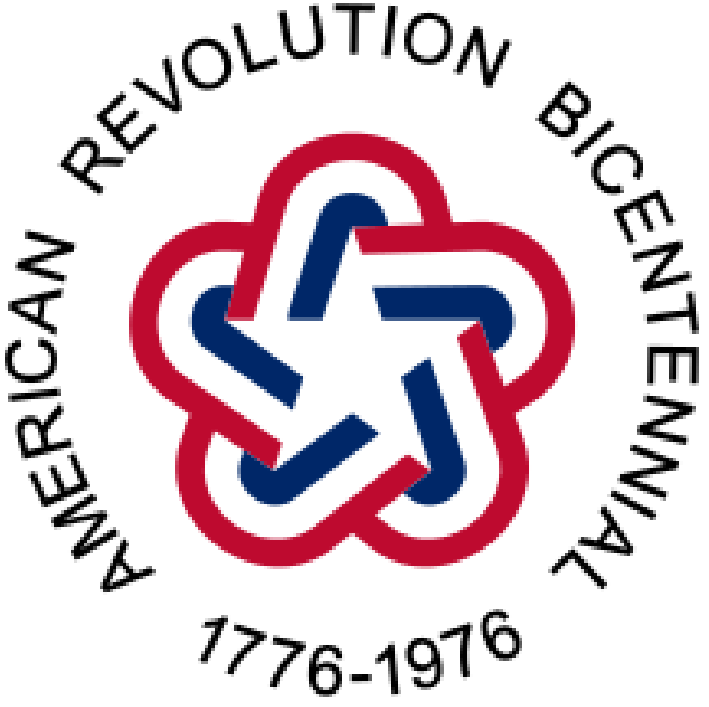

AND NOW FOR
SOMETHING
COMPLETELY
DIFFERENT

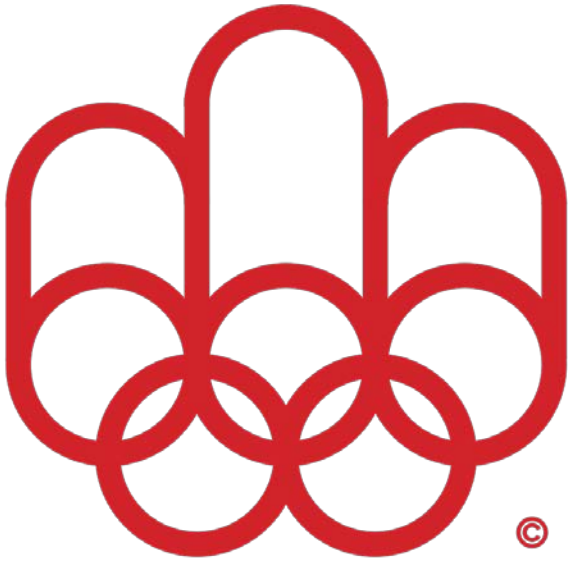
Legionella

John P. Springston, CIH, CSP, FAIHA


SOOOOO...
ANY QUESTIONS?
memes.com

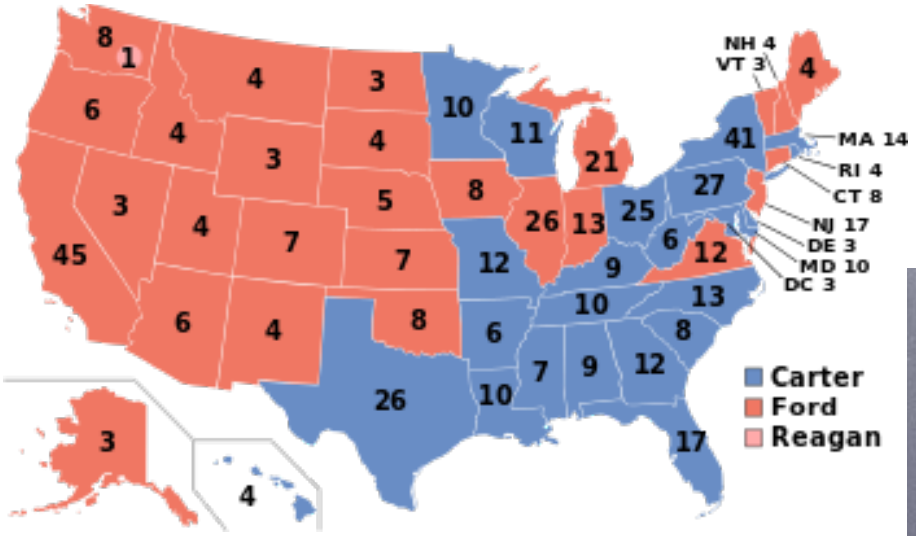
Summer of 1976





Montréal 1976

Summer of 1976

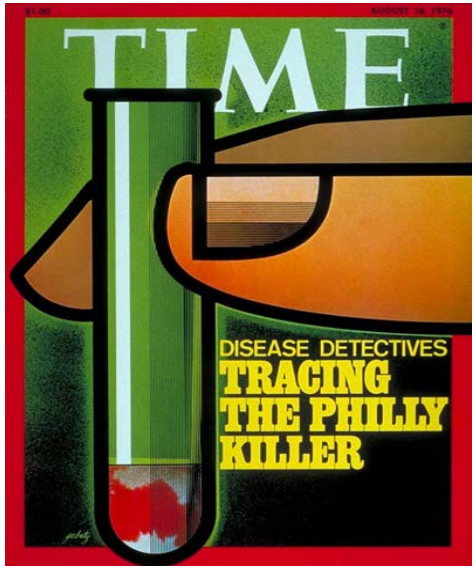


First Known Outbreak

- Summer of 1976
- Bellevue Stratford hotel
- American Legion Convention
- ~4,000 attendees
- 221 cases
- 34 deaths

Epidemiological Study

- **CDC investigation provided no results over 5 months**
- **Disease airborne**
- **Cause: unknown**
  - Chemical warfare germ (CIA)
  - Foul play to secure funding for CDC
  - Nickel carbonyl poisoning
  - Toxic fumes from copy machine
  - Air conditioning refrigerant
  - Terrorist attack

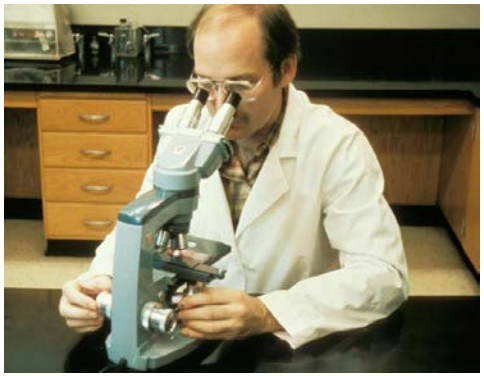


Source: Time Magazine

Only consensus: definitely not bacterial

Epidemiological Study

- **Dr. Joseph McDade**
- **January 1977**
- **Isolation of disease bacterium**
  - *Legionella pneumophila*
- **Unconventional staining**
- **Fastidious nutritional requirements**



