Network Systems
Science & Advanced
Computing

Biocomplexity Institute
& Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

March 23rd, 2022

(data current to March 20th – 22nd)

Biocomplexity Institute Technical report: TR 2022-020

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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 and hospitalizations continue to dramatic decline**

- VA 7-day mean daily case rate has eased down to 10/100K from 11/100K

    - US is also down to 9/100K (from 10/100K)

- BA.2 subvariant growth has resumed, remains slower than observed in Europe, though should be dominant in the coming weeks
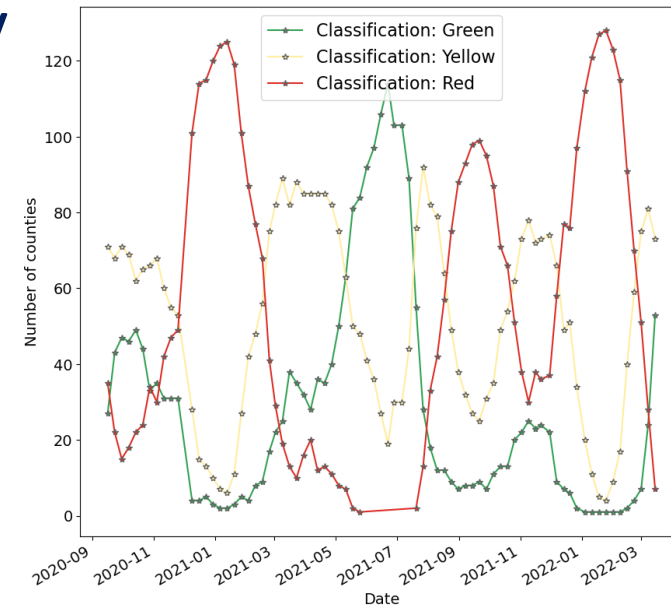
The situation continues to change. Models continue to be updated regularly.

Situation Assessment

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Case Rates (per 100k) and Test Positivity

- Case rate increase across all health districts
- Some past 50% of winter peak and growing
- More than 50% of counties with TPR > 10%

County level RT-PCR test positivity
Green: <5.0% (or <20 tests in past 14 days)
Yellow: 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")
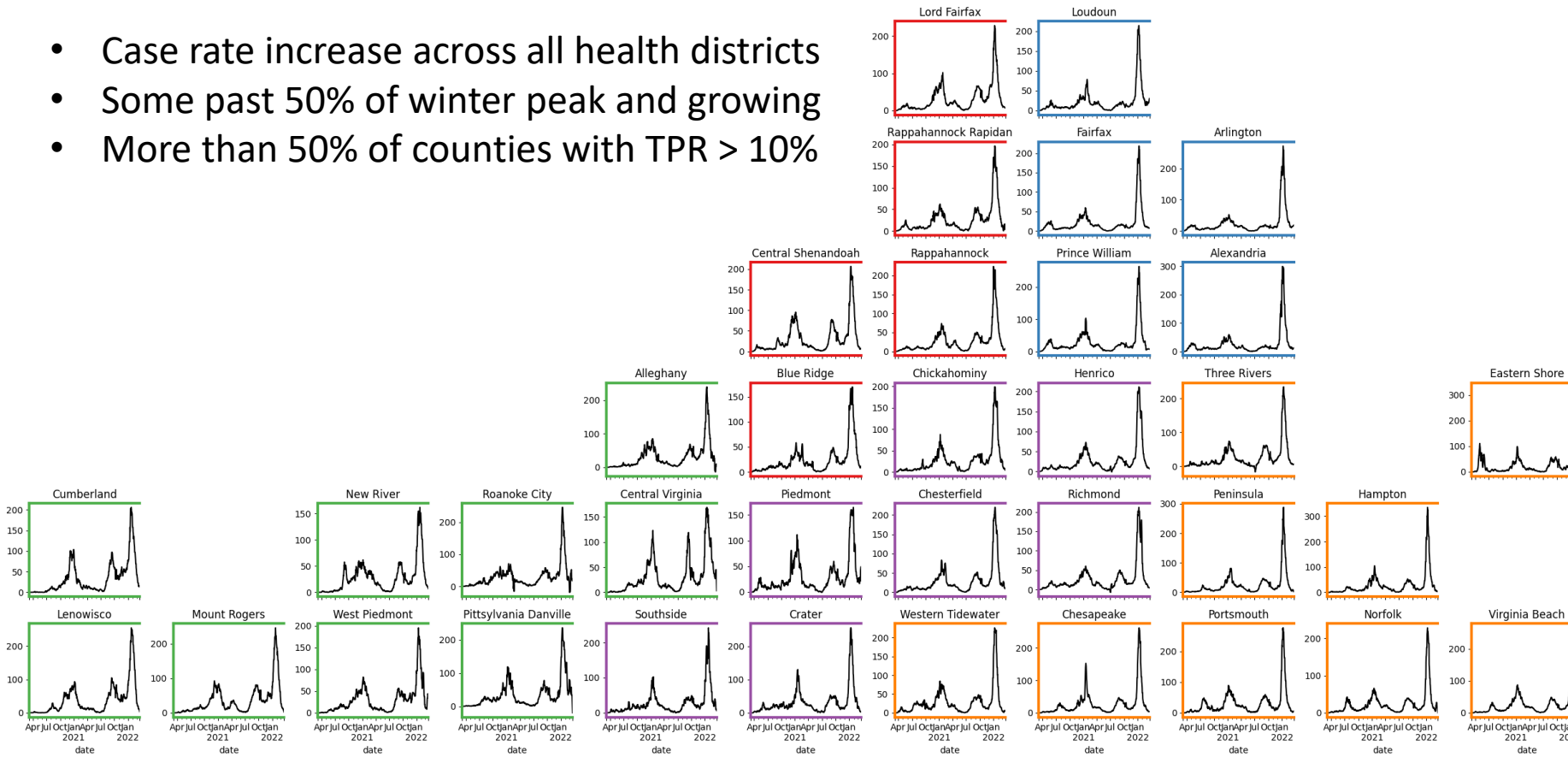
District Trajectories

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
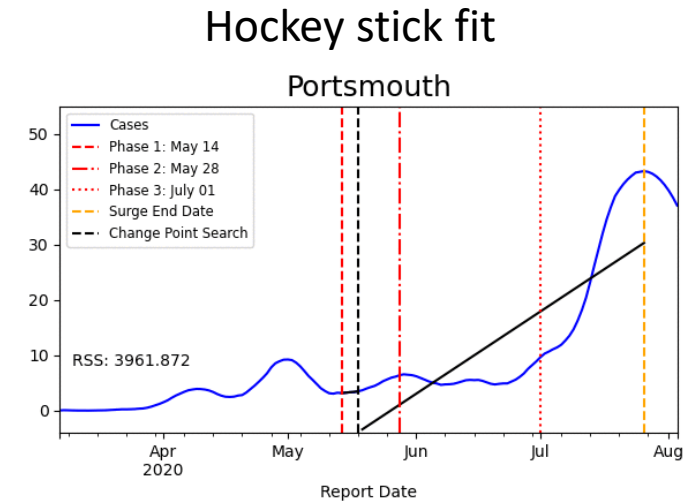
Trajectory	Description	Weekly Case Rate (per 100K) bounds	# Districts (prev week)
Declining	Sustained decreases following a recent peak	below -0.9	35 (35)
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5	0 (0)
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5	0 (0)
In Surge	Currently experiencing sustained rapid and significant growth	2.5 or greater	0 (0)

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District Trajectories – last 10 weeks

Status	# Districts (prev week)
Declining	31 (35)
Plateau	1 (0)
Slow Growth	3 (0)
In Surge	0 (0)

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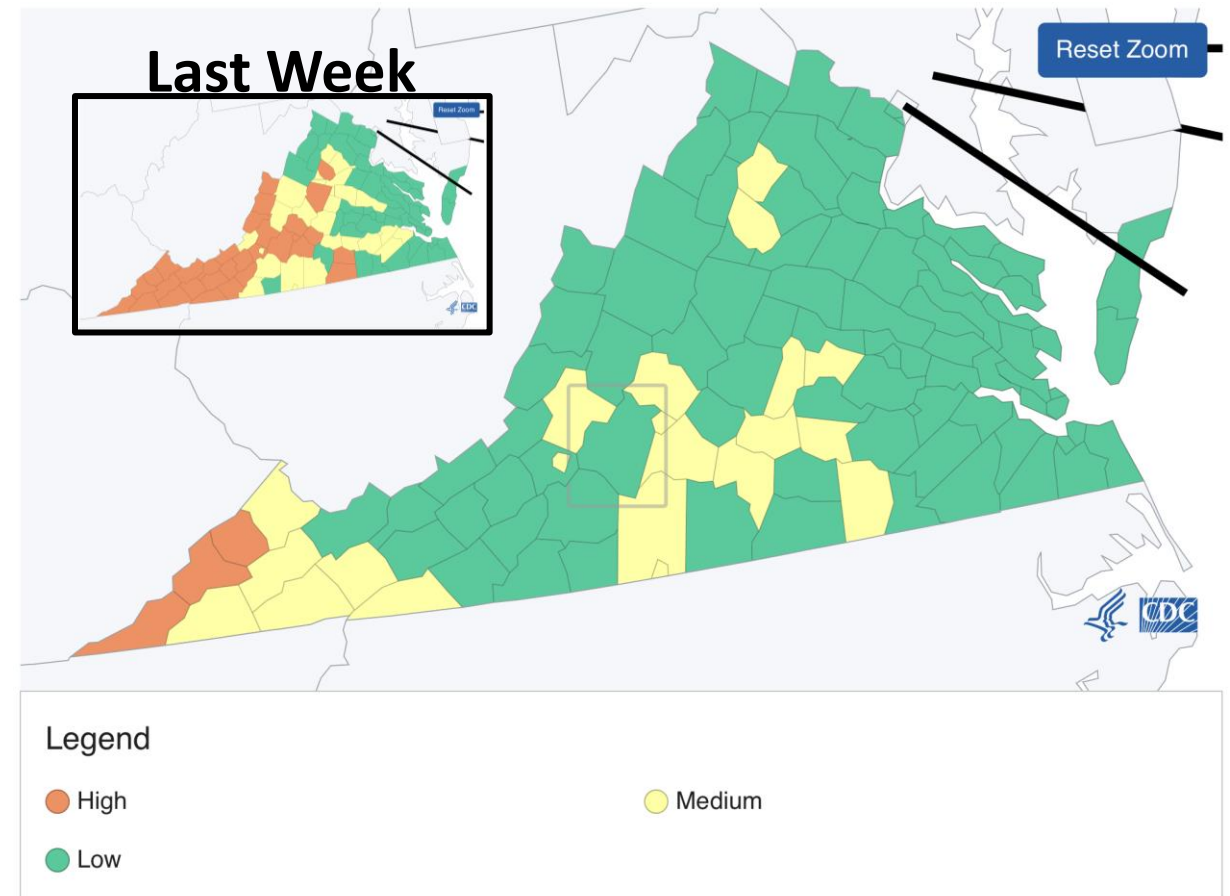Case Rate curve colored by Reproductive number

