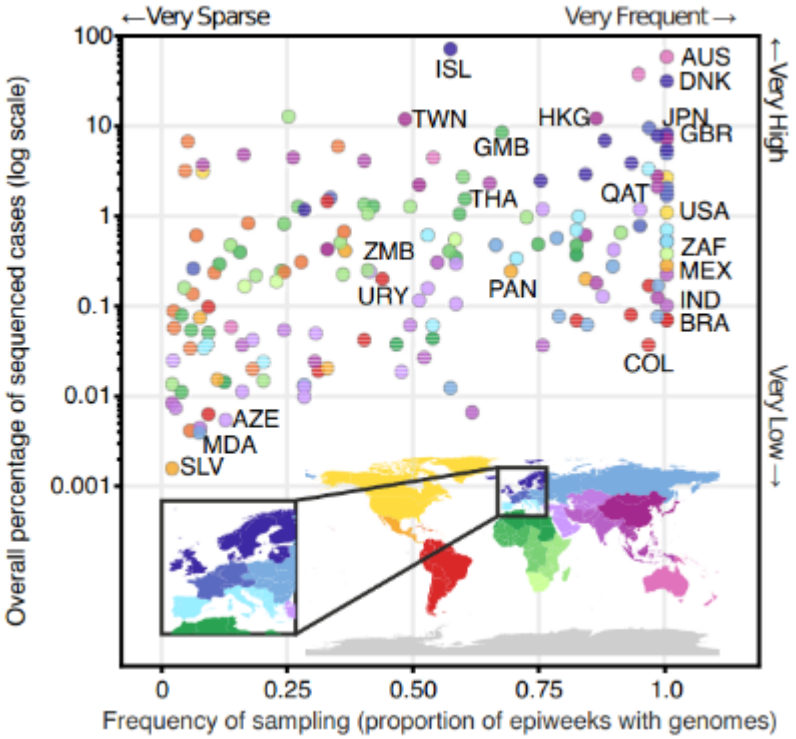
Wastewater sequencing analyses uncover pathogen evolution and spread

