Emerging contaminants in NC rivers: Strategies for protecting water quality

P. Lee Ferguson, Ph.D.

Associate Professor

Department of Civil & Environmental Engineering and
Nicholas School of the Environment, Duke University,
Durham, NC

lee.ferguson@duke.edu

On behalf of the NC Coastal Federation

Sept. 28, 2017

Unlisted emerging contaminants in drinking water sources

- When chemicals are not included in priority pollutant lists, there are no water quality standards and monitoring is not routinely performed.
- Safe Drinking Water Act provides for priority contaminant monitoring (53 organic chemicals) and emerging contaminant prioritization (Contaminant Candidate List – currently includes 97 chemicals).
- EPA decides which chemicals are priorities for monitoring and future regulation.
- Which chemicals are “emerging”? Which pose risks to human health?

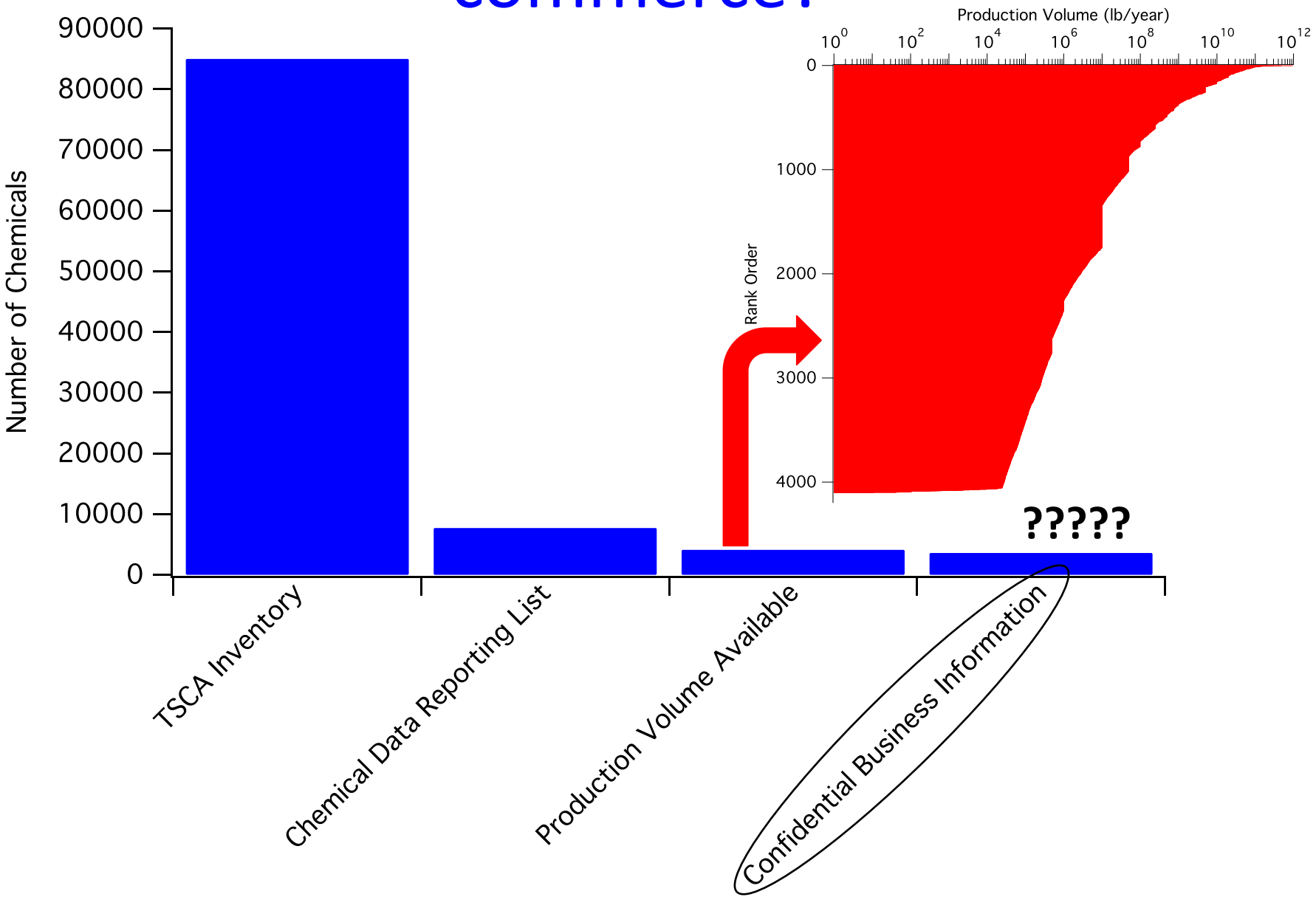
How do we avoid another GenX situation in NC waters?

- The only way to avoid being taken by surprise with unlisted (non-priority designated) emerging contaminants is to monitor for them.
- "Holistic" emerging contaminant monitoring in water is not routine. State labs do not have this capability currently.
- There are two approaches for anticipating emerging contaminant problems in water:
  - Top Down: Know which chemicals in commerce are potentially problematic, and monitor for those in water.
  - Bottom Up: Extensively monitor drinking water sources for the presence, identity, and levels of pollutants

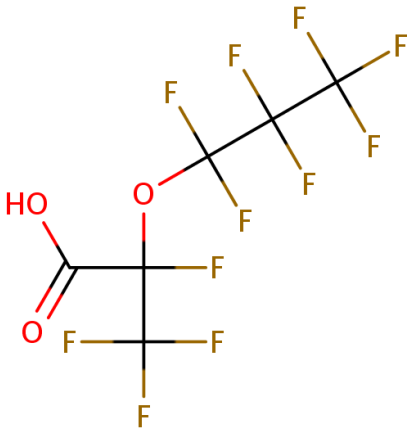
Top Down: Can we tabulate risky chemicals from regulatory lists?

