Listeria workshop: introduction and overview

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NZFSSRC

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New Zealand
FOOD SAFETY SCIENCE
& RESEARCH CENTRE

Purpose:
To determine the research priorities of Industry in relation to *Listeria*

1245 John Donaghy, Nestle By Zoom

"WGS: - Using it for real in the food manufacturing industry"

1305 Dr Arnoud van Vliet, University of Surrey By Zoom

"*Whole Genome sequencing and Listeria: technology, applications and opportunities*"

1325 Dr Lucy Rivas, ESR

"Getting a handle on Listeria in New Zealand –developing a shared whole genome sequence database for food safety applications"

1340 Dr Helen Withers, MPI

"Listeria monocytogenes: ongoing monitoring and control. How does NZFS use WGS data to support safe food production?"

1355 Philip Wescombe, Oceania Dairy

"*Implementing WGS alongside the NZFSSRC"*

1410 Denver McGregor, NZKS

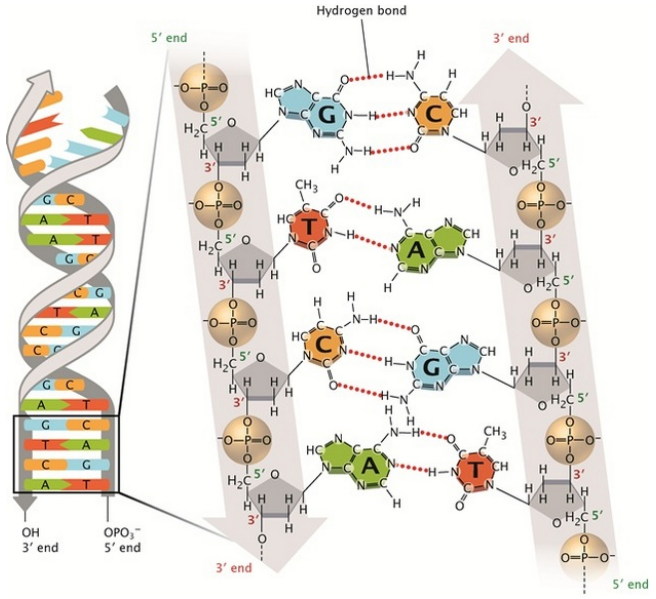
Working Title: *"NZ King Salmon experience in whole genome sequencing of Listeria"*

1425 Open Session

- What are the priorities for Industry?
- Pros and Cons of data sharing
- Next steps

Overview

- Listeria – the problem
  - –Disease, epidemiology
  - –Impact on food industry
  - –Global and local
- Genomics for food safety/listeria control
  - –What it can and can't do
  - –Limitations to adoption
- NZFSSRC Listeria programme introduction



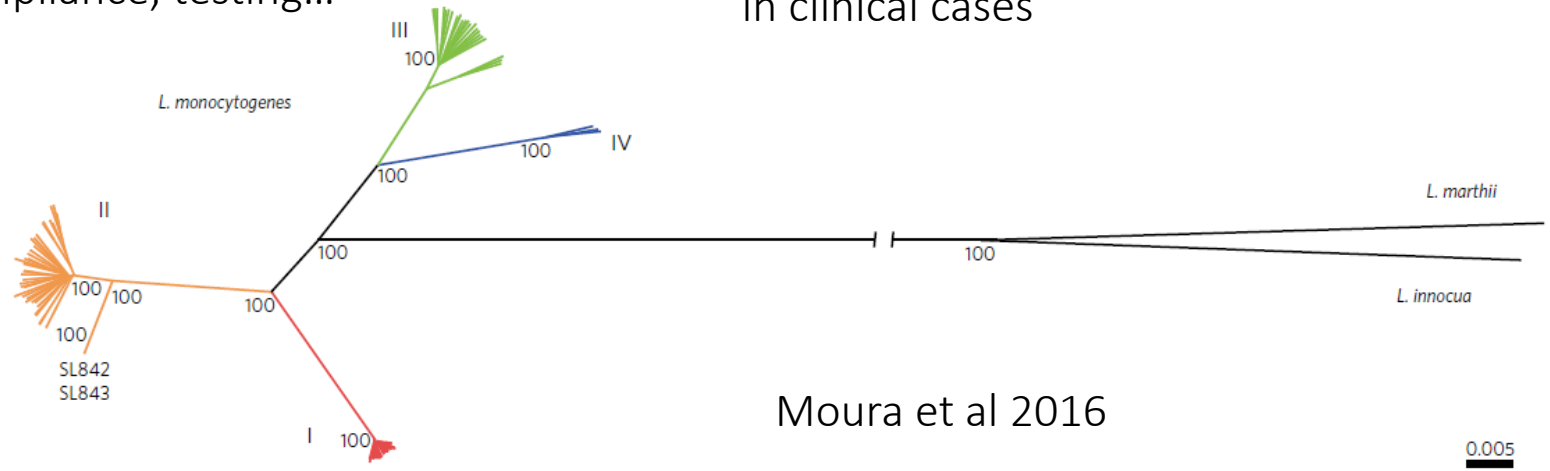
Listeria – the problem

Globally

- –Many different species of *Listeria* recovered from food and processing environments
- –*L. monocytogenes* an important foodborne pathogen
  - not as common as other FBPs, but can cause severe illness
- –Major cause of product recall
- –Large scale outbreaks
- –Large costs associated with illness, hospitalisation, recalls, compliance, testing…

Key features:

- –Grows at low temperatures
- –Can overcome ‘stresses’ e.g. Osmotic stress
- –Can survive mild heat treatments (milder than pasteurisation)
- –Can persist for decades in processing plants (ST121)
- –Some strains resistant to santisers (QACs)
- –Form biofilms
- –Four different lineages of mono – lineage 1 more in clinical cases



Moura et al 2016

Listeriosis epidemiology

- *Listeria* food poisoning more common in YOPI (babies, elderly, pregnant, immunocompromised)
- Listeriosis in pregnancy (PW 10x risk): miscarriage, stillbirths, preterm labour, serious illness and death of newborns
- Outbreaks of listeriosis before year 2000 primarily linked to deli meats / processed meats. Now, more often linked to dairy products and fresh produce (RTEs)
- Recent global outbreaks in soft cheeses, beansprouts. cantaloupe, and ice cream.

