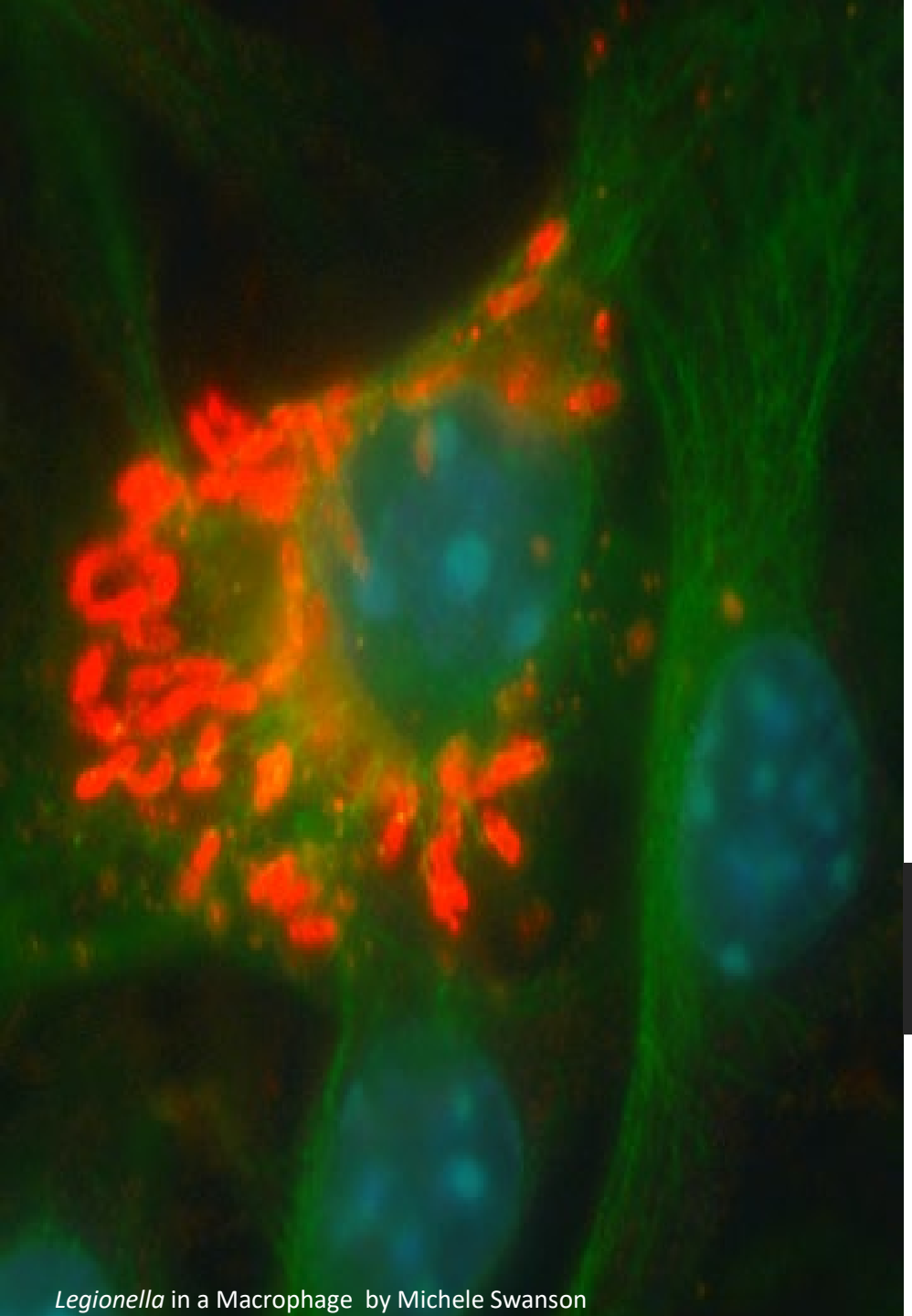


Legionella in a Macrophage by Michele Swanson

The National Academies of Sciences, Engineering and Medicine
Water Science and Technology Board

