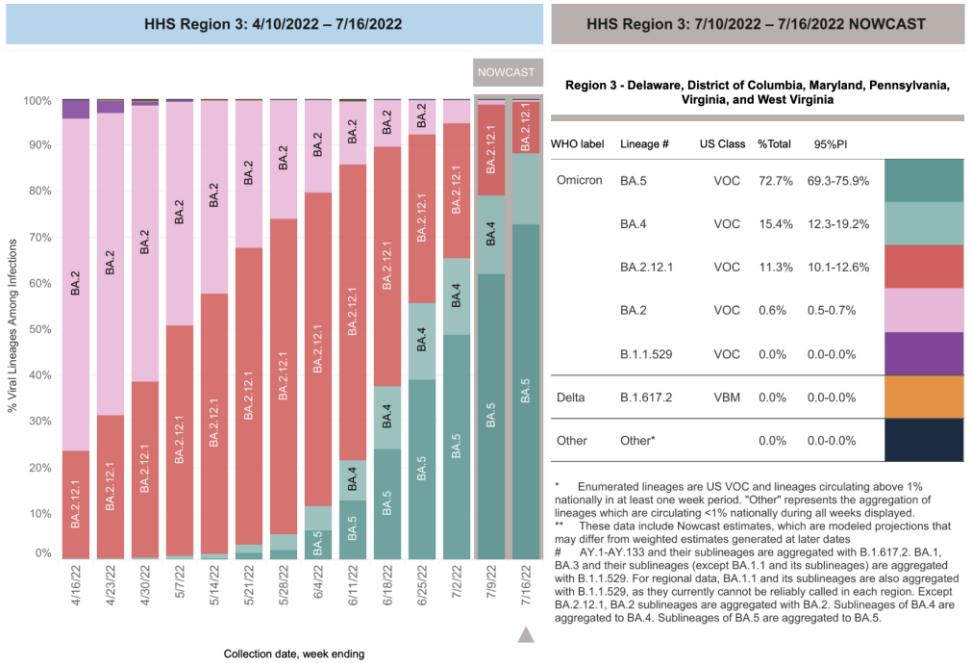
- BA.2.12.1 growth has continued to decline, shrinking to 11% from 25% last week
- BA.4 stagnated at 15-19% for past 4 weeks
- BA.5 continues to grow rapidly, nowcasted at 53% (up from 56% last week)
- BA.4 and BA.5 have same mutation as BA.1 that produces S-gene target failure, so can be tracked in more real time with SGTF from some PCR tests

[SGTF in San Diego]



Currently estimated to be nearly 100%% in San Diego





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

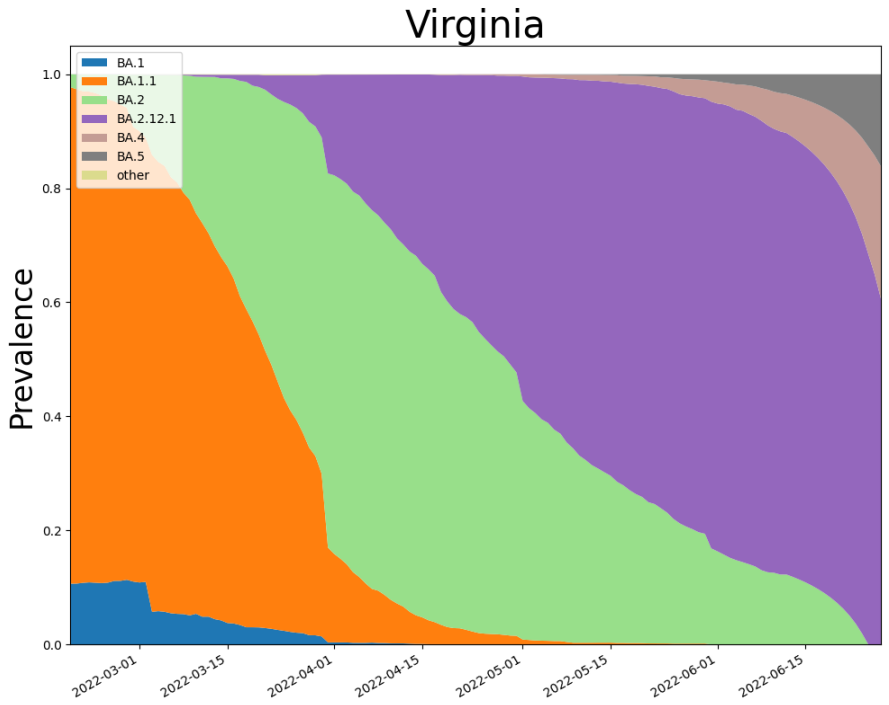
WHO label	Lineage #	US Class	%Total	95%PI
Omicron	BA.5	VOC	72.7%	69.3-75.9%
	BA.4	VOC	15.4%	12.3-19.2%
	BA.2.12.1	VOC	11.3%	10.1-12.6%
	BA.2	VOC	0.6%	0.5-0.7%
	B.1.1.529	VOC	0.0%	0.0-0.0%
Delta	B.1.617.2	VBM	0.0%	0.0-0.0%
Other	Other*		0.0%	0.0-0.0%

