NY State wastewater surveillance for COVID-19

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COVID-19 transmission is an unobservable phenomenon

Indicators provide us clues that transmission is occurring or has occurred

Cases / test positivity – dependent on symptoms and testing access and reporting

Hospitalizations – lags days or weeks behind transmission – tip of the iceberg

**Deaths** – lags days or weeks behind transmission – tip of the iceberg

Wastewater surveillance was broadly used in the 1990's to fight polio

Wastewater surveillance has caught polio outbreaks and triggered mop-up vaccination campaigns before any children were paralyzed

Wastewater surveillance has been adopted to monitor illicit drug use, microbial resistance, and other non-polio pathogens
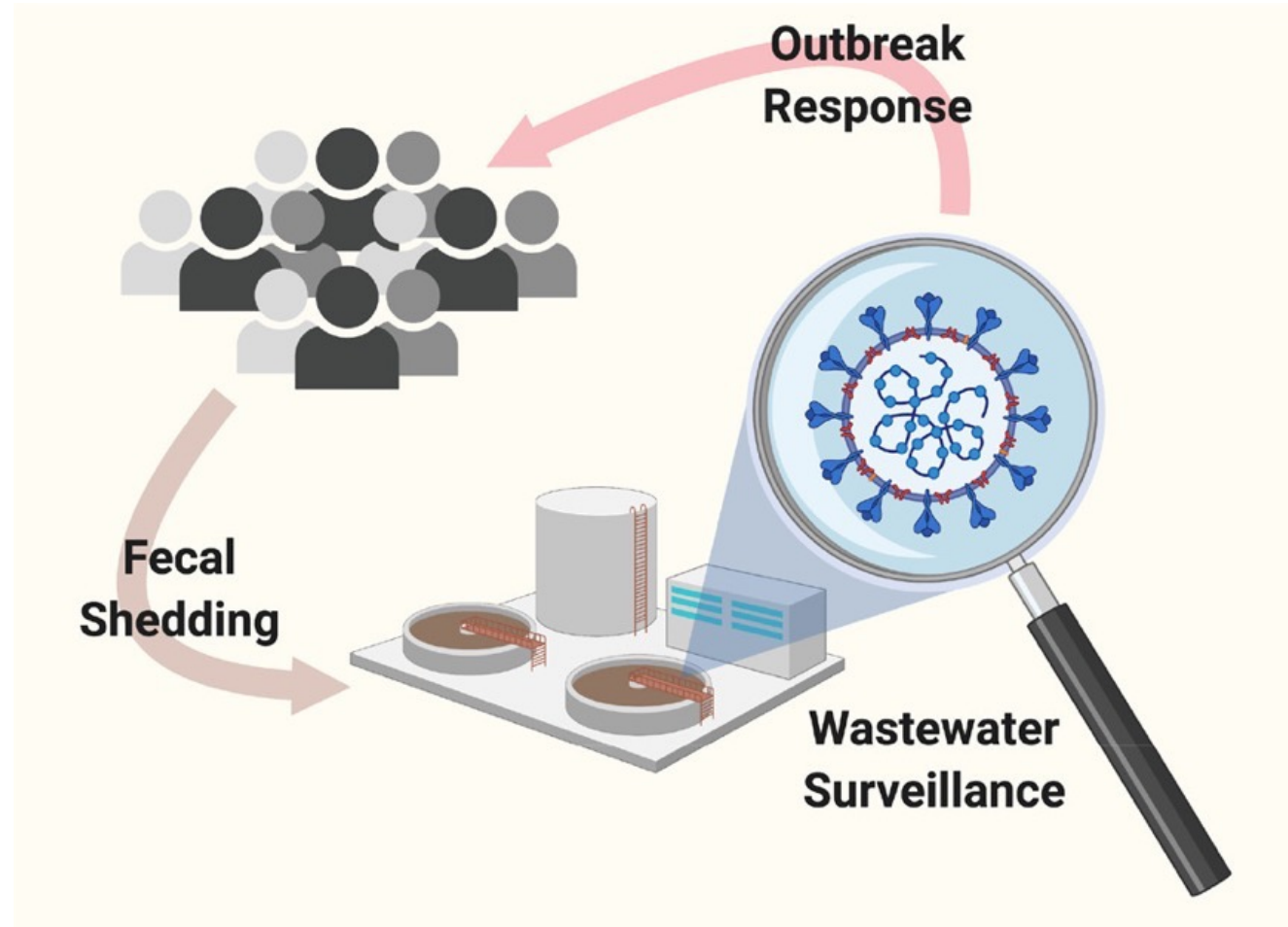
Bivins A, North D, Ahmad A, Ahmed W, Alm E, Been F, Bhattacharya P, Bijlsma L, Boehm AB, Brown J, Buttiglieri G. Wastewater-Based Epidemiology: Global Collaborative to Maximize Contributions in the Fight Against COVID-19.

1. Sewage is sampled

2. Sample is filtered/concentrated

3. Sample is tested for presence of pathogens

4. Interventions are deployed when pathogens are found

http://polioeradication.org/news-post/explaining-environmental-surveillance/

Cases / test positivity – dependent on symptoms and testing access and availability – many missed

Hospitalizations – lags days or weeks behind transmission – tip of the iceberg

Deaths – lags days, weeks, or months behind transmission – tip of the iceberg

Wastewater – a real-time, unbiased community-level indicator?

Genetic sequence of SARS-CoV-2 published Dec 31, 2019

Scale-up of diagnostic testing was disastrous

NY state schools closed on March 18, before widespread testing was available
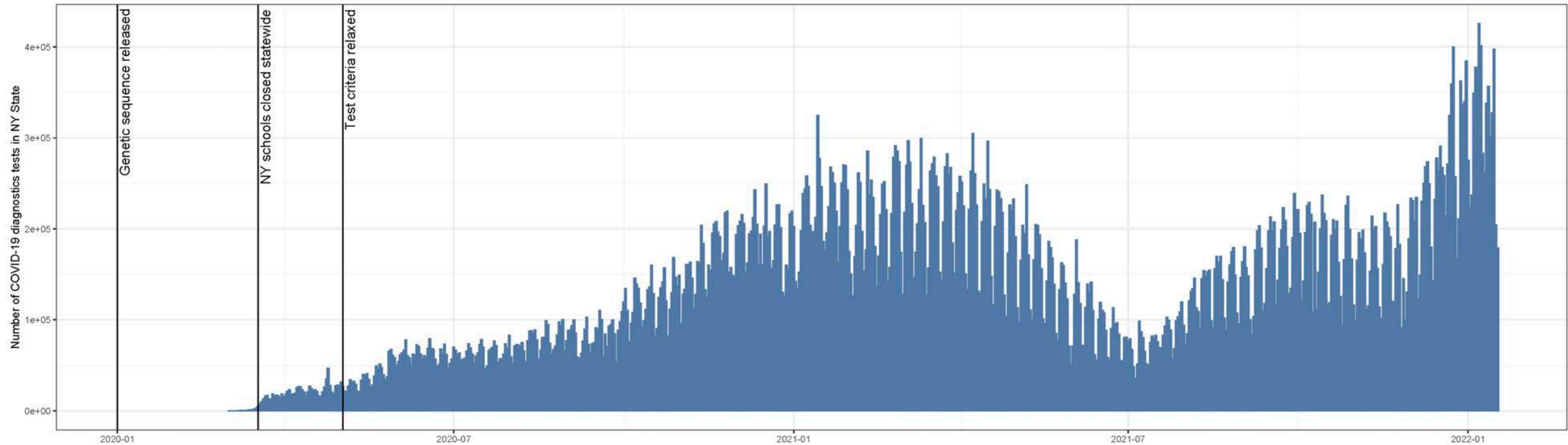
Wastewater provides a representative sample of the community

- Everybody poops

- Human waste gives detailed information on the health and consumption of an individual

- 80% of homes across New York State are connected to sewer

- A sample from the wastewater treatment plant provides **representative** information about the **community**

- Wastewater treatment plants **routine**ly sample their wastewater

- Just over 600 wastewater treatment plants across the state

- **Low cost and convenient**

Municipal wastewater treatment plants in New York State

Average Millions of Gallons per Day   0   100   200   300
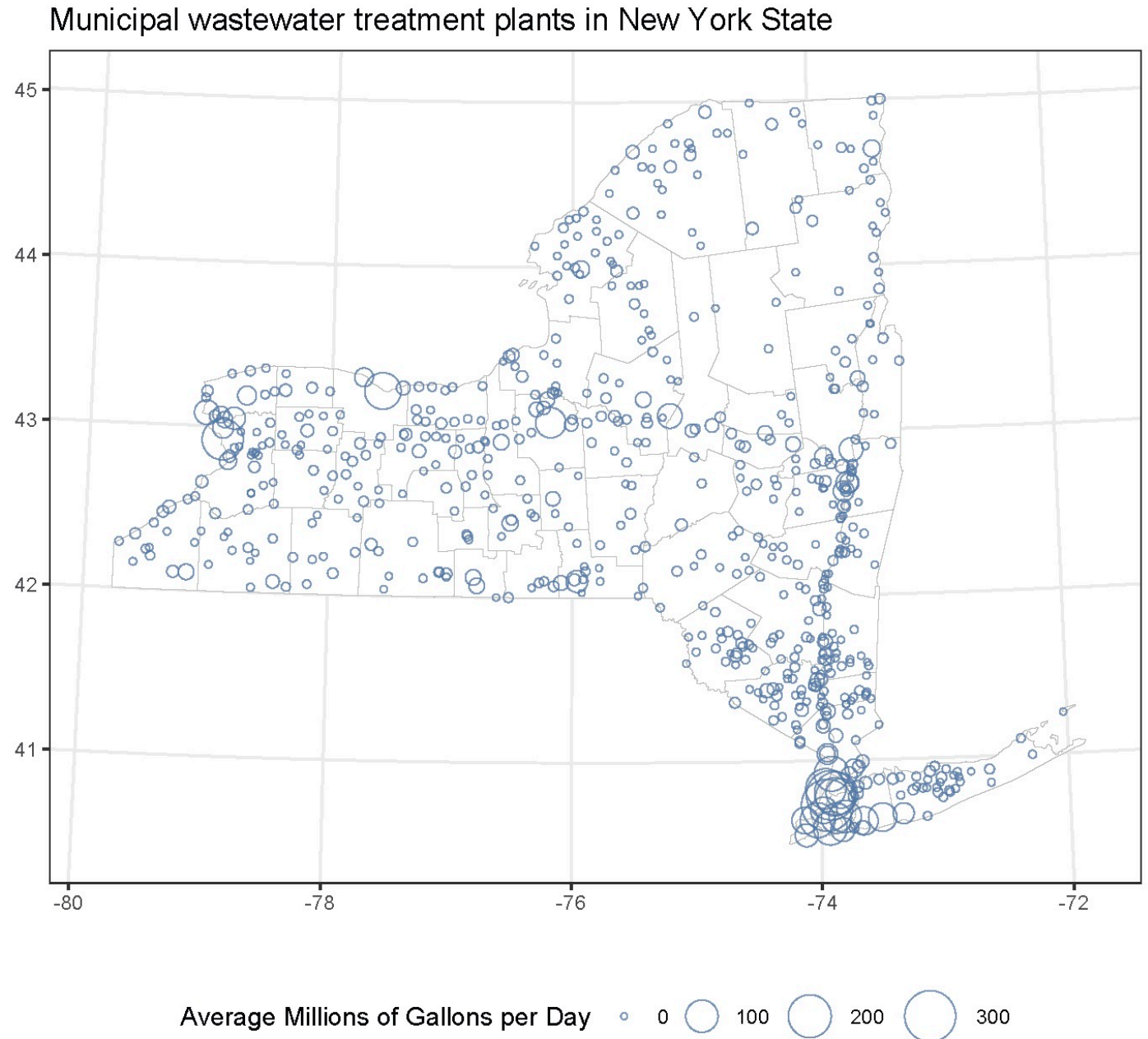
Wastewater surveillance – a pillar of health security

