

# The Secret to Successful Long-Term Monitoring

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Cary Institute of Ecosystem Studies

Hudson River Watershed Alliance Workshop

December 5, 2019

# Topics for this talk

- Why do long-term monitoring – why it matters
- How to manage the data
- How to use the data
- Different approaches to monitoring – e.g., community (citizen) science

# The 7 Habits of Highly Effective Monitoring Programs\*

1. Design the program around clear and compelling scientific questions.
2. Choose measurements carefully and with the future in mind, e.g., basic measures of system health, indicators of change, or variables of particular human interest.
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7. Plan for long-term data accessibility and [possibly] sample archiving.

\*Lovett et al. 2007. *Frontiers in Ecology & the Environment* 5(5): 253–260

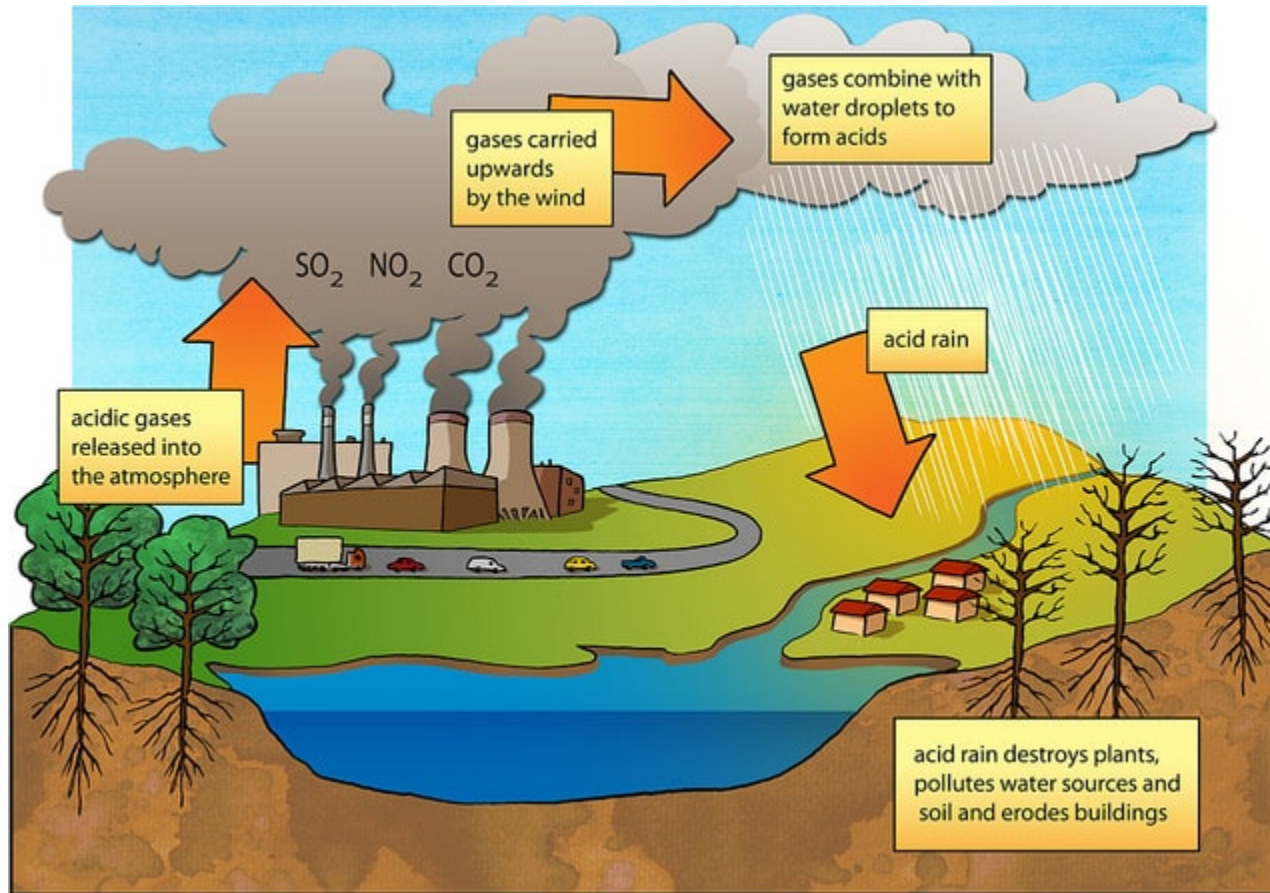
# Why do long-term monitoring

## Cary Institute Story 1984-present





# Acid Rain



# Air Quality Was Extremely Poor



# Water Quality Was Just As Bad



***1969 Cuyahoga River fire in Cleveland, Ohio***

# Clean Air Act 1970



Nixon signs the Clean Air Act of 1970 as William Ruckelshaus (*left*), head of the newly formed Environmental Protection Agency, and Russell Train (*right*), chairman of the Council on Environmental Quality, look on.

