Network Systems Science & Advanced Computing

Biocomplexity Institute & Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

October 28th, 2020

(data current to October 27th)

Biocomplexity Institute Technical report: TR 2020-133

UNIVERSITY of VIRGINIA

BIOCOMPLEXITY INSTITUTE

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

Points of Contact

Bryan Lewis
brylew@virginia.edu

Srini Venkatramanan
srini@virginia.edu

Madhav Marathe
marathe@virginia.edu

Chris Barrett
ChrisBarrett@virginia.edu

Biocomplexity COVID-19 Response Team

Aniruddha Adiga, Abhijin Adiga, Hannah Baek, Chris Barrett, Golda Barrow, Richard Beckman, Parantapa Bhattacharya, Andrei Bura, Jiangzhuo Chen, Clark Cucinell, Patrick Corbett, Allan Dickerman, Stephen Eubank, Arindam Fadikar, Joshua Goldstein, Stefan Hoops, Ben Hurt, Sallie Keller, Ron Kenyon, Brian Klahn, Gizem Korkmaz, Vicki Lancaster, Bryan Lewis, Dustin Machi, Chunhong Mao, Achla Marathe, Madhav Marathe, Fanchao Meng, Henning Mortveit, Mark Orr, Joseph Outten, Akhil Peddireddy, Przemyslaw Porebski, SS Ravi, Erin Raymond, Jose Bayoan Santiago Calderon, James Schlitt, Aaron Schroeder, Stephanie Shipp, Samarth Swarup, Alex Telionis, Srinivasan Venkatramanan, Anil Vullikanti, James Walke, Amanda Wilson, Dawen Xie

Overview

- **Goal**: Understand impact of COVID-19 mitigations in Virginia
- **Approach:**
    - Calibrate explanatory mechanistic model to observed cases
    - Project infections through December
    - 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:

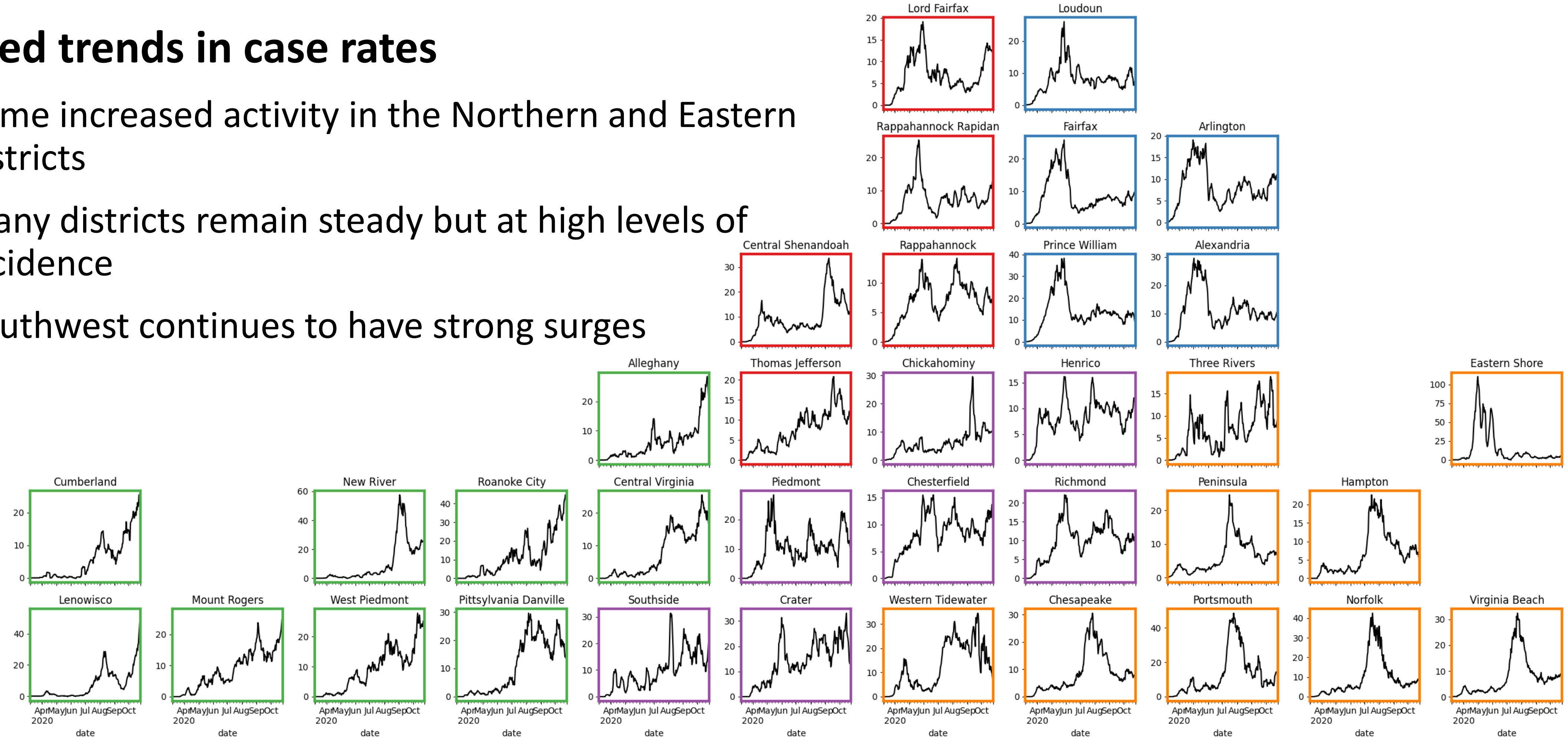
- **Virginia remains steady while many states surge, mixed districts.**
- VA weekly incidence (12.1/100K) is steady and below the growing national average (27/100K).
- Projections are mostly up, but many districts continue to decline.
- Recent updates:
  - Planning Scenarios adjusted, as Adaptive Fitting tracks recent surge, to represent population's ability to exert further control on transmission following Thanksgiving holidays, Nov 26th.
  - Case ascertainment parameters now bounded by updated seroprevalence data.
- The situation is changing rapidly. Models will be updated regularly.

Situation Assessment

Case Rate (per 100k) by VDH District

Mixed trends in case rates

- Some increased activity in the Northern and Eastern districts
- Many districts remain steady but at high levels of incidence
- Southwest continues to have strong surges

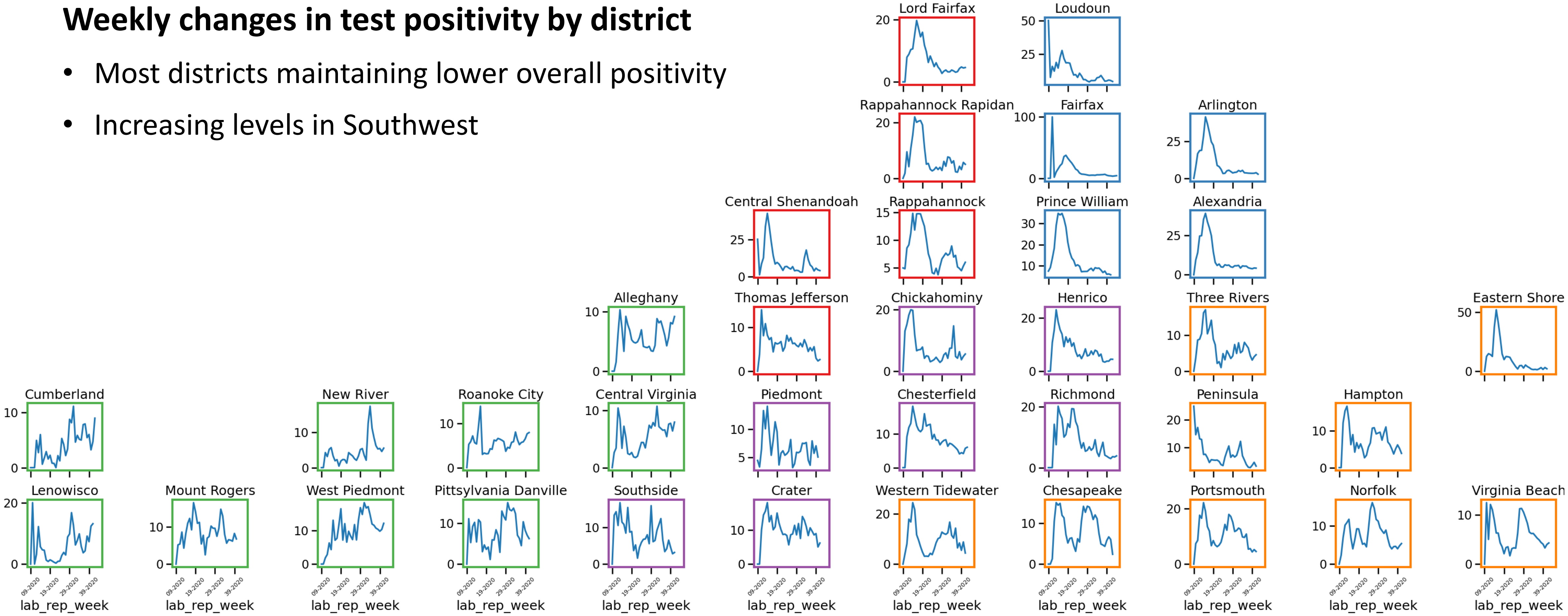


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Test Positivity by VDH District

Weekly changes in test positivity by district

- Most districts maintaining lower overall positivity
- Increasing levels in Southwest

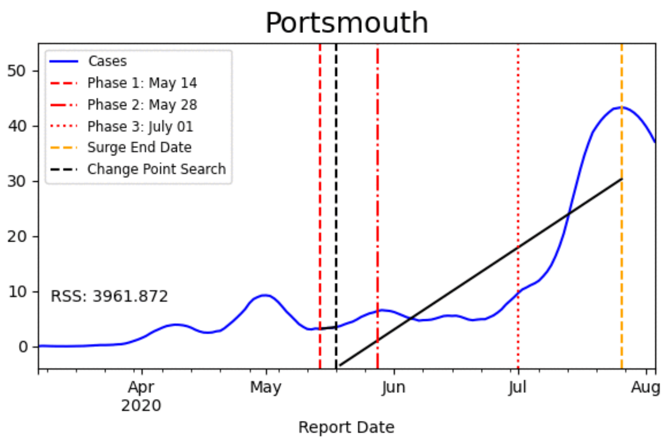


UNIVERSITY of VIRGINIA

BIOCOMPLEXITY INSTITUTE

District Trajectories

Hockey stick fit



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

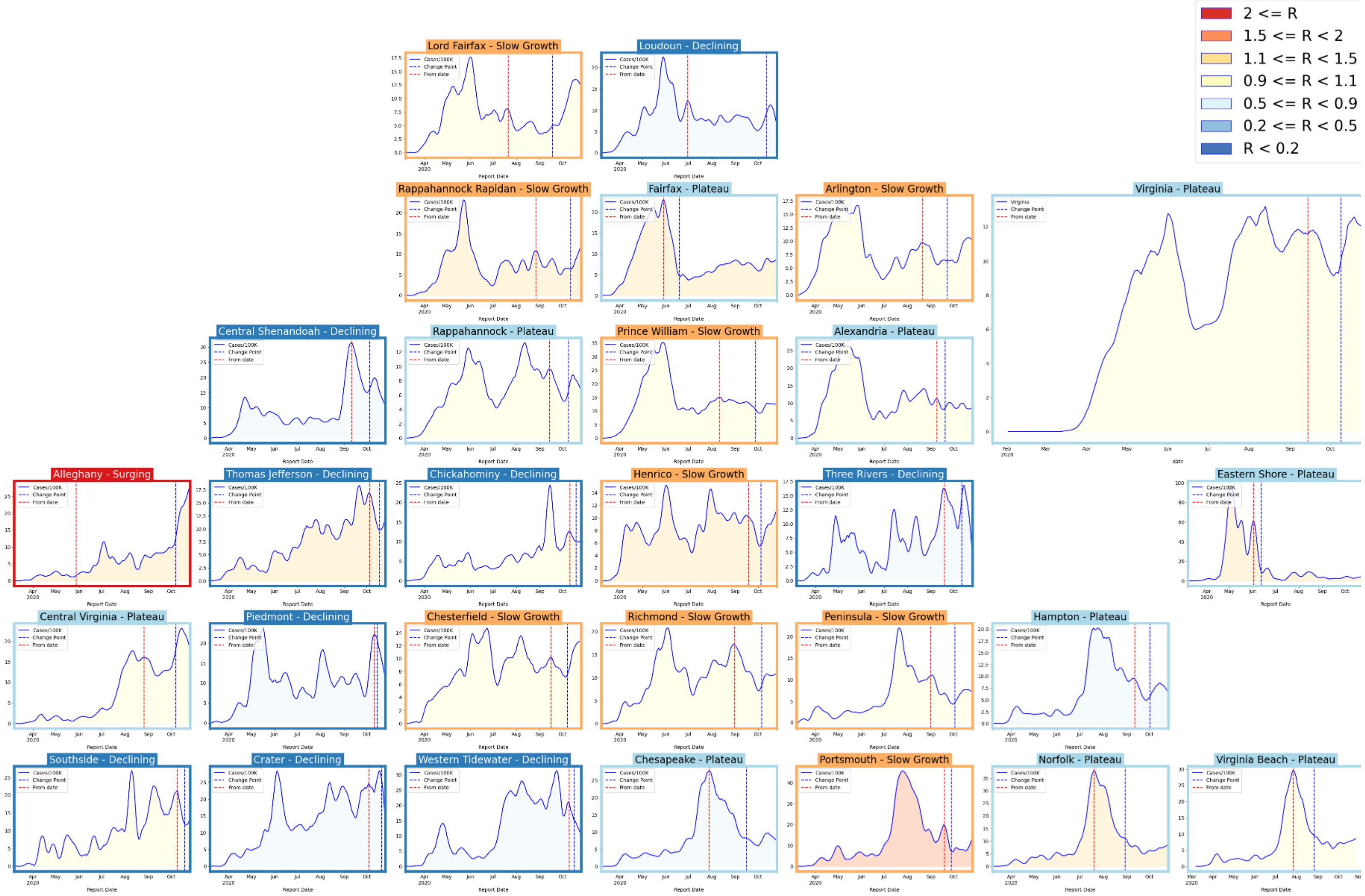
Method: Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory

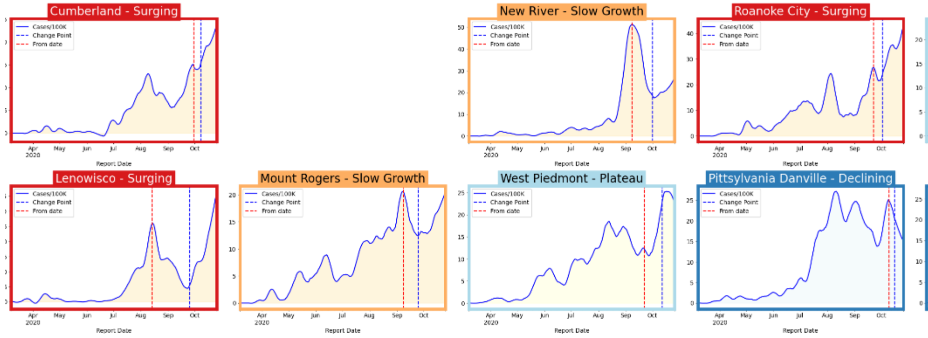
Trajectory	Description	Weekly Case Rate (per 100K) bounds	# Districts (last week)
Declining	Sustained decreases following a recent peak	below -0.9	10 (4)
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5	10 (7)
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5	11 (17)
In Surge	Currently experiencing sustained rapid and significant growth	2.5 or greater	4 (7)

District Trajectories

Status	# Districts (last week)
Declining	10 (4)
Plateau	10 (7)
Slow Growth	11 (17)
In Surge	4 (7)