- Infectious disease surveillance systems need to be capable of confirming that a community is safe

- Wastewater surveillance provides a community-level measure of transmission and as such is much more scalable than surveillance based upon individual clinical diagnoses

- We are training the system and local health departments on how to utilize the information from wastewater surveillance

Health security

Infectious disease surveillance

| Wastewater surveillance | Genetic sequencing | Electronic health records | Contact tracing corps |
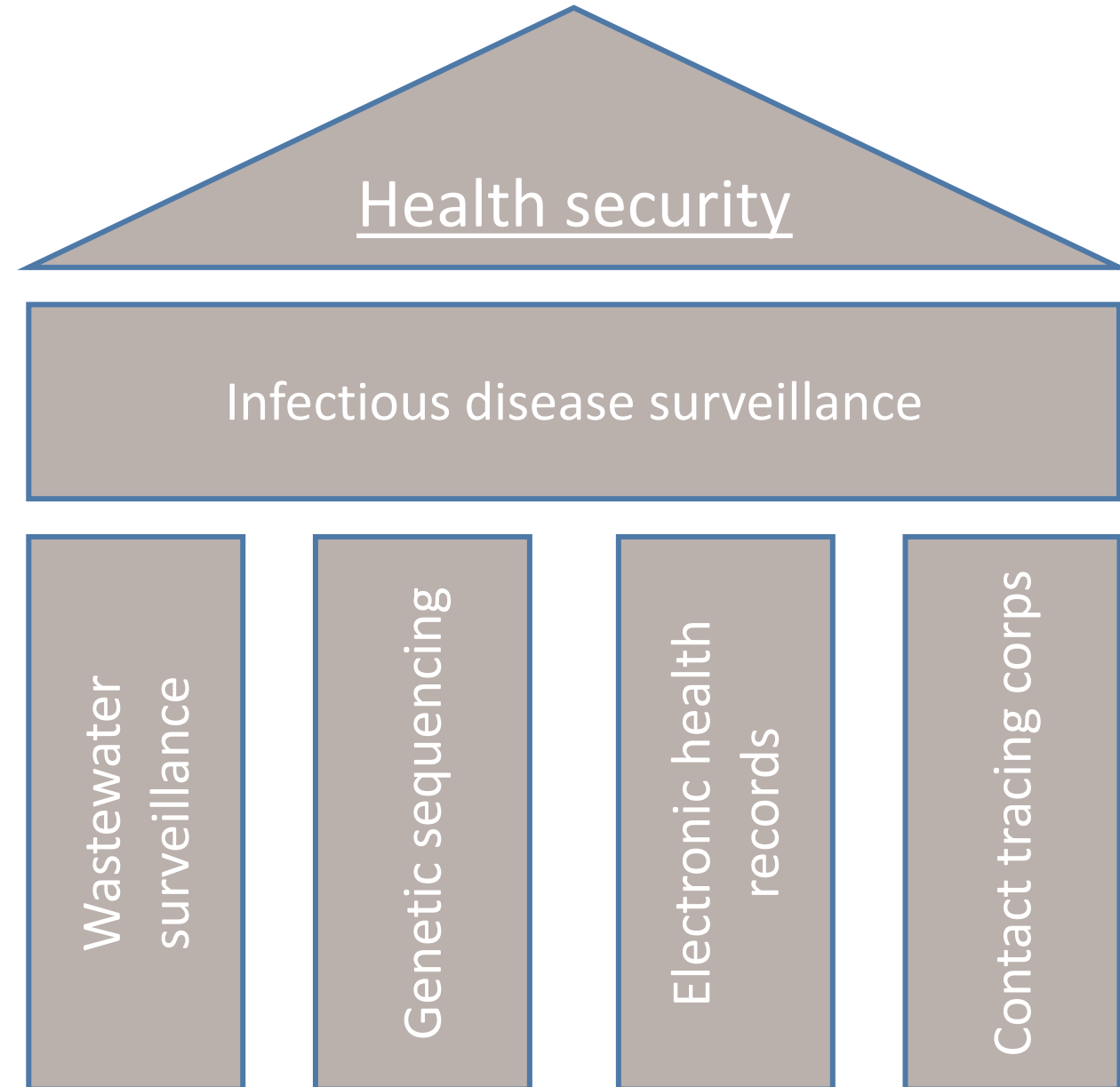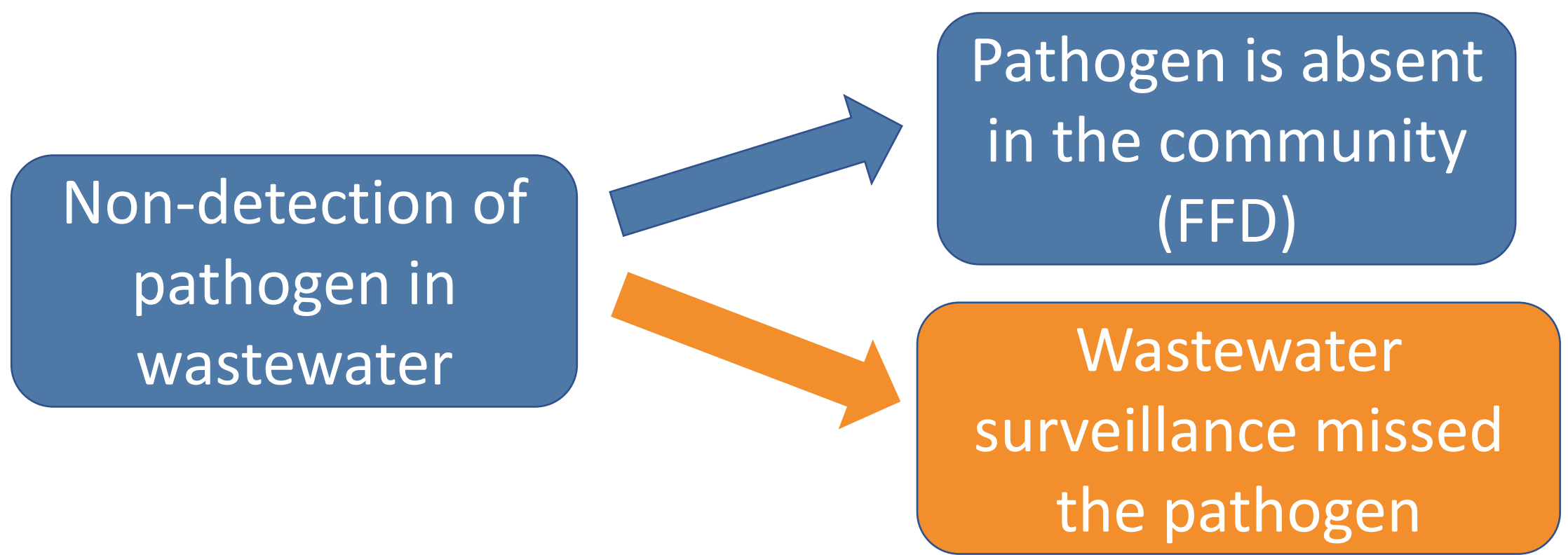
$$FFD = 1 - (1 - sensitivity)^n$$

FFD = freedom from disease
sensitivity affected by community population size, community sewer
    connection, and method sensitivity
n = number of consecutive non-detections

A) COVID-19 Incidence

Levels of SARS-CoV-2 RNA found in wastewater: Quantifiable, Detected, Not detected

7-day COVID-19 cases per 100,000 population at time of wastewater sample

Low, Moderate, Substantial, High

B) Test positivity

Levels of SARS-CoV-2 RNA found in wastewater: Quantifiable, Detected, Not detected

7-day COVID-19 test positivity at time of wastewater sample
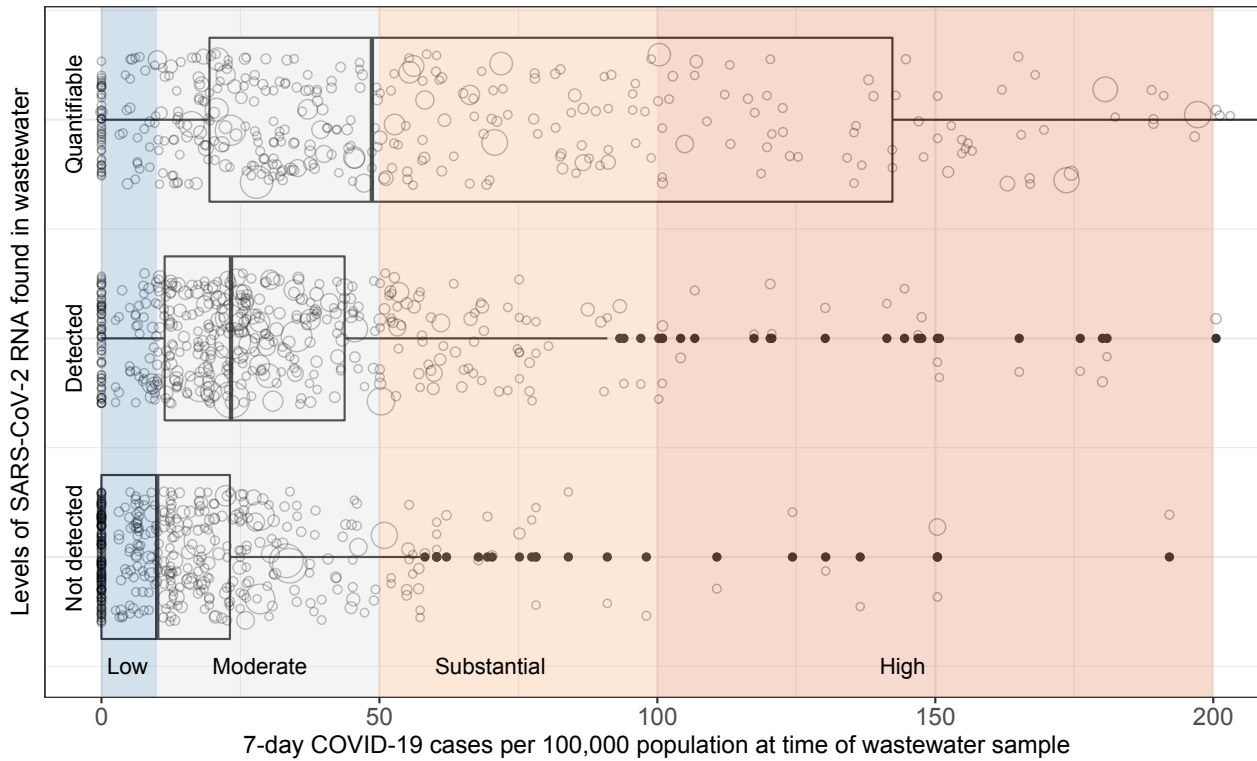
Low, Moderate, Substantial, High
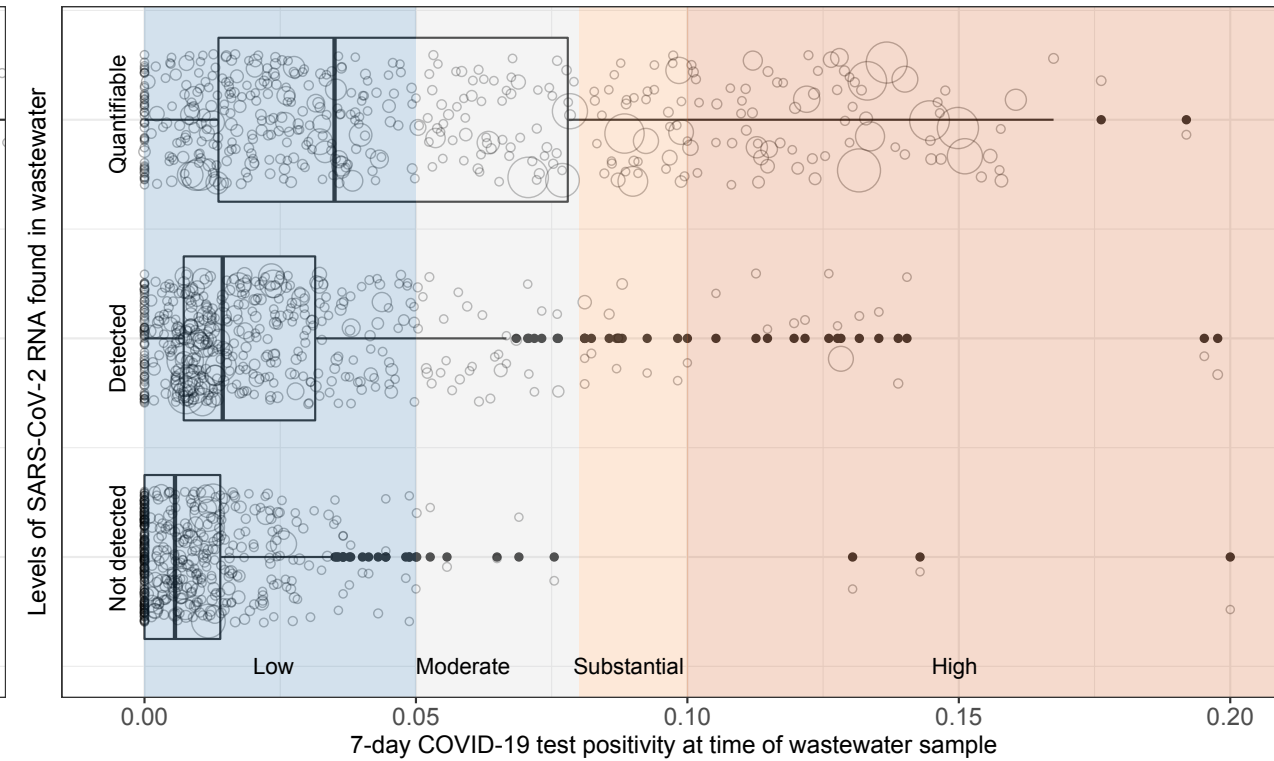
CDC classification of COVID-19 transmission	New COVID-19 cases in past 7 days	Test positivity in past seven days
Low	0-9 per 100,000	< 5%
Moderate	10-49 per 100,000	5-7.9%
Substantial	50-99 per 100,000	8-9.9%
High	≥ 100 per 100,000	≥ 10%

