Potential Presence of and Risks from COVID-19 in Water

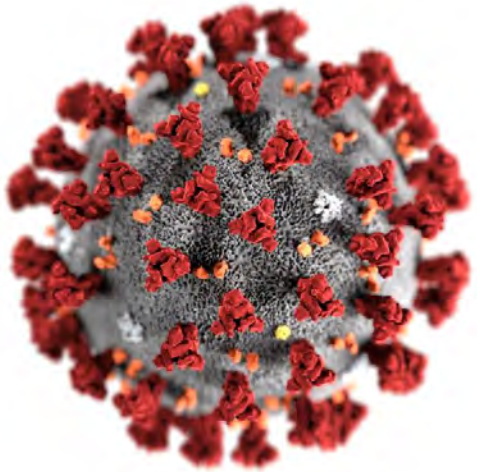
September 29, 2020

Speakers and Panelists

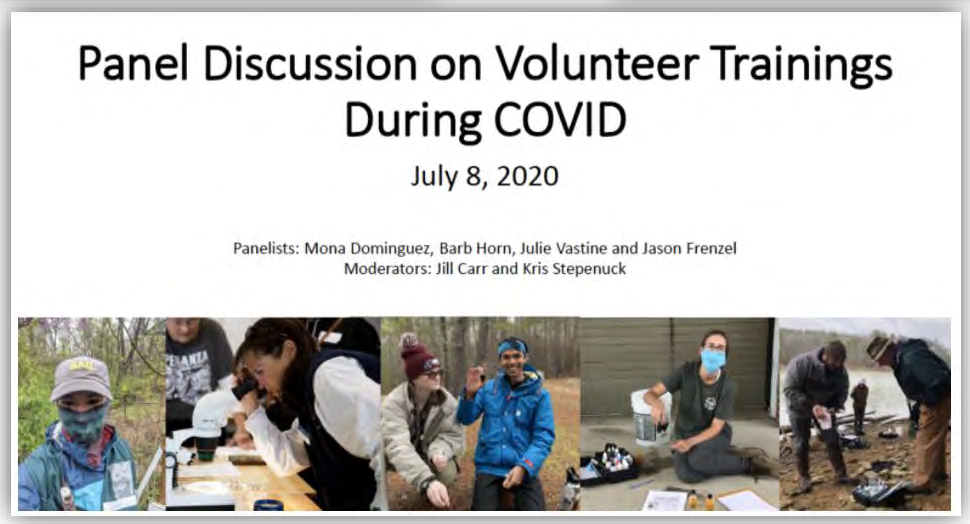
Sam Chan, Linda Tucker Serniak, Winnie Kong, Tania Siemens, Daniel Arisa, Aaron Cathcart
(Oregon SeaGrant)

Moderators

Jill Carr (MassBays) and Kris Stepenuck (UVM / VT SeaGrant)



Building on previous work



http://volunteermonitoring.org/covid

Agenda

- Introductions / Polls
- Speakers: 50mins
- Q & A: 30mins

Housekeeping

- We are recording
- You are automatically muted
- Use Q&A box for panelist Q's
- Use chat box for intros/discussion among participants
- Real-time captioning – link in chat

http://volunteermonitoring.org/covid

Our Speakers & Scientists

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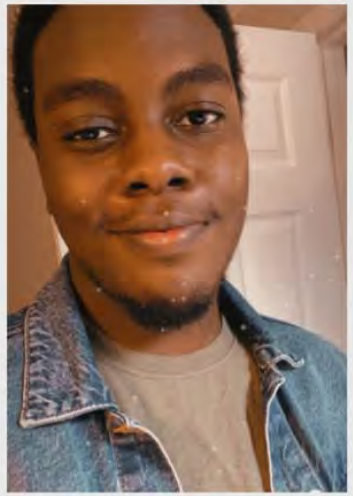
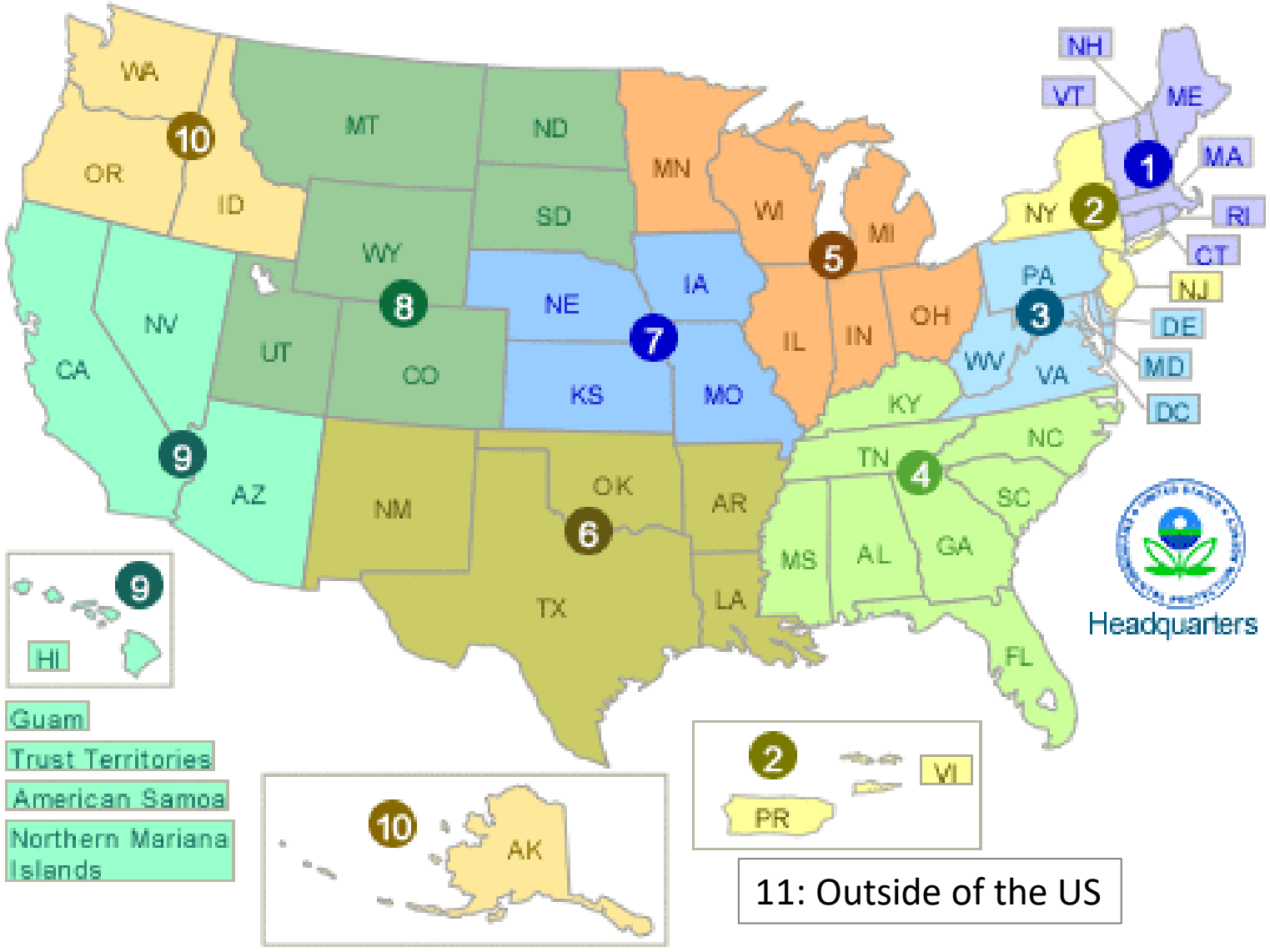
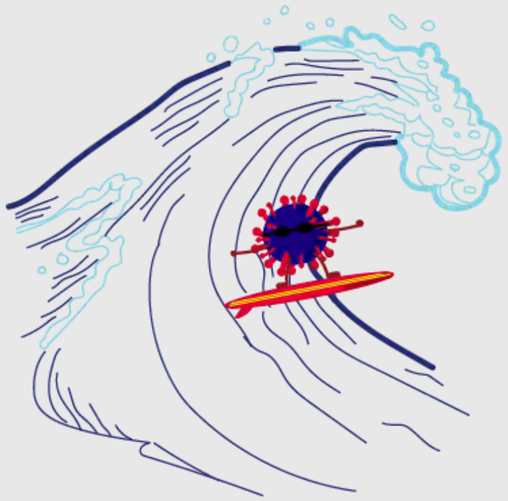


DANIEL ARISA
GREEN RIVER COLLEGE

Poll: Getting to Know One Another

- Identify your
  - EPA region
  - Monitoring focus
  - Affiliation





Potential Presence of and Risk from Covid-19 in Water

PRESENTED BY OREGON SEA GRANT
AT THE UNIVERSITY OF VERMONT "ENGAGING IN COMMUNITY SCIENCE AND WATER MONITORING DURING TIMES OF COVID-19" WEBINAR SERIES
SEPTEMBER 29, 2020

Sea Grant Oregon
Oregon State University
Massachusetts Bays National Estuary Partnership
University of Vermont Extension
Sea Grant Lake Champlain

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THE PLAN

COVID Risk Concerns

- Why are we interested in COVID in water environments
- Early precautions for preventing the spread of COVID-19
- What we know and do not know about COVID transmission

Knowns and Uncertainties about COVID in the Water

- Transmission of diseases in water
- Survival of SARS-CoV-2 in water environments
- Aerosolization of the virus
- Ongoing research and outreach

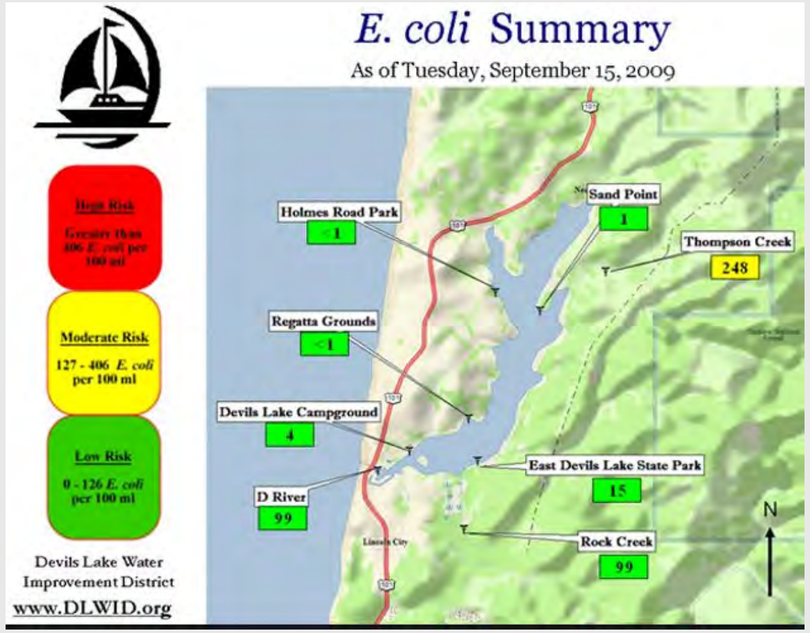
Collaboration and Next Steps

- Research needs
- Precautionary principle
- Precautions for water monitoring and recreation
- Collaborative research and outreach opportunities