Source: U.S. CDC

Epidemics prior to 1976

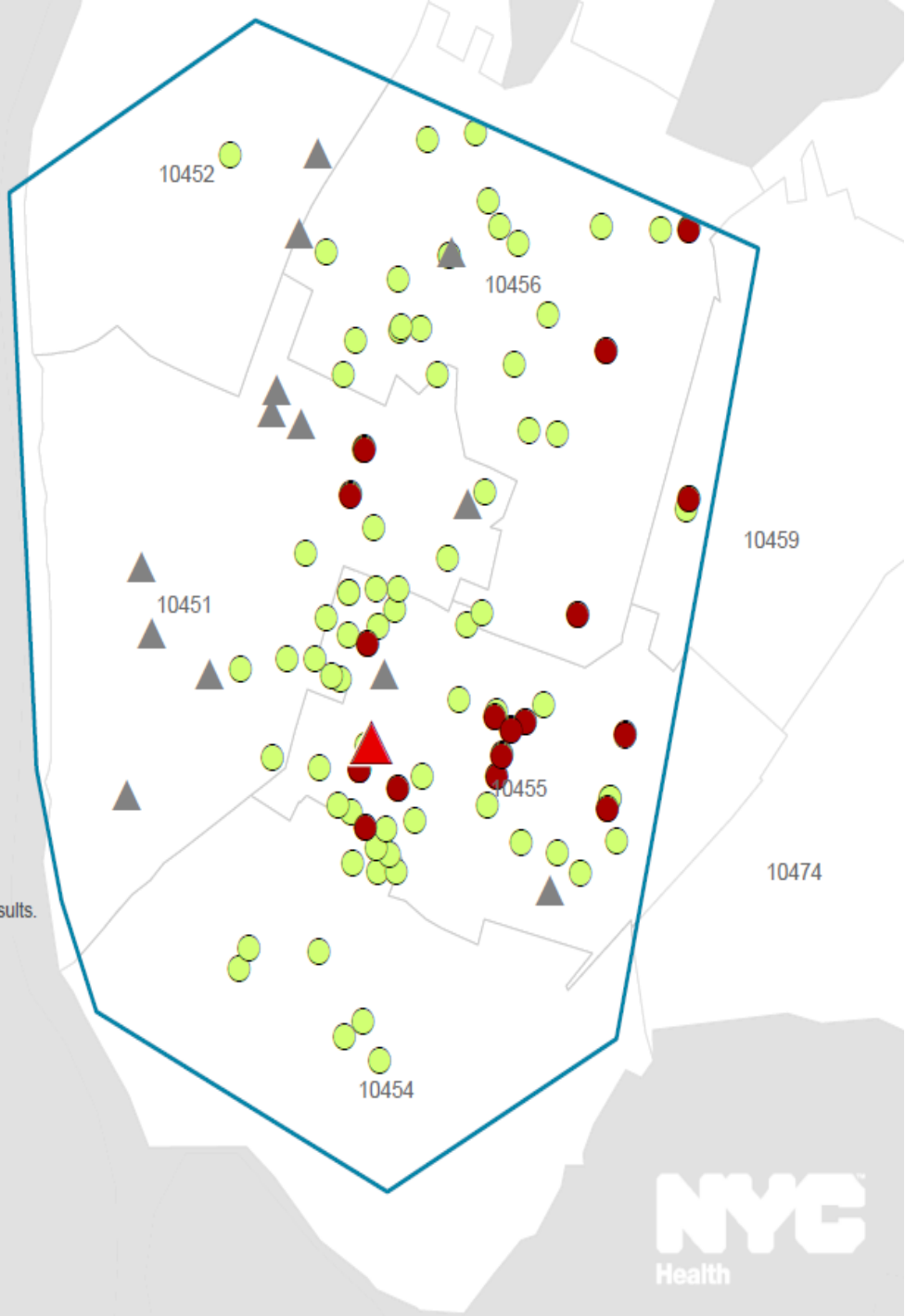
- **1957, Austin, Minnesota: SPAM City**
  - 78 cases of pneumonia between June and August
- **1965, Washington D.C.: St. Elizabeth's Hospital**
  - 81 patients developed pneumonia (July-August)
  - 14 deaths
- **1974, Philadelphia, PA: Bellevue Stratford Hotel**
  - Independent Order of Odd Fellows convention
  - ~1,500 attendees
  - 20 cases, 2 deaths

New York City 2015

- **December 2014/January 2015**
  - 12 confirmed cases in the Bronx
  - 8 cases among Co-op City residents
- **April/May 2015**
  - 13 confirmed cases in Flushing-Clearview section of Queens
  - No common source identified
- **July 2015**
  - 133 confirmed cases and 16 deaths in the South Bronx
- **September 2015**
  - 15 confirmed cases in Morris Park East Bronx, 1 death

Finding the Source

Linking Cooling Towers and Patients by DNA



Affected Area

Outbreak Pattern Found

- Opera House Hotel Cooling Tower
- Patients (with *Legionella* DNA results)*

Outbreak Pattern Not Found

- Cooling Towers†
- Patients (without *Legionella* DNA results)

*As of last update, all patient results match the outbreak pattern.

†Includes cooling towers in which the outbreak pattern could not be determined and those with pending results.

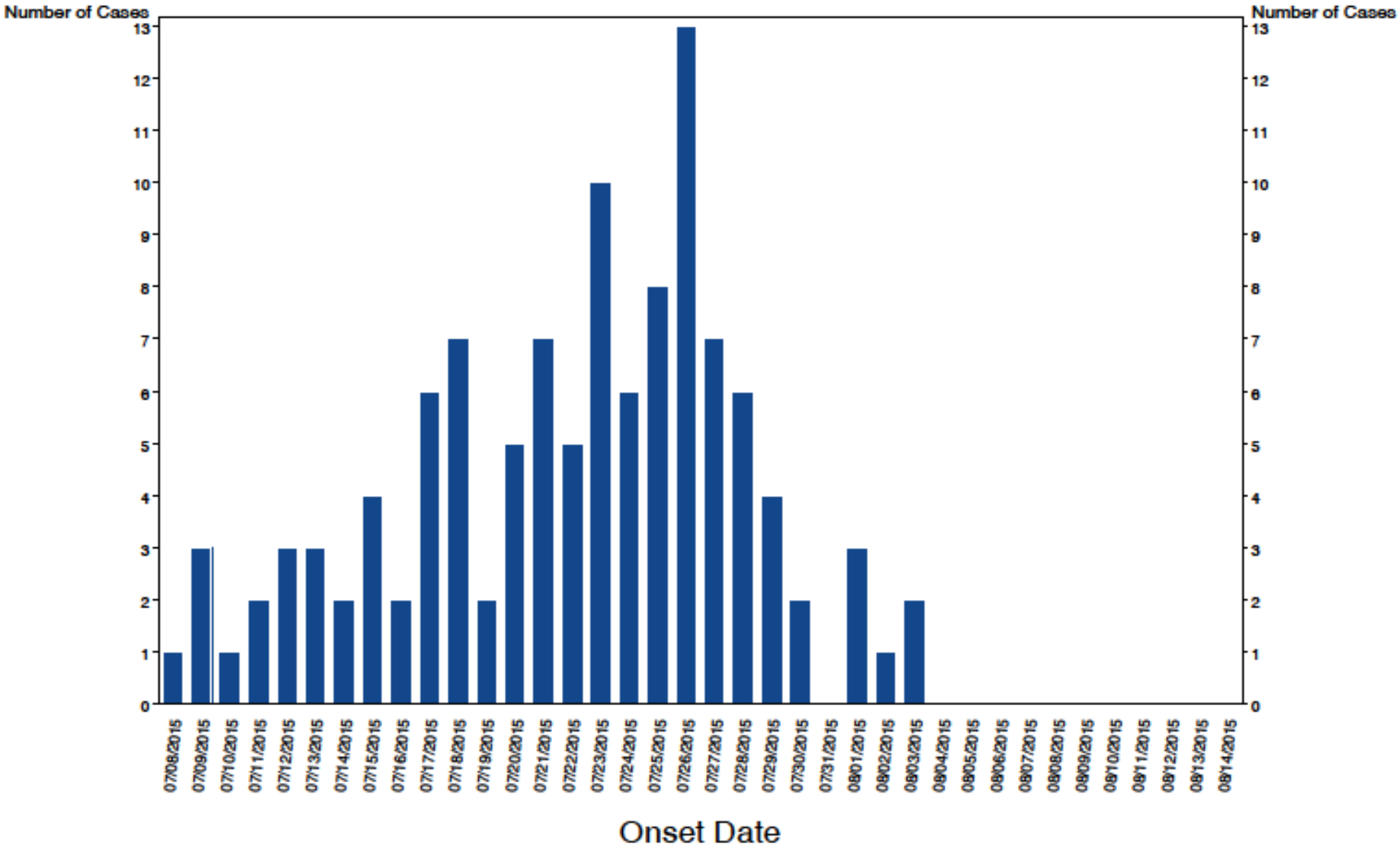
Map updated on August 20, 2015.

Bronx, New York Highlighting
Affected Zip Codes

NYC Health

Legionellosis Cluster in the South Bronx

07/08/2015 - 08/14/2015, by day
Last updated 08/15/2015



Date of symptom onset obtained from patient interviews. Reporting lags may exist due to patient availability.
Case was not shown if patient was unable to be interviewed or refused.

