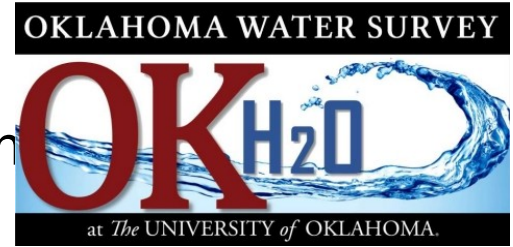




COVID-19 Challenges and Opportunities for the Oklahoma Water Survey

**Jason R. Vogel, Ph.D., P.E.
Director and Professor
September 24, 2021**

Oklahoma Water Survey



One of five *Surveys* currently housed at OU (Archeological, Biological, Clim

Goals:

- Have an ***impact*** on the sustainability of ***Oklahoma's water resources*** by providing ***leadership*** to find solutions for the water challenges facing Oklahoma through research, partnerships, and outside-the-classroom education
- ***Facilitate*** the implementation of University of Oklahoma water-related research solutions into public-policy development and implementation in Oklahoma and beyond (societal impact)
- ***Connect*** the OU faculty, stu

nerships



Monitoring:

- Quantity and Quality: Wastewater; Rivers; Reservoirs; Stormwater; Erosion; Vadose Zone; Groundwater

Outreach:

- Conference organization; Serving on statewide water committees; OU Water Day; Erosion Control Inspector Certification; Workshops

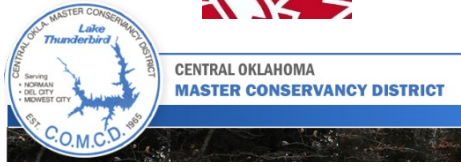
Research:

- Improved Water Quality; Sustainable Water Management; Improved Water Resources Infrastructure

Education:

- Have provided paid outside-the-classroom educational opportunities for over 50 students in over a dozen majors in 4+ years, including 26





Impacts to Work and Mission

• **Monitoring and Research**

• ***Challenges***

- All field and laboratory work halted for two months
- Transportation to the field – two people in a 12-passenger van
- Remote coordination of staff and students
- Staff professional development opportunities are limited

• ***Opportunities***

- New collaborations on monitoring SARS-CoV-2 (and more) in wastewater as an early warning system for COVID-19 cases (more on that later)
- Expanded media coverage of our work



Impacts to Work and Mission

• Outreach

• *Challenges*

- Pause of all in-person outreach workshops, which has not yet resumed
- Pause of state and national water conferences, such as the Oklahoma Governors Water Conference
- Coincided with loss of outreach staff member at the beginning of the pandemic; have not yet rehired because of COVID concerns for in-person workshops

• *Opportunities*

- Zoom workshops and conferences, including a 6-week workshop with professionals on managing stormwater; demand has dropped on this, likely because of Zoom fatigue
- Continue to get requests, so demand is still there.



Impacts to Work and Mission

- **Education**

- **Challenges**

- Lack of in-person mentoring of students
 - Lack of student networking opportunities

- **Opportunities**

- SARS-CoV-2 wastewater project has funded over 25 students who have gained valuable research experiences



OKH₂O

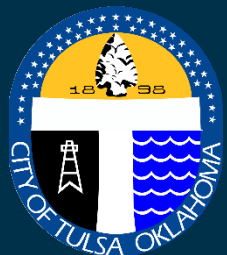


The UNIVERSITY *of* OKLAHOMA



New Opportunity: Monitoring COVID-19 with Wastewater

University of Oklahoma Sewage Surveillance Team



OU Sewage Surveillance Team



Dr. Katrin Kuhn
Assistant Professor of
Biostatistics &
Epidemiology, Hudson
School of Public
Health, OU Health

Dr. Jason Vogel
Professor, School of Civil
Engineering &
Environmental Science;
Director, Oklahoma Water
Survey, OU-Norman

**Halley Reeves, MPH,
MCP**
Vice President, Community
and Rural Health Impact,
OU Health

Dr. Bradley Stevenson
Associate Professor,
Microbiology, OU-
Norman

Not pictured:
Dr. Bryce Lowery
Associate Professor,
Regional and City
Planning
Dr. Madison Swayne
Assistant Professor, City
Planning, San Diego
State University