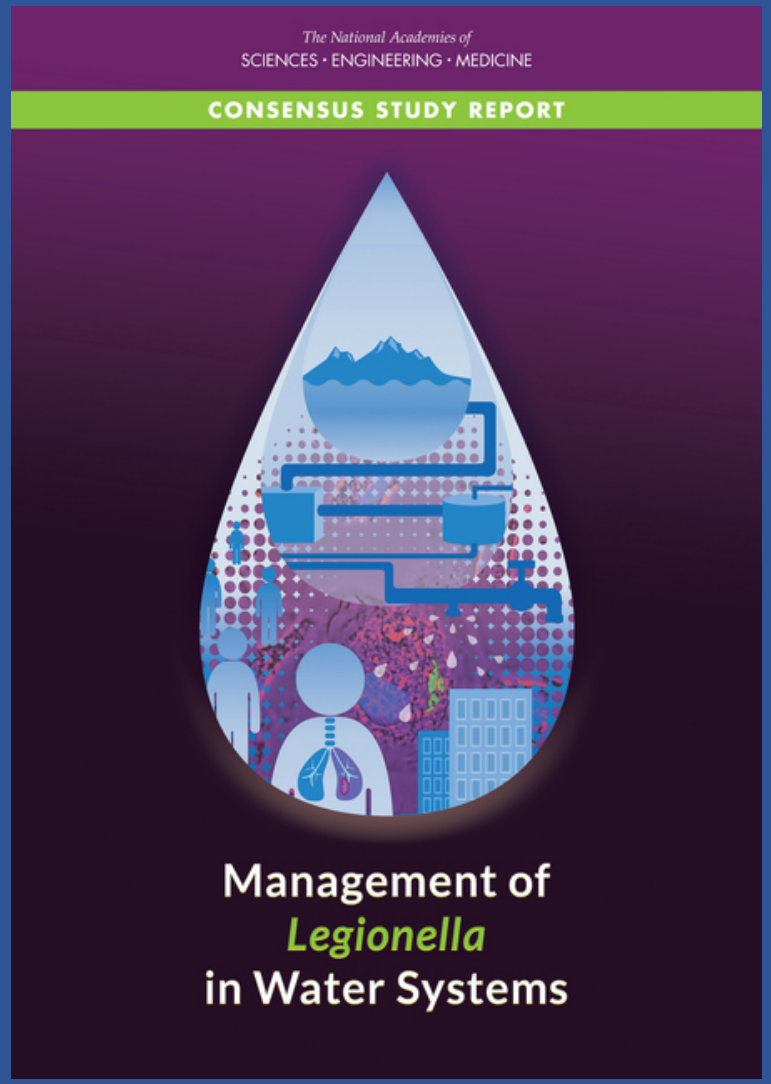
Management of *Legionella* in Water Systems (NASEM, 2020)