Devil's Lake on the central Oregon Coast with arguably the world's shortest estuary to the ocean had frequent water quality alerts for *E-coli* from failing septic systems and cyanobacteria (HAB) blooms

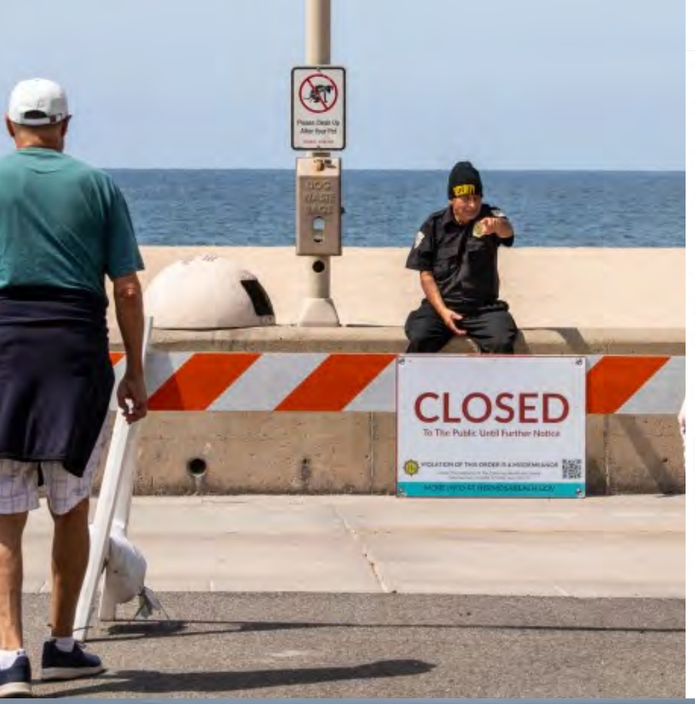
Note: a low pressure sewer line was completed in 2017 enabling volunteer hook-up

Monthly HABs and E-Coli Surveillance



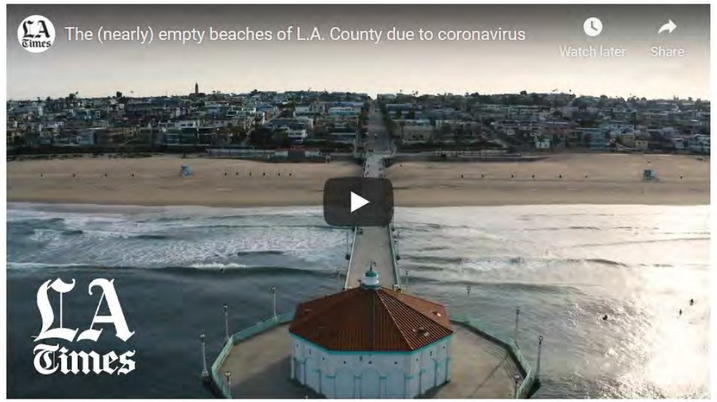
HABs

Harmful Algal Bloom Surveillance



Los Angeles Times

Scientists are unsure of coronavirus effects at the beach



By ROSANNA XIA | STAFF WRITER

APRIL 2, 2020 | 7 AM **UPDATED** 7:18 AM

Kim Prather, a leading atmospheric chemist at the Scripps Institution of Oceanography, wants to yell out her window at every surfer, runner, and biker she

CORONAVIRUS AND PANDEMIC ›

There's a pandemic, but home prices are at record levels in Southern California

Here's how schools in other countries are handling reopening

In Israel, the Jewish High Holidays clash with a new coronavirus lockdown

If you absolutely have to fly right now, here's how to do it as safely as possible

Sweden has escaped a second coronavirus wave so far. The question is why

Cases statewide »

808,922	15,601
confirmed	deaths

AEROSOLS IN THE COASTAL ENVIRONMENT

The combination of intense waves and winds can generate aerosol to transport microbes (ex. E. coli), pathogens, and/or viruses to extreme lengths.

Water droplets from an infected person through sneezing or coughing can transfer between the water and air and onto another person

AEROSOLS GENERATED FROM A FRESHWATER OUTFLOW

THE PRECAUTIONARY PRINCIPLE

"...applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen..."

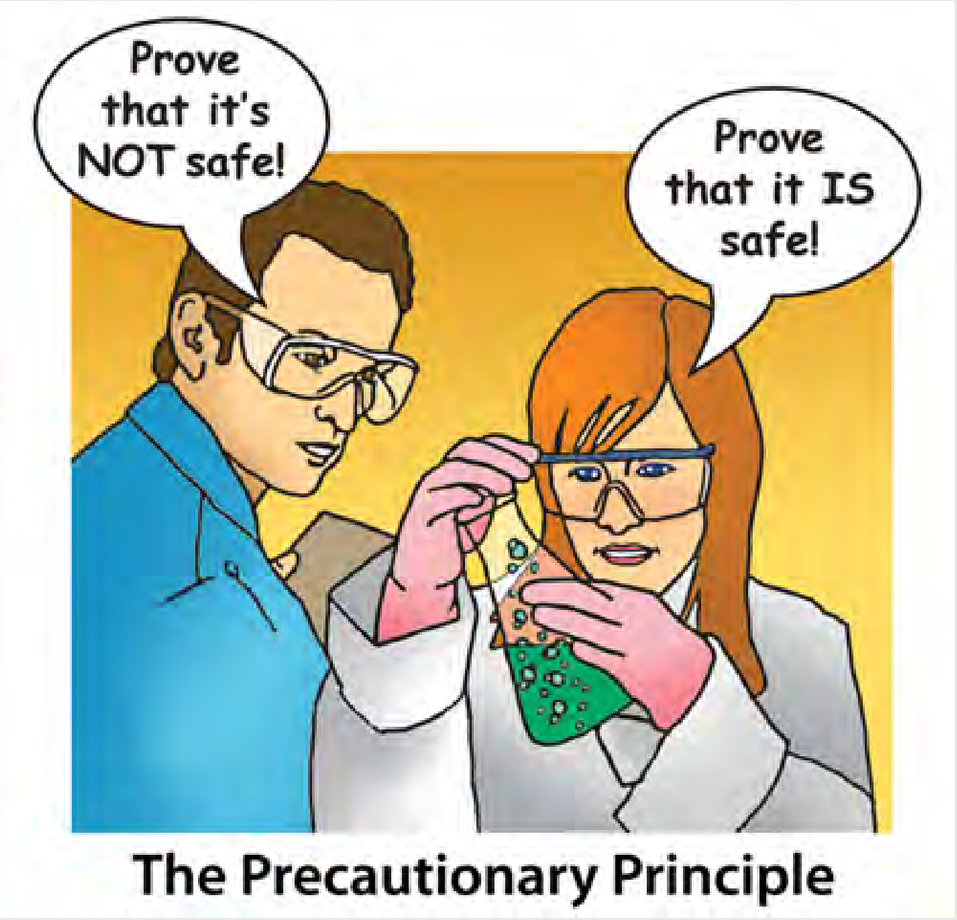


Image Credit: Imperial College London

February 2, 2000: European Commission Communication on the Precautionary Principle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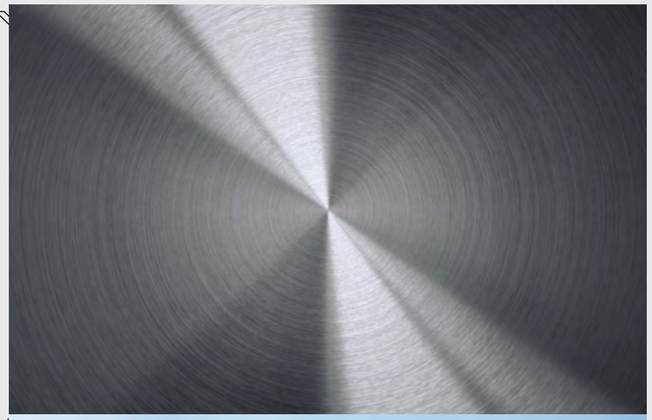
Oregon
EARLY IN THE PANDEMIC

FOCUS ON CATCHING COVID-19 FROM SURFACES

EARLY PREVENTION FOR CATCHING COVID-19 FROM SURFACES

PRINTING AND TISSUE PAPERS AFTER A 3-HOUR INCUBATION

STAINLESS STEEL DAY 7



TREATED WOOD AND CLOTH ON DAY 2

PLASTIC ON DAY 7

TREATED SMOOTH SURFACES ON DAY 4 (GLASS AND BANKNOTE)