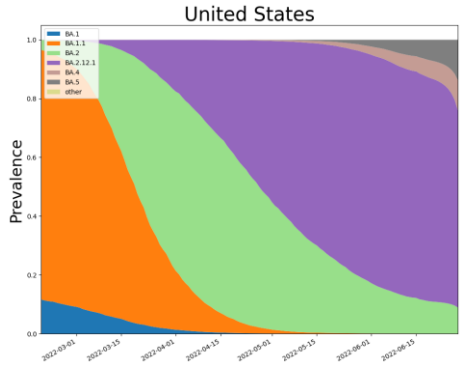
* Enumerated lineages are US VOC and lineages circulating above 1% nationally in at least one week period. "Other" represents the aggregation of lineages which are circulating <1% nationally during all weeks displayed.
** These data include Nowcast estimates, which are modeled projections that may differ from weighted estimates generated at later dates
# AY.1-AY.133 and their sublineages are aggregated with B.1.617.2. BA.1, BA.3 and their sublineages (except BA.1.1 and its sublineages) are aggregated with B.1.1.529. For regional data, BA.1.1 and its sublineages are also aggregated with B.1.1.529, as they currently cannot be reliably called in each region. Except BA.2.12.1, BA.2 sublineages are aggregated with BA.2. Sublineages of BA.4 are aggregated to BA.4. Sublineages of BA.5 are aggregated to BA.5.

CDC Variant Tracking

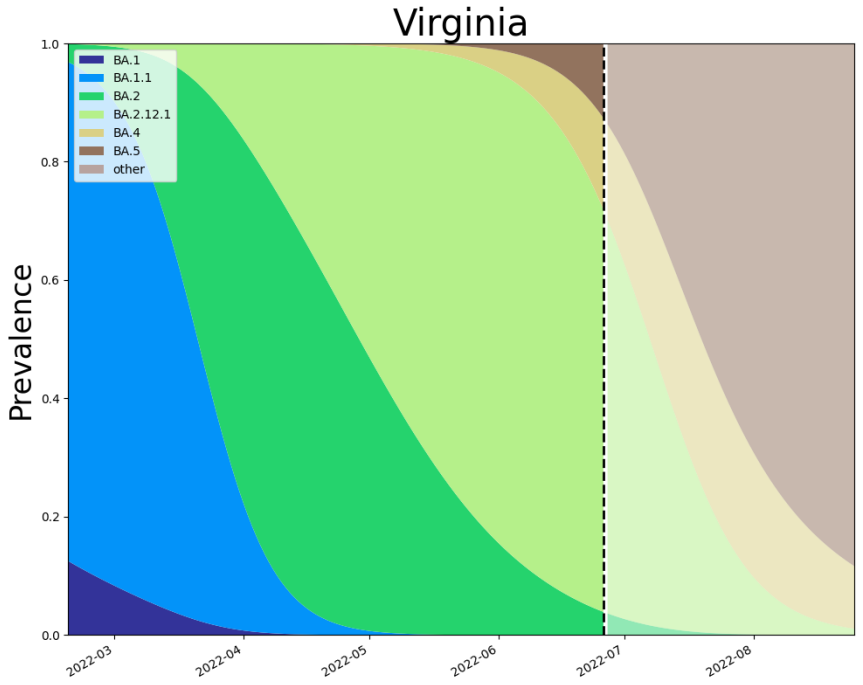
SARS-CoV2 Omicron and Sub-Variants

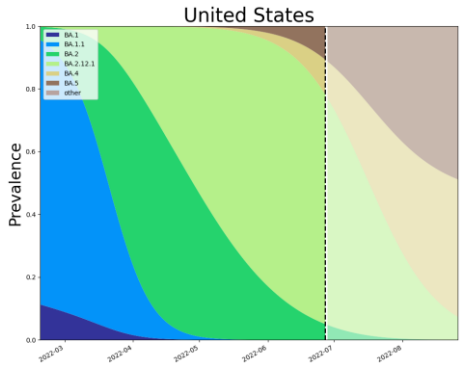
As detected in whole Genomes in public repositories