Discussion Meeting on Environmental Monitoring
December 10, 2020

Committee Members

Laura Ehlers, Senior Staff Officer, NASEM

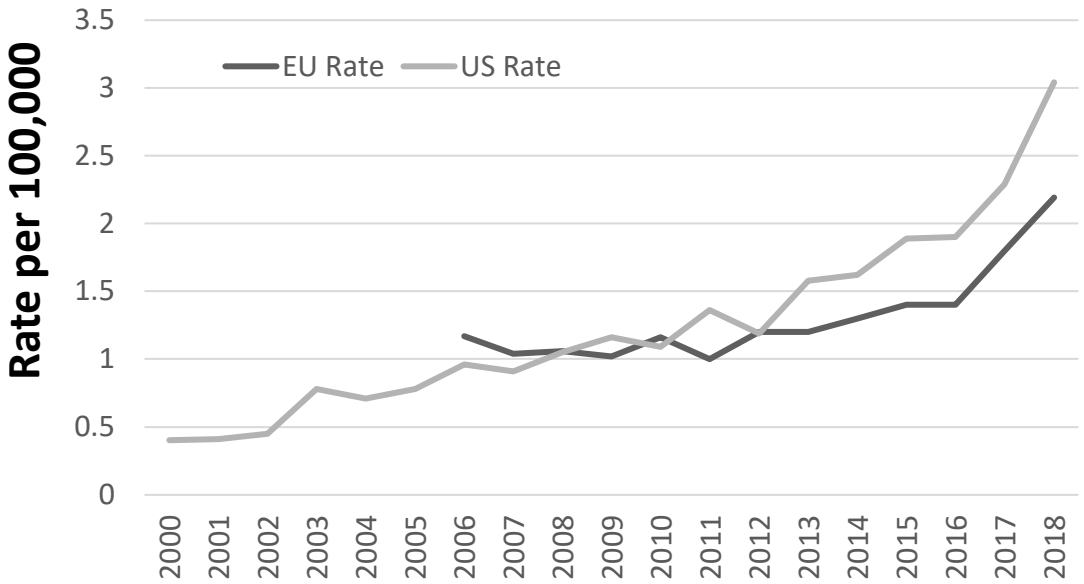
1. **Joan B. Rose,** *Chair,* Michigan State University, Lansing
2. **Nicholas J. Ashbolt**, University of Alberta, Edmonton
3. **Ruth L. Berkelman**, Emory University, Atlanta, GA
4. **Bruce J. Gutelius**, New York City Department of Health and Mental Hygiene
5. **Charles N. Haas**, Drexel University, Philadelphia, PA
6. **Mark W. LeChevallier**, Dr. Water Consulting LLC, Morrison, CO
7. **John T. Letson**, Memorial Sloan Kettering, Bronxville, NY
8. **Steven A. Pergam**, Fred Hutchinson Cancer Research Center and the University of Washington
9. **Michèle Prévost**, Polytechnique Montréal, Quebec
10. **Amy Pruden**, Virginia Polytechnic Institute and State University, Blacksburg
11. **Michele S. Swanson**, University of Michigan, Ann Arbor
12. **Paul W. J. J. van der Wielen**, KWR Watercycle Research Institute, Nieuwegein, The Netherlands
13. **Lan Chi Nguyen Weekes**, La Cité, Ottawa, ON



- **Chapter 1 Introduction:** Legionnaires' disease and *Legionella*, water systems as sources for *Legionella* growth.
- **Chapter 2 Diagnosis and Ecology:** Human host, *Legionella* species and strains, ecology in amoebae, exposure pathways, recommended research
- **Chapters 3 Quantification of Legionnaires' disease and *Legionella* in water systems:** Committee's estimate of true incidence; thresholds for environmental monitoring; QMRA
- **Chapter 4 Prevention and Control Strategies:** Temperature control, disinfection, managing hydraulics, nutrient limitation; plumbing materials, actions at the distal portion of plumbing, and aerosol control; many buildings water systems considered
- **Chapter 5 Regulations and Guidelines on *Legionella* Control:** **R**egulations, codes, and guidelines on control, quantification, and prevention of *Legionella* and Legionnaires' disease

Report available at https://www.nap.edu/catalog/25474/management-of-legionella-in-water-systems

Chapter 3: QUANTIFICATION OF *LEGIONELLA* AND LEGIONNAIRES' DISEASE



Topics covered:

- Disease surveillance for Legionnaires' disease
- Committee estimates that the number of persons with Legionnaires' disease ranges from **52,000 to 70,000 in the United States each year**
- **Environmental monitoring of *Legionella***
- **Compilation of *Legionella* data from across the world**
- **Quantitative Microbial Risk Assessment for *Legionella pneumophila***

Evolving Methods for Quantification of *Legionella*

Purpose: Diagnosis, Outbreak investigation, Routine monitoring, Mitigation assessment, and Research