Legionellosis Cluster in the South Bronx

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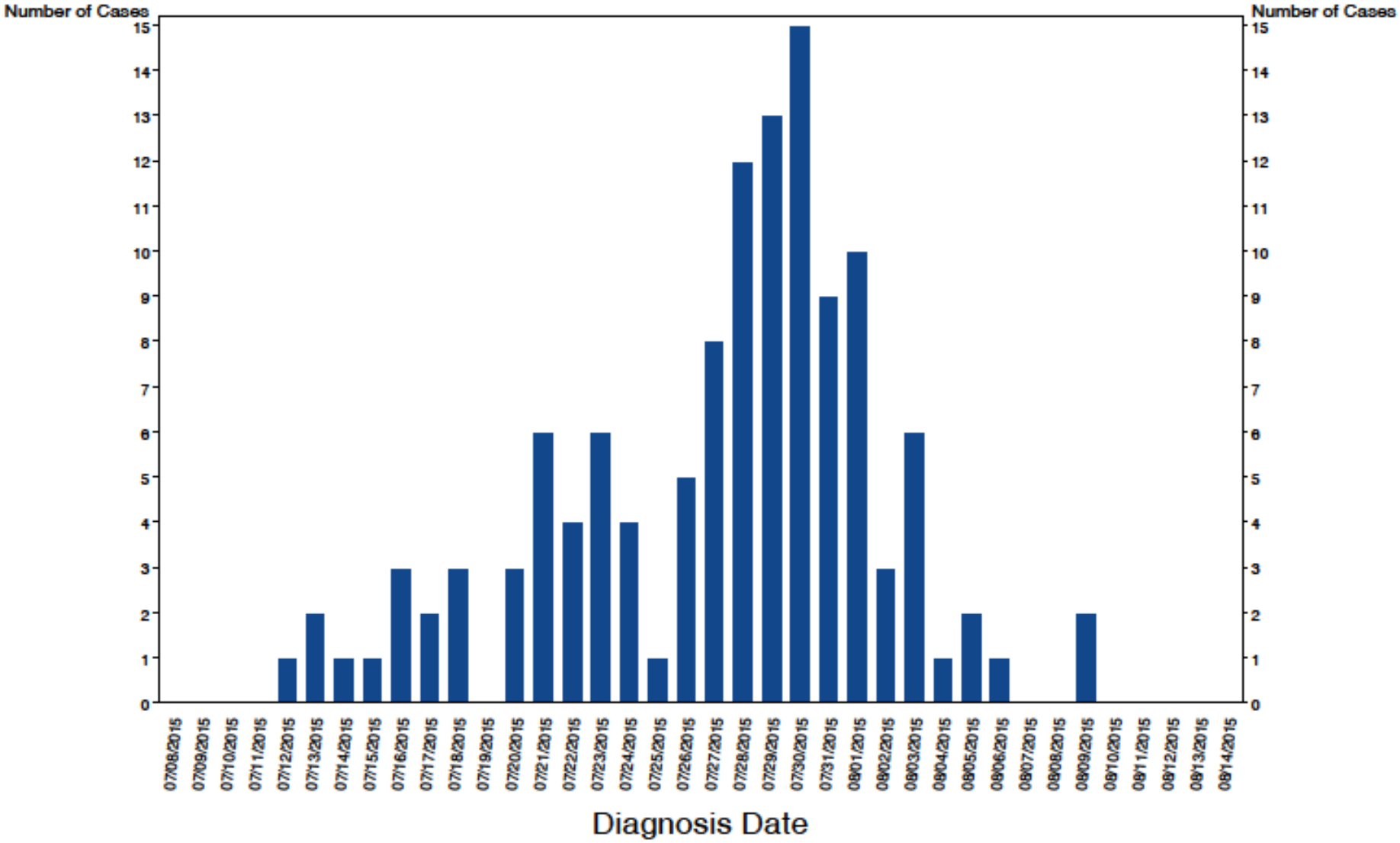
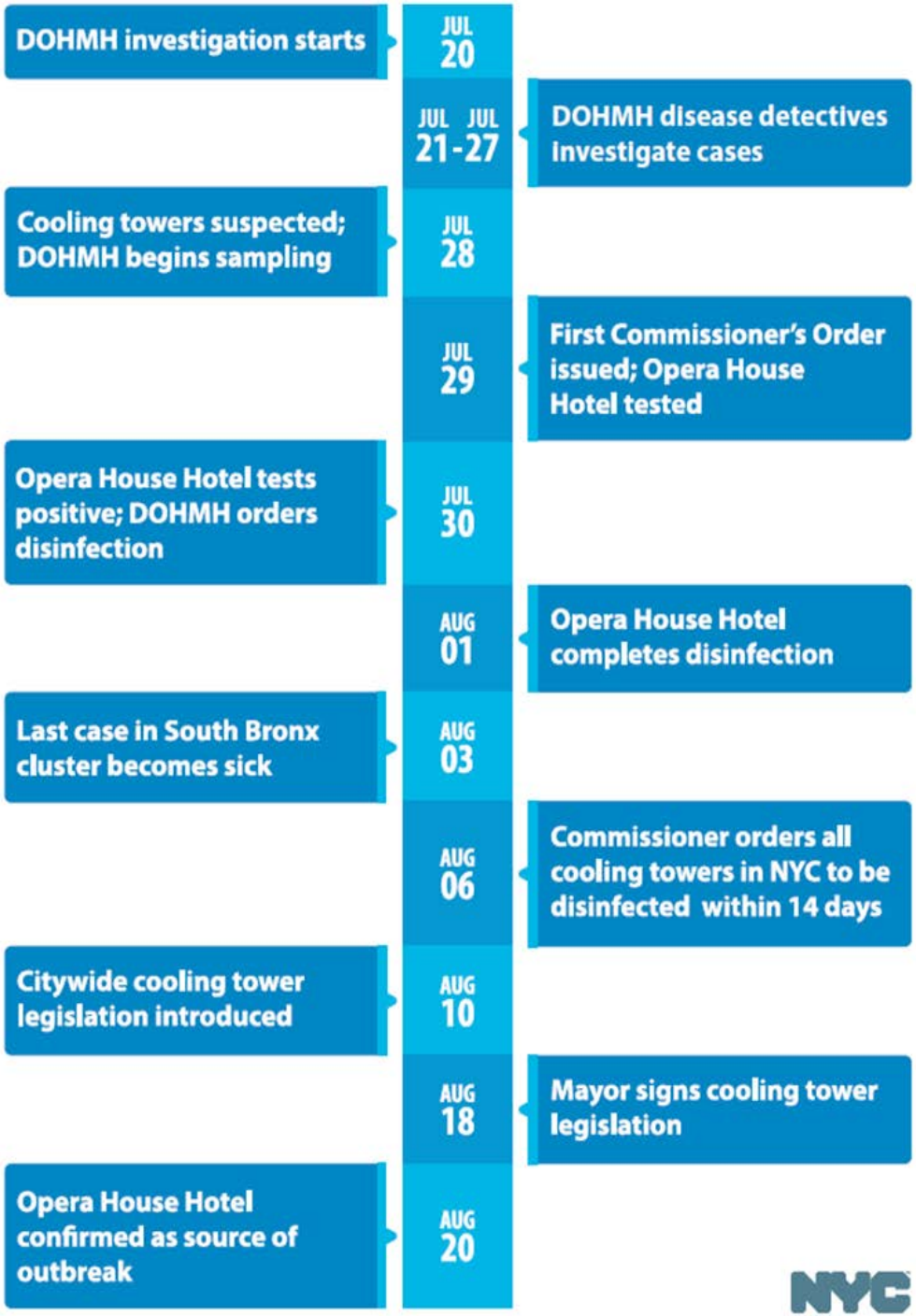


*Information in this report is preliminary. Date of diagnosis is obtained from provider and laboratory reports. Some cases had delays in diagnosis, as testing for Legionella was not initially done. Onset dates provide a better indication of the progression of the outbreak.



- July 10 - The first Legionnaires' case was reported to the city Health Department… then another… and another….
- July 25 – A computer algorithm flagged something was wrong. There were now 31 cases reported.
- July 28 The City Health Department (DOHMH) started sampling cooling towers in the area on.
- July 29 – The City DOHMH alerts doctors and the press. The next day, the City announces a total of 46 cases, and two deaths . Officials urge anyone with pneumonia-like symptoms to seek help.
- July 30 - Legionella bacteria is detected in two cooling systems.
- August 3 – Packed Town Hall Meeting , City reports 5 towers tested positive for Legionella with 97 sick and 8 dead.
- August 6 – Commissioners Orders all Cooling Towers in NYC to be Disinfected in 14-days
- August 10 the City Council passes a law requiring disinfection and registration of cooling towers. And requires that a Water Safety Plan based on ASHRAE Standard 188 must be in effect by March 1st, 2016.
- On August 20, 2015, cooling towers at the Opera House Hotel were identified as a source of the outbreak.
- A CDC official calls the city's response swift and appropriate.

