Presentation to the

New England Biosafety Association 2021 Symposium

A Utility Perspective on 18 Months of Wastewater Monitoring for SARS-CoV-2

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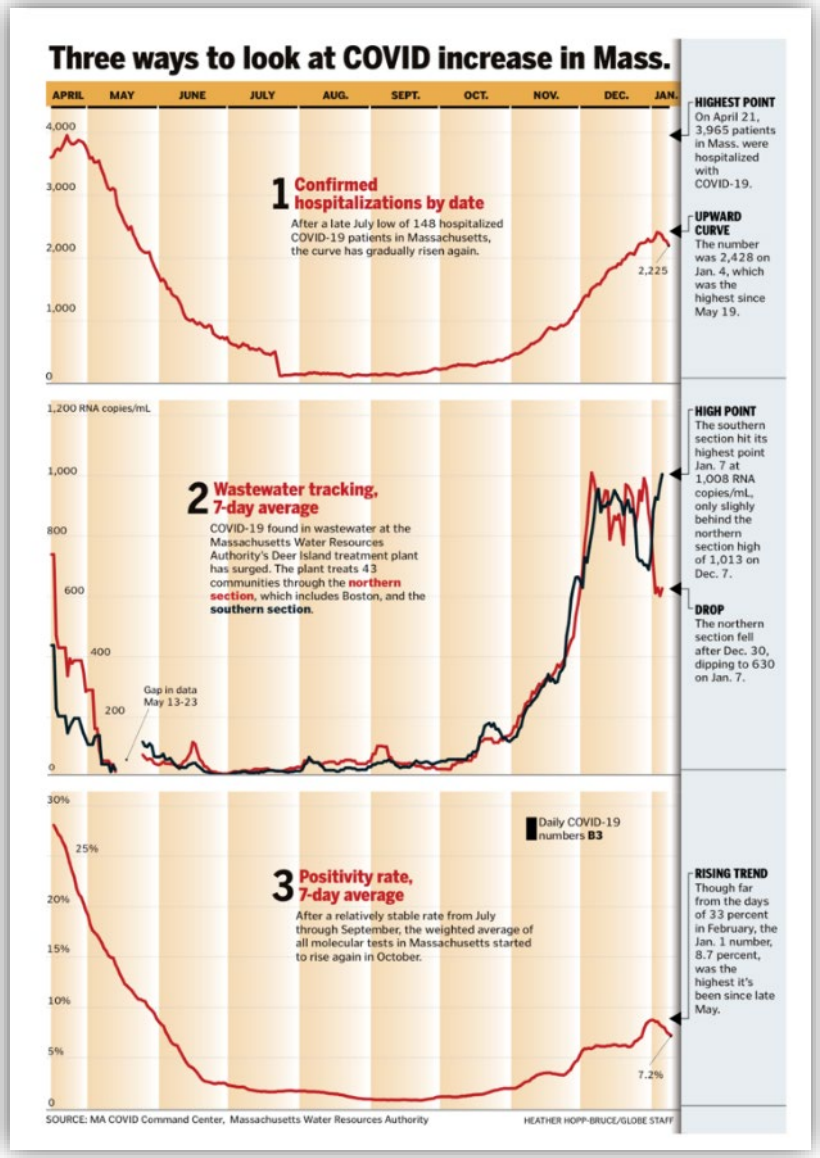
COVID Wastewater Testing

- Since the pandemic began, MWRA has been working with Biobot Analytics on sampling wastewater at Deer Island to track the amount of COVID in the north and south systems as an additional tool for the public health community
- Testing results are posted on MWRA's website
- The program has garnered local and national media attention and the Boston Globe uses it as one of the key graphs to watch