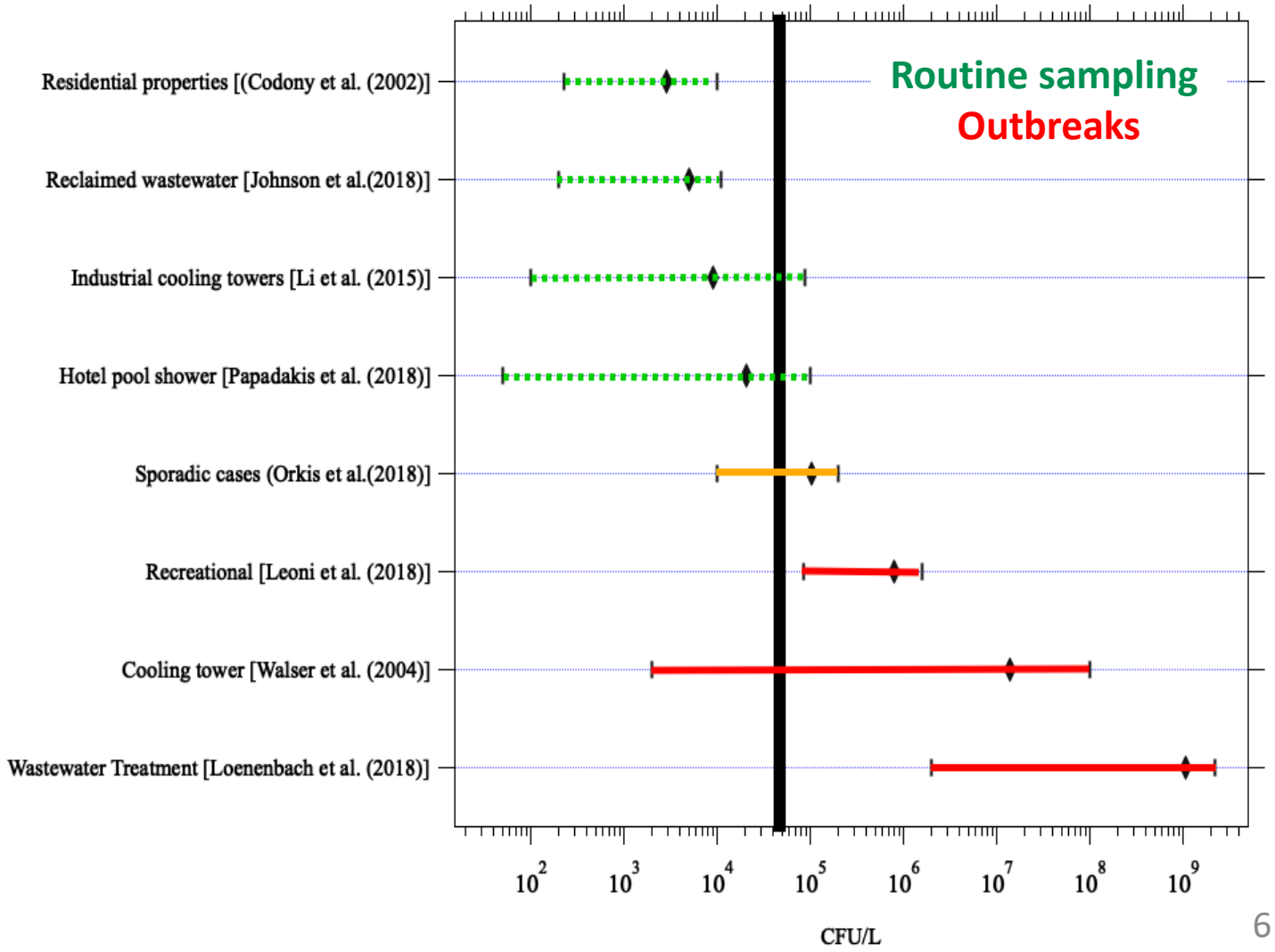
- There are now lots of tools
  - Certified standard culture methods vs. new culture methods
  - Quantitative PCR/droplet digital PCR
- Can distinguish between *Legionella* spp., *Lp, Lp1, L. anisa,* etc.
- Many methods are quantifiable
- Pros and cons
  - Culture methods can underestimate because of VBNC cells
  - PCR methods can detect inactivated *Legionella*

Legionella on Charcoal Yeast Extract Agar

Range of Environmental Concentrations Without and With Observed Disease Outbreaks

A *Legionella* concentration of **50,000 CFU/L** should be considered an "action level", that is, a concentration high enough to warrant serious concern and trigger remediation