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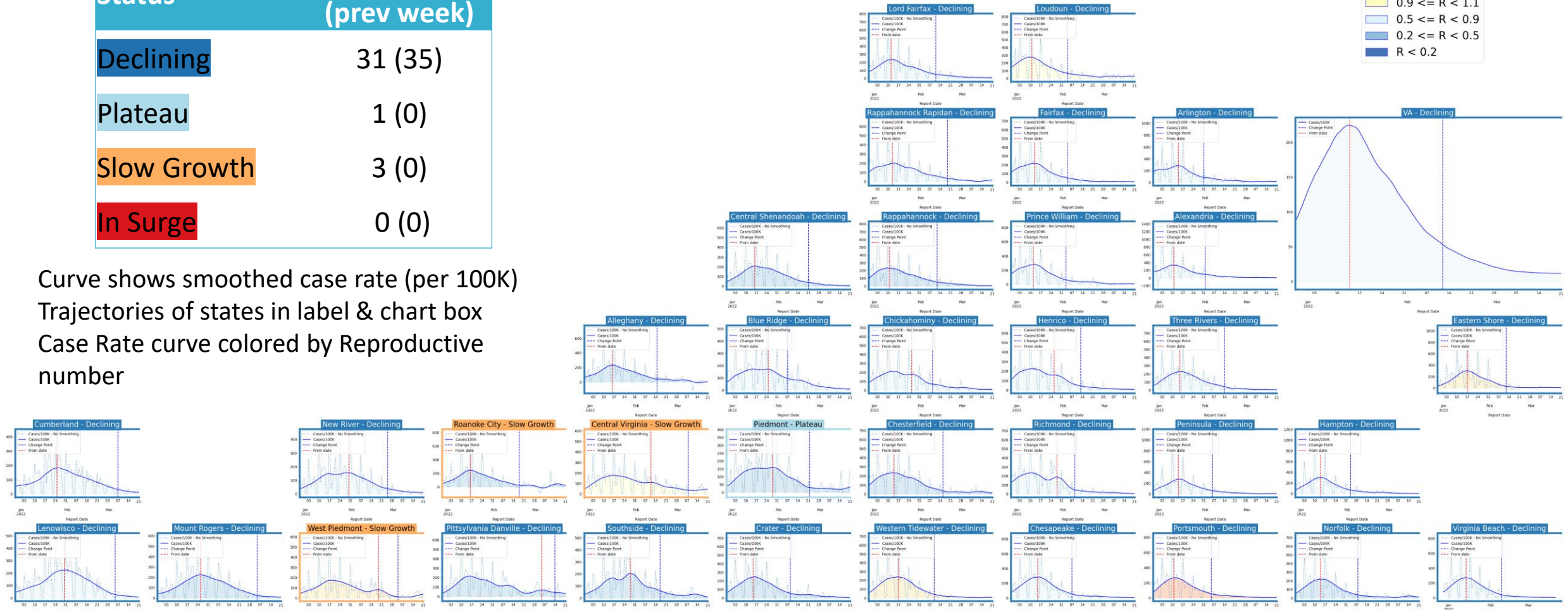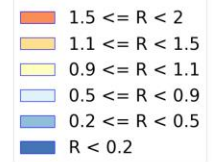
CDC's new COVID-19 Community Levels

What Prevention Steps Should You Take Based on Your COVID-19 Community Level?
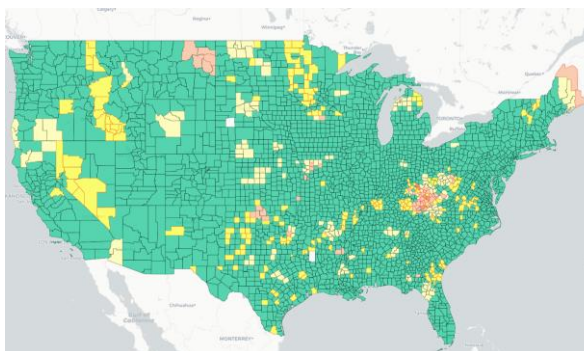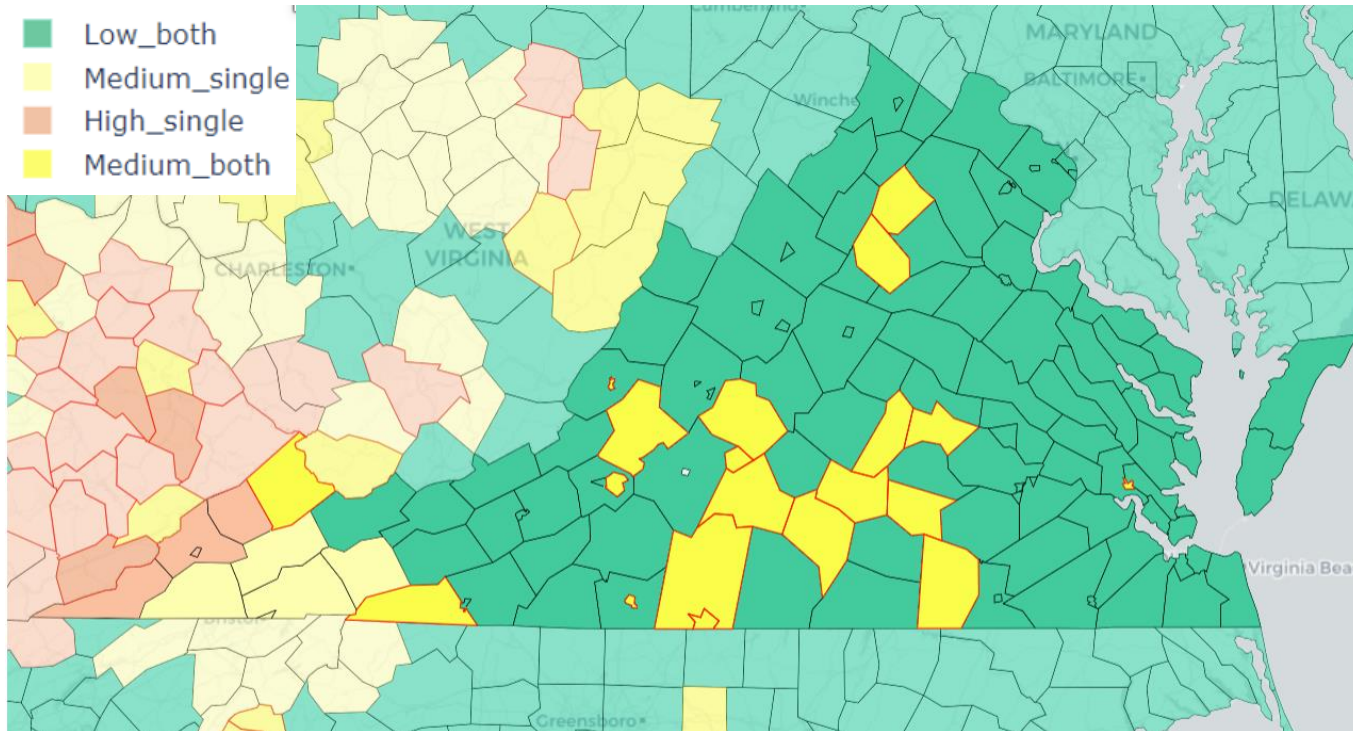
Low	Medium	High
• Stay up to date with COVID-19 vaccines • Get tested if you have symptoms	• If you are at high risk for severe illness, talk to your healthcare provider about whether you need to wear a mask and take other precautions • Stay up to date with COVID-19 vaccines • Get tested if you have 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

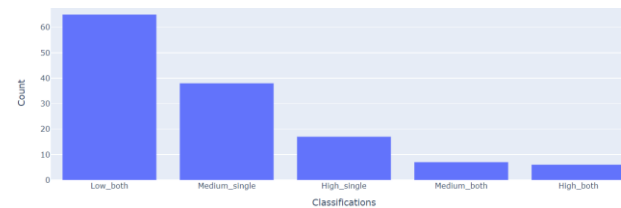| New COVID-19 Cases Per 100,000 people in the past 7 days	Indicators	Low	Medium	High
Fewer than 200	New COVID-19 admissions per 100,000 population (7-day total)	<10.0	10.0-19.9	≥20.0
	Percent of staffed inpatient beds occupied by COVID-19 patients (7-day average)	<10.0%	10.0-14.9%	≥15.0%
200 or more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

Last Week

Reset Zoom

Legend
- High
- Low
- Medium

[CDC Data Tracker Portal](#)

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CDC's new COVID-19 Community Levels

Low_both
Medium_single
High_single
Medium_both

VA Levels

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

Pale color indicates only one of 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
Fewer than 200		New COVID-19 admissions per 100,000 population (7-day total)	<10.0	10.0-19.9	≥20.0
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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.