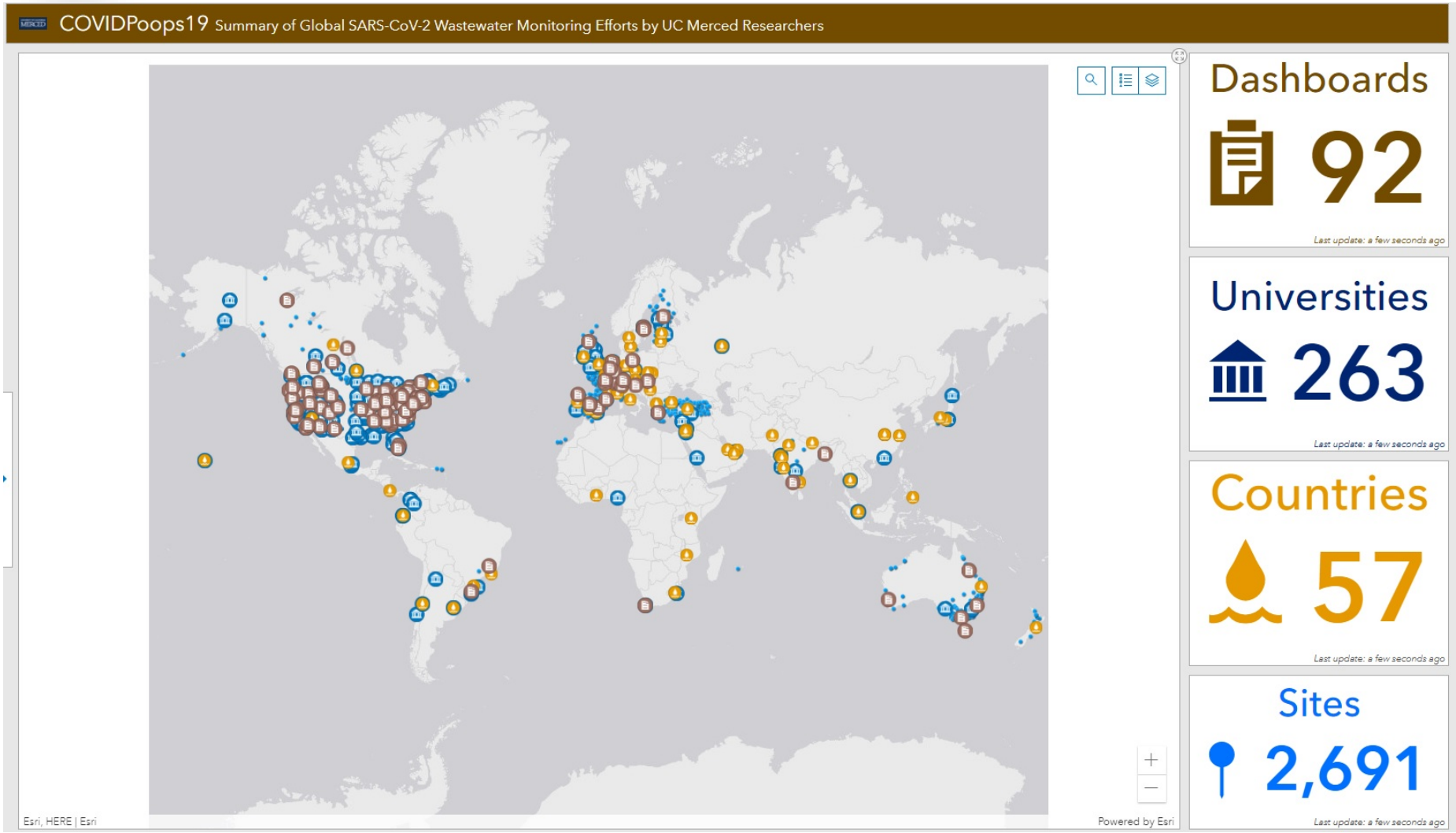


Groups Around the World are working to use Wastewater as a Predictor of COVID – early 2020

- International Utilities/Research Groups
  - Miami, Detroit, Portland, New Haven
  - France, Netherlands, Australia, Spain

- MWRA has provided samples to:
  - Biobot Analytics/MIT
  - Stanford/UMichigan/Tufts national study
  - Northeastern
  - ActiveSignal
  - UMASS Amherst
  - NIH/CDC
  - UNH