Associated Press

# Clean Air Act Amendments 1990 Addresses Acid Rain



President Bush signing the Clean Air Act Amendments of 1990.  
Standing left to right are EPA Administrator William K. Reilly, Energy  
Secretary James Watkins, and Vice President Dan Quayle.



# Clean Water Act 1972



Passed Congress, Vetoed By Nixon, Veto Overridden by Congress

<https://www.mainmemory.net/search/more?cp=Bates>



# Air, Precipitation & Stream Monitoring at Cary began 1984 & 1985



# Program Consisted of In-Stream Sensors





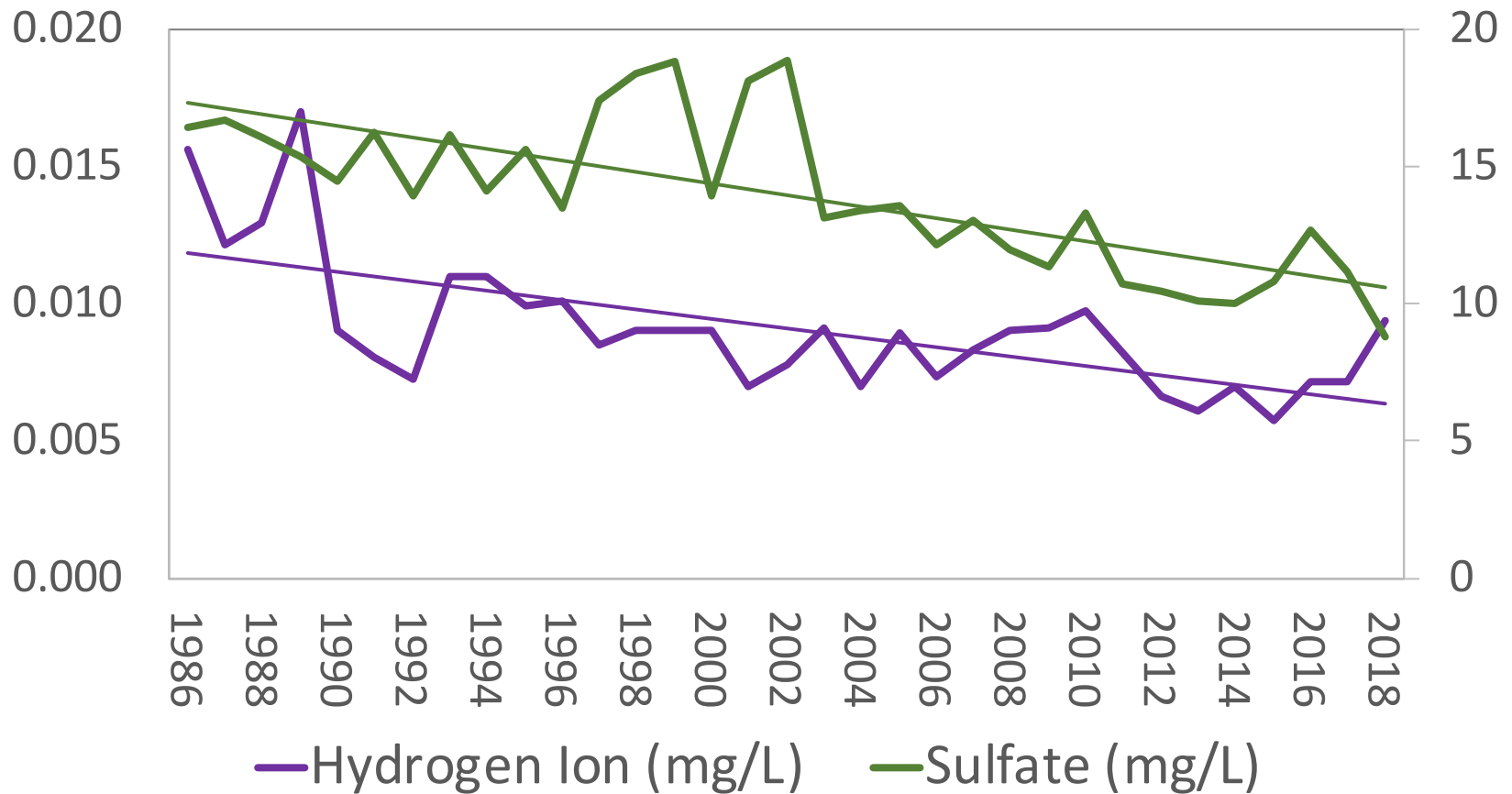
# Monthly Grab Samples



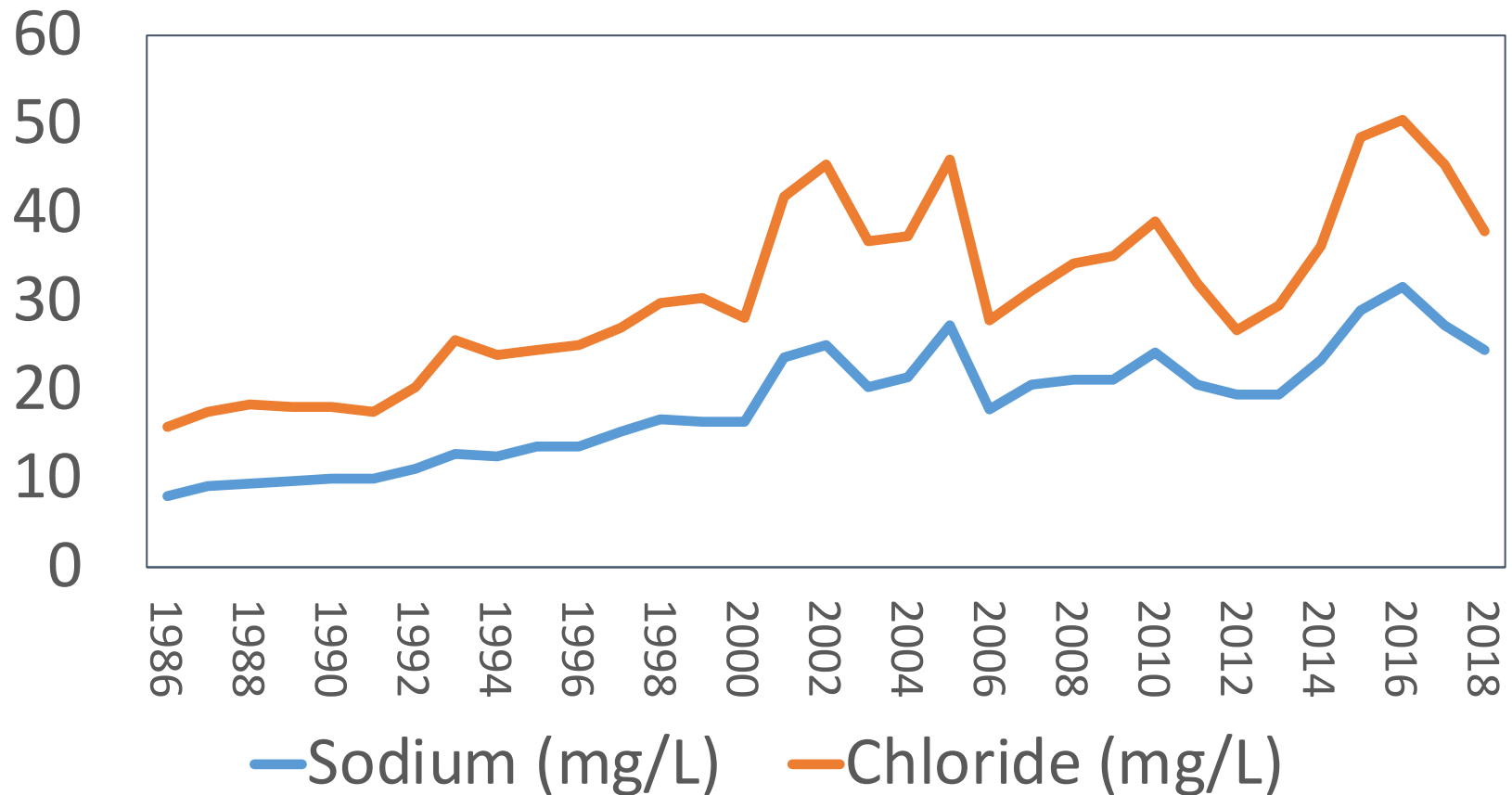
# Broad-brush Approach to Monitoring

CA	concentration of Ca <sup>+2</sup> (mg/L)
CL	concentration of Cl <sup>-</sup> (mg/L)
COND	conductivity (umho)
DATE	date sample was collected
K	concentration of K <sup>+</sup> (mg/L)
MG	concentration of Mg <sup>+2</sup> (mg/L)
NA	concentration of Na <sup>+</sup> (mg/L)
NH4	concentration of NH <sub>4</sub> <sup>+</sup> (mg/L)
NO3	concentration of NO <sub>3</sub> <sup>-</sup> (mg/L)
PH	pH
PO4	concentration of PO <sub>4</sub> <sup>-3</sup> (mg/L)
Q	stream flow rate at site 2 (m <sup>3</sup> /s)
SIO2	concentration of SiO <sub>2</sub> (mg/L)
SITE	site on Wappinger Creek
SO4	concentration of SO <sub>4</sub> <sup>-2</sup> (mg/L)
STM_HT	Stream height (cm)
STM_TMP	Stream temperature (deg C)