Data from: CDC Data Tracker Portal

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District Trajectories with Community Levels
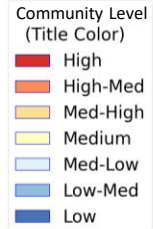
Curve shows smoothed case rate (per 100K)
CDC's new Community Level aggregated to district level in label & chart box color
Case Rate curve colored by Trajectory
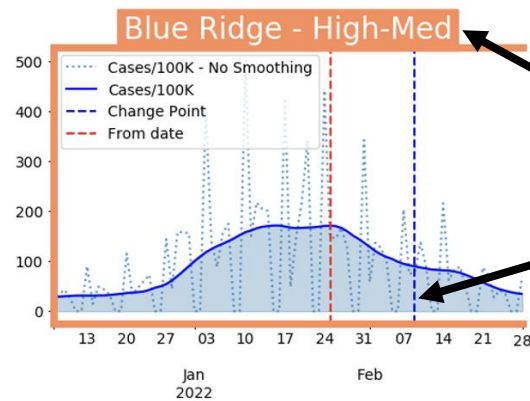
District's Aggregate Community Level
Aggregate level a simple mean of all levels for counties in district

Case rate Trajectory

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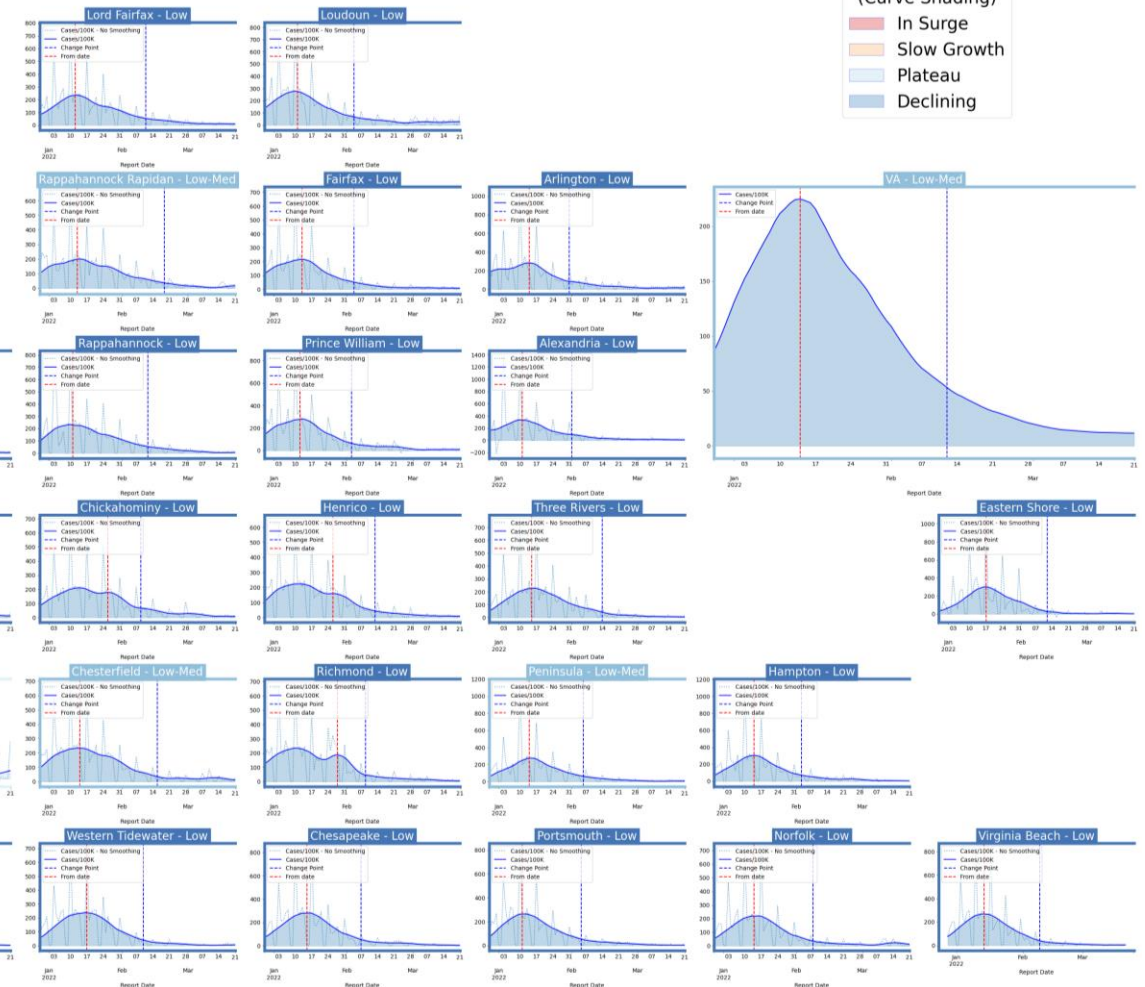
Estimating Daily Reproductive Number –
Redistributed gap

March 22nd Estimates

Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	0.593	-0.155
Central	0.397	-0.456
Eastern	0.436	-0.642
Far SW	0.456	-0.116
Near SW	0.669	0.145
Northern	0.818	-0.020
Northwest	0.656	-0.073

Methodology

- Wallinga-Teunis method (EpiEstim[1]) for cases by **confirmation date**
- Serial interval: 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 redistributed GT 2022-03-21

VA RE by VHASS region with 7 day moving window by confirmation date redistributed GT 2022-03-21
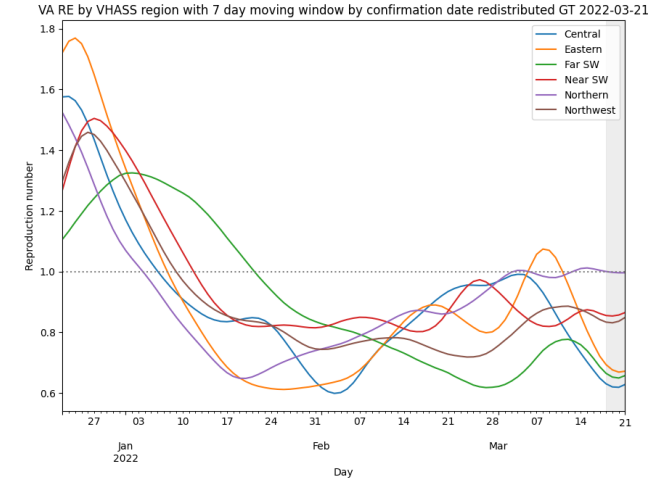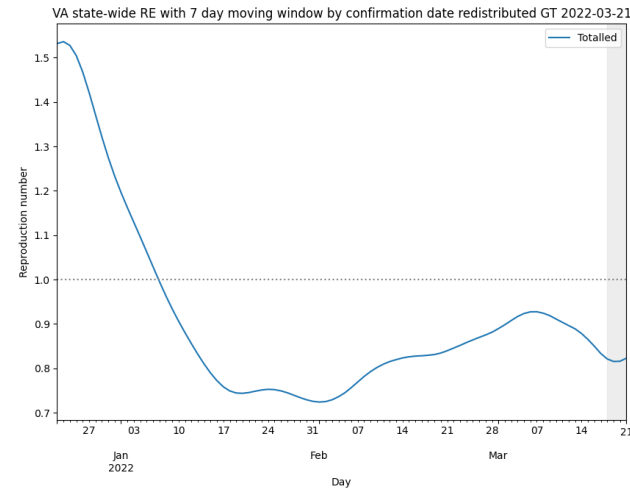
Skipping Weekend Reports & holidays biases estimates

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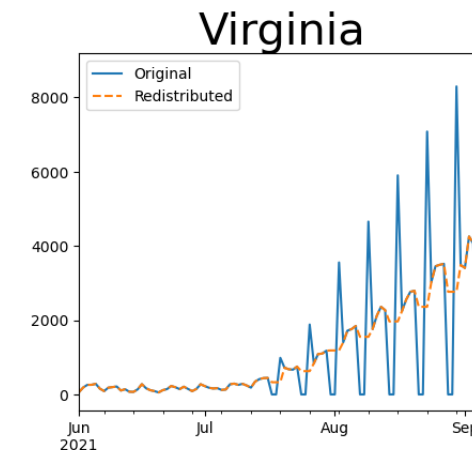
Virginia

Vaccination Administration in Virginia

Vaccine Doses administered:

