Leveraging Fecal DNA to enhance water quality

January 23rd, 2018
California Environmental Protection Agency Workshop

Source Molecular

ilac-MRA

ACCREDITED
Certificate 4126.01

ISO 17025 Accredited Testing Laboratory

Providing Genetic & Analytic Solutions for Water

Accredited* Water DNA Lab

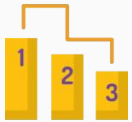
*World's only ISO 17025 Accredited MST Lab

Project & Site Analytics

Digital PCR

Pathogens (BSL2)

Nutrient Source Tracking



Host Fecal Score

Increasing pressure on Water Board to “get it right”

AgAlert
THE WEEKLY NEWSPAPER FOR CALIFORNIA AGRICULTURE

State water board hears concerns about regulation

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Issue Date: December 13, 2017

By Ching Lee

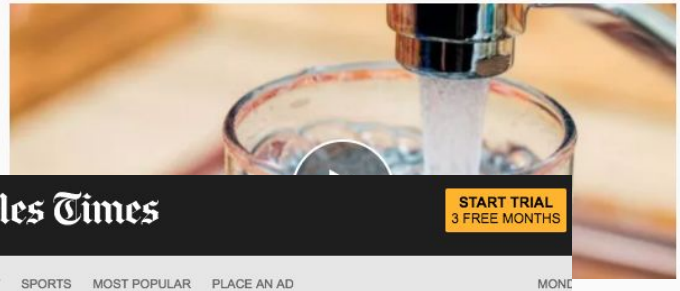
With the diverse mix of crops grown in the state an[TIONS] farmers and their advocates told the State Water R[esources Control Board] regulating water quality remains burdensome, expe[nsive].

They shared their concerns during a public worksh[op] the East San Joaquin River watershed that would h[elp] programs. The meeting, held last week in Sacrame[nto] on the proposed order, with written comments due

The Californian | HOME | NEWS | SPORTS | LIFE | OPINION | OFF 68 | ARCHIVES | USA TODAY | MORE

Central Coast conservationists sue water boards

Amy Wu, The Californian Published 6:01 p.m. PT Aug. 15, 2017 | Updated 6:28 p.m. PT Aug. 15, 2017



SEARCH

Los Angeles Times

START TRIAL
3 FREE MONTHS

CALIFORNIA | U.S. & WORLD YEAR IN REVIEW LOCAL ENTERTAINMENT SPORTS MOST POPULAR PLACE AN AD MOND

Column **The next crisis for California will be the affordability of water**

> STYLE > TECHNOLOGY > PERFORMANCE

Source Molecular

Lesson from other industries

Forensics

Food Testing

God's signature: DNA profiling, the new gold standard in forensic science.

Lynch M[1].

Author information

1 Department of Science & Technology Studies, Cornell University, 302 Rockefeller Hall, Ithaca, NY 14853-2401, USA.

CDC Using DNA Testing to Find Source of Chipotle's E. Coli Outbreak

The exact source of the foodborne illness outbreak is still unknown.

by Whitney Filloon | @whitneyfilloon | Nov 6, 2015, 5:00pm EST

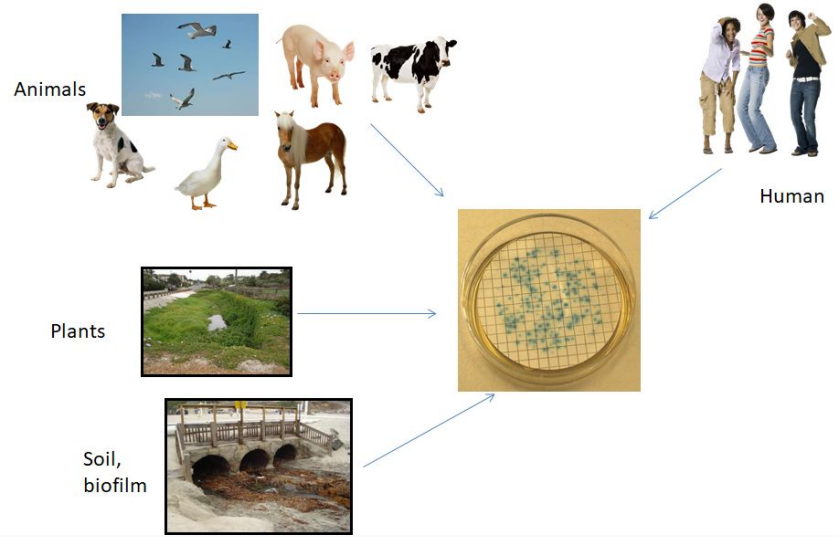
TWEET SHARE PIN

Source Molecular

How does genetic technology solve?