VoC Polynomial Fit Projections



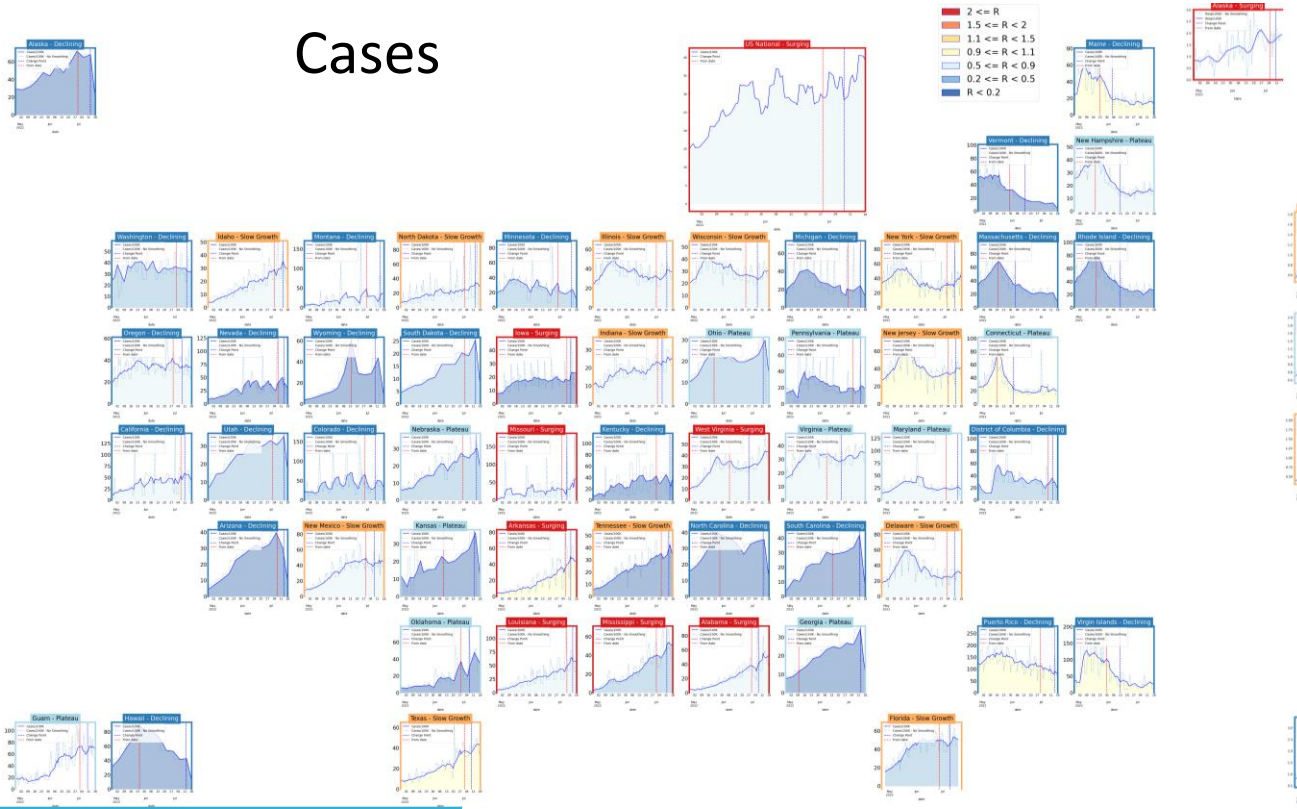


Note: Data lags force projections to start in past. Everything from dotted line forward is a projection.