Not pictured:
Dr. Graham Wiley
Manager, Sequencing
Core Facility
OMRF

Multi-Disciplinary Team	Working with 5 Oklahoma Municipalities
First Group in Oklahoma Monitoring Sewage	Monitoring at Different Scales



Wastewater-based Epidemiology

Detection of Polio since the 1940s

- Israel began monitoring wastewater for polio in 1989.
- In 2013, indication of an outbreak was detected, authorities swept in to



Early warning for potential hotspot identification for substance abuse



Wastewater Based Epidemiology

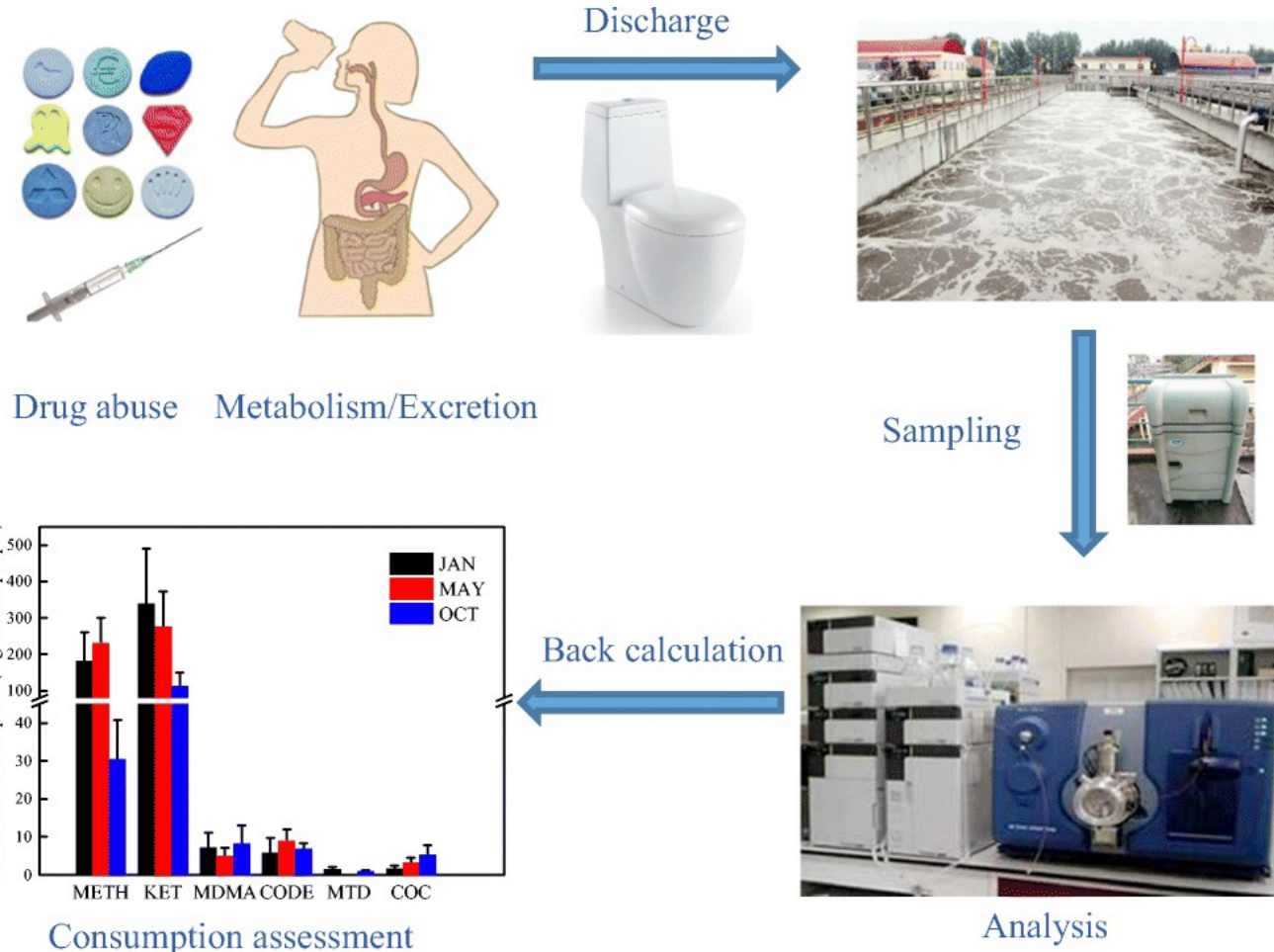
Detection of Polio since the 1940s

- Israel began monitoring wastewater for Polio in 1989.
- In 2013, indication of an outbreak was detected, authorities swept in to mitigate.