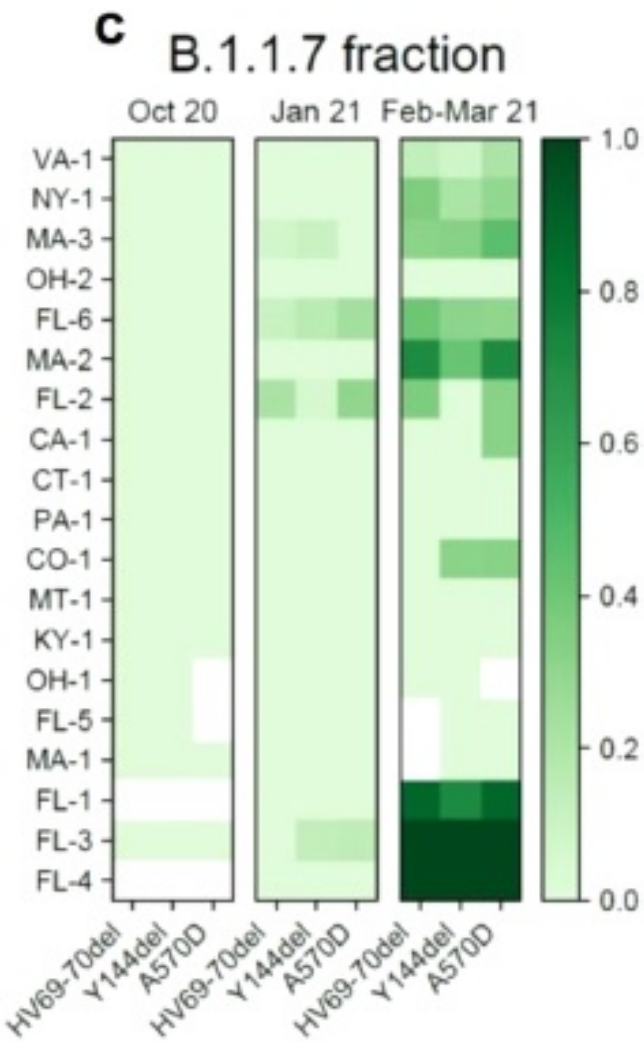
Groups Around the World are working to use Wastewater as a Predictor of COVID - now



https://ucmerced.maps.arcgis.com/apps/opsdashboard/index.html#/c778145ea5bb4daeb58d31afee389082
accessed 9/14/2021