IDM

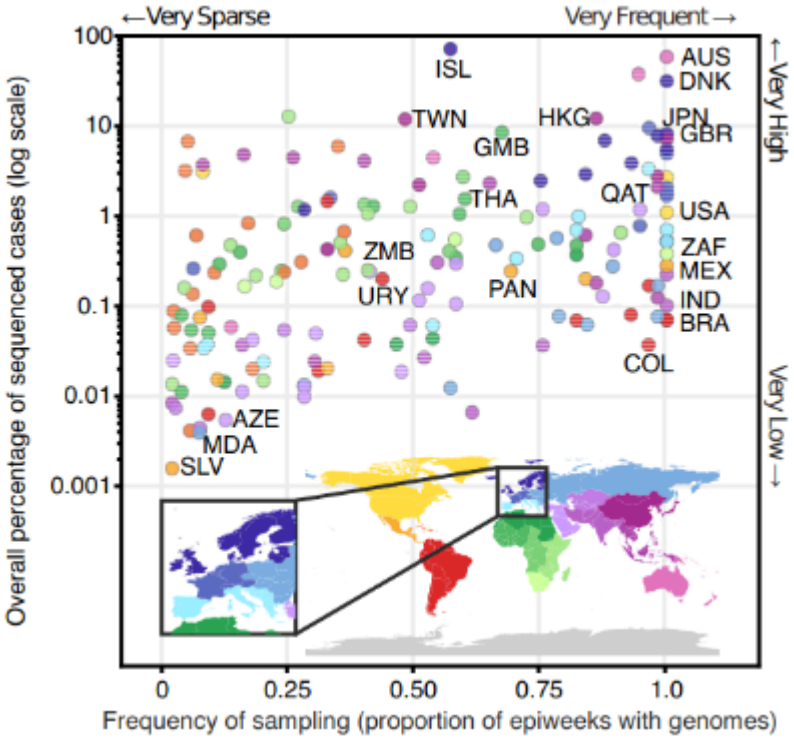
May 23rd, 2023

Clinical sampling blind spots

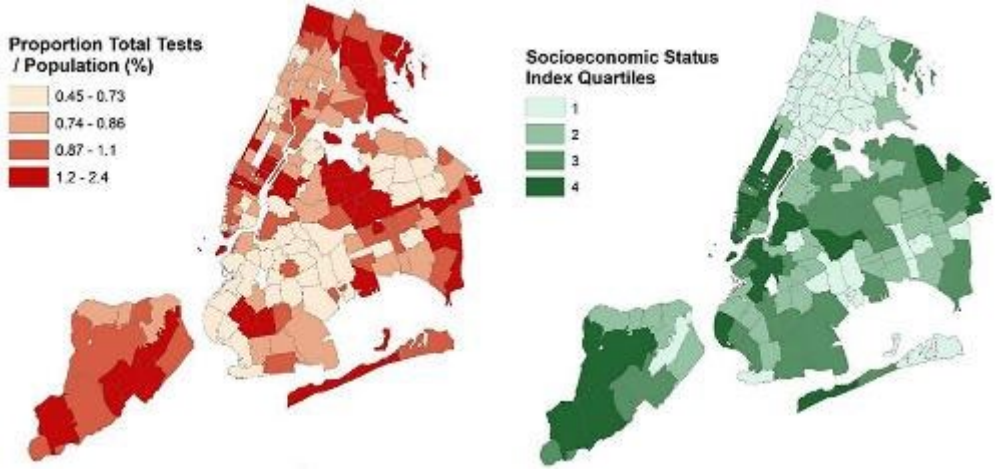


Brito, Semenova, Dudas et al., 2021

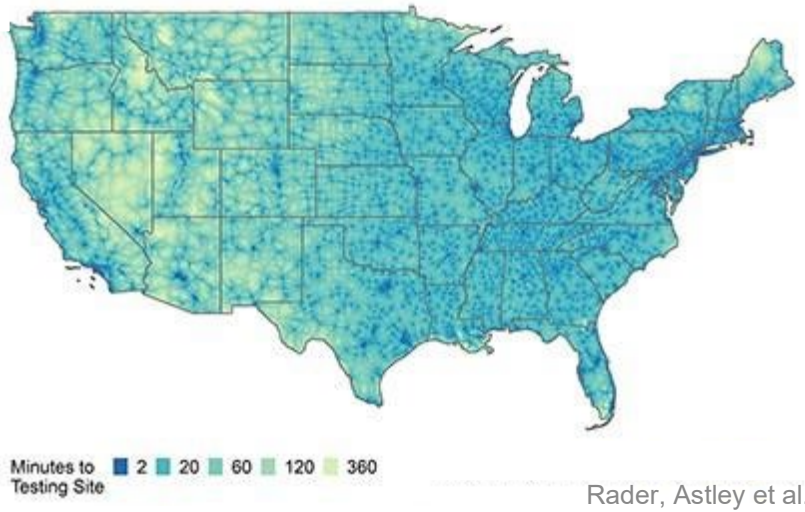
Clinical sampling blind spots



Brito, Semenova, Dudas et al., 2021



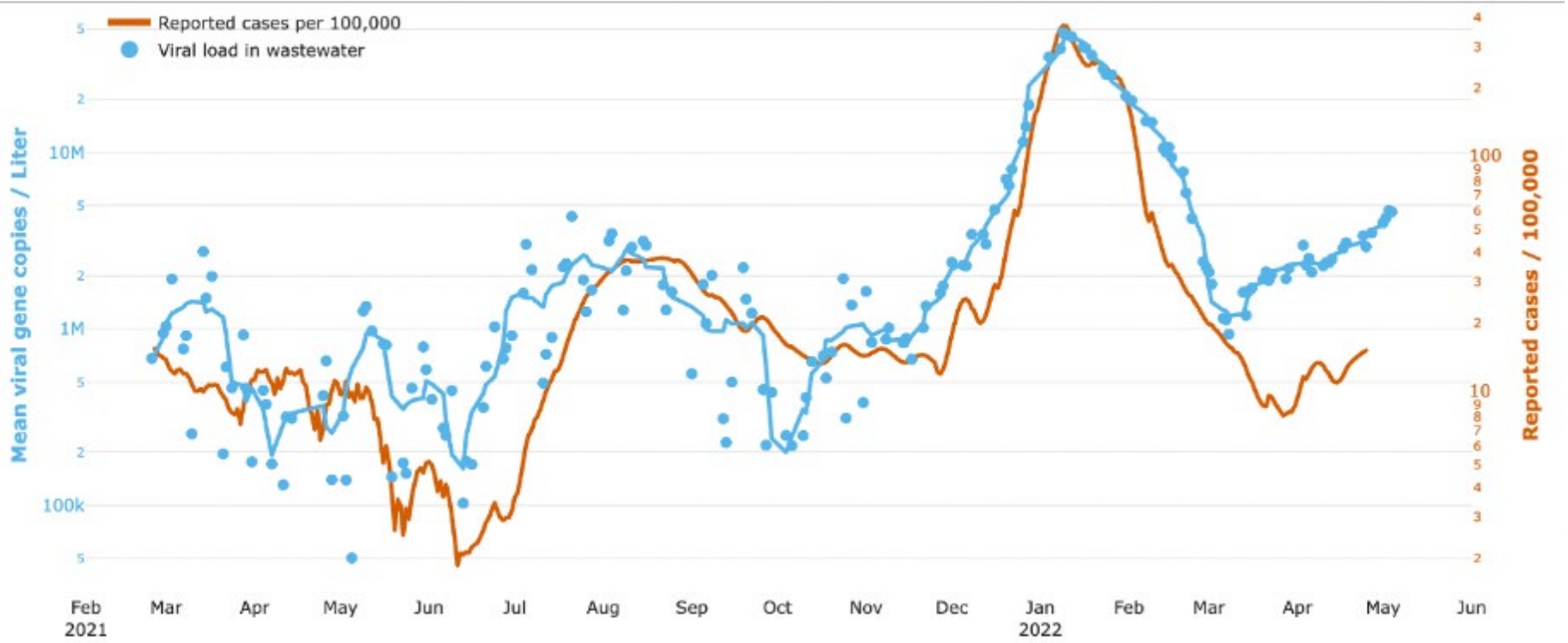
Lieberman-Cribbin et al., 2020



Rader, Astley et al., 2020

Wastewater as a promising alternative

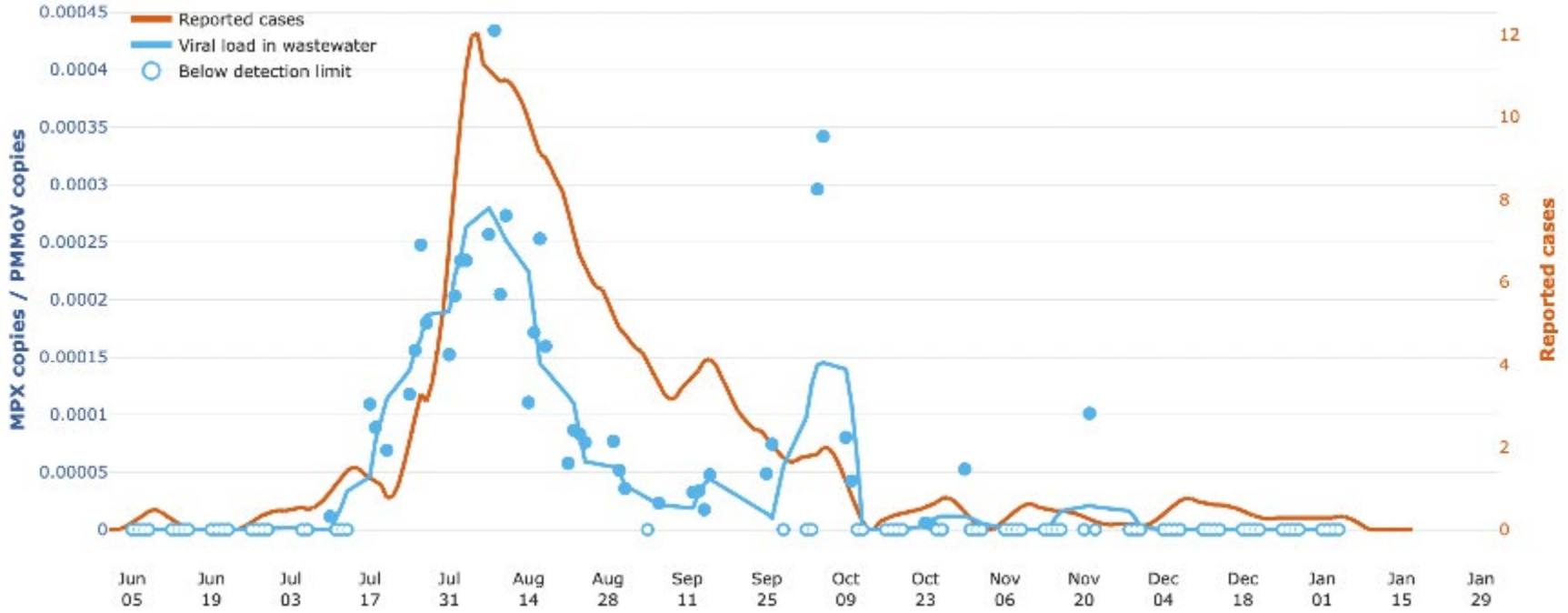