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



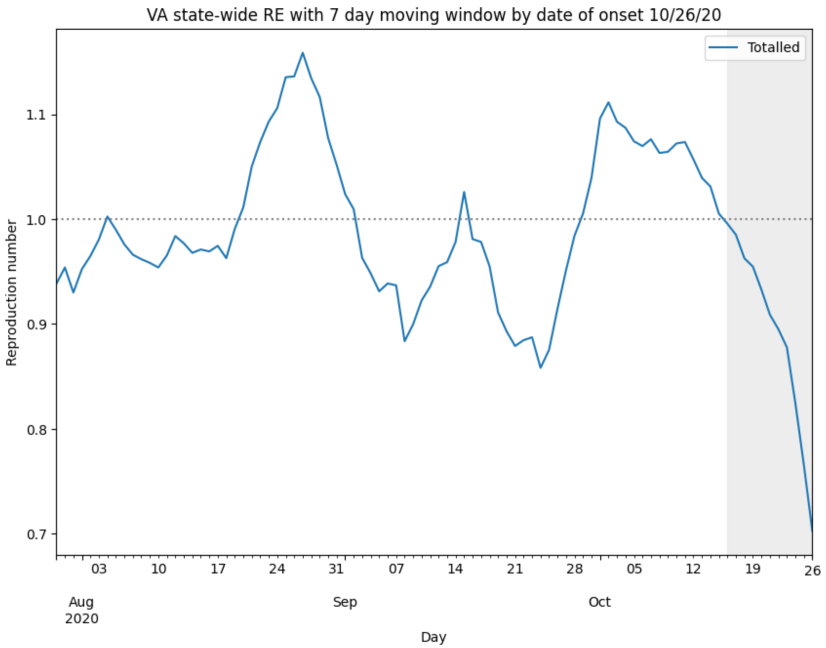


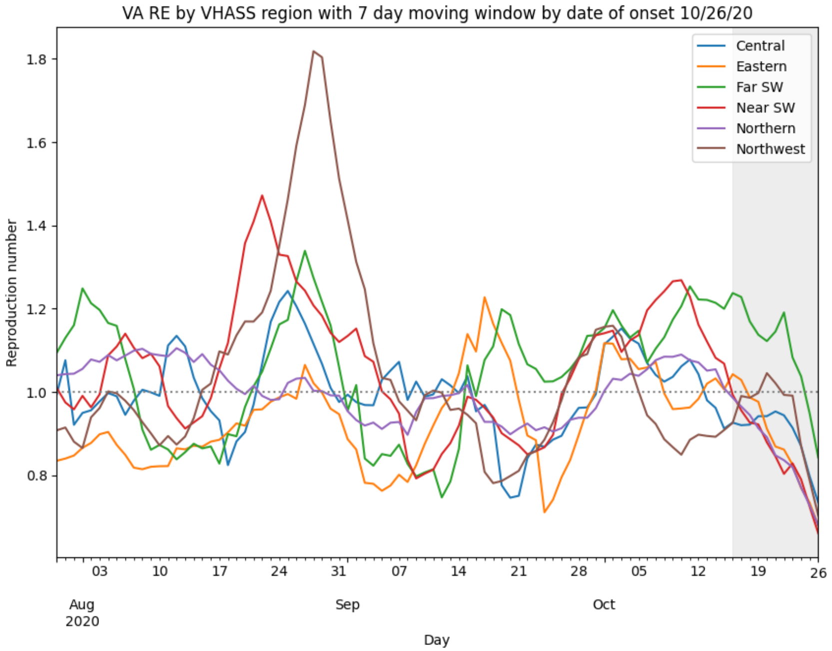
UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Estimating Daily Reproductive Number

October 17th Estimates

Region	Current R_e	Diff Last Week
State-wide	0.968	-0.069
Central	0.912	-0.131
Eastern	1.042	0.114
Far SW	1.230	0.063
Near SW	0.976	-0.264
Northern	0.970	-0.061
Northwest	0.917	0.085





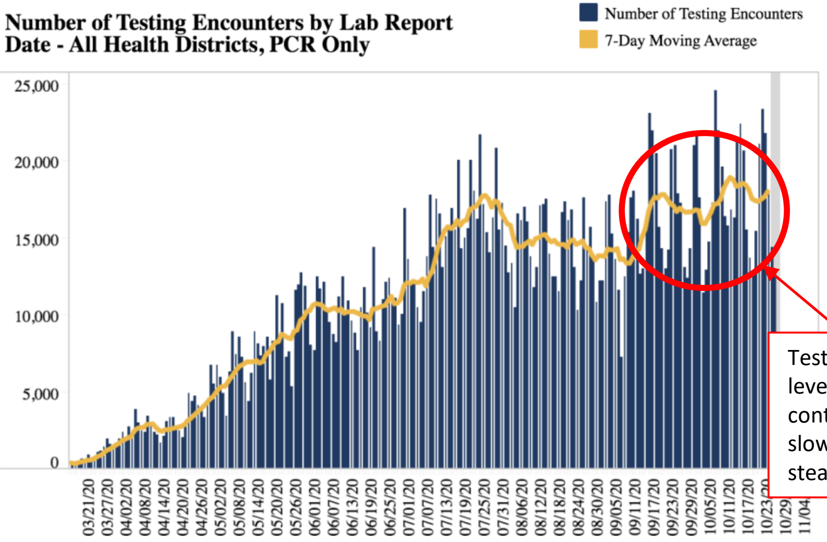
Methodology

- Wallinga-Teunis method (EpiEstim[1]) for cases by date of onset
- Serial interval: 6 days (2 day std dev)
- Recent estimates may be unstable 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

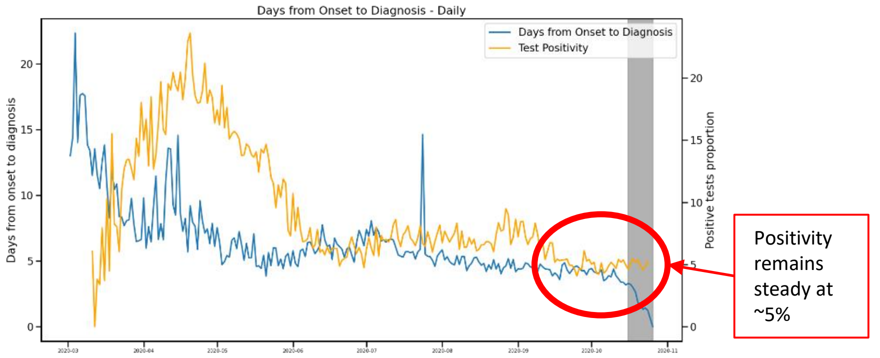
Changes in Case Detection

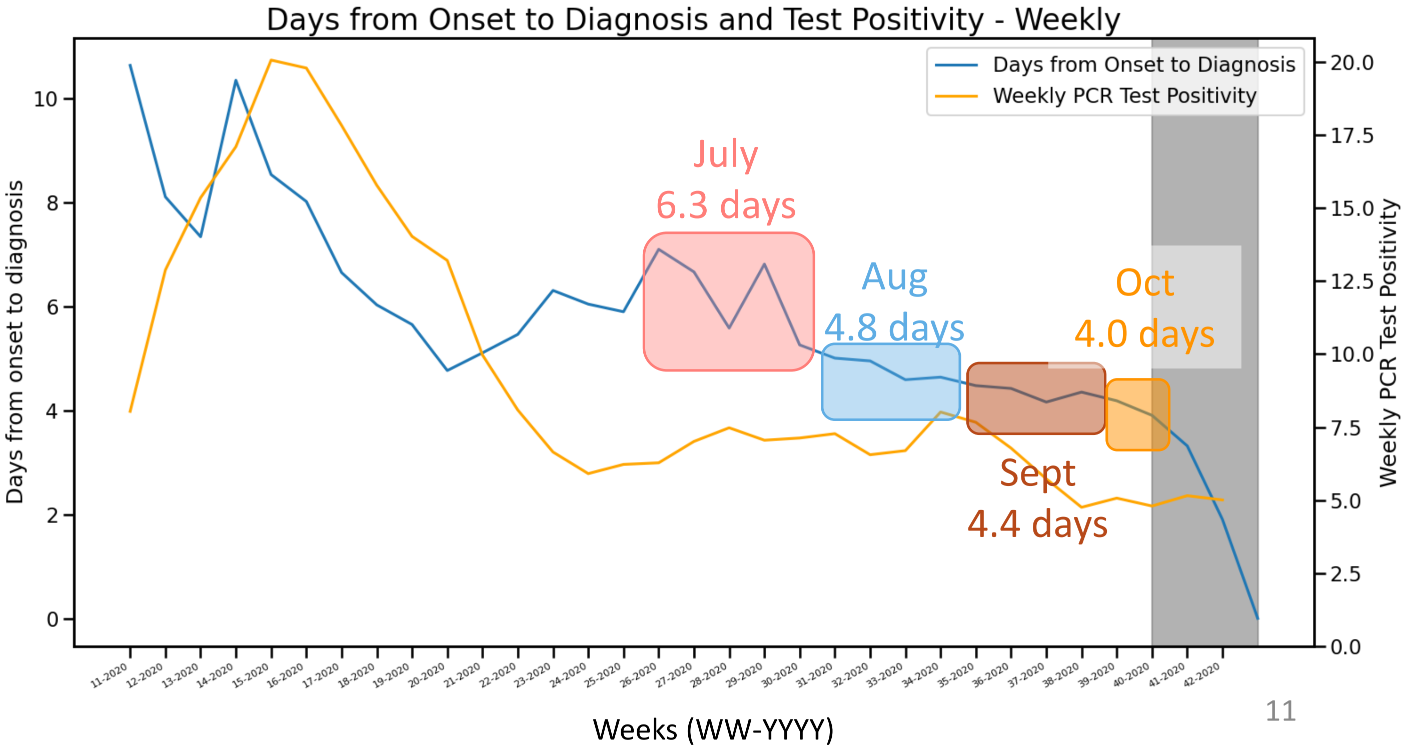
Timeframe (weeks)	Mean days	% difference from overall mean
April (13-16)	8.6	48%
May (17-21)	5.6	-3%
June (22-25)	5.9	2%
July (26-30)	6.3	8%
Aug (31-34)	4.8	-17%
Sept (35-38)	4.4	-25%
Oct (39-40)	4.0	-30%
Overall (13-37)	5.8	0%



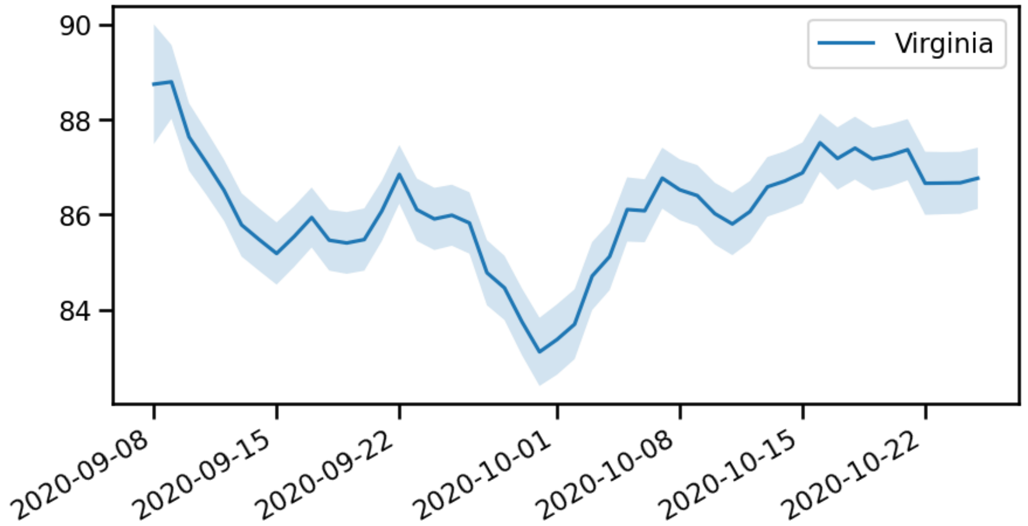
Accessed 9:00am October 28, 2020
https://www.vdh.virginia.gov/coronavirus/

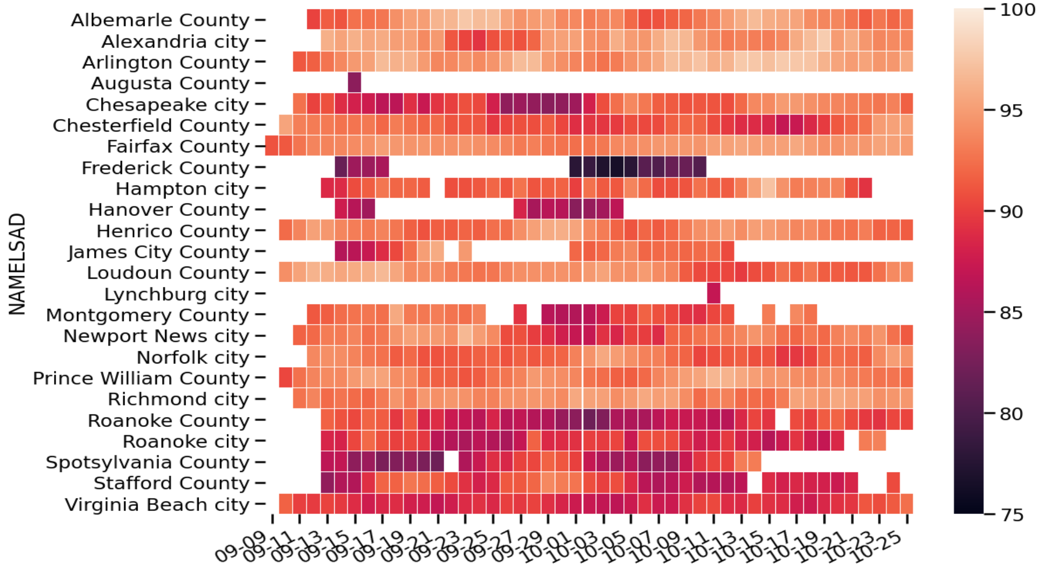
Test positivity vs. Onset to Diagnosis





Mask usage in Virginia





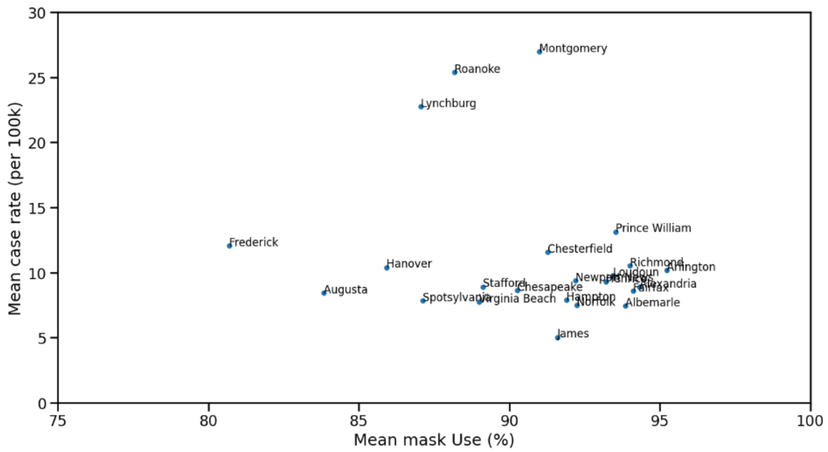
Some county level fluctuations since beginning of Sept., though data quality may be affected by sample sizes.

State level mask usage as reported via Facebook surveys over the past month shows ranges from 83% to 89%

- Relatively stable over time
- Limited variance across the commonwealth
- ~3000 daily responses from VA.

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

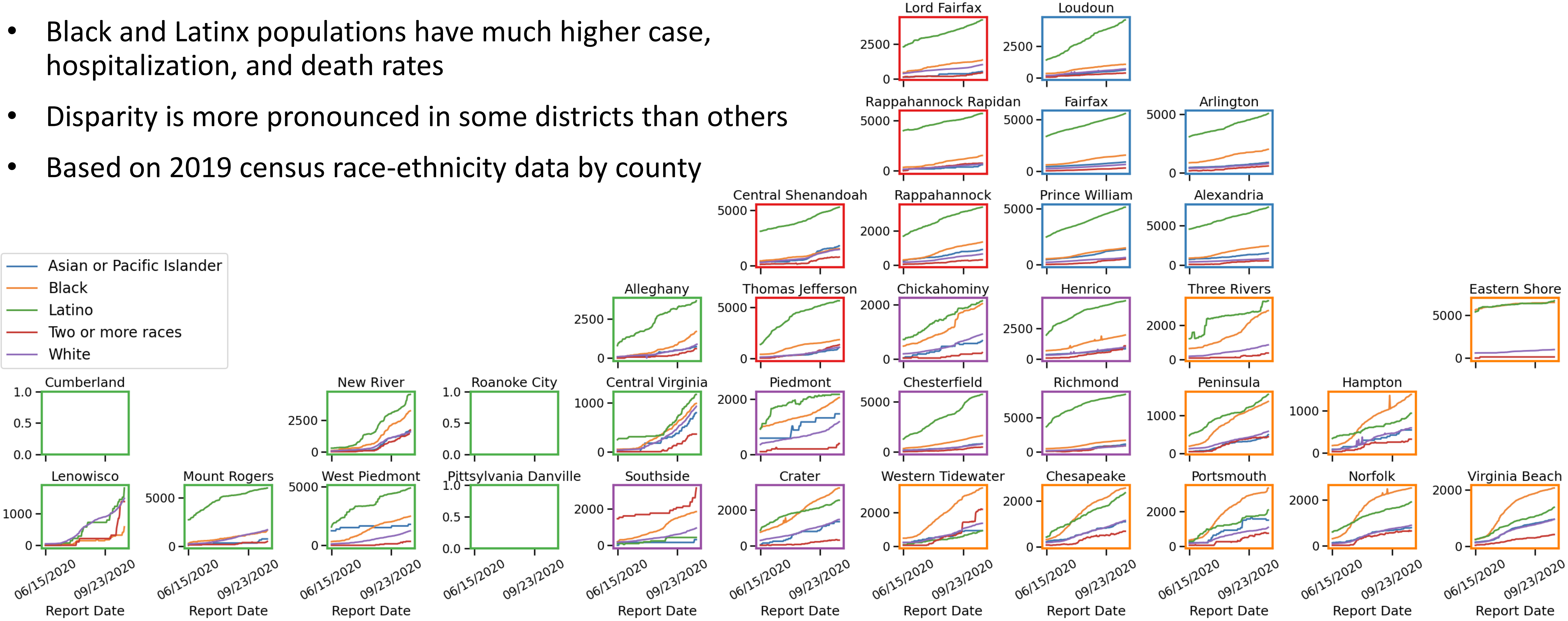
Correlations seen at national level with mask use and case rate not emerging across VA counties, reflecting high use across commonwealth