Legionellosis Cluster in the South Bronx

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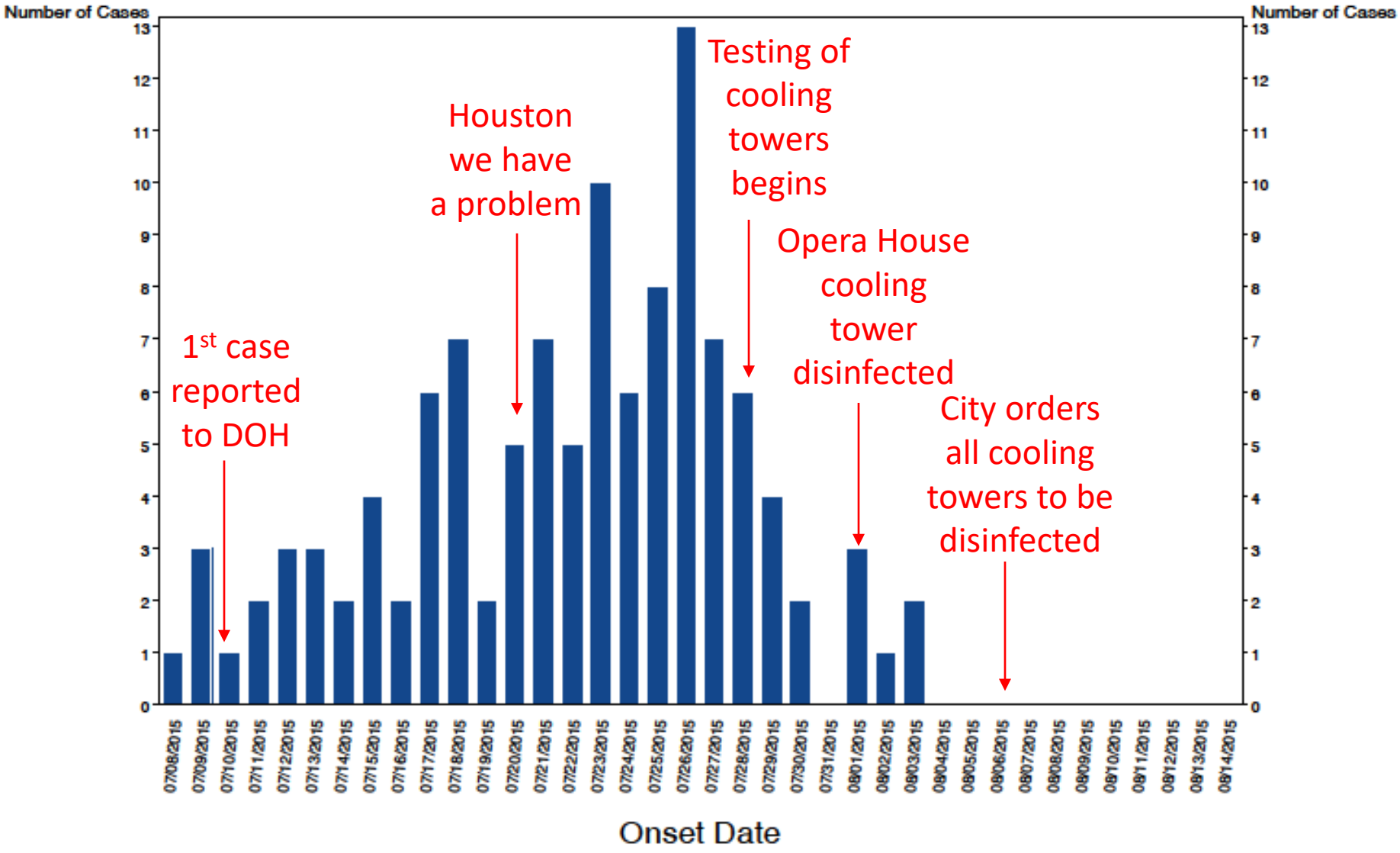
Last updated 08/15/2015



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BIOLOGY, ECOLOGY AND ENVIRONMENT OF *LEGIONELLA*

Legionella

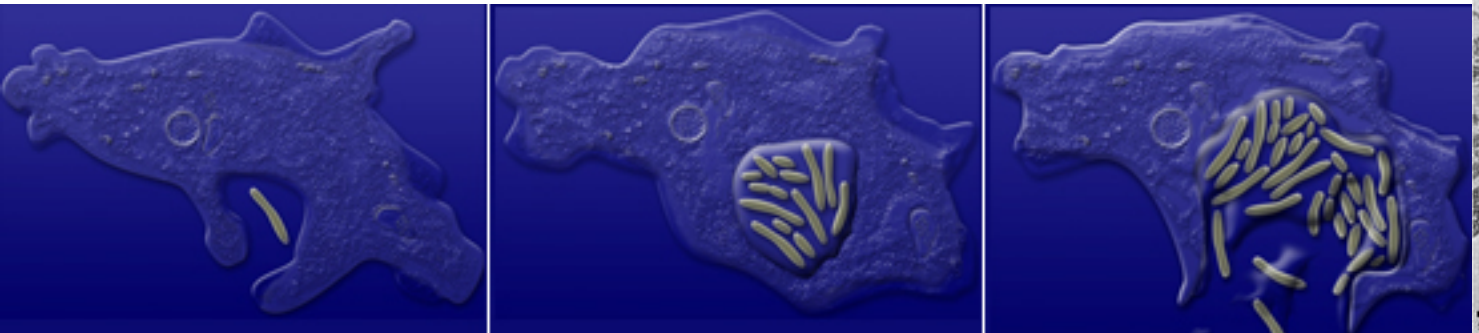
- **Gram-negative rod**
- **Most motile – 1-3 flagellae**
- **58+ species, 70+ serogroups**
  - 19+ pathogenic (pneumophila, longebeachae, bozemanii, micdadei, etc.)
- **L. pneumophila accounts for ~90% of all cases in the U.S.**

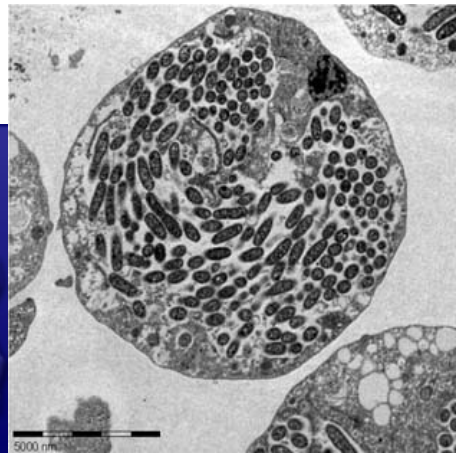
Where do we find Legionella?

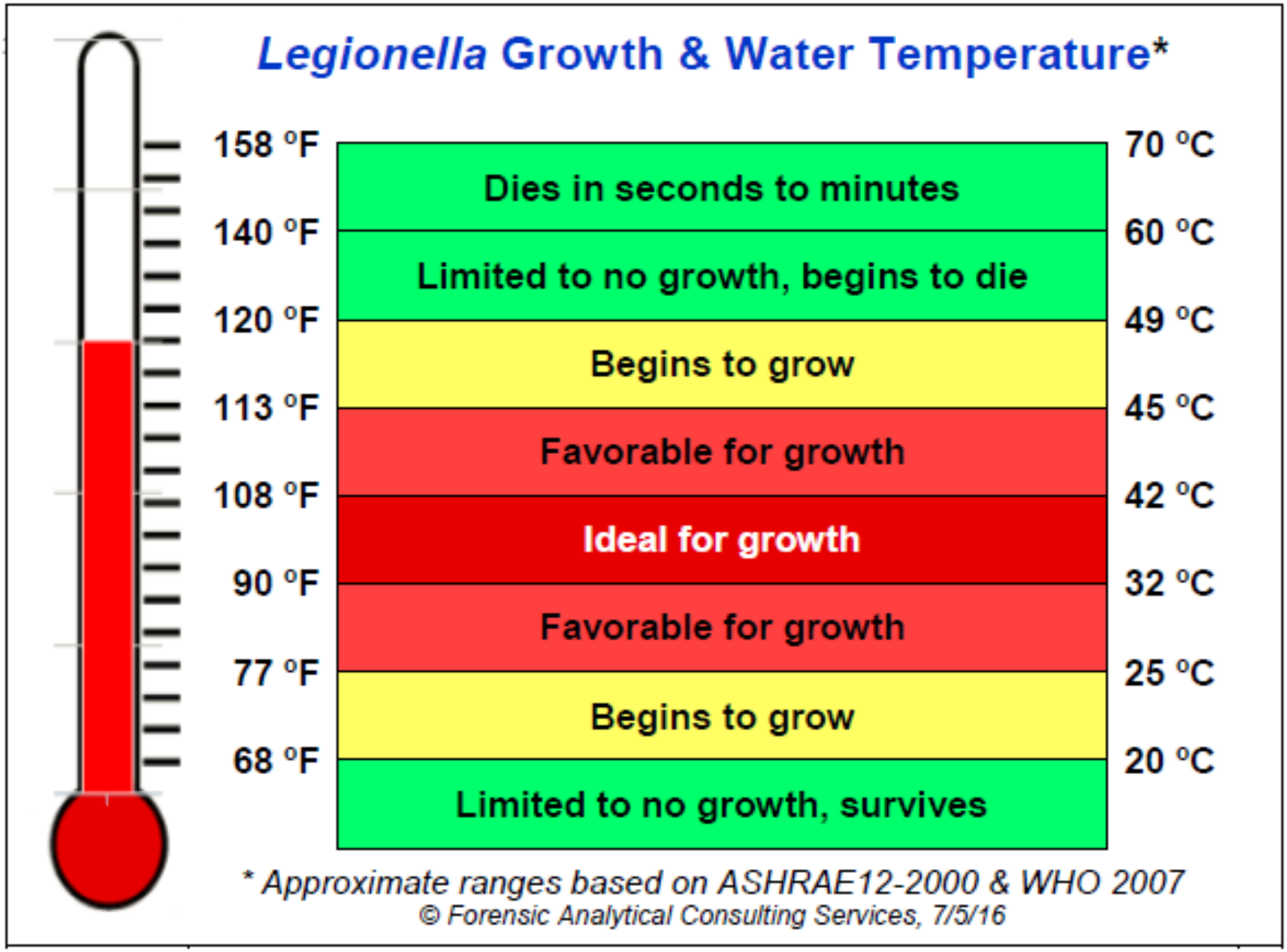
- **Habitat: freshwater**
  - Natural (ponds, lakes, rivers, etc)
  - Man-made (heat rejection and hot water systems, decorative fountains, hot tubs, etc)
- **Certain species (*L. longbeachae*) are prominent in soil**
- ***L. pneumophila* grows within amoeba**
- **Infects human alveolar macrophages**