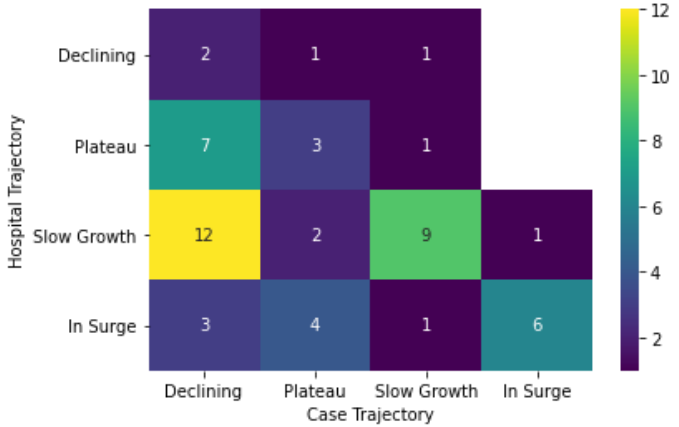
GISAID outbreak.info

United States Case & Hospitalizations

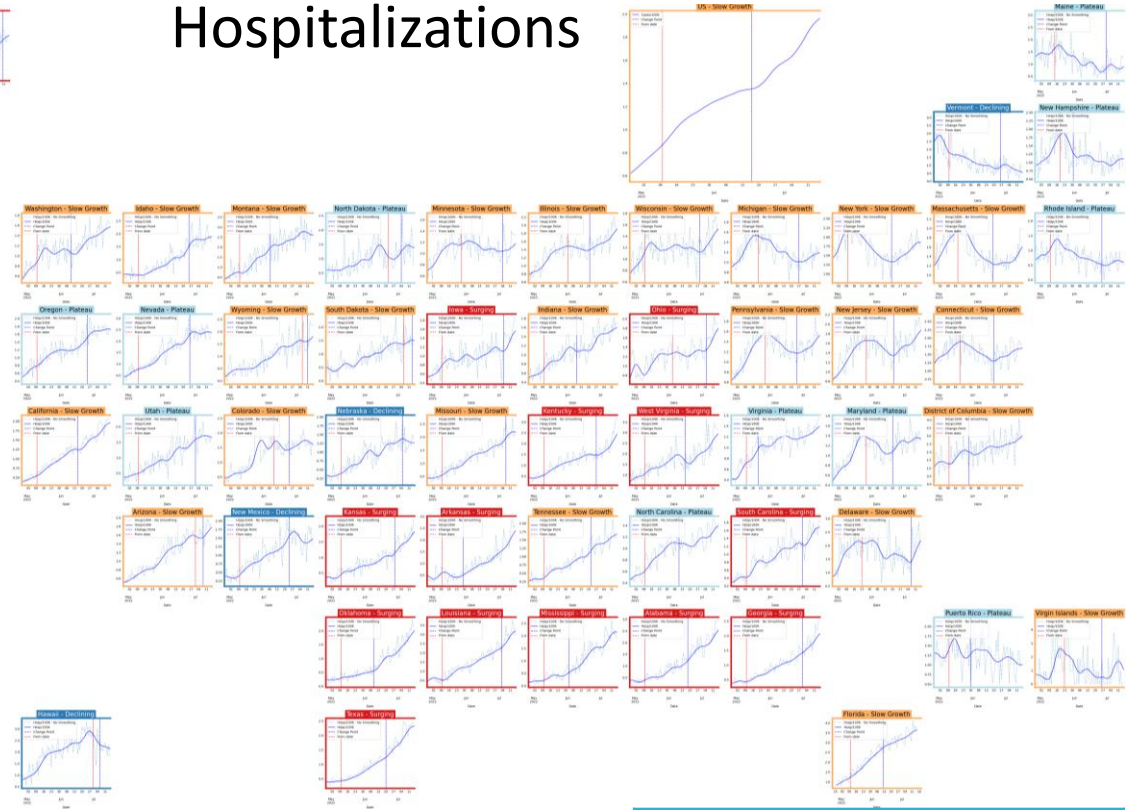
Cases



Status	# States
Declining	24 (32)
Plateau	11 (16)
Slow Growth	12 (2)
In Surge	7 (4)