- Our chemical universe:
  - How many chemicals exist? ~ 80-130 million
  - How many chemicals are used in commerce? ~ 85,000 (TSCA)
  - How many chemicals have been tested for toxicity? < 10,000 (hard to tabulate)
  - How many chemicals are flagged as"priority pollutants" under CWA? 126
  - How many chemicals are flagged as "toxic pollutants" under CWA? 65
  - How many chemicals have been banned by EPA? 9 (PCBs, dioxins, chlorofluorocarbons, asbestos, hexavalent chromium, and four carcinogenic mixed nitrates used in metalworking)

Which chemicals are highly used in commerce?



Example: What can we find out about GenX from EPA TSCA inventory data?



Print | E-mail Url

Home

Chemical Name:
TSCA § 12(b) Export Notification CAS #:
2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propionic acid 13252-13-6

EPA Actions

TSCA § 5 Orders
CO

Chemicals Subject to TSCA § 12(b) Export Notification
TSCA § 12(b) information

Manufacturing, Processing, Use, and Release Data Maintained by EPA

Chemical Data Reporting
CDR Summary

Print | E-mail Url

Home

TSCA SECTION 5 ORDER

View TSCA Section 5 Order

Chemical Name: 2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid
Chemical Identifier: 13252-13-6
Effective Date: January 28, 2009
Chemical Category: PBT chemicals

What type of TSCA Section 5 Order was developed for this chemical substance?

- Exposure-based
- May present an unreasonable risk

TSCA Section 5 Order for: 2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid , 13252-13-6

PMN Number: P-08-0508

Has the chemical been commenced?: Yes

Functional Use: Intermediate for polymerization aid (generic)

What are the health or environmental toxicity concerns?

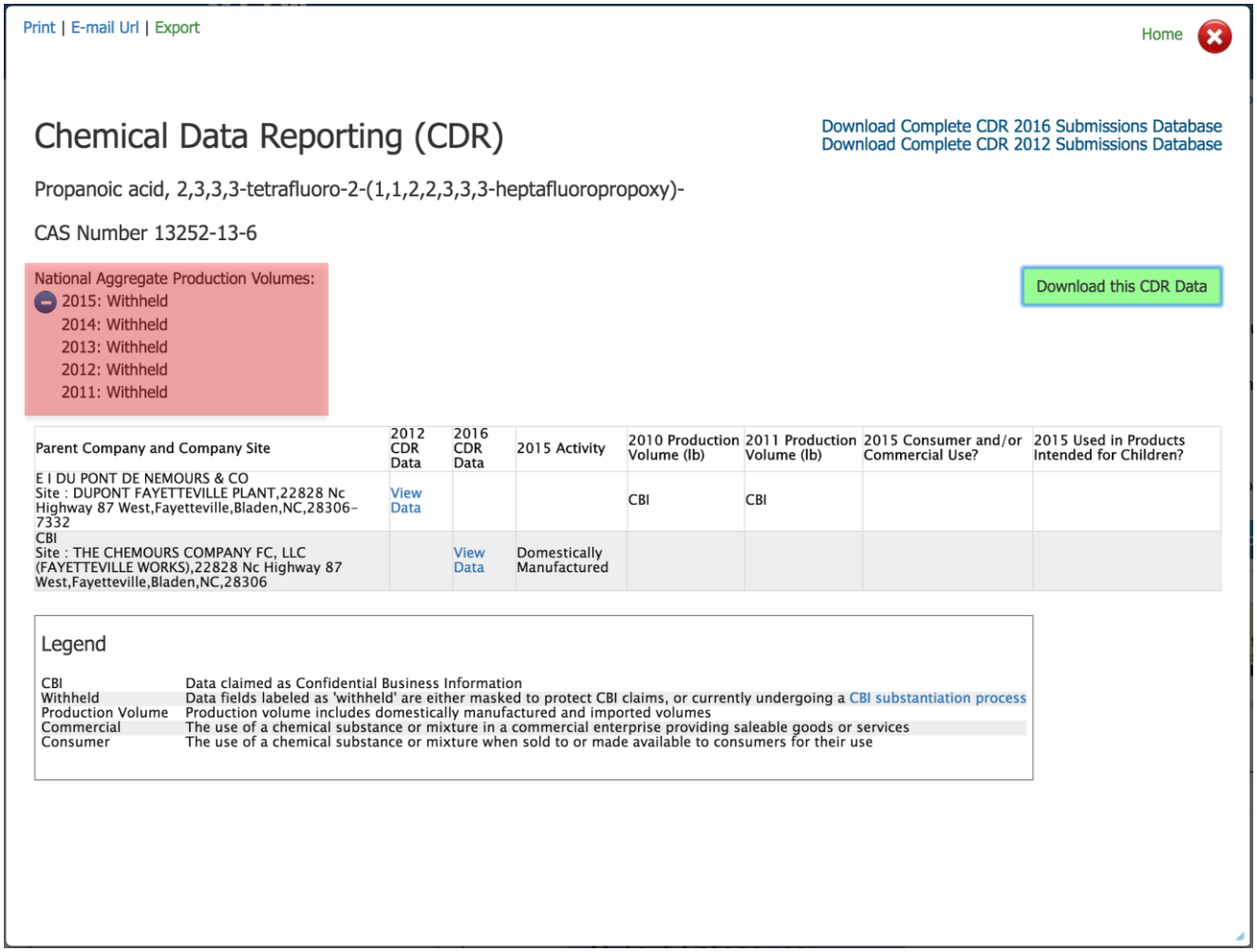
- Aquatic and/or terrestrial toxicity
- Cancer effects
- Developmental/reproduction
- Internal organs (e.g., liver, blood, kidney, etc.)/systemic toxicity
- Lung toxicity (including lung overload)
- Mutagenicity
- Persistent, Bioaccumulative, Toxic (PBT) properties