Monitoring Illicit Drug Use (est. 2001)

Zhang, X., Huang, R., Li, P. et al. Temporal profile of illicit drug consumption in Guangdong, China monitored by wastewater-based epidemiology. *Environ Sci Pollut Res* 26, 23593–23602 (2019). <https://doi.org/10.1007/s11356-019-05575-8>

Early warning for potential hot spot identification for substance abuse



Sewage Surveillance Benefits

Timely

Geographic
ally and
Functionally
Representat
ive

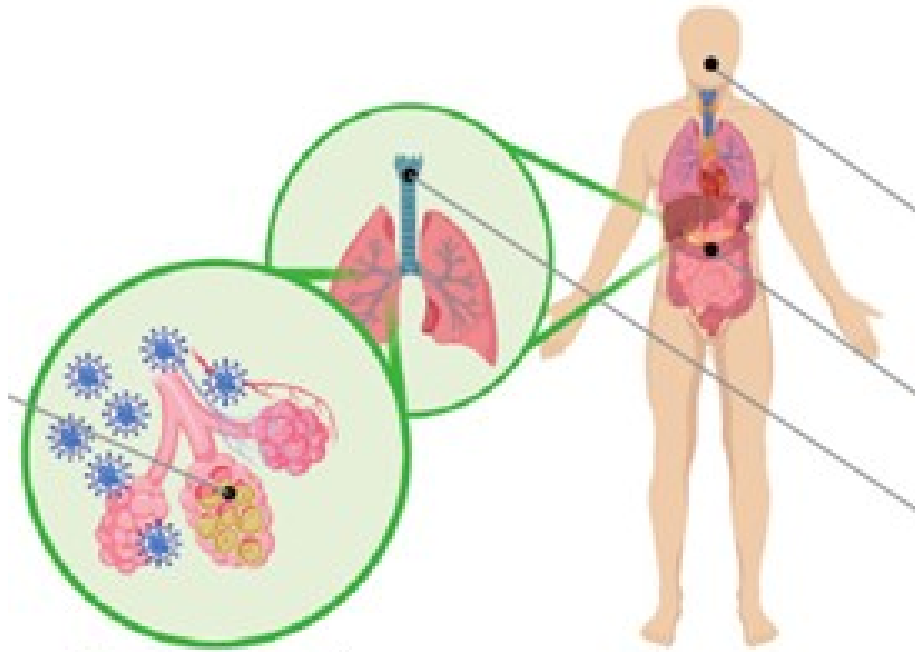
Unbiased
by
Individual
Testing

Cannot
Isolate
an
Individual

OK_{H₂O}

A decorative graphic at the bottom of the slide featuring a blue water splash that curves across the width of the page. The splash is composed of many small droplets and bubbles, creating a dynamic, flowing effect.

The SARS-CoV-2 virus is shed during infection



	Concentration (Maximal observed values following diagnosis)
Nasopharynx	$10^6 - 10^9$ RNAs / swab
Throat	$10^4 - 10^8$ RNAs / swab
Stool	$10^4 - 10^8$ RNAs / g
Sputum	$10^6 - 10^{11}$ RNAs / mL