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Oneonta WWTP
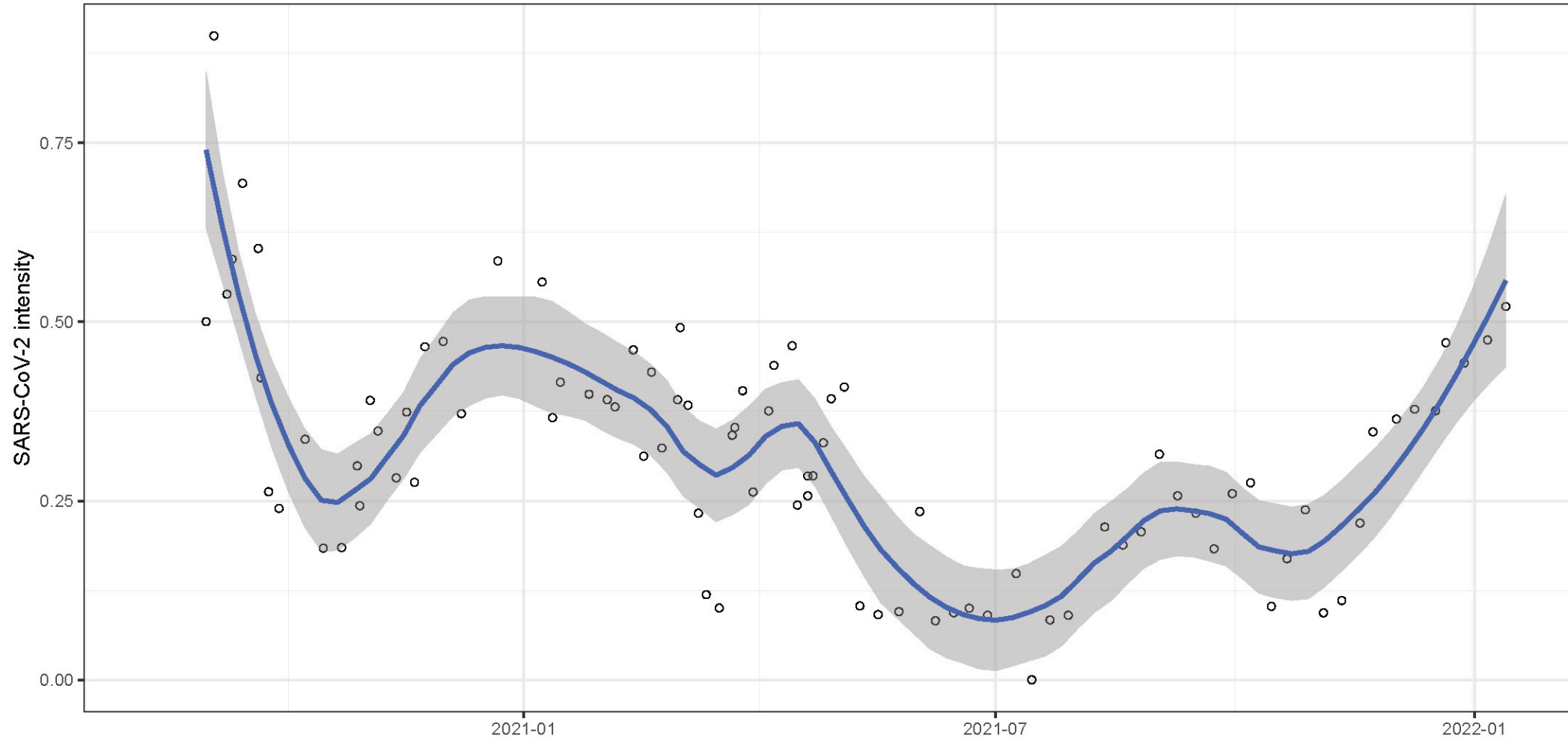
- *Surveillance data gains strength over time*

New York State announces wastewater surveillance for COVID-19

- Governor's announcement: https://www.governor.ny.gov/news/governor-hochul-announces-department-health-partnership-syracuse-university-expand-innovative
- State website: https://storymaps.arcgis.com/stories/b30ca571e00b42779875e3eaf7577b1b

Counties in state wastewater surveillance pilot - 2020
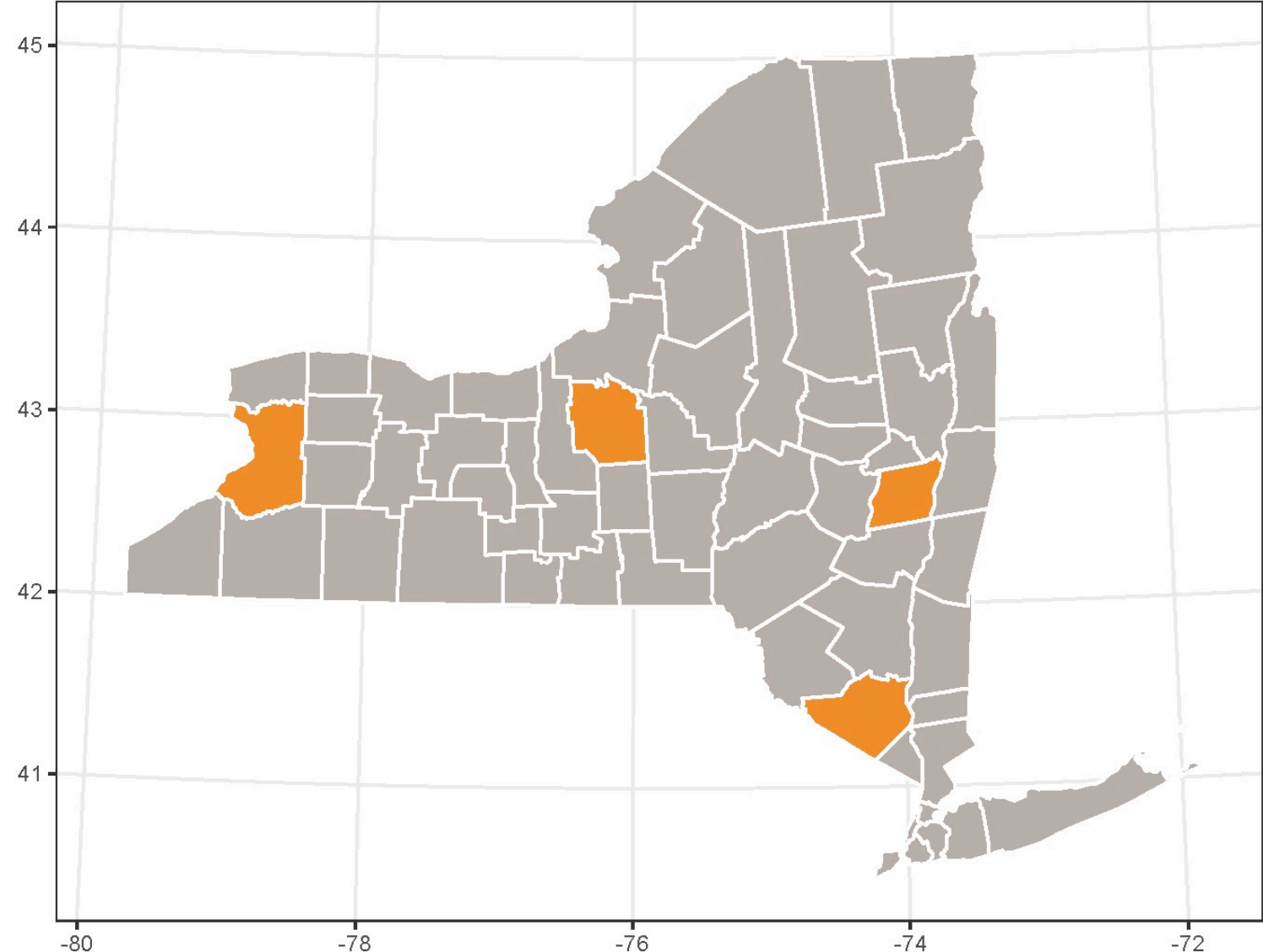
A treatment plant in network in every county