What is the basis for the health or environmental toxicity concerns?

- Analog data
- PBT chemicals

Example: What can we find out about GenX from EPA TSCA inventory data?

"The Chemical Data Reporting (CDR) Rule, issued under the Toxic Substances Control Act (TSCA), requires manufacturers (including importers) to give EPA information on the chemicals they produce domestically or import into the United States. EPA uses the data to help assess the potential human health and environmental effects of these chemicals and **makes the non-confidential business information it receives available to the public**."



Print | E-mail Url | Export

Home

Chemical Data Reporting (CDR)

Download Complete CDR 2016 Submissions Database
Download Complete CDR 2012 Submissions Database

Propanoic acid, 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-

CAS Number 13252-13-6

National Aggregate Production Volumes:
- 2015: Withheld
- 2014: Withheld
- 2013: Withheld
- 2012: Withheld
- 2011: Withheld

Download this CDR Data

Parent Company and Company Site	2012 CDR Data	2016 CDR Data	2015 Activity	2010 Production Volume (lb)	2011 Production Volume (lb)	2015 Consumer and/or Commercial Use?	2015 Used in Products Intended for Children?
E I DU PONT DE NEMOURS & CO Site : DUPONT FAYETTEVILLE PLANT,22828 Nc Highway 87 West,Fayetteville,Bladen,NC,28306-7332	View Data			CBI	CBI		
CBI Site : THE CHEMOURS COMPANY FC, LLC (FAYETTEVILLE WORKS),22828 Nc Highway 87 West,Fayetteville,Bladen,NC,28306		View Data	Domestically Manufactured				

Legend

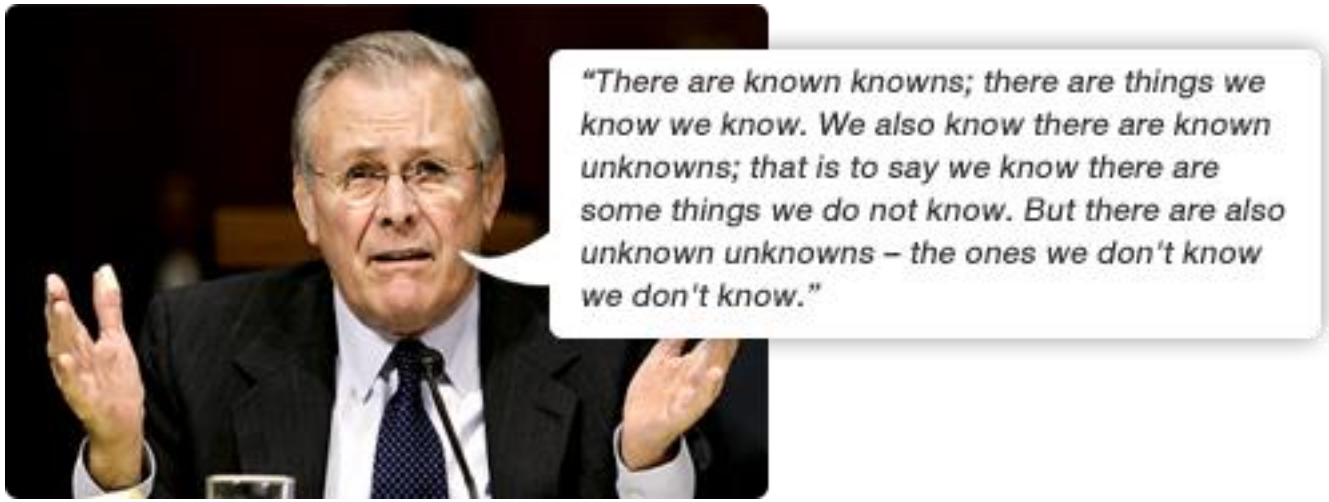
CBI	Data claimed as Confidential Business Information
Withheld	Data fields labeled as 'withheld' are either masked to protect CBI claims, or currently undergoing a CBI substantiation process
Production Volume	Production volume includes domestically manufactured and imported volumes
Commercial	The use of a chemical substance or mixture in a commercial enterprise providing saleable goods or services
Consumer	The use of a chemical substance or mixture when sold to or made available to consumers for their use

Top Down chemical prioritization: What do we need to prevent GenX situation?

- More information on which chemicals in commerce are produced and used, with location.
- Full production-volume information on chemicals in commerce (all chemicals on TSCA list).
- Relief from Confidential Business Information (CBI) disclosure limits: must be made available to researchers outside US EPA.

Bottom Up: Why is it hard to identify emerging contaminants early?