# Acid Rain Components in East Branch Wappinger Creek at Cary

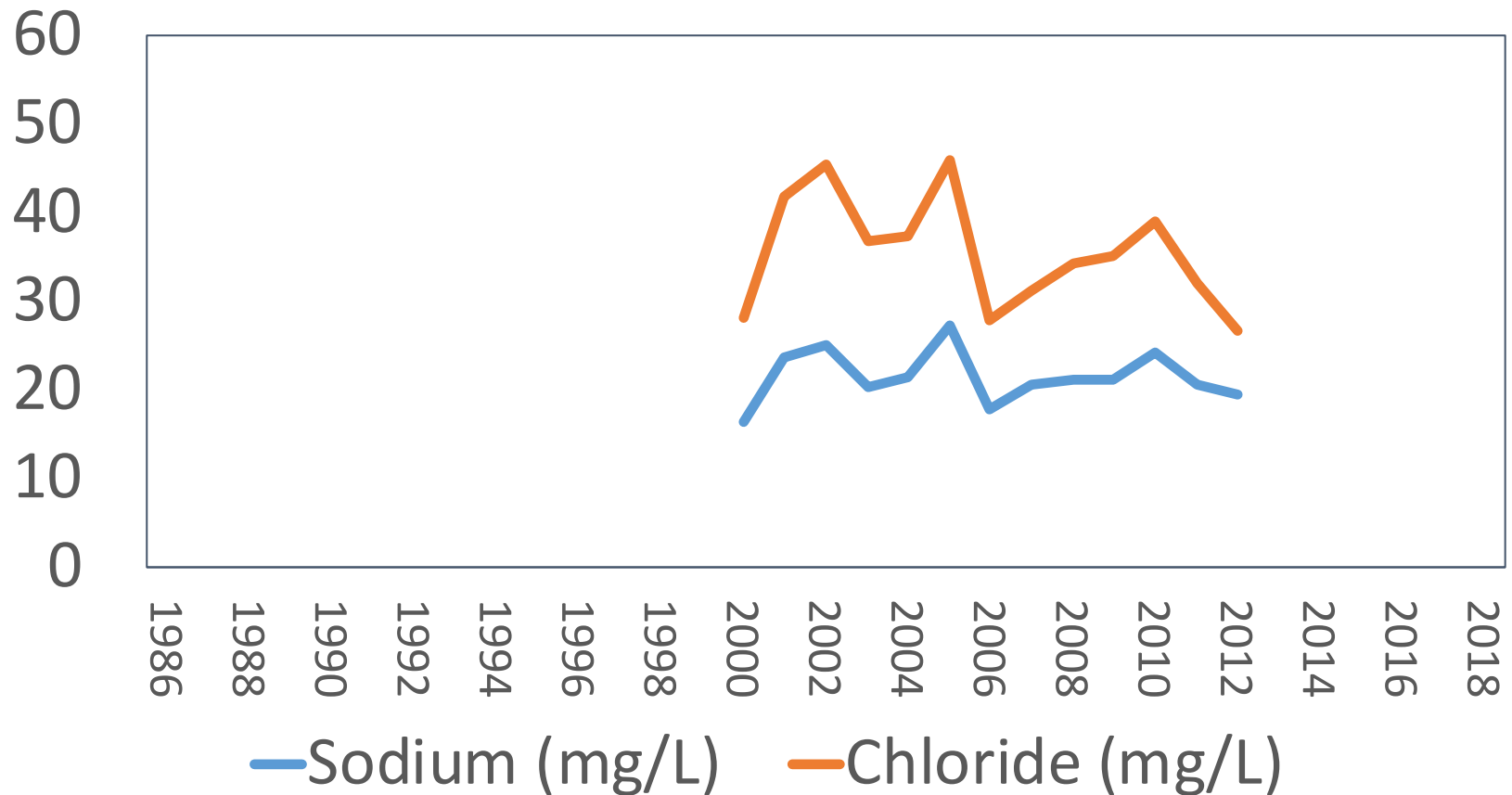


# Na & Cl in East Branch Wappinger Creek at Cary





# Na & Cl in East Branch Wappinger Creek at Cary



# Topics for this talk

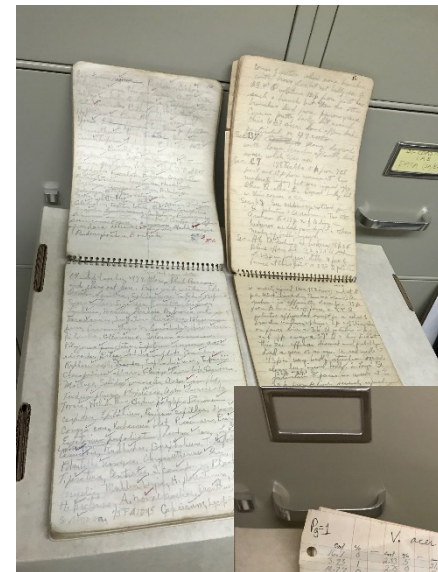
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# Maintaining Data & Ensuring Data Quality



V. acc		11/11/74		31	
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# Data from Cary Analytical Lab (note Lab has its own QC)

Wappingers Creek\_Jul2018-Mar2019.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Sign in Share

Paste Clipboard Font Alignment Number Styles Cells Editing

A1 Data Summary Report

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Data Summary Report																						
2	IES Analytical Laboratory																						
3	Scientist	Cost Center	0008,,		11/15/19																		
4	Project Contact	Matrix	Water																				
5	Project Name	Preservative	F/4C																				
6	Comments																						
7	Sample Information				Data																		
8	Date Submitted	Lab Sample ID	Project Sample ID	Collection Date	Test:																		
9					Ammonium-N	Calcium-ICP	Chloride gnesium-ICP	Nitrate-N	Phosphate-P	otassium-ICP	Silicate	Sodium-ICP											
