Monitoring Water Quality in the Cayuga Lake Watershed, 2004-Present

Presentation to the Seneca County Water Quality Committee

May 13, 2019

Seneca County Health Department

Stephen Penningroth, Ph.D., Director, Community Science Institute

Community Science Institute

Independent, nonprofit, tax-exempt environmental organization founded in 2000, website: **communityscience.org**

Budget and Staff: Four (4) full-time, four (4) part-time; $268,000 in 2017, ~40 % from local governments and other stakeholders in Tompkins and Cayuga Counties

Certified water quality testing lab: NY State and EPA certified for both non-potable water and drinking water since 2003.

QAPP-based, affordable monitoring partnerships between certified lab and volunteer groups: We recruit, train and partner with community-based volunteer groups to build scientifically credible, long-term data sets -- at less than half the cost of environmental consulting firms -- with the goal of understanding and protecting water resources locally and regionally

Free online access to raw data and interpretive maps and graphs: Public can view raw data with maps and graphs, also search and download results, at **database.communityscience.org**

Biological stream monitoring: CSI staff also partner with volunteer groups to monitor the health of streams as aquatic ecosystems by collecting and identifying small bottom-dwelling organisms called benthic macroinvertebrates (BMI), on a par with NYSDEC’s stream monitoring program

CSI Uses Both Chemical and Biological Approaches to Track Water Quality

CSI

Certified Water Testing Lab ELAP# 11790

Chemical and Biological Monitoring Partnerships with Volunteer Groups

Public Dissemination of Results in Online Database

Volunteer Monitoring Partnerships

Synoptic Chemical Sampling – Cayuga and Seneca Lake Watersheds

- Impacts from agriculture, urban development, point sources

Red Flag Chemical Monitoring – Upper Susquehanna Watershed

- Baseline and nutrient data collection on small streams

Biological Monitoring (BMI) – Any stream of local interest

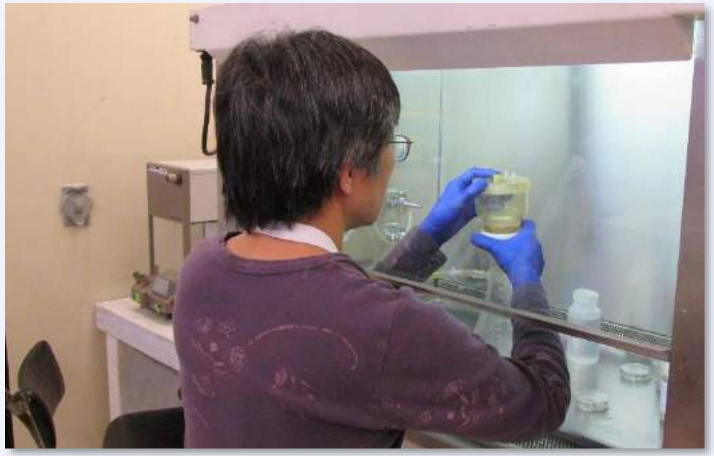
- Aquatic insect communities show long-term water quality

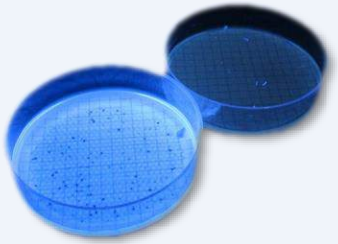
Certified Lab

- Regulated by NYS Department of Health
  - Regulatory & Legal purposes
- Potable and Non-potable water
- Chemistry & Microbiology
- Full list of tests and fees online

Learn more about testing your drinking water at www.communityscience.org/certified-lab/