Strategies for analytical characterization of emerging contaminants			
Screening technique:	*Targeted*	*Suspect*	*Non-target*
Question:	*Are compounds x, y, & z present in this sample?*	*Which compounds of a defined list are present in this sample?*	*Which compounds are present in this sample?*
Compound Types:	*Known-knowns*	*Known-unknowns*	*Known-unknowns & unknown-unknowns*



Challenges for routine Bottom Up analysis of emerging contaminants

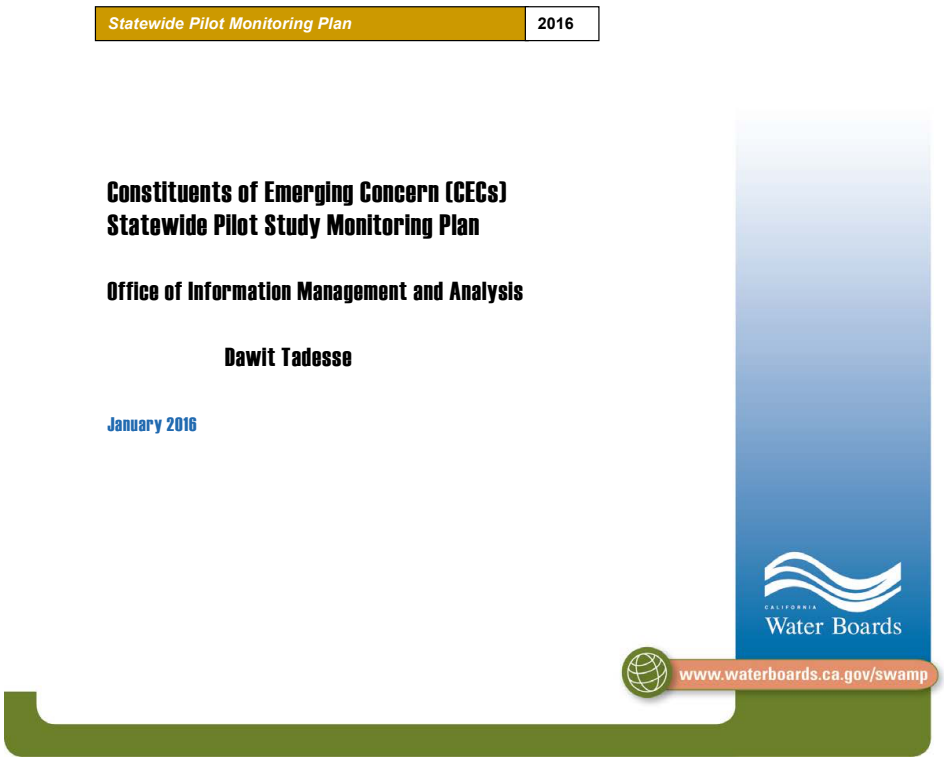
- “Non-Targeted” analysis of emerging contaminants relies on very specialized analytical instrumentation.
- The high resolution mass spectrometers needed are not available in most state monitoring labs (~ $1,000,000 capital cost).
- Standard methods are not deployed for performing “Non-Targeted” contaminant monitoring in ambient waters of NC.
- Expertise for such analysis is at research level.

Bottom up analysis of non-priority pollutants in water CAN be done

- Several “Non-Targeted” emerging contaminant surveillance programs are in place within the US and Europe:
  - California EPA State Water Resources Control Board
  - San Francisco Bay Regional Monitoring Program
  - International Rhine River Monitoring Network (Canton of Basel, Switzerland)

California State Water Resources Control Board

SWAMP
Surface Water Ambient Monitoring Program



- California has implemented a state-wide emerging contaminant monitoring program.
- Incorporates risk-based screening as well as ambient monitoring.
- Collaboration of state regulatory agencies, local water boards, non-profit organizations, and academic researchers.
- Multi-Tier, science-based prioritization scheme for anticipating risks associated with emerging contaminants in water.

Secure | https://public.tableau.com/profile/swamp.oima#!/vizhome/StatewideCECMonitoringDashboard/Dashboard

Apps | CompTox Dashboard | PubChem Search | Facebook | NOAA Weather | Wikipedia | Duke University Libr... | News | EndNote Web 3.5 | EPA Chemical Data... | Perfect Prime Rib R... | Substance Registry... | Other Bookmarks

tableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

SWAMP OIMA - Profile | Favorite | Download Workbook

Statewide CEC Monitoring (1993-2016)

Filter by Program/Station Name

Program: (All)

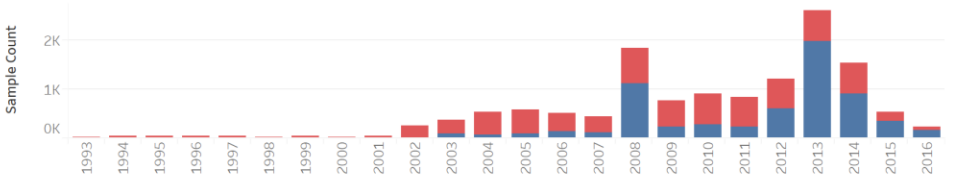
Station Name: (All)