- Doses administered rates approach levels first experienced when vaccines were first available
- Considerable reduction in vaccination rate experienced since mid-January
- Third dose administration outpaces 1st dose
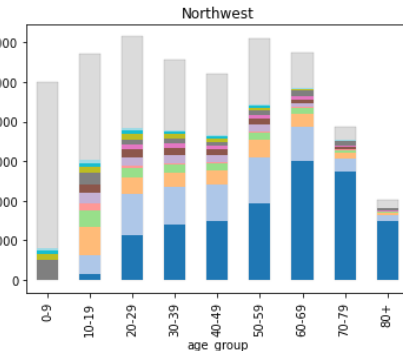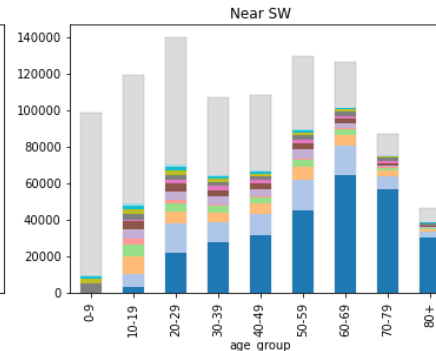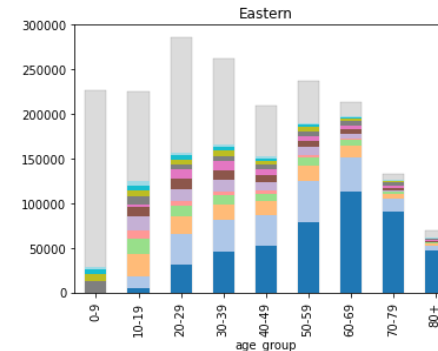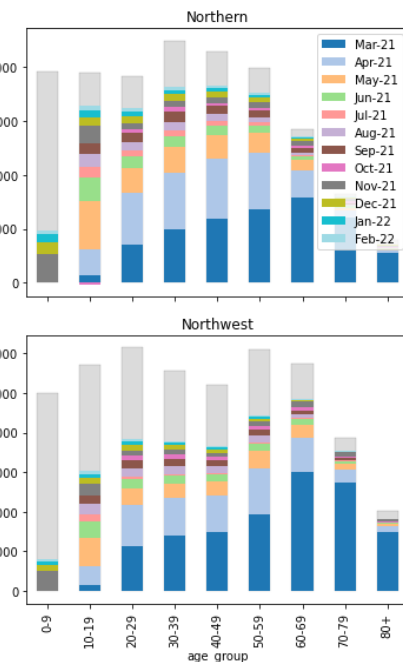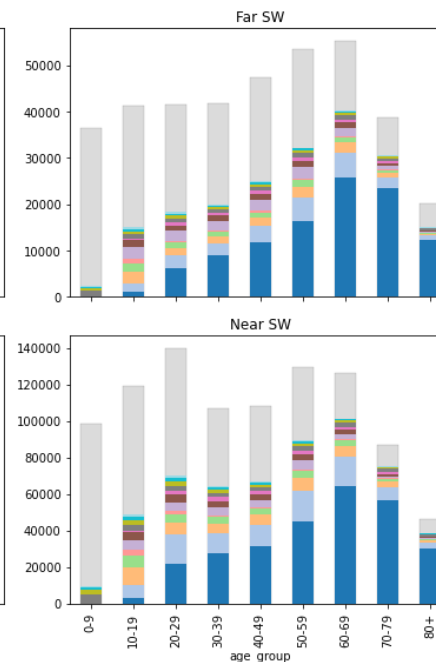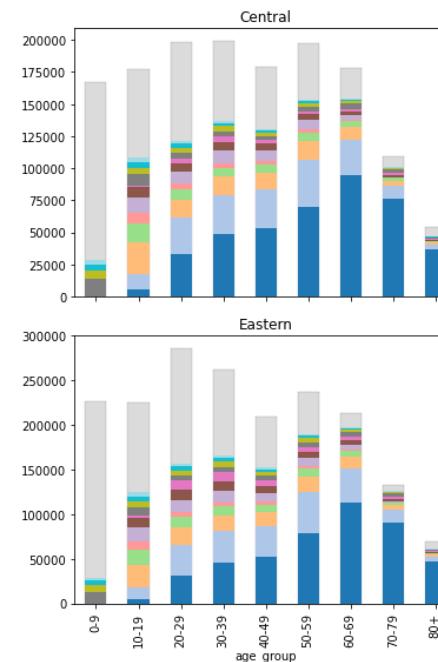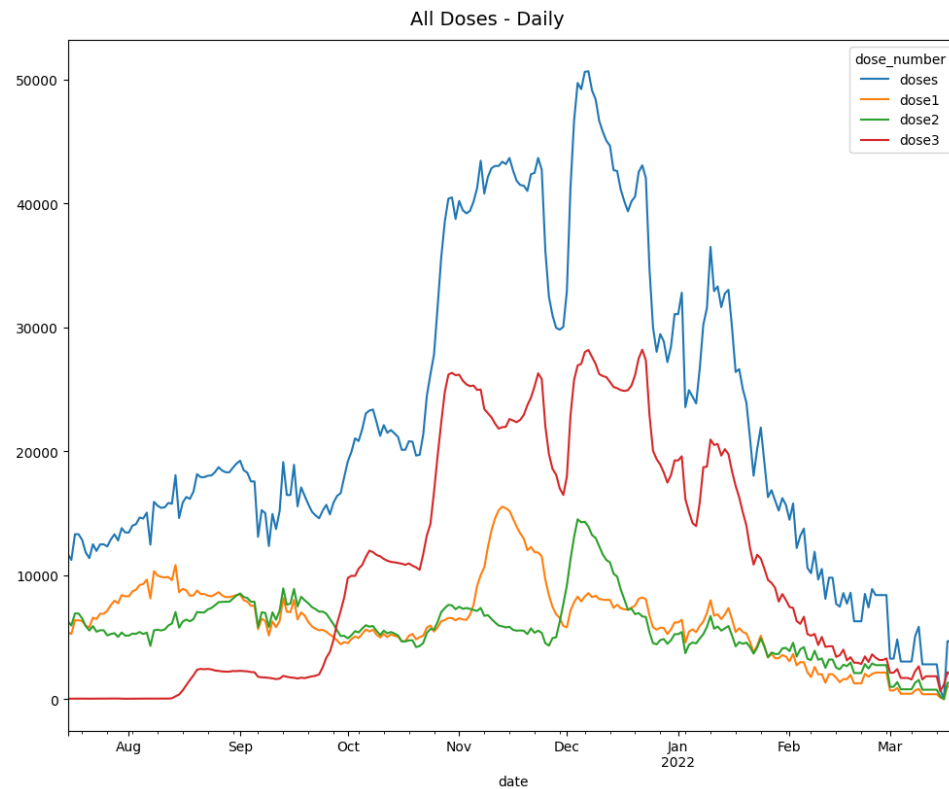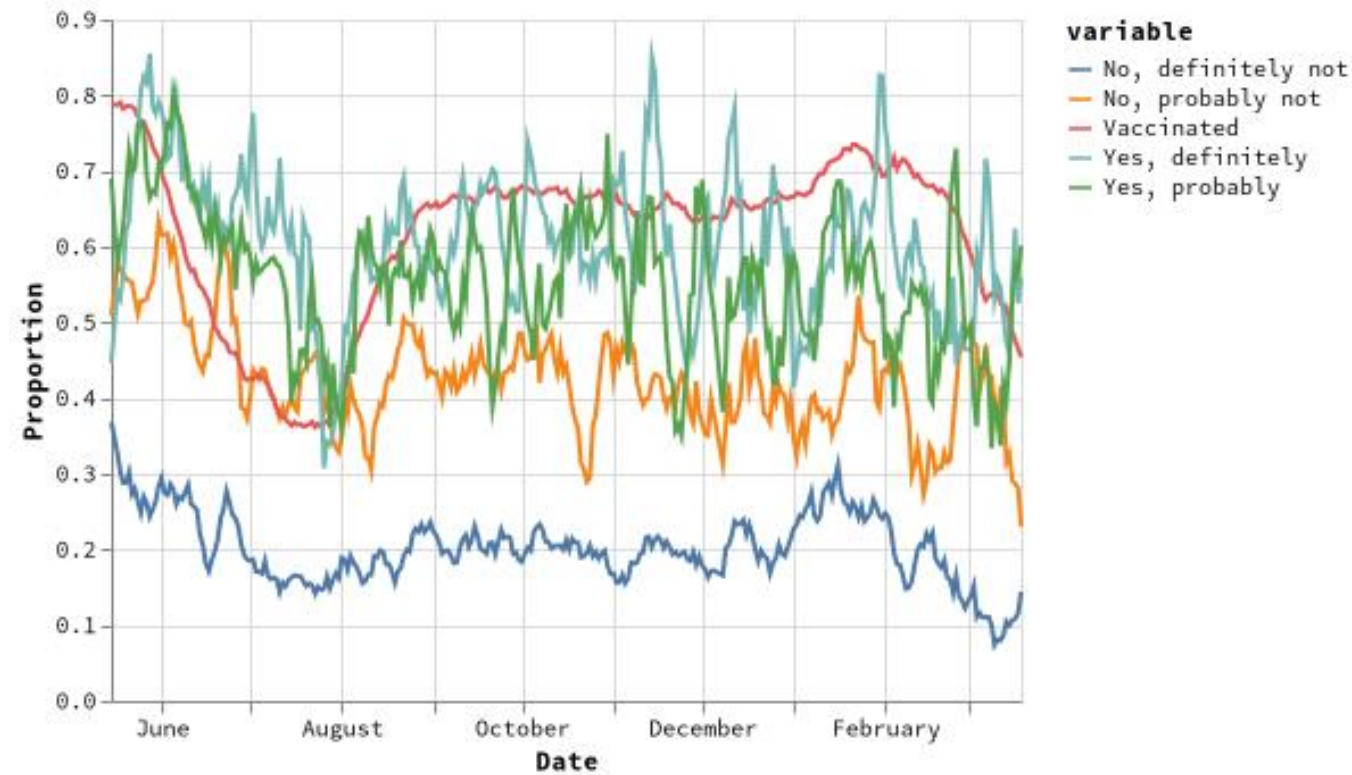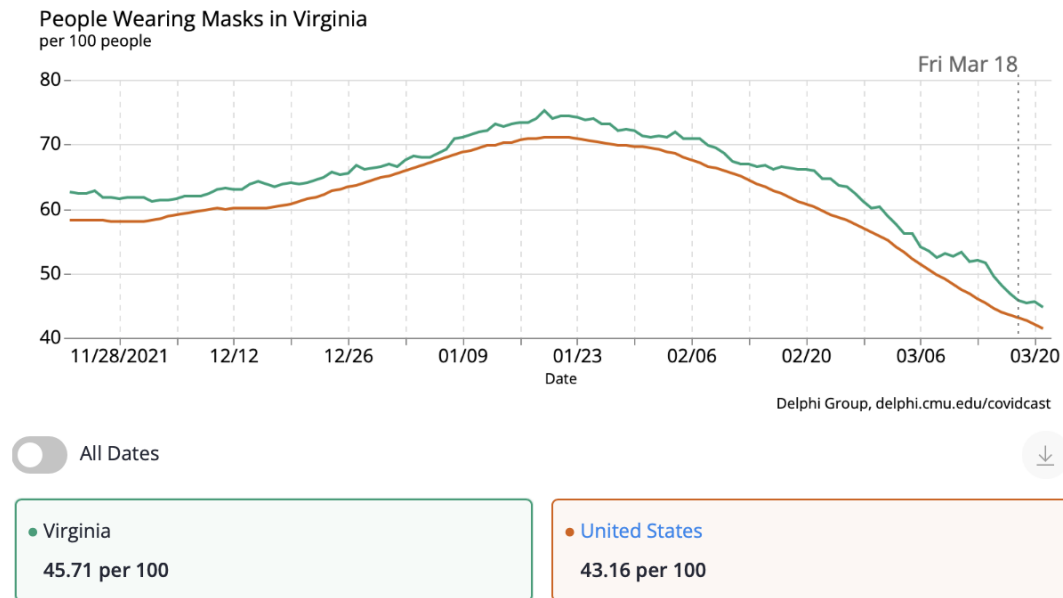
Mask Usage

Self-reported mask usage continues to fall

- US and VA experienced similar decreases
- Mask wearing remains lower amongst unvaccinated especially among least willing to be vaccinated