Legionella Growth Conditions

- **Water (potable, industrial, lakes, etc.)**
- **Temperature 68-120°F (20-49°C)**
  - Ideal growth range 96-115°F (35-46°C)
- **Commensal organisms (amoebae)**
- **Sediment, scale, algae**
- **Biofilms**



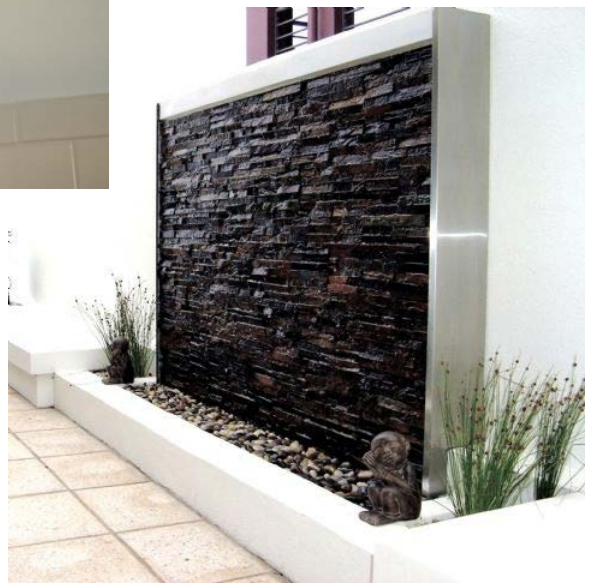



Legionella Growth & Water Temperature*
158 °F
140 °F
120 °F
113 °F
108 °F
90 °F
77 °F
68 °F
70 °C
60 °C
49 °C
45 °C
42 °C
32 °C
25 °C
20 °C
Dies in seconds to minutes
Limited to no growth, begins to die
Begins to grow
Favorable for growth
Ideal for growth
Favorable for growth
Begins to grow
Limited to no growth, survives
* Approximate ranges based on ASHRAE12-2000 & WHO 2007
© Forensic Analytical Consulting Services, 7/5/16

Common Sources

Places we frequently find biofilm, amoeba, protozoa and *Legionella* include:

- Cooling Towers
- Potable Water
  - Aerators
  - Shower heads
  - Misters
  - Humidifiers
- Ornamental waterfalls, ponds, and fountains

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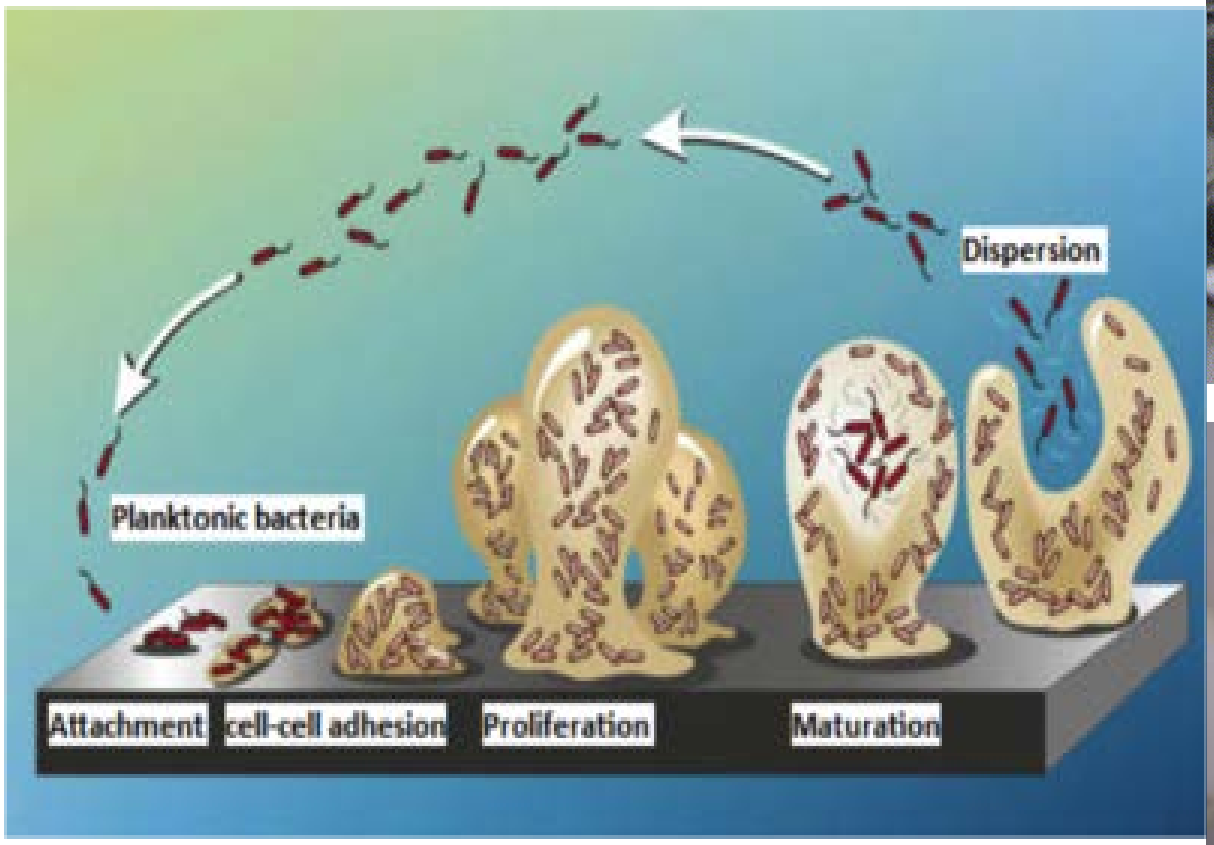
Biofilm

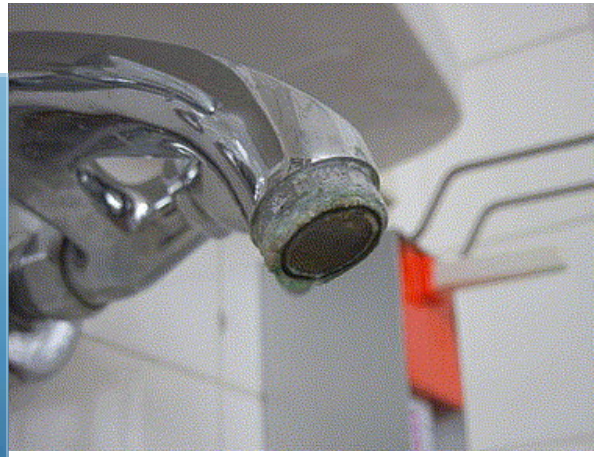
- **Biological organisms adhering to one another on a living or non-living surface**
- **Self-produced matrix**
- **Extrapolymeric substance (EPS)**
- **Extracellular DNA, protein, polysaccharides**
- **Biofilms are common**
  - Oil recovery
  - Food processing
  - Cooling towers
  - Paper manufacturing
  - Medical implants, etc.

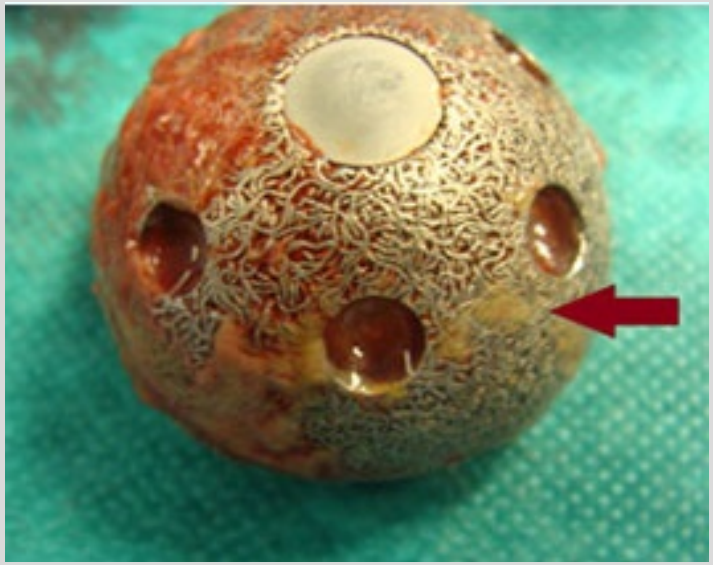
Biofilm

- **Biofilms are heterogeneous, sometimes comprised of competing organisms**
- **So…why do biofilms grow?**
  - Microniche
  - Nutrient transport
  - Protection from unfavorable environments
  - Anti-microbial/antibiotic resistance
  - Proliferation, growth potential, dispersal
  - Exchange of genetic material

Biofilm


Dispersion
Planktonic bacteria
Attachment
cell-cell adhesion
Proliferation
Maturation

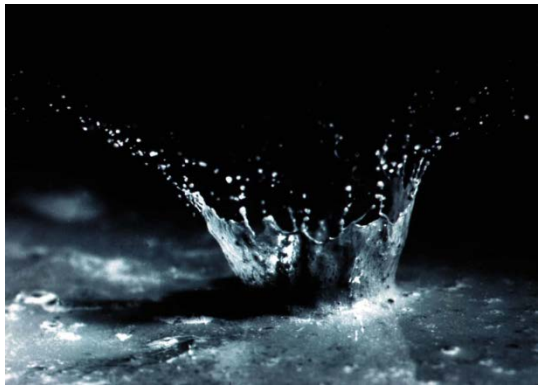




EPIDEMIOLOGY OF *LEGIONELLA*

Disease Process

- ***Legionella* amplification at the source**
- **Droplets/aerosols of contaminated aerosol generation**
- **Infection caused by:**
  - Inhalation of droplets/aerosols to deep lungs
  - Aspiration of contaminated water
  - Handling of contaminated soil
  - Surgical wound infections?
  - Other?