Rockmelon listeria outbreak: Victorian man becomes fifth person to die from contaminated fruit

Posted Fri 16 Mar 2018 at 11:41am, updated Fri 16 Mar 2018 at 1:33pm

Large outbreaks can occur

- South Africa outbreak
- Enterprise Foods in Polokwane
- 2017/18
- 1060 confirmed cases
- 216 deaths
- Polony products
- Tiger Brand's stock price dropped by 7%, resulting in a US$438.69 million reduction in total value
- Class action lawsuit, 1000 claimants

Listeriosis NZ

- Sporadic cases and outbreaks

Year	Age group (years)											Total
	<1	1 to 4	5 to 9	10 to 14	15 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70+	
2019					1	5	3	3	3	3	13	31
2018						1	3	2	2	5	17	30
2017	1						1	1	3	5	10	21
2016	1				1	2	4		5	7	17	37
2015	1	2				5	3	2	1	3	9	26
2014						1	4	1	2	7	10	25
2013			1			2	4	1	2	3	6	19

HAWKES BAY TODAY

Bay Cuisine fined over listeria meat

15 Jul, 2015 01:47 PM · Quick Read

4 cases, 2 deaths, 2012

4 cases 2020. product recall

Jeffs *et al. BMC Public Health* (2020) 20:116
https://doi.org/10.1186/s12889-020-8221-z

BMC Public Health

RESEARCH ARTICLE Open Access

The epidemiology of listeriosis in pregnant women and children in New Zealand from 1997 to 2016: an observational study

Emma Jeffs[1], Jonathan Williman[2], Cheryl Brunton[2], Joanna Gullam[3] and Tony Walls[1*]

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Food recall after listeria found in pre-made salads

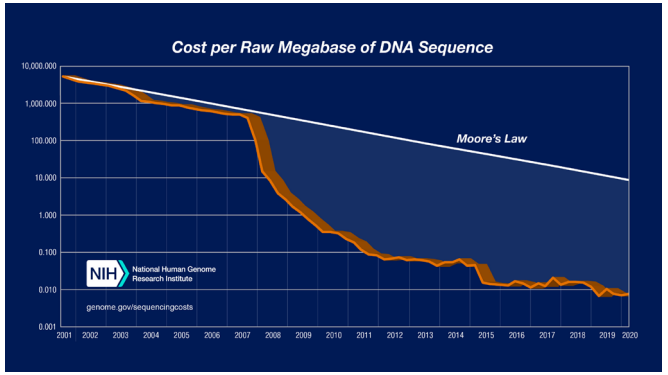
10:12 am on 30 January 2021

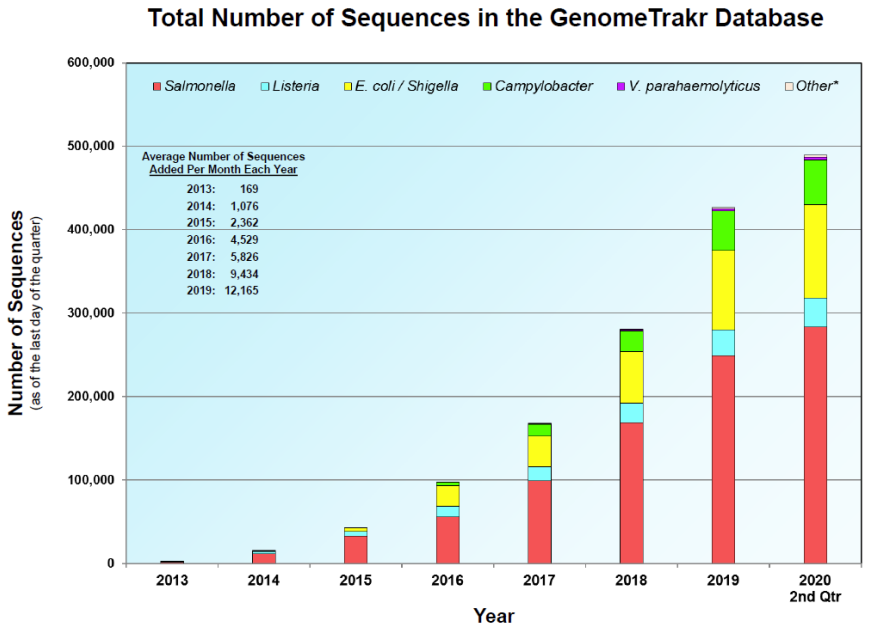
Share this

A clutch of ready-made salads are being recalled over fears they could contain potentially harmful bacteria.