Michi tests for total coliform and E. coli bacteria

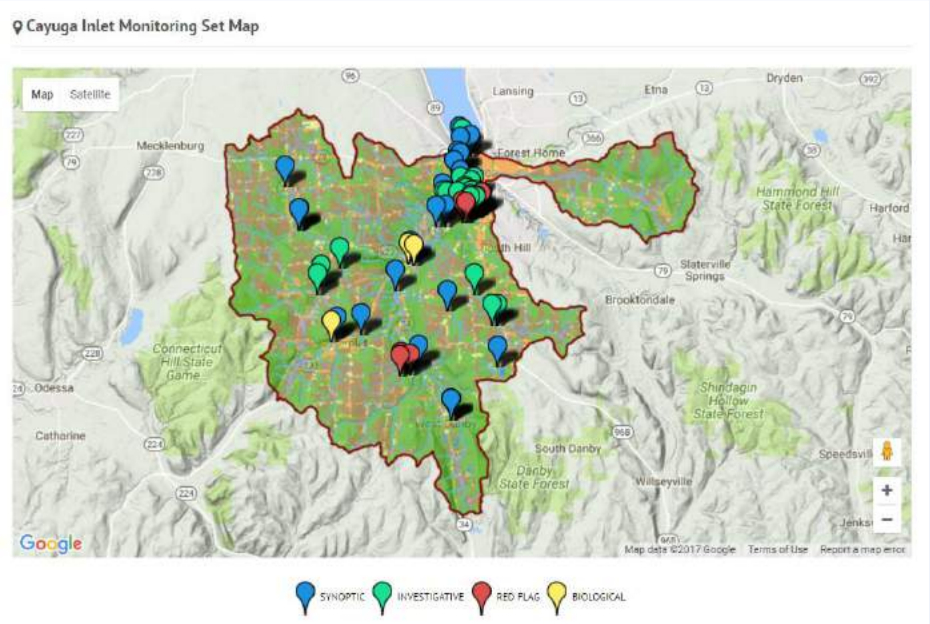


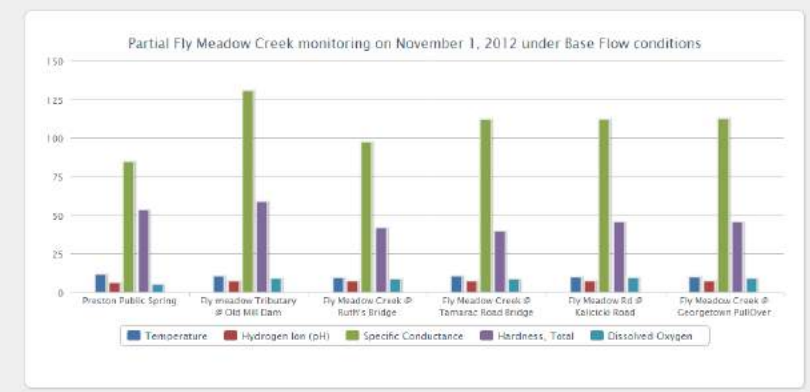


After the assay is complete bacteria colonies grow and are counted on plates

Online Databases for Surface Water, Groundwater and (coming in 2019) BMI and HABs

- Raw stream monitoring data are archived in **public** online databases that may be searched and downloaded **free** of charge
- Goal is to disseminate scientifically credible results to the public, to local and regional stakeholders, and to government agencies at all levels in order to improve water resource understanding and management
- Streams and lakes database launched in 2006
- Groundwater database launched in 2014
- BMI and HABs databases in 2019