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


WHO label	Pango lineage*	GISAID clade	Nextstrain clade	Additional amino acid changes monitored°	Earliest documented samples	Date of designation
Alpha	B.1.1.7	GRY	20I (V1)	+S:484K +S:452R	United Kingdom, Sep-2020	18-Dec-2020
Beta	B.1.351	GH/501Y.V2	20H (V2)	+S:L18F	South Africa, May-2020	18-Dec-2020
Gamma	P.1	GR/501Y.V3	20J (V3)	+S:681H	Brazil, Nov-2020	11-Jan-2021
Delta	B.1.617.2	G/478K.V1	21A, 21I, 21J	+S:417N +S:484K	India, Oct-2020	VOI: 4-Apr-2021 VOC: 11-May-2021
Omicron*	B.1.1.529	GRA	21K, 21L	+R346K	Multiple countries, Nov-2021	VUM: 24-Nov-2021 VOC: 26-Nov-2021
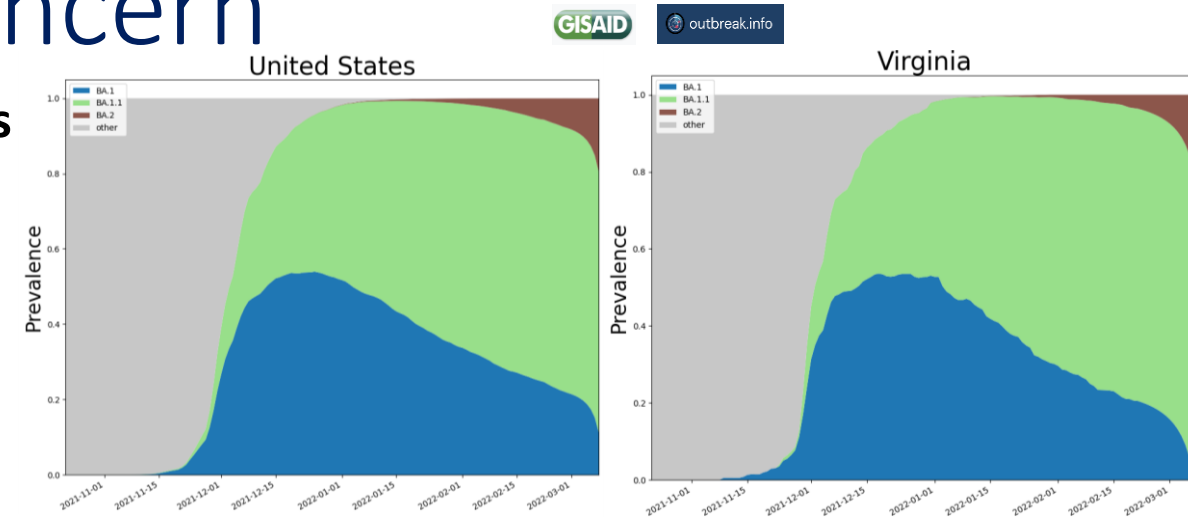
Omicron Prevalence

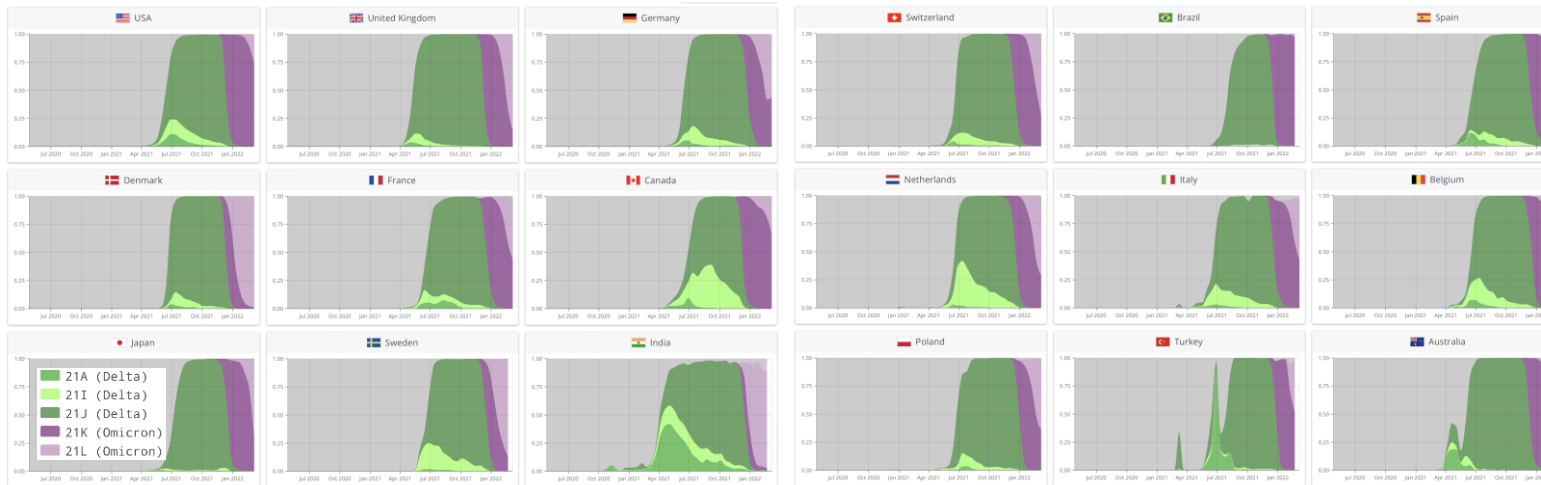CDC nowcast for week ending March 19th shows 30% BA2 in Region 3 (19% last week)

USA now at 35%
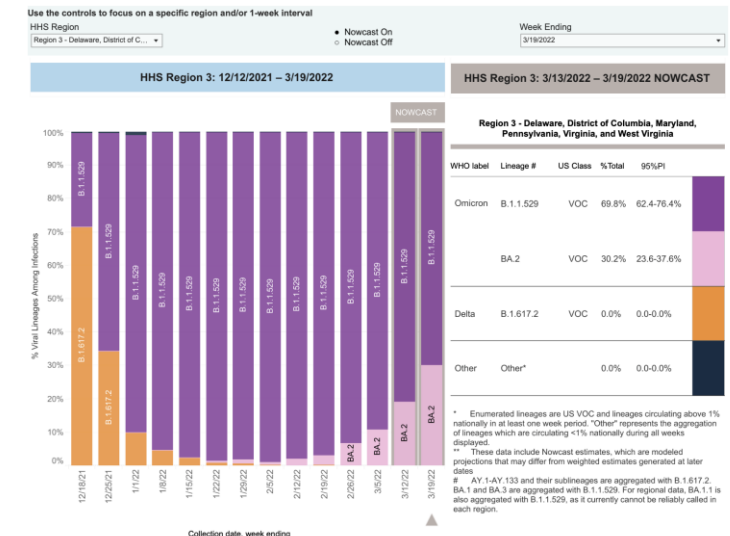
SARS-CoV2 BA.2 subvariant Tracking

BA.2 subvariant growing rapidly in some European countries

- Both Delta and the Omicron BA.2 subvariant don't have the SGTF signal with PCR tests, so the reduction caused by Omicron BA.1 SGTF can be an imperfect signal for increased BA.2

- Subvariant BA.2 in all HHS regions of USA, Region 3 (includes VA) has highest estimated prevalence

- BA.2 is now majority subvariant in most northern European countries and India and some neighbors
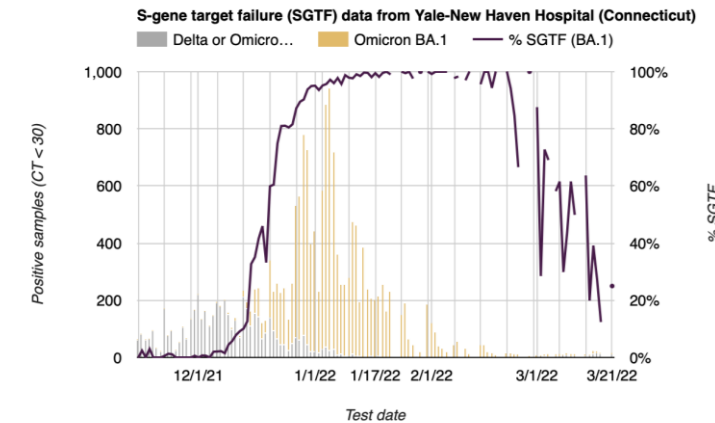
SGTF proxy in US

Yale- New Haven

San Diego
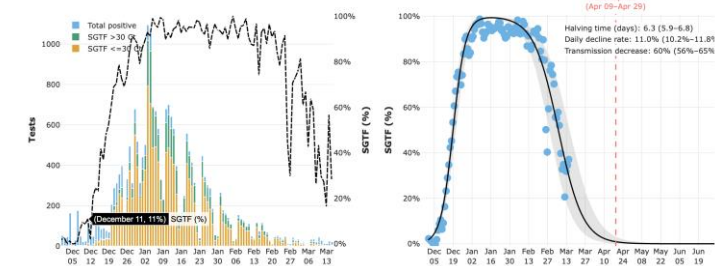
Some drops in SGTF in CT and CA

CoVariants.org

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Pandemic Pubs

**1.** CDC Study Vaccine effectiveness against severe outcomes higher after a 3rd dose than after the 2nd, though wanes with time
2. High immunogenicity of mRNA vaccines is achieved after three doses with antibody levels restored by a fourth dose. Fourth dose displayed reduced vaccine efficacy against infections in young health care workers
3. Though Omicron BA.1 and BA.2 evade human plasma neutralizing antibodies elicited by infection or primary vaccine series, mRNA booster doses rescue neutralization potency across many initial vaccine types.
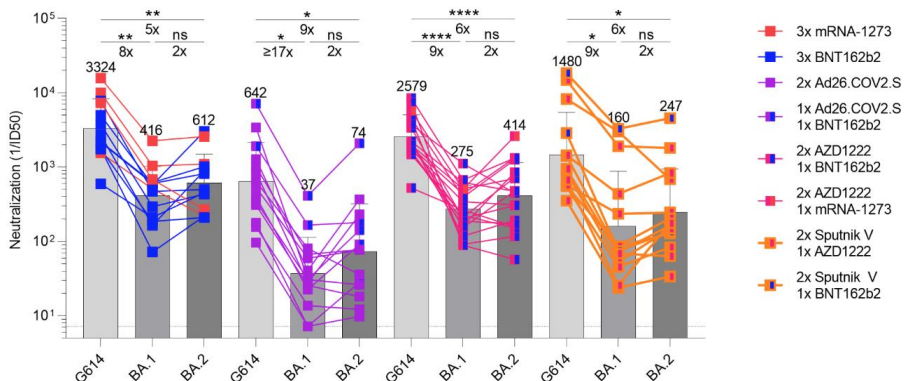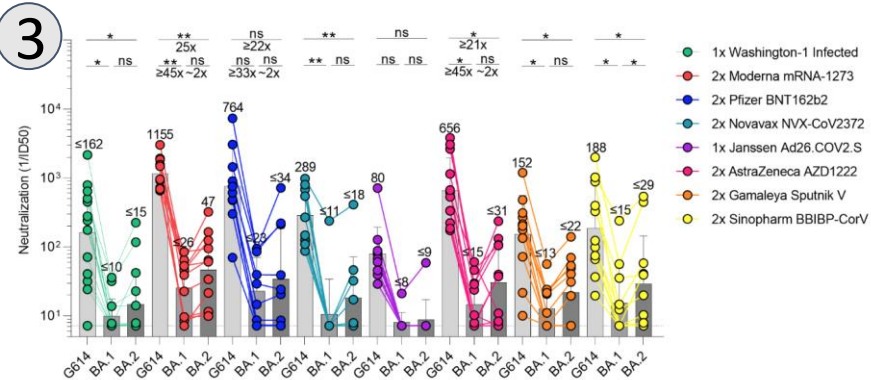
①