DETECTABLE LEVEL OF INFECTIOUS VIRUS STILL PRESENT ON THE OUTER LAYER OF A SURGICAL MASK ON DAY 7

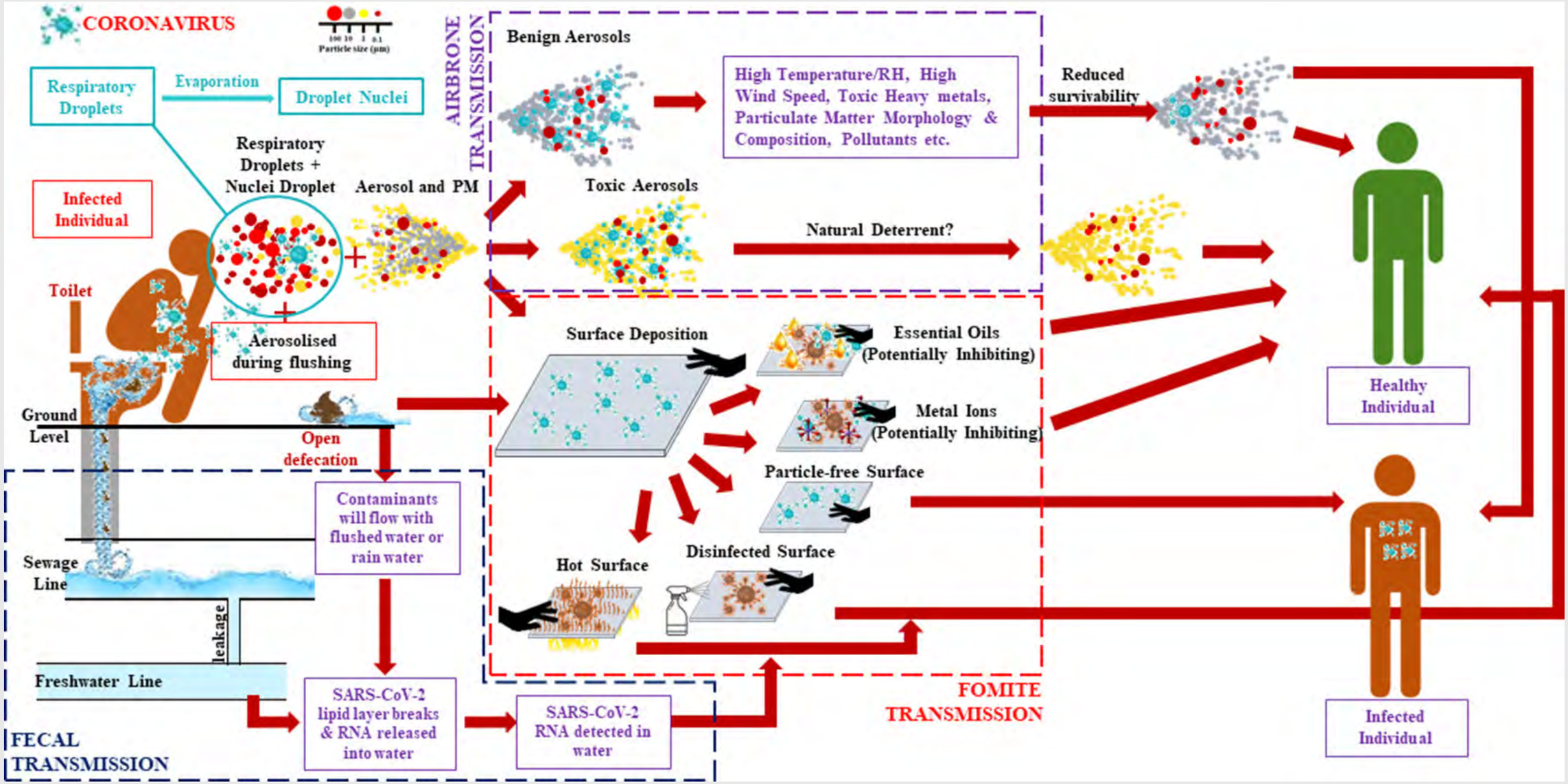
TRANSMISSION VIA AEROSOLS

New evidence suggests aerosols are the main transmission of COVID-19 instead of surfaces.

Aerosol is a suspension of fine solid particles or liquid droplets in air or another gas (0.01 - 10 microns)

El Baz & Imziln 2020
Morawska & Cao 2020
Prather et al. 2020
Setti et al. 2020
Stadnytskyi et al. 2020

COVID TRANSMISSION- FECAL TO ORAL AND AIRBORNE



From Wathore et al. 2020

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KNOWNS AND UNCERTAINTIES ABOUT COVID IN THE WATER ENVIRONMENT

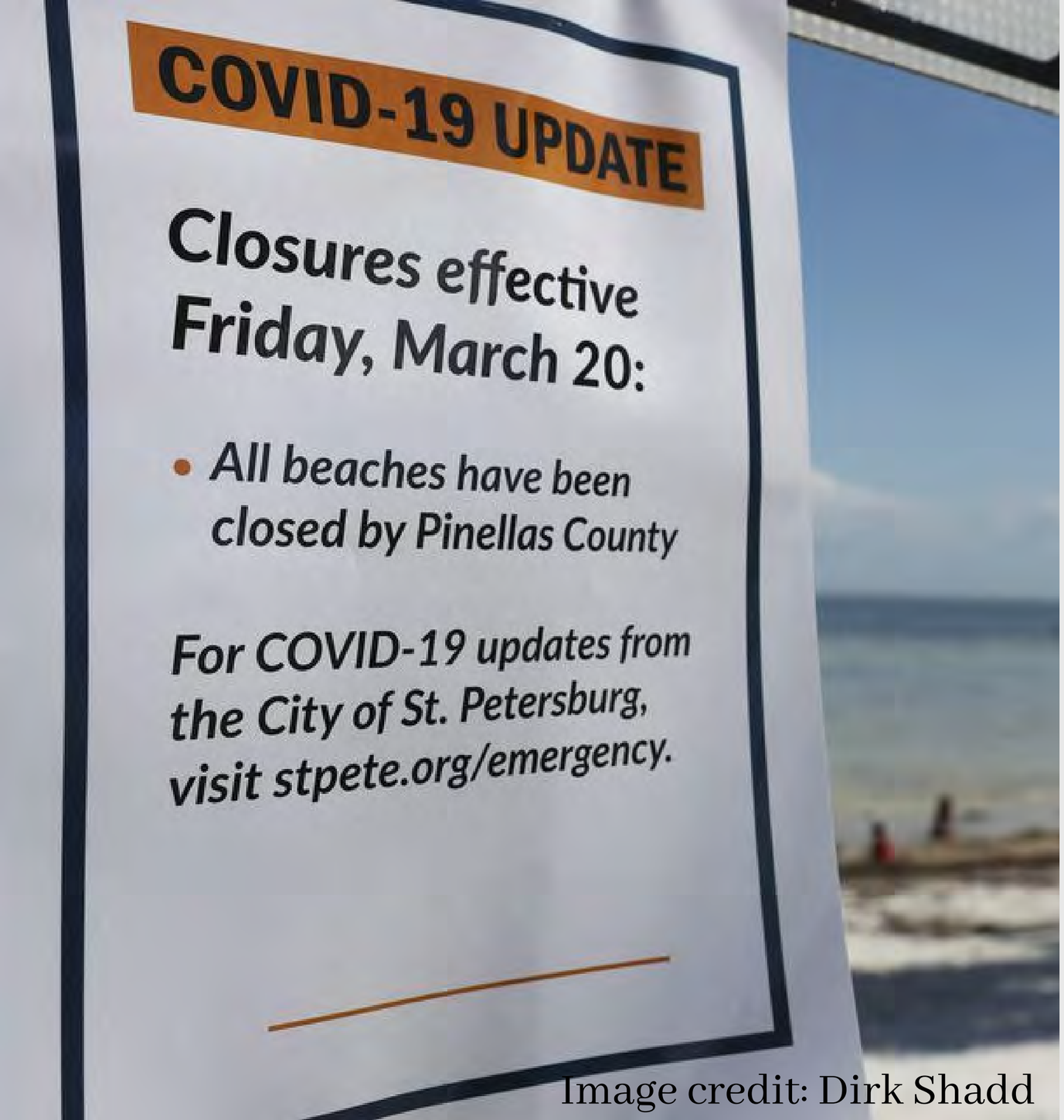


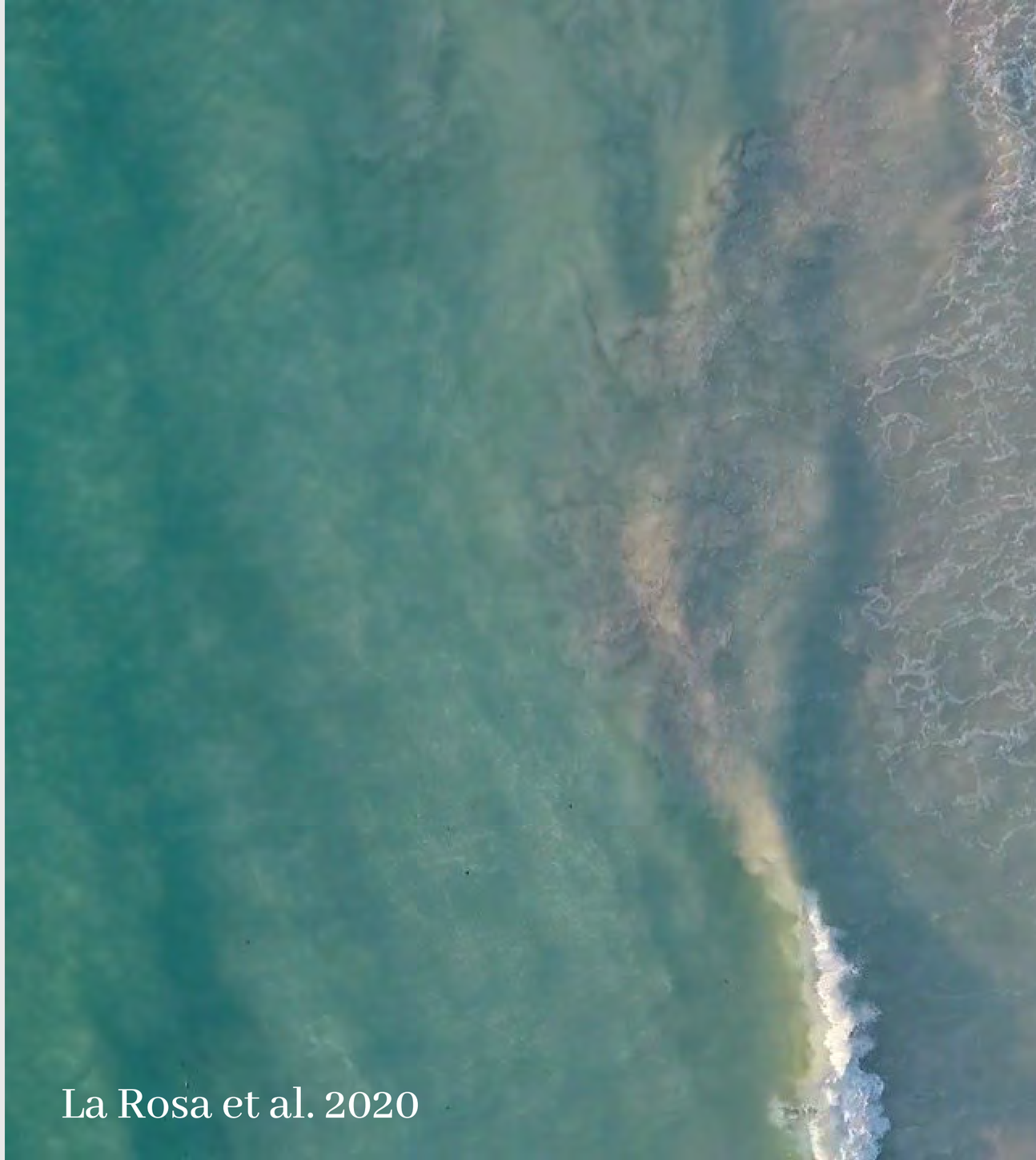
Image credit: Dirk Shadd

Poll:

Beach closures

TRANSMISSION OF DISEASES IN WATER

- Fecal contamination of water supplies has long been a threat to human health
- Many bacteria and pathogenic viruses are frequently detected in water environments
- The most well-known viruses which spread through water include Norovirus, Enterovirus, Hepatitis A, and Adenovirus
- These are all non-enveloped viruses