Genome sequencing and pathogen genomics for food safety: applications

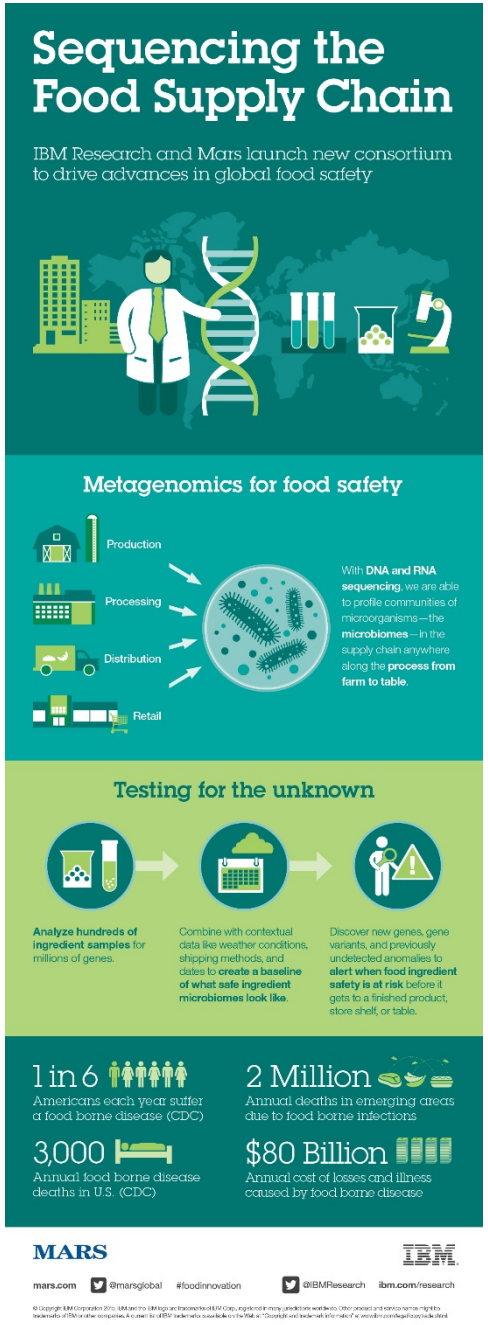
- Identifying ‘source’ and transmission of pathogens
  - Outbreak investigation
  - Foodborne pathogen surveillance
  - ‘Source attribution’ of human illness
  - Time and origin of incursions
    - Into country
    - Into processing environment
  - Source tracking
    - Along production chain (including between farms)
    - In processing environments
    - Locating and eradicating pathogens from factory environment





Genome sequencing, pathogen genomics and food safety

- Diagnostic test development
- Establishing normal and abnormal ‘flora’ in supply chain
- Evolution, antimicrobial resistance, virulence
- Genotype and phenotype expression – new/appropriate interventions
- Probiotic safety



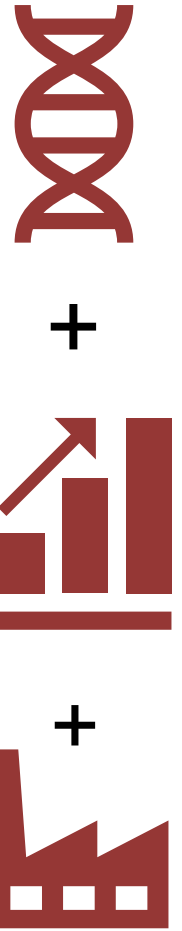
WGS: just one piece of information in the bigger picture!

(from Pightling et al 2018)

- "Epidemiology considerations, traceback information, and other data are critical to determining the most appropriate regulatory responses."

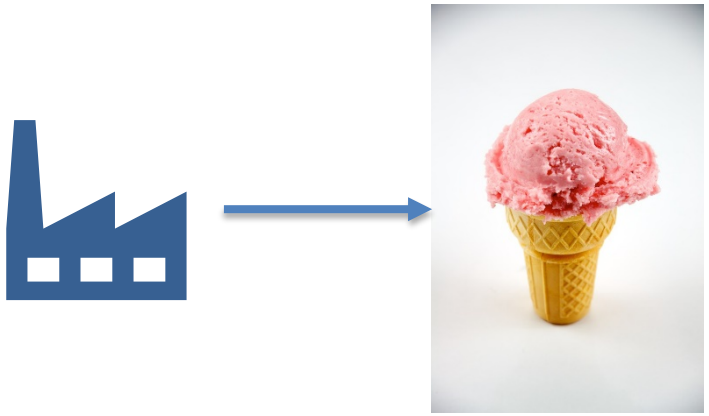
- "Bacteria with non-identical genome sequences can originate from the same source, …….and identical genome sequences should not lead to presumptions of causality."

- "The goal of investigators is to consider these complexities, along with epidemiological and traceback evidence, to determine whether two or more isolates arose from the same reservoir population."