SARS-CoV-2



SEARCH Dashboard

Wastewater as a promising alternative

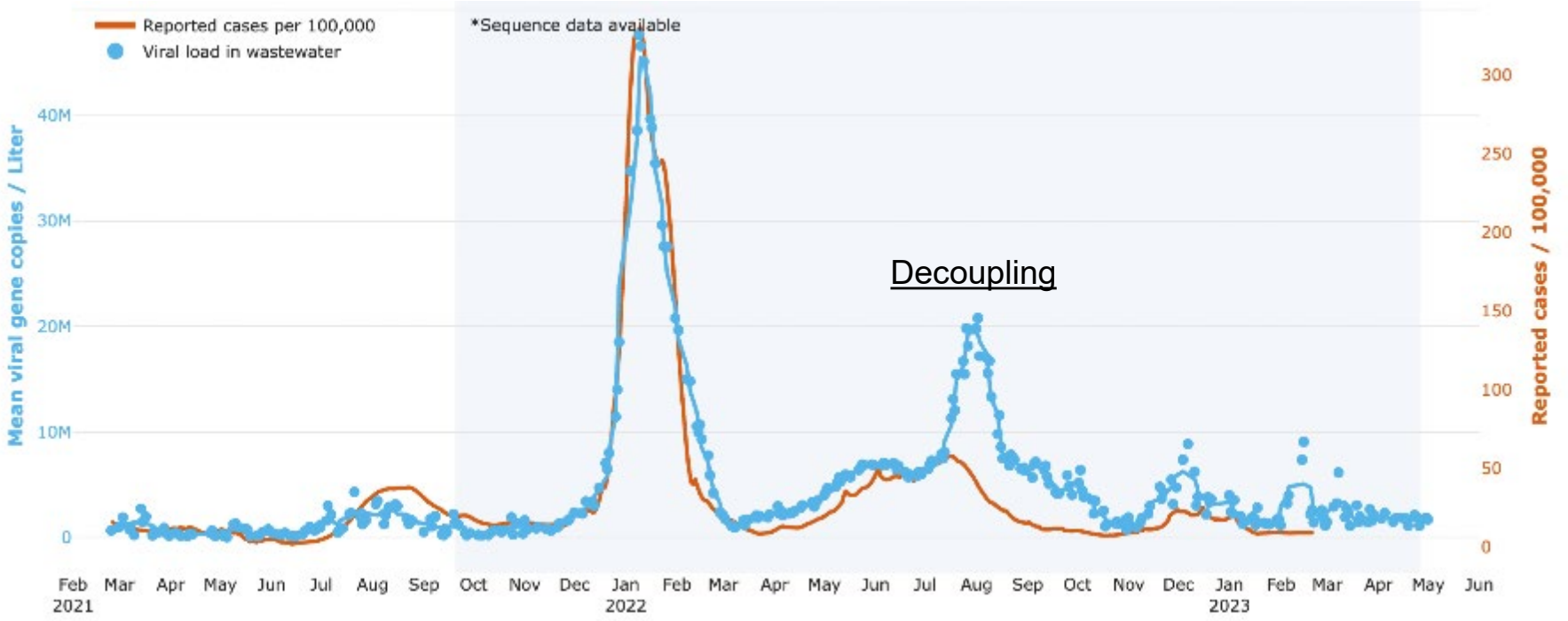
Mpox



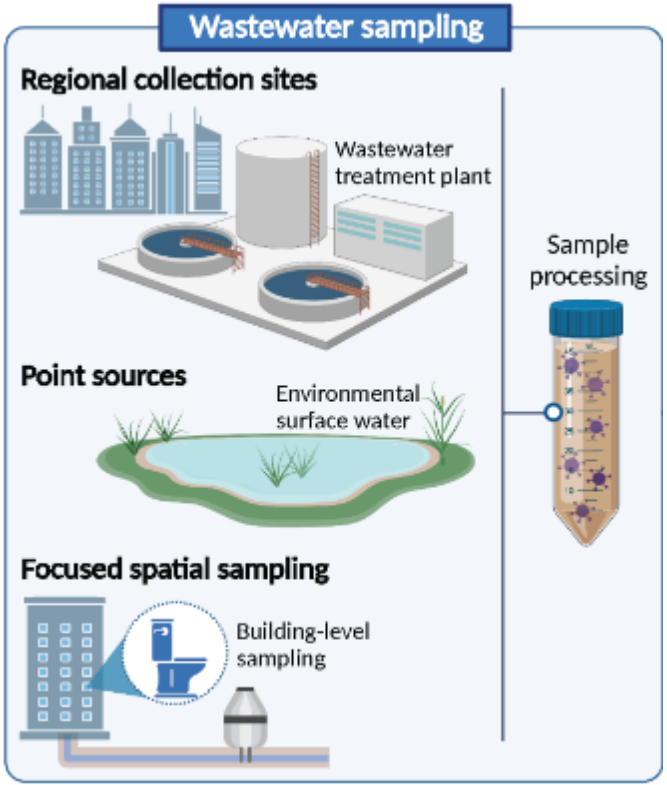
SEARCH Dashboard

Wastewater as a promising alternative

SARS-CoV-2

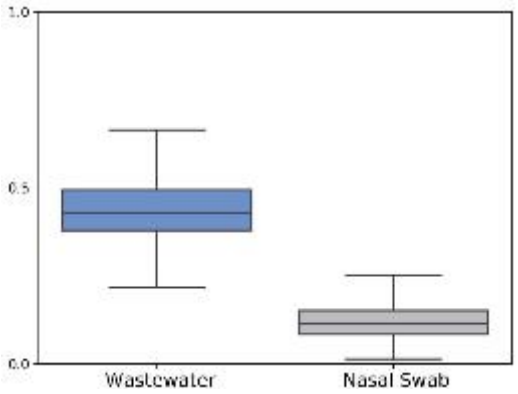


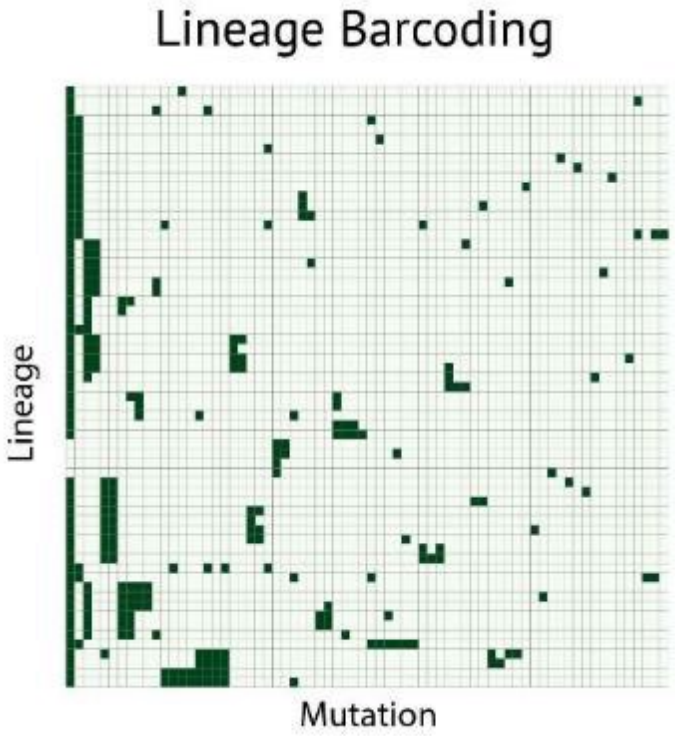
Need a new approach for wastewater sequencing analyses



<u>Wastewater samples are fundamentally mixtures,</u>
with mutations linked by their frequency in the sample