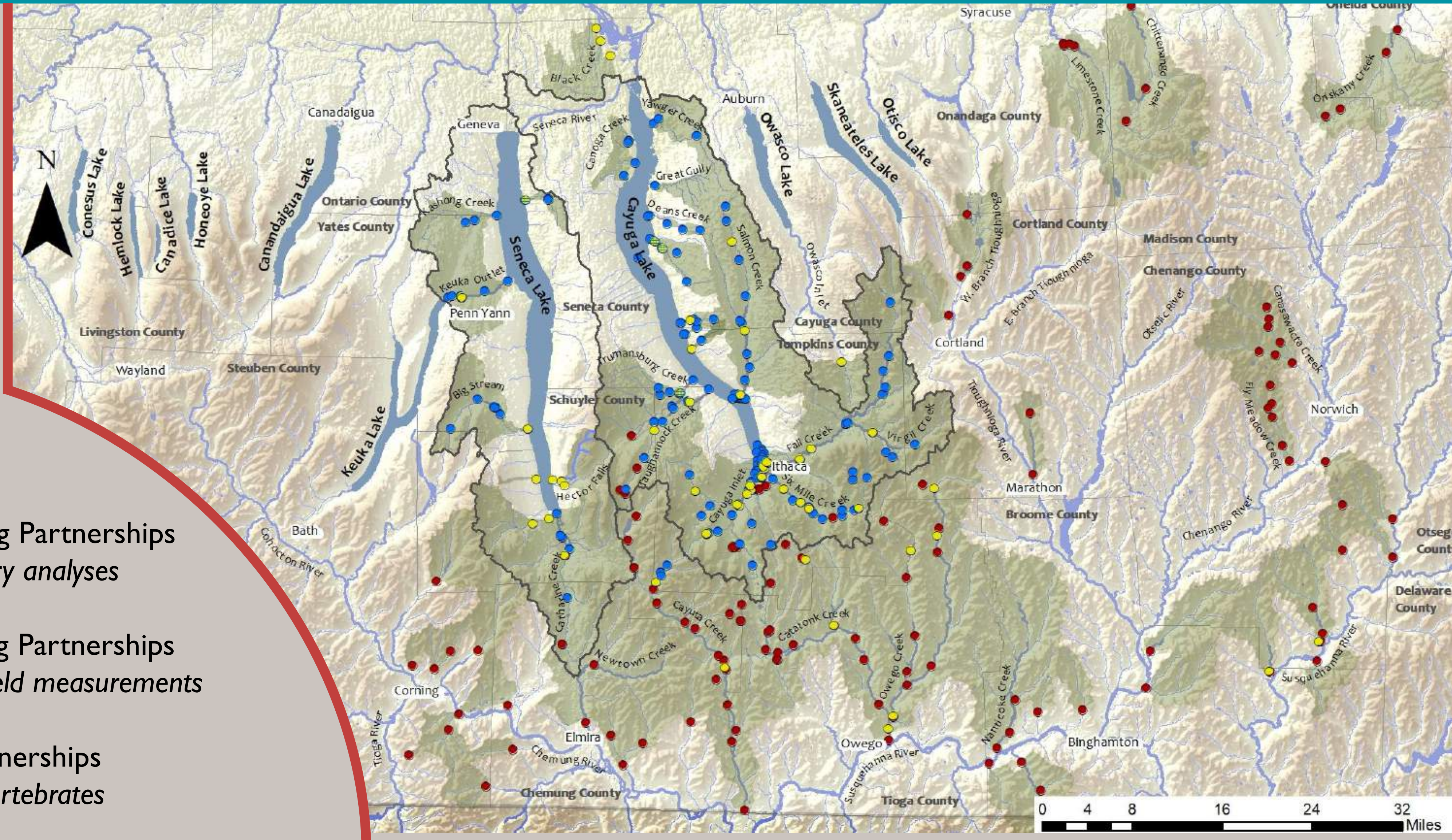




Volunteer Water Monitoring Partnerships

Three Volunteer Water Monitoring Programs

- Synoptic Sampling
- Red Flag Monitoring
- Biomonitoring



Synoptic Monitoring Partnerships

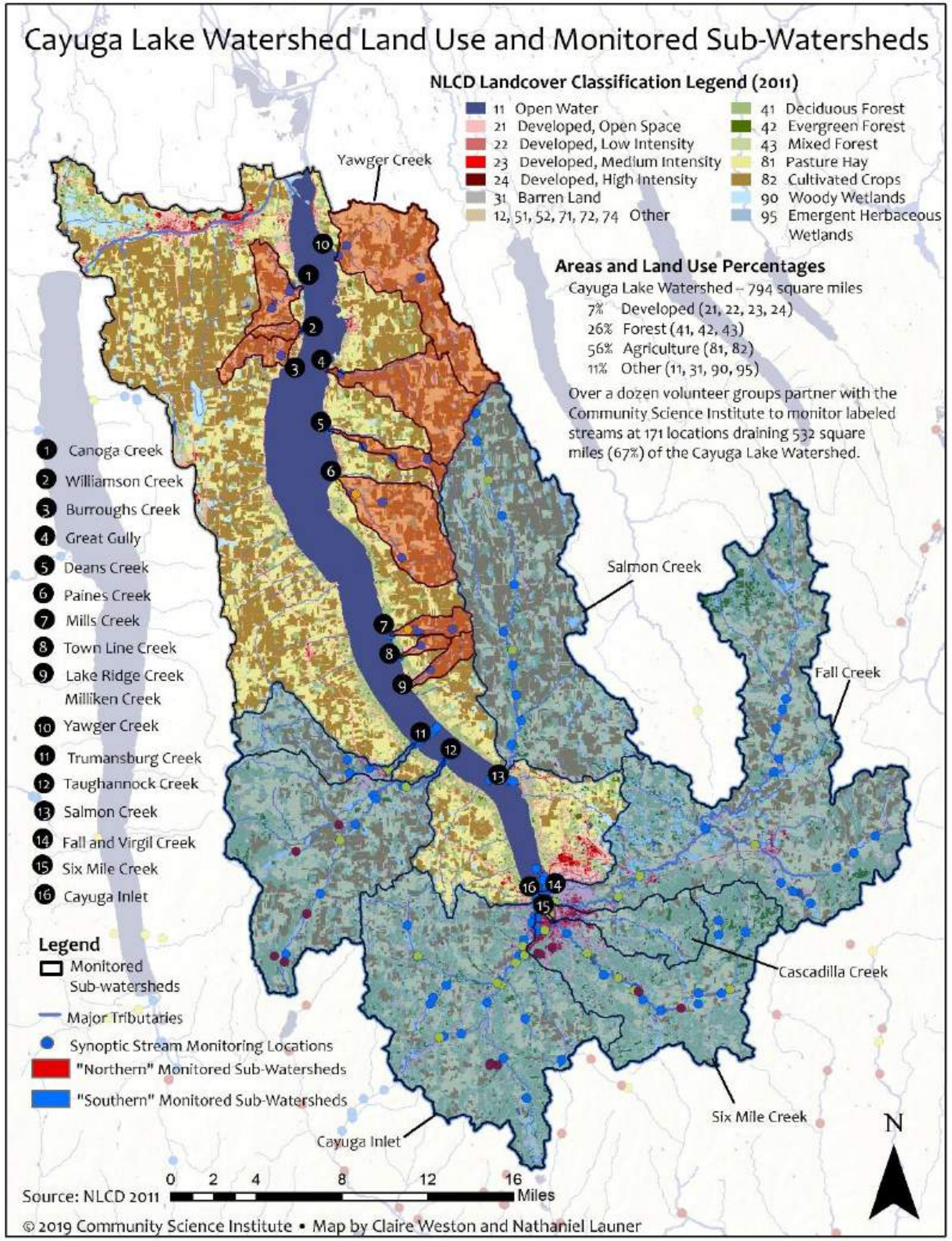
Certified laboratory analyses

Red Flag Monitoring Partnerships

Quality-assured field measurements

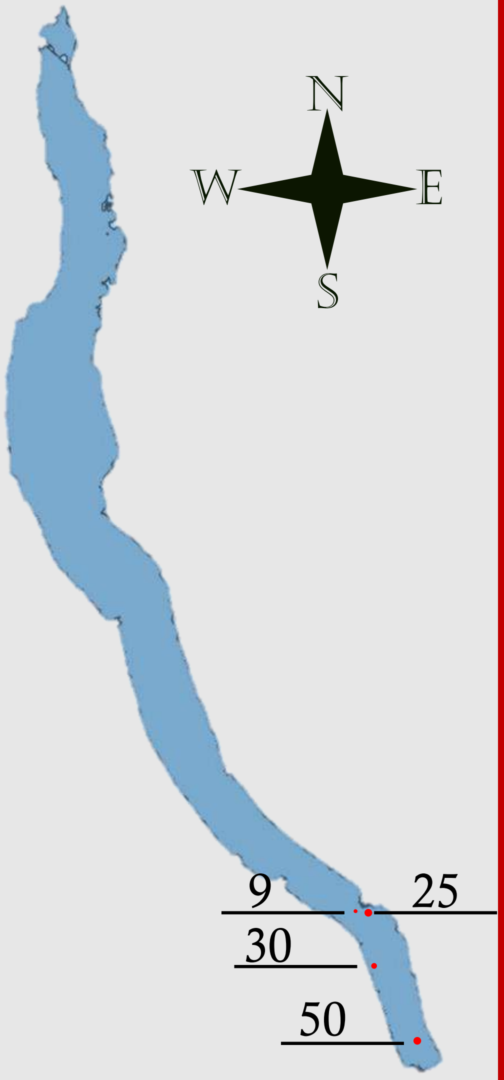
Biomonitoring Partnerships

Benthic macroinvertebrates