Characteristic	Total	SARS-CoV-2 positive test result no. (%)	VE fully adjusted % (95% CI)*	Waning trend p value††
Any mRNA vaccine, 3 doses	10,957	471 (4)	93 (92–94)	<0.001
<2 mos	7,332	221 (3)	95 (94–95)	
2–3 mos	3,413	211 (6)	91 (89–92)	
≥4 mos	212	39 (18)	81 (72–87)	
Delta-predominant period				
Unvaccinated (Ref)	36,214	14,445 (40)	—	—
Any mRNA vaccine, 2 doses	38,707	3,315 (9)	85 (84–85)	<0.001
<2 mos	1,574	49 (3)	94 (92–96)	
2–3 mos	2,790	154 (6)	91 (89–92)	
4 mos	3,129	192 (6)	90 (89–92)	
≥5 mos	31,214	2,920 (9)	82 (82–83)	
Any mRNA vaccine, 3 doses	8,124	195 (2)	95 (95–96)	<0.001
<2 mos	6,071	118 (2)	96 (95–97)	
2–3 mos	2,030	74 (4)	93 (91–95)	
≥4 mos	23	3 (13)	76 (14–93)	
Omicron-predominant period				
Unvaccinated (Ref)	3,911	1,890 (48)	—	—
Any mRNA vaccine, 2 doses	3,619	979 (27)	55 (50–60)	0.01
<2 mos	88	22 (25)	71 (51–83)	
2–3 mos	294	69 (23)	65 (53–74)	
4 mos	150	42 (28)	58 (38–71)	
≥5 mos	3,087	846 (27)	54 (48–59)	
Any mRNA vaccine, 3 doses	2,833	276 (10)	88 (86–90)	<0.001
<2 mos	1,261	103 (8)	91 (88–93)	
2–3 mos	1,383	137 (10)	88 (85–90)	
≥4 mos	189	36 (19)	78 (67–85)	

"Vaccine effectiveness (VE) against COVID-19–associated emergency department/urgent care (ED/UC) visits and hospitalizations was higher after the third dose than after the second dose but waned with time since vaccination. During the Omicron-predominant period, VE against COVID-19–associated ED/UC visits and hospitalizations was 87% and 91%, respectively, during the 2 months after a third dose and decreased to 66% and 78% by the fourth month after a third dose. Protection against hospitalizations exceeded that against ED/UC visits."
https://www.cdc.gov/mmwr/volumes/71/wr/mm7107e2.htm?s_cid=mm7107e2_w

③

https://www.biorxiv.org/content/10.1101/2022.03.15.484542v1.full.pdf

②

This nonrandomized clinical study, assessed the immunogenicity and safety of a fourth dose of either BNT162b2 (Pfizer–BioNTech) or mRNA-1273 (Moderna) administered 4 months after the third dose in a series of three BNT162b2 doses. Vaccine efficacy was estimated to be higher for the prevention of symptomatic disease (43% for BNT162b2 and 31% for mRNA-1273)
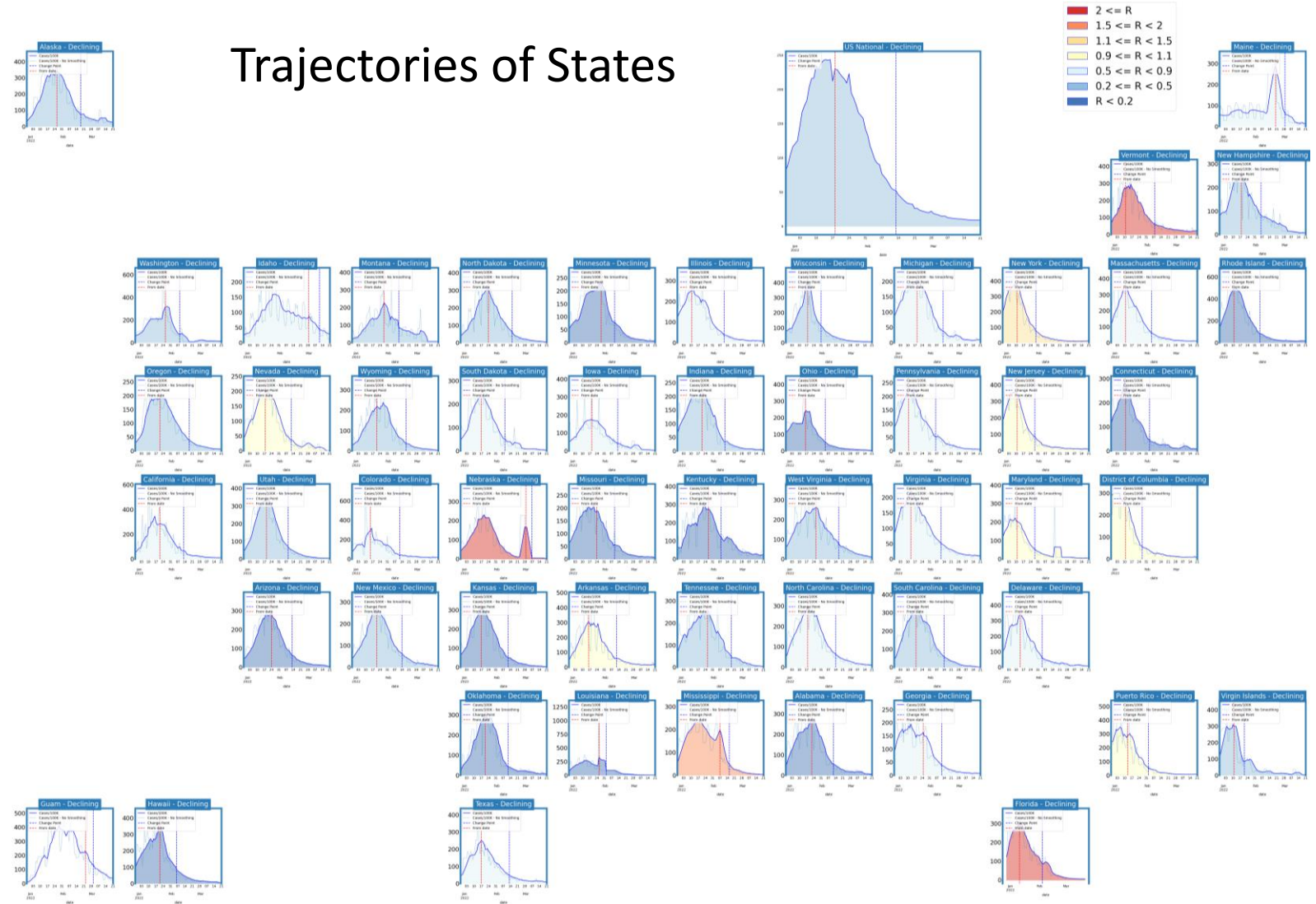https://www.nejm.org/doi/pdf/10.1056/NEJMc2202542?articleTools=true
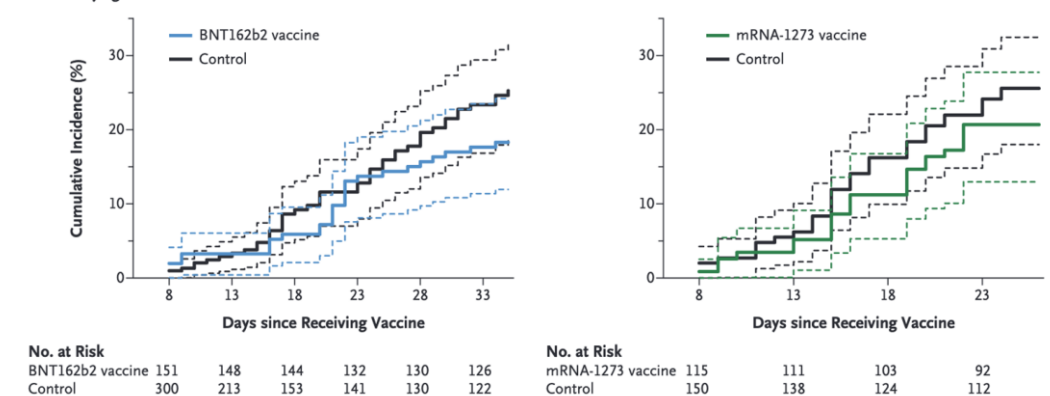
United States Overall