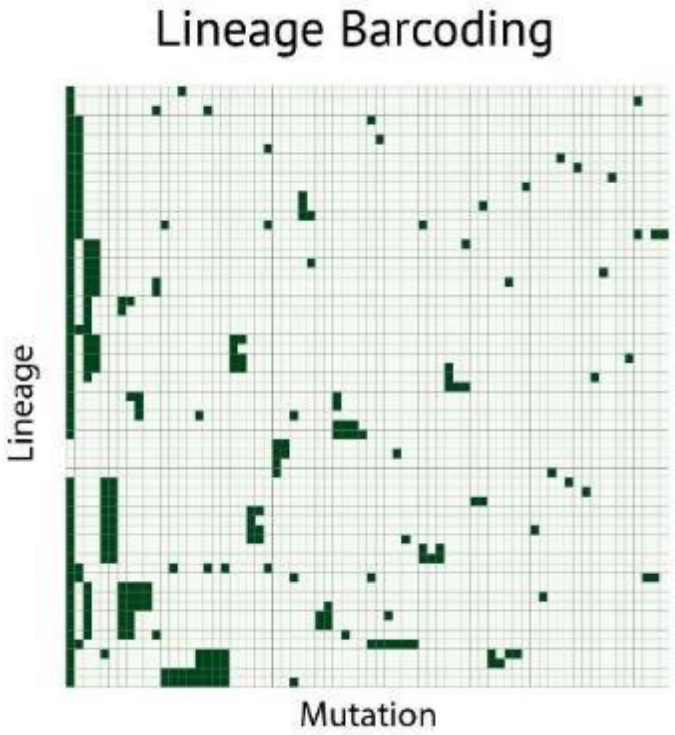
Shannon entropy

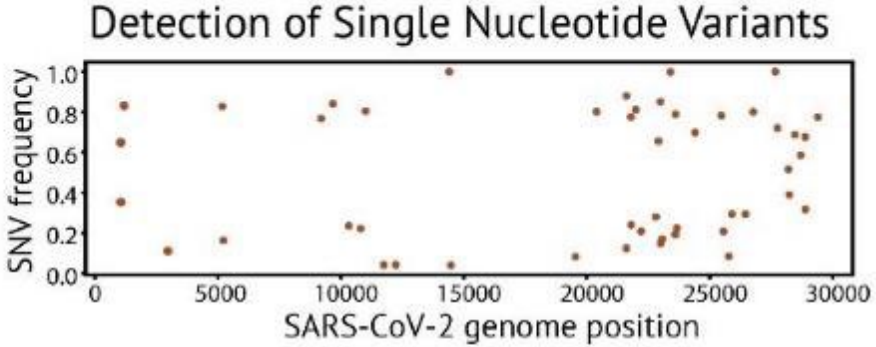




>3000 SARS-CoV-2 lineages

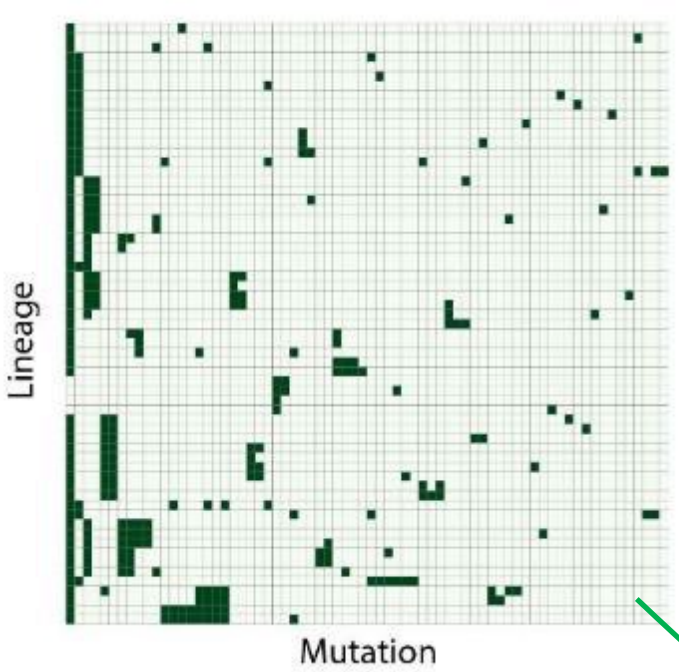
Turakhia et al., 2021





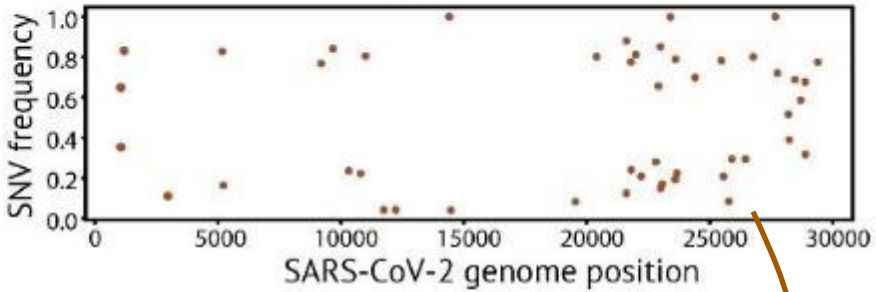
>3000 SARS-CoV-2 lineages

Lineage Barcoding



>3000 SARS-CoV-2 lineages

Detection of Single Nucleotide Variants

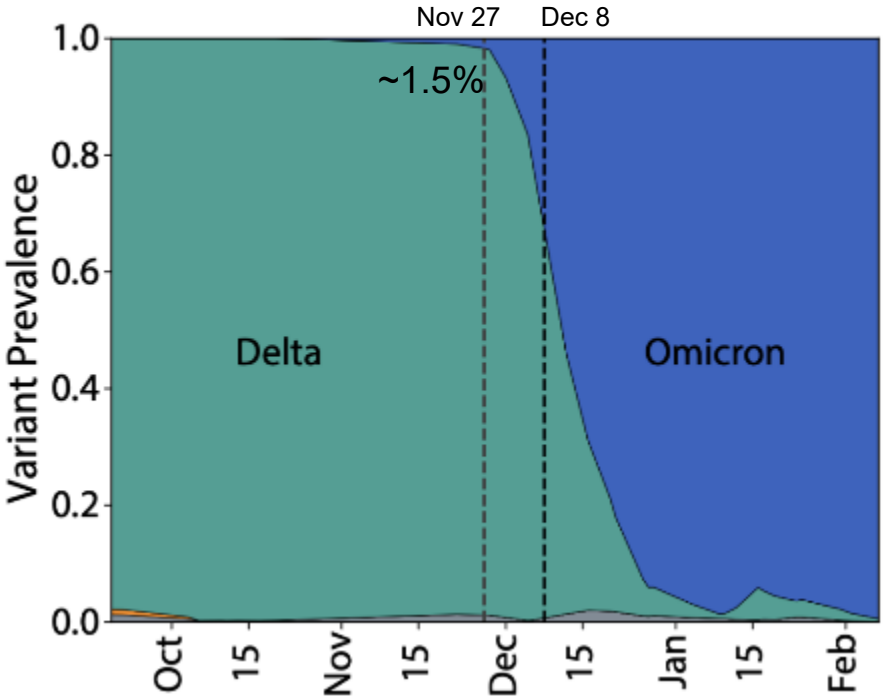


Depth-weighted de-mixing

$$\hat{x} = \underset{\substack{x \geq 0 \\ \sum x = 1}}{\operatorname{argmin}} \; ||A^T x - b||_{1W}$$