A lower level may be necessary for at-risk individuals



QMRA Derived Concentrations for Devices/Fixtures Corresponding to Reference Infection Risks and DALYs

Devices/Fixtures	Critical Average *Lp* Concentration (CFU/L)
Target Risk Value: 10^{-4} infections per person per year	
Conventional faucet	104,000
Conventional toilet	857,000
Conventional shower	1,410
Target Risk Value: 10^{-6} DALY per person per year	
Conventional faucet	1,060
Conventional toilet	8,830
Conventional shower	14.4

L. pneumophila concentrations in various plumbing fixtures that correspond to target risk levels.
NOTE: Median estimates from a Monte Carlo simulation.
SOURCE: Hamilton et al. (2019).

Chapter 5: REGULATIONS AND GUIDELINES ON *LEGIONELLA* CONTROL IN WATER SYSTEMS

- Lack of federal laws and regulations pertinent to *Legionella*
- State and local regulations and other enforceable policies
- Guidance documents
- **Regulations and policies from other countries**
- **Recommendations on monitoring and other steps forward**

Chapter 5 Recommendations

1. Expand the Centers for Medicare & Medicaid Services memo **to require monitoring for *Legionella*** in environmental water samples for all hospitals
2. **Register and monitor cooling towers**
3. Require **water management plans in all public buildings** including hotels, businesses, schools, apartments, government buildings
4. Require a temperature of **60°C (140°F) at hot-water heaters** and **55°C (131°F) to the distal points** (the point of connection to fixtures including thermal mixing values)
5. Require a **minimum disinfectant residual** and **monitor** for *Legionella* throughout public water systems

Today's Program

Three purposes of *Legionella* Monitoring *Amy Pruden, 15 min.*

- Monitoring to ensure a prevention strategy is working (based on a *Legionella* water management plan)
- Monitoring for positive sites (presumably after an outbreak)
- Collaborative, widespread national survey of *Legionella*

Refining the Action Levels/Thresholds *Chuck Haas, Mark LeChevallier, and Paul van der Wielen, moderated by Joan Rose, 45 min.*

- Report identified several thresholds (50,000 CFU/mL; QMRA results)
- Should numbers be based on *L. pneumophila* or *Legionella* species?
- If molecular methods are used, how would the action levels/thresholds be recalculated?
- Can numbers be refined depending on type of building/water device (toilets vs. faucets vs. showers vs. cooling towers), exposure route, or characteristics of building occupants?

Break *20 min.*

In Complex Water Systems, Where and When Should Monitoring Occur? How should Chapter 5 Recommendations be Implemented in the Real World?

Buildings and Cooling Towers *Michele Prevost, 20 min.*

Utilities and Distribution Systems *Mark LeChevallier, 20 min.*

Questions from the Audience *45 min.*

Selected International *Legionella* Regulations

Country/ Province	Buildings/Devices Covered	Preferred Treatment	Monitoring Thresholds (All Converted To CFU/L)
Netherlands	Priority premises (large buildings), swimming and bathing facilities, cooling towers	Temperature control, flushing, UV, filtration	**>1,000 CFU/L, take response actions**
Germany*	Large buildings, cooling towers, swimming pools, bathing water, WWTPs	None, though temperature control and avoiding stag-nation evident in codes	**>1,000 CFU/L, take response actions**
England	Evaporative cooling systems, cooling towers, hot and cold water systems, spa/pool systems, healthcare facilities	Temperature control, biocides	**100-1000 CFU/L, take response actions**
France	Buildings except private residences, cooling towers	None apparent	**<1,000 CFU/L target for public facilities <50 or 100 CFU/L target for prevention of nosocomial infections**
Australia	Premise plumbing in healthcare and aged care facilities, cooling towers	Temperature control, biocides	**> 10^6 CFU/L, take response actions**
Canada*	Cooling towers, open water systems, HVAC components, and hot- and cold-water systems in 360 government buildings	None	**>10^6 CFU/L, take response actions**
Quebec*	Cooling towers only	Biocides	**≥10^4 to <10^6 CFU/L, take response actions**

***Countries/Provinces that have evidence of lower environmental concentrations since regulations went into effect**