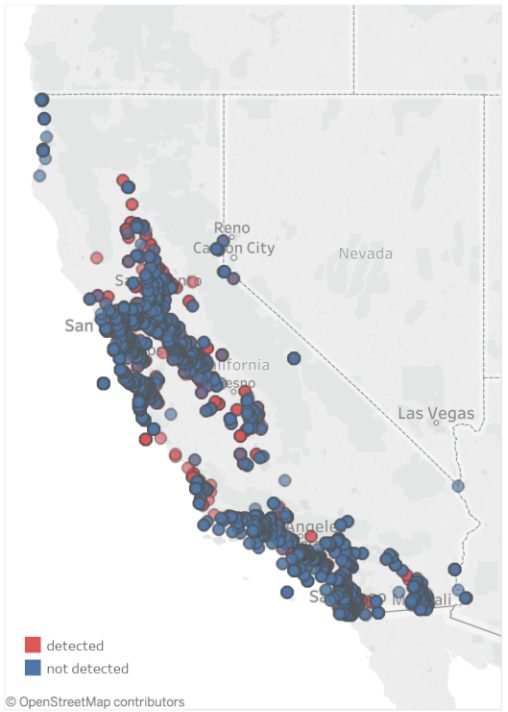
Filter by Analyte

Analyte Category: (All)

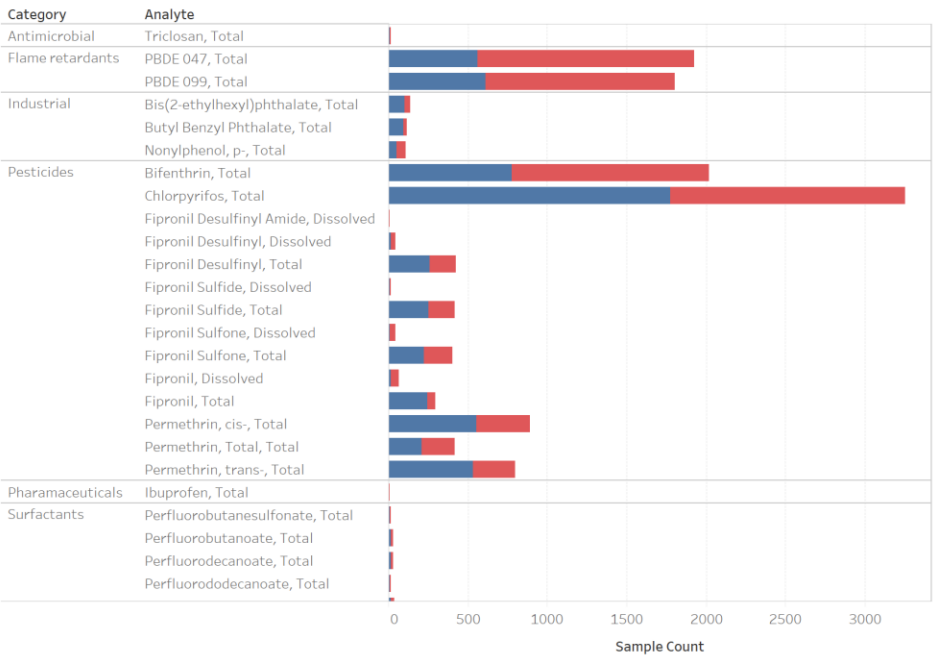
Analyte: (All)

Filter by Year





Analytes (click to highlight)



Undo | Redo | Reset

tableau

144 views | more by this author

Share | Download | Full Screen

Statewide CEC Monitoring Dashboard

152 views | SWAMP OIMA

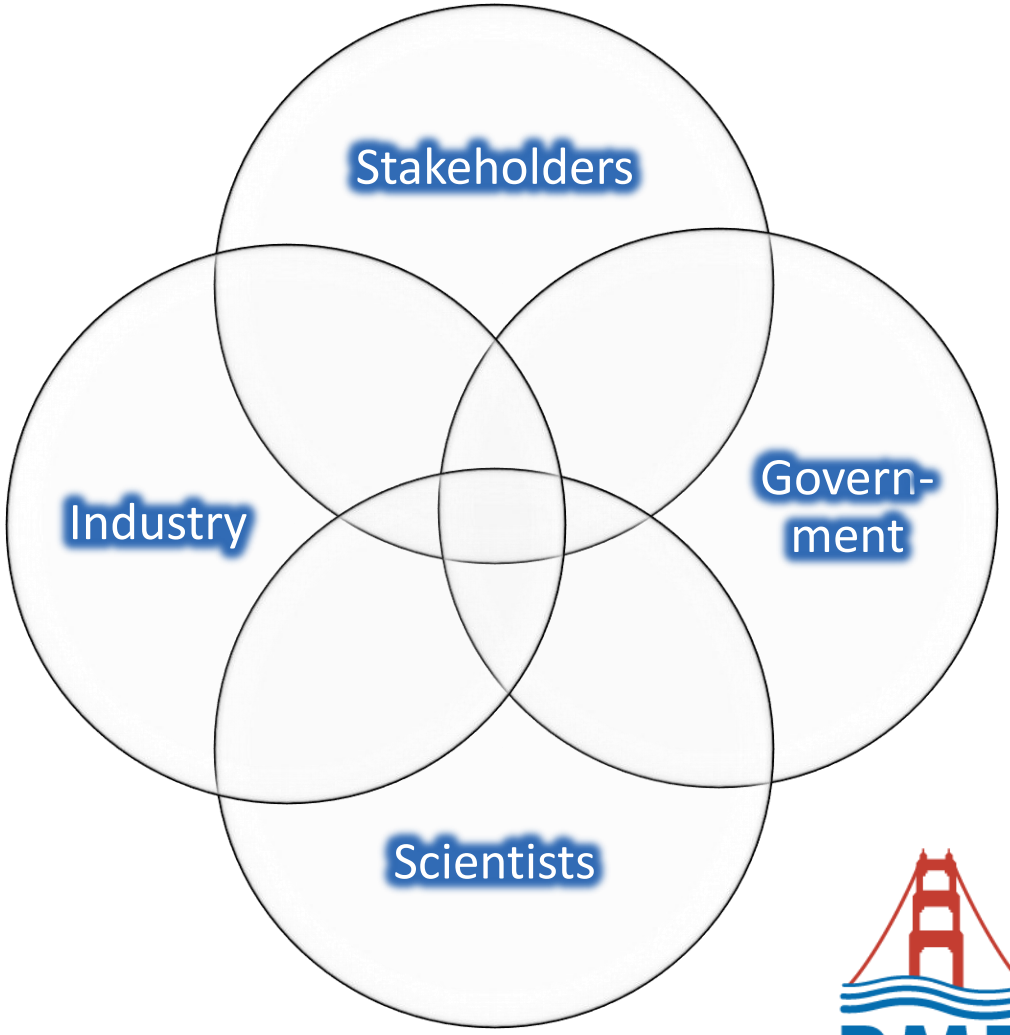
Contaminants of Emerging Concern (CEC): The San Francisco Bay Story