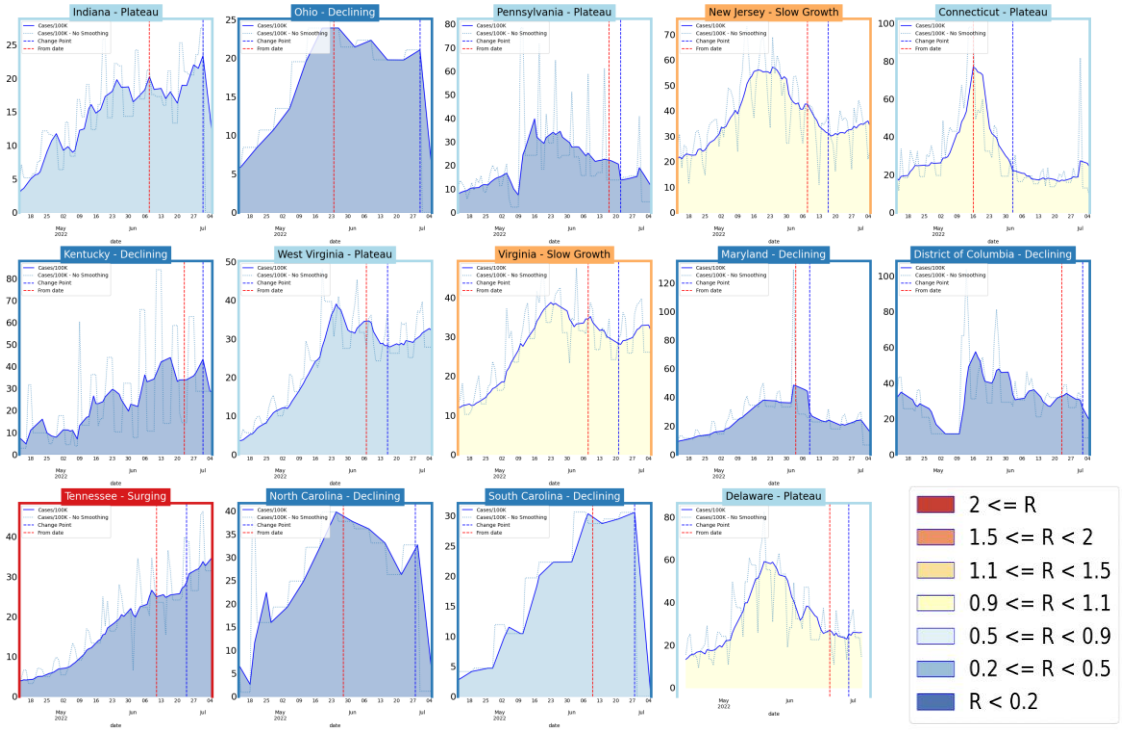
Hospitalizations



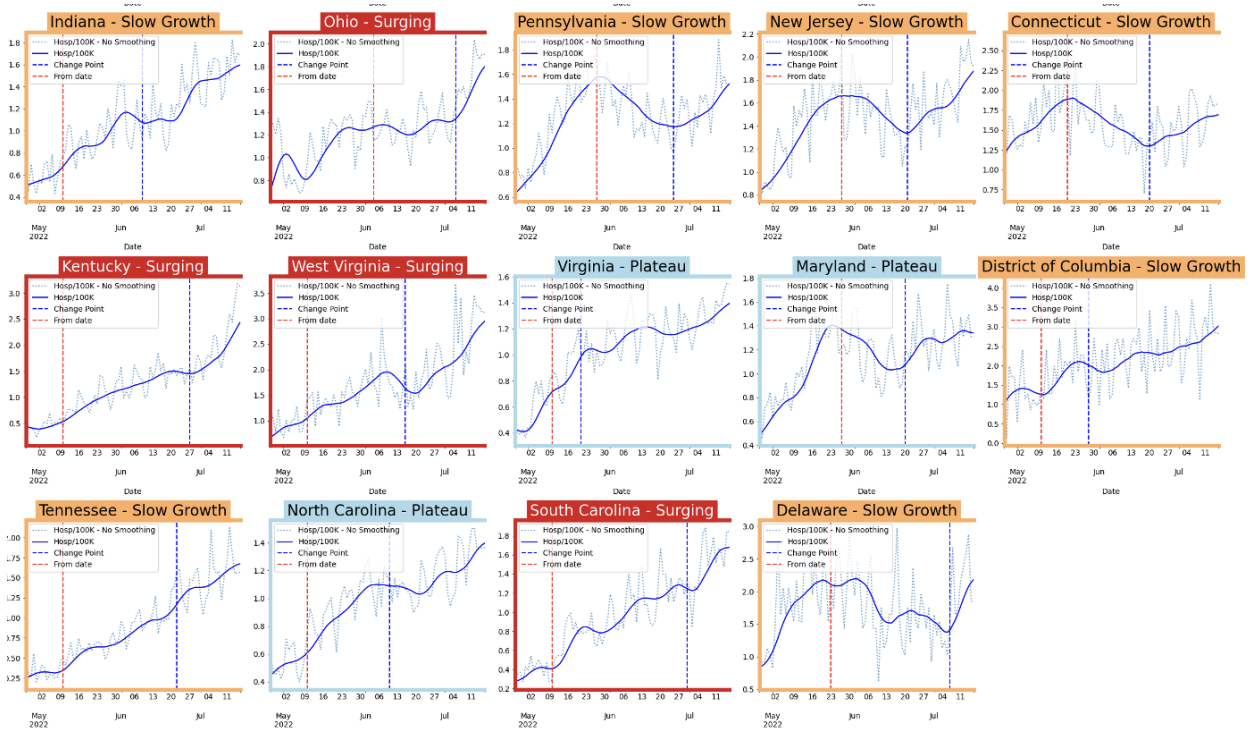
Status	# States
Declining	4 (5)
Plateau	11 (10)
Slow Growth	24 (25)
In Surge	14 (13)