Regulatory Challenges	Microbial Source Tracking
Where is the pollution coming from?	✓
Unclear who is responsible?	✓
How do I evaluate permittees' BMP effectiveness?	✓

Available Tools - Legacy Testing (Culture FIB)



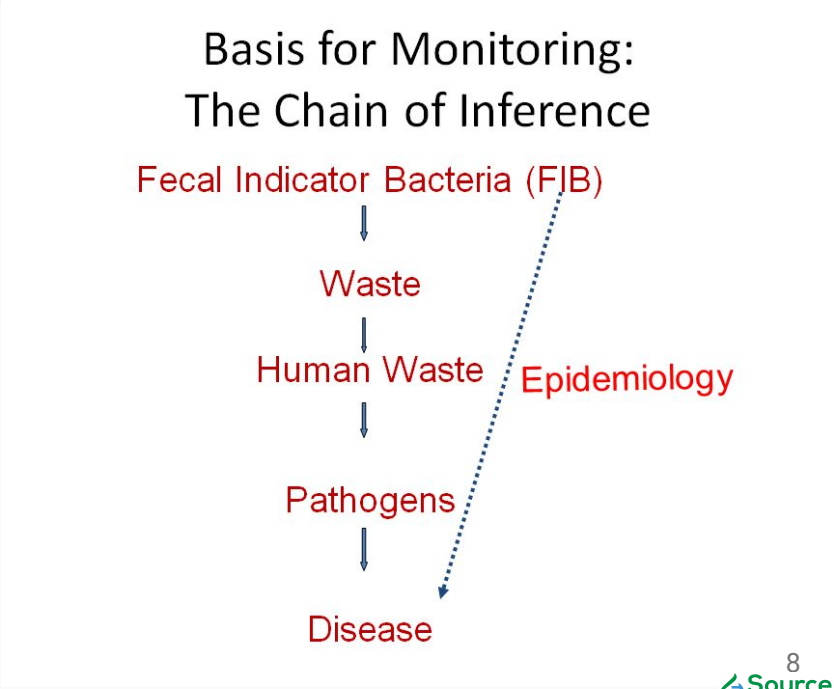
Concerns: Ineffective at discriminating between sources.

Available Tools - Field Observations

Concerns: Circumstantial and subjective evidence. Difficult to defend.

Consequence

- Hinders source abatement
  - Source identification must precede mitigation
- Weakens the chain of inference
  - Not all sources present the same level of human health risk
    - Non-fecal < fecal
    - Non-human < human