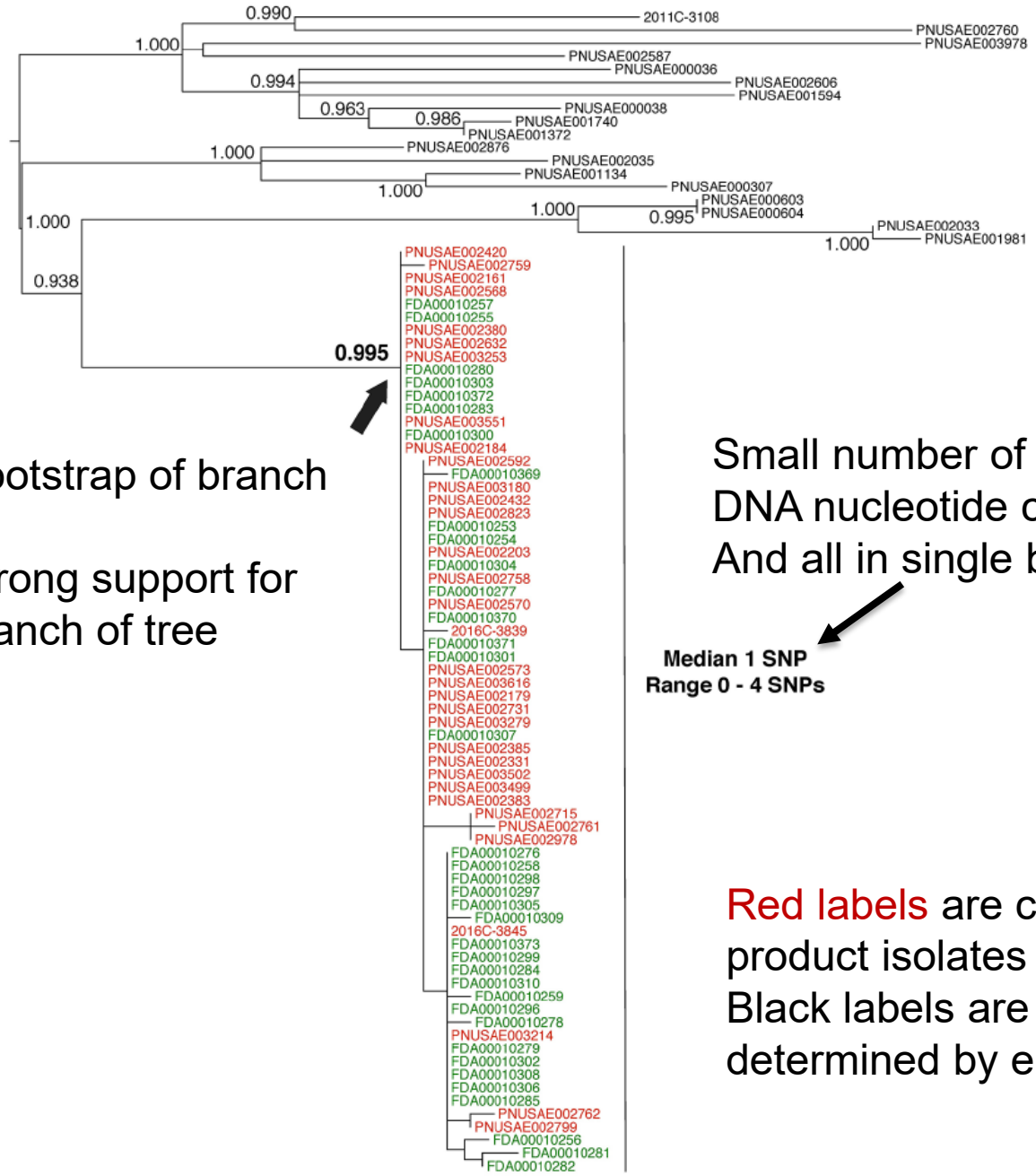


WGS food safety applications and interpretation

- Source of an outbreak?
- Source of contamination in processing?
- Resident strains or new introductions?



Identifying the source of an outbreak



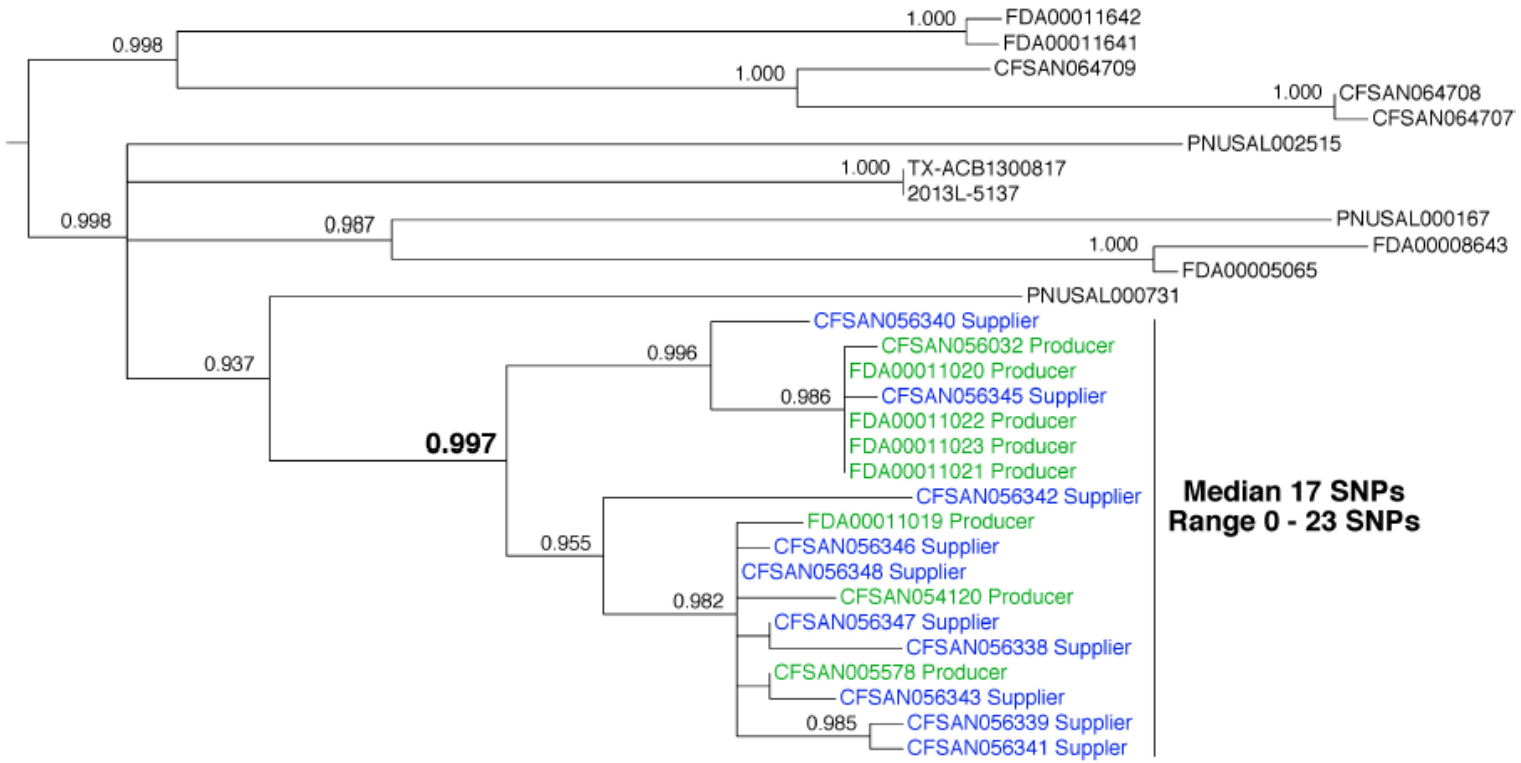
Bootstrap of branch

Strong support for branch of tree

Small number of
DNA nucleotide changes
And all in single branch of tree

Median 1 SNP
Range 0 - 4 SNPs

Red labels are clinical isolates, green labels indicate food product isolates related to the outbreak.
Black labels are isolates not involved in the outbreak as determined by epidemiology and traceback investigations.