Virginia and Her Neighbors

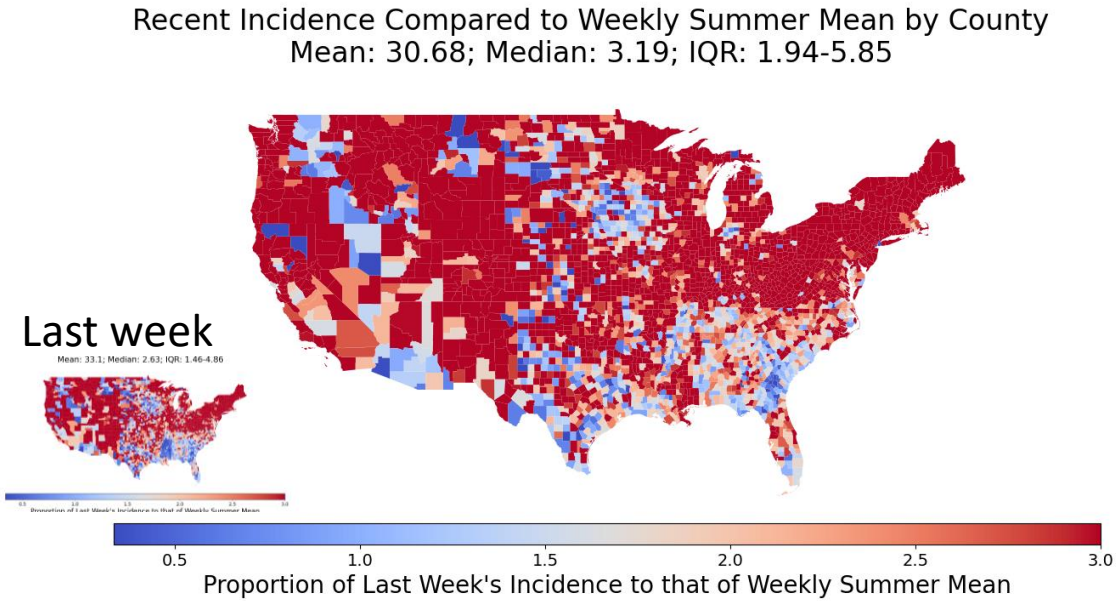
Cases

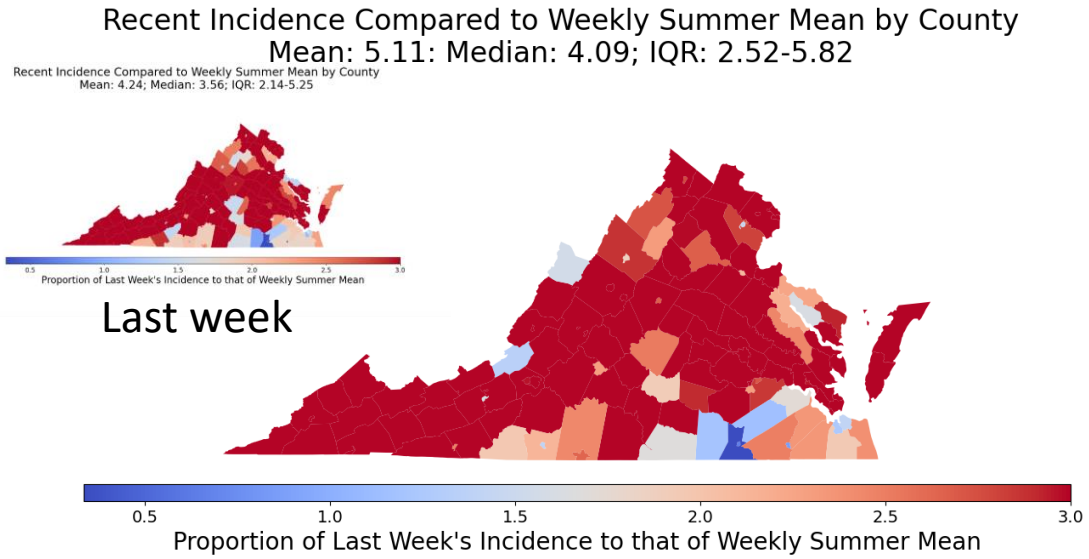


Hospitalizations



County-level comparison to last Summer





Using Ensemble Model to Guide Projections

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

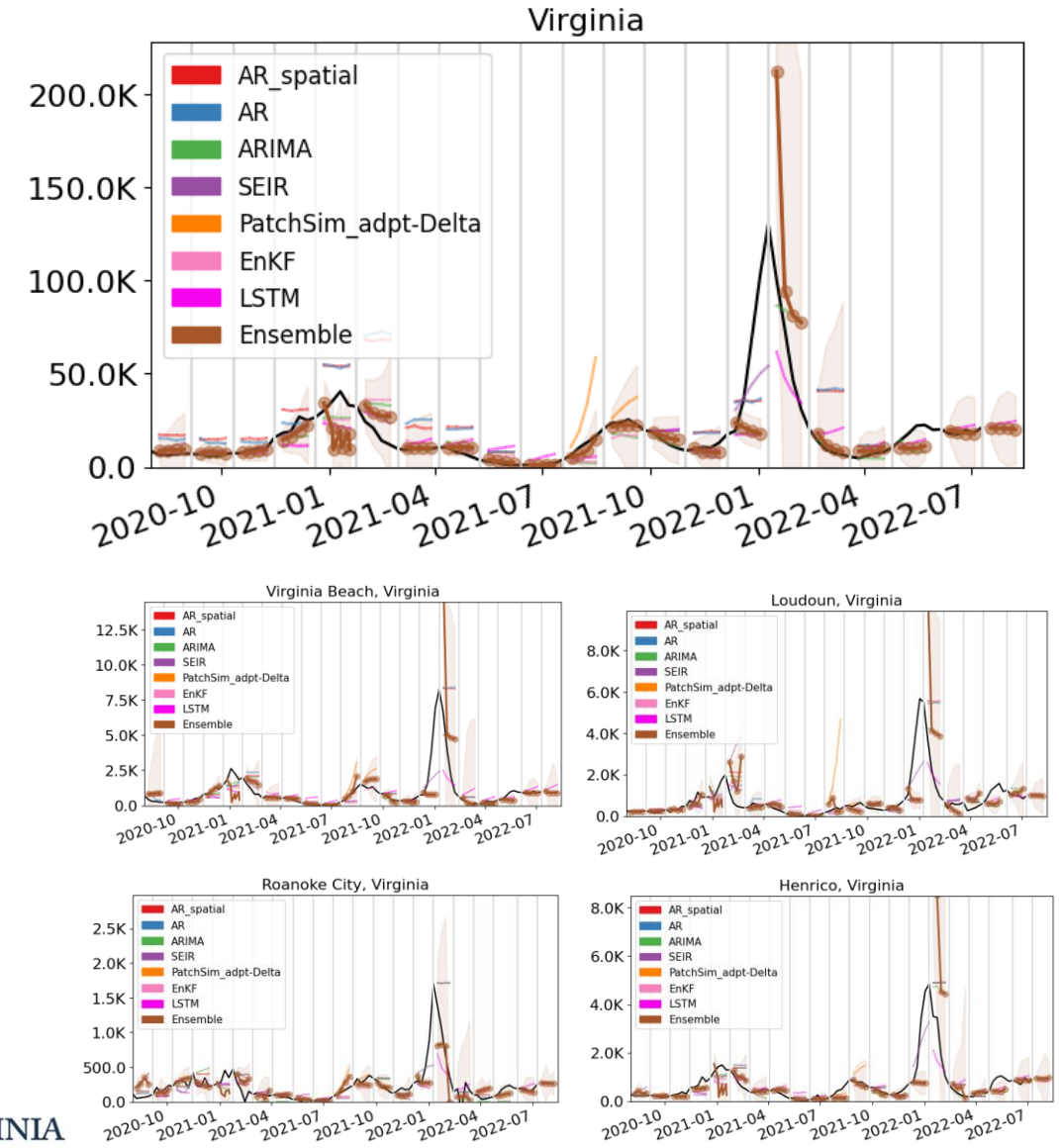
- Autoregressive (AR, ARIMA)
- Neural networks (LSTM)
- Kalman filtering (EnKF)

<u>Weekly forecasts</u> done at county level.