OKH₂O

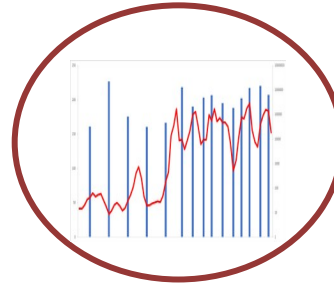
Overview: Sewage Surveillance



Discharged



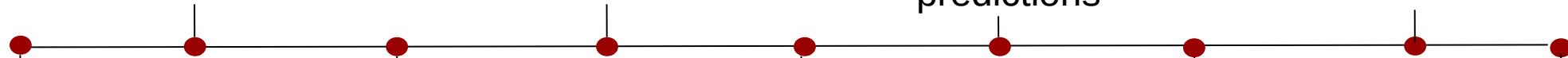
Sampling



Epidemiological correlations & predictions



Sample Archive



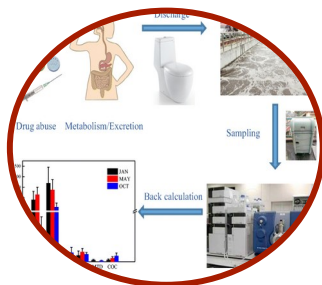
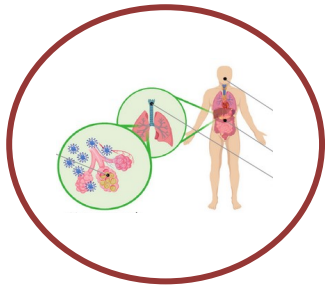
Metabolism & Excretion

Found in Sewage

Analysis

Sequencing

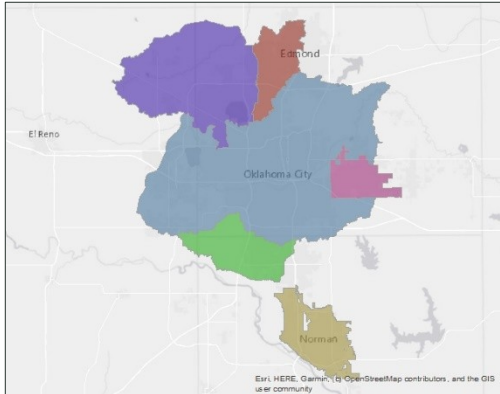
Public Health Response



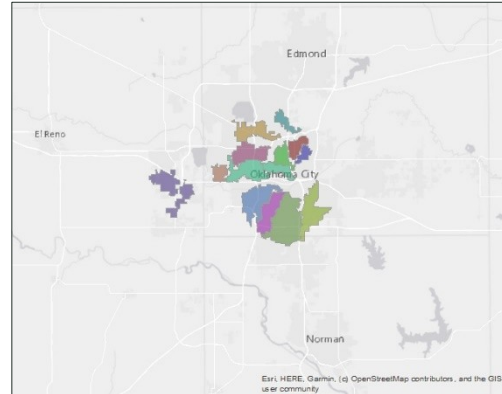
Citation: Modified from Zhang, X., Huang, R., Li, P. et al. Temporal profile of illicit drug consumption in Guangzhou, China monitored by wastewater-based epidemiology. Environ Sci Pollut Res 26, 23593–23602 (2019). <https://doi.org/10.1007/s11356-019-05575-3>

OKH₂O

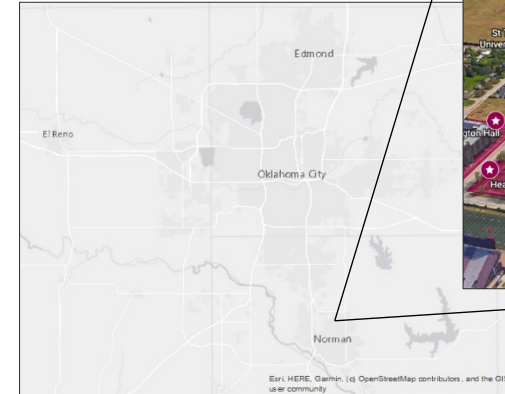
Monitoring is Scalable



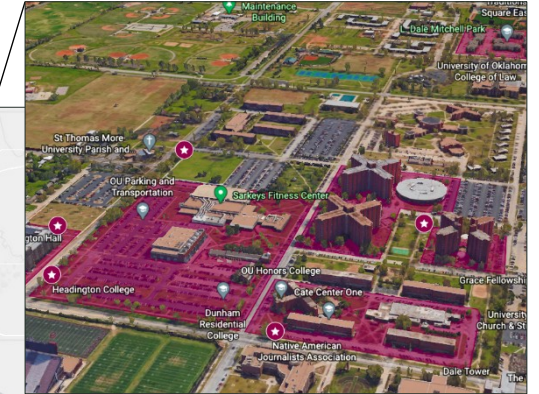
Community
Scale:
Wastewater
Treatment
Facilities