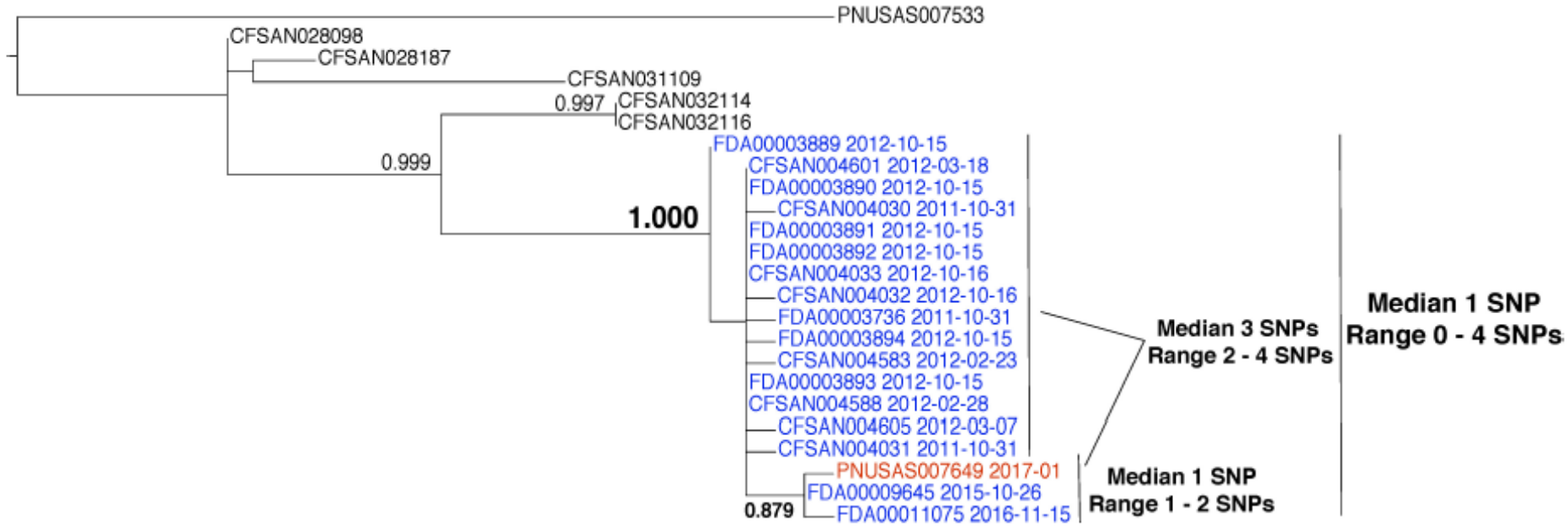
Green labels isolates from final product and blue labels environmental isolates from ingredient supplier. Black labels indicate bacteria not isolated from either the ice cream samples or the supplier environment but closely related

Source of contamination: matching food isolates from one company to environmental isolates from ingredient supplier

Listeria mono in ice cream (from Pightling et al 2018

Identifying a Persistent/Resident Pathogen

Food factory isolates over 6 years (from Pightling et al 2018



Blue labels indicate environmental isolates and the red label indicates a clinical isolate. Black labels indicate isolates that did not originate from the subject food processing facility but are closely related.

Local transmission studies: micro-mapping of food production/processing environments

- Plant-scale micromapping
- Previously applied to transmission within hospitals
- Same technology and analytical tools applied in within processing plants
- Entry points and vectors?
- Resident strains?
- Resistance to sanitisers, heat...etc
- *Campylobacter, Listeria*, *Cronobacter* and *E. coli*.