- Provide unbiased estimates of transmission in each county

- Inform public regarding risk of COVID-19

- Empower County Health Departments and policymakers

- Build health security

Municipal wastewater treatment plants in New York State

Average MGD
- 0
- 100
- 200
- 300

Status
- CDC funding
- Not included
- State funding
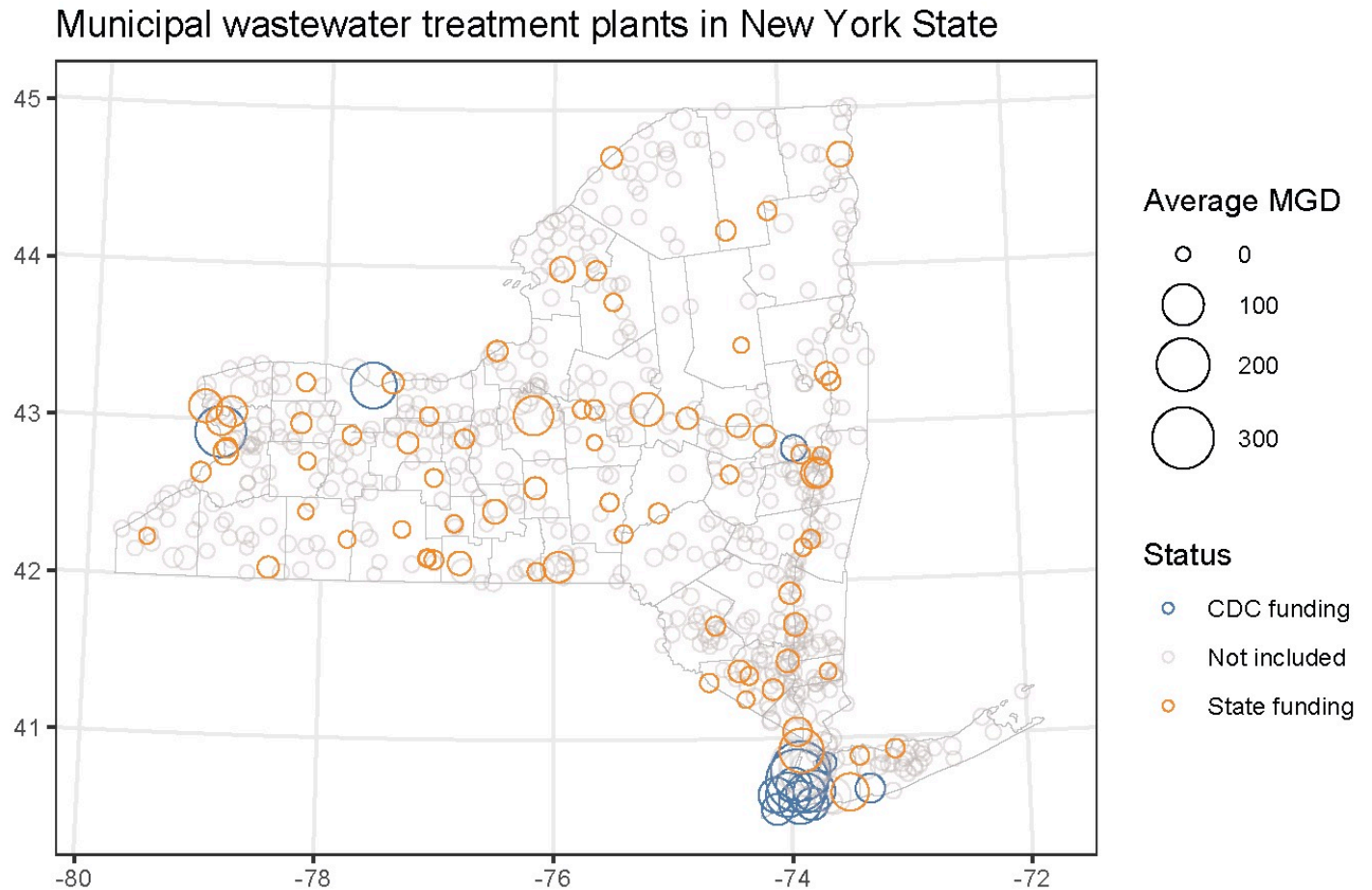
CDC National wastewater surveillance system

Kirby AE, Walters MS, Jennings WC, et al. Using Wastewater Surveillance Data to Support the COVID-19 Response — United States, 2020–2021. MMWR Morb Mortal Wkly Rep 2021;70:1242–1244. DOI: http://dx.doi.org/10.15585/mmwr.mm7036a2external icon

https://www.cdc.gov/healthywater/surveillance/wastewater-surveillance/wastewater-surveillance.html

https://coronavirus.ohio.gov/wps/portal/gov/covid-19/dashboards/other-resources/wastewater

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Surveillance system infrastructure built in last few months

- 85% of New York State is on sewer
- State surveillance network will cover 75% of New York State population
- State surveillance network will cover 70% of the non-New York City population

Municipal sewersheds across New York State
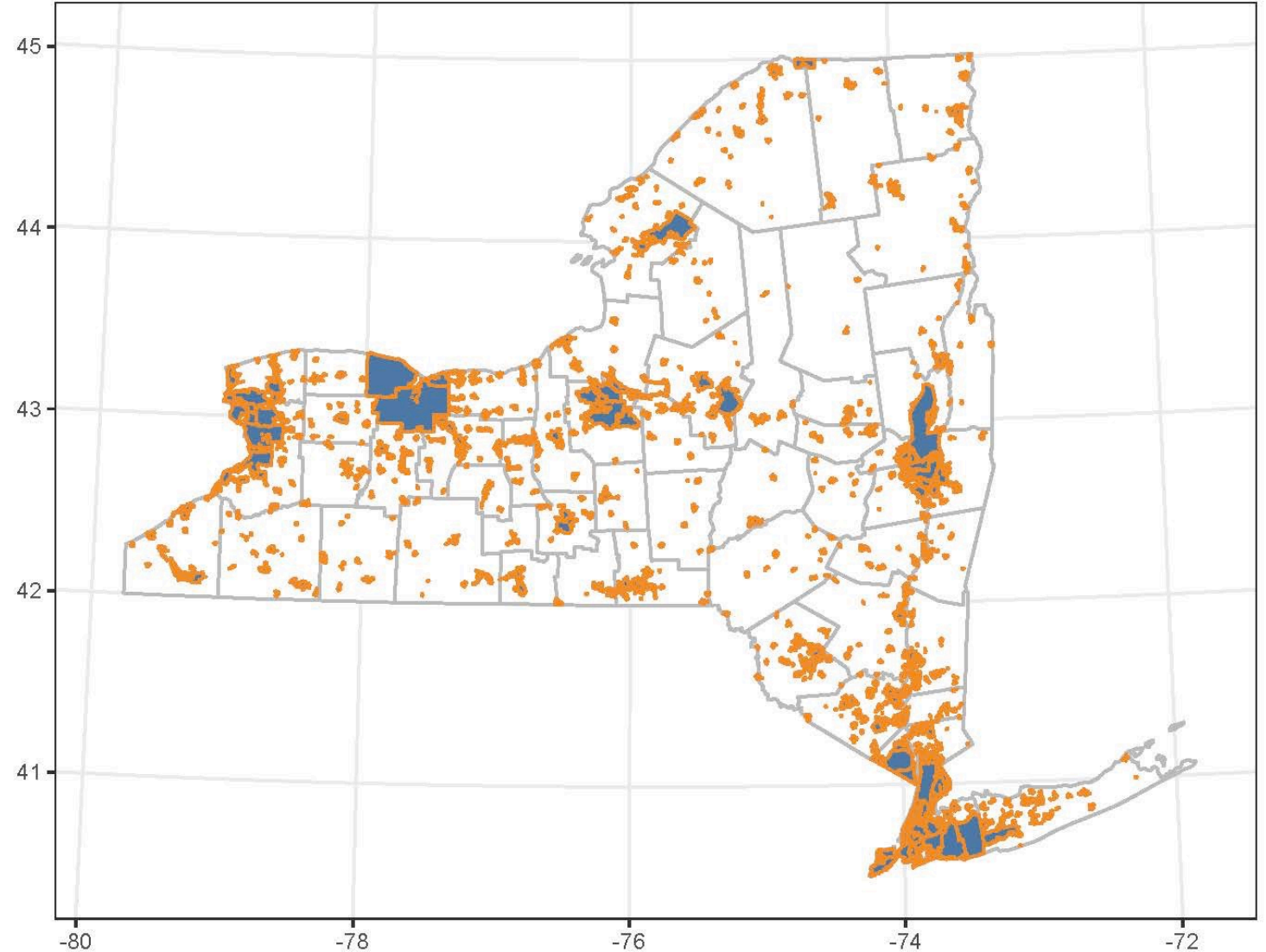
Complementary measure of transmission to support <u>public health</u>

- Strongest correlation with active cases and test positivity

- 3-5 day lead time from date of test for wastewater compared to clinical surveillance

WW SARS-CoV-2 (Blue) and New COVID-19 Cases (Red) in Cortland
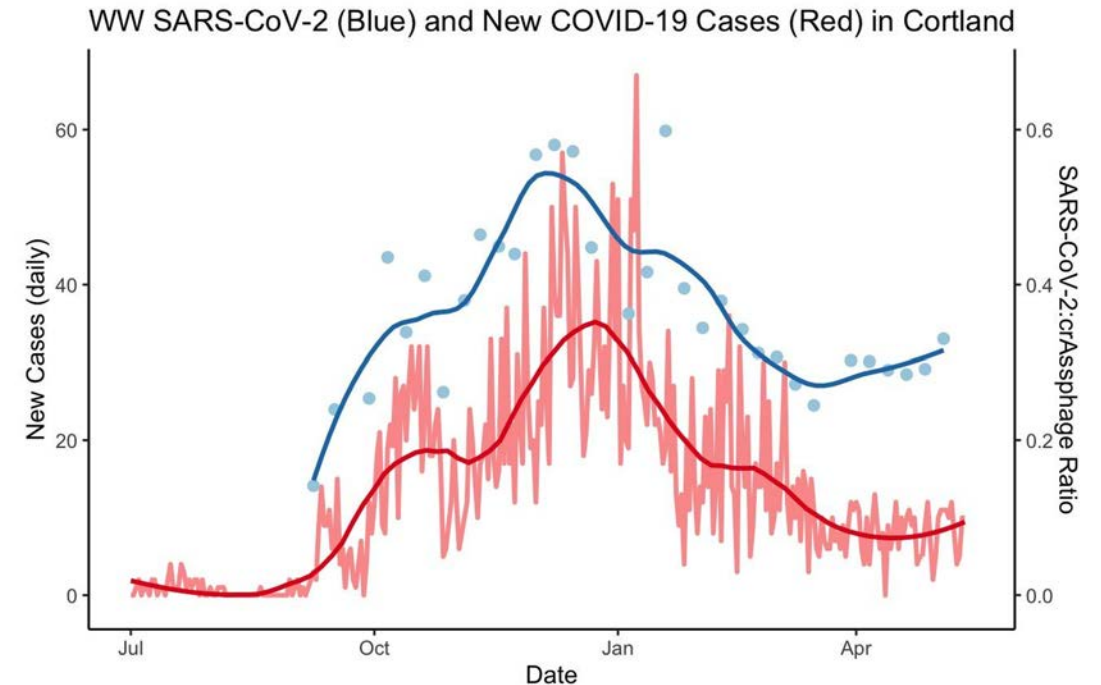
Relationship between SARS/CrAssphage Ratios and Cases in Cortland