Neighborhood
Scale: Sub-
sewershed



Facility Scale:
OU Norman
Dormitories



Sewage Surveillance Process

The quest for representative

samples
Sample
Collection



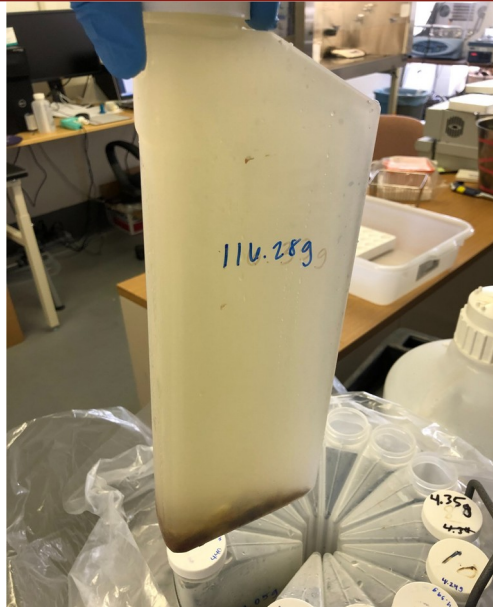
OK_{H2O}

Sewage Surveillance Process

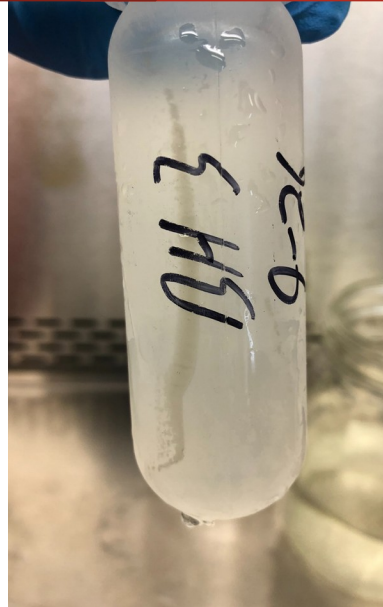
Analysis of representative samples

Sample
Collection

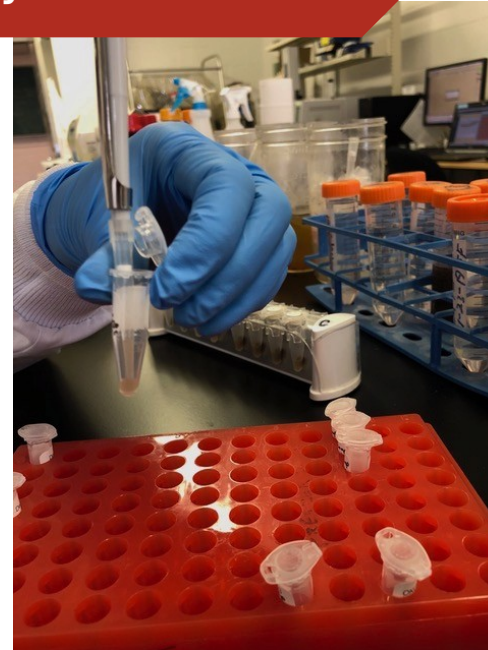
Sample
Analysis



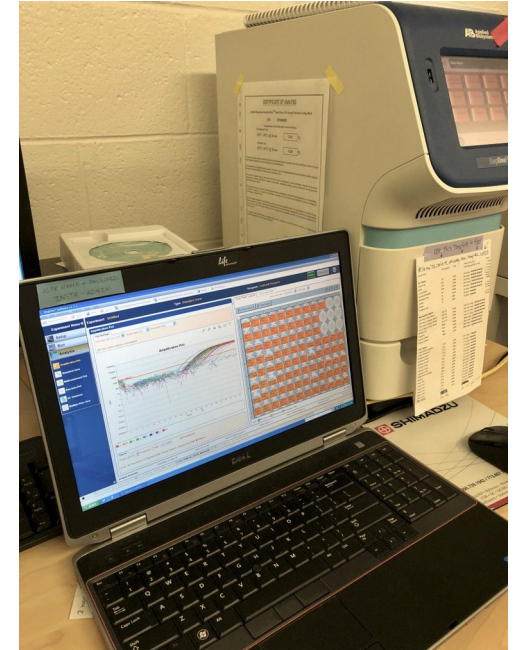
Prepare
Sample



Concentrate
Virus



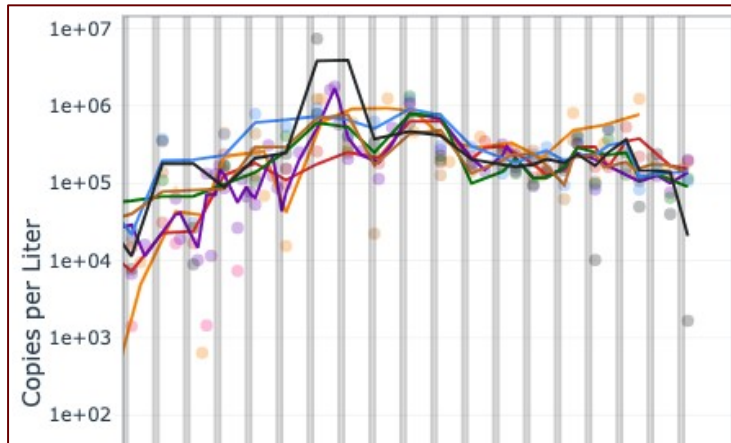
Extract and Purify
Genetic Material



Quantify Virus
by RT-qPCR

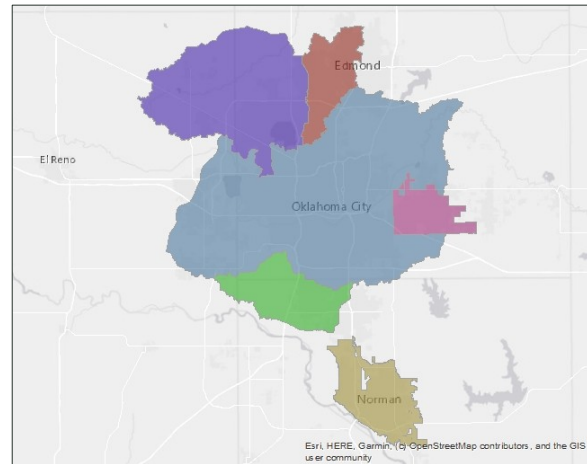
Sewage Surveillance Process

Sample
Collection



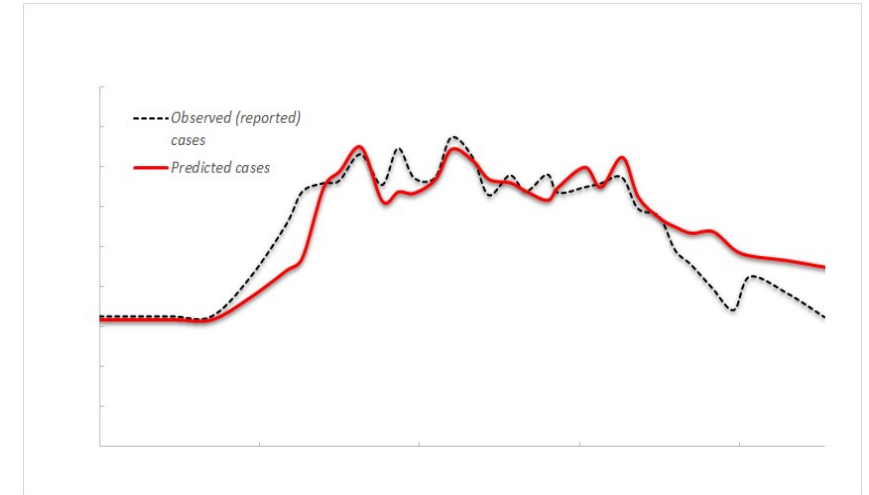
Concentrations of
SARS CoV-2

Sample
Analysis



Extrapolation
to Population

Population Level
Extrapolation



Modeling /
Predictions

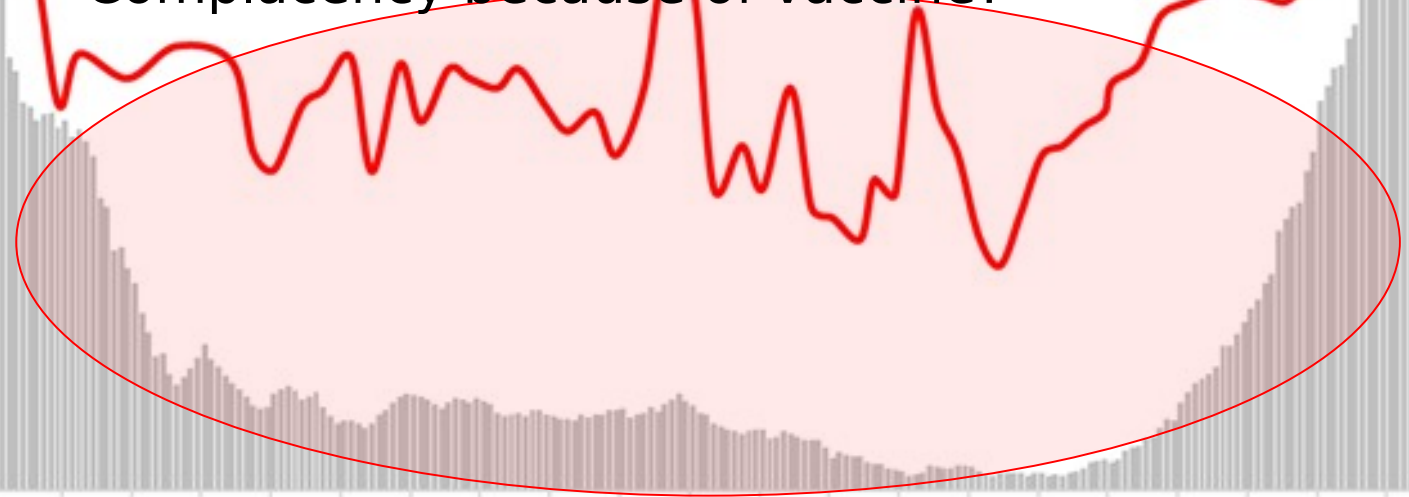