FREYJA

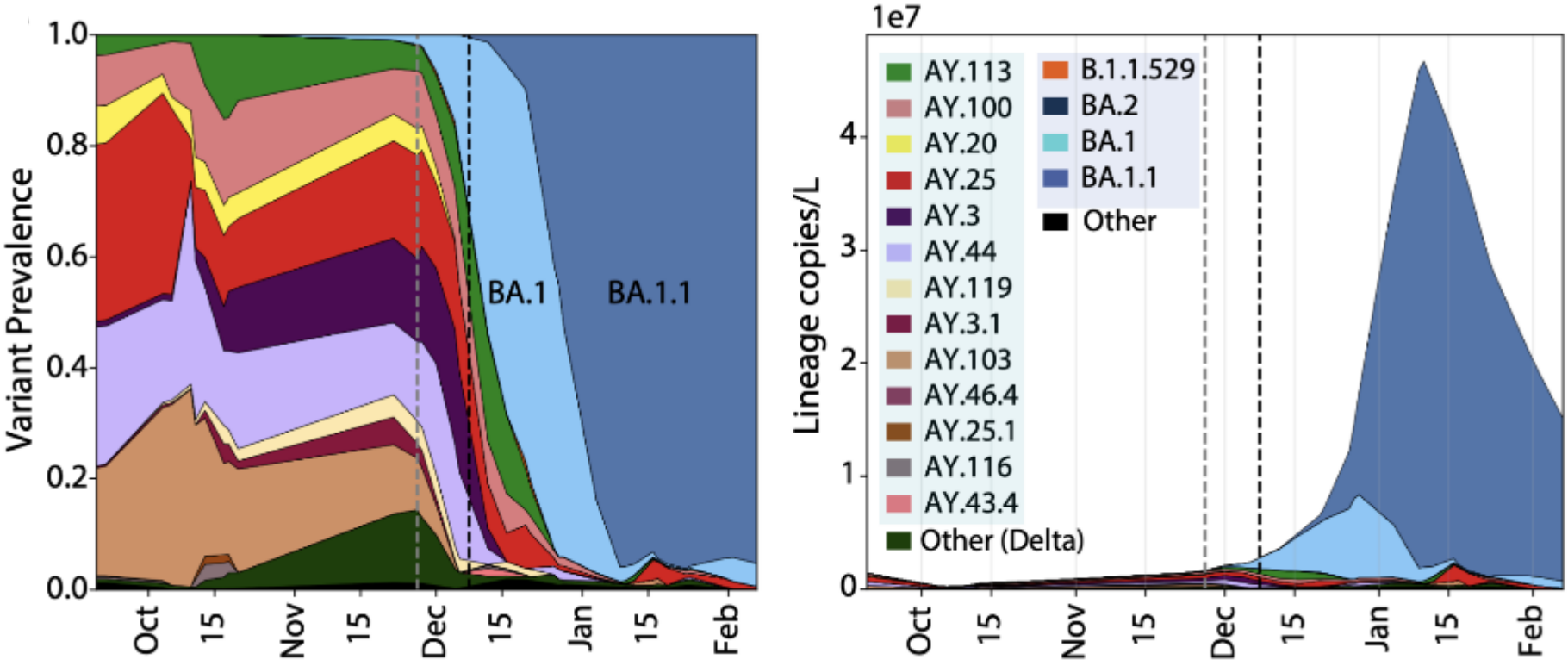
The BA.1 Omicron wave in San Diego



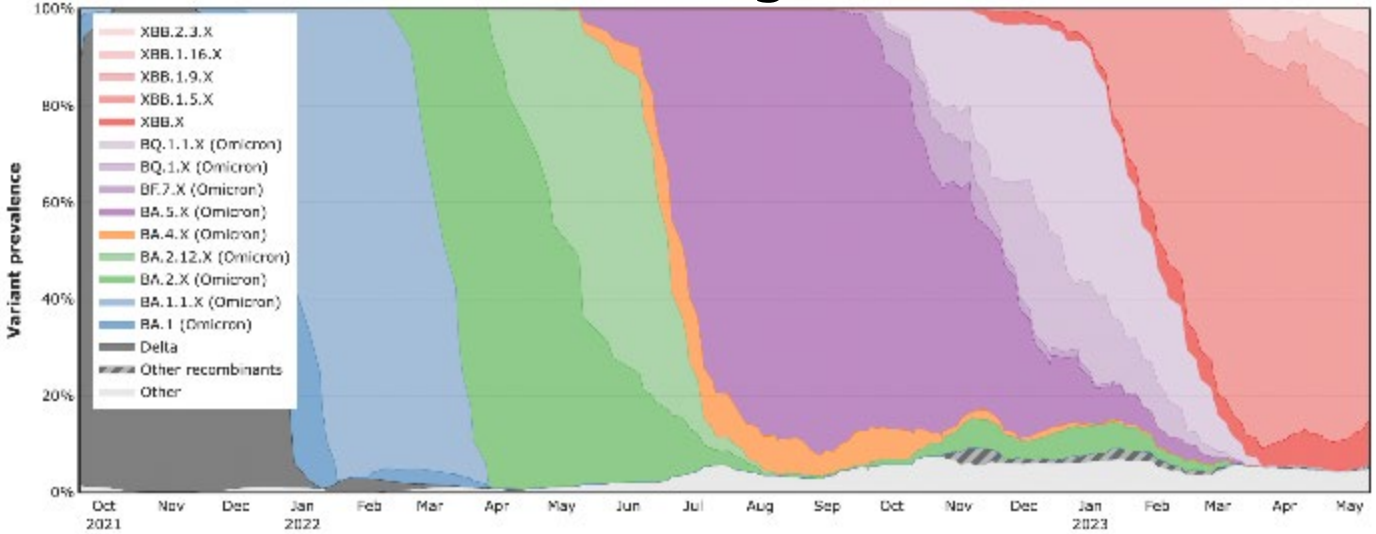
@ Point Loma

~2.3 million individuals in catchment

The BA.1 Omicron wave in San Diego

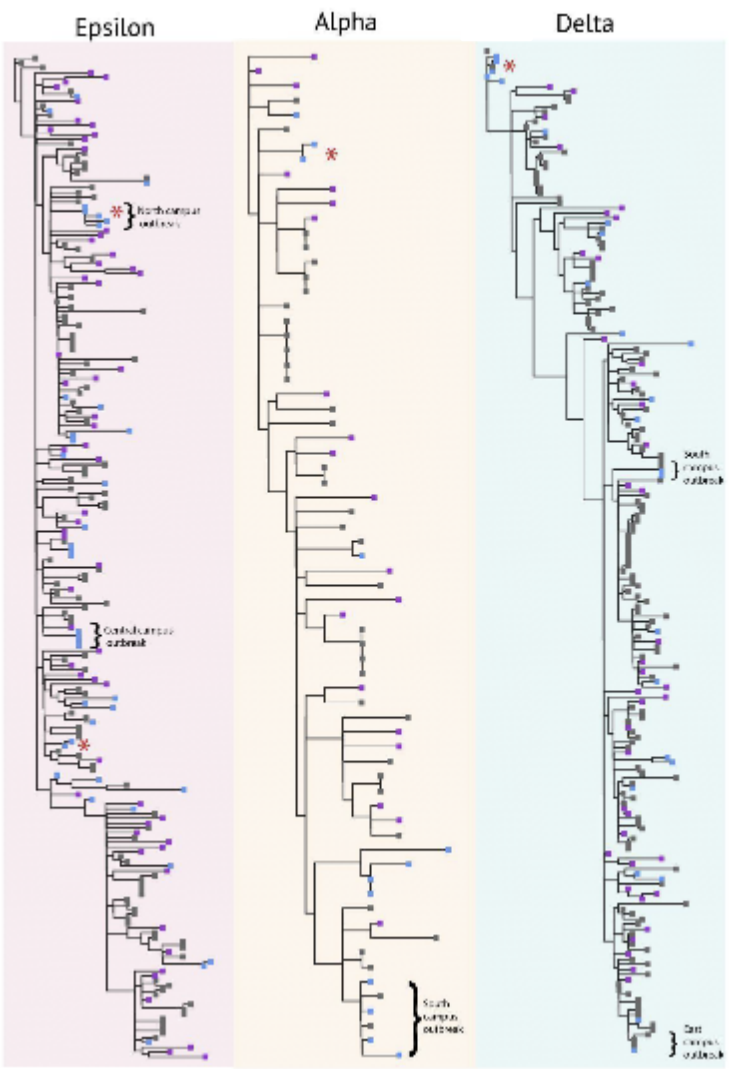


Ongoing real-time surveillance in San Diego

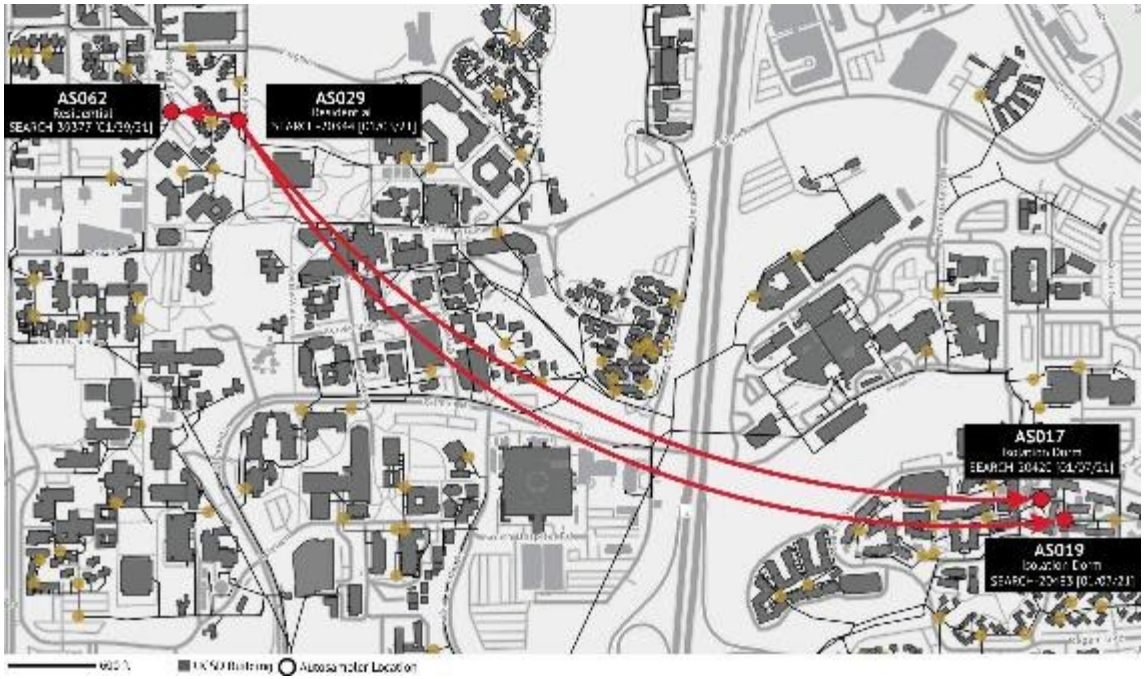


Growth rate estimation from wastewater

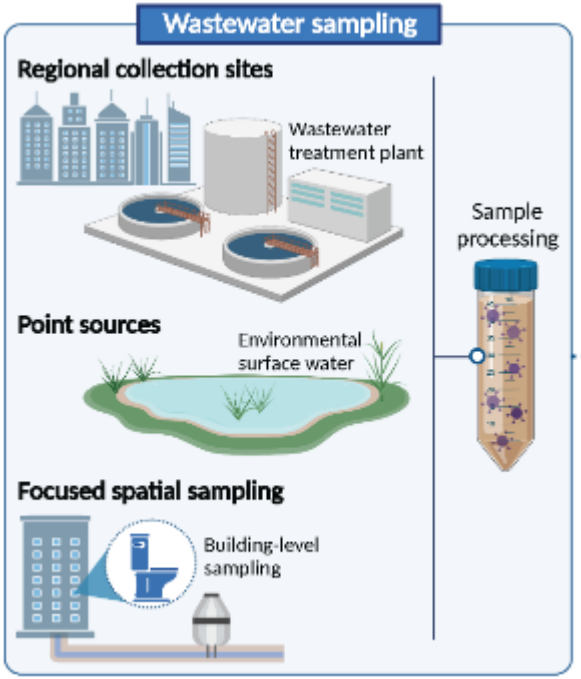
Lineage	Growth Advantage	Bootstrap 95% CI