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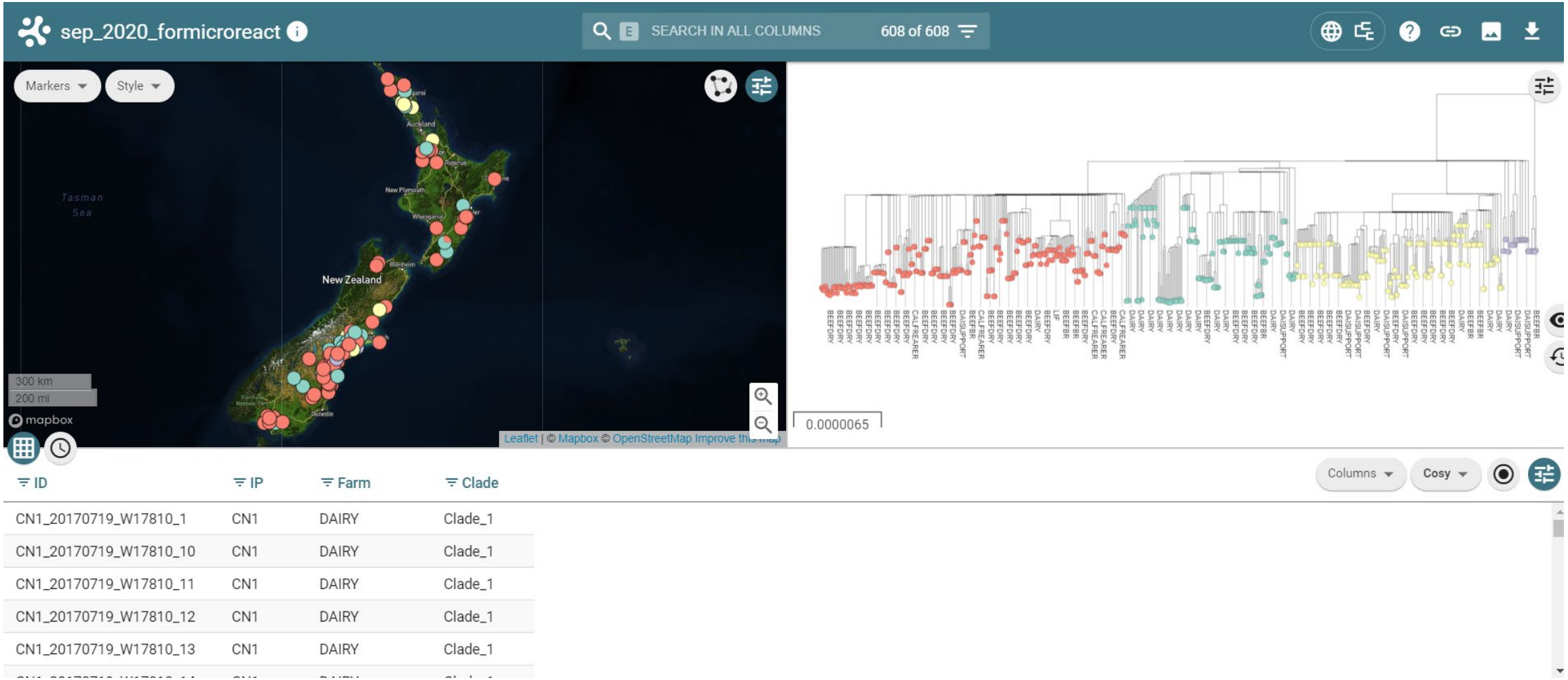
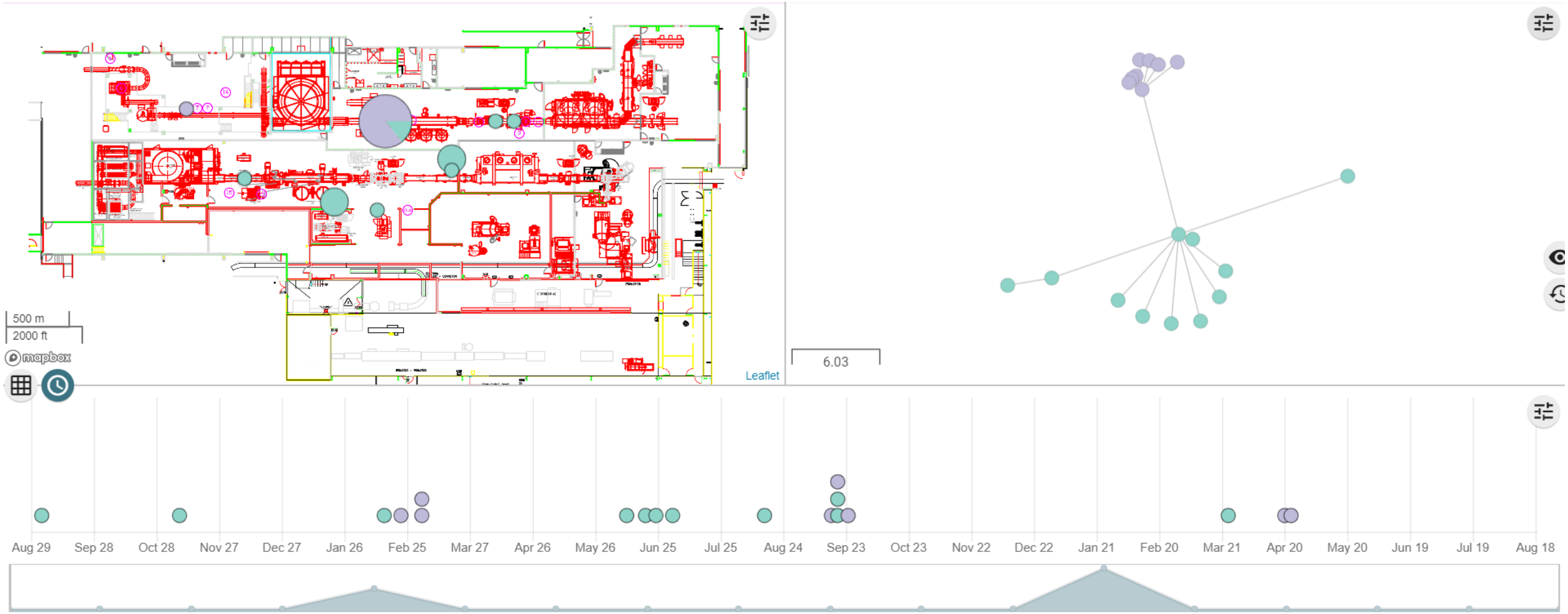
Visualisation tools: microreact