DNA-based Microbial Source Tracking

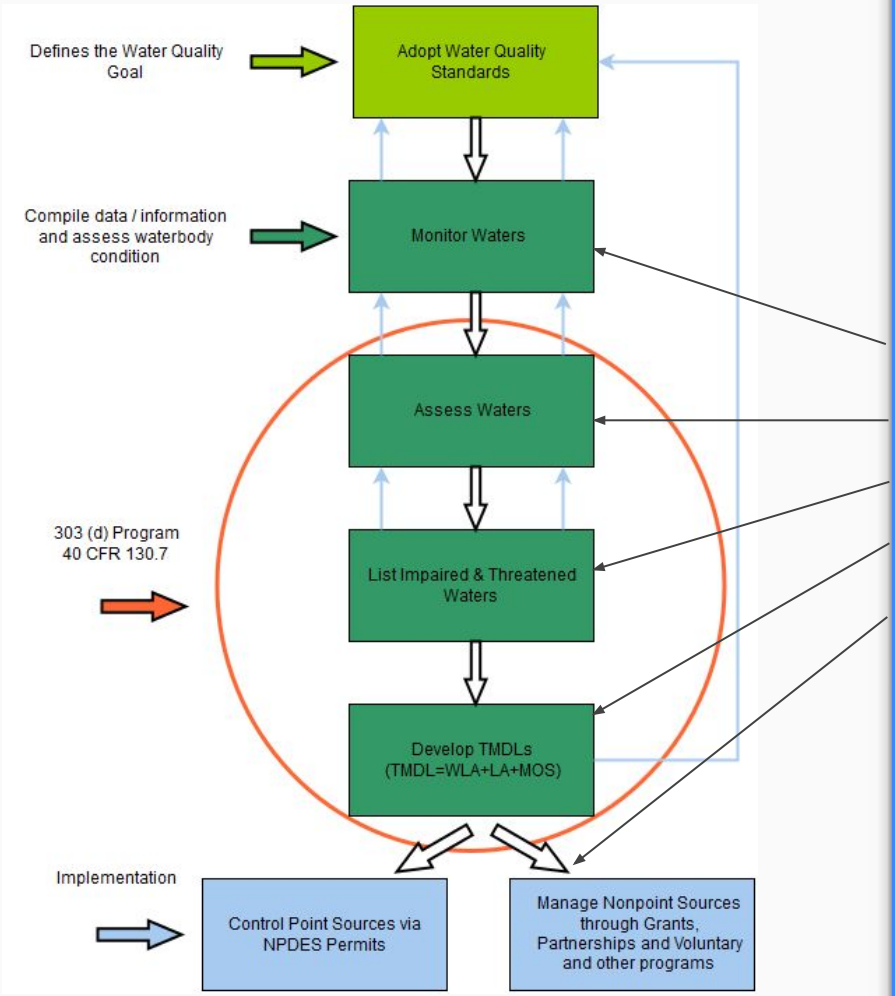
- There are special microbes that are only associated with a given source
  - Host and gut microbes co-evolve
    - Physiological difference of the gut
    - Dietary difference between hosts

- MST provides a set of methods to identify sources of contamination

Microbial Source Tracking - Maturity

Precedent	✓	Clean Beach Iniative Projects Boston Projects in >40 States
Credible Tests	✓	Validated Methods (SIPP)
Access to Technology	✓	Laboratories (Accredited)
Objective Interpretation	✓	**Host Fecal Score**

Water Quality-Based Approach of the Clean Water Act



Microbial Source Tracking is being applied at each stage of the CWA*

*(Source Molecular national projects from 2010-2017)

Site Prioritization - Florida DEP/Martin County

Summary of Costs / Ranking (Total)

Ranking	Communities	# of Parcels	Totals Cost			Cost Per Parcel		
			Vacuum Collection System*	Gravity Sewer System*	Grinder Pump System**	Vacuum Collection System*	Gravity Sewer System*	Grinder Pump System**
1	Martin Downs / Sunset Gardens (Old Palm City) Area	1078	$13,532,368	$20,852,279	$16,412,724	$12,553	$19,343	$15,225
2	Golden Gate Subdivision	775	$9,589,163	$15,656,572	$11,923,663	$12,373	$20,202	$15,385
3	Beau Rivage Subdivision	256	$3,974,236	$5,909,039	$4,029,218	$15,524	$23,082	$15,739
4	Gaines Ave Area	277	$4,445,731	$6,817,429	$4,447,102	$16,050	$24,612	$16,055
5	Hibiscus Park Area	1349	$14,165,566	$18,617,161	$18,924,589	$10,501	$13,801	$14,029
6	Port Salerno / New Monrovia Area	878	$10,536,133	$14,665,435	$12,878,941	$12,000	$16,703	$14,668
7	Salerno / Manatee Pocket Area	478	$5,434,992	$7,858,844	$6,905,908	$11,370	$16,441	$14,448
8	Nor							$16,802
9	Eve							$15,452
10	Sou							$23,178
11	Sou							$15,398
12	Town of Sewall's Point	931	$11,559,281	$16,658,298	$14,024,705	$12,416	$17,893	$15,064
13	Rio / St. Lucie (East)	331	$4,223,304	$6,408,478	$4,894,485	$12,759	$19,361	$14,787
14	Rosewalk Galleon Bay	25	--	$1,173,985	$437,729	--	$46,959	$17,509
15	Stuart Yacht & Country Club	504	$7,065,980	$9,910,480	$7,596,348	$14,020	$19,664	$15,072
16	Four Rivers Subdivision	106	--	$3,171,393	$1,955,547	--	$29,919	$18,449
17	Crane Creek Country Club	381	$6,462,014	$10,991,624	$6,385,546	$16,961	$28,849	$16,760
18	North Rivers Shore - Phase 2	292	$4,186,403	$6,168,524	$4,484,891	$14,337	$21,125	$15,359
19	Tropical Farms Area	652	$9,846,595	$14,796,687	$10,299,471	$15,102	$22,694	$15,797
20	River's End Subdivision	113	--	$3,050,687	$2,011,467	--	$26,997	$17,801
21	Vista Salerno / US 1 Area	234	$3,404,083	$4,781,277	$3,558,041	$14,547	$20,433	$15,205
22	Rio / St. Lucie (West)	97	--	$2,197,773	$1,582,174	--	$22,657	$16,311
23	Captain's Creek Subdivision	167	--	$4,591,743	$2,760,291	--	$27,495	$16,583
24	Lake Grove Subdivision	76	--	$2,027,883	$1,395,236	--	$26,683	$18,358
	Totals***	10,358	$118,082,117	--	$20,150,037			
			Total Cost****		$138,232,154			