Legionnaires' Disease

- **Incubation period: 2-14 days (avg. 5-6 days) after exposure to *Legionella***
- **Symptoms (extrapulmonary) include:**
  - Headache, muscle pain, chills
  - Fever that may be 104 F (40 C) or higher
  - Cough, mucus and sometimes blood
  - Shortness of breath, chest pain
  - Gastrointestinal symptoms, such as nausea, vomiting and diarrhea
  - Confusion or other mental changes
  - Cardiovascular collapse and death

Legionnaires' Disease

- **Reportable disease**
  - Health Department, CDC
- **Incidence tripled from 2000 to 2009**
- **8,000 to 18,000 hospitalizations in the US per year**
- **Not transmissible from person to person***

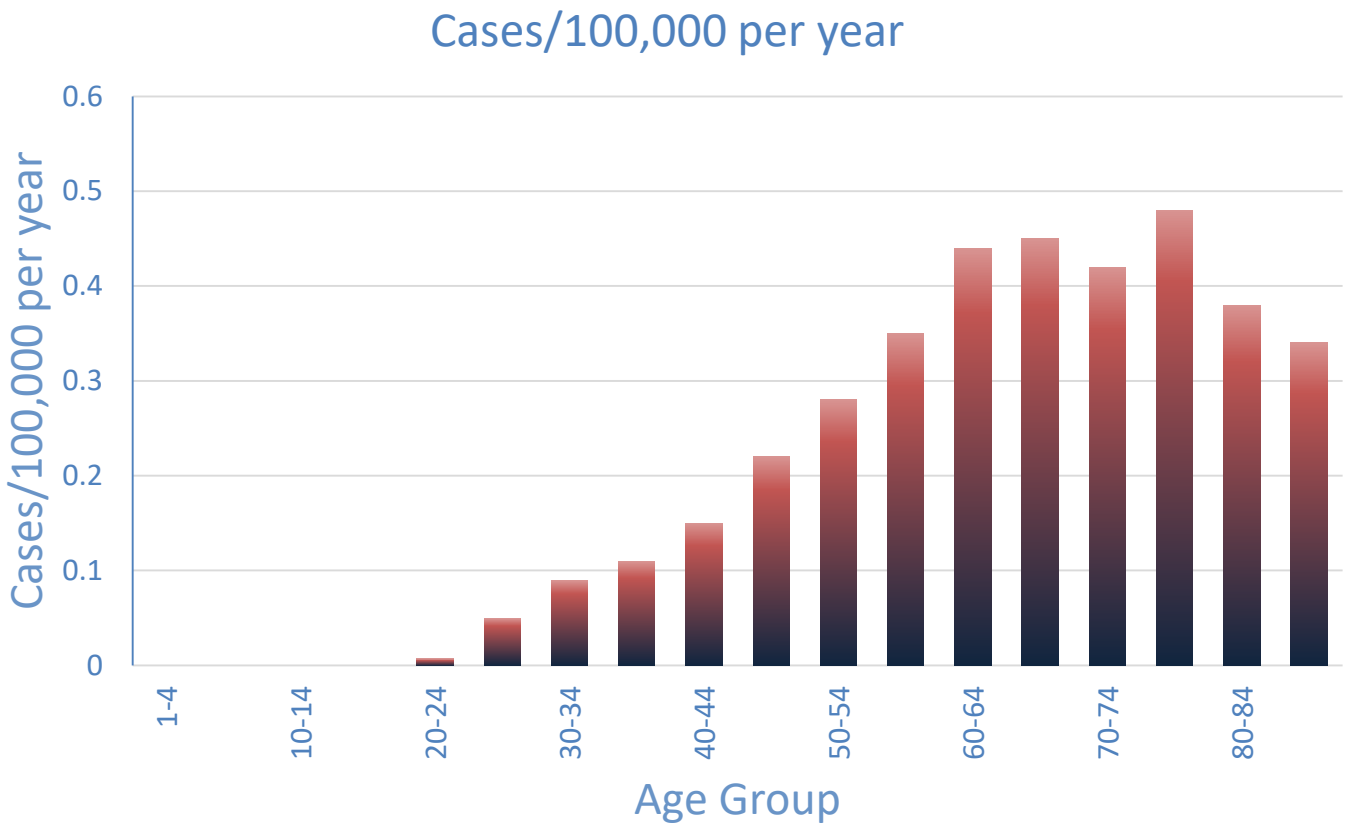
Risk Factors for LD

- Current or former smoker
- Elderly (age 50 or older)
- Lung or kidney disease
- Diabetes
- Cancer
- Weakened immune system due to medications or disease

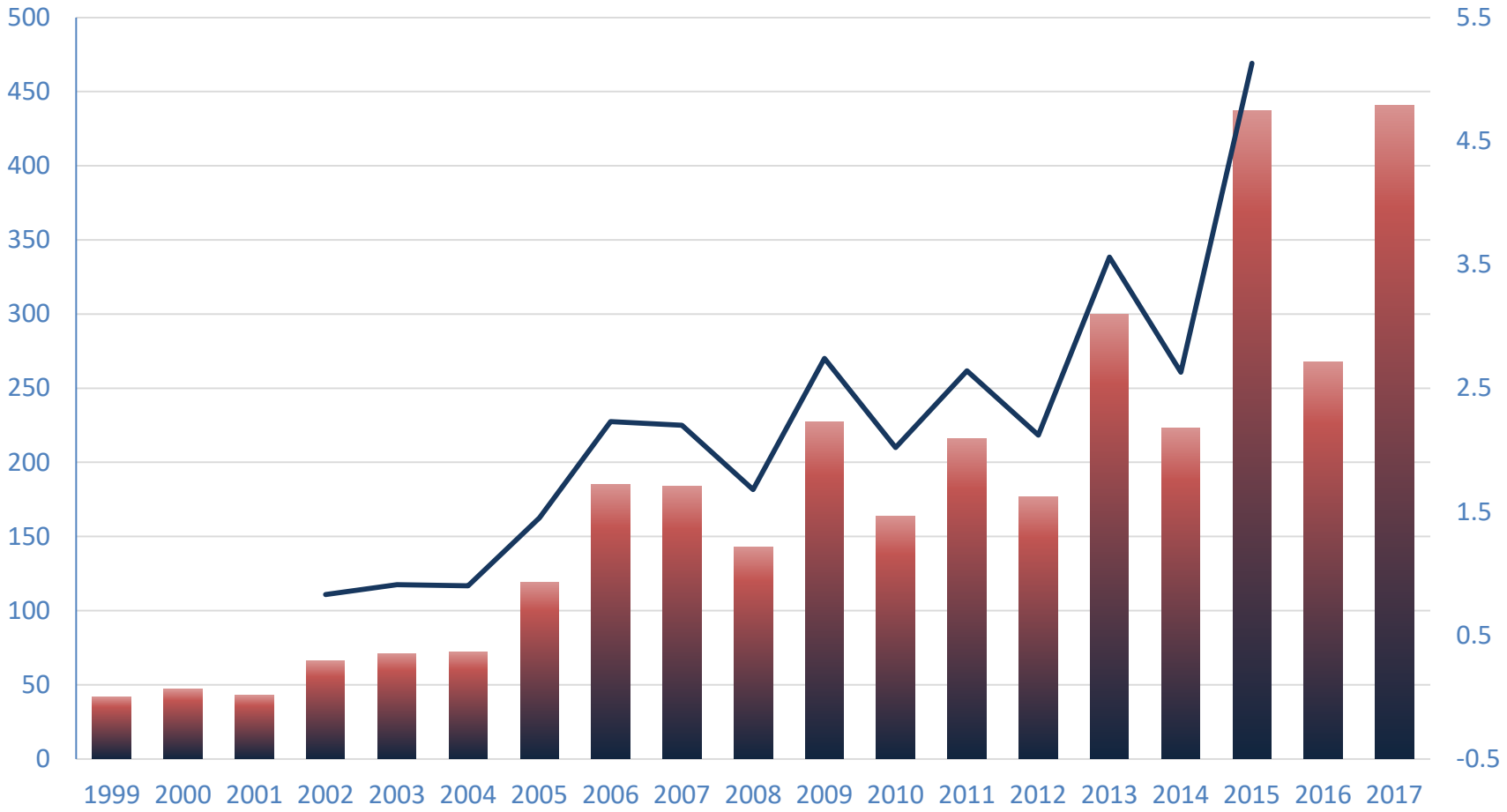
Presentation

- **Outbreak associated LD's – 4% to 9.3% of all LD's reported in US & EU**
- **Travel related LD's (Domestic and foreign) – 19% to 24% of LD cases reported in US & EU**
- **Are the rest sporadic cases?**
- ***Legionellae* persistence and remediation**