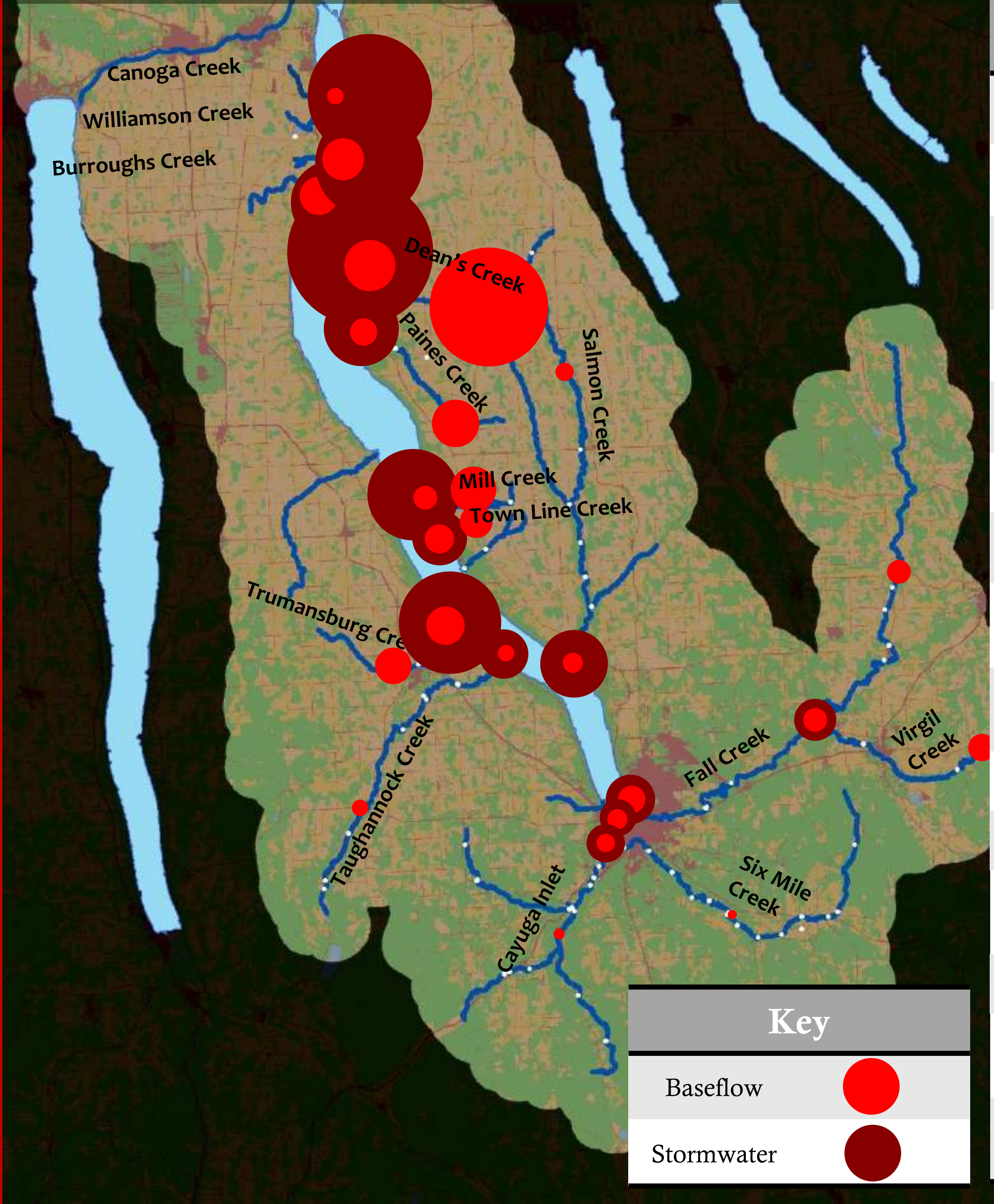
Cayuga Lake Watershed Land Use and Monitored Sub-Watersheds
NLCD Landcover Classification Legend (2011)
11 Open Water
21 Developed, Open Space
22 Developed, Low Intensity
23 Developed, Medium Intensity
24 Developed, High Intensity
31 Barren Land
12, 51, 52, 71, 72, 74 Other
41 Deciduous Forest
42 Evergreen Forest
43 Mixed Forest
81 Pasture Hay
82 Cultivated Crops
90 Woody Wetlands
95 Emergent Herbaceous Wetlands
Areas and Land Use Percentages