Race and Ethnicity Attack Rates (per 100K)

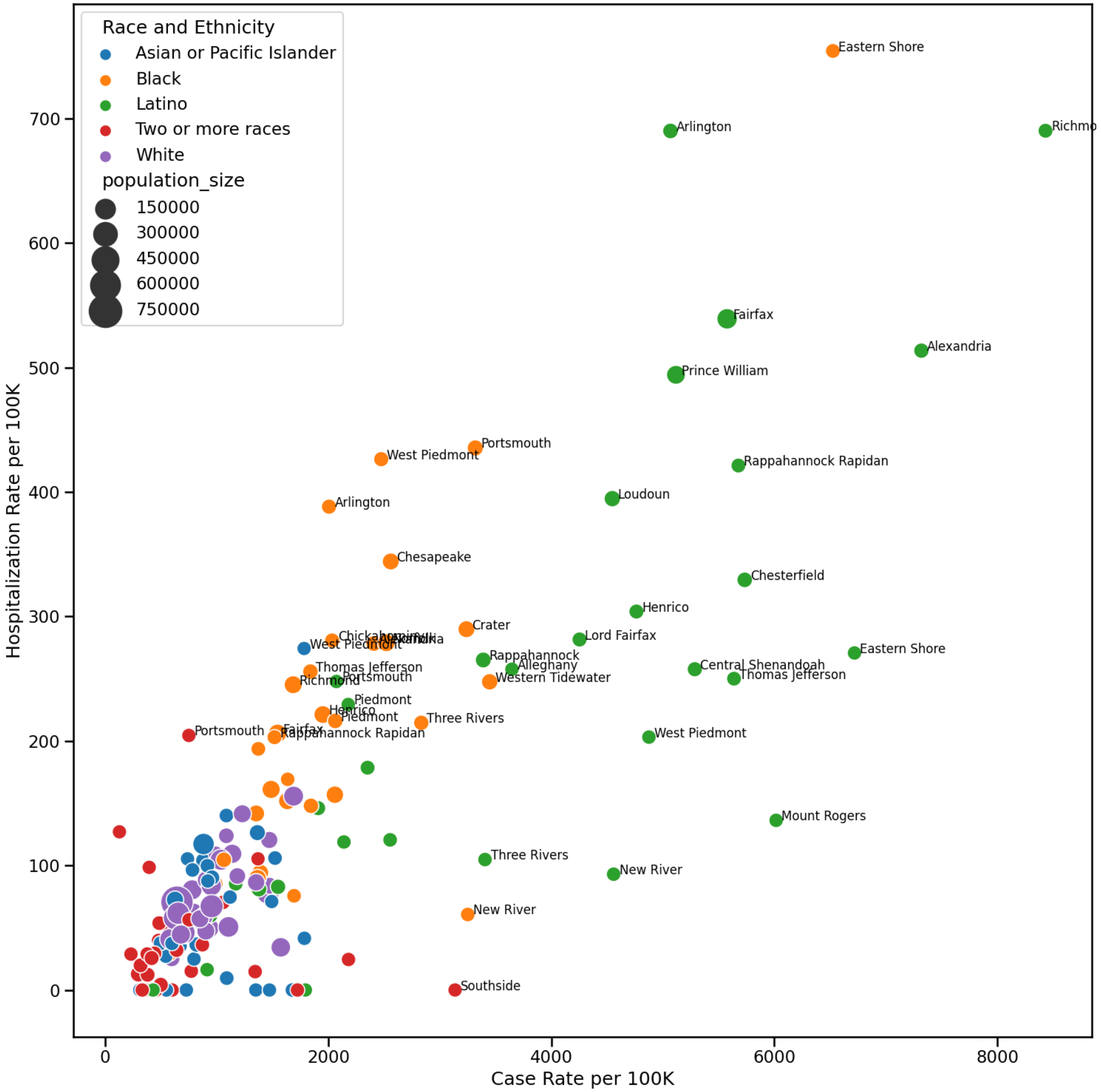
Cumulative Race and Ethnicity Attack Rates (per 100k)

- Black and Latinx populations have much higher case, hospitalization, and death rates
- Disparity is more pronounced in some districts than others
- Based on 2019 census race-ethnicity data by county



UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Race and Ethnicity cases per 100K



Rates per 100K of each Racial-Ethnic population by Health District

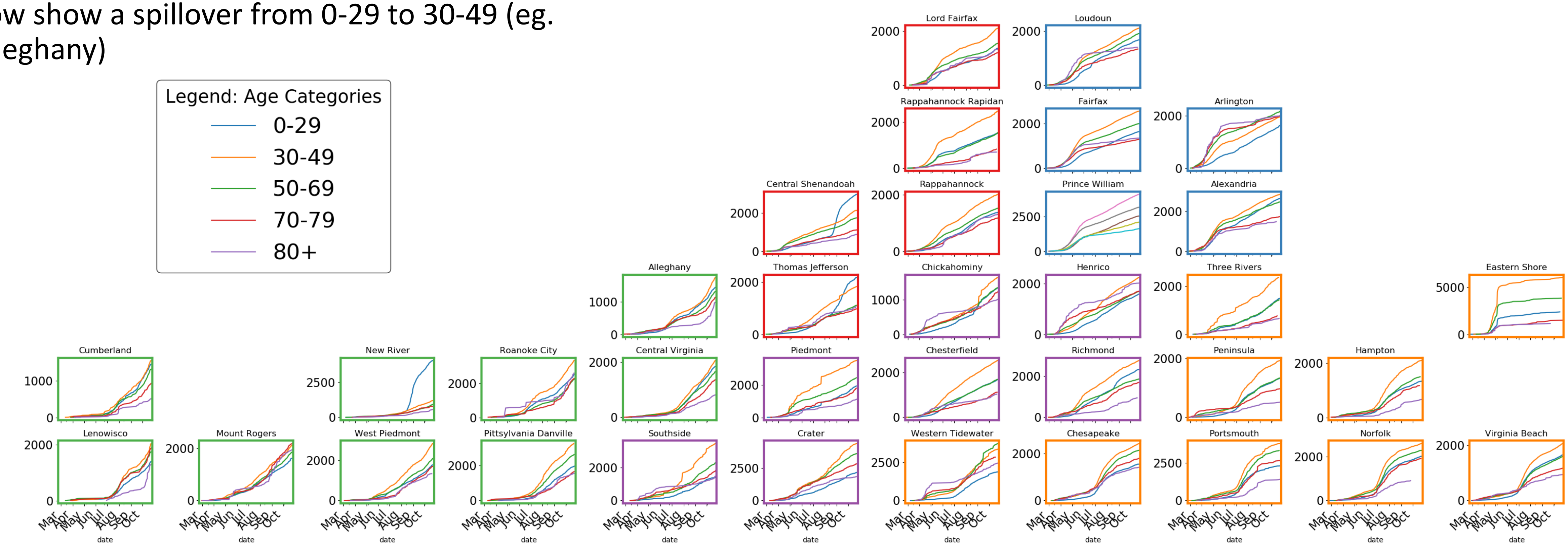
- Each Health District's Racial-Ethnic population is plotted by their Hospitalization and Case Rate
- Points are sized based on their overall population size
- Overlapping labels removed for clarity

Age-Specific Attack Rates (per 100K)

Cumulative Age-specific Attack Rates (per 100k)

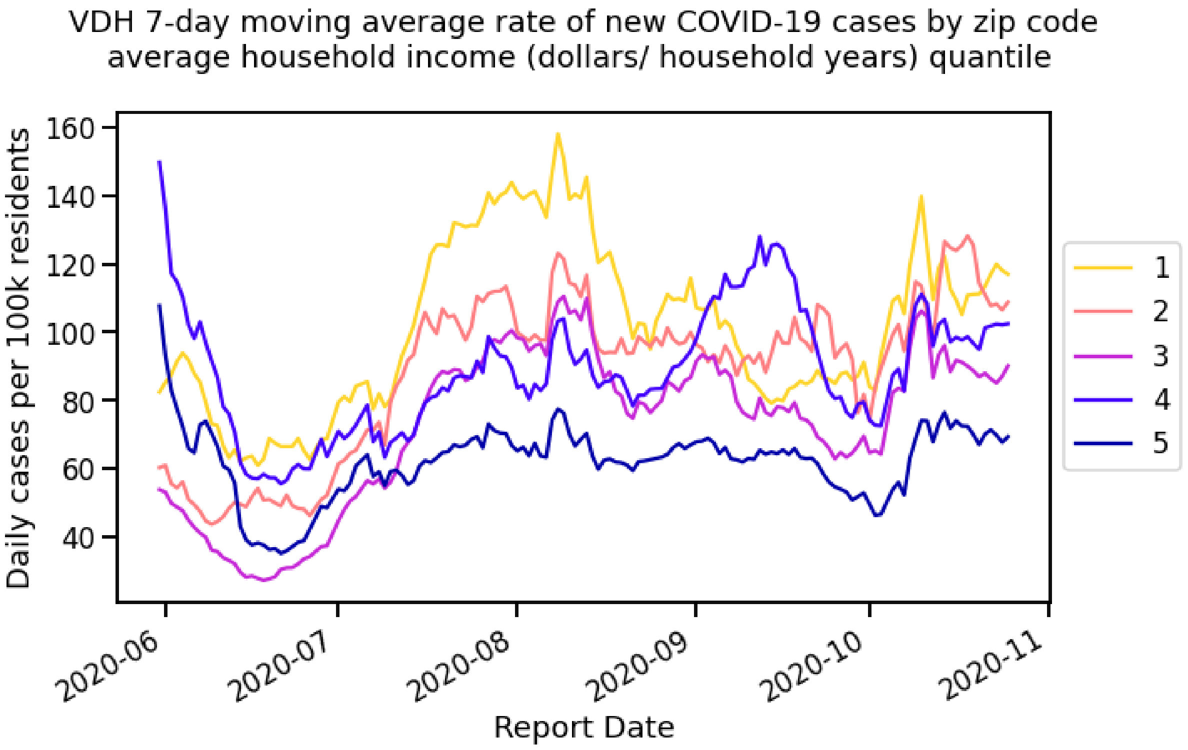
- Younger age groups outpace older in many districts
- Some districts with previous surge in young cases now show a spillover from 0-29 to 30-49 (eg. Alleghany)

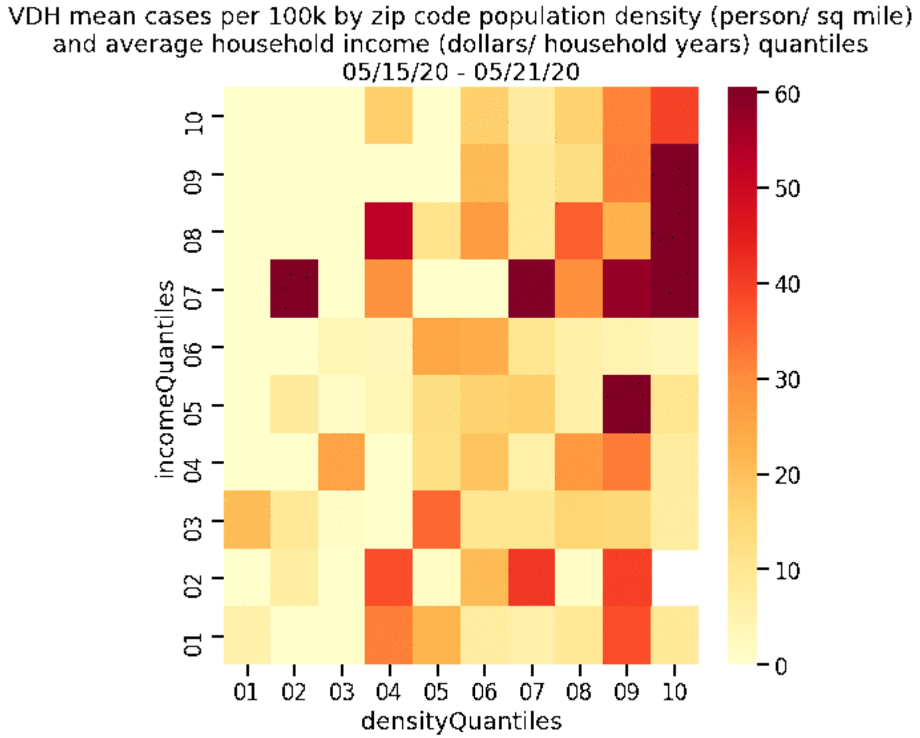
Age-adjusted Cumulative Prevelance Rate Per 100k District Population



UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Impact across Density and Income



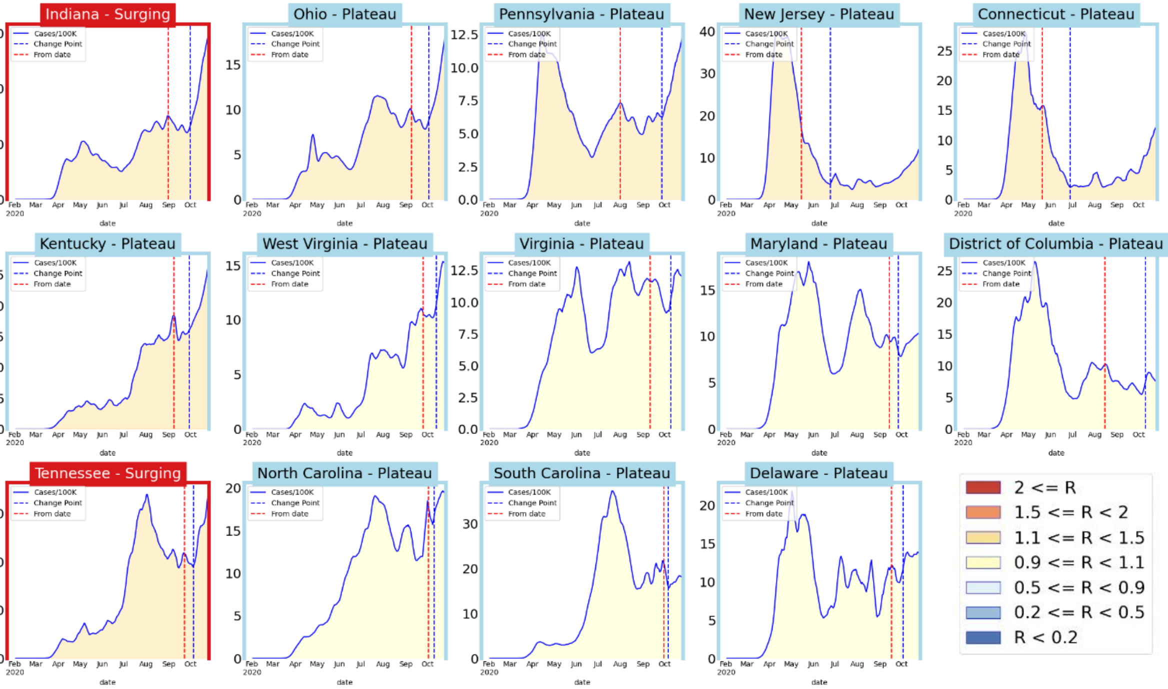


Shift back to higher income zip codes partially driven by surges in areas surrounding universities, which has since receded with the lower 40% bearing higher rates of disease