$$y = 0.074 + 0.27 \cdot x, \; r^2 = 0.41$$

$$y = -0.16 + 0.26 \cdot x, \; r^2 = 0.553$$
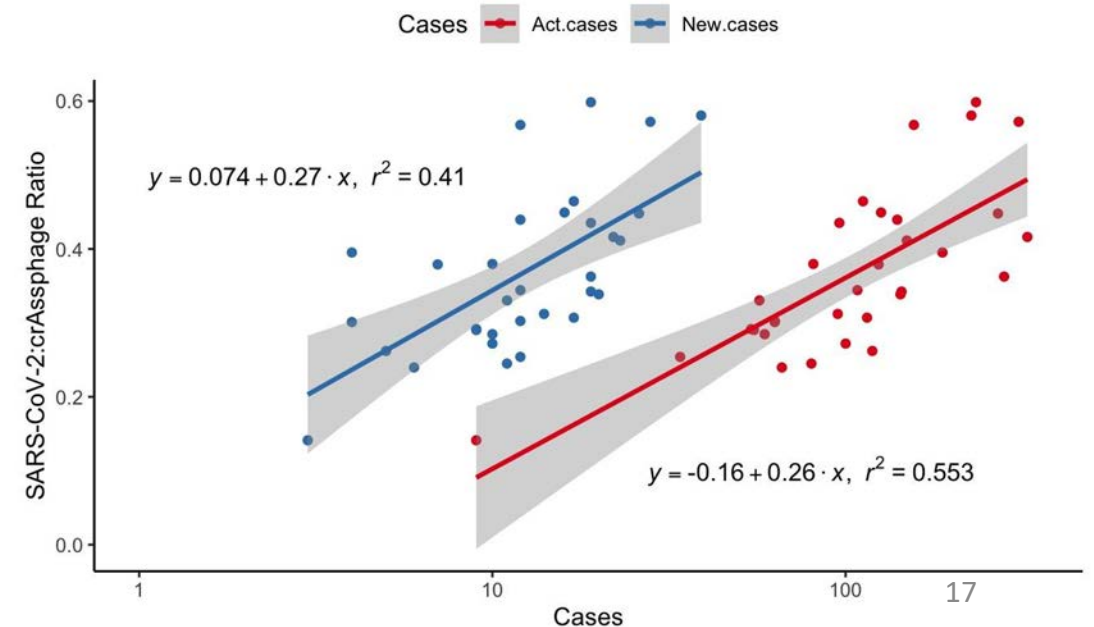
Coronavirus levels in Massachusetts wastewater hit new records

By **Christina Prignano**   Globe Staff, Updated December 8, 2020, 4:54 p.m.

DITP Viral RNA Signal by Date

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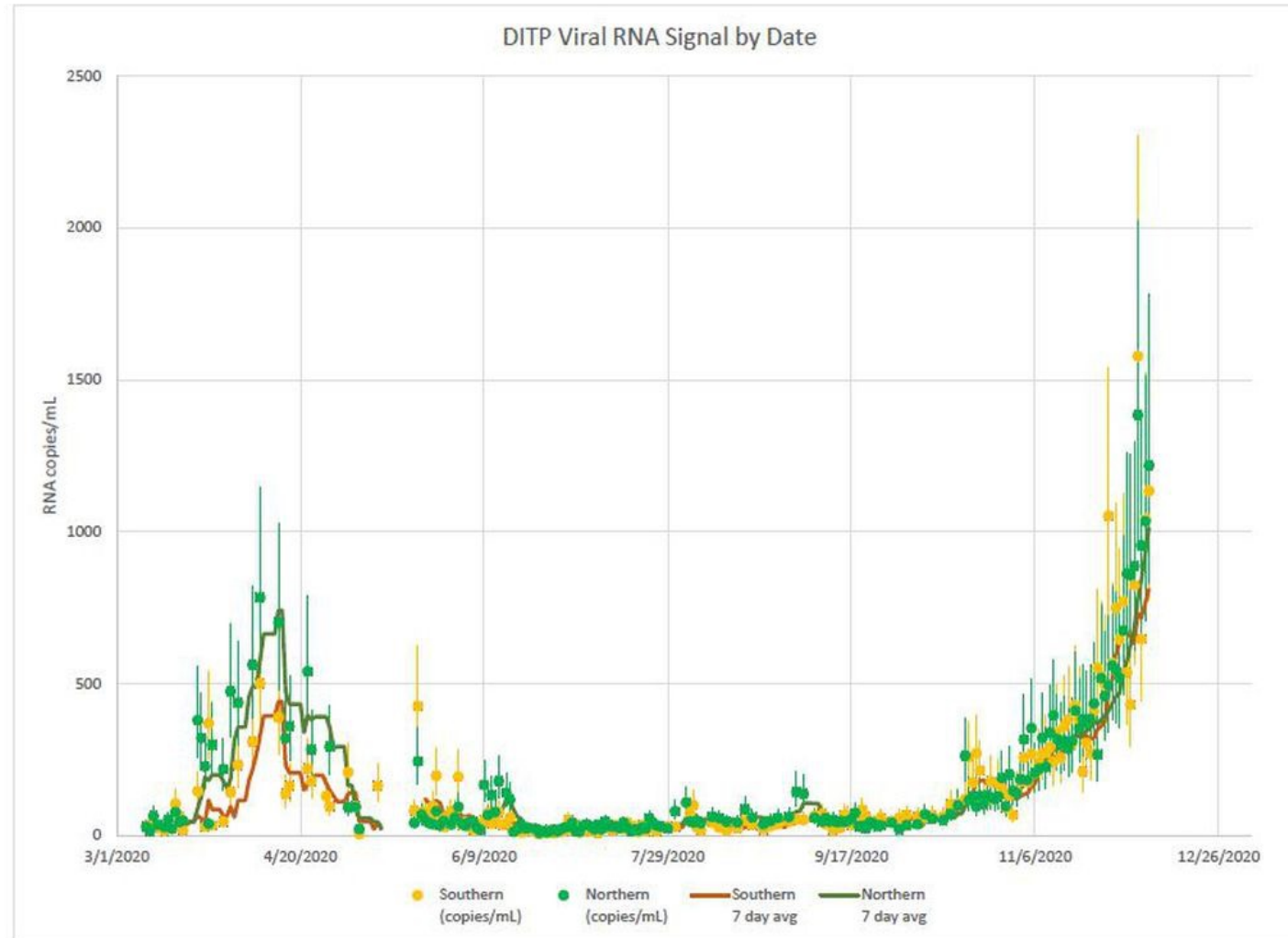
Use case – decline
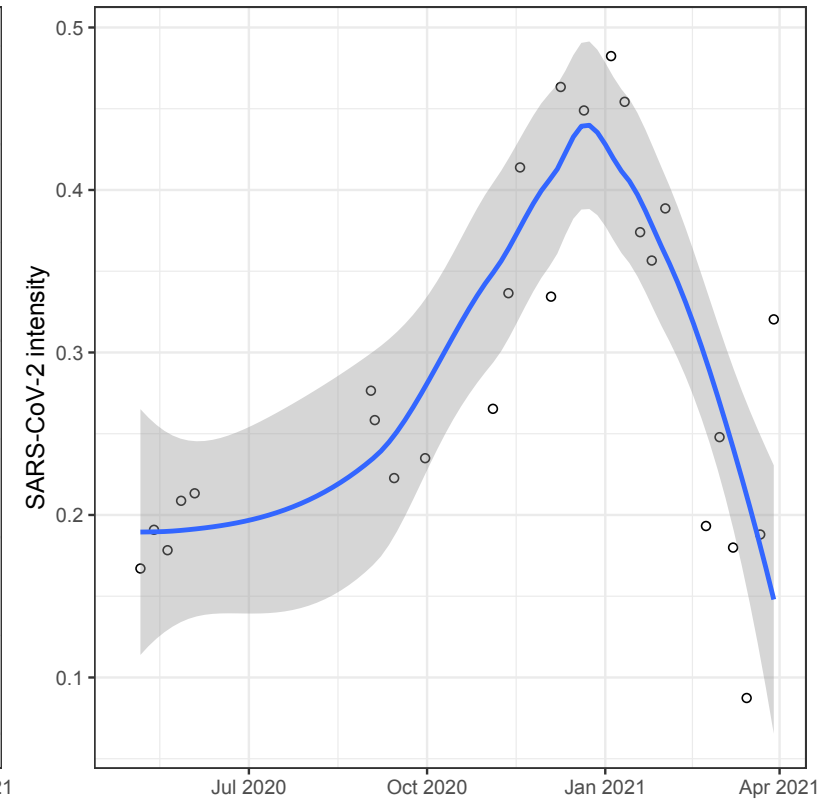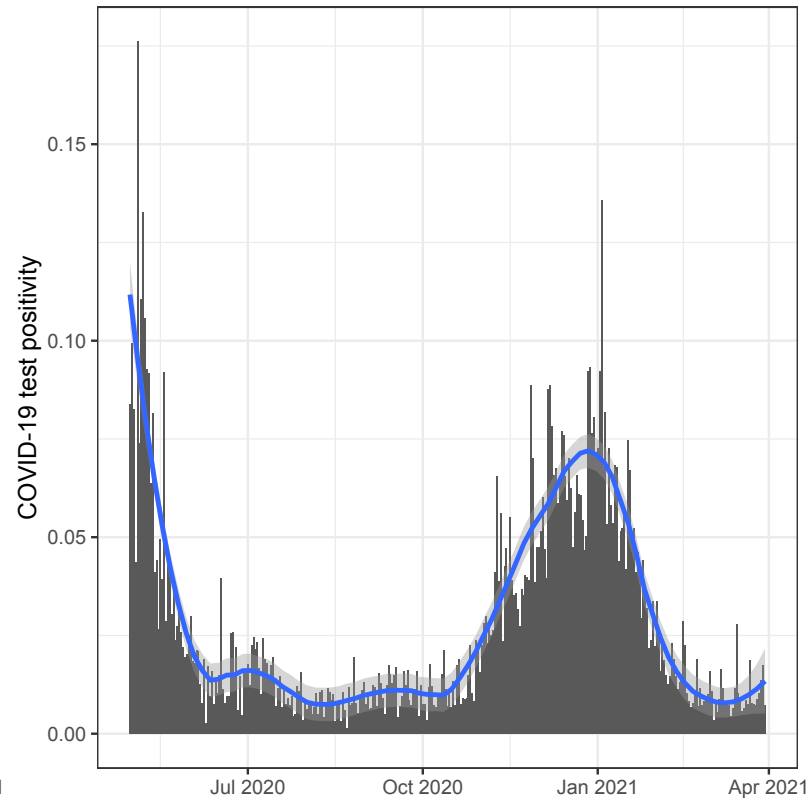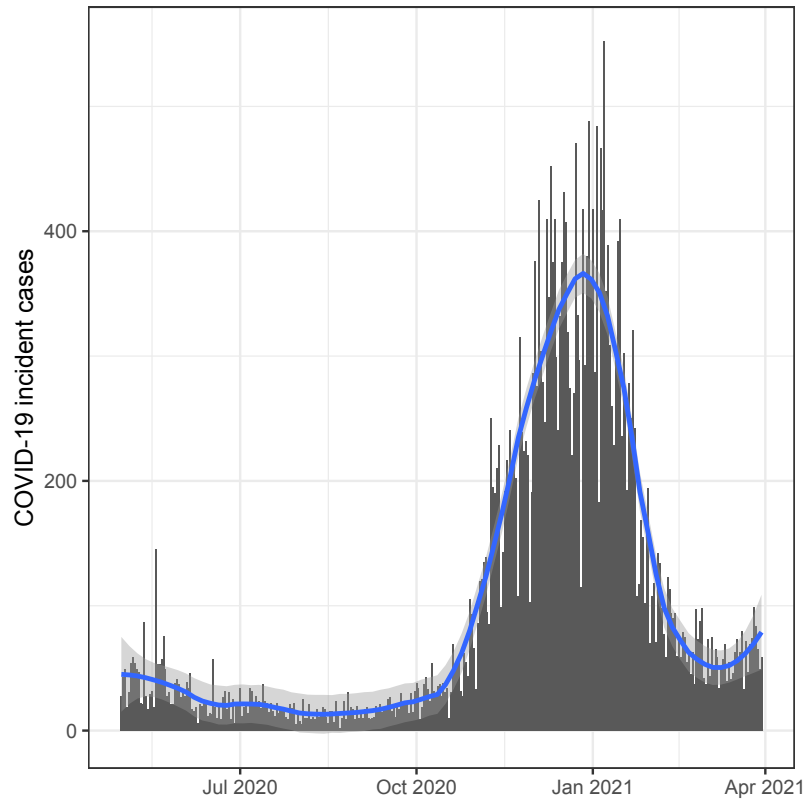
How will case and testing numbers and change in the future?