La Rosa et al. 2020

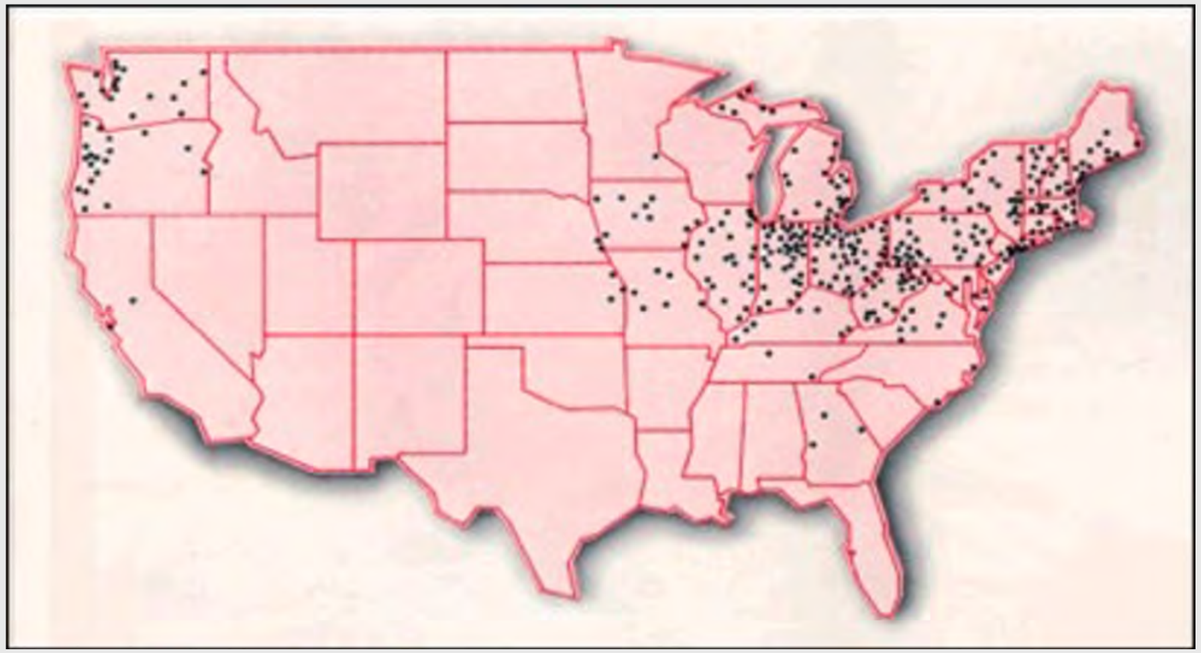
PATHWAYS OF FECAL CONTAMINATION

- Agricultural runoff
- Floodwaters
- Stormwater runoff
- Swimmers
- Untreated sewage

Poll:

The wastewater treatment system in your community

COMBINED SEWER OVERFLOWS (CSO)



772 CSO communities in the USA

Image Credit: EPA

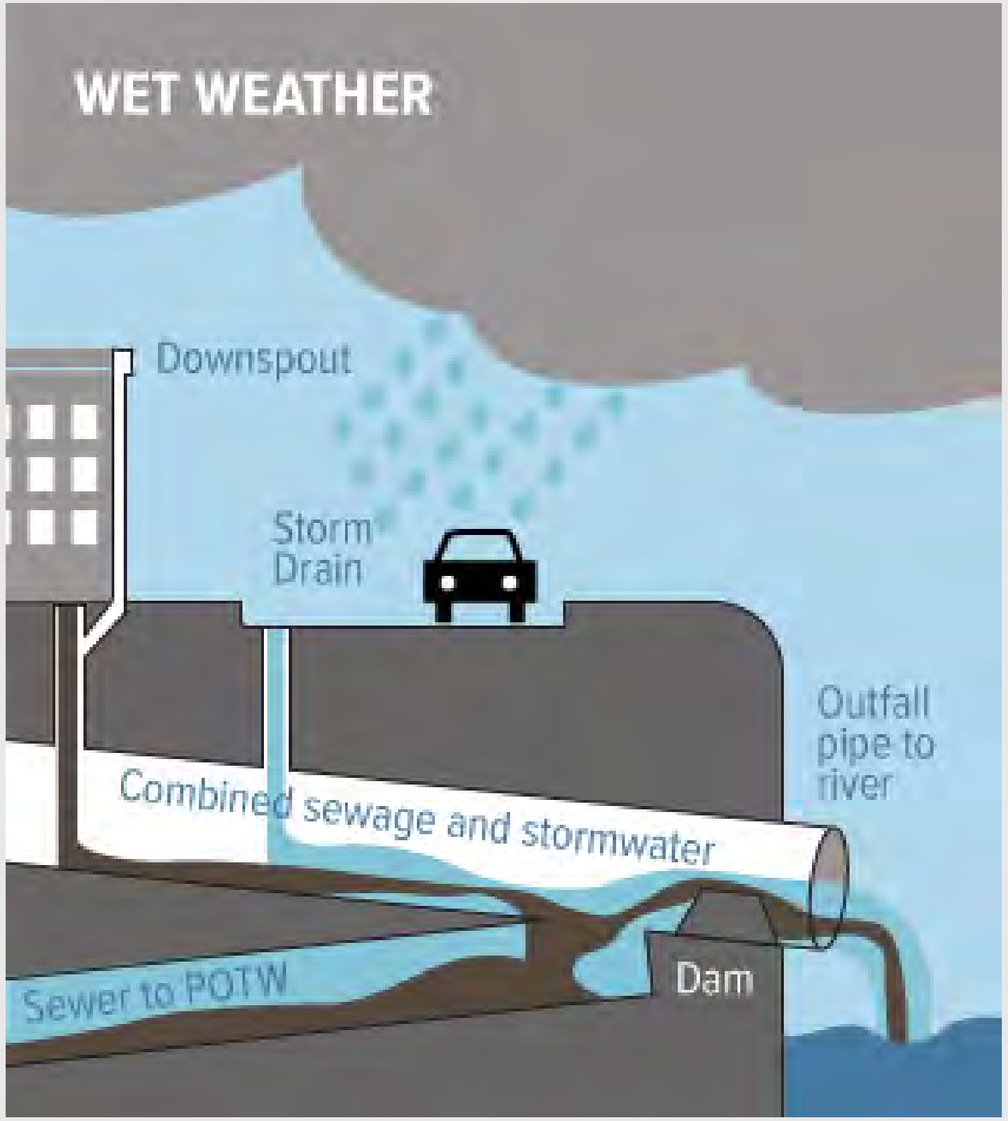


Image Credit: Jersey Water Works

COMBINED SEWER OVERFLOWS

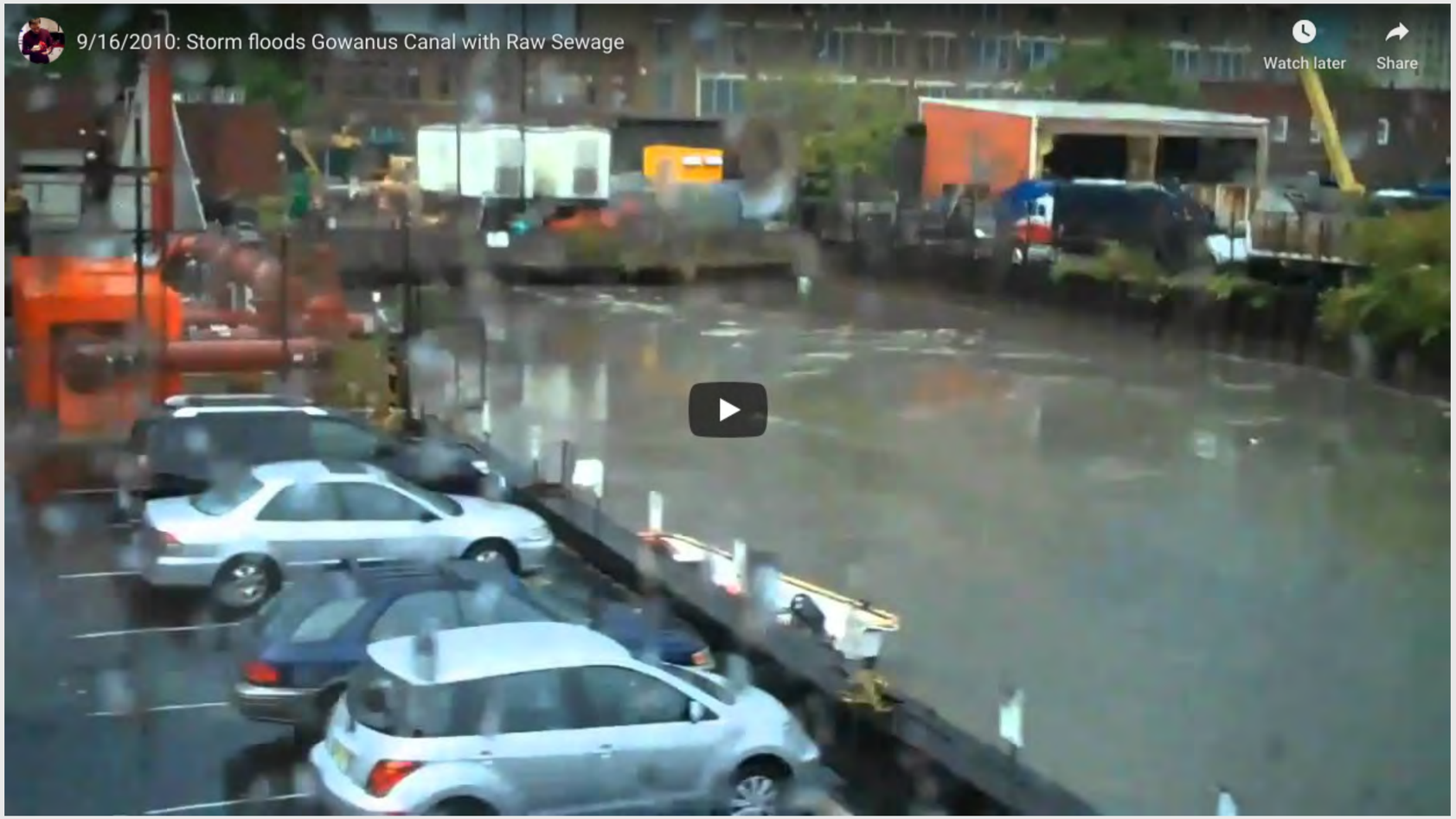
- Combined sewers regularly overflow during rainfall events
- New York City: 27 billion gallons per year
- Great Lakes basin: 22 billion gallons per year
- United States: poor infrastructure leads to 900 billion gallons annually