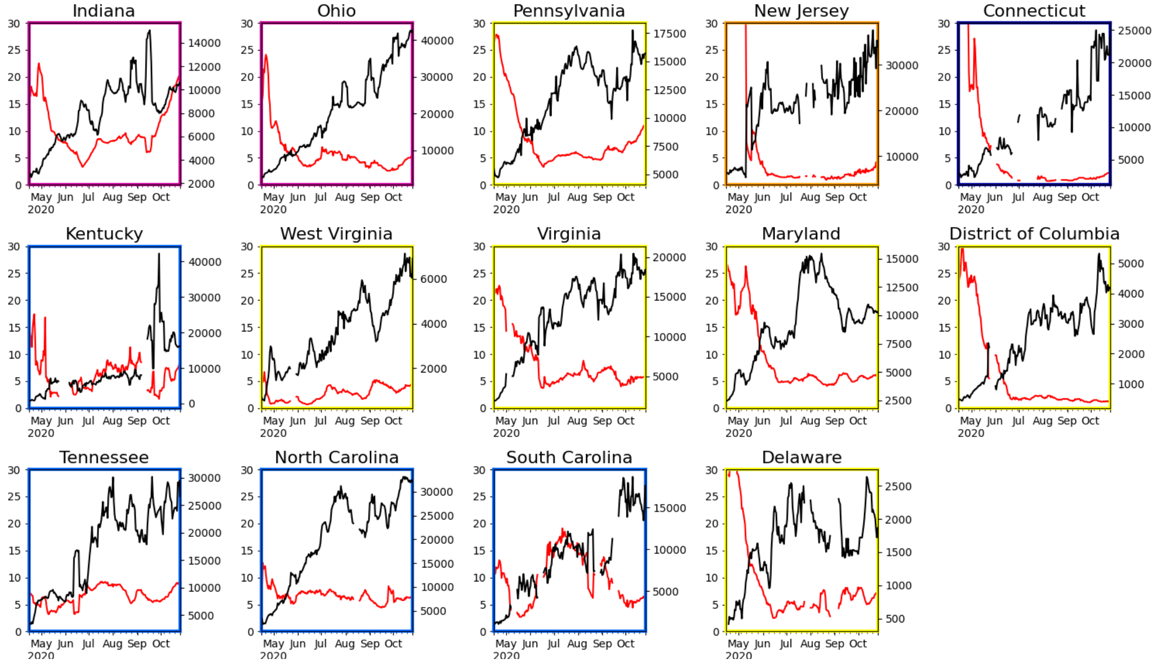
Can see the evolution from denser and wealthier zip codes to poorer and less dense zip codes, then back to denser wealthier zip codes, with an additional shift back again to poorer and less dense areas

Other State Comparisons

Trajectories of States



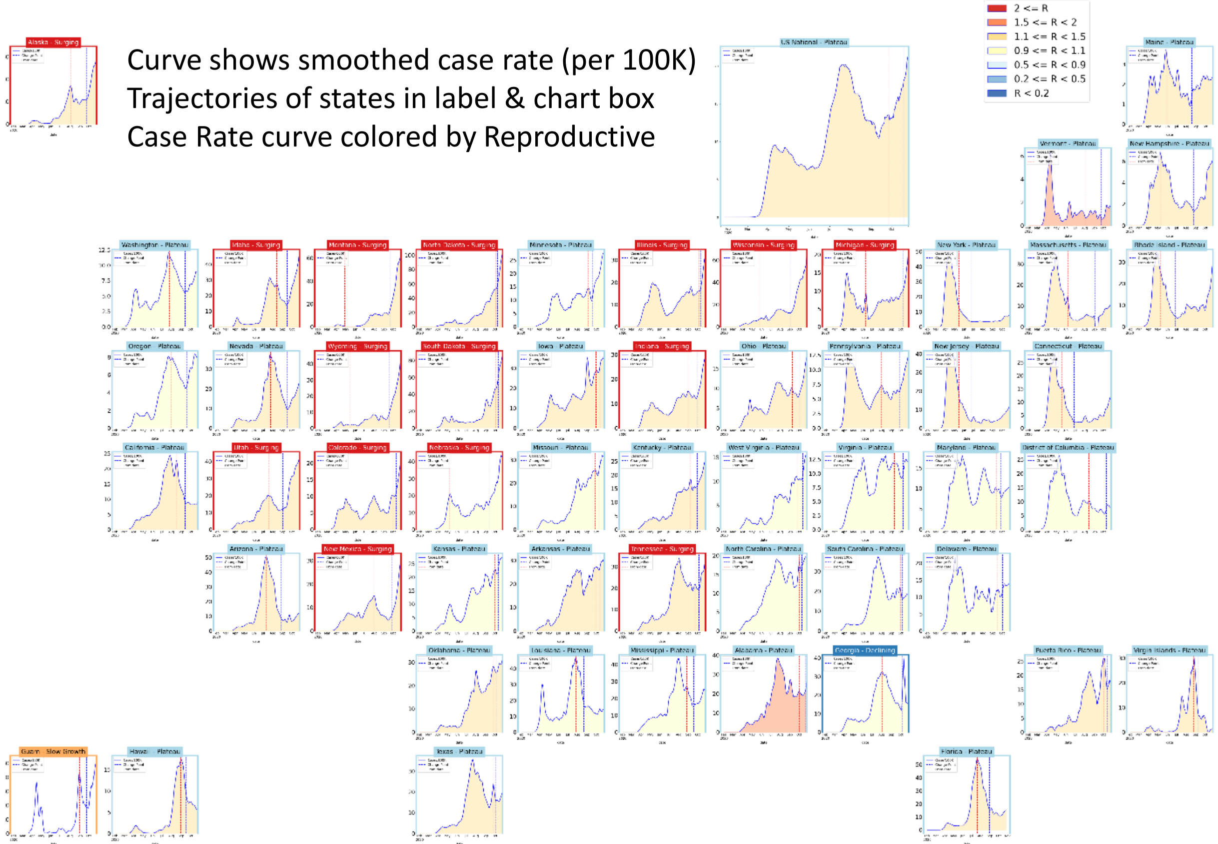
Tests per Day and Test Positivity

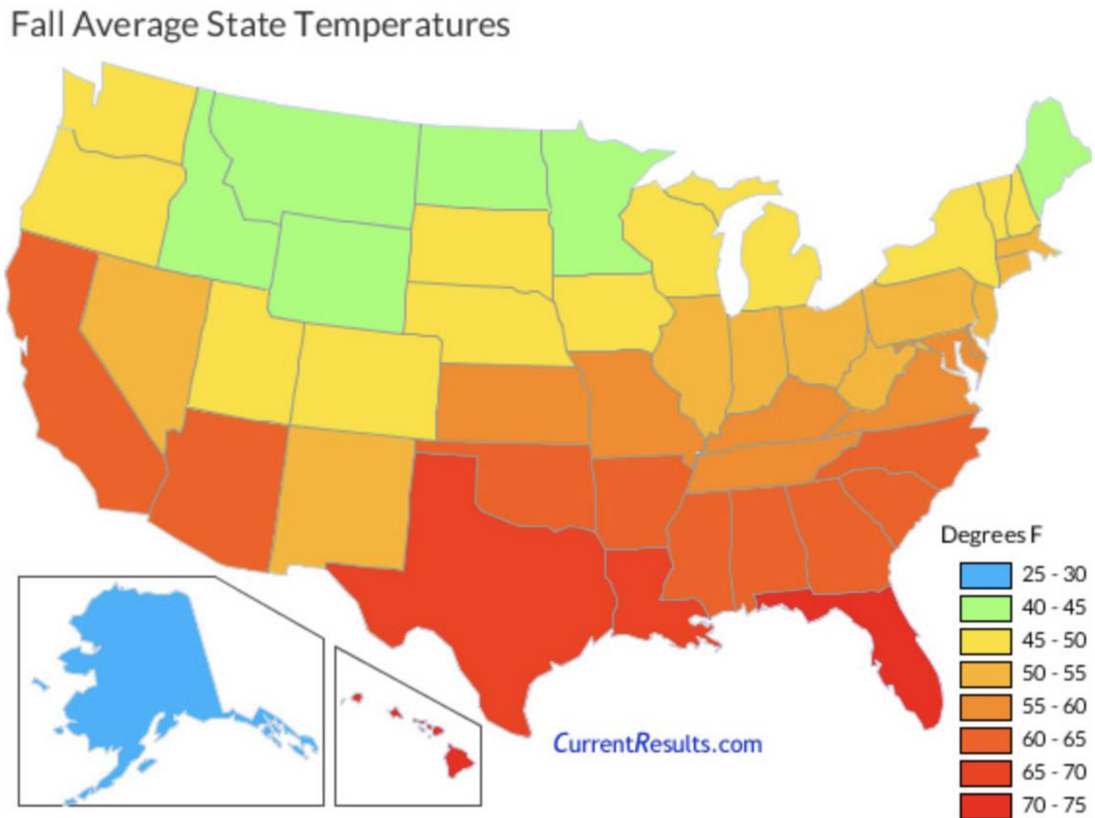


- VA and other mid-Atlantic states in plateaus with signs of growth
- TN and IN remain in surge (along 15 others across nation)
- Most of the Mid-Atlantic at or above 10/100K

- Test positivity mixed, VA's declining rate has slowed.
- Testing volumes remain steady and relatively high

Growth Associated with Temperature and Humidity





https://www.currentresults.com/Weather/US/state-temperature-maps-seasonal.php

- As weather cools and humidity drops, COVID-19 survival and chance of transmission may rise.
- This may be contributing, with other factors, to the rise in cases in plains and Midwest as well as Northeast

UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

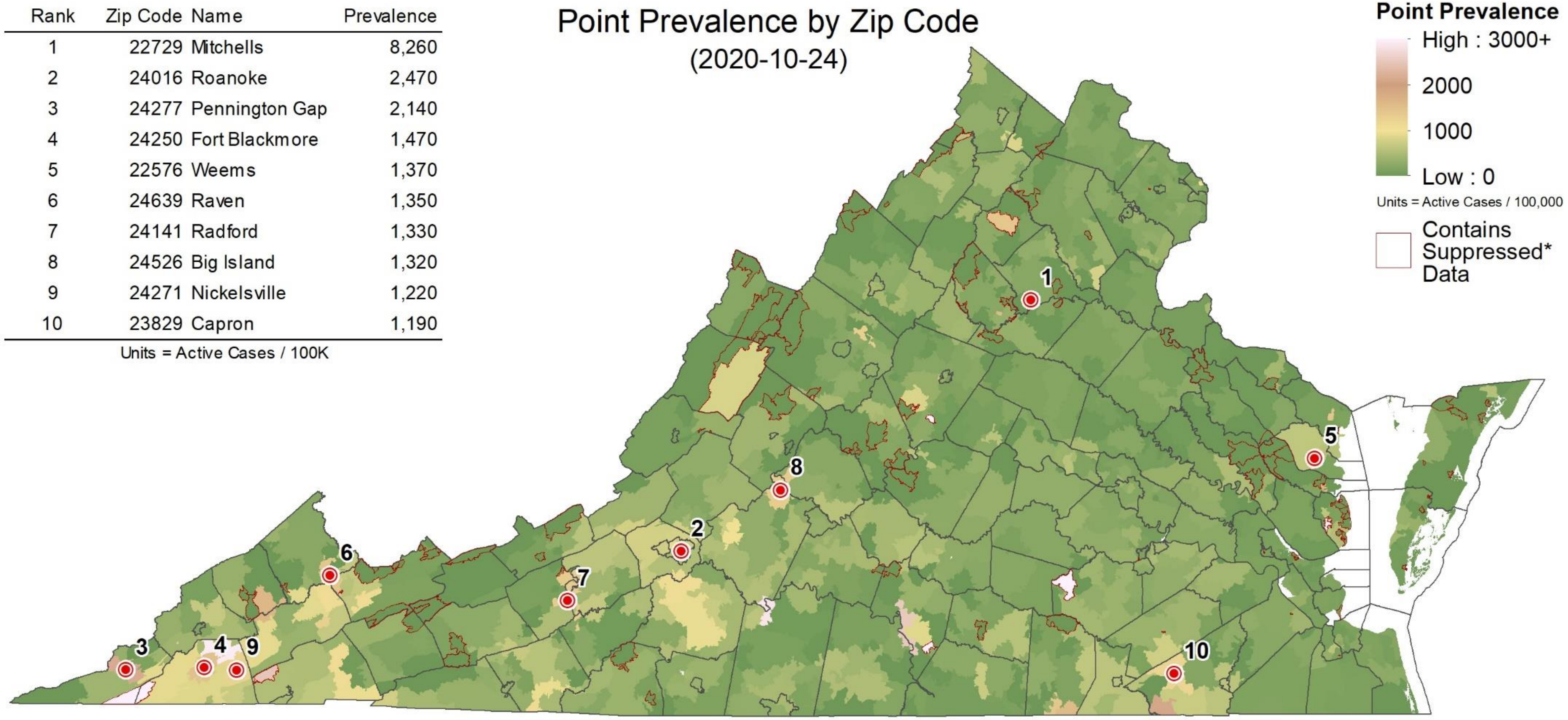
Zip code level weekly Case Rate (per 100K)

Case Rates in the last week by zip code

- Concentrations of very high prevalence in some zip codes
- Trend back towards very high rates in a few zips and lower in surrounding areas
- Southwest has considerable concentration of high prevalence zips
- Some counts are low and suppressed to protect anonymity, those are shown in white

Rank	Zip Code	Name	Prevalence
1	22729	Mitchells	8,260
2	24016	Roanoke	2,470
3	24277	Pennington Gap	2,140
4	24250	Fort Blackmore	1,470
5	22576	Weems	1,370
6	24639	Raven	1,350
7	24141	Radford	1,330
8	24526	Big Island	1,320
9	24271	Nickelsville	1,220
10	23829	Capron	1,190

Units = Active Cases / 100K

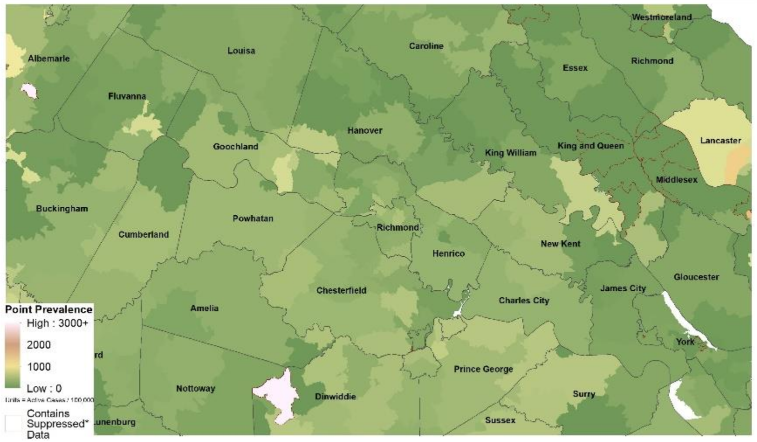


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Zip code level weekly Case Rate (per 100K)