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

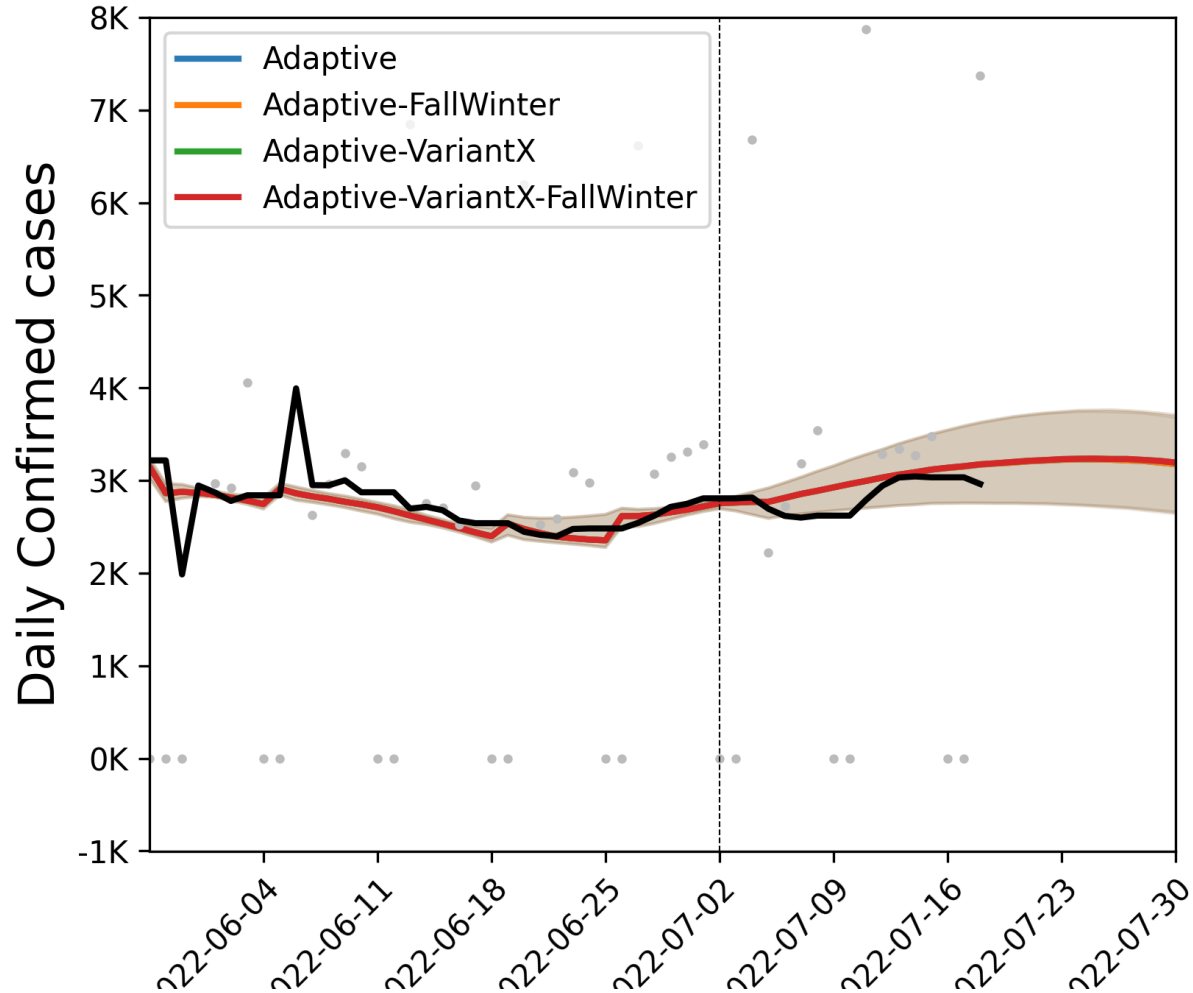
Ensemble forecast provides additional ‘surveillance’ for making scenario-based projections.

Also submitted to CDC Forecast Hub.