Cayuga Lake Watershed – 794 square miles
7% Developed (21, 22, 23, 24)
26% Forest (41, 42, 43)
56% Agriculture (81, 82)
11% Other (11, 31, 90, 95)
Over a dozen volunteer groups partner with the Community Science Institute to monitor labeled streams at 171 locations draining 532 square miles (67%) of the Cayuga Lake Watershed.
Yawger Creek
Salmon Creek
Fall Creek
Cascadilla Creek
Six Mile Creek
Cayuga Inlet
1 Canoga Creek
2 Williamson Creek
3 Burroughs Creek
4 Great Gully
5 Deans Creek
6 Paines Creek
7 Mills Creek
8 Town Line Creek
9 Lake Ridge Creek Milliken Creek
10 Yawger Creek
11 Trumansburg Creek
12 Taughannock Creek
13 Salmon Creek
14 Fall and Virgil Creek
15 Six Mile Creek
16 Cayuga Inlet
Legend
Monitored Sub-watersheds
Major Tributaries
Synoptic Stream Monitoring Locations
"Northern" Monitored Sub-Watersheds
"Southern" Monitored Sub-Watersheds
N
0 2 4 8 12 16
Miles
Source: NLCD 2011
© 2019 Community Science Institute • Map by Claire Weston and Nathaniel Launer