Riverkeeper 2020

American Society of Civil Engineers 2016

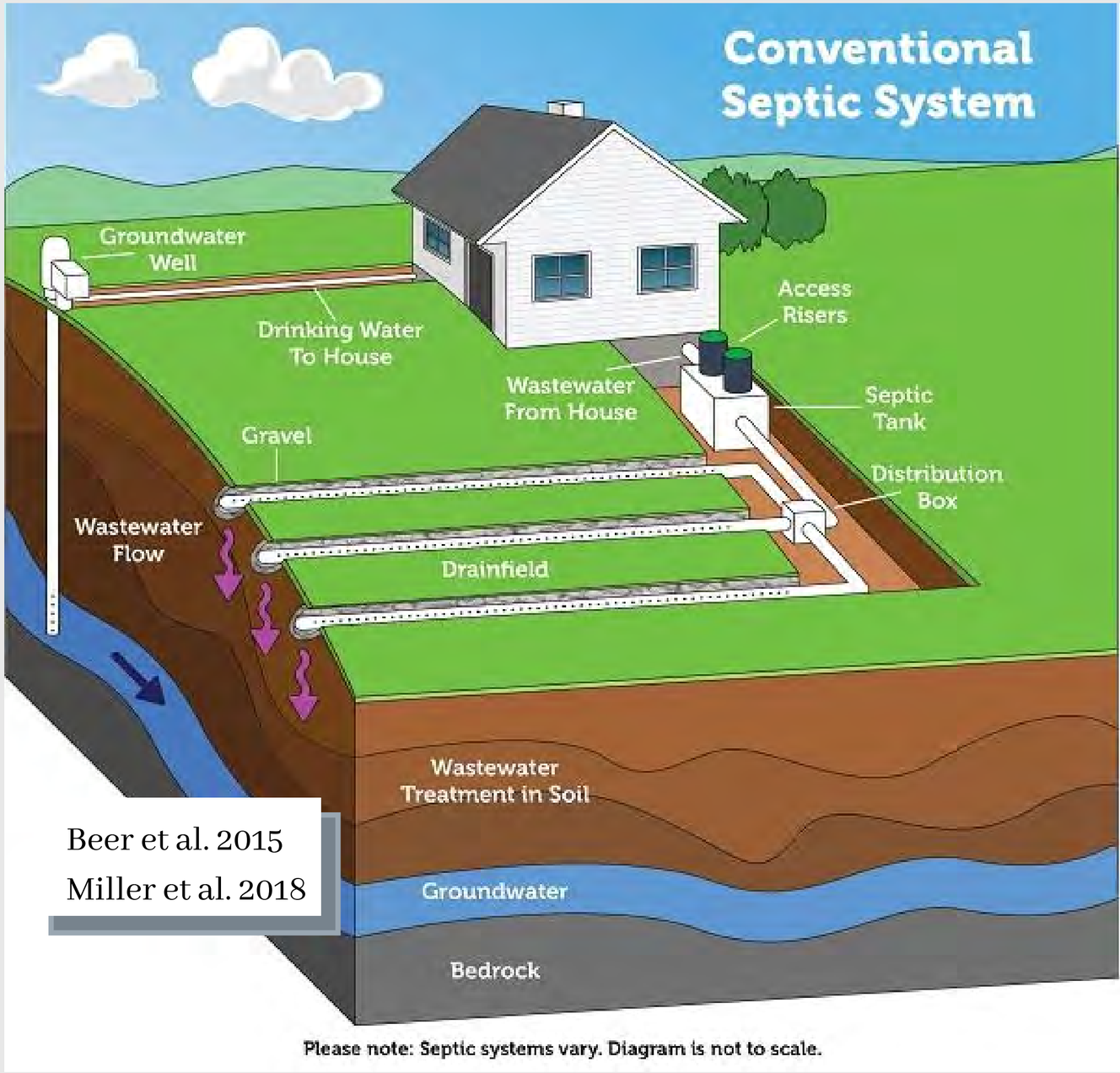
American Society of Civil Engineers 2017

COMBINED SEWER OVERFLOW IN NEW YORK CITY



RISKS OF FAILING SEPTIC SYSTEMS

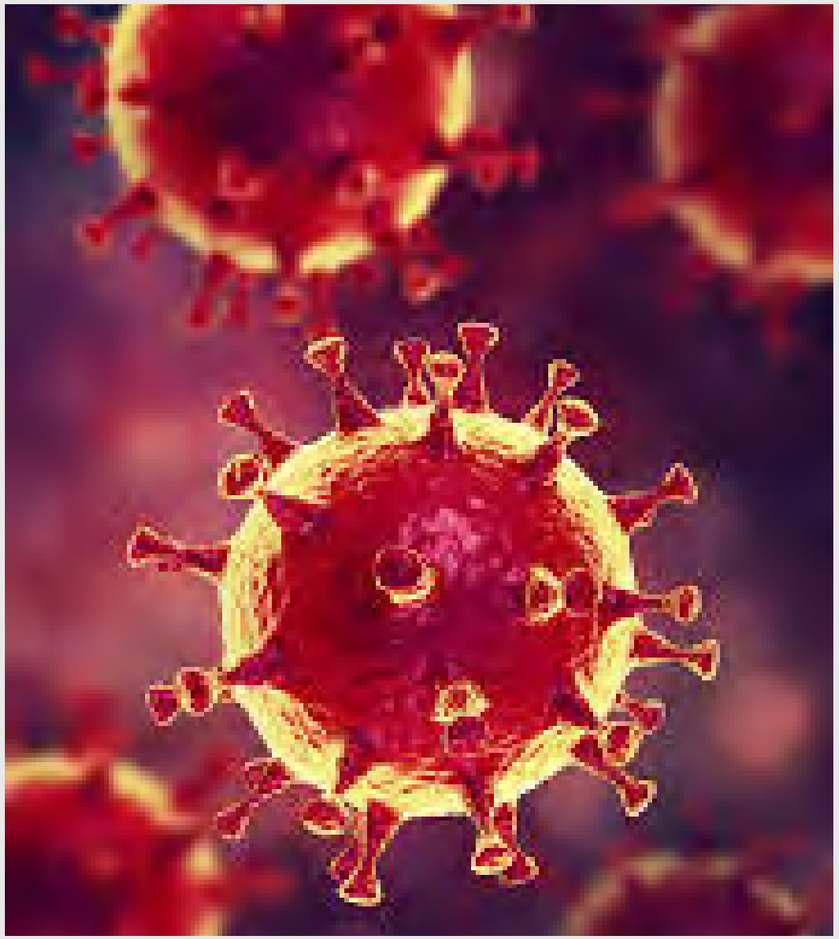
- Septic systems used in 20% of U.S. homes
- Each year, 10 – 20% of septic systems malfunction
- Septic systems contributed to 67% of reported outbreaks from groundwater contamination from 1971–2008
- Septic systems linked to viral contamination of oyster beds in the Pacific Northwest



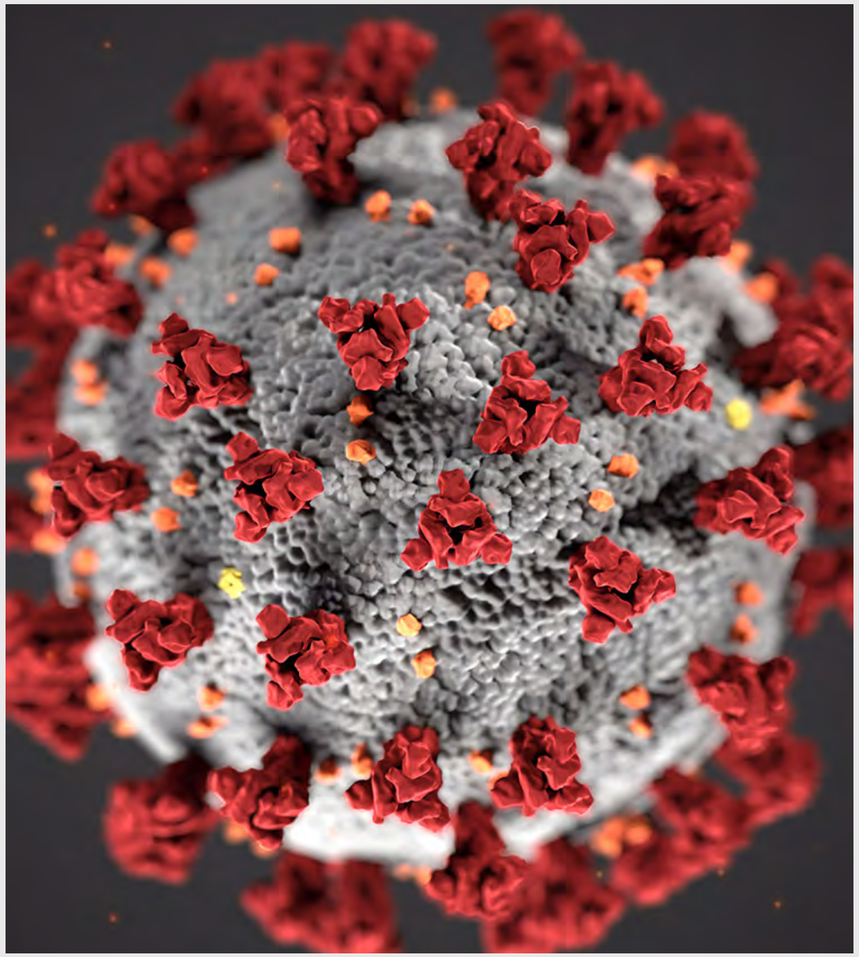
Beer et al. 2015
Miller et al. 2018

Image Credit: University of Maryland Extension

KNOWLEDGE OF SARS-COV (2003) CAN BE APPLIED TO SARS-COV-2 (COVID-19)



Enveloped Coronaviruses



SARS-COV

SARS-COV-2

COMPARISON BETWEEN SARS-COV-2 AND SARS-COV

SARS-COV

- Common symptoms: fever, cough, malaise, body aches & pains, headache, shortness of breath
- 20-30% required mechanical ventilation
- 10% mortality rate
- No reported cases of transmission before symptom development

SARS-COV-2 (COVID-19)

- Common symptoms: fever, cough, fatigue, shortness of breath
- 20% required mechanical ventilation
- 0.25-3% mortality rate
- More asymptomatic cases and thus more easily transmittable

Seladi-Schulman 2020

SURVIVAL OF SURROGATE CORONAVIRUSES IN WASTEWATER

- SARS Coronavirus (SARS-CoV) has been detected in wastewater but not as infectious particles.
- Temperature is an important environmental factor affecting CoV survival in water.
- CoV show limited environmental stability and sensitivity to oxidants as chlorine.
- There was no evidence of CoV transmission through contaminated water, but caution was still advised by the CDC.
- Methods for CoV concentration from waters should be optimized.