Richmond

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24

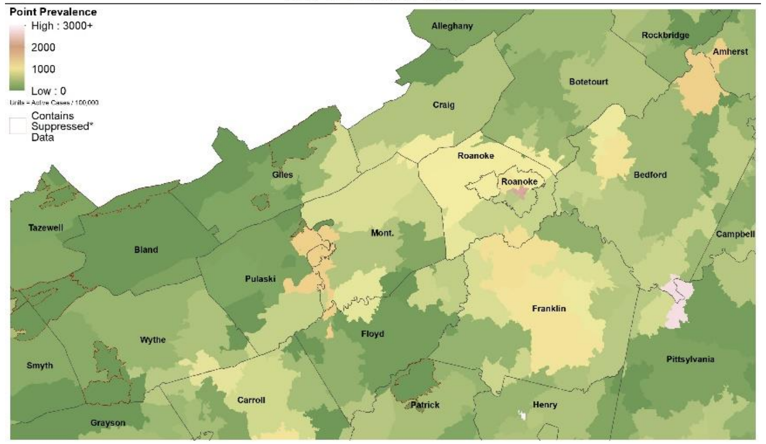


Albemarle

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24

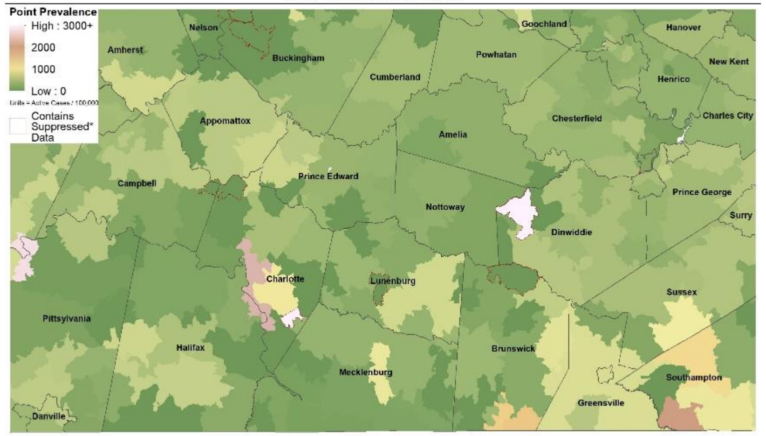
New River Valley

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24



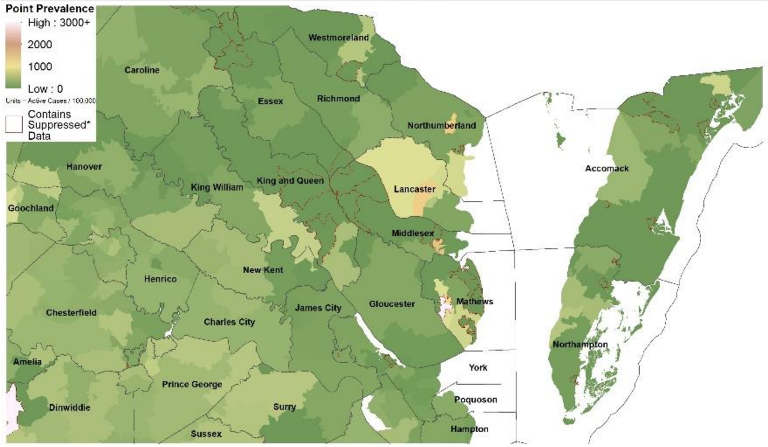
Southside

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24



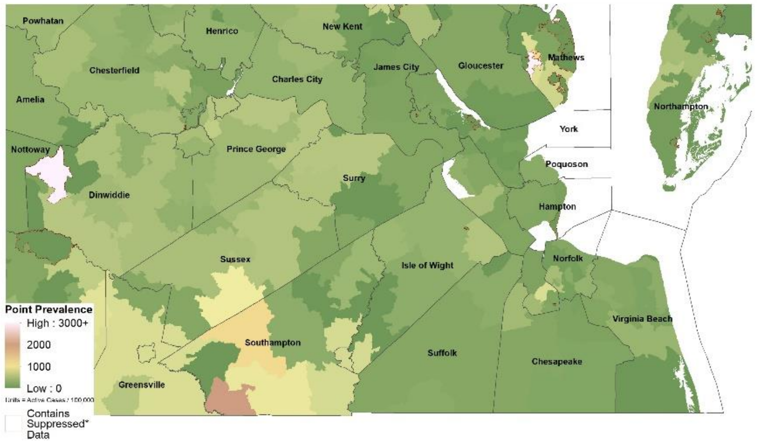
Three Rivers

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24



Tidewater

Point Prevelence by Zip Code
2020-10-18 to 2020-10-24

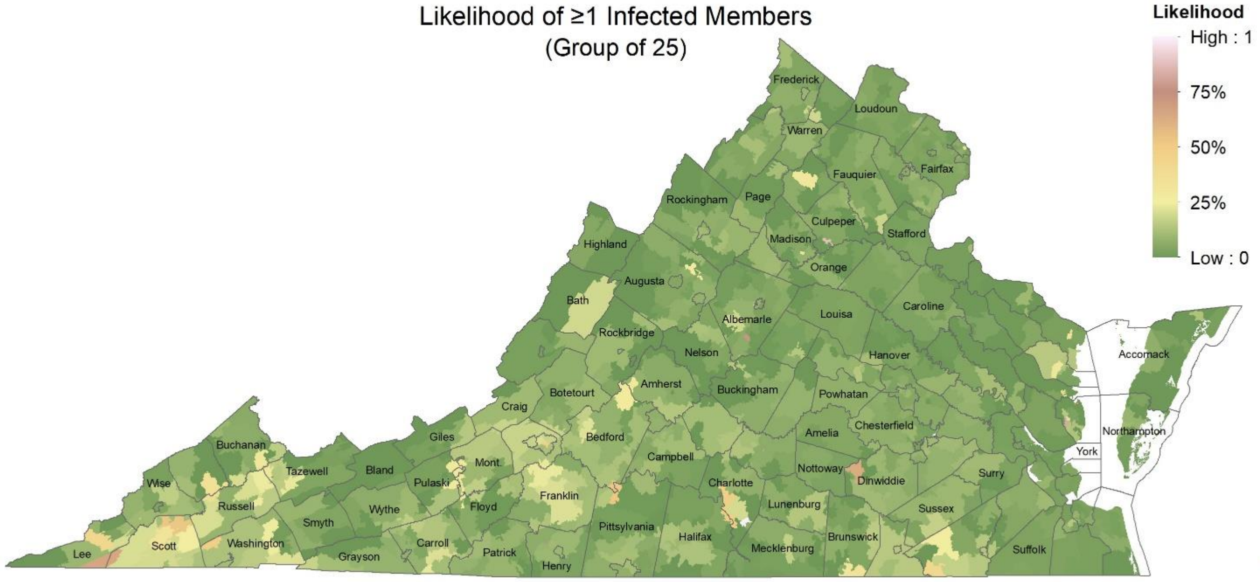


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

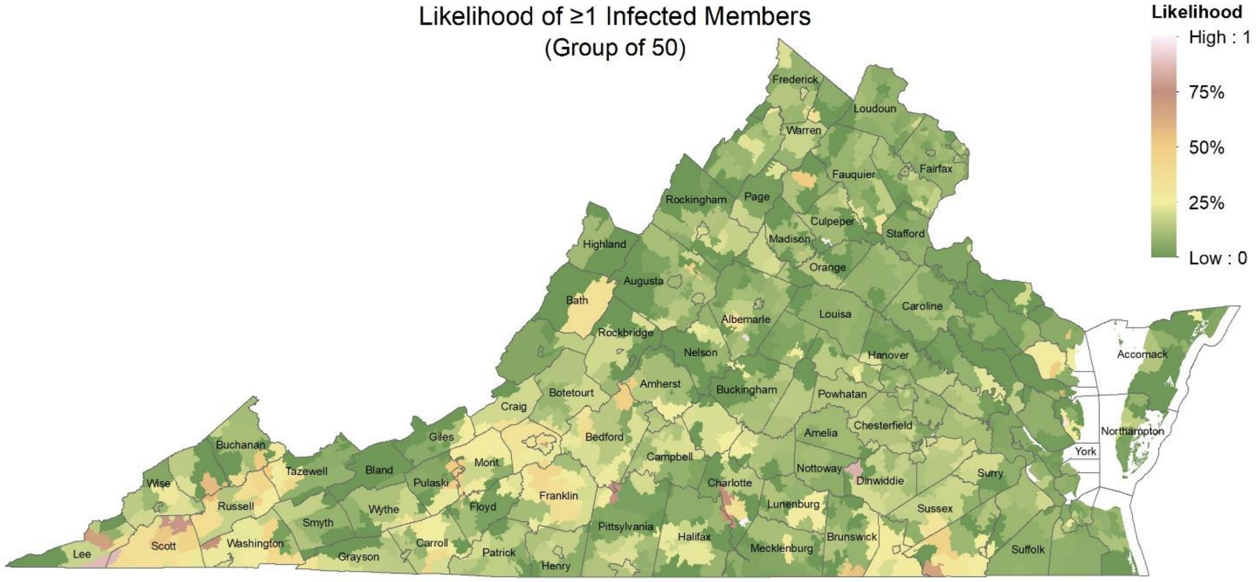
Risk of Exposure by Group Size

Case Prevalence in the last week by zip code used to calculate risk of encountering someone infected in a gathering of randomly selected people (group size 25 or 50)

- Assumes 3 undetected infections per confirmed case (ascertainment rate from recent seroprevalence survey)
- Moderate risk for groups of 50 across the commonwealth, especially in the southern half of the state
- Some zip codes have high likelihood of exposure even in groups of 25



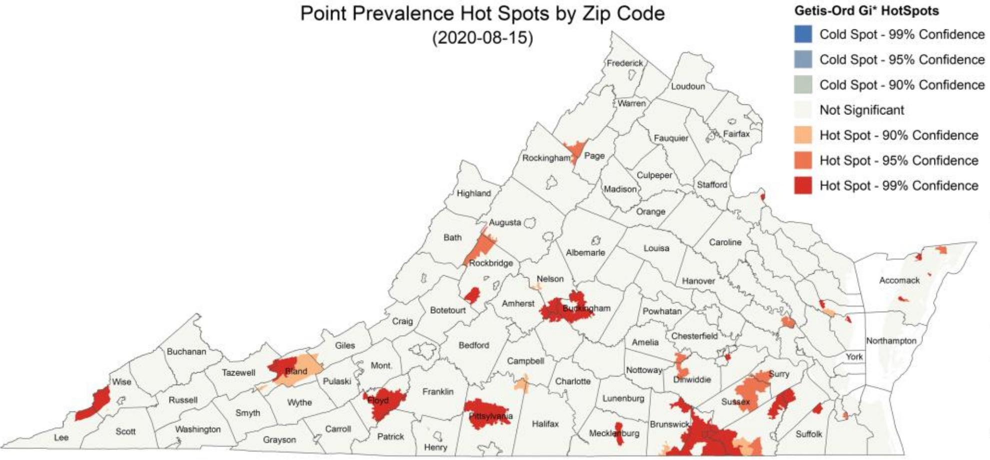
Based on zip code point prevelence for week ending 2020-10-24



Based on zip code point prevelence for week ending 2020-10-24

Zip Code Hot Spots

Previous weeks



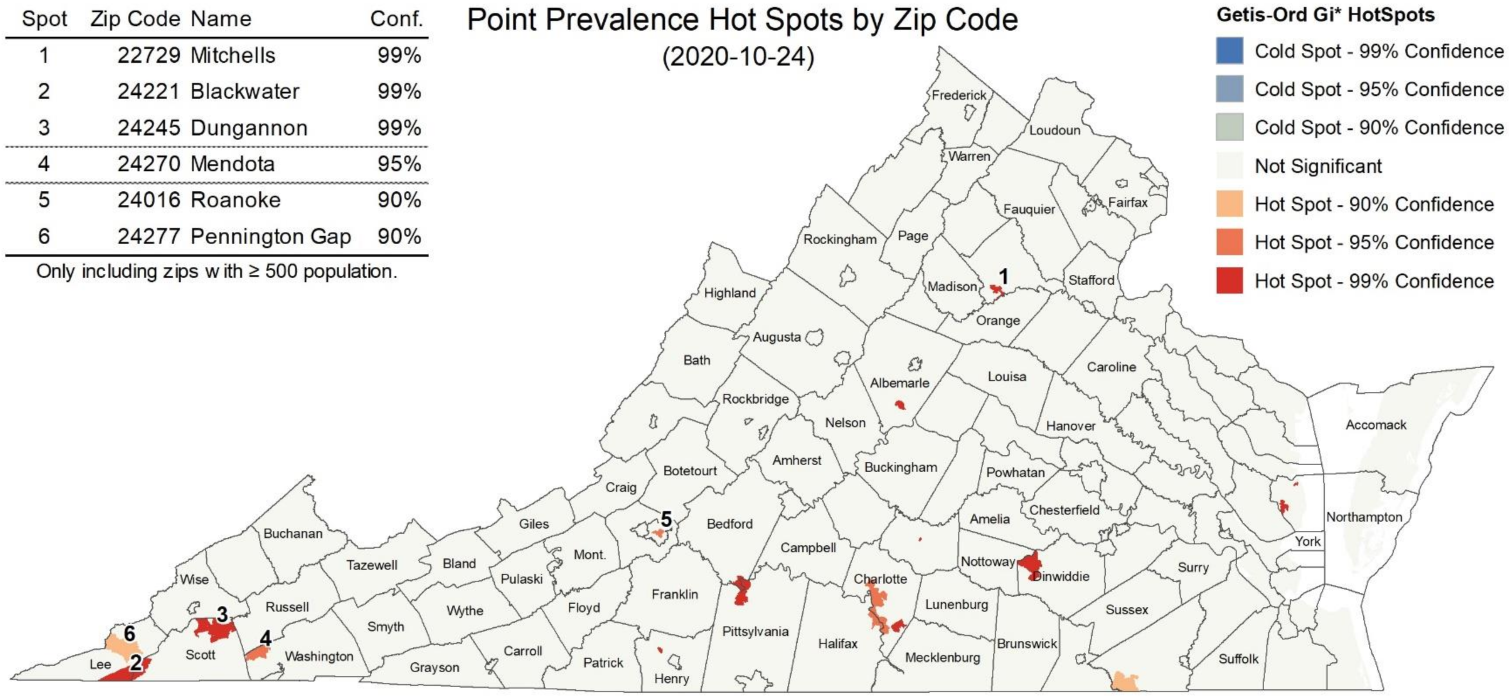
Hot Spot Significance	# of Zips (last week)
99%	11 (5)
95%	3 (3)
90%	3 (2)

Hotspots across commonwealth

- Similar number of hotspots this week compared to last week
- Fewer university associated hotspots

Spot	Zip Code	Name	Conf.
1	22729	Mitchells	99%
2	24221	Blackwater	99%
3	24245	Dungannon	99%
4	24270	Mendota	95%
5	24016	Roanoke	90%
6	24277	Pennington Gap	90%

Only including zips w ith ≥ 500 population.



UNIVERSITY of VIRGINIA

BIOCOMPLEXITY INSTITUTE

Model Update – Adaptive Fitting

Adaptive Fitting Approach

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

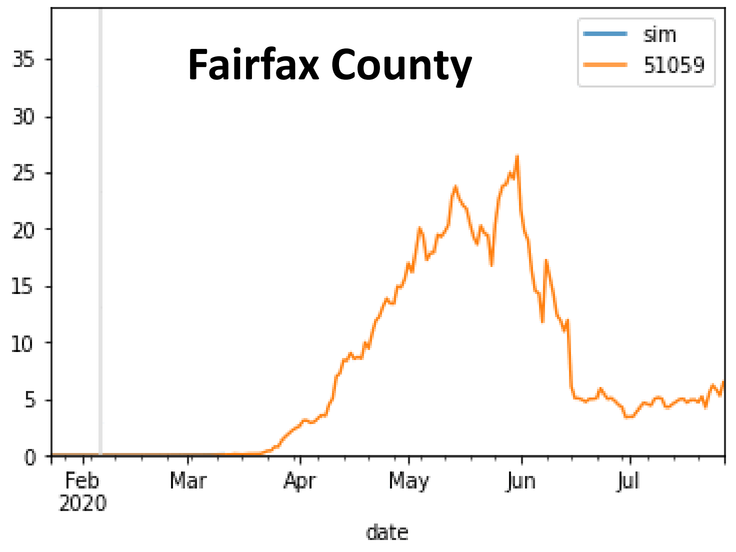
- Allows history to be precisely captured, and used to guide bounds on projections

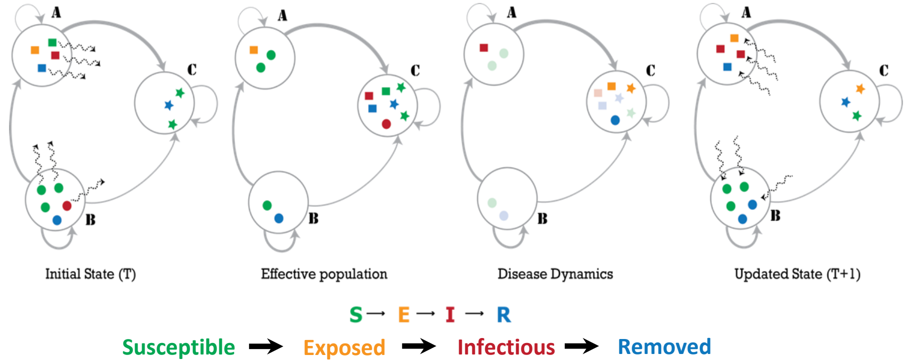
Model: An alternative use of the same meta-population model, PatchSim

- 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





UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

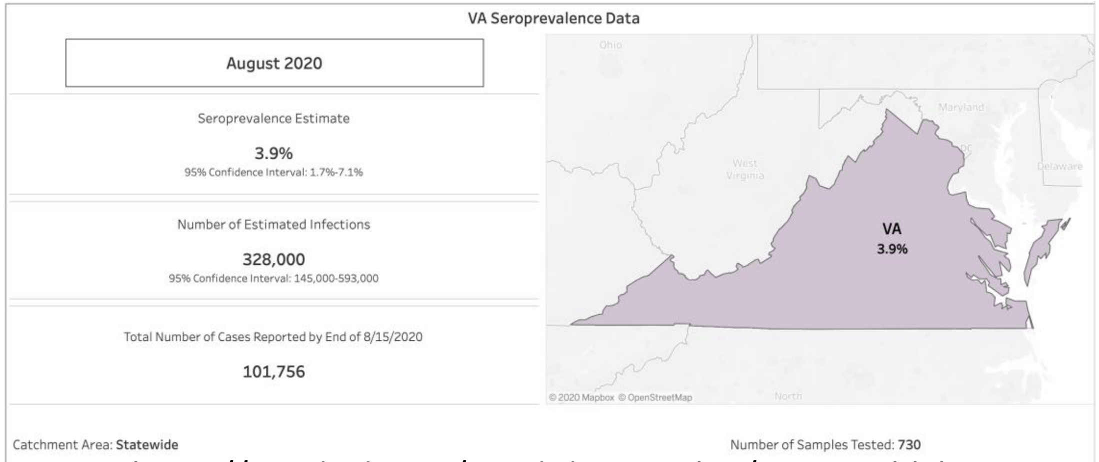
Seroprevalence updates to model design

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

- Virginia Serology Study estimated 2.4% of Virginians estimated infected (as of Aug 15th)
- CDC Nationwide Commercial Laboratory Seroprevalence Survey estimated 3.9% [1.7% – 7.1%] seroprevalence as of Aug 15th

These findings are equivalent to an ascertainment ratio of ~3x, with bounds of (1x to 7x)

- Thus for 3x there are 3 total infections in the population for every confirmed case
- Uncertainty design has been shifted to these bounds (previously higher ascertainments as was consistent earlier in the pandemic were being used)