E. coli concentrations in southern Cayuga Lake and along east and west shores (colonies/100 ml)

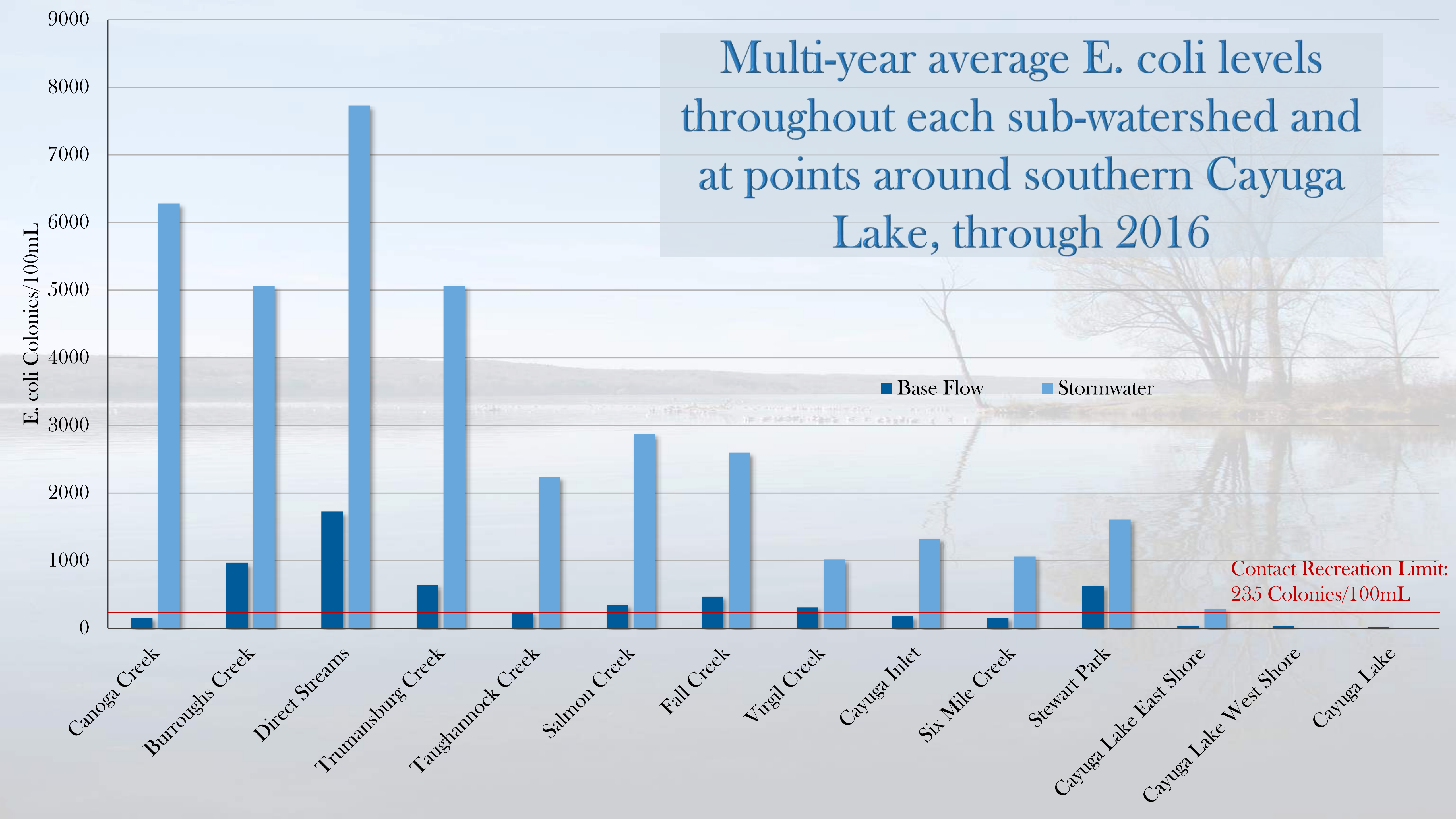


Selected E. coli Concentrations

Contact recreation limit = 235 colonies/100 ml



Stream (North to South)	Base Flow E. coli at mouth (colonies/100 ml)	Base Flow E. coli at Other Location (colonies/100 ml)	Stormwater E. coli at mouth (colonies/100 ml)
Canoga Creek	235	2.5	12135
Williamson Creek	1350	ND	9170
Burroughs Creek	1140	ND	5435
Dean's Creek	2046	11051	16746
Paine's Creek	620	1799	4306
Mill Creek	432	1581	6475
Town line creek	637	862	2362
Trumansburg Creek	1114	1078	8247
Taughannock Creek	231	210	1887
Salmon Creek	326	287	3560
Fall Creek	549	409	1959
Virgil Creek	439	606	1376
Cayuga Inlet	251	84	1200
Six Mile Creek	311	65	1076
Cascadilla Creek*	424	ND	2659