Casanova et al. 2009

EFFECT OF TEMPERATURE ON SARS-COV

Table 1. Persistence of SARS-CoV in different waters at 20 °C

Water samples	Detection time (day)								
	0	1	2	3	4	5	6	8	14
309th hospital	+	+	+	–	–	–	–	–	–
Domestic sewage	+	+	+	–	–	–	–	–	–
Dechl tap wat[b]	+	+	+	–	–	–	–	–	–
PBS	+	+	+	+	+	+	+	+	+

Table 2. Persistence of SARS-CoV in different waters at 4 °C

Water samples	Detection time (day)								
	0	1	2	3	4	5	6	8	14
309th hospital	+	+	+	+	+	+	+	+	+
Domestic sewage	+	+	+	+	+	+	+	+	+
Dechl tap wat[b]	+	+	+	+	+	+	+	+	+
PBS	+	+	+	+	+	+	+	+	+

From
Wang et al. 2005

EFFECT OF TEMPERATURE ON SURROGATE CORONAVIRUSES

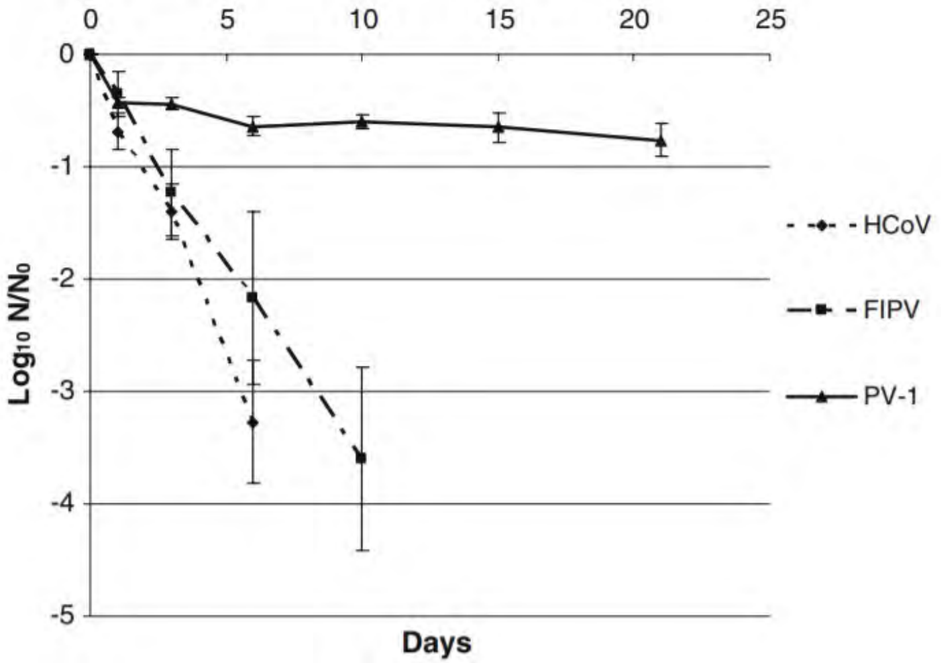


Fig. 1 Average $\log_{10}$ reduction (average $\log_{10}$ N/N_0 where N is titer of virus at specified day and N_0 is titer of virus at time 0) of study viruses [human coronavirus 229E (HCoV), feline infectious peritonitis virus (FIPV), poliovirus 1 (PV-1)] in dechlorinated, filtered tap water at room temperature (23°C)

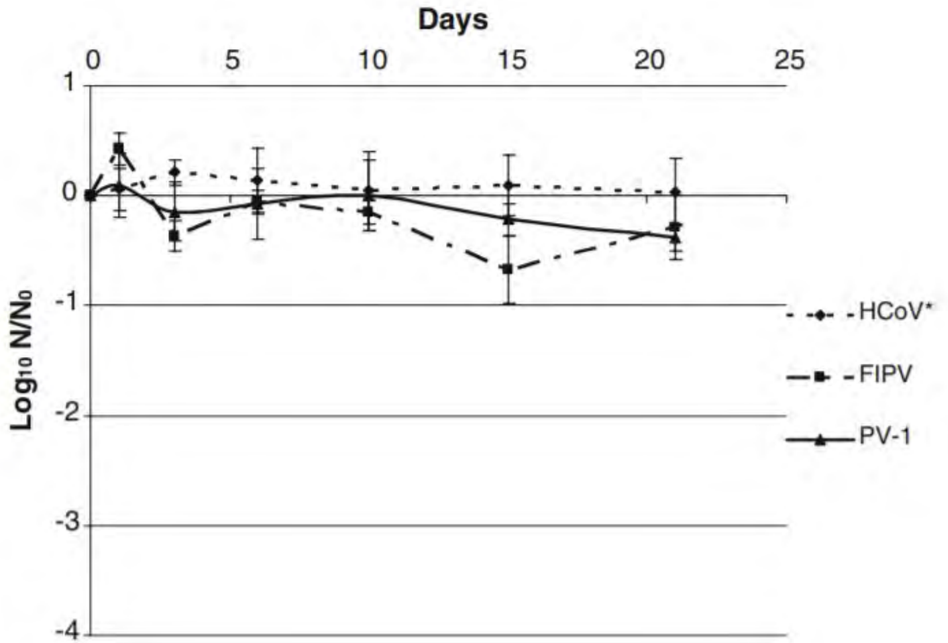


Fig. 2 Average $\log_{10}$ reduction (average $\log_{10}$ N/N_0 where N is titer of virus at specified day and N_0 is titer of virus at time 0) of study viruses [human coronavirus 229E (HCoV), feline infectious peritonitis virus (FIPV), poliovirus 1 (PV-1)] in dechlorinated, filtered tap water at 4°C. *Unfiltered

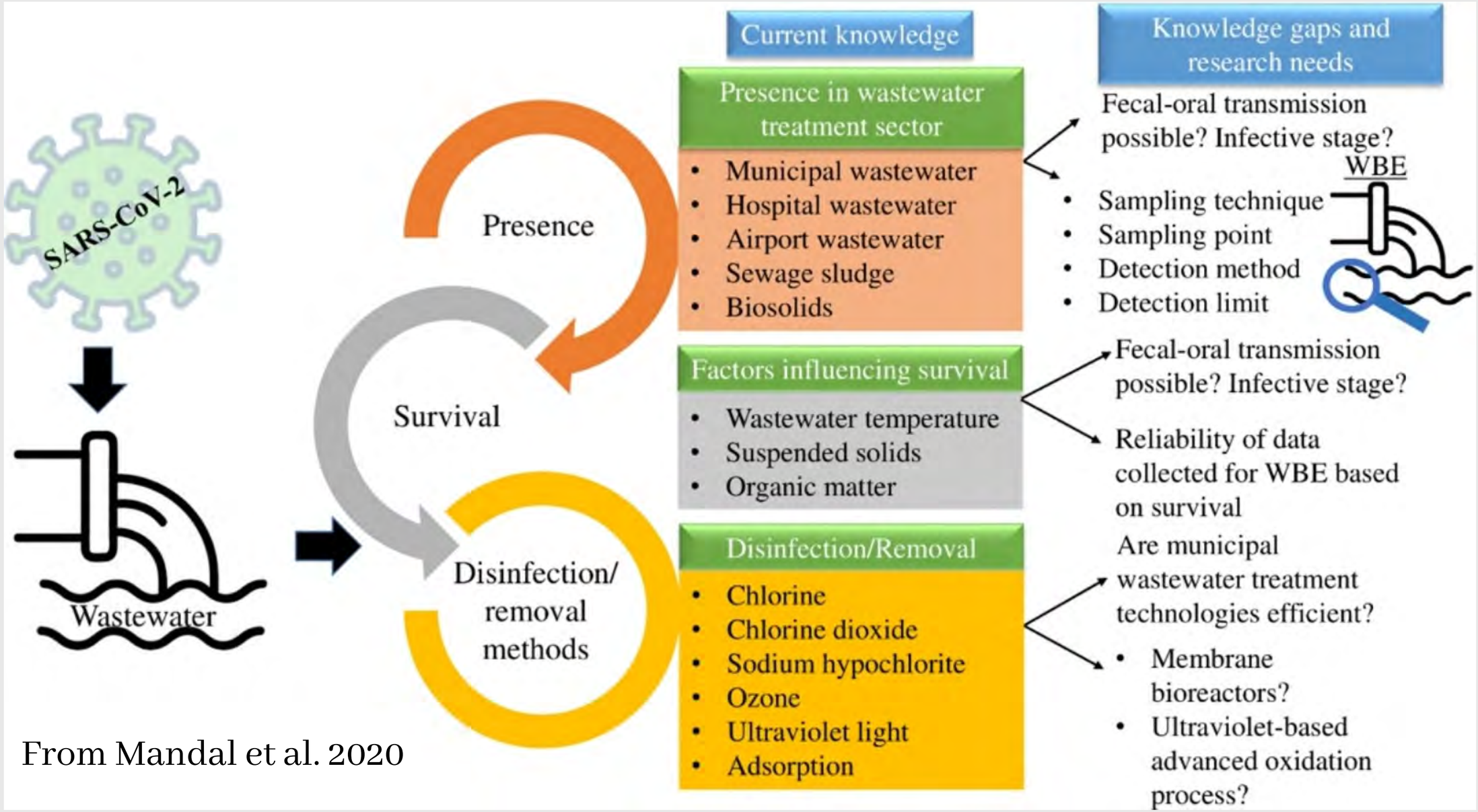
From Gundy et al. 2009

Ahmed et al. 2020
Kumar et al. 2020
Mandal et al. 2020
Nemudryi et al. 2020
Randazzo et al. 2020
Rimoldi et al. 2020
Serchan et al. 2020
Zhang et al. 2020

SARS-COV-2 IN WASTEWATER

- Numerous studies have identified SARS-CoV-2 RNA particles in untreated wastewater in several countries
- One study found that the virus had no infectivity in the wastewater
- Water treatment facilities should also break down the virus through chlorination and warm temperatures
- Still a great deal of uncertainty

SARS-COV-2 IN WASTEWATER



From Mandal et al. 2020

SARS-COV-2 IN FRESHWATER ECOSYSTEMS

- Two studies have identified SARS-CoV-2 in rivers
- One in Ecuador where wastewater treatment is poor and one in Italy where a CSO was suspected of overflowing into the river
- Study in Italy did not find SARS-CoV-2 to be infectious

Guerrero-Latorre et al. 2020
Rimoldi et al. 2020

SARS-COV-2 IN MARINE ENVIRONMENTS

- No research on SARS-CoV-2 in oceans or brackish water
- The virus can remain viable in 0.9% saline solution
- Many coronaviruses found in ocean animals which are similar in shape and replication to human coronaviruses
- Enveloped viruses typically decay quickly in seawater at a rate of 2-4% per hour, but there is no research specifically on the decay of coronaviruses in seawater