10	07/30/18	1807008-001	7/30/2018 WC 2F	07/30/18		36.2 mg/L	53.3 mg/L	10.4 mg/L								1.51 mg/L	8.5 mg/L	33.9 mg/L	8.				
11	07/30/18	1807008-002	7/30/2018 WC 4F	07/30/18		37.2 mg/L	56.3 mg/L	9.07 mg/L								1.2 mg/L	8.5 mg/L	33.5 mg/L	9.				
12	07/30/18	1807008-003	25JUL2018 Test Blank	07/30/18		0.05 mg/L	0.04 mg/L	0.03 mg/L								<0.02 mg/L	<0.1 mg/L	0.29 mg/L	<0.				
13	07/30/18	1807008-004	7/30/2018 WC 2F/A	07/30/18	0.03 mg/L					0.52 mg/L	0.107 mg/L												
14	07/30/18	1807008-005	7/30/2018 WC 4F/A	07/30/18	0.05 mg/L					0.32 mg/L	0.048 mg/L												
15	07/30/18	1807008-006	Test Blank Acidified	07/30/18	0.02 mg/L					<0.02 mg/L	<0.002 mg/L												
16	08/24/18	1808011-001	WC 2F	08/24/18		29.9 mg/L	37.6 mg/L	7.73 mg/L								1.32 mg/L	9.2 mg/L	24.9 mg/L	7.				
17	08/24/18	1808011-002	WC 4F	08/24/18		33.3 mg/L	45 mg/L	7.43 mg/L								1.26 mg/L	9.5 mg/L	28.9 mg/L	8.				
18	08/24/18	1808011-003	WC 2F/A	08/24/18	0.03 mg/L					0.3 mg/L	0.038 mg/L												
19	08/24/18	1808011-004	WC 4F/A	08/24/18	0.03 mg/L					0.34 mg/L	0.028 mg/L												
20	09/24/18	1809008-001	WC2 F	09/24/18		29.3 mg/L	33.7 mg/L	7.56 mg/L								1.27 mg/L	9.5 mg/L	23.6 mg/L	7.				