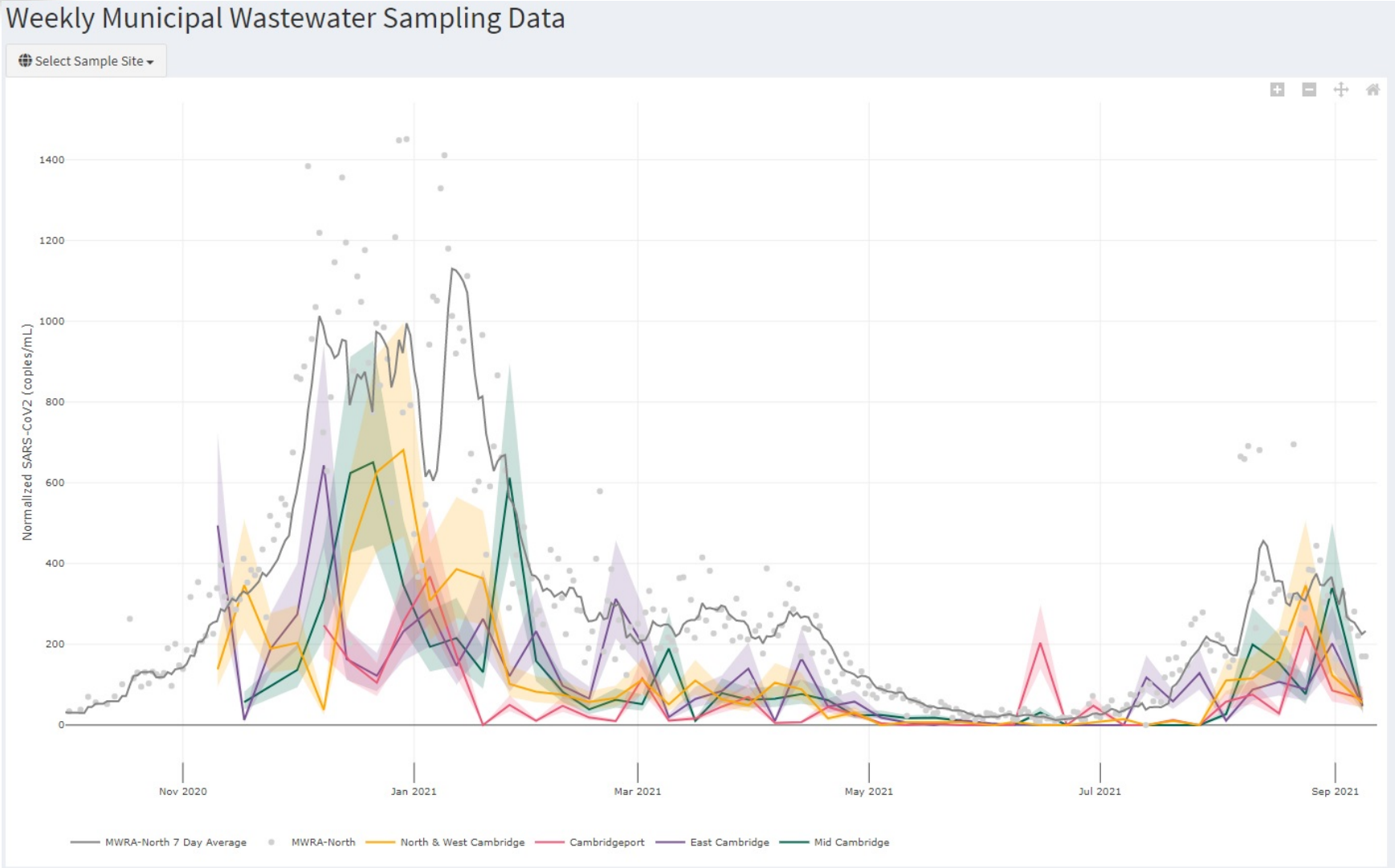
Current Applications

- Around the world, wastewater data are being used for in several different ways
  - Building level for detection of new outbreaks
  - Neighborhood level for directing local interventions
  - City wide level for tracking overall activity
  - Genomic surveillance for changes in the circulating variants



Lee et al (2021) https://doi.org/10.1021/acs.estlett.1c00375

Neighborhood Level Example



https://cityofcambridge.shinyapps.io/COVID19/#shiny-tab-wastewater
Accessed 9/14/2021

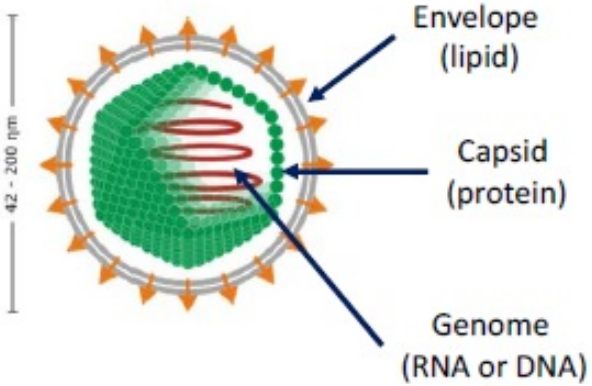
Timeline of Biobot Analytics Deer Island Study

- Started in March, 2020 with a preliminary request for samples
- Follow up included samples archived sample from Deer Island from January and February, and daily samples for early March, and one to two weekly samples through April
- Concurrently Biobot worked with Boston Water and Sewer Commission to analyze neighborhood results
- Current program:
  - Samples 3 times per week (or more) from Deer Island
  - Increase to daily if it looks like there is a change
  - Results are shared with the state Command Center as received
  - Biobot added capability to estimate Alpha variant prevalence in March 2021