Mordecai & Hewson 2020

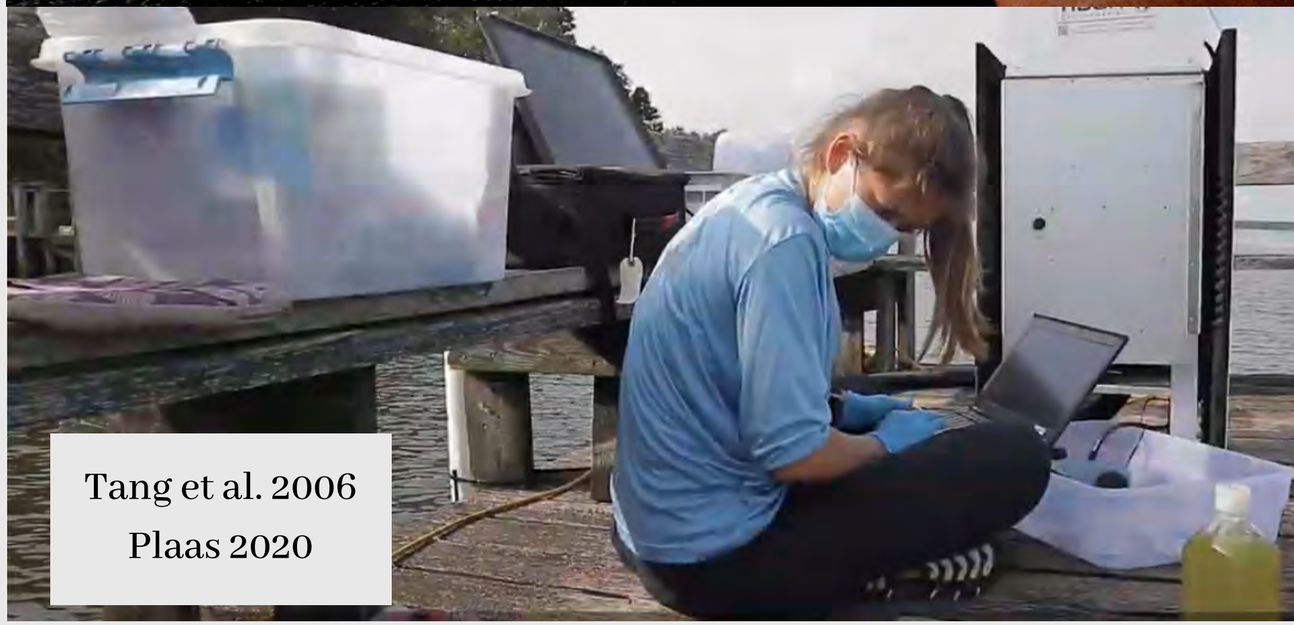
Rodino et al. 2020

RISKS FROM AEROSOL TRANSMISSION

- Aerosol or airborne transmission already well recognized for many human pathogens

- Aerosol dispersal of infectious agents has also been demonstrated in wastewater spray sites, the flushing of the household toilet, and even just opening a standard hinged door

- Cyanobacteria in algae blooms is being investigated for the potential to aerosolize



Tang et al. 2006
Plaas 2020

Poll:

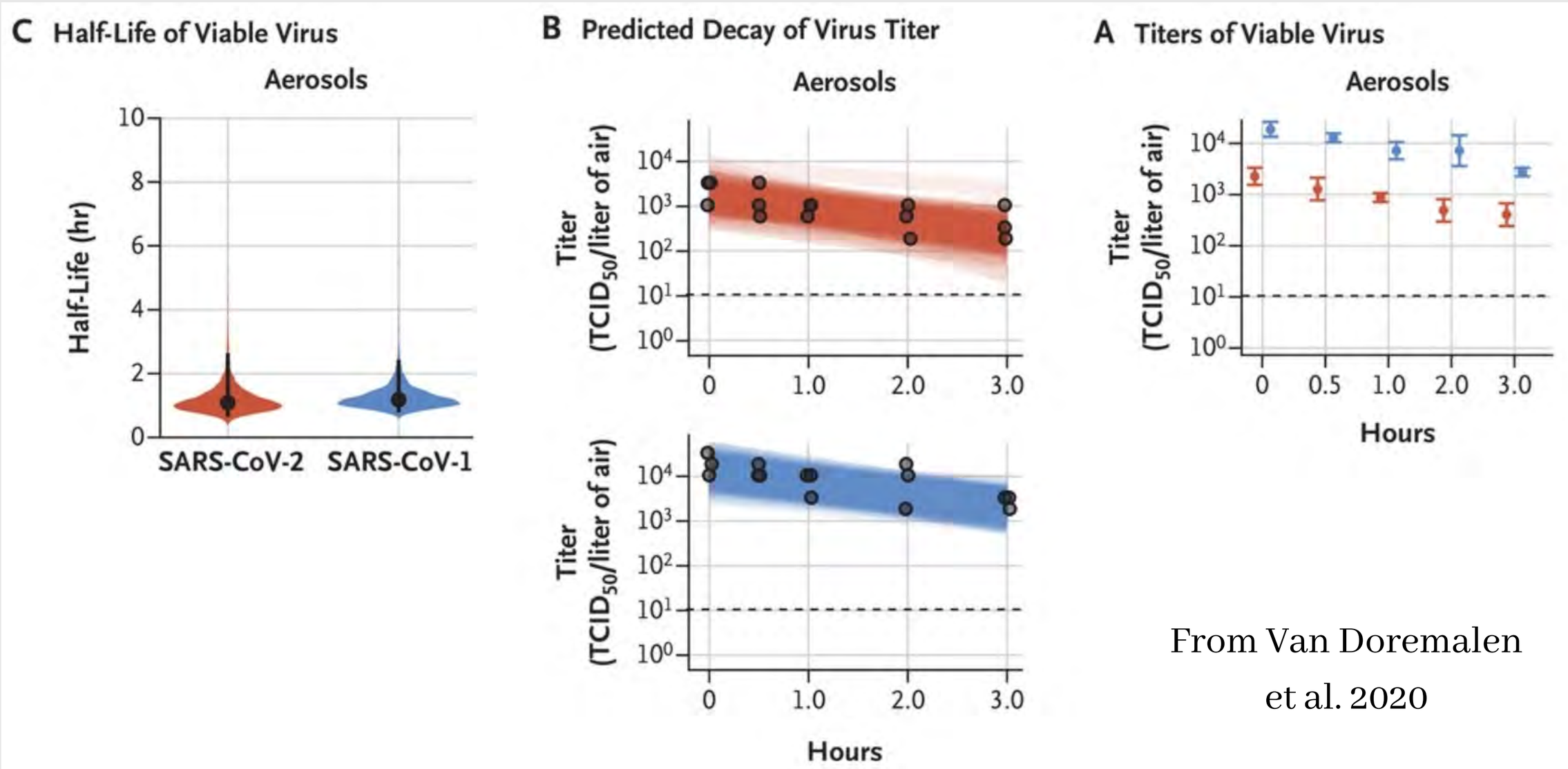
Diseases spread through mist and spray generated from coastal winds and waves

AEROSOLIZATION OF VIRUSES BY WAVES

- A 2018 study examined ability of bacteria and viruses to aerosolize in sea water by wave action
- Viruses had lower aerosolization than bacteria
- Enveloped viruses found at higher numbers in aerosols than non-enveloped

Michaud et al. 2018

VIABILITY OF SARS-COV AND SARS-COV-2 IN AEROSOLS



From Van Doremalen et al. 2020

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ONGOING RESEARCH AND OUTREACH

ONGOING WORK: COVID IN NATURAL WATERS

- Dr. Robert Quilliam of the University of Sterling leading a £1.85 million study into the transport of bacteria and viruses in marine environments

- Minnesota Sea Grant is monitoring the presence of SARS-CoV2 virus in surface waters connected to public recreation sites

- Dr. Kim Prather at Scripps Institute studying the aerosolization of viruses and bacteria in the coastal atmosphere

ONGOING WORK: WASTEWATER SURVEILLANCE

- Wastewater surveillance can be used to estimate the prevalence of COVID-19 in a population
- Oregon State University, University of Michigan, Stanford University, University of Minnesota, University of Arizona, and beyond
- CDC is developing best practices for sampling, handling, and quality control procedures to standardize data across the country
- CDC launching National Wastewater Surveillance System (NWSS)

Poll:

Have you shared outreach resources

OUTREACH IS EVOLVING: ACKNOWLEDGING OUTREACH OUTSIDE OF SEA GRANT

SURFRIDER FOUNDATION

NACWA
A CLEAR COMMITMENT TO AMERICA'S WATERS

Water Environment Federation®
the water quality people®

Massachusetts Bays
NATIONAL ESTUARY PARTNERSHIP

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

COLLABORATION AND NEXT STEPS

Sea Grant
Oregon

RESEARCH NEEDS

- Infectivity of SARS-CoV-2 in wastewater and receiving fresh waters
- Survival and decay rate of virus in salt and brackish water
- How well does SARS-CoV-2 aerosolize through wind and waves
- Improving confidence and technologies of wastewater disinfection to be effective under a wider range of conditions