Slides courtesy of:

Rebecca Sutton, San Francisco Estuary Institute – Aquatic Science Center

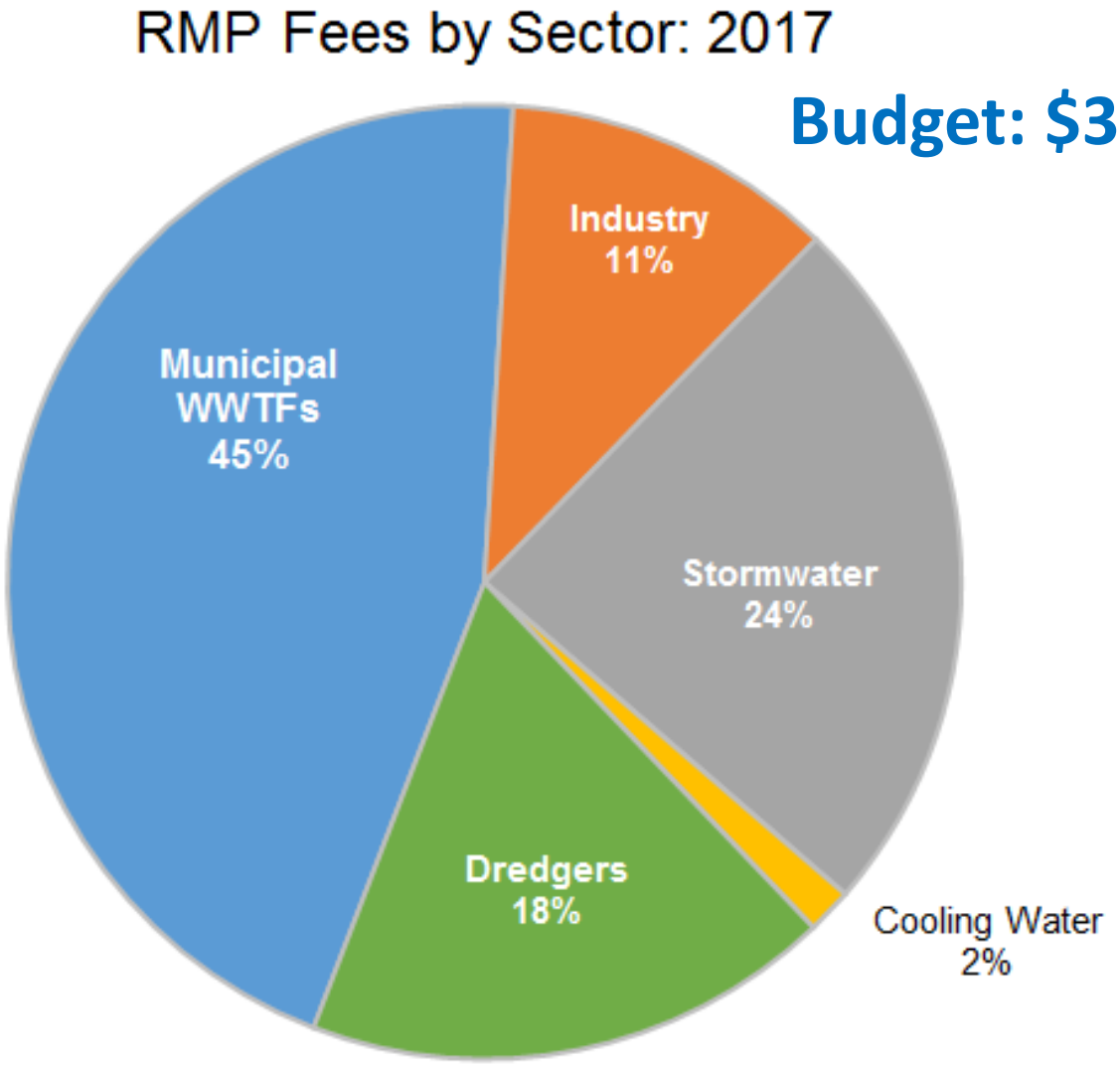
Regional Monitoring Program

Partnership to understand the **health** of San Francisco Bay



RMP

RMP Participants



RMP Focus on CECs

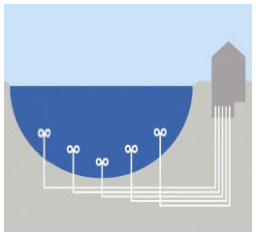
- 10+ years of monitoring and studies
  - Primarily ambient water, sediment, biota
  - Some wastewater and stormwater
- 2013 CEC Synthesis and Strategy
  - Added non-targeted analysis, bioanalytical tools
- 2017 Strategy Revision

Courtesy of: **Heinz Singer**, Rahel Comte, Martin Loos, Matthias Ruff, Juliane Hollender
Swiss Federal Institute for Aquatic Research

River Rhine

An Overview...