- Nation completely declining
- Most are sustained declines

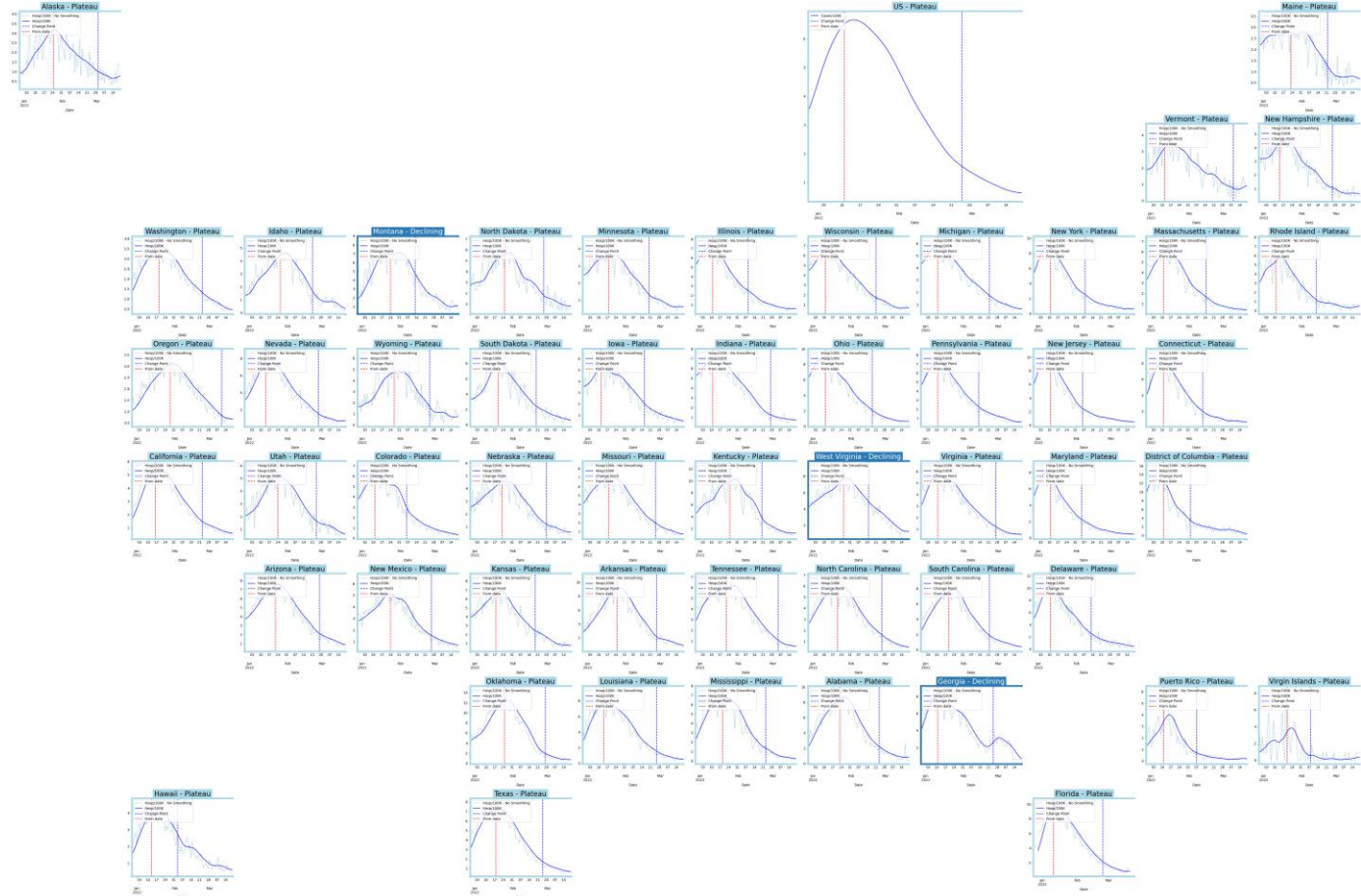| Status	# States
Declining	54 (54)
Plateau	0 (0)
Slow Growth	0 (0)
In Surge	0 (0)

Trajectories of States

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United States Hospitalizations

- Hospital admissions are lagging case rates, and are declining

Status	# States (prev week)
Declining	3 (4)
Plateau	50 (49)
Slow Growth	1 (0)
In Surge	0 (0)

Trajectories of States

Virginia and Her Neighbors

- Case rates are much lower and dipping into the moderate range
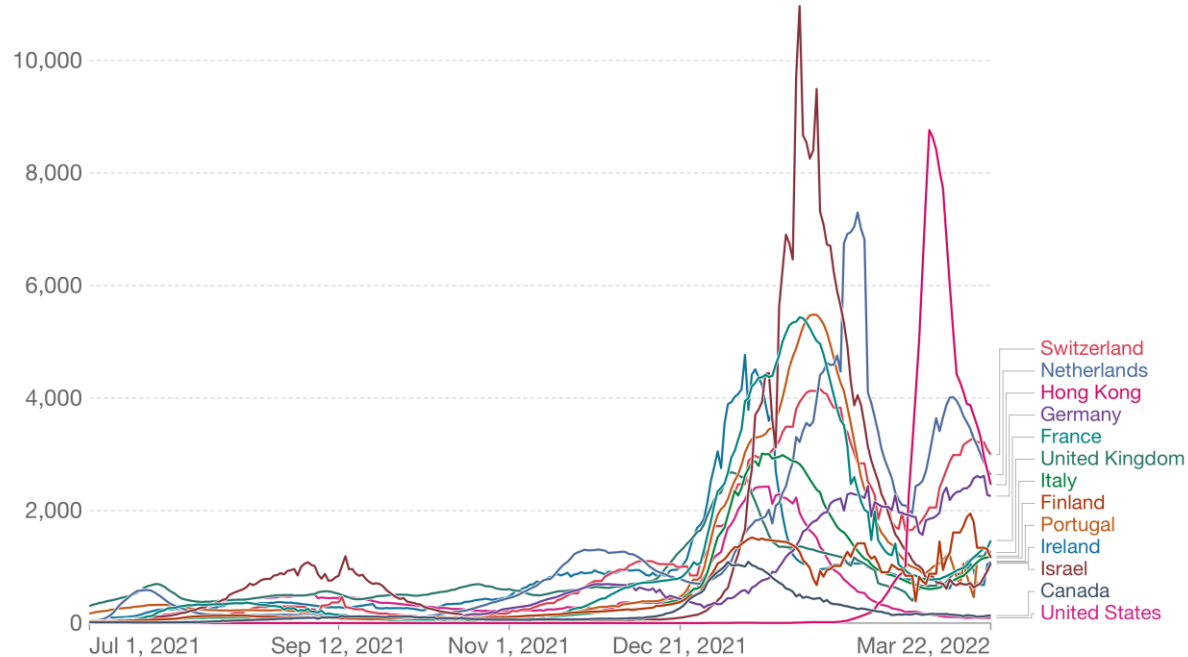
- Most now below 10/100K
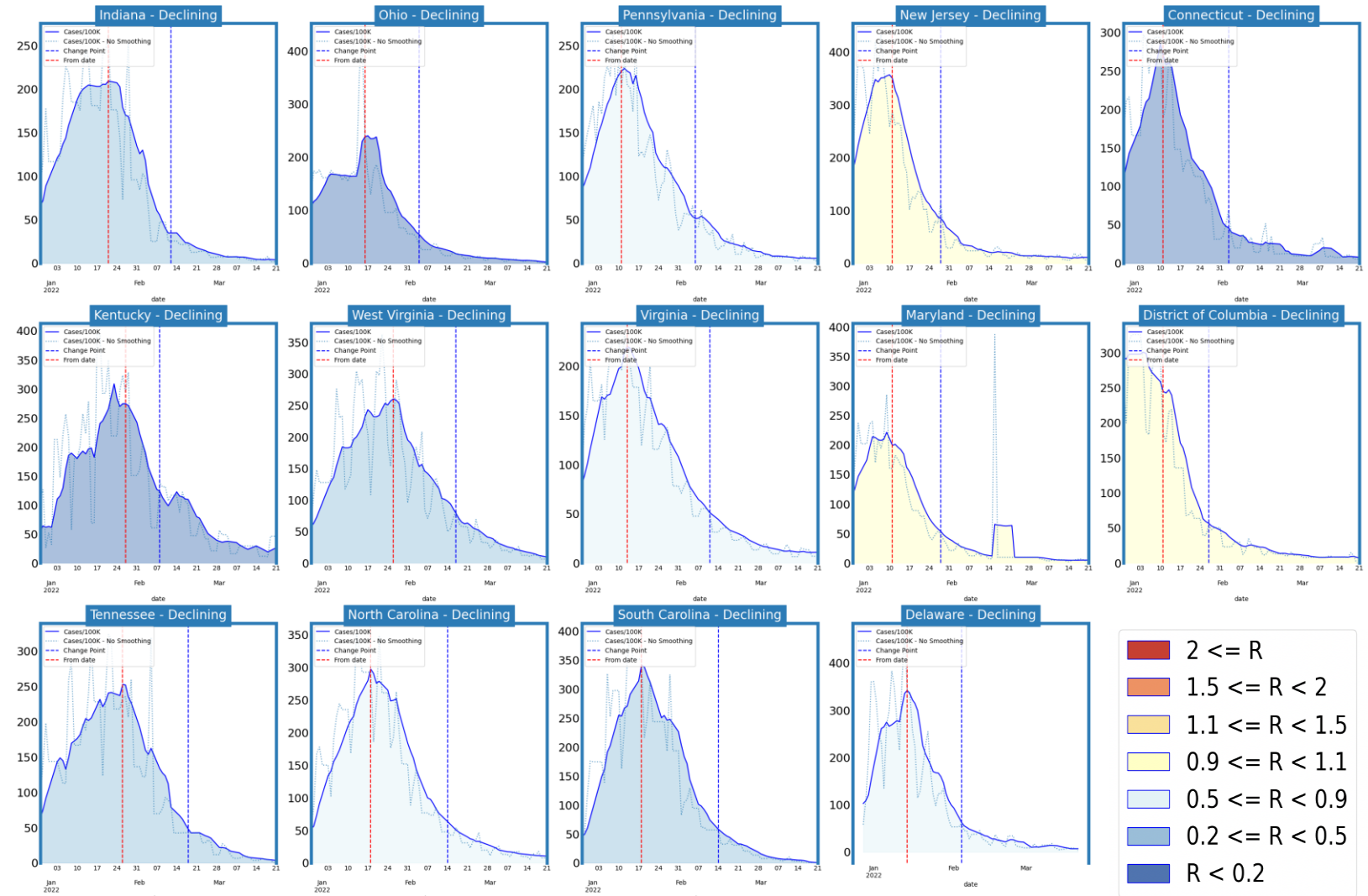
Other Countries

- UK, Netherlands, and Switzerland show increases in hospitalizations
- Cases also rebounding in several European countries