Adapted to local, plant scale mapping

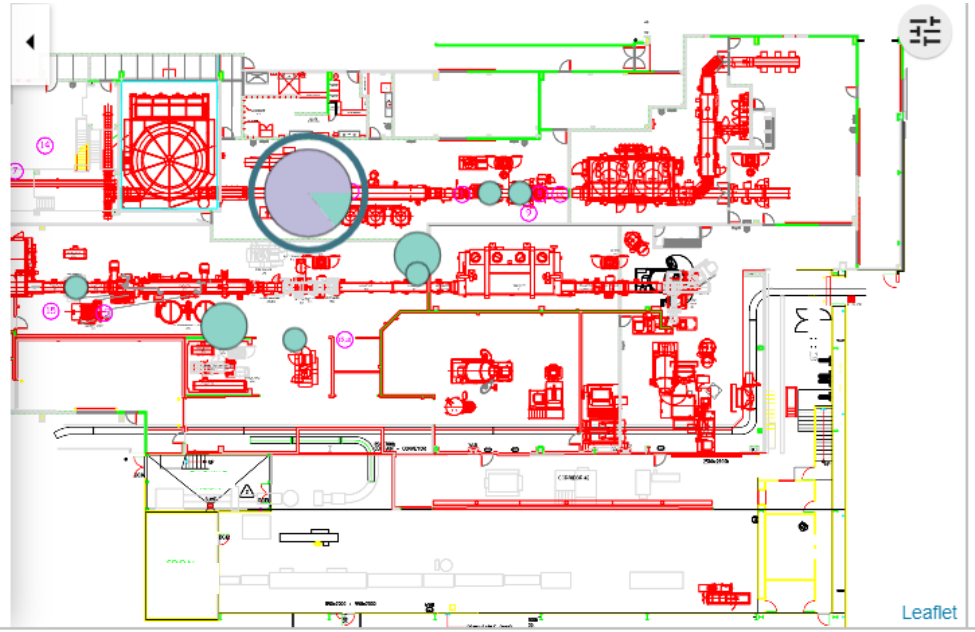


Application using microreact (https://microreact.org/)

7 ITEMS

1 × Listeria innocua

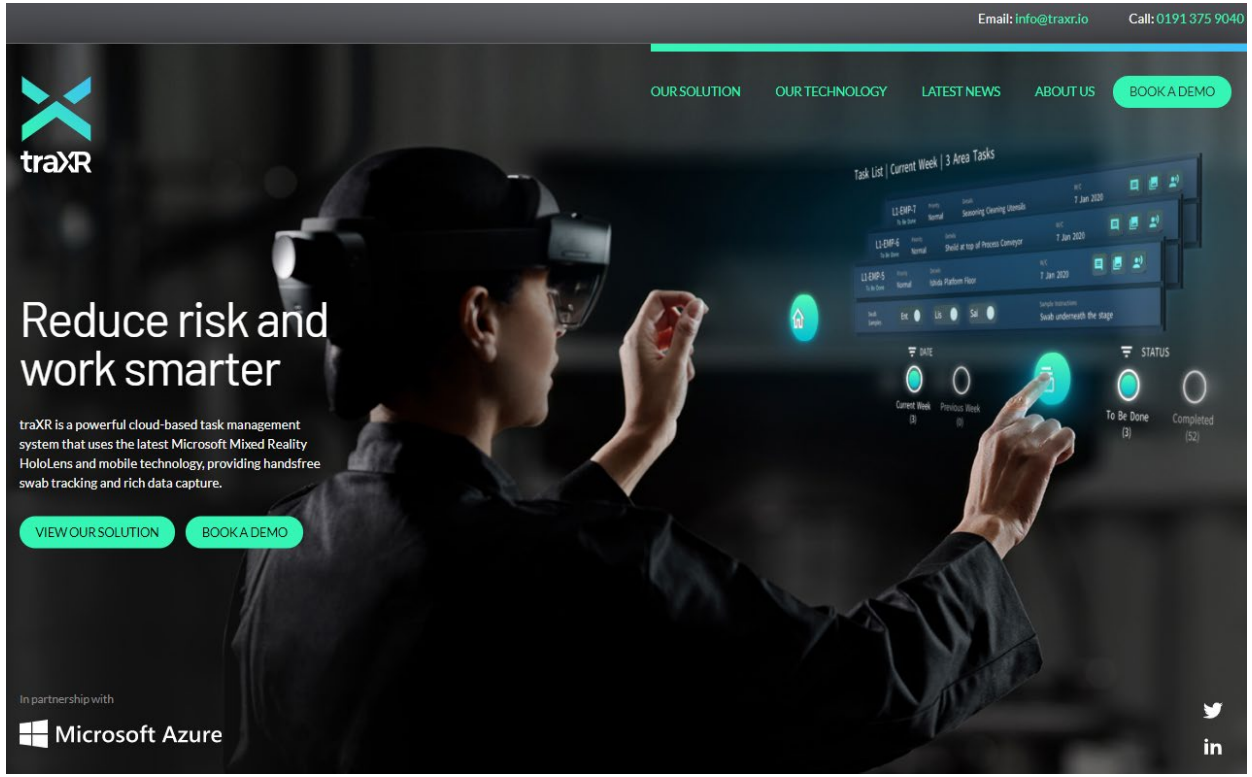
6 × Listeria innocua



6.03

Aug 29 Sep 28 Oct 28 Nov 27 Dec 27 Jan 26 Feb 25 Mar 27 Apr 26 May 26 Jun 25 Jul 25 Aug 24 Sep 23 Oct 23 Nov 22 Dec 22 Jan 21 Feb 20 Mar 21 Apr 20 May 20 Jun 19 Jul 19 Aug 18

Commercial systems: traxR



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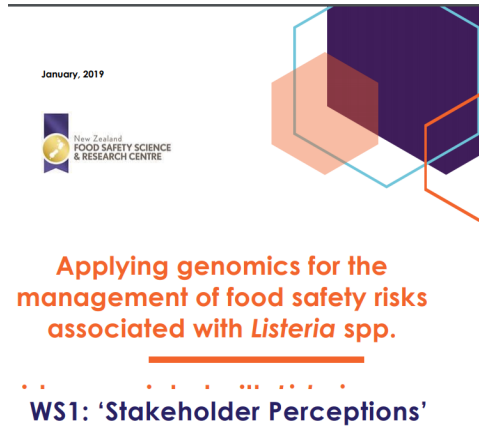
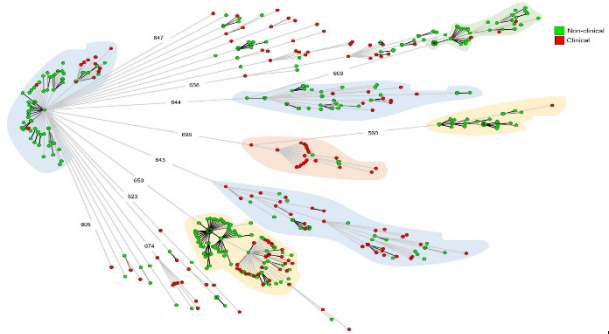
NZFSSRC Listeria programme