- Results are available at http://www.mwra.com/biobot/biobotdata.htm

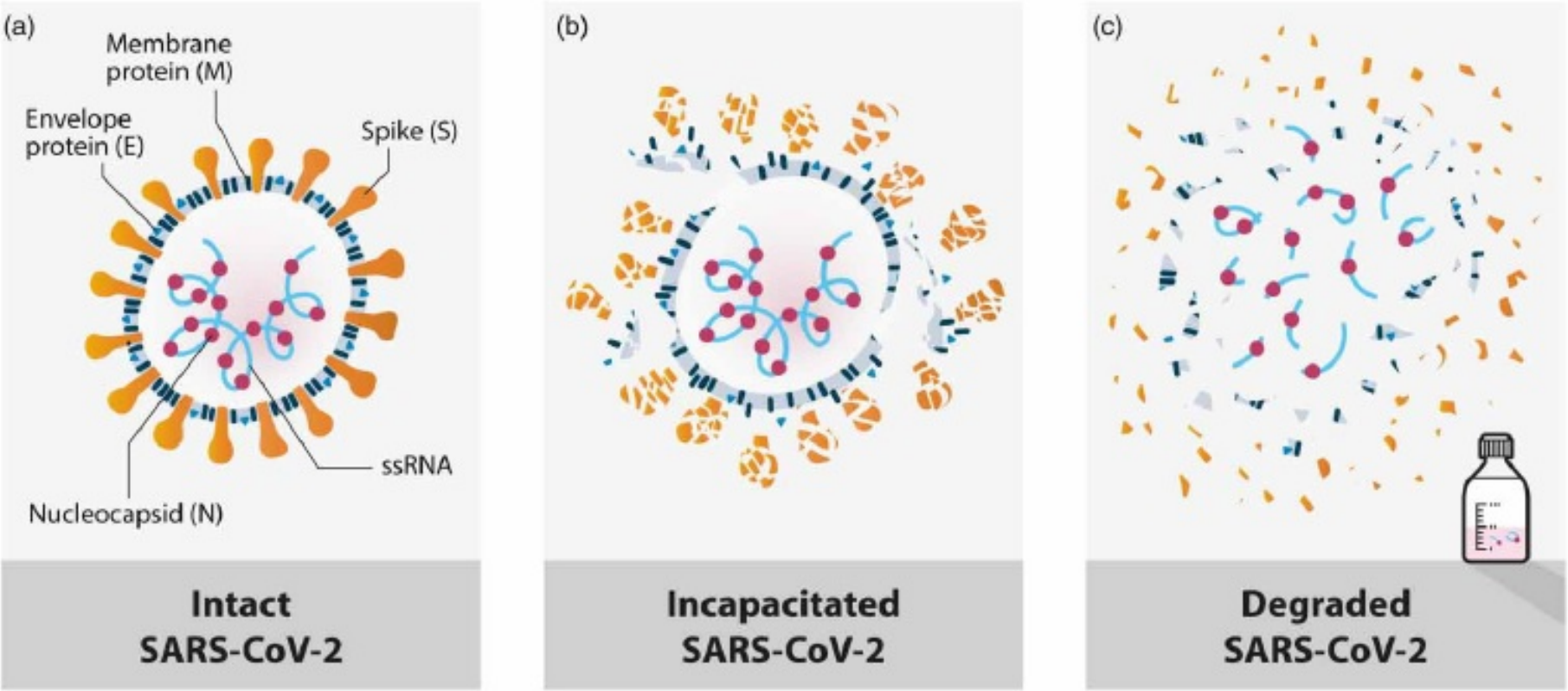
We aren't testing for "live" virus

PCR Detection Does Not Mean Virus Is Infectious



- Culture of live virus requires an intact virus particle
- PCR detects specific regions of the viral genome
  - Damage to the envelope, capsid or genome does not necessarily prevent PCR detection