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

Virginia Coronavirus Serology Project

Interim findings by region and statewide - July 22, 2020

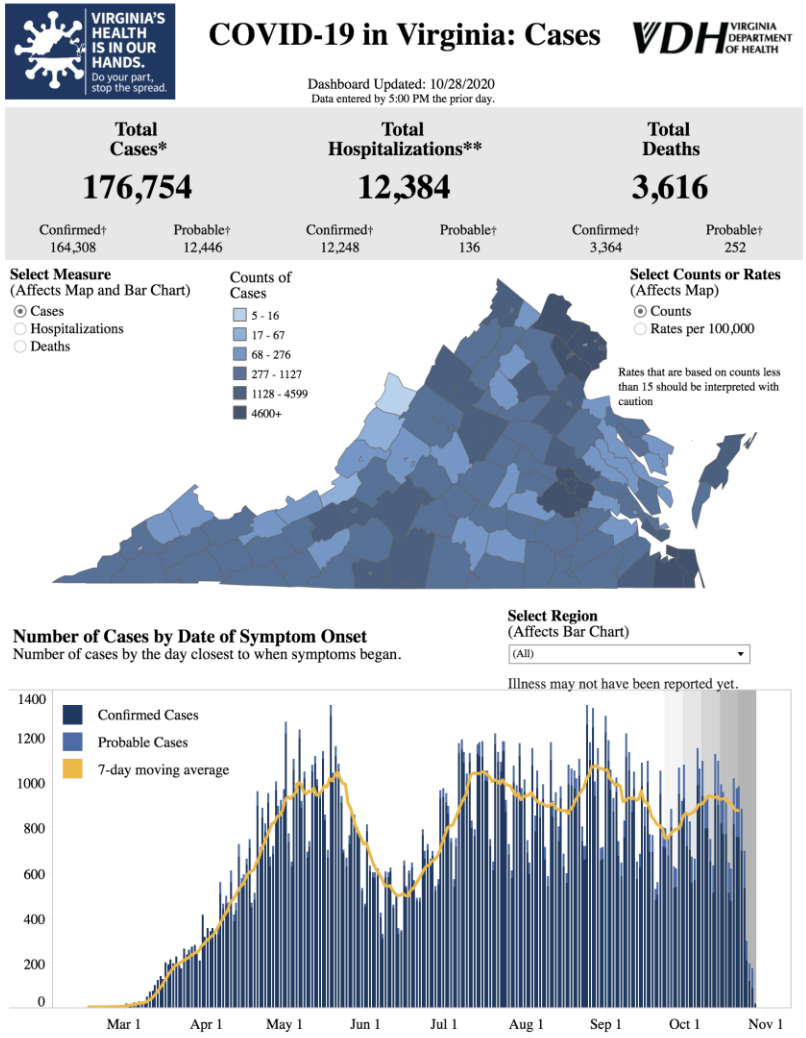
Region	Number of participants	Number antibody positive	Crude prevalence per 100 participants	Weighted prevalence* per 100 population	Weighted prevalence* (95% CI)
Central	400	8	2.0	3.0	(0.5, 5.5)
East	707	9	1.3	1.5	(-0.2, 3.2)
Northern	819	36	4.4	4.2	(2.5, 5.9)
Northwest	756	11	1.5	0.9	(0.2, 1.6)
Southwest	431	3	0.7	1.0	(-0.2, 2.1)
Virginia	3,113	67	2.2	2.4	(1.6, 3.1)

* Weighted prevalence is reweighted by region, age, sex, race, ethnicity, and insurance status to match census population.

https://www.vdh.virginia.gov/content/uploads/sites/8/2020/08/VDH-Serology-Projects-Update-8-13-2020.pdf

Calibration Approach

- **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting
- **Calibration:** fit model to observed data
  - 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 using the most recent parameters with constraints learned from the history of the fit parameters
  - Mean trend from last 7 days used, adjusted by variances in the previous 3 weeks
  - 1 week interpolation to smooth transitions in rapidly changing trajectories
  - Particles with high error or variance filtered out



Accessed 9:00am October 28, 2020
https://www.vdh.virginia.gov/coronavirus/

UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

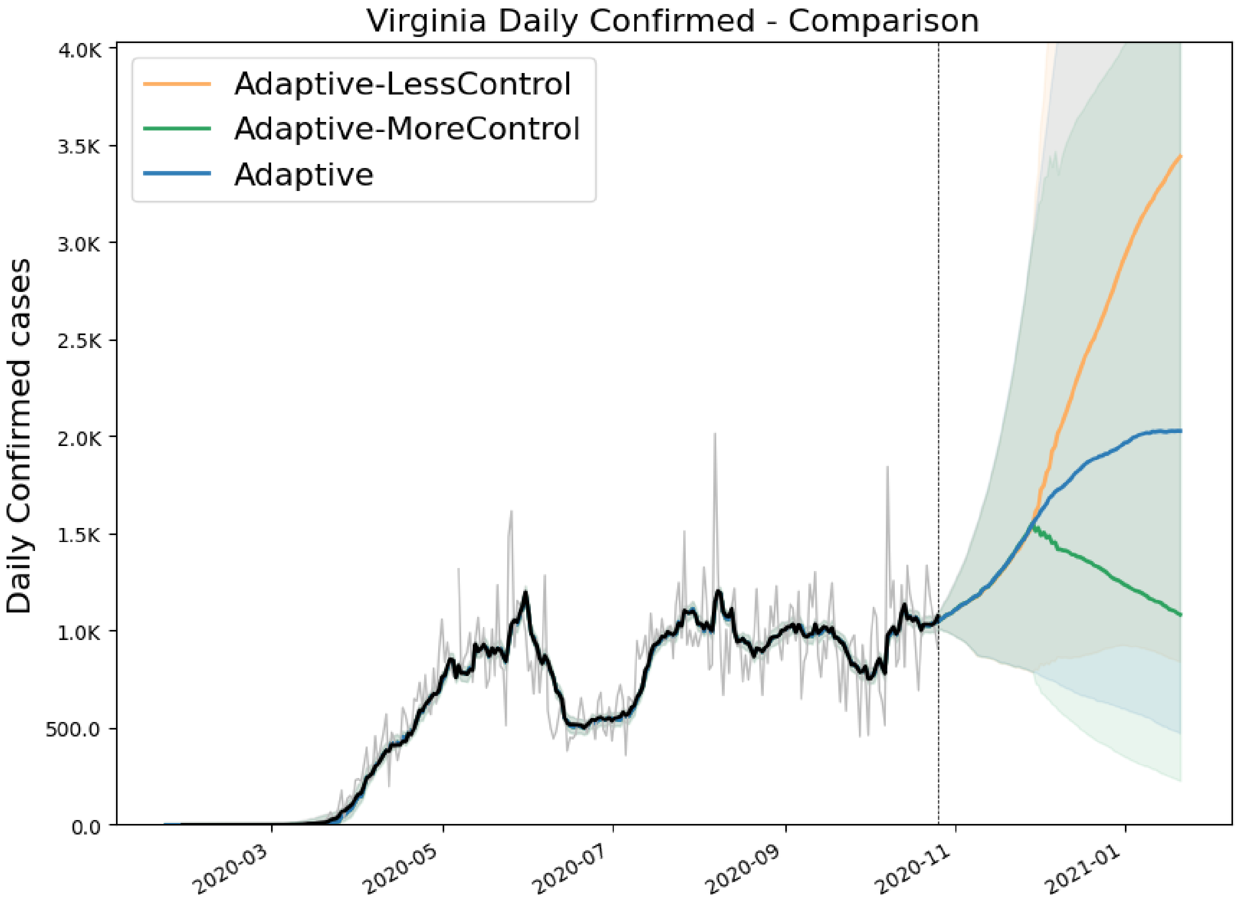
Scenarios – Seasonal Effects

- Societal changes in the past month have led to an increase in transmission rates, these could continue to drive transmission
  - Seasonal impact of weather patterns
  - More interactions at places of learning
  - Travel related to holidays and traditional large family gatherings
  - Fatigue with infection control practices
- Population's behaviors determine the level of control of transmission we can achieve
- Three scenarios capture possible trajectories starting Nov 26th, 2020
  - Adaptive: No change from base projection
  - Adaptive-MoreControl: 15% decrease in transmission starting Nov 26th, 2020
  - Adaptive-LessControl: 15% increase in transmission starting Nov 26th, 2020

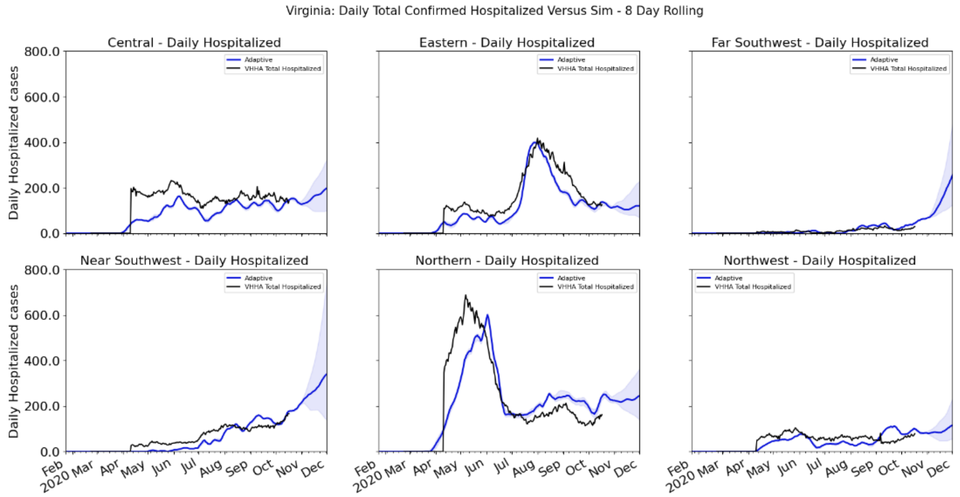
Model Results

Outcome Projections

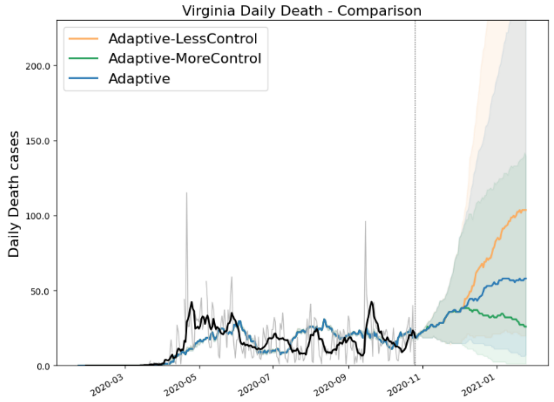
Confirmed cases



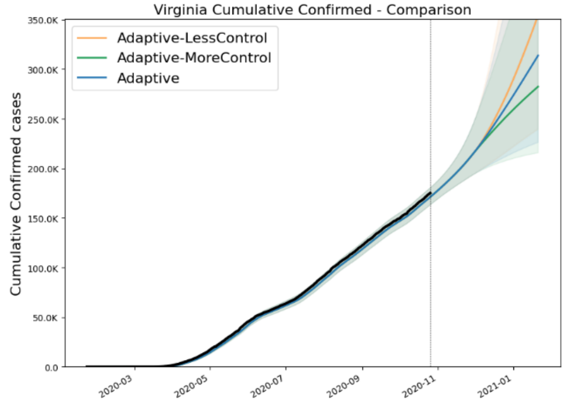
Estimated Hospital Occupancy



Daily Deaths



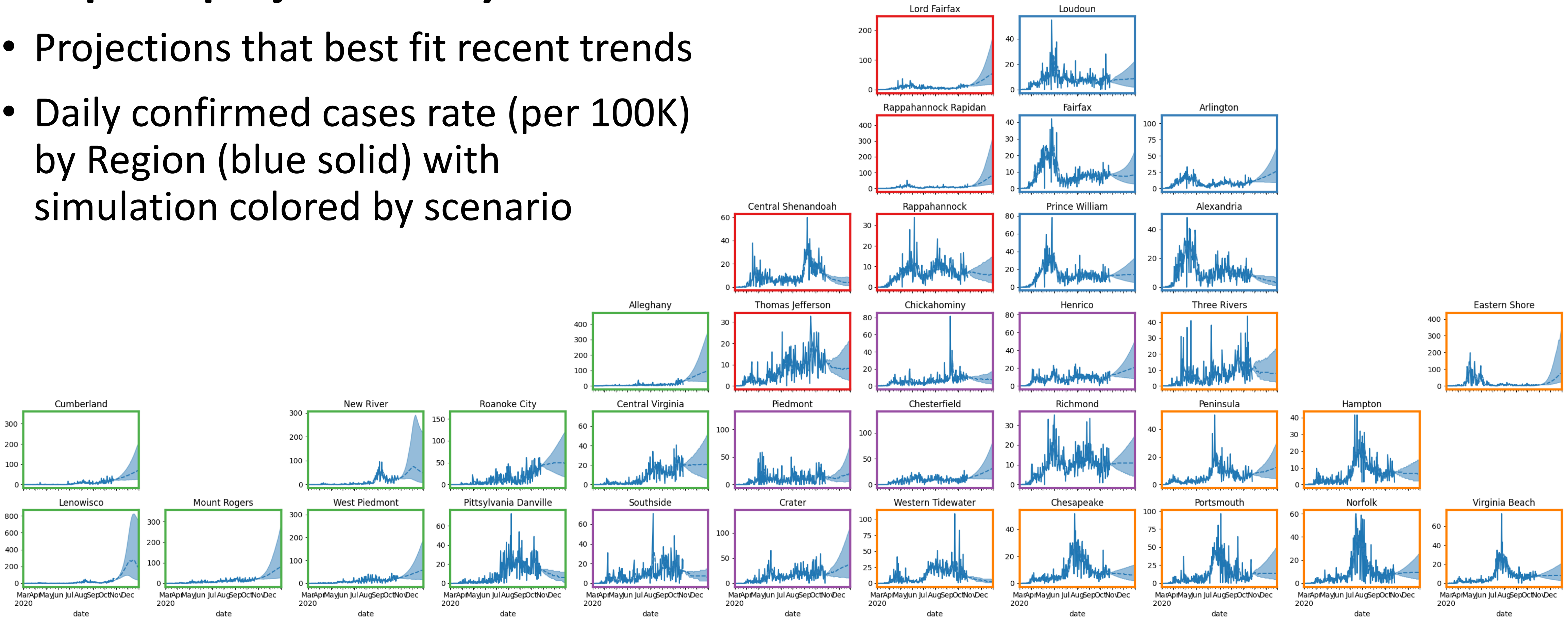
Cumulative Confirmed cases



District Level Projections: Adaptive

Adaptive projections by District

- Projections that best fit recent trends
- Daily confirmed cases rate (per 100K) by Region (blue solid) with simulation colored by scenario

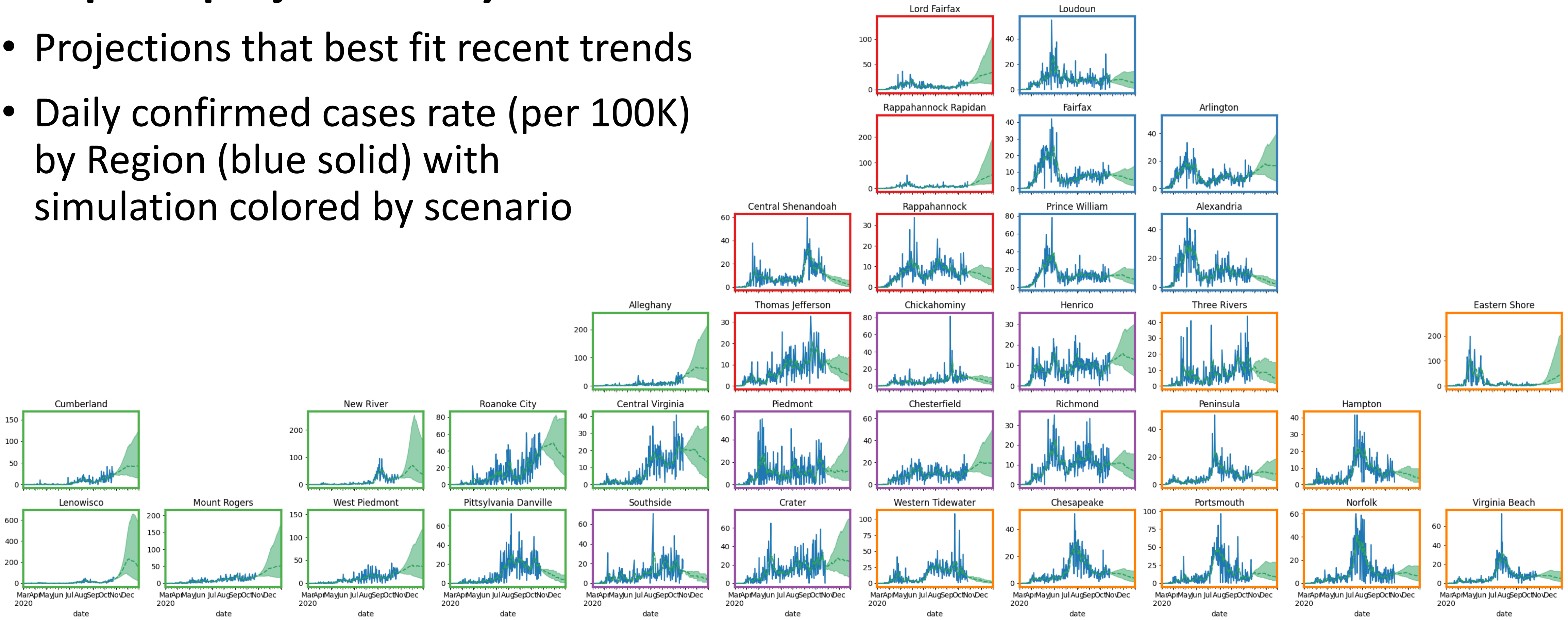


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

District Level Projections: Adaptive-MoreControl

Adaptive projections by District

- Projections that best fit recent trends
- Daily confirmed cases rate (per 100K) by Region (blue solid) with simulation colored by scenario