IES\_ResultsReport

Ready

# Put data in file so it can be appended to long-term dataset

WAP2019.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Sign in Share

Clipboard Font Alignment Number Styles Cells Editing

B2

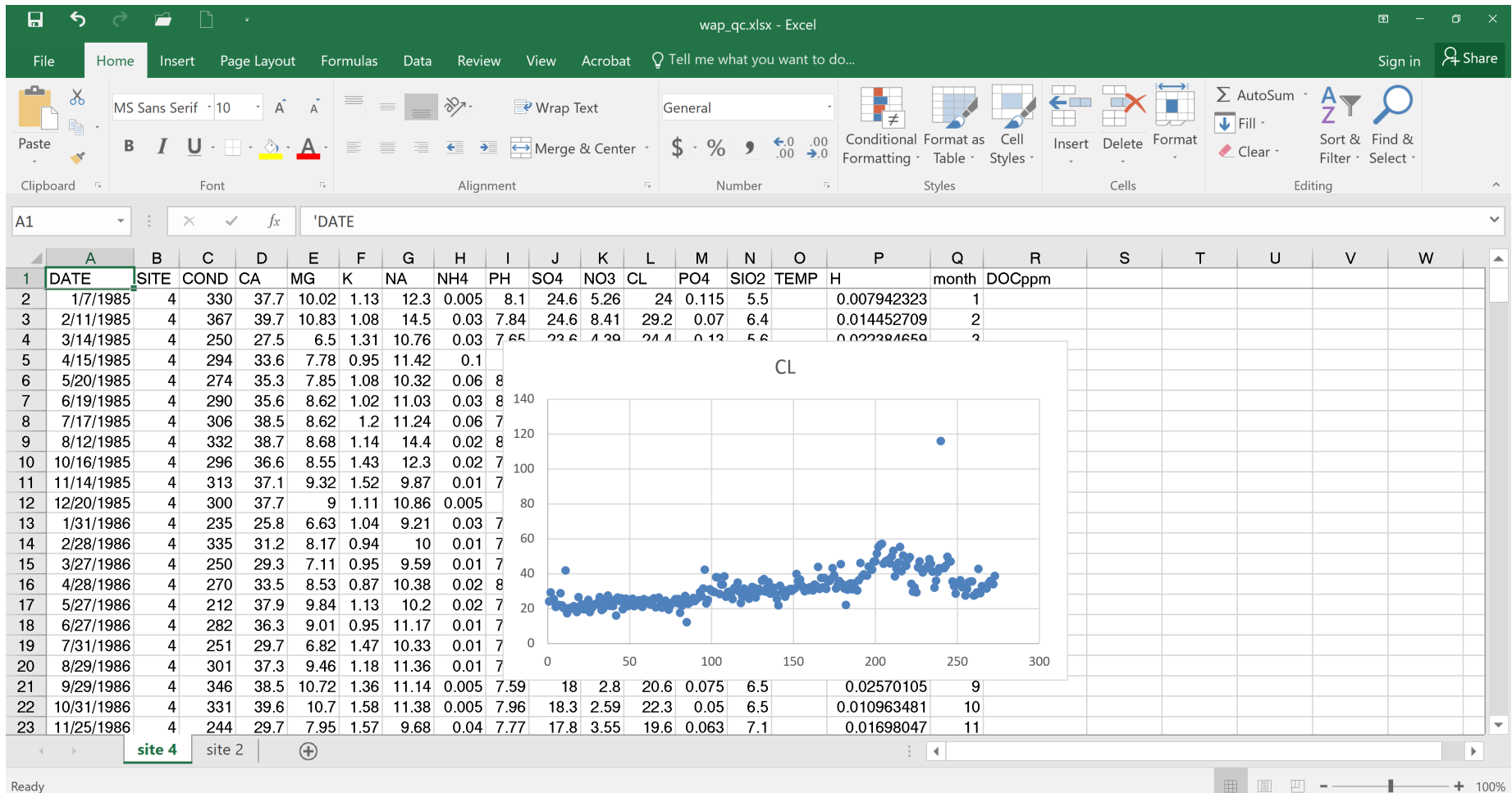
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	date	site	cond	pH	Ca	Mg	K	Na	Cl	SO4	NO3-N	NH4-N	PO4-P	SiO2	temp	Handar ht	Q	DOCppm	instream cond.	USGSQ	Notes	
2	01/28/2019	2	226	7.88	21.6	5.68	1.1	16.9	23.3	7.45	0.66	0.12	0.025	6.3	0.1	37.75	1.60		233	673		
3	02/26/2019	2	286	8.08	27.8	7.03	0.9	21.5	33.1	8.38	0.64	0.05	0.02	5.2	2.3	34.38	1.24		304	505		
4	03/25/2019	2	289	8.65	25.3	6.78	0.83	19.6	29.2	7.82	0.42	0.04	0.015	3.9	6.8	34.75	1.28		279	426		
5	04/29/2019	2	204	8.10											19.9	43.38	2.29		267	725		
6	05/28/2019	2	284	8.02											16.7	28.00	0.71		322			
7	06/26/2019	2	323	8.36											22.7	20.87	0.31		389			
8	07/26/2019	2	320	8.14											19.0	17.12	0.19		400			
9	08/27/2019	2	317	8.37											17.9	15.62	0.15		442			
10	09/24/2019	2	366	8.37																		
11	10/29/2019	2	296	8.26																		
12		2																				
13		2																				
14	01/28/2019	4	255	7.84	24.4	5.62	1.04	21.4	30.2	8.84	0.78	0.09	0.018	6.9								
15	02/26/2019	4	316	8.04	29.1	6.67	0.9	27.1	42.6	9.41	0.71	0.05	0.012	5.7								
16	03/25/2019	4	328	8.35	27.3	6.19	0.8	24.2	39.4	9.12	0.46	0.04	0.007	4.4								
17	04/29/2019	4	226	7.96																		
18	05/28/2019	4	306	7.96																		
19	06/26/2019	4	319	8.13																		
20	07/26/2019	4	318	7.95																		
21	08/27/2019	4	317	8.22																		
22	09/24/2019	4	327	8.21																		
23	10/29/2019	4	327	8.07																		