XBB.2.3.X	15.4%	[3.05% , 32.75%]
XBB.1.16.X	9.0%	[3.29% , 17.37%]
XBB.1.9.X	5.9%	[1.53% , 10.31%]
XBB.X	3.0%	[-4.69% , 9.73%]
XBB.1.5.X	-7.5%	[-10.90% , -3.48%]



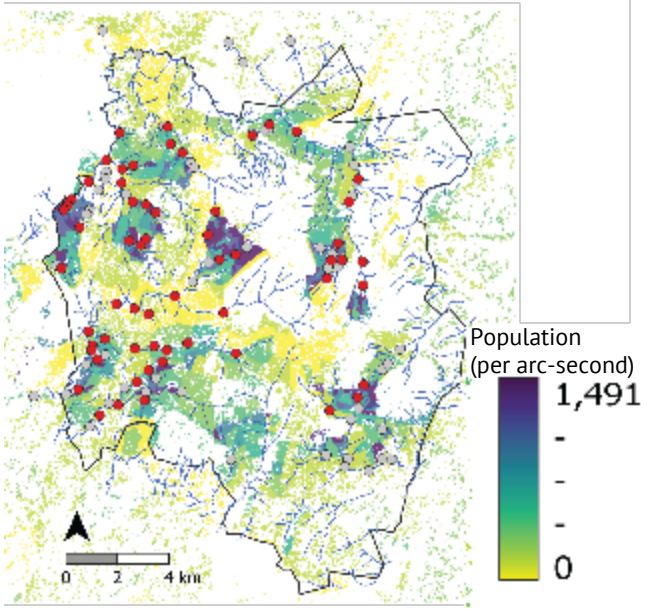
Haplotype recovery, phylogenetics, outbreak tracking



Wastewater surveillance across the world



Wastewater surveillance in Blantyre, Malawi



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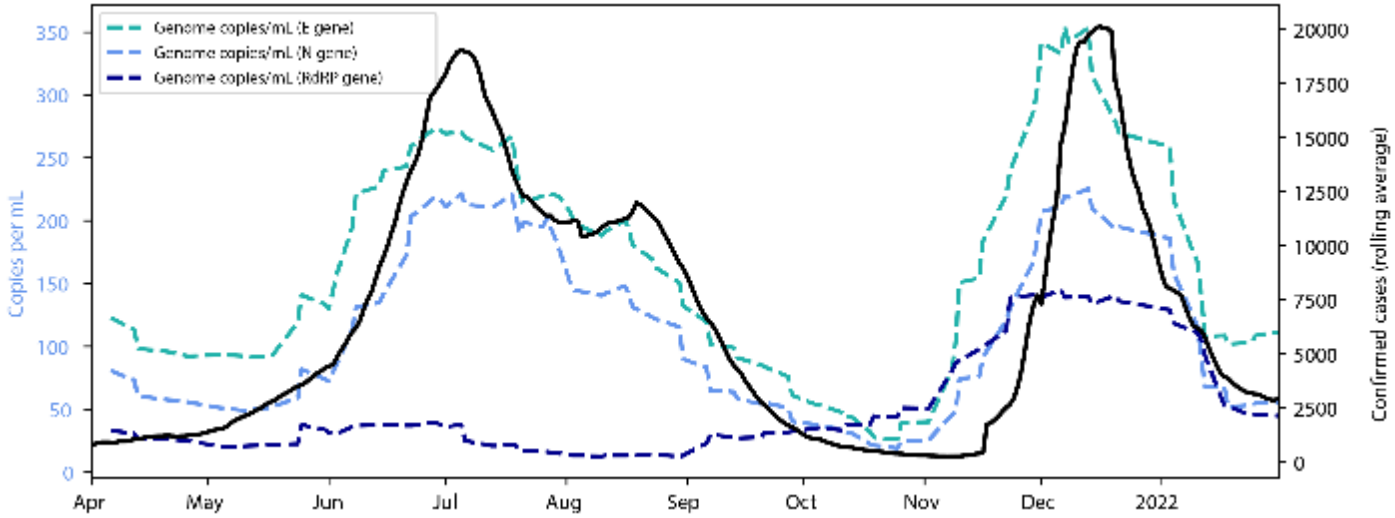
Barnes et al., 2023