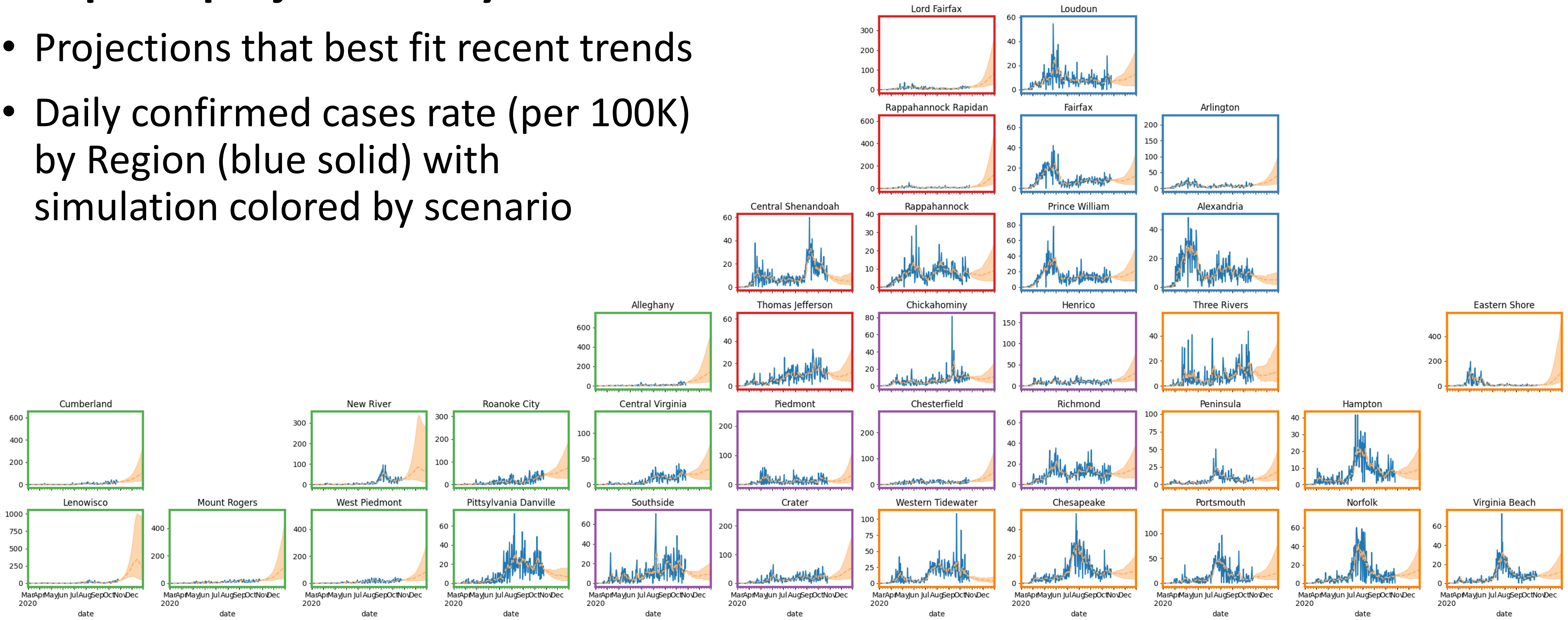


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

District Level Projections: Adaptive-LessControl

Adaptive projections by District

- Projections that best fit recent trends
- Daily confirmed cases rate (per 100K) by Region (blue solid) with simulation colored by scenario

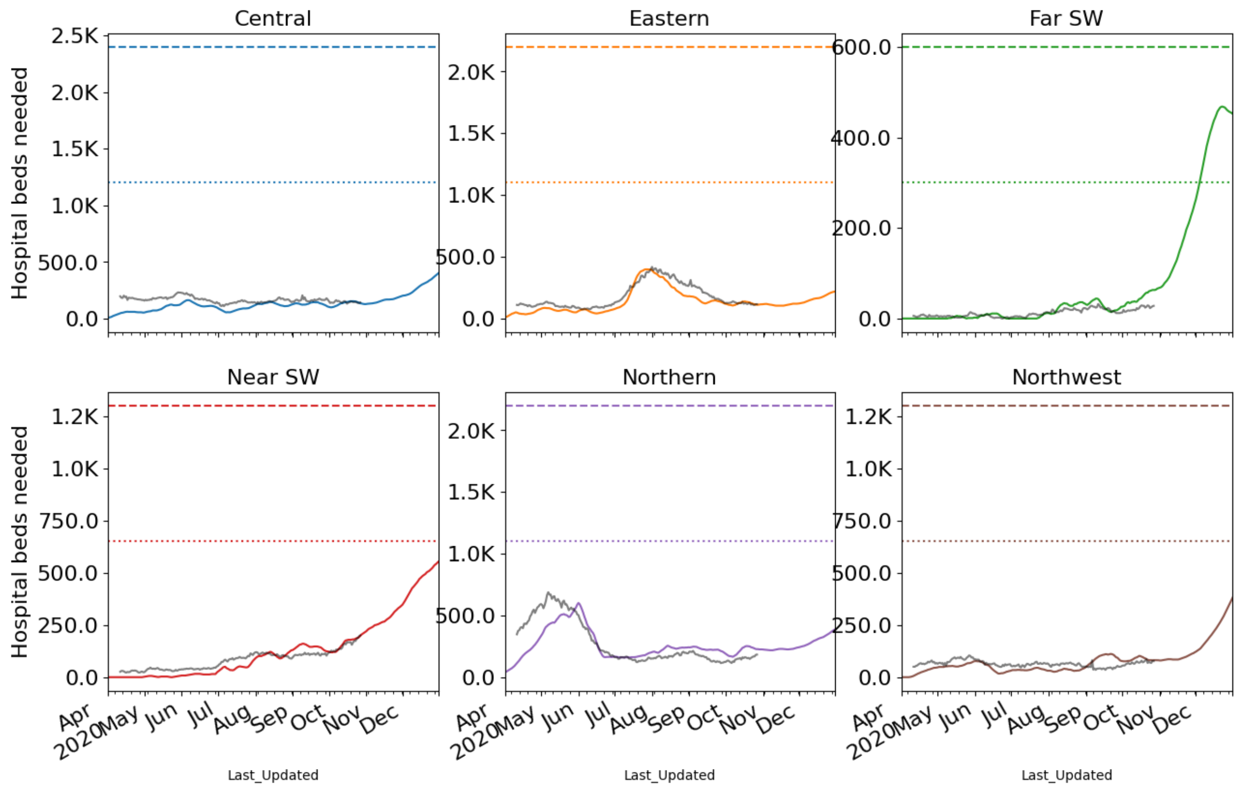


UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

Hospital Demand and Bed Capacity by Region

Capacities by Region – Adaptive-LessControl

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



Week Ending	Adaptive	Adaptive-LessControl
10/18/20	7,470	7,470
10/25/20	7,204	7,204
11/1/20	7,528	7,524
11/8/20	8,000	7,988
11/15/20	8,530	8,490
11/22/20	9,330	9,276
11/29/20	10,347	10,272
12/06/20	11,438	12,292
12/13/20	12,224	14,582
12/20/20	12,903	16,610
12/27/20	13,310	18,280
1/3/20	13,672	20,174

If Adaptive-LessControl scenario persists:

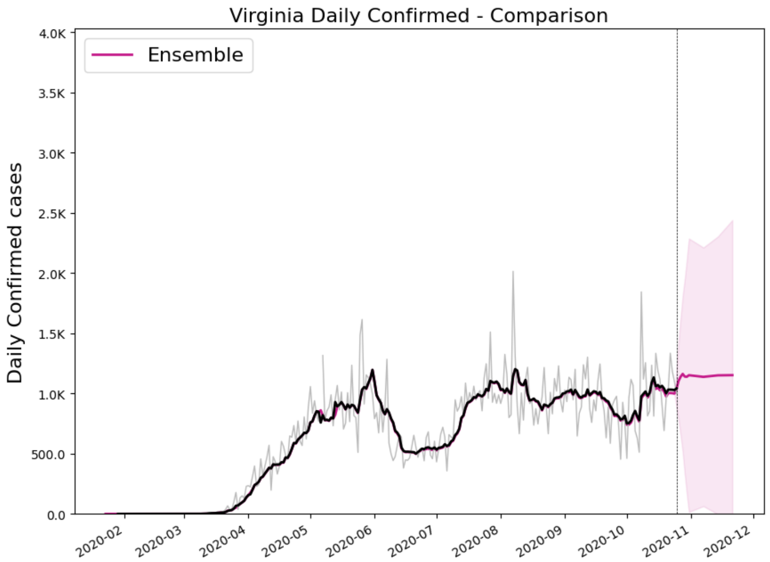
- Far Southwest may begin to exceed capacity in early December
- Near Southwest trends toward capacity as well by January

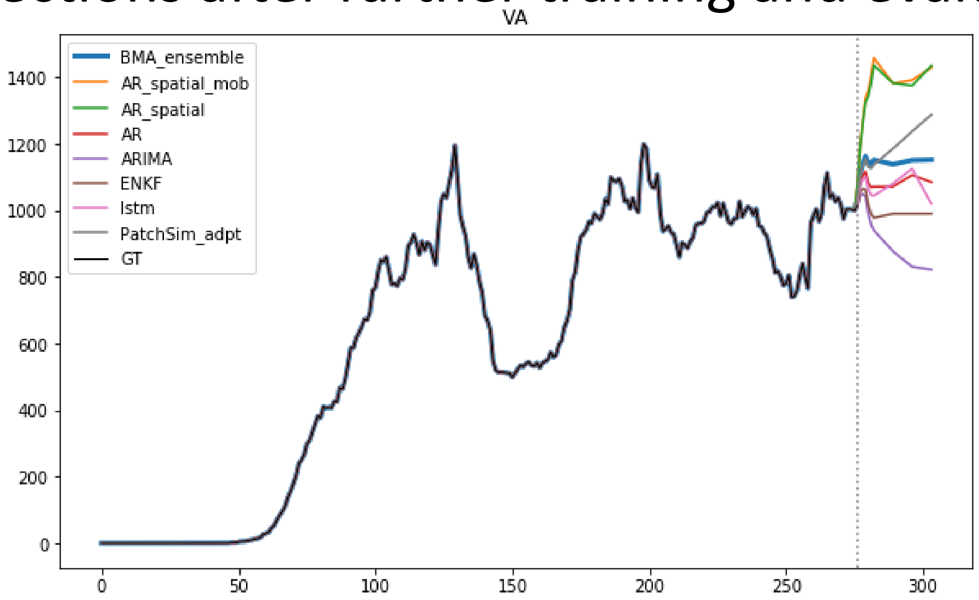
* Assumes average length of stay of 8 days

Additional Projection Methods under development

An ensemble methodology that combines the Adaptive Fitting and other machine learning and statistical models has been developed to facilitate use of other data (weather, mobility, etc.)

- **Models**: Adaptive Fitting, ARIMA, LSTM, AR, spatially driven AR, Kalman Filters (ENKF)
- Ensemble will be folded into these projections after further training and evaluation





Key Takeaways

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

- **Virginia remains steady while many states surge, mixed districts.**
- VA weekly incidence (12.1/100K) is steady and below the growing national average (27/100K).
- Projections are mostly up, but many districts continue to decline.
- Recent updates:
  - Planning Scenarios adjusted, as Adaptive Fitting tracks recent surge, to represent population's ability to exert further control on transmission following Thanksgiving holidays, Nov 26th.
  - Case ascertainment parameters now bounded by updated seroprevalence data.
- The situation is changing rapidly. Models will be updated regularly.

References

Venkatramanan, S., et al. "Optimizing spatial allocation of seasonal influenza vaccine under temporal constraints." *PLoS computational biology* 15.9 (2019): e1007111.

Arindam Fadikar, Dave Higdon, Jiangzhuo Chen, Bryan Lewis, Srinivasan Venkatramanan, and Madhav Marathe. Calibrating a stochastic, agent-based model using quantile-based emulation. SIAM/ASA Journal on Uncertainty Quantification, 6(4):1685–1706, 2018.

Adiga, Aniruddha, Srinivasan Venkatramanan, Akhil Peddireddy, et al. "Evaluating the impact of international airline suspensions on COVID-19 direct importation risk." *medRxiv* (2020)

NSSAC. PatchSim: Code for simulating the metapopulation SEIR model. https://github.com/NSSAC/PatchSim (Accessed on 04/10/2020).

Virginia Department of Health. COVID-19 in Virginia. http://www.vdh.virginia.gov/coronavirus/ (Accessed on 04/10/2020)

Biocomplexity Institute. COVID-19 Surveillance Dashboard. https://nssac.bii.virginia.edu/covid-19/dashboard/

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?

Biocomplexity COVID-19 Response Team

Aniruddha Adiga, Abhijin Adiga, Hannah Baek, Chris Barrett, Golda Barrow, Richard Beckman, Parantapa Bhattacharya, Andrei Bura, Jiangzhuo Chen, Patrick Corbett, Clark Cucinell, Allan Dickerman, Stephen Eubank, Arindam Fadikar, Joshua Goldstein, Stefan Hoops, Ben Hurt, Sallie Keller, Ron Kenyon, Brian Klahn, Gizem Korkmaz, Vicki Lancaster, Bryan Lewis, Dustin Machi, Chunhong Mao, Achla Marathe, Madhav Marathe, Fanchao Meng, Henning Mortveit, Mark Orr, Joseph Outten, Akhil Peddireddy, Przemyslaw Porebski, SS Ravi, Erin Raymond, Jose Bayoan Santiago Calderon, James Schlitt, Aaron Schroeder, Stephanie Shipp, Samarth Swarup, Alex Telionis, Srinivasan Venkatramanan, Anil Vullikanti, James Walke, Amanda Wilson, Dawen Xie