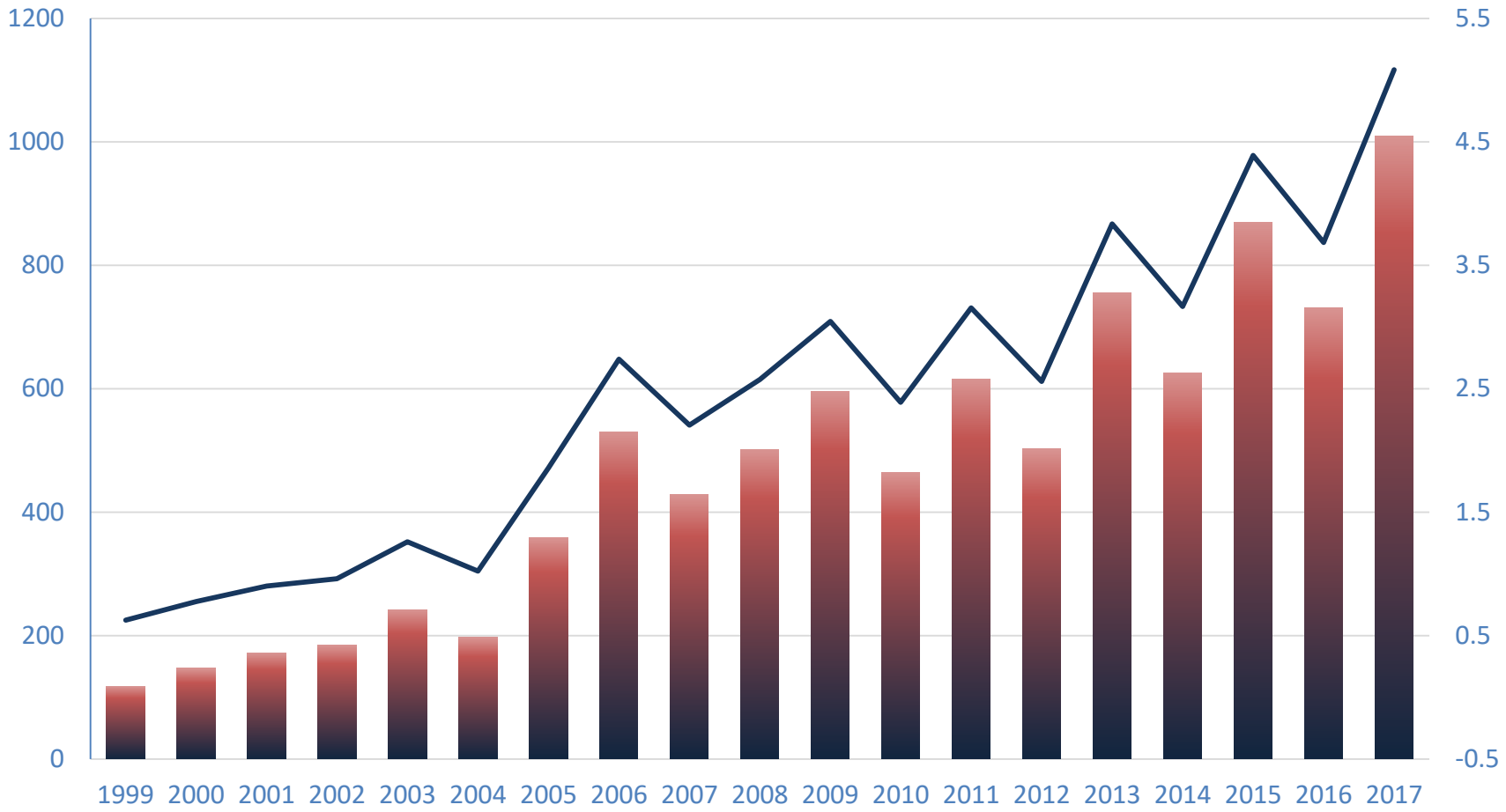
LD by Age Group



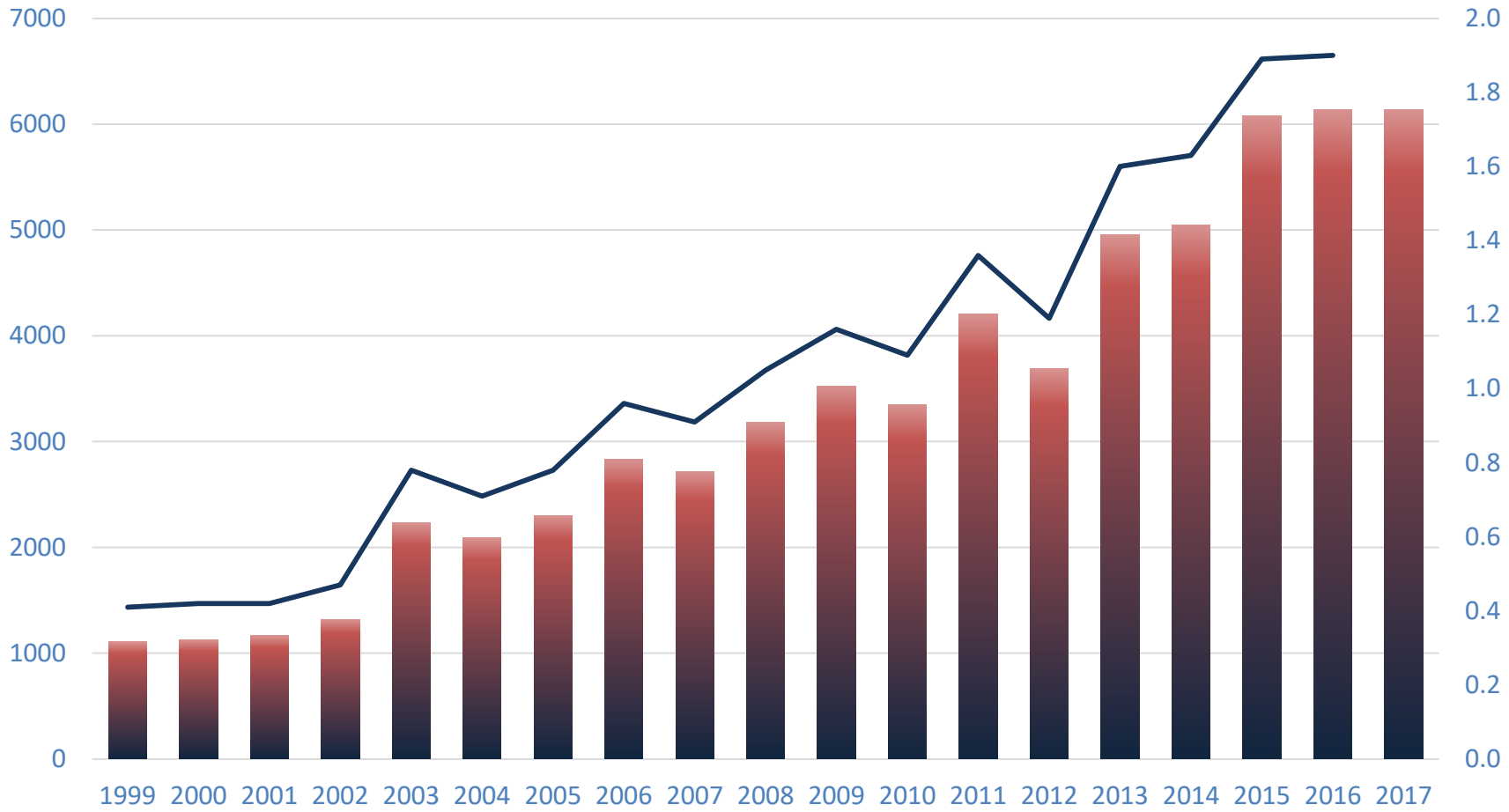
Reported cases, NYC



Reported cases, New York State



Reported cases, U.S.



Pontiac Fever (PF)

- **Less severe than Legionnaires' Disease**
- **Flu-like symptoms, including:**
  - Fever
  - Chills
  - Headache
  - Muscle aches
- **Not a lung infection**
- **Usually clears within 2-5 days**

Why the Increase?