OKH₂O

Sewage predicts COVID cases...

■ Reported COVID-19 cases
— Sewage-driven predicted COVID-19 cases

7 days before they are reported!

Sewage predicts more cases than reported during the summer
Discrepancy = Lack of testing?
Complacency because of vaccine?



Oct Jul Nov Aug Dec Jan Feb Mar Apr May Jun

Next Steps for the OU Sewage Surveillance Team

- Monitoring more Communities – create a statewide network
- Expand our palette of wastewater-based epidemiology targets.

Viruses

SARS-CoV-2
Influenza (all types)
Norovirus
Hepatitis (A and B)
West Nile Virus (*urine*)
Zika virus (*urine*)
Dengue virus (*urine*)

Bacteria

Salmonella spp.
Campylobacter spp.
E.coli spp.
Listeria
monocytogenes
Vibrio spp.
Shigella spp.
Clostridium difficile
Bacillus anthracis

Chemicals & Other

Opioids
Cannabis
MDMA (Ecstasy)
Methamphetamine
Antihistamines
Antimicrobial
resistance
Cholesterol

???

OK H₂O

Future of the Oklahoma Water Survey in response to COVID-19?

- Reinvigorate in-person outreach program
- Find a new and improved physical space to match our expanded team and goals
- Continue connecting students with the Oklahoma water community at statewide conferences when they resume



OK H₂O

Future of the Oklahoma Water Survey in response to COVID-19?

- Create a public dashboard and publish our COVID-19 work to share methods and successes
- Expand sewage surveillance network, including for other pathogens, opioids and other illicit drugs
- Further collaborations with researchers at OU and beyond
 - NSF Predictive Intelligence for Pandemic Prevention Proposal
 - Rockefeller Foundation Pathogen Panel Development Proposal



OKH₂O

Thank you for your contributions

The OU Sewage Surveillance Team



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