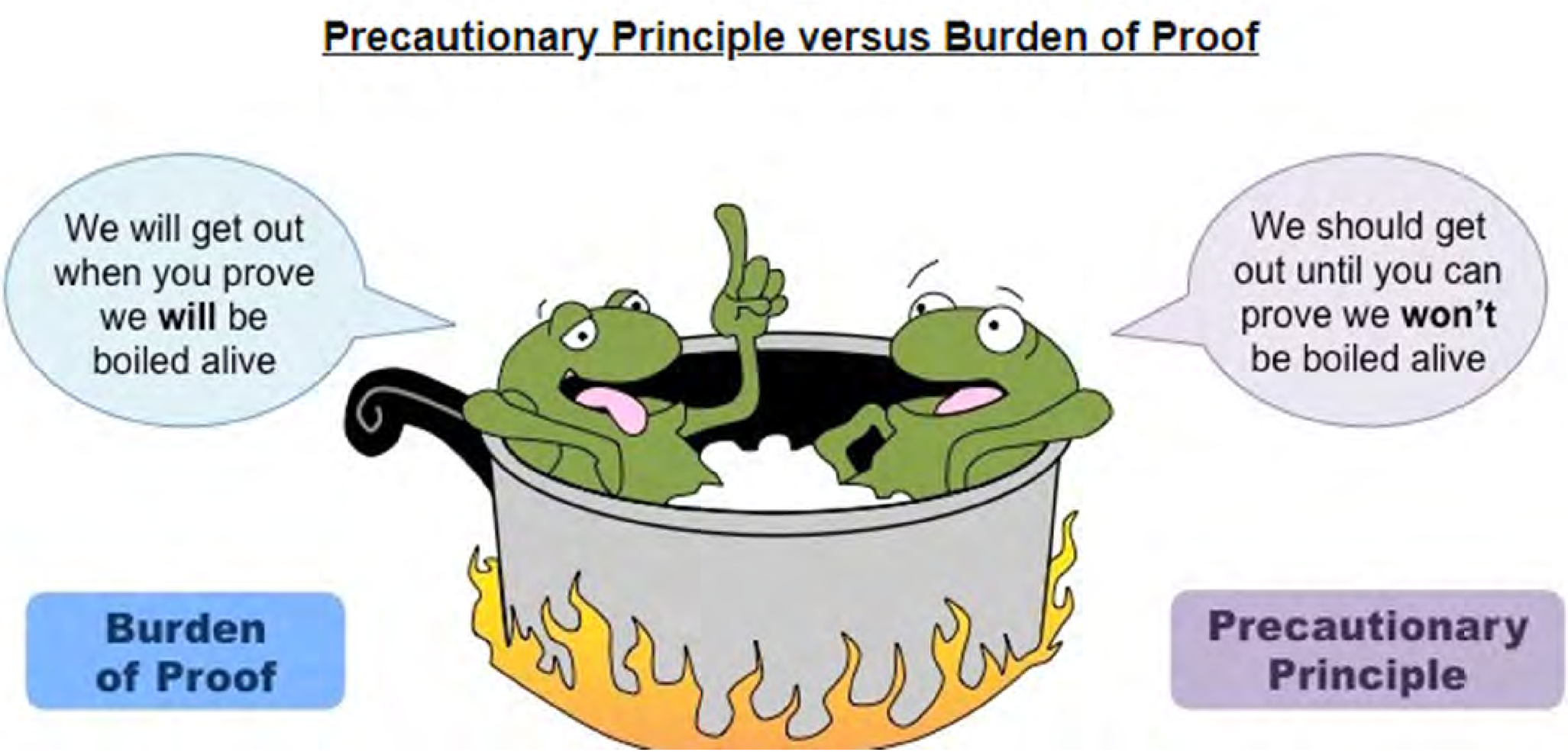


Image credit: Bioninja.com

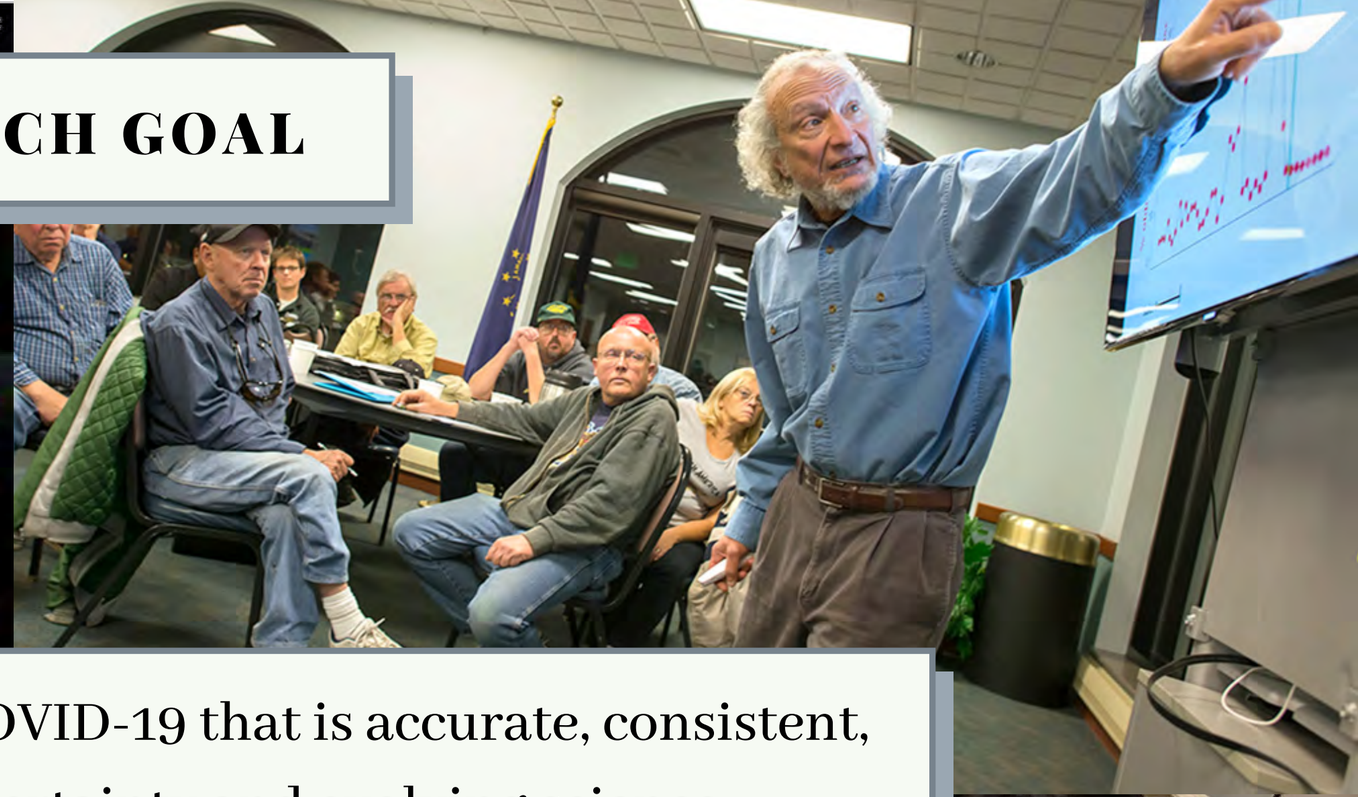
SUMMARY OF CONDITIONS WITH GREATER RISK OF EXPOSURE TO SARS-COV-2

- During and after storm events that could lead to discharge of untreated wastewater
- Near known sewer outflows, especially those that are not disinfected
- In water bodies near known failing septic systems
- Waters where *E. coli* is detected or has a history of *E. coli* contamination (*E. coli* comes from fecal contamination)
- When coastal conditions are windy with large waves or manmade causes that generate mist, spray, and aerosols near waste water outflows or in waters with known biological contamination
- In areas with posted beach closures advisories
- Where people are in close contact

PRECAUTIONS FOR WATER MONITORING AND RECREATION

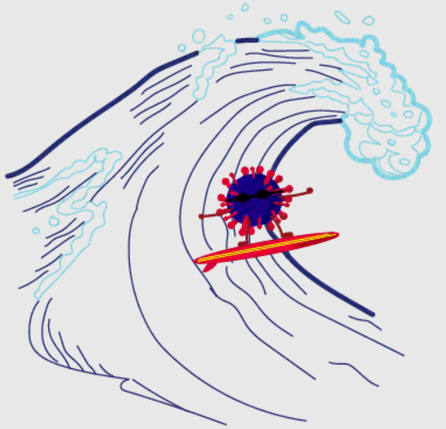
- Avoid sampling and recreating during and immediately after storm events near sewer outfalls
- Stay away when windy and heavy surf conditions are expected
- Take added precaution in areas with a history of *E. coli* contamination and follow beach/water body advisories and closures
- Precaution may also be considered for pets and service animals (e.g., cats and dogs) CDC, August 24, 2020

OUTREACH GOAL



Collaborative outreach on COVID-19 that is accurate, consistent, and acknowledges uncertainty and evolving science

TAKE-HOME MESSAGES

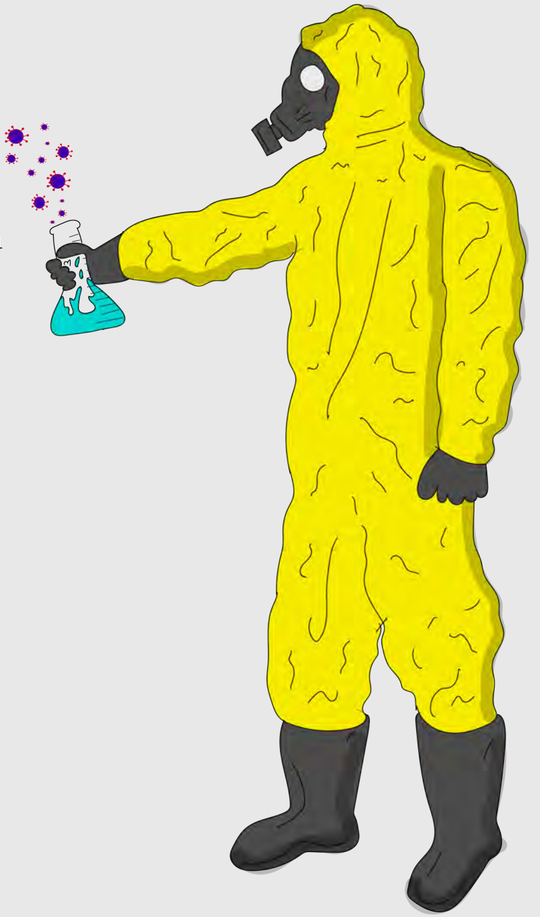


Is SARS-CoV-2 found in wastewater?

- Yes, but there is uncertainty on whether the virus is still infectiuos.
- "Previously SARS-CoV in wastewater was successfully inactivated with chlorine dose of 10 mg l–1 in a contact period of 10 min or chlorine dioxide dose of 40 mg l–1 with a contact period 30 min" Wang et al. 2005, Kataki et al. 2020

Has SARS-CoV-2 been found in any natural water bodies?

-Yes, it has been found in rivers near urban areas.



Can wastewater be effectively treated to kill the virus?

- Yes, chlorine and emerging classes of disinfectants (e.g. peracetic acid) can breakdown the virus, but not all wastewater makes it through the treatment process.

Can we get COVID-19 from the water or ocean aerosols?

- Maybe. However, the risks are low. The science on this is still uncertain and incomplete, and the risks will depend on environmental conditions.

What are the recommendations?

- Apply precaution - use protective equipment and avoid conditions with higher risk of exposure to COVID-19.
- Research strategy to address knowledge gaps of SARS-CoV-2 in different water environments.

SOURCES

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Thank you!

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Oregon State University

Massachusetts Bays National Estuary Partnership

University of Vermont Extension

Sea Grant Lake Champlain

Chime in!

- Use Q&A box for panelist questions
- Use Chat Box for individual discussion

Speakers and Panelists: Sam Chan, Linda Tucker Serniak, Winnie Kong, Tania Siemens, Daniel Arisa, Aaron Cathcart (Oregon Sea Grant)

Moderators: Jill Carr (MassBays) and Kris Stepenuck (UVM / VT Sea Grant)

Next steps

Sharing slides, Q&A text and recording to:

- USA Volunteer Monitoring Network, Covid Page (http://volunteermonitoring.org/covid)
- MassBays' "Monitoring Resources" YouTube playlist (https://www.youtube.com/playlist?list=PLqrr9eewSGTKkGPbsqdHrctLuy2stvwdB)

Thank You
and
Stay Well

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