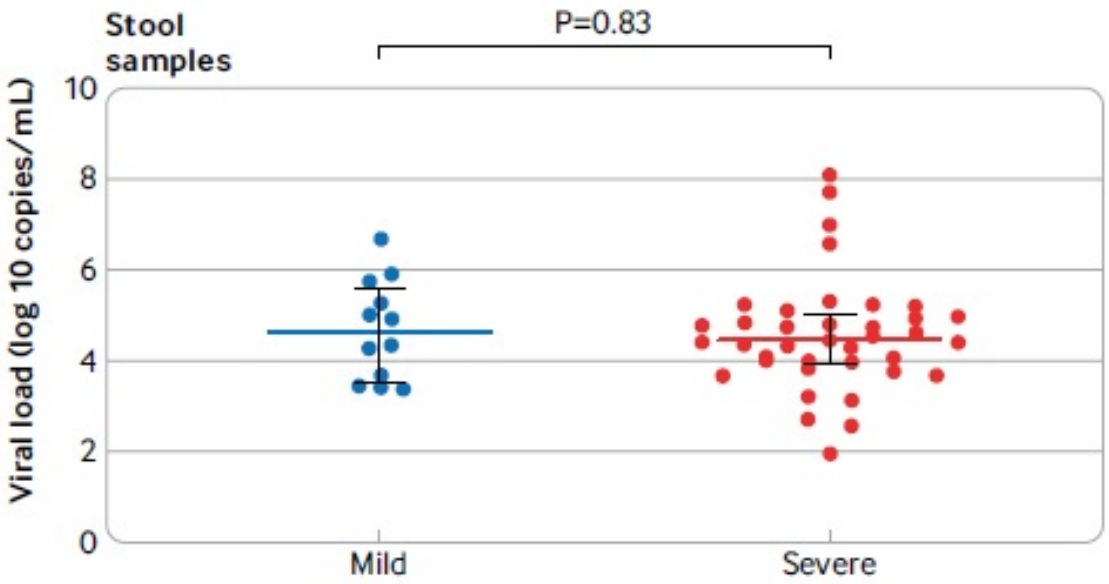
Viral degradation example



- Virus is inactivated and degraded over time, but is still detectable

K. Hill et al. | Global experiences with the COVID-19 pandemic Water Quality Research Journal | 56.2 | 2021

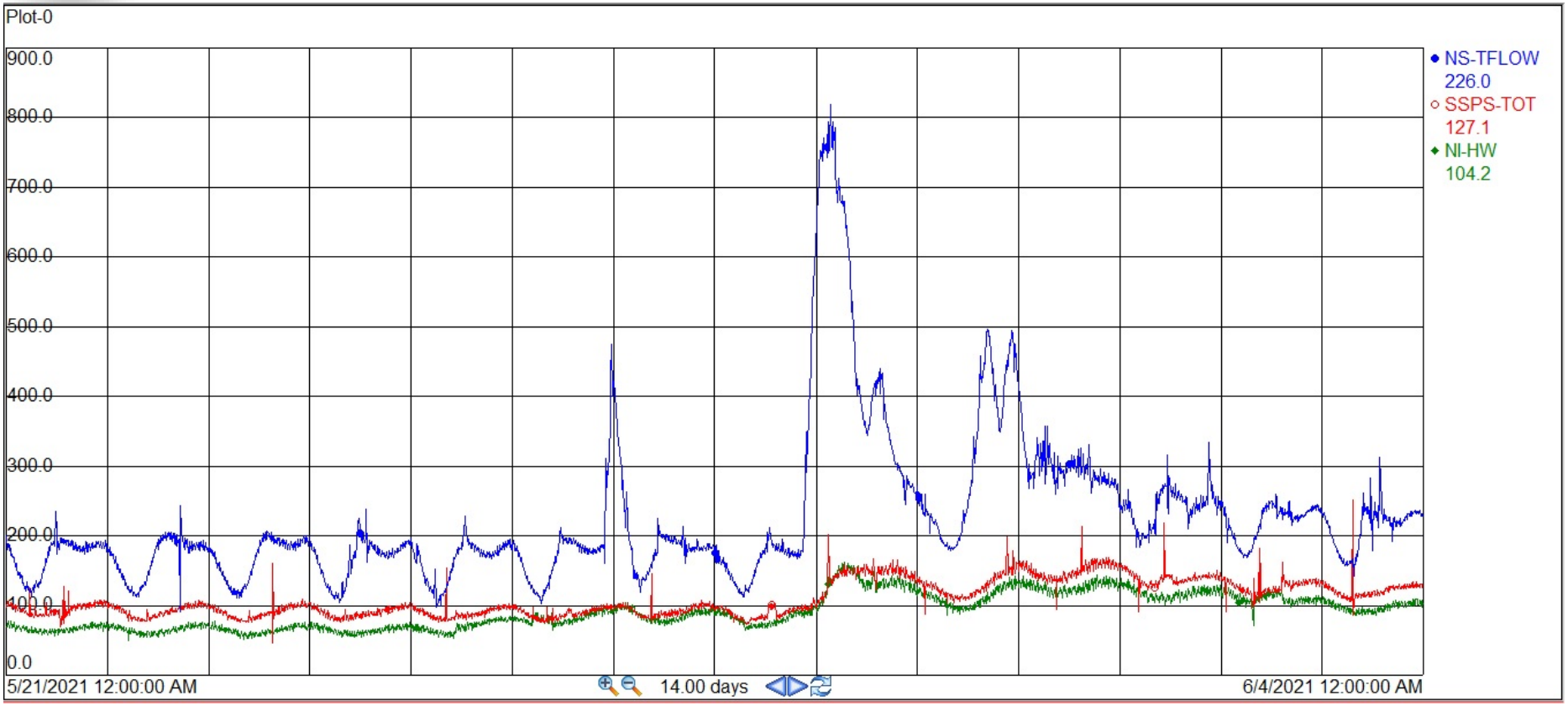
Calibrating the Viral Signal is Difficult