Last projection comparison – 1 week ago

Projection from July 13th update (based on surveillance up July 2nd)



Key Takeaways

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

- **Case rates remain high and continue to rise as do hospitalizations**
- VA weekly case rate slightly up to 284/100K from 242/100K
  - US also slightly down to 259/100K from 233/100K
  - VA hospital occupancy (rolling 7 day mean of 670 from 641) continues to rise for past 10 days
- Omicron sub-variants BA.5 still dominates overall, however, there remains pockets where it has not yet reached which are likely to experience growth in cases
- Projections from last week remain largely on target

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

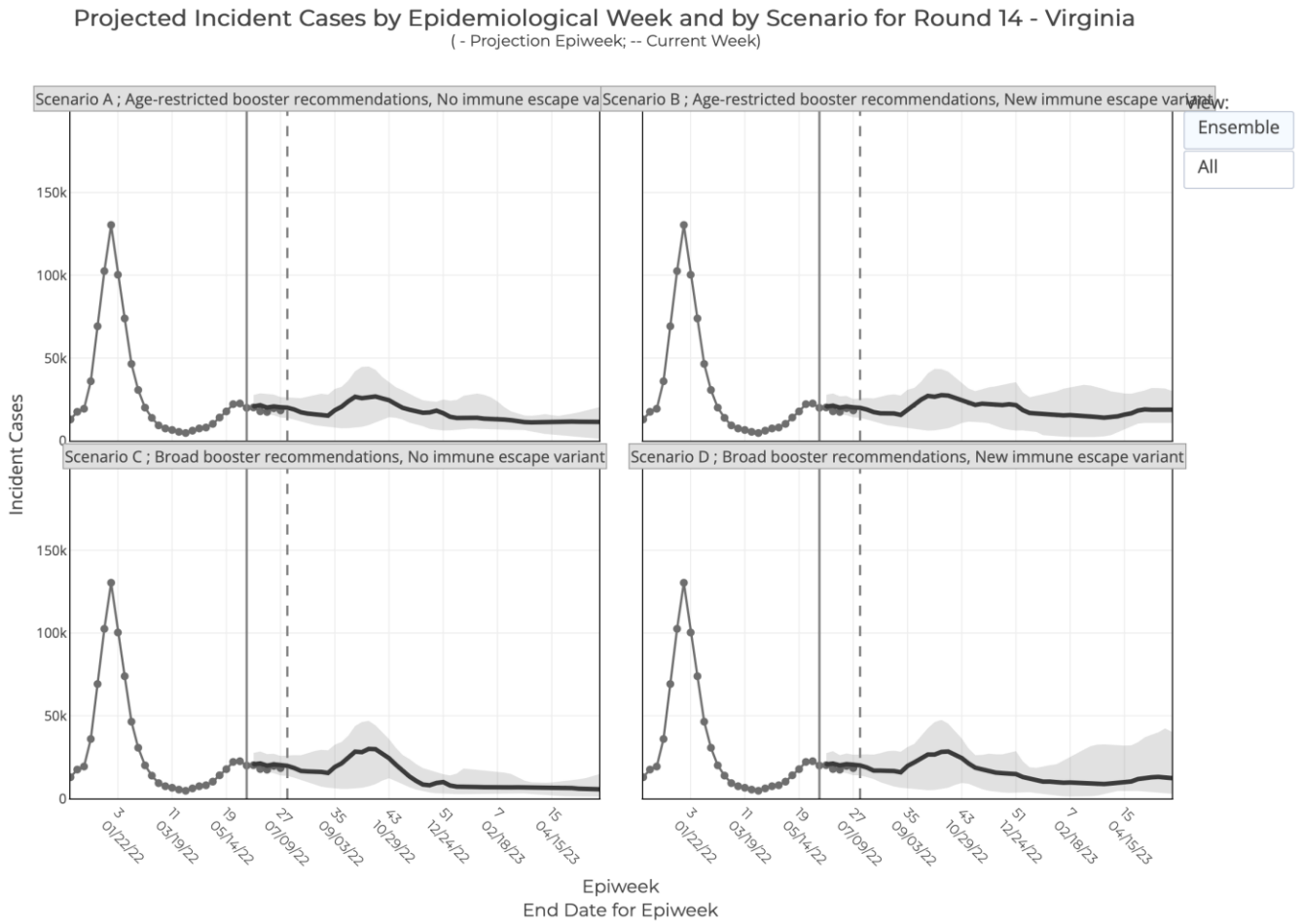
Additional Analyses

COVID-19 Scenario Modeling Hub – Round 14

Collaboration of multiple academic teams to provide national and state-by-state level projections for 4 aligned scenarios

- Round 14 results getting finalized
  - Scenarios: Test benefits of reformulated fall boosters w/ and w/out a new variant
- Round 15 update being discussed

https://covid19scenariomodelinghub.org/viz.html



Round 14

Scenario defined as of 2022-05-17
Model Projecting from Epiweek 23 to Epiweek 23

- ☑ **Scenario A**
  Age-restricted booster recommendations
  No immune escape variant
  (A-2022-05-09)
- ☑ **Scenario B**
  Age-restricted booster recommendations
  New immune escape variant
  (B-2022-05-09)
- ☑ **Scenario C**
  Broad booster recommendations
  No immune escape variant
  (C-2022-05-09)
- ☑ **Scenario D**
  Broad booster recommendations
  New immune escape variant
  (D-2022-05-09)

References

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Google. COVID-19 community mobility reports. https://www.google.com/covid19/mobility/

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

Questions?

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