Use case - variant detection and sequencing

We are building capacity for whole genome sequencing from wastewater including rapid geographic estimation of distribution of variants of concern

Estimated Threshold for Variant Detection Dec 12-19, 2021

Variant prevalence
- 0.25
- 0.20
- 0.15
- 0.10
- 0.05
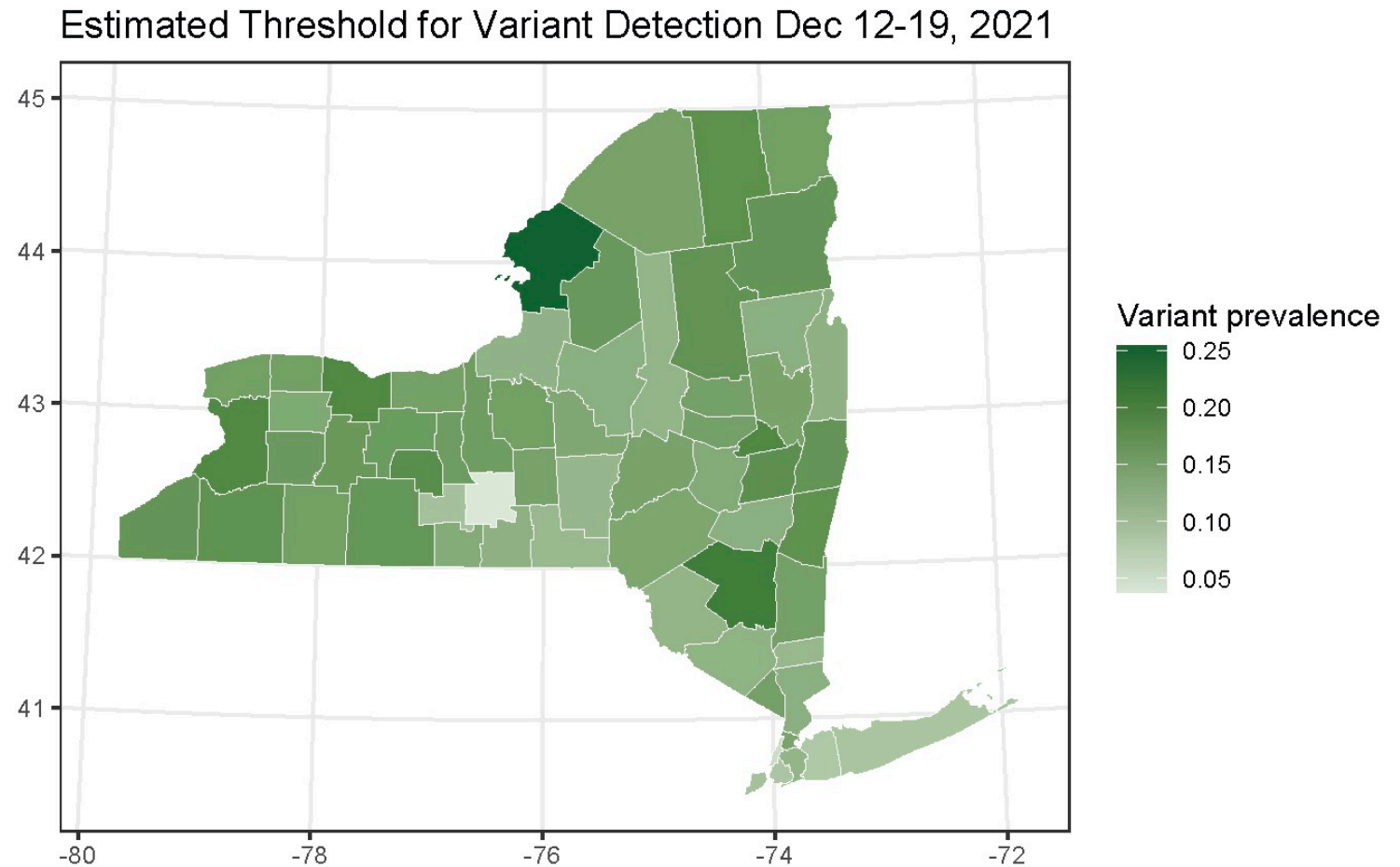
Nudging vaccine acceptance and guiding mobile clinics
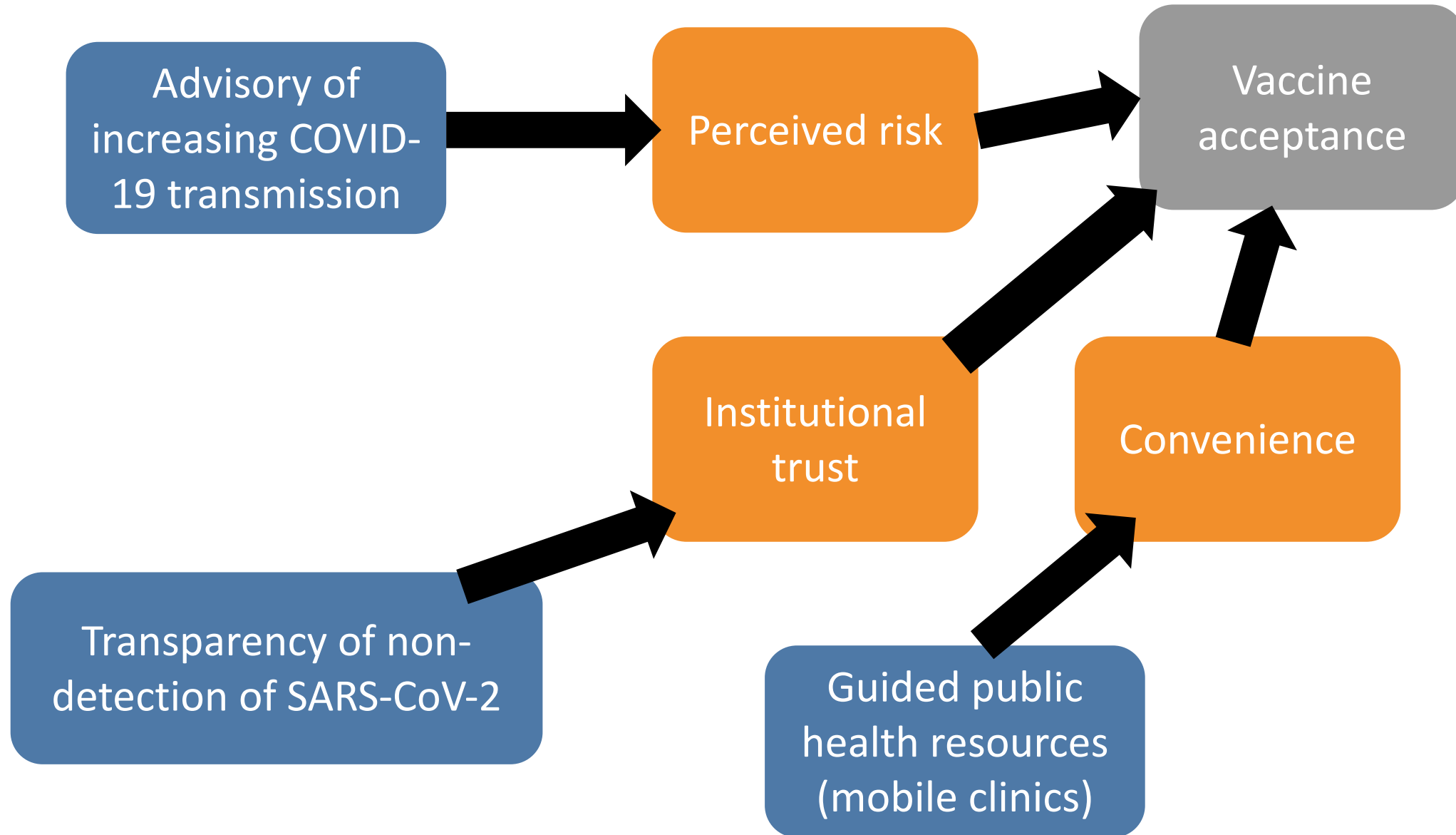
What is the cost of a comprehensive statewide wastewater surveillance program?

- Estimated $350 per sample for centralized program
- $23 million for twice weekly sampling for one year at 632 municipal plants
- $1.19 per NY state resident
- 0.36% of CARES funding
- 3% of lost sales tax revenue

Proportional cost

■ CARES act   ■ Wastewater surveillance

Proportional cost

■ Sales tax lost   ■ Wastewater surveillance
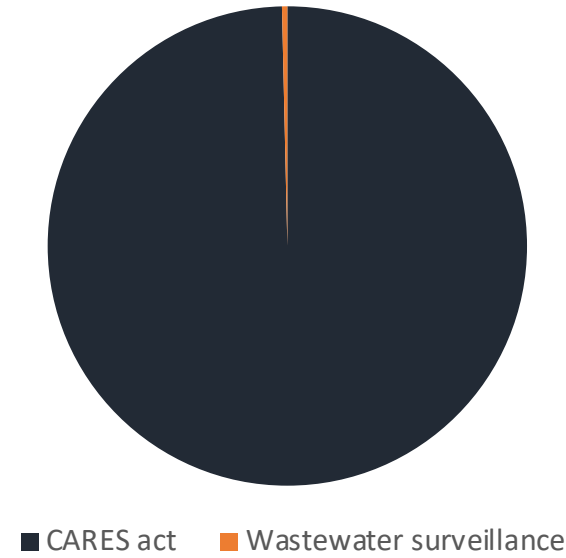
Future steps

- Wastewater surveillance is simply a system – it can be applied to many public health issues

- Monitoring opioid use

- Influenza, RSV, and other infectious diseases

- The next pandemic threat?