Points of Contact

Bryan Lewis
brylew@virginia.edu

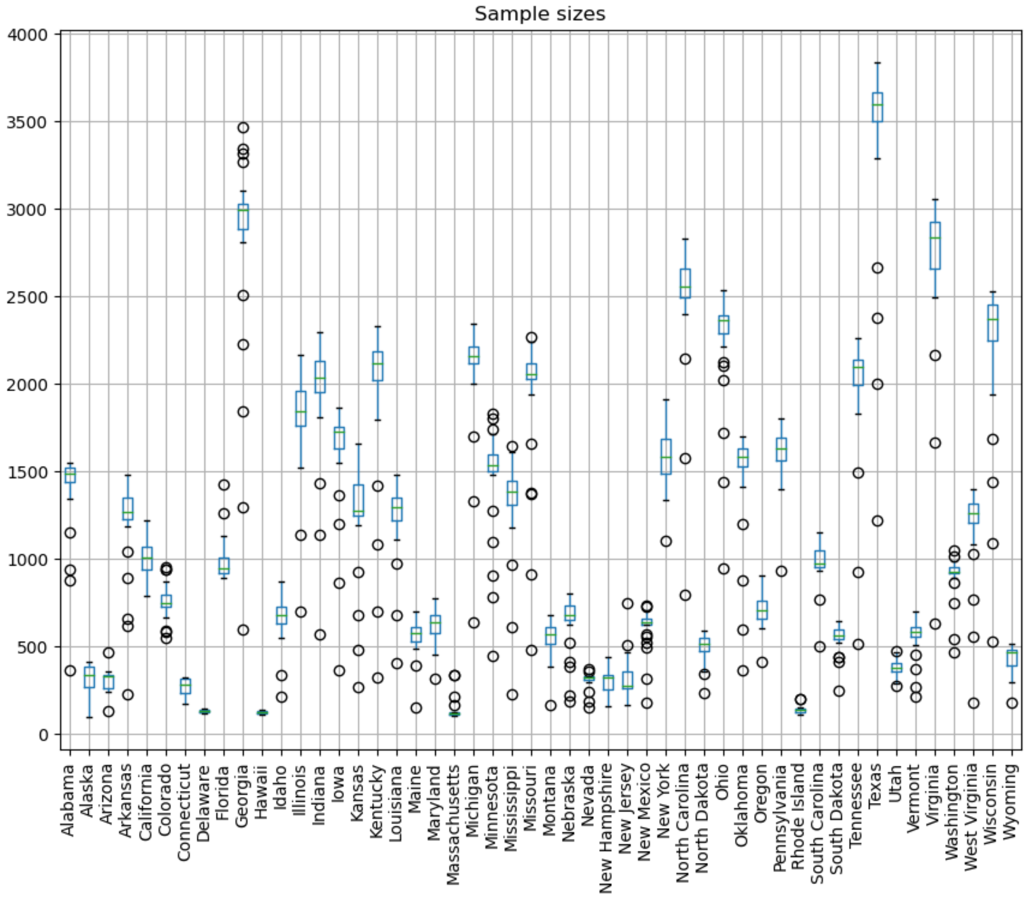
Srini Venkatramanan
srini@virginia.edu

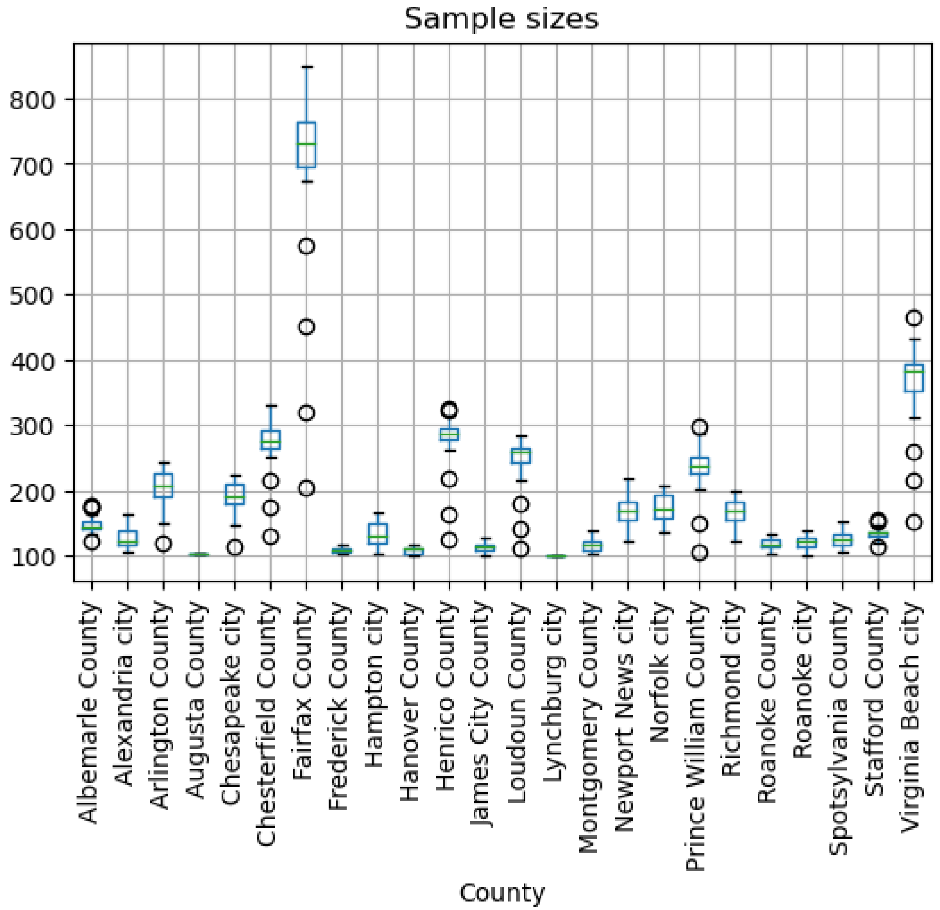
Madhav Marathe
marathe@virginia.edu

Chris Barrett
ChrisBarrett@virginia.edu

Supplemental Slides

Mask usage sample sizes





Test positivity across VA counties

- CMS weekly summary (used for guiding nursing homes testing protocol)
- Data: COVID-19 Electronic Lab Reporting (CELR); HHS Unified Testing Dataset;
- County level testing counts and test positivity rates for RT-PCR tests.
  - Green: Test positivity <5.0% or with <20 tests in past 14 days
  - Yellow: Test positivity 5.0%-10.0% or with <500 tests and <2000 tests/100k and >10% positivity over 14 days
  - Red: >10.0% and not meeting the criteria for "Green" or "Yellow"

County	Sep-30	Oct-07	Oct-14	Oct-21
Amherst County	Yellow	Red	Red	Red
Bedford County	Yellow	Red	Red	Red
Bristol City	Yellow	Yellow	Red	Red
Campbell County	Yellow	Red	Red	Red
Charlotte County	Red	Red	Red	Red
Craig County	Yellow	Yellow	Red	Red
Franklin City	Yellow	Yellow	Red	Red
Franklin County	Red	Red	Red	Red
Galax City	Red	Yellow	Yellow	Red
Greensville County	Red	Red	Red	Red
Henry County	Red	Yellow	Red	Red
Lee County	Yellow	Yellow	Red	Red
Manassas City	Yellow	Red	Red	Red
Martinsville City	Yellow	Red	Red	Red
Prince Edward County	Yellow	Yellow	Yellow	Red
Prince George County	Red	Red	Red	Red
Radford City	Green	Green	Yellow	Red
Roanoke County	Yellow	Yellow	Red	Red
Scott County	Yellow	Yellow	Red	Red
Southampton County	Red	Red	Red	Red
Tazewell County	Yellow	Yellow	Yellow	Red
Washington County	Red	Red	Red	Red
Wise County	Yellow	Red	Yellow	Red
Wythe County	Yellow	Yellow	Yellow	Red

Red on Oct 21 (latest)

County	Sep-30	Oct-07	Oct-14	Oct-21
Charlotte County	Red	Red	Red	Red
Franklin County	Red	Red	Red	Red
Galax City	Red	Yellow	Yellow	Red
Grayson County	Red	Yellow	Yellow	Yellow
Greensville County	Red	Red	Red	Red
Harrisonburg City	Red	Yellow	Yellow	Yellow
Henry County	Red	Yellow	Red	Red
Mathews County	Red	Red	Yellow	Yellow
Pittsylvania County	Red	Red	Red	Yellow
Prince George County	Red	Red	Red	Red
Rockingham County	Red	Red	Red	Yellow
Southampton County	Red	Red	Red	Red
Surry County	Red	Red	Yellow	Yellow
Sussex County	Red	Yellow	Green	Green
Washington County	Red	Red	Red	Red

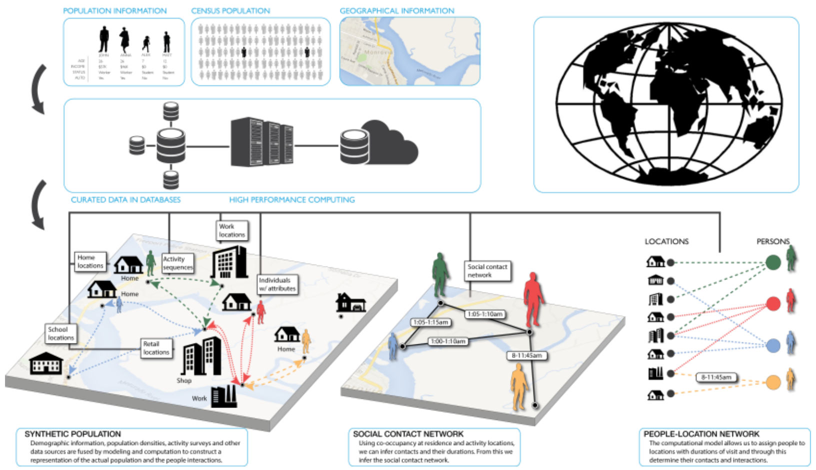
Red on Sep 30 (4-week back)

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

Agent-based Model (ABM)

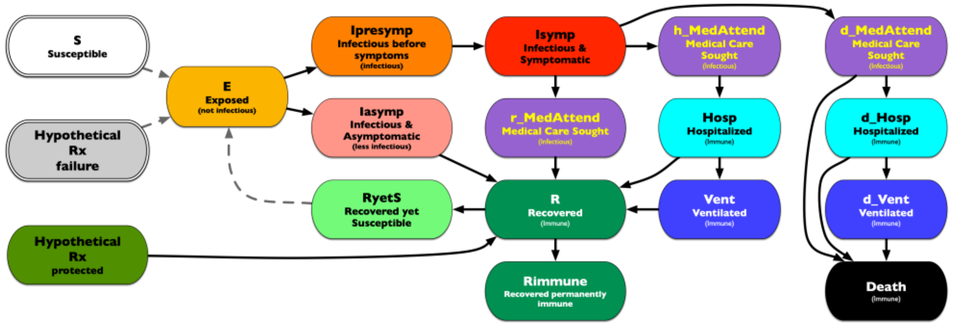
EpiHiper: Distributed network-based stochastic disease transmission simulations

- 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

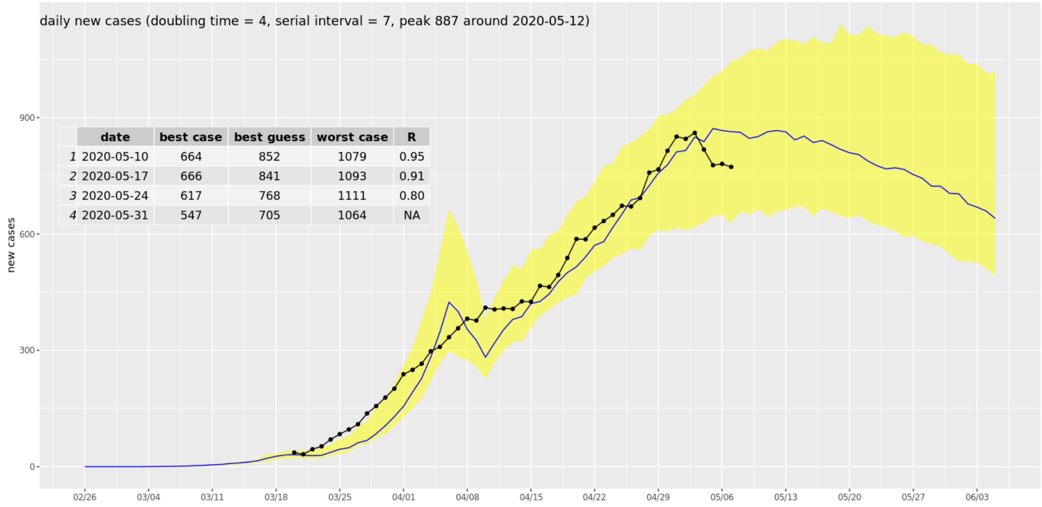
- Literature based probabilities of outcomes with appropriate delays
- Varying levels of infectiousness
- Hypothetical treatments for future developments

UNIVERSITY of VIRGINIA
BIOCOMPLEXITY INSTITUTE

ABM Social Distancing Rebound Study Design

Study of ”Stay Home” policy adherence

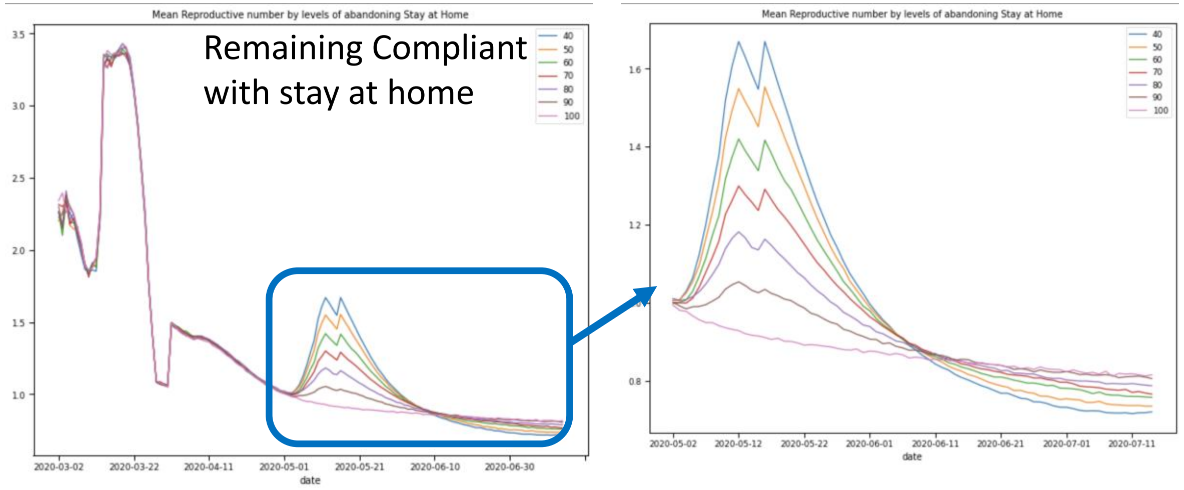
- Calibration to current state in epidemic
- Implement “release” of different proportions of people from ”staying at home”



	date	best case	best guess	worst case	R
1	2020-05-10	664	852	1079	0.95
2	2020-05-17	666	841	1093	0.91
3	2020-05-24	617	768	1111	0.80
4	2020-05-31	547	705	1064	NA

Calibration to Current State

- Adjust transmission and adherence to current policies to current observations
- For Virginia, with same seeding approach as PatchSim

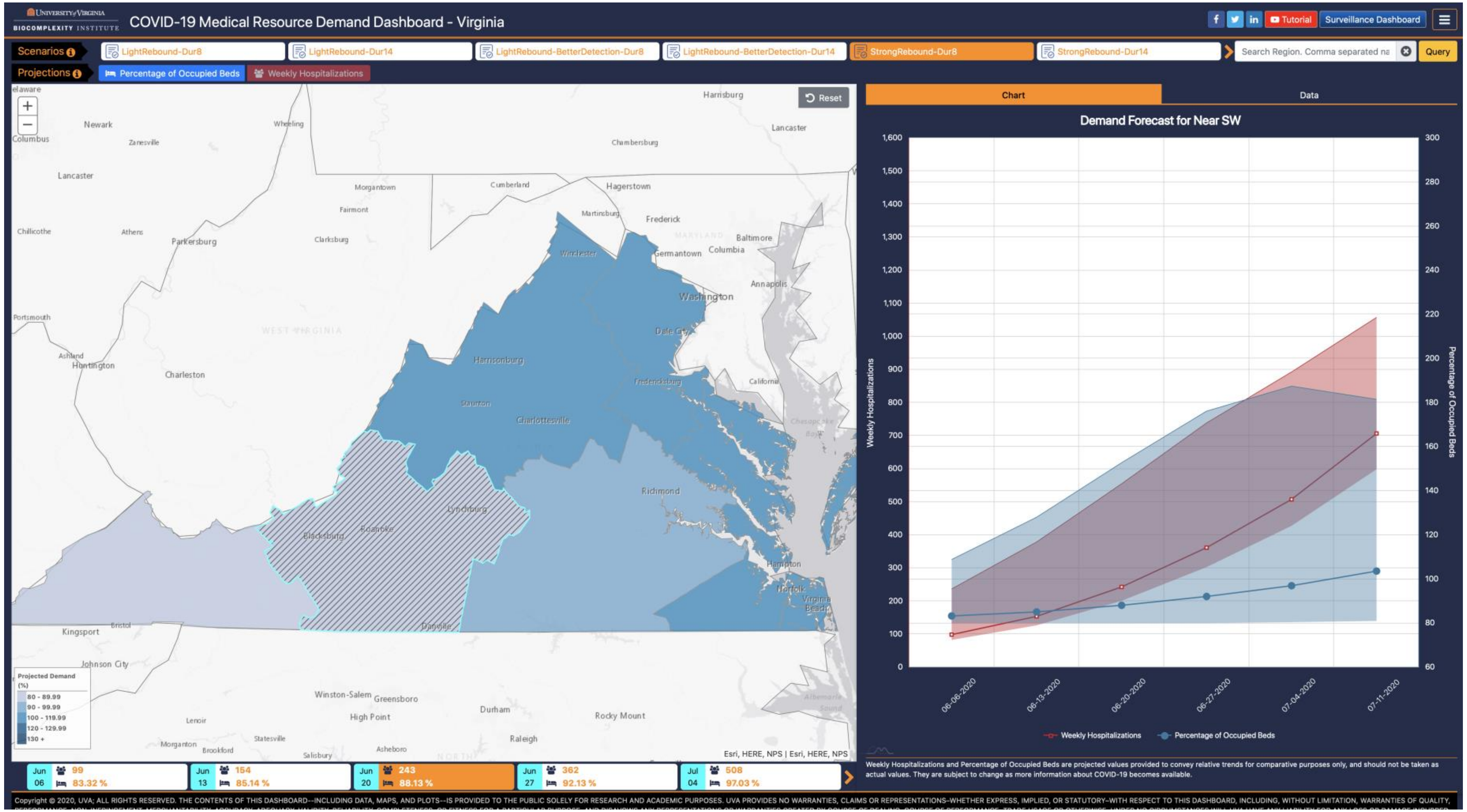


Impacts on Reproductive number with release

- After release, spike in transmission driven by additional interactions at work, retail, and other
- At 25% release (70-80% remain compliant)
- Translates to 15% increase in transmission, which represents a 1/6th return to pre-pandemic levels

Medical Resource Demand Dashboard

https://nssac.bii.virginia.edu/covid-19/vmrddash/



UNIVERSITY of VIRGINIA

BIOCOMPLEXITY INSTITUTE