QAQC notes misc calcs data

Ready



# Quality Control



# Archiving/Storing Data

- Email it to yourself &/or collaborators
- Cloud storage, e.g., Google Drive, Dropbox, etc.
- External Hard Drive
- Data repositories – may need a researcher
- **Include Metadata**

# Guidelines for Good Data Management

- Document what you did – notebooks
- Keep a copy of the original data file unchanged
- Versioning – Save the file with a new name every time you change it. Document your file naming method – e.g., Filename\_Date – date refers to the date it was changed, keep all versions, describe how data were changed
- **METADATA** – Units, time (EST or DST), location - GPS coordinates, sampling protocol, analysis information, description of project, see attached
- Backup – 3 ways (your computer, external hard drive, google drive, 2 different sites (you, a collaborator, the cloud))

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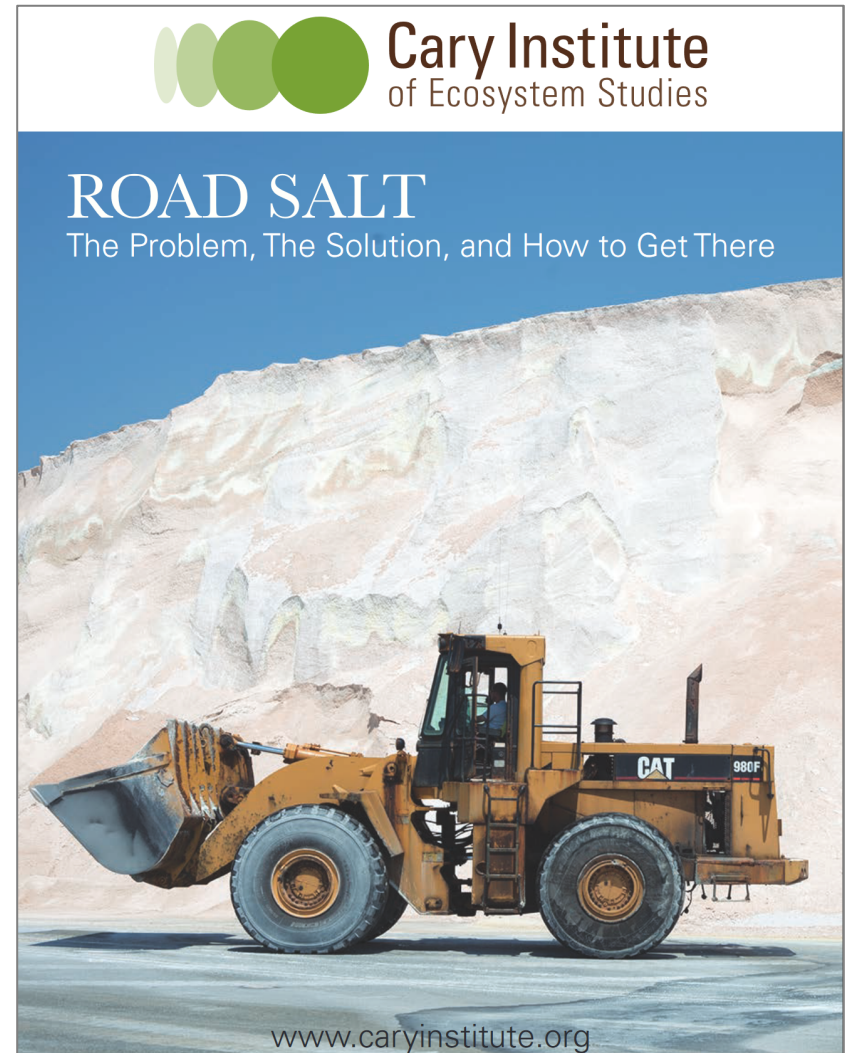
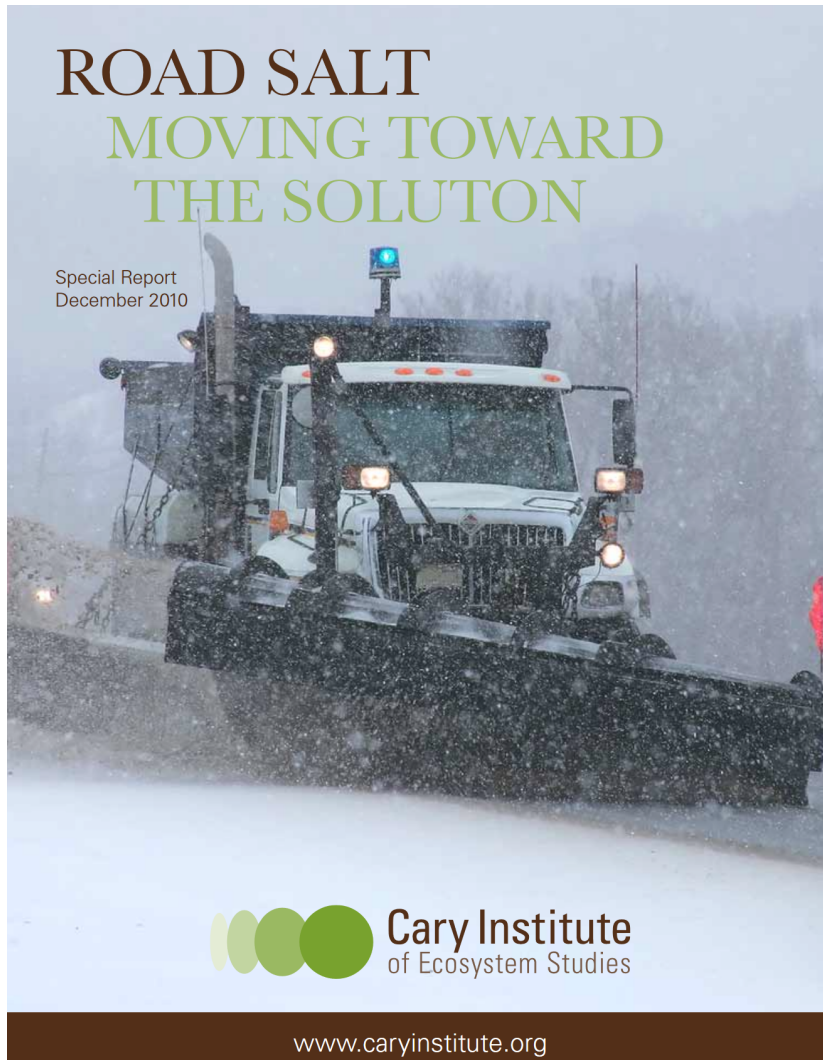
# How To Use The Data

Examine, interpret, and present the monitoring data





# Connect with Public Policy & Practice





# Engage The Public



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# Different Approaches To Monitoring

- Engage a researcher
- Community (Citizen) Science
- Join/form a network (HRECOS, EMMA, THuRST...)



**EMMA**  
Environmental Monitoring  
and Management Alliance



**The Hudson River Subwatershed & Tributary (THuRST)**  
**Research Network**

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# Thank You! Questions

[KellyV@caryinstitute.org](mailto:KellyV@caryinstitute.org)