Pathogens detected in wastewater

- Adenoviridae (Mastadenovirus, and Unspecified)
- Astroviridae
- Caliciviridae (Norovirus, Sapovirus, and Unspecified)
- Coronaviridae
- Cryptosporidiidae (Cryptosporidium)
- Enterobacteriaceae (Salmonella, Escherichia, and Unspecified)
- Filoviridae (Ebolavirus)
- Flaviviridae (Flavivirus)
- Hepeviridae (Hepevirus, and unspecified)
- Herpesviridae
- Hexamitidae (Giardia)
- Matonaviridae
- Papillomaviridae
- Parvoviridae
- Picornaviridae (Enterovirus, Parechovirus, Hepatovirus, Kobuvirus, Cosavirus, Salivirus, and Unspecified)
- Poxviridae
- Reoviridae
- Retroviridae
- Togaviridae

Greatest burden of disease (Family, Genus):

- Lower respiratory infections
- Diarrheal diseases
- HIV/AIDS (Retroviridae, Lentivirus)
- Tuberculosis (Mycobacteriaceae, Mycobacterium)
- Malaria (Plasmodiidae, Plasmodium)
- Meningitis
- Whooping cough (Alcaligenaceae, Bordetella)
- Measles (Paramyxoviridae, Morbillivirus)

Infectious diseases of international concern (Family, Genus):

- Coronavirus* (Coronaviridae)
- Ebola* (Filoviridae, Ebolavirus)
- Influenza (Orthomyxoviridae)
- HIV/AIDS (Retroviridae, Lentivirus)
- Poliovirus* (Picornaviridae, Enterovirus)
- Zika* (Flaviviridae, Flavivirus)

- Kilaru P, Hill D, Anderson K, Collins MB, Green H, Kmush BL, Larsen DA. Wastewater surveillance for infectious disease: a systematic review. medRxiv. 2021.
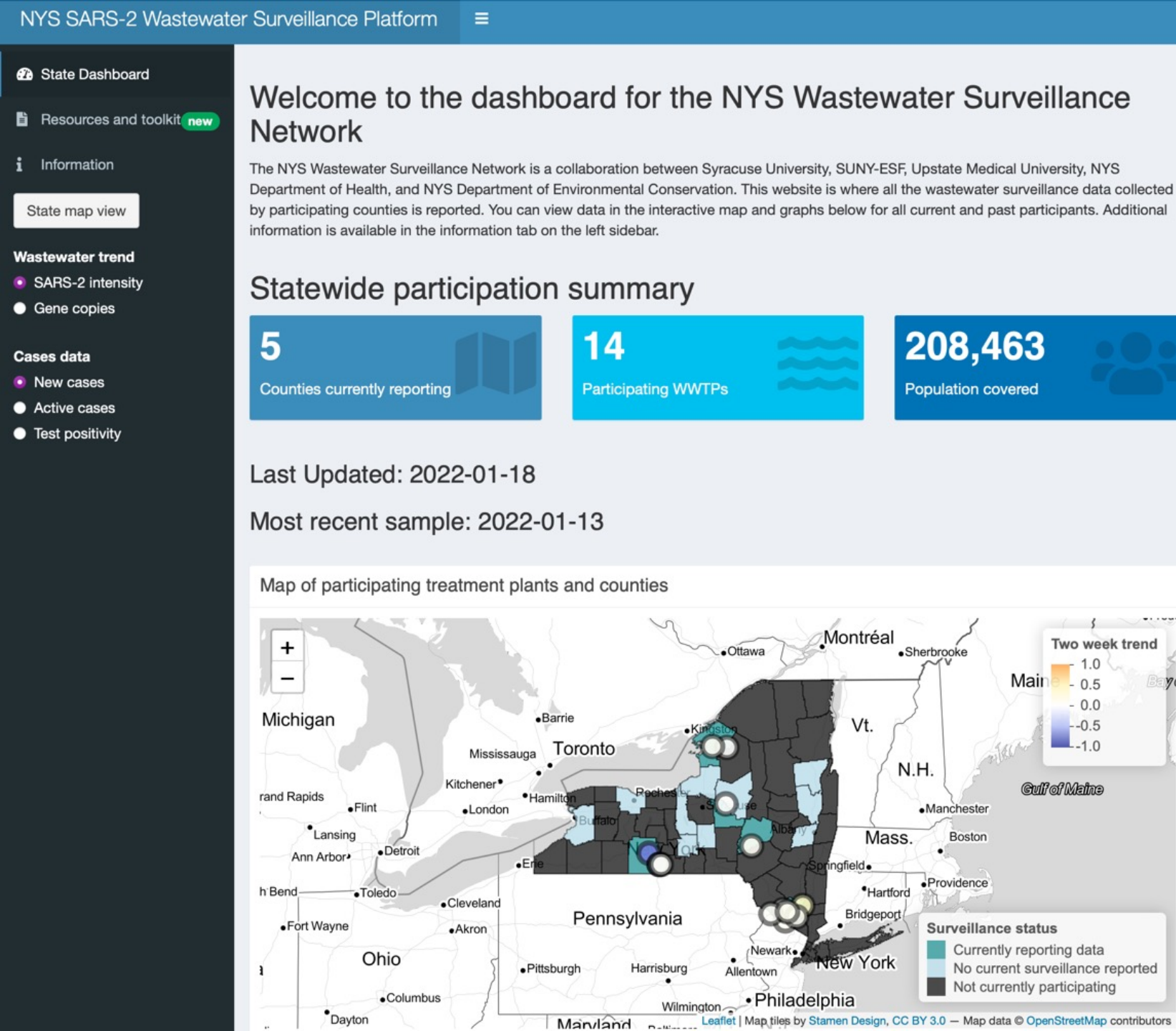
Welcome page:

- Supporting information
- Summary information
- Navigation of:
  - Wastewater and Case data
  - By county

Choose your county:

- Zoom map to see county details.

- Choose wastewater trend

- Choose case data

Zoom in example:

- Orange county
- Display various base maps
- Specific collection points

Middleton collection point

- Interested in comparing gene copies various case data values

Middleton collection point

- Comparing gene copies to new cases
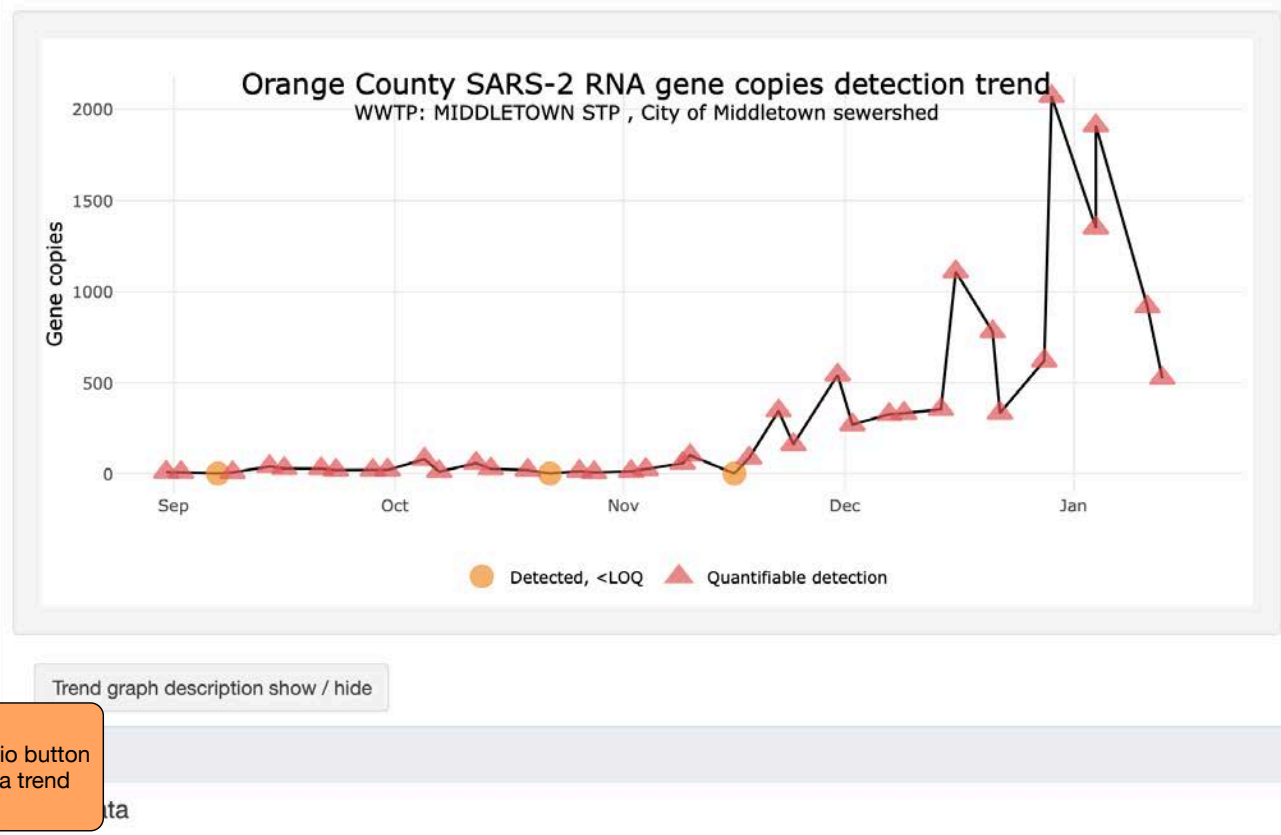
Middleton collection point