- **Increasing population of older persons**
- **Increasing population of persons at high risk for infection**
- **Improved diagnosis and reporting**
- **Climate change?**

Why the Increase?

- **Plumbing codes limiting temperature of hot water**
- **Decrease in disinfectant levels of supply water**
- **Energy codes**
- **Green buildings movement**

Why the Increase?

Why the Increase?

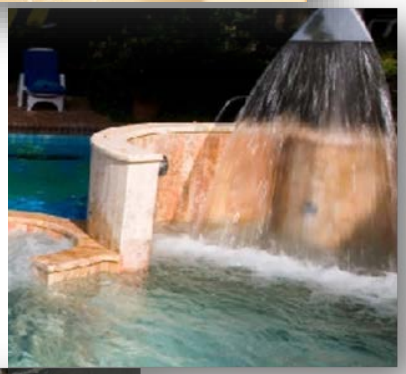
- **Water management problems. Nearly half of the outbreaks that CDC investigates are caused by one or more of the following:**
  - 65% due to process failures, like not having a water management program.
  - 52% due to human error, such as not cleaning or replacing hot tub filter as recommended.
  - 35% due to equipment, such as disinfection system, not working.

Qualitative Risk Assessment

- **Primary Goal: identify potential amplification sites and transmission sources**
- **Assessment should minimally document locations where:**
    - Water temperature between 80 and 120° F
    - Water is stored or recirculated; low flow/pressure
    - Stagnant water; actual or effective dead legs
    - Water contains rust, sludge, scale organic matter and/or biofilms
    - Aerosols or mists are produced
    - People are likely to be exposed to water aerosols
    - Recent construction may have resulted in disruption of the water system
    - Design deficiencies exist

Qualitative Risk Assessment

- **Inventory Water systems**
  - Incoming water supply
  - Potable water system- hot and cold
  - Water tempering and storage
  - HVAC - cooling towers, evaporative condensers, in-duct humidifiers
  - Non-potable sources (fountains, spas, irrigation, fire sprinklers, etc.)
  - Known or potential dead legs



Qualitative Risk Assessment

- **Observe and Characterize Water Systems for Amplification Hazard**
  - Water temperatures
  - Residual chlorine
  - Presence of scale, sediment, and biofilm
  - Equipment cleaning schedule & effectiveness
  - Dead legs, issues with flow
  - Supplemental water treatment
  - Exposure to/entrainment of mists

Water Systems Assessment

- **Develop Water Management Team**
- **Qualitative Risk Assessment**
  - Building/History review
  - Inventory Water Systems/Diagram
  - Characterize Water systems
- **Perform Environmental Sampling**
- **Recommend Mitigation Measures/Controls**
- **Verification and Validation**
- **Disease Surveillance**

ASHRAE Standard 12-2000

ASHRAE Standard 12-2000 *Minimizing the Risk of Legionellosis Associated with Building Water Systems.*

- Provides guidance on how to minimize *Legionella* in building water systems.
- Potable and emergency water systems; heated spas; architectural fountains and waterfalls; cooling towers and evaporative coolers.

Cooling Tower Institute

Cooling Technology Institute.

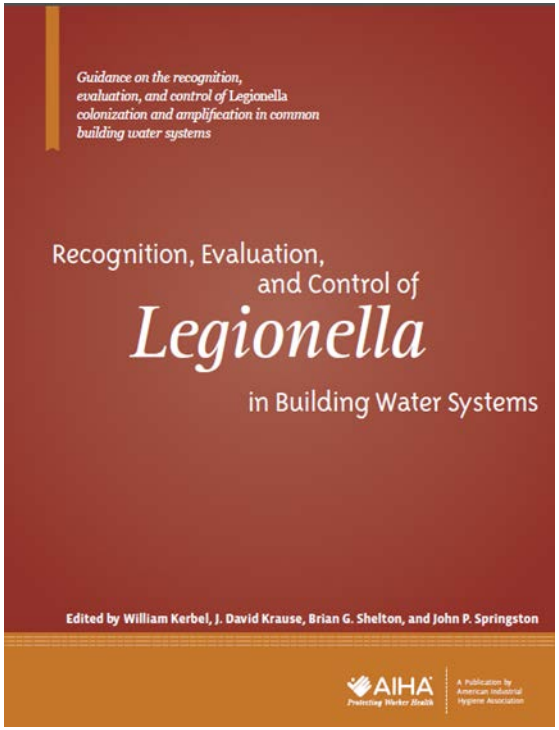
2008 Guideline *Best Practices for Control of Legionella.*

- Monitoring *Legionella* in cooling water systems via visual inspection an regular monitoring of planktonic (bulk water) and sessile (surface) microbial populations (i.e., dip slides and HPC)
- Does not recommend testing for *Legionella* unless there is an outbreak.
- Provides guidance on routine and emergency disinfection of cooling towers.

AIHA 2015 Legionella Guideline

Recognition, Evaluation, and Control of *Legionella* in Building Water Systems

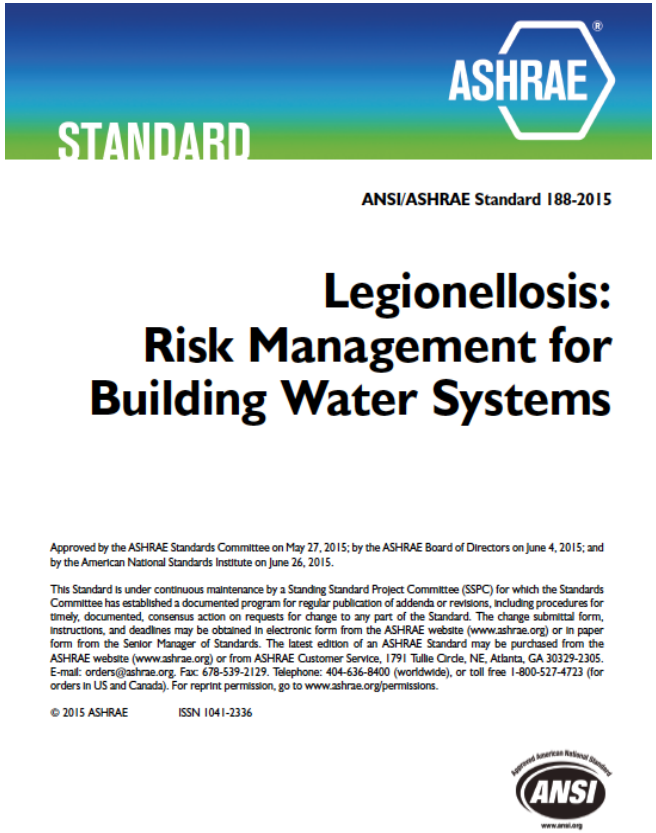
- Legionella working group response to ASHRAE 188 drafts and the use of Hazard Analysis Critical Control Points (HACCP) risk assessment.
- Incorporate industrial hygiene perspective.
- Focus on proactive effort.
- Prevent disease through source identification, risk assessment, and control.



ASHRAE Standard 188-2015

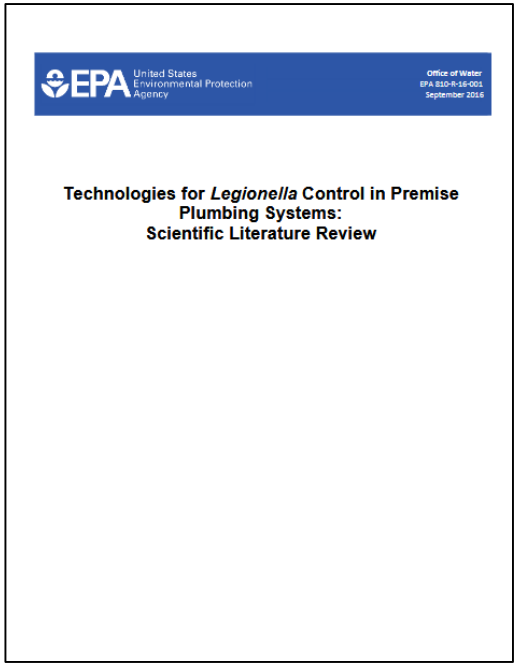
ASHRAE Standard 188-2015
Legionellosis: Risk Management for Building Water Systems.

- Management system based on HACCP.
- Establishes minimum risk mgmt. requirements for building water systems.
- Develop water-system schematics of potable and non-potable water systems.
- Determine where control measures are applied and monitored.



Environmental Protection Agency

- September 2016
- Non-regulatory document
- Guidance on control strategies for premise plumbing systems
- Does not cover cooling towers
- No “recommendations”



Centers for Disease Control

- CDC “Toolkit” June 2016
- Practical guide for implementing standards
- Guidance on development of a WPMP
- Understanding risk
- Identifying buildings and systems at risk
- Sampling and risk assessment guidance

Question…Why do outbreaks happen??

Answer…Lack of, or absence of, accurate validation