- Fecal shedding by patients can range from 100 copies/g to 100,000,000 copies/g
- This complicates the conversion from how much viral RNA is present to how many people that signal represents, along with other variables at treatment plants (like rainfall)

Zheng et al. 2020

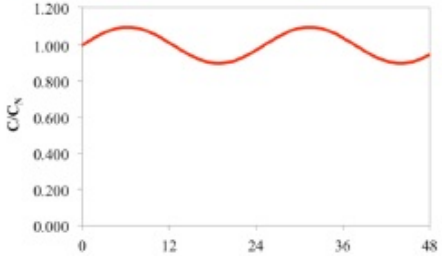
Actual Flow Example



- Clear diurnal pattern in dry weather
  - Morning flush, evening flush, less flow overnight
- Wet weather, spikes when it rains and washes out the pattern
  - Can impact flow for days after a large rain

Sample Collection: Implications of Sample Type

Ubiquitous Indicator (Sucralose)

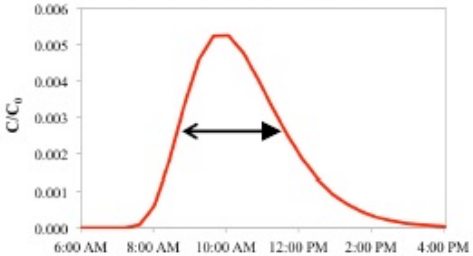


Diurnal Variation

Rare Contaminant Spike

Instantaneous Spike

Effect of Dispersion



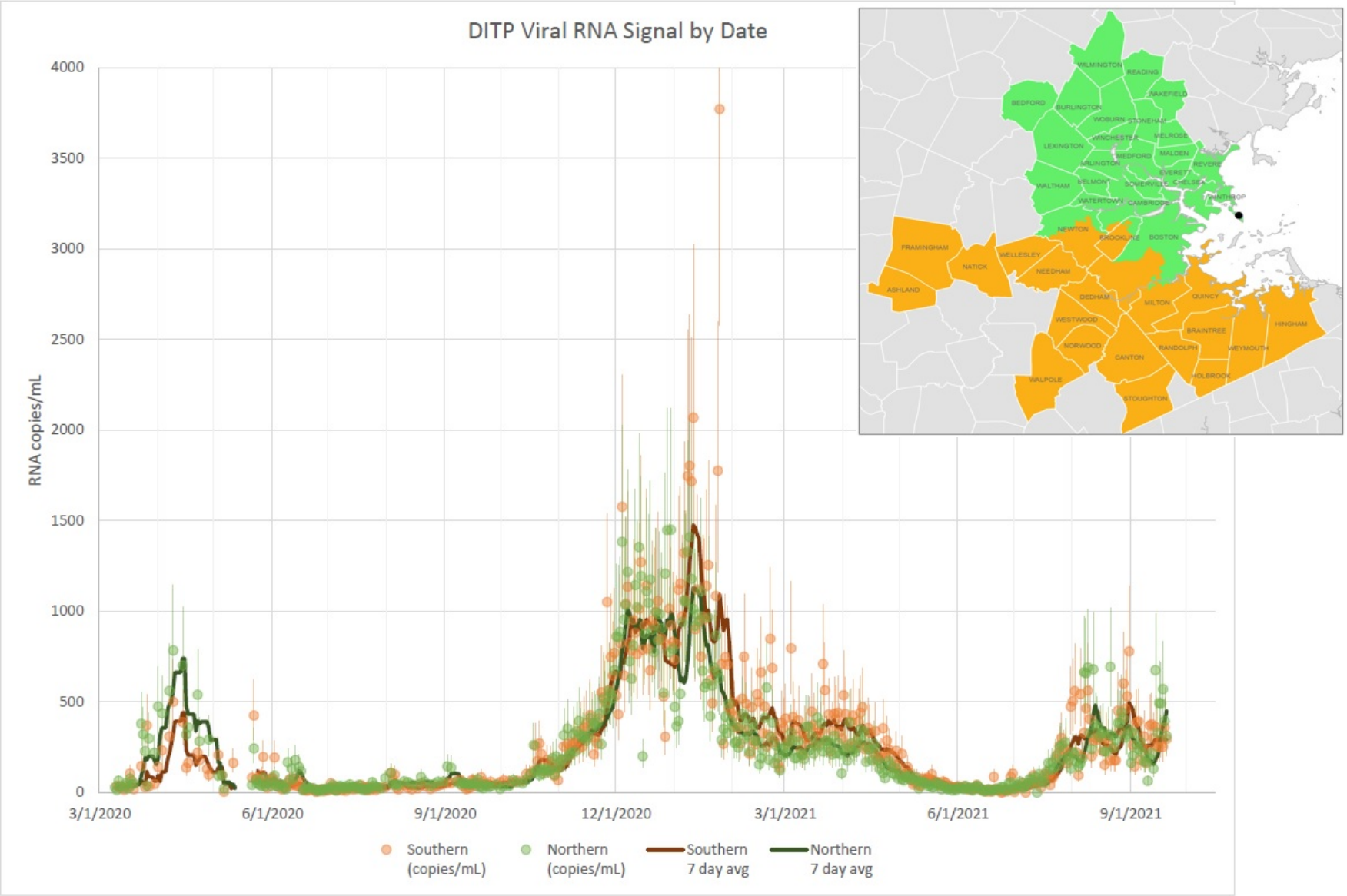
Diluted but Distributed

How do we overcome the 'rare spike' effect?

- Continuous or high frequency composite sampling
- Sampling from locations with equalization/mixing
- Sampling downstream in the treatment facility (e.g., primary effluent)