- Comparing gene copies to active cases
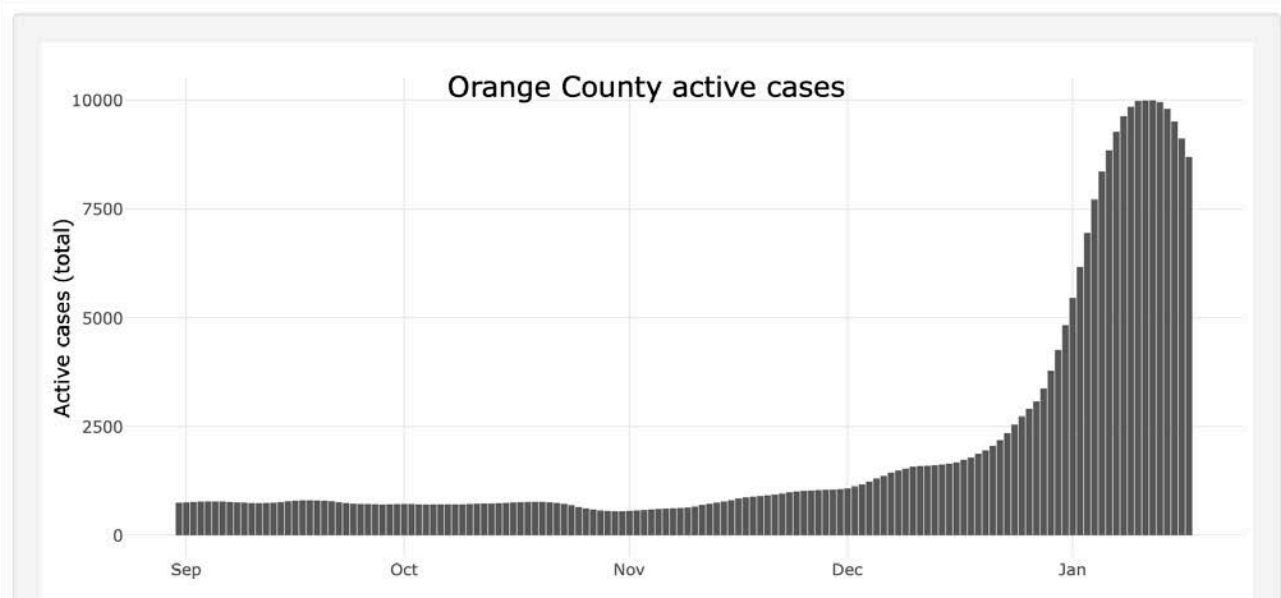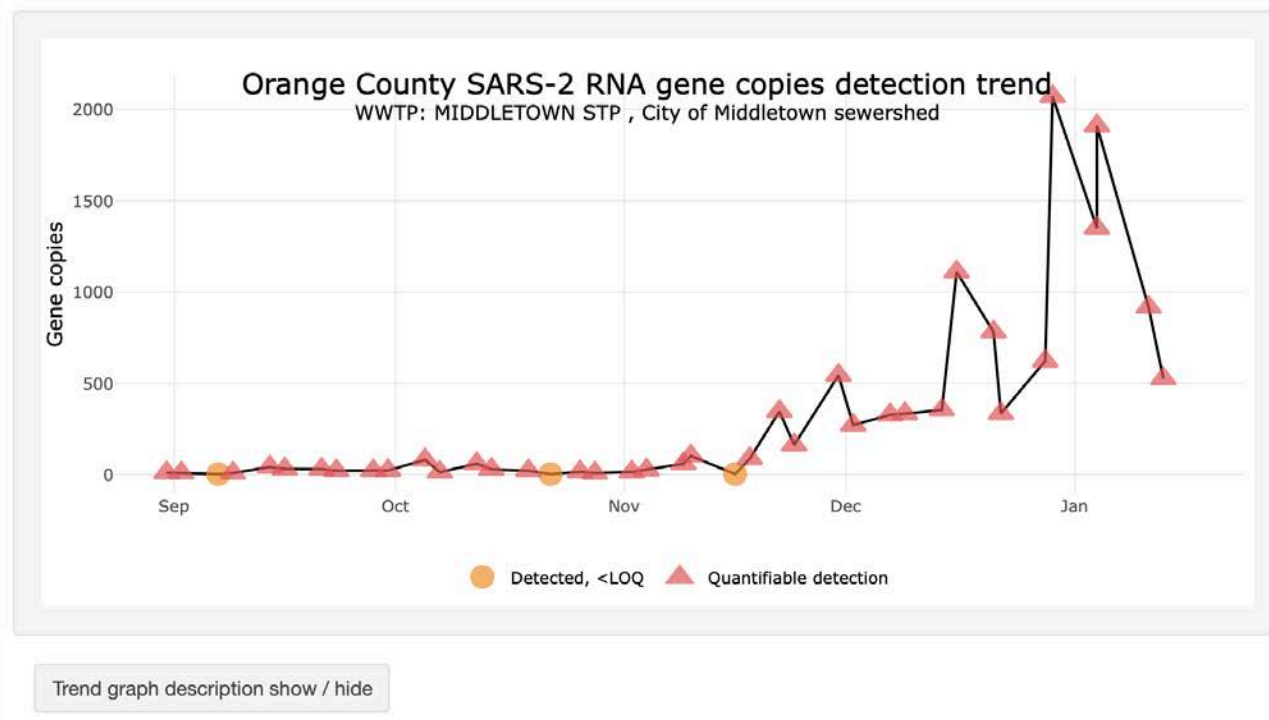
Middleton collection point

- Comparing gene copies to test positivity
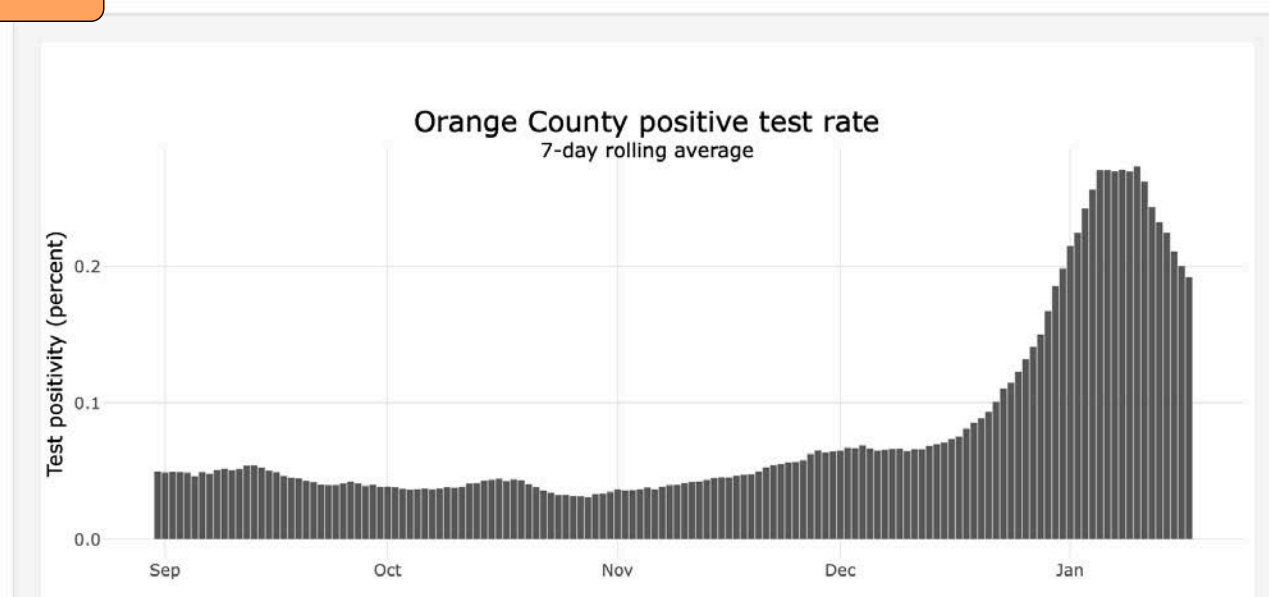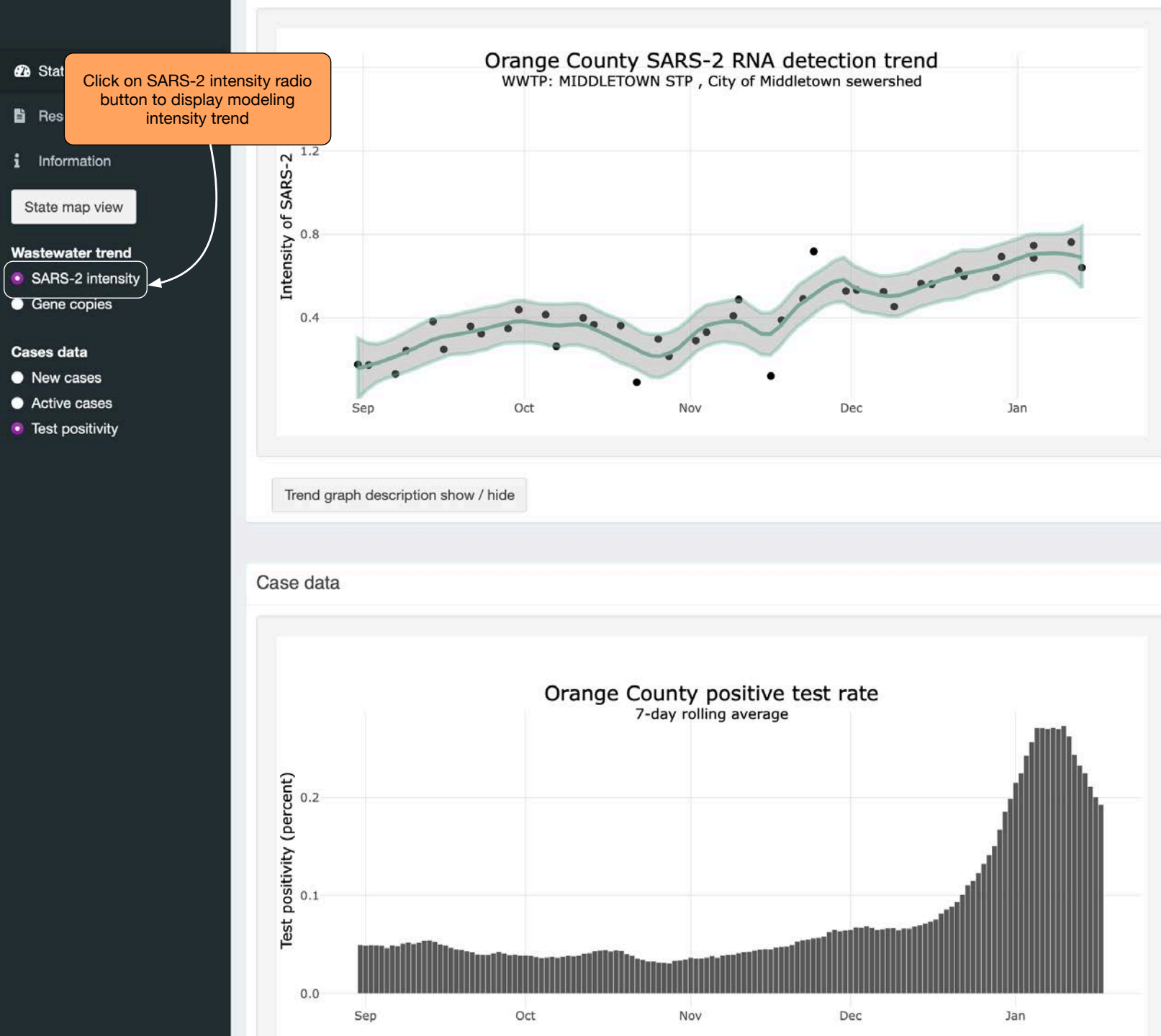
Intensity model:

- Normalized gene copy data, to account for upstream population

- Higher values are higher loads, potentially higher transmission

- Log adjustment dampens the peaks

Start over by clicking on the "state map view" button!

Link:
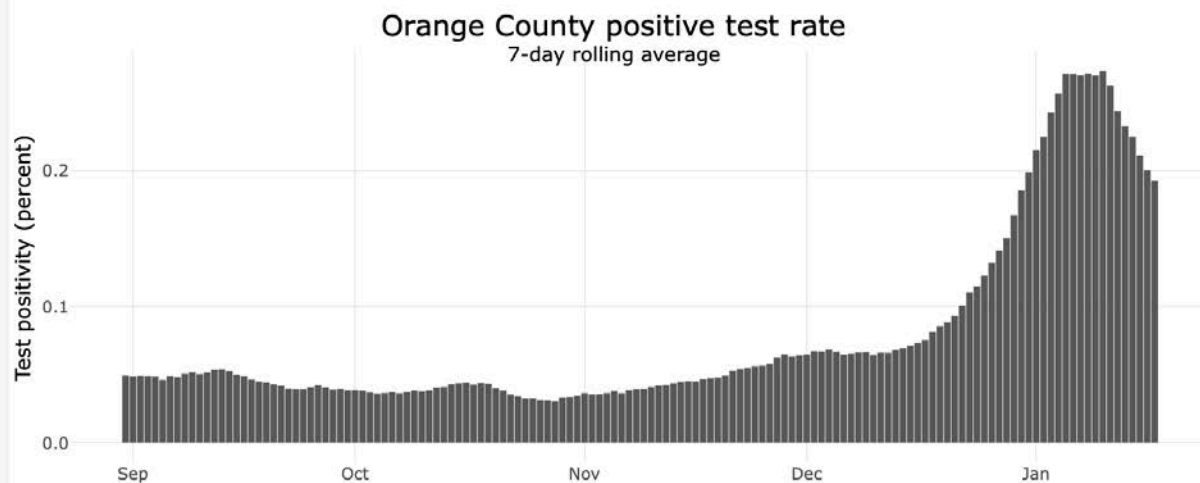
Thank you!

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