Total Cost** $138,232,154

Ranking Summary

Ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Communities	n Downs / Sunset ns (Old Palm City)	n Gate	Rivage	s Ave	ens Park	salerno / Monrovia	to / Manatee Pocket	Mapp Road	rcen G&CC (Hideaway Mid Rivers)	Mapp Road	Fork Area	ll's Point	St. Lucie (East)	valk / Galleon Bay	Yacht & Country Club	Rivers	Creek Country Club	Rivers Shore - PH 2	cal Farms	s End	Salerno / US 1 Area	St. Lucie (West)	in's Creek	Lake Grove
Human Biological Markers	12								12			12			0			0			0			
Total Score	99.35	90.85	85.51	84.37	82.93	82.30	81.90	80.66	79.64	79.36	76.33	74.57	73.98	73.15	72.69	72.10	71.65	71.35	71.17	70.80	68.62	68.52	65.74	53.53
Populat Density																								4
Potable Systems																								12
Classifi Surface																								4
Proximi Surface																								4
FEMA Plain																								4
Ground Table																								8.85
Soil Typ																								12.00
Surface Water Management	12	12	12	12	12	12	12	12	10	12	4	12	12	8	12	4	12	12	9	4	12	12	4	4
Nitrogen Contribution	9.59	6.89	2.28	2.46	12.0	7.81	4.23	1.46	7.87	0.33	2.42	8.28	2.98	0.22	4.48	0.94	3.39	2.60	5.80	1.01	2.08	0.86	1.49	0.68
Human Biological Markers	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Where is the pollution coming from - Boston Water and Sewer

- First ever effectiveness assessment of MS4 IDDE program using DNA markers
- Human markers measured at outfalls regardless of degree of IDDE completion, and conventional tools (test kits) found to be insufficiently sensitive or specific for detecting illicit discharges
- New IDDE procedures now recommended, including DNA markers to improve program effectiveness
- Outcome will be greater bacteria and phosphorus reduction (at **lower unit cost and greater health benefit** than Green Infrastructure), **moving City closer to TMDL compliance**
- Project recognized with national O&M Performance Award from NACWA

Geosyntec consultants

NACWA presents the NATIONAL Environmental Achievement AWARDS

Source Molecular

Demonstrating BMP effectiveness - Santa Barbara

Santa Barbara Beaches (with UCSB), for SWRCB under Clean Beaches Initiative grant

- Infrastructure sources investigated and largely ruled out
- Homeless and bather sources continue to be evaluated
- DNA markers have been an essential complement to conventional tools (dye, CCTV, GIS, etc.)
- Management actions recommended based on study results, **improving public health protection at high use beaches**
- Prior work was first ever to document and publish on sewer exfiltration into stormdrains, shedding new light on this important source for agencies nationwide

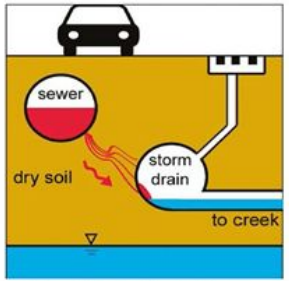

Figure 3-1. Leaking Sanitary Sewer Exfiltrating to Storm Sewer (Source: Sercu et al. 2011[4])

Summary

Genetics is a superior tool for water quality monitoring

It can be used for effective investigations of bacteria impairment

Building a data driven approach on top of rich DNA test data enables analytics

Thank You

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