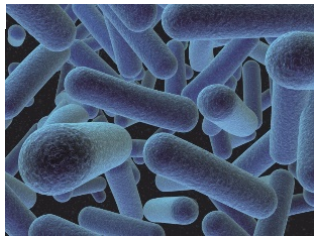
Workstreams:

- **WS1**: 'Stakeholder Perceptions' and attitudes towards source tracking of *Listeria* spp., and acceptance of novel control technologies.
- **WS2**: Mining the isolates: using sequencing to understand population structure of *Listeria* spp. in NZ.
- **WS3:** WGS Micro mapping in food production environments.
- **WS4**: Using genomics and phenotypic array technology to understand the ability of New Zealand food-chain associated *Listeria* spp. to survive/persist



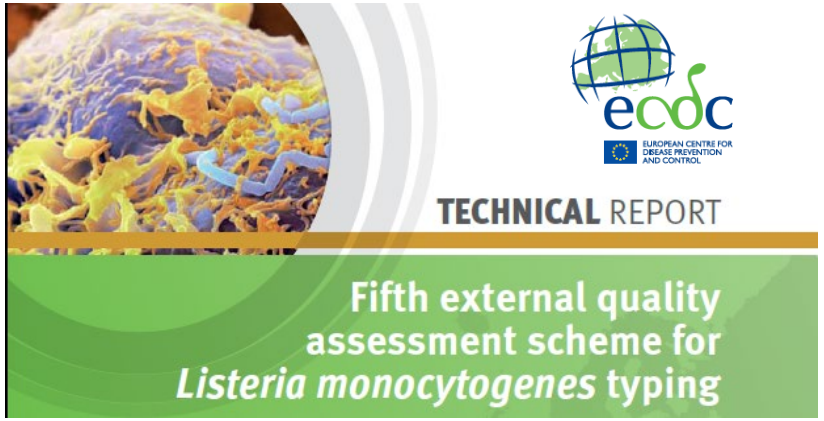


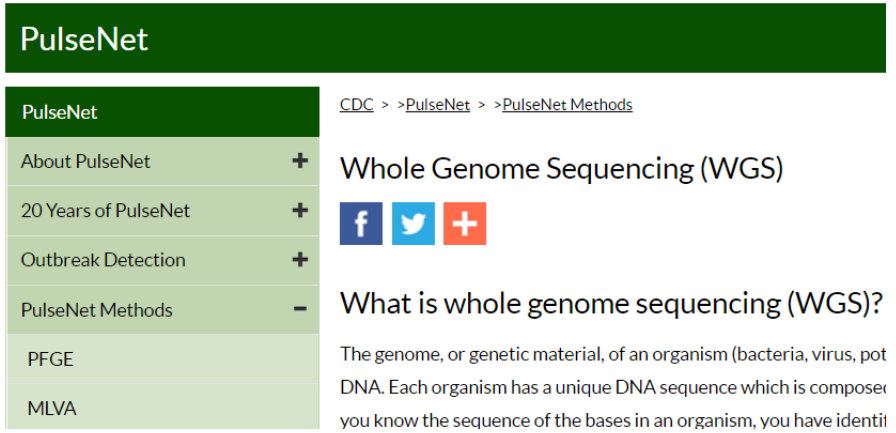
Involves scientists across 5 research organisations



Future challenges:

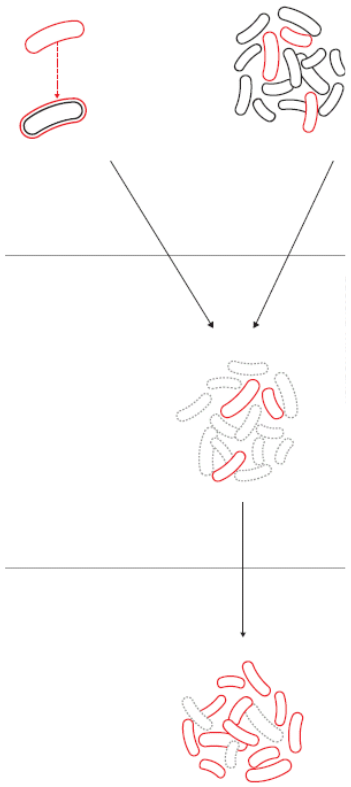
- Need for clear guidance on interpretation of WGS data
  - –Currently limited guidance available
- Need for standardisation/accreditation/harmonisation
  - –Throughout the process (laboratory, bioinformatics, metadata)
  - –SOPs and QC
- Need good governance and management of WGS data to maximise benefit while minimising risks





Summary

- *Listeria mono* an important FBP
  - –Illness and severe complications/death
  - –Recalls and compliance costs for food industry
- Whole genome sequencing now used extensively and increasingly routinely for food safety and other applications
  - –Global and local transmission
  - –Food processing environments
  - –Outbreak investigation
  - –Source attribution
  - –Resistance to sanitisers, heat. Biofilm etc...
- Databases and visualisation tools improving
  - –Searchable, web-based
  - –Bioinformatics tools
- Many challenges ahead including standardisation, harmonisation, governance and legal issues



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- Massey: Patrick Biggs, Jackie Benschop
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- Food industry partners

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HĪKINA WHAKATUTUKI

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