Ort, C., M. G. Lawrence, J. Rieckermann, and A. Joss. "Sampling for Pharmaceuticals and Personal Care Products (PPCPs) and Illicit Drugs in Wastewater Systems: Are Your Conclusions Valid? A Critical Review." Environ. Sci. Technol. 2010, 44(16): 6024-6035. Publication Date: July 26, 2010. https://doi.org/10.1021/es100779n. Copyright © 2010 American Chemical Society. Permission pending.

Latest Data


DITP Viral RNA Signal by Date
RNA copies/mL
4000
3500
3000
2500
2000
1500
1000
500
0
3/1/2020
6/1/2020
9/1/2020
12/1/2020
3/1/2021
6/1/2021
9/1/2021
Southern (copies/mL)
Northern (copies/mL)
Southern 7 day avg
Northern 7 day avg
WILMINGTON
READING
WAKEFIELD
BEDFORD
BURLINGTON
WOBURN
STONEHAM
WINCHESTER
MELROSE
LEXINGTON
MEDFORD
MALDEN
ARLINGTON
REVERE
EVERETT
WALTHAM
BELMONT
SOMERVILLE
CHELSEA
WINTHROP
WATERTOWN
CAMBRIDGE
NEWTON
BROOKLINE
BOSTON
FRAMINGHAM
WELLESLEY
NATICK
NEEDHAM
ASHLAND
DEDHAM
MILTON
QUINCY
WESTWOOD
BRAINTREE
HINGHAM
NORWOOD
RANDOLPH
WEYMOUTH
CANTON
WALPOLE
HOLBROOK
STOUGHTON

Comparing Cases to Viral Signal