Daily new confirmed COVID-19 cases per million people

Weekly new hospital admissions for COVID-19 per million people
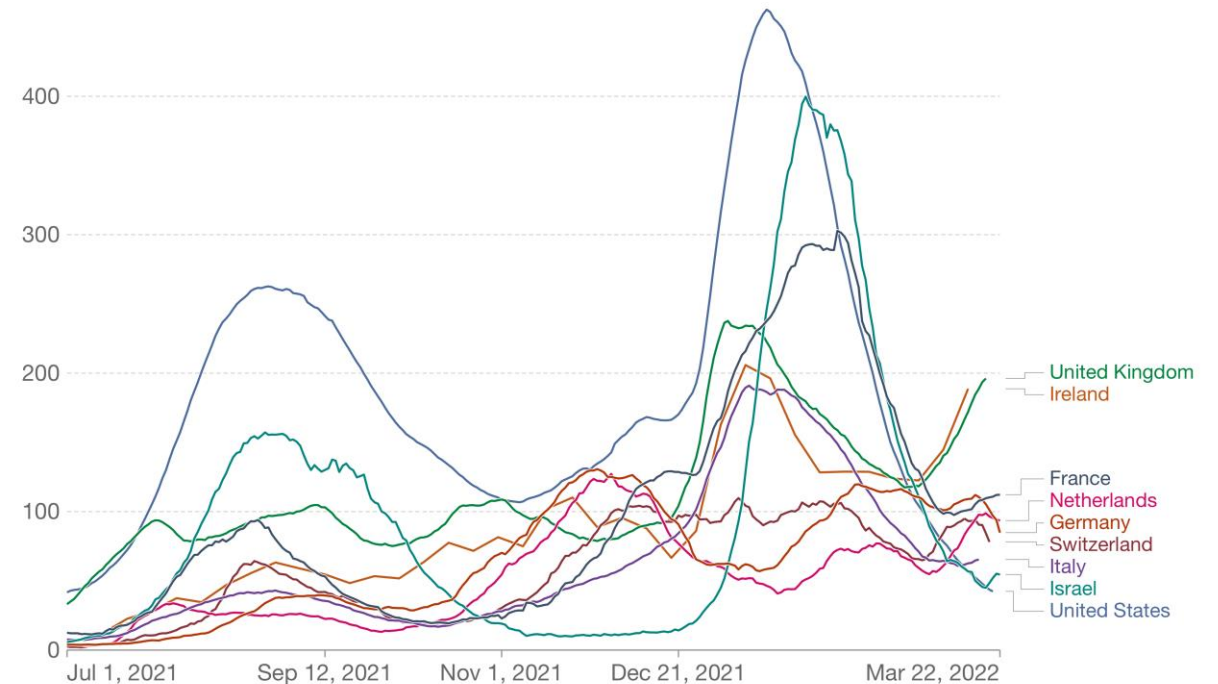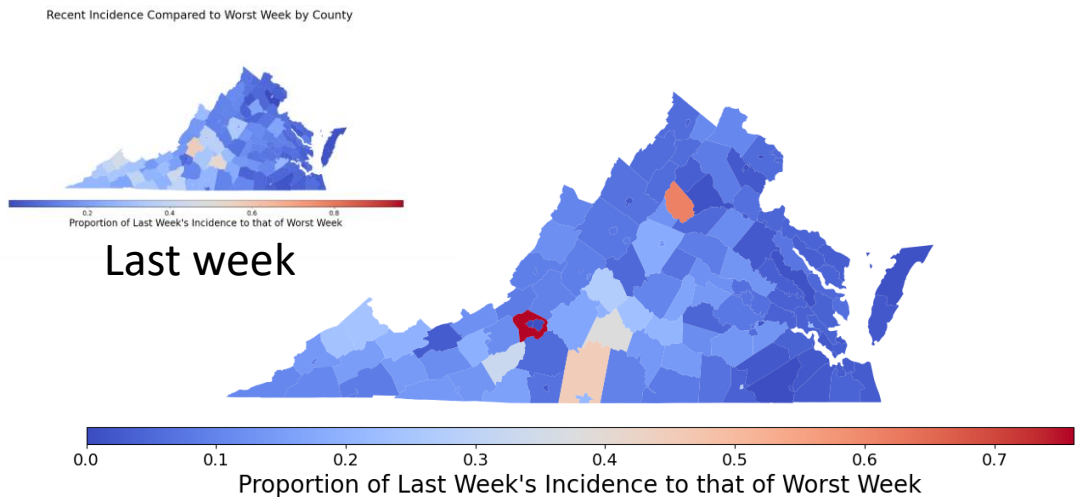
County-level comparison to previous highest peak

- Most counties in VA have had the highest case rate of the pandemic in the last week
- Nationally the number of counties at their highest rate has expanded considerably
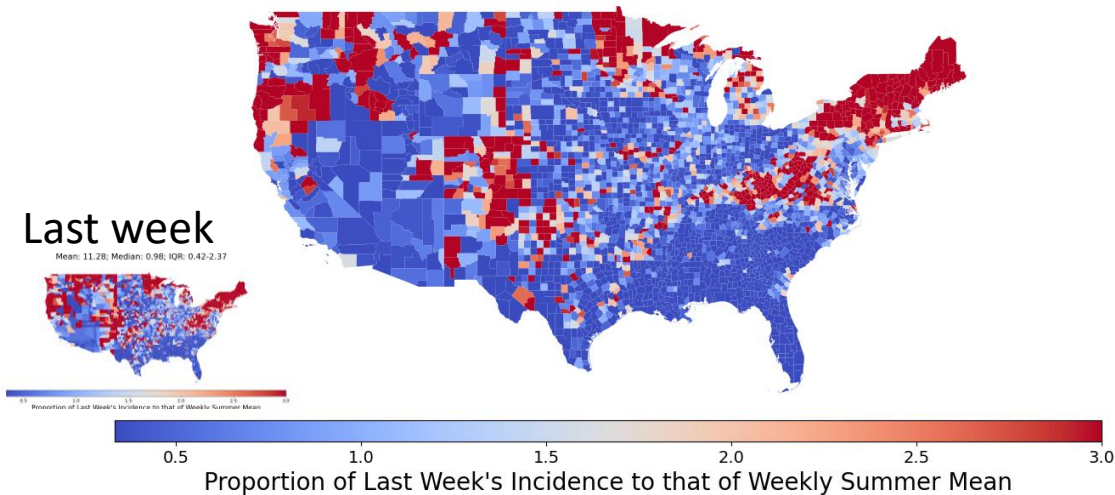
Recent Incidence Compared to Worst Week by County
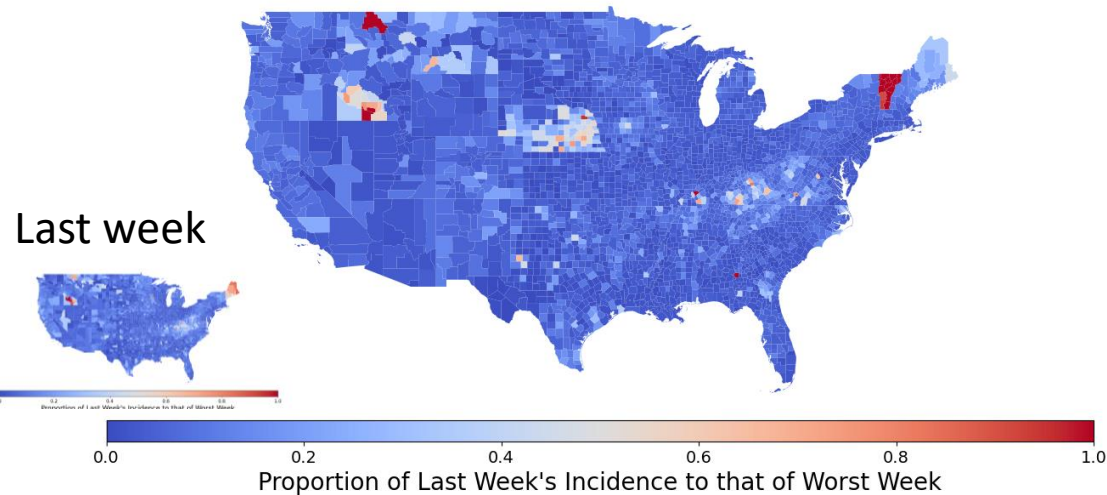
Recent Incidence Compared to Worst Week by County
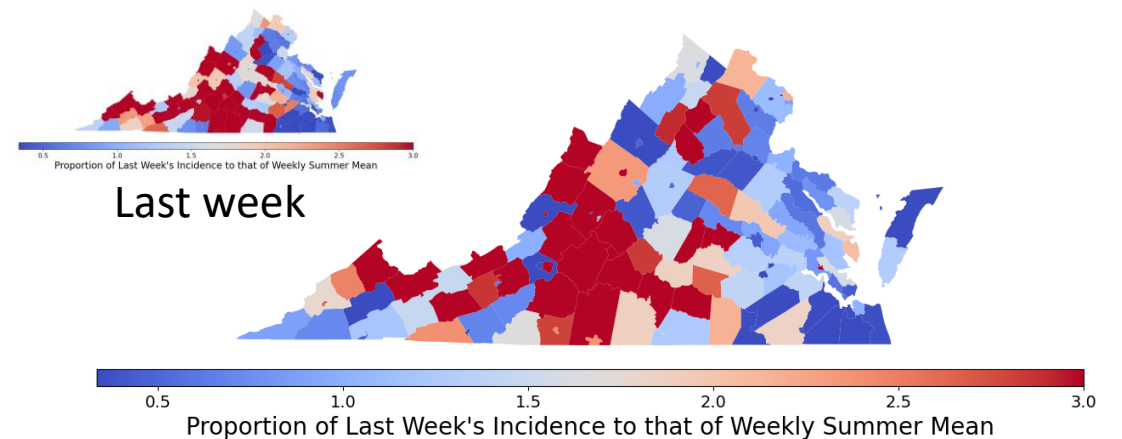

Last week

Last week

County-level comparison to last Summer

- Most counties in VA have had the highest case rate of the pandemic in the last week
- Nationally the number of counties at their highest rate has expanded considerably

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 7.84; Median: 0.67; IQR: 0.24-1.79

Last week

Mean: 11.28; Median: 0.98; IQR: 0.42-2.37

Proportion of Last Week's Incidence to that of Weekly Summer Mean

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 2.29; Median: 1.29; IQR: 0.54-2.64

Recent Incidence Compared to Weekly Summer Mean by County
Mean: 2.57; Median: 1.46; IQR: 0.75-2.97

Proportion of Last Week's Incidence to that of Weekly Summer Mean

Last week

Proportion of Last Week's Incidence to that of Weekly Summer Mean

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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 12 underway to update 11

- Round 11 recently released to assist in federal response to Omicron wave

- Only national consortium tracking Omicron wave well

- Rounds 4-11 now available

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 11 - US
(- Projection Epiweek; -- Current Week)