Wastewater surveillance in South Africa with NICD



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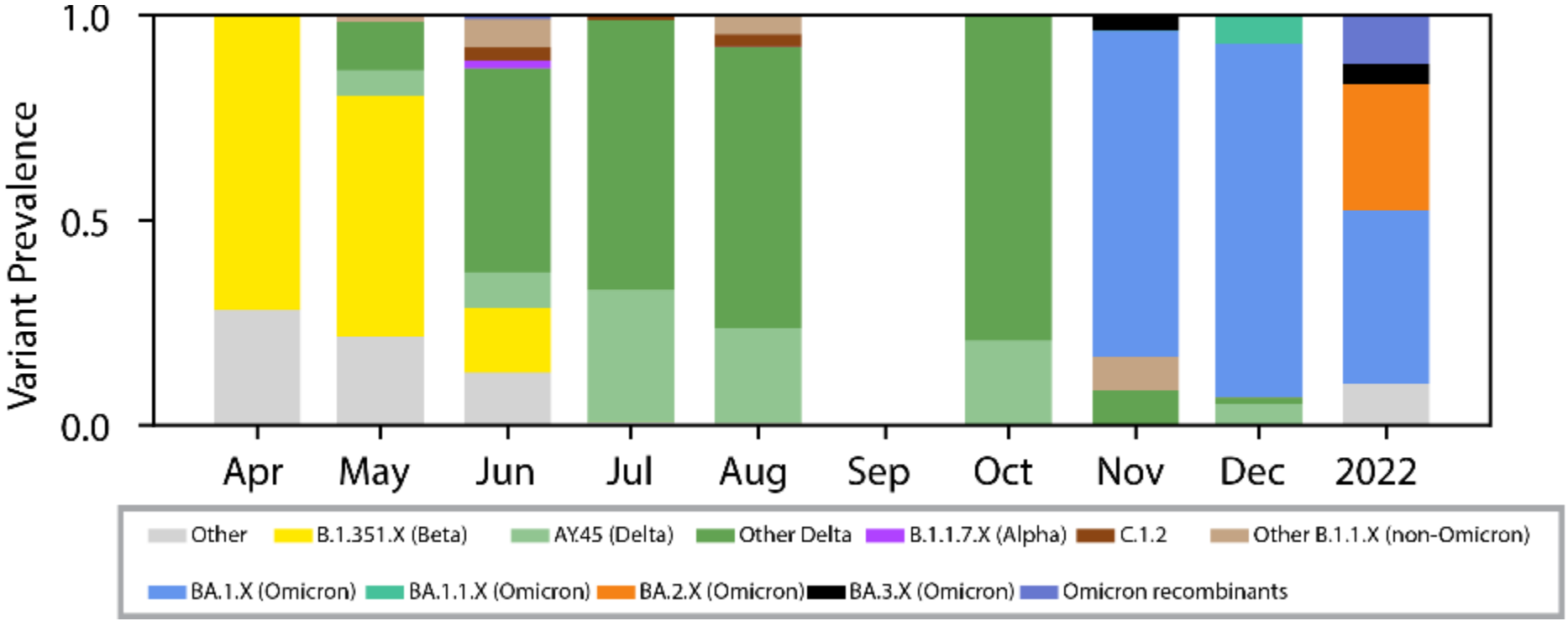
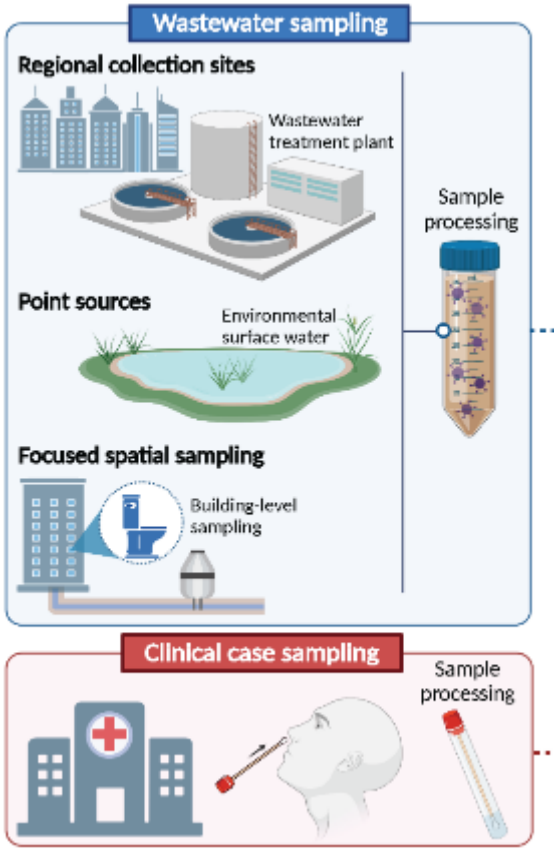
SARS-CoV-2 waves in South Africa via wastewater



Integrated wastewater and clinical surveillance



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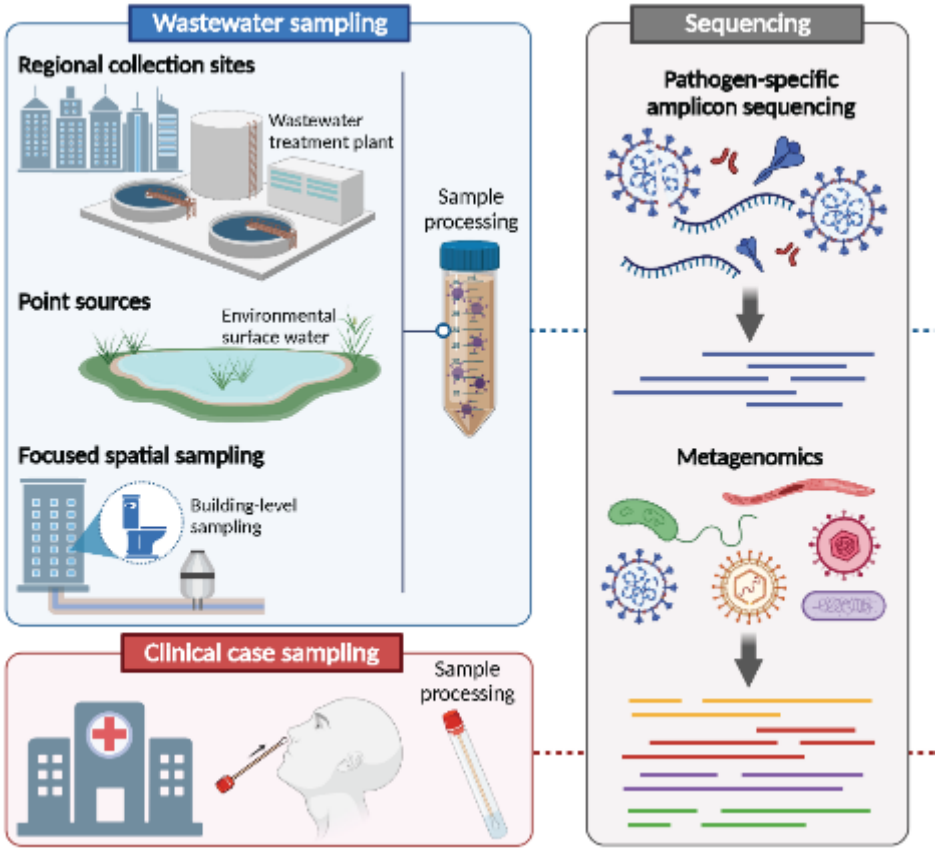