Length	1233 km
Catchment area	220,000 km^2
Total discharge	2,300 m^3/sec
Habitants living in the catchment	58 Mio
Habitants supplied with drinking water	20 Mio



Monitoring Station

Courtesy of: **Heinz Singer**, Rahel Comte, Martin Loos, Matthias Ruff, Juliane Hollender
Swiss Federal Institute for Aquatic Research

International monitoring network

Warning and Alarm Plan

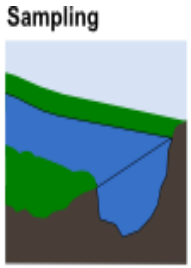
7 Headquarters

7 Monitoring stations

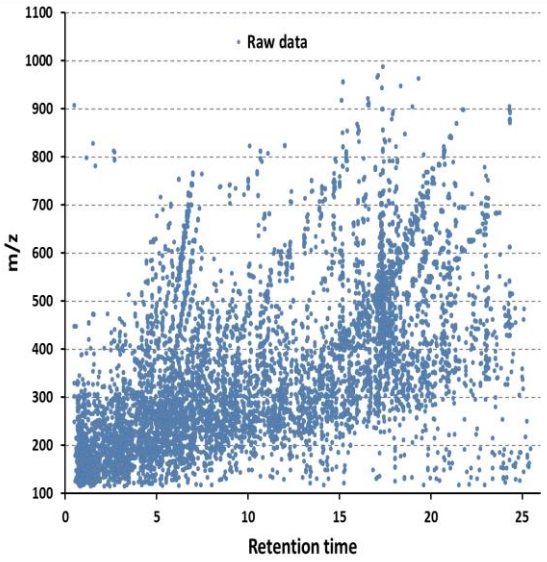
Threshold concentration levels [µg/L]		
	regional	international
Pesticides, Biocides, Pharmaceuticals	0.1	0.3
other Substances	1	3

Courtesy of: **Heinz Singer**, Rahel Comte, Martin Loos, Matthias Ruff, Juliane Hollender
Swiss Federal Institute for Aquatic Research