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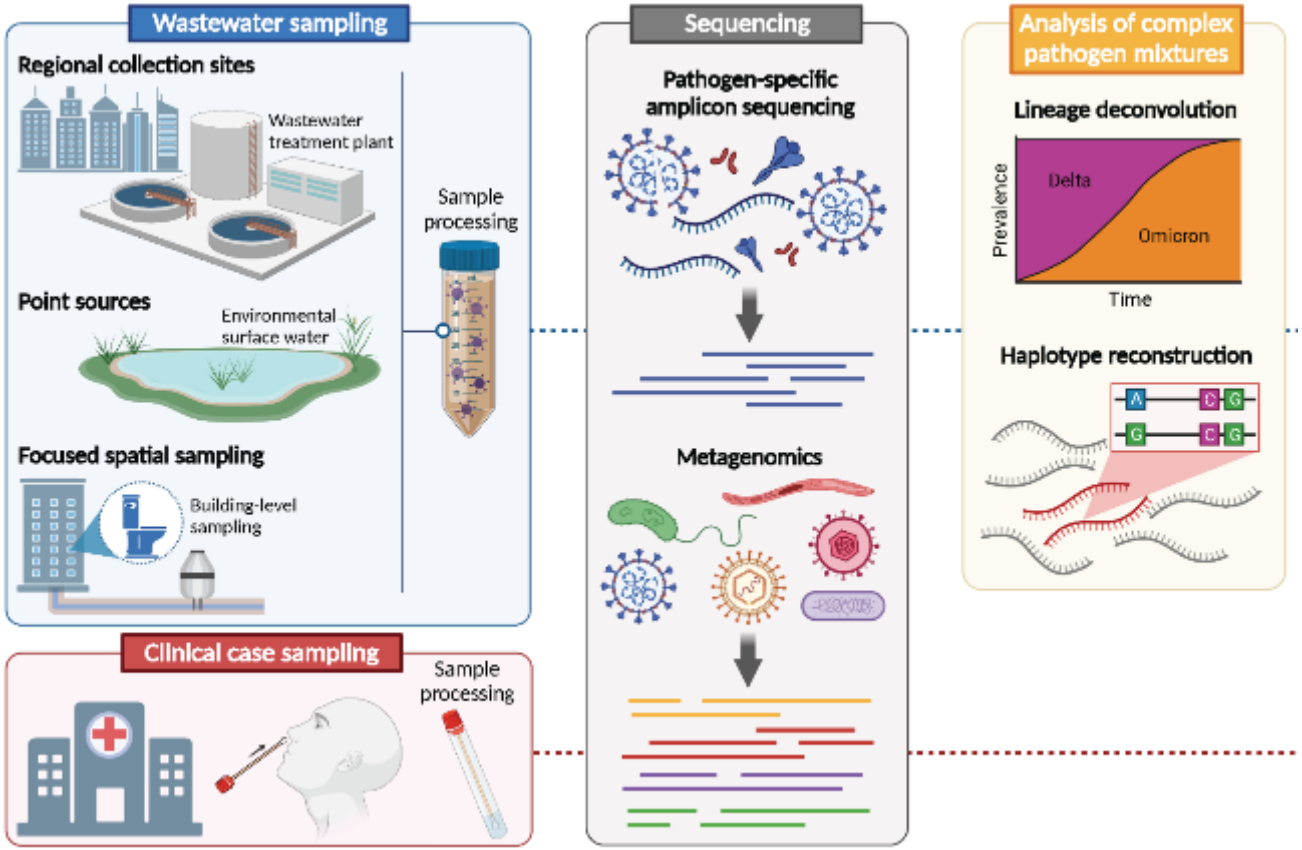

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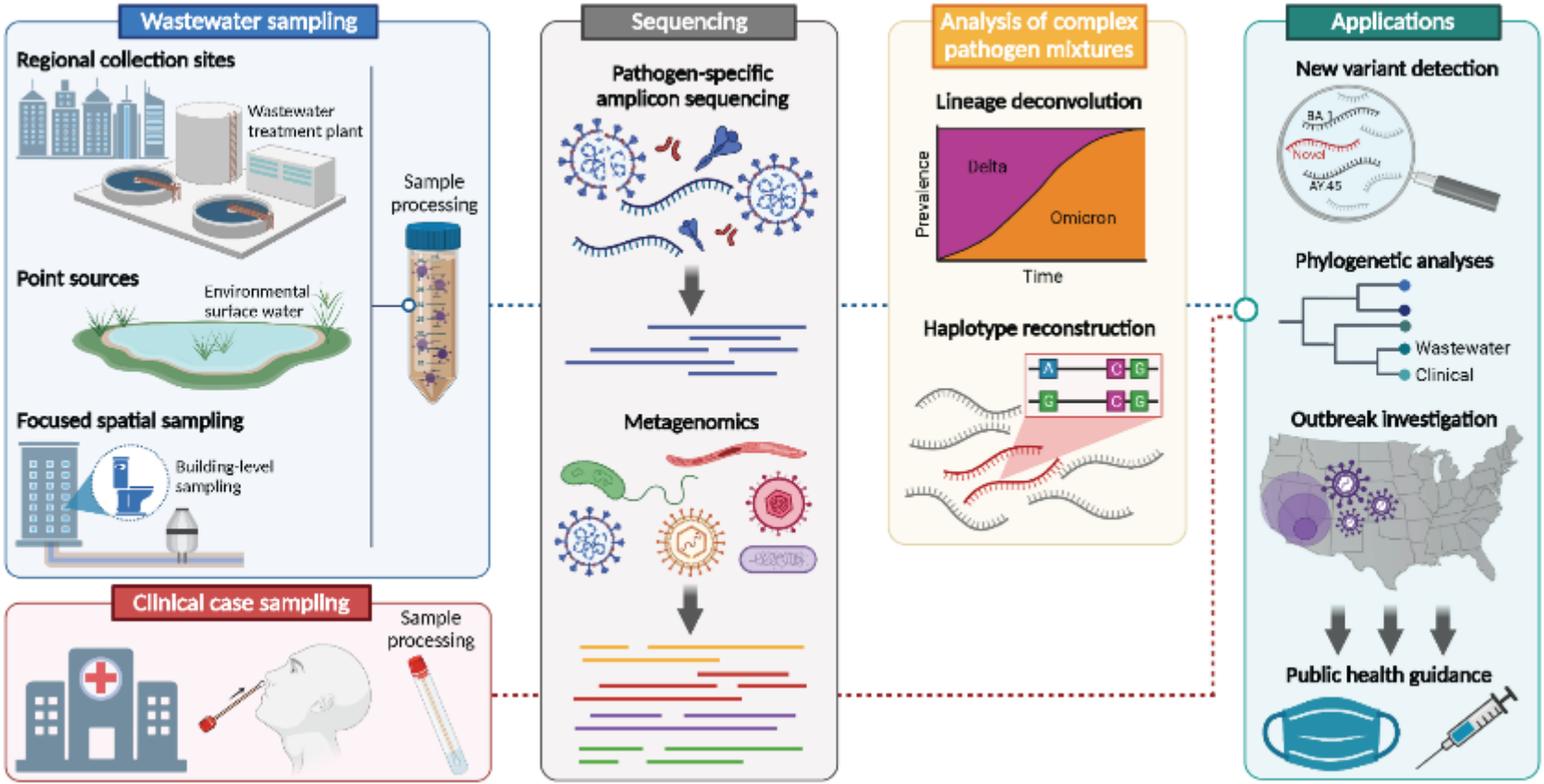

Freyja availability and usage

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>80k downloads

Acknowledgements

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UC San Diego

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CDC U.S. Department of Health and Human Services Centers for Disease Control and Prevention

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