Principle of using time series



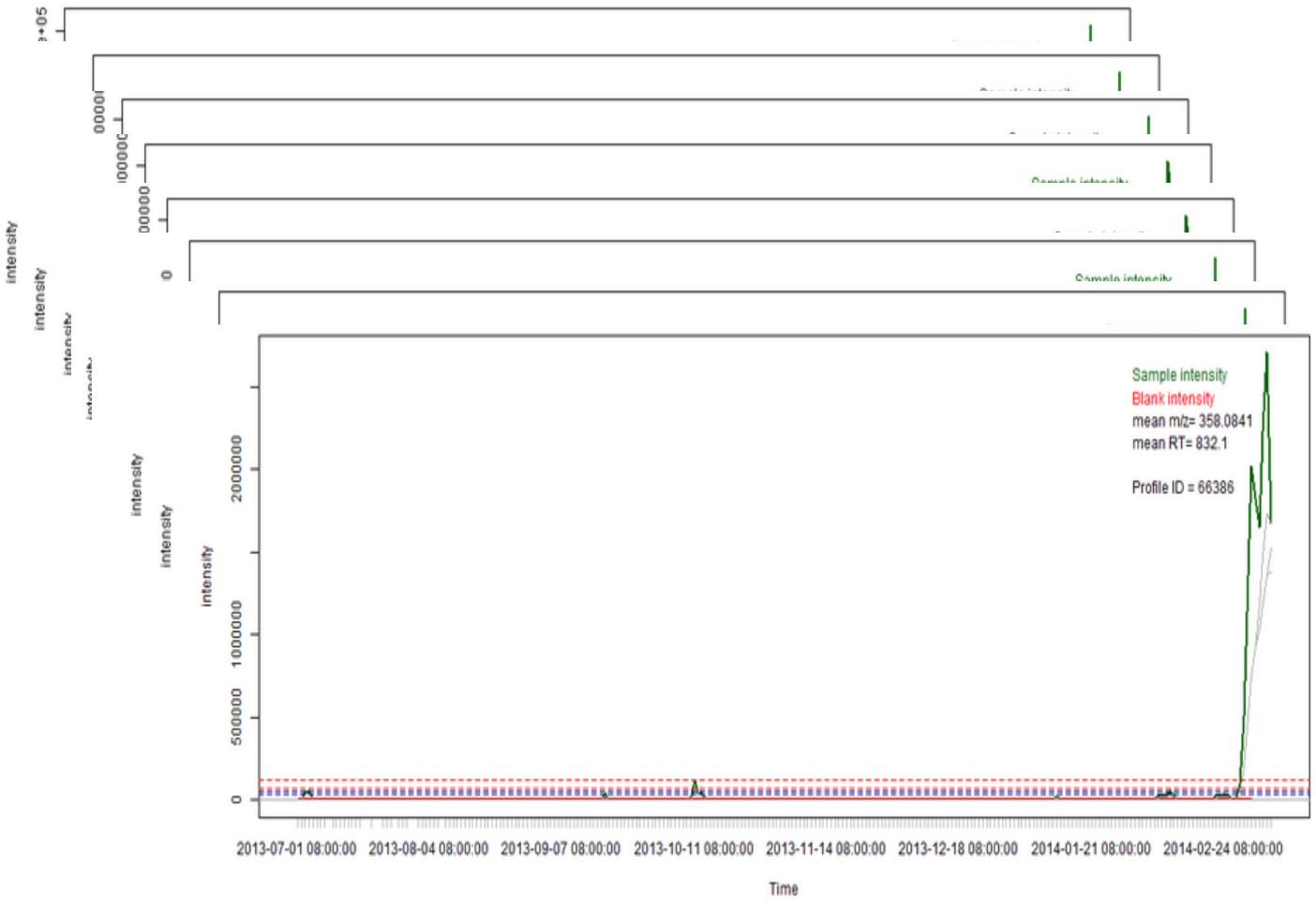
LC-HRMS



Statistical analysis

Courtesy of: **Heinz Singer**, Rahel Comte, Martin Loos, Matthias Ruff, Juliane Hollender
Swiss Federal Institute for Aquatic Research

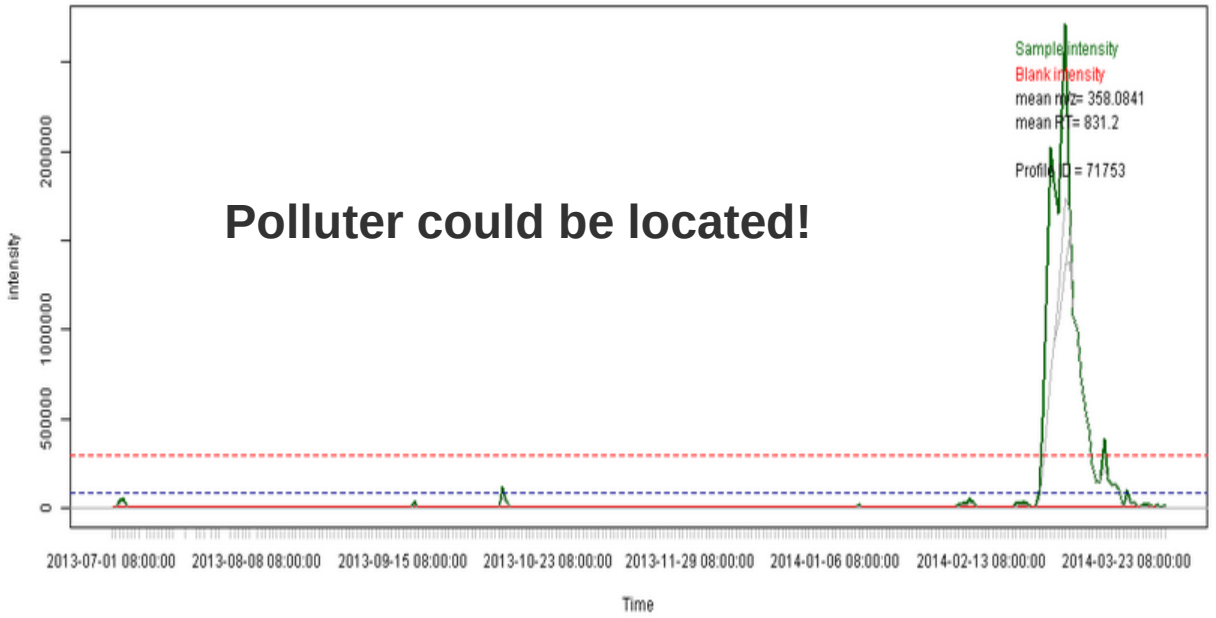
Indomethacin spill

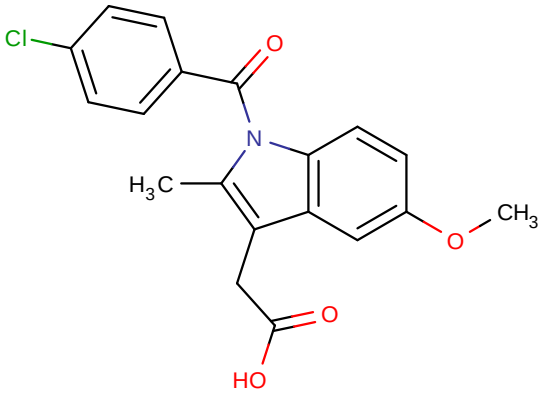


March 2014	1	2	3	4	5	6	7	8

Courtesy of: **Heinz Singer**, Rahel Comte, Martin Loos, Matthias Ruff, Juliane Hollender
Swiss Federal Institute for Aquatic Research

Indomethacin spill





Concentration (max):	> 0.4 µg/L
Load (over 14 days):	170 kg

Take home messages: Anticipating emerging contaminant risks in water

- Routine water quality monitoring programs will NOT protect human health from unlisted, non-priority emerging contaminants.
- Chemical production, use, and release information databases are insufficient for effective emerging contaminant prioritization.
- Sophisticated emerging contaminant monitoring programs are currently in use here in the US and abroad.
- Emerging contaminant surveillance in rivers will require significant investment in expertise and infrastructure.
- State, private, and academic entities can and should all work in concert to avoid another GenX situation in NC.