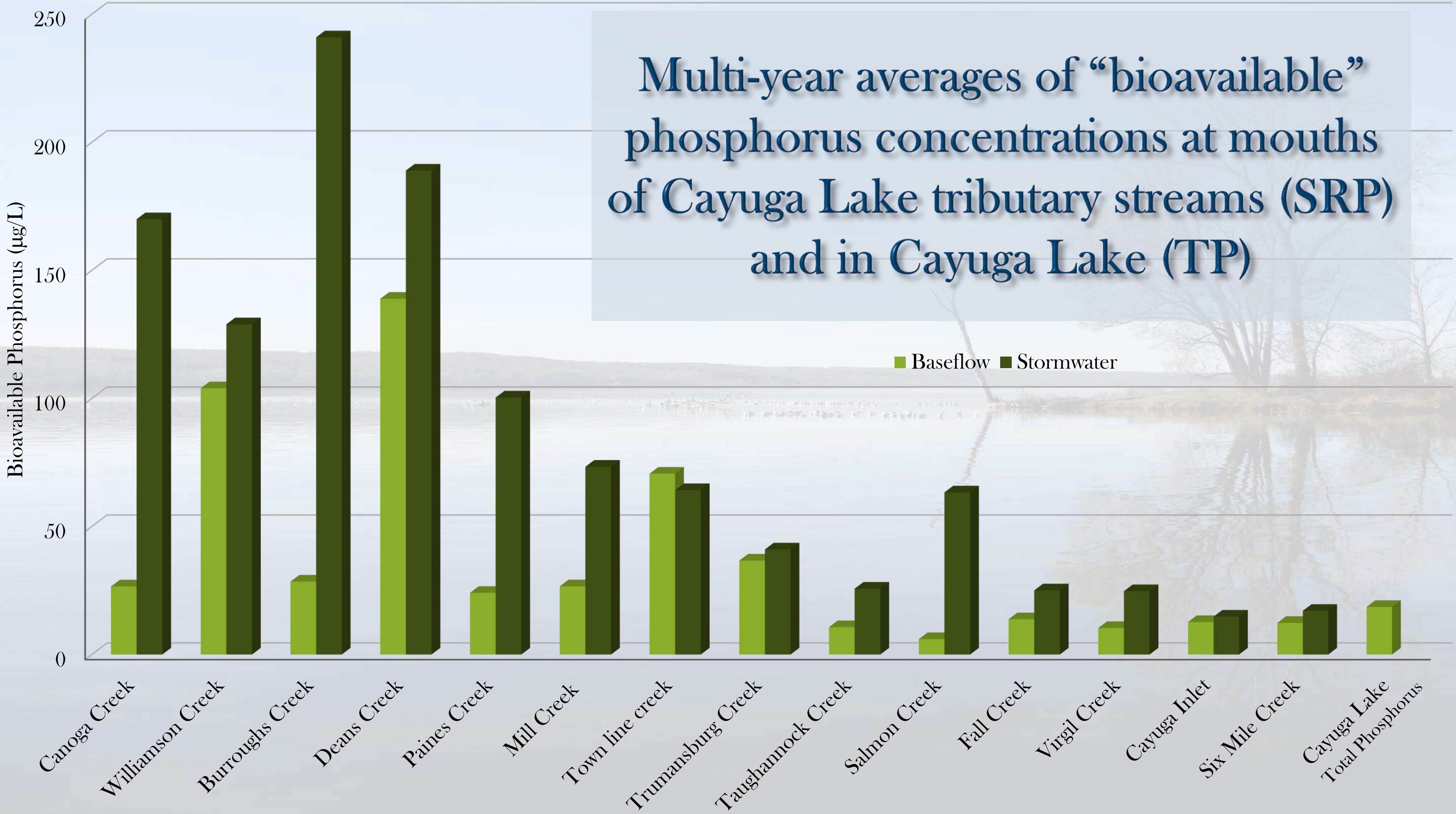

Multi-year average E. coli levels throughout each sub-watershed and at points around southern Cayuga Lake, through 2016
E. coli Colonies/100mL
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Flow
Stormwater
Contact Recreation Limit:
235 Colonies/100mL
Canoga Creek
Burroughs Creek
Direct Streams
Trumansburg Creek
Taughannock Creek
Salmon Creek
Fall Creek
Virgil Creek
Cayuga Inlet
Six Mile Creek
Stewart Park
Cayuga Lake East Shore
Cayuga Lake West Shore
Cayuga Lake

Multi-Year Average Soluble Reactive ("Bioavailable") Phosphorus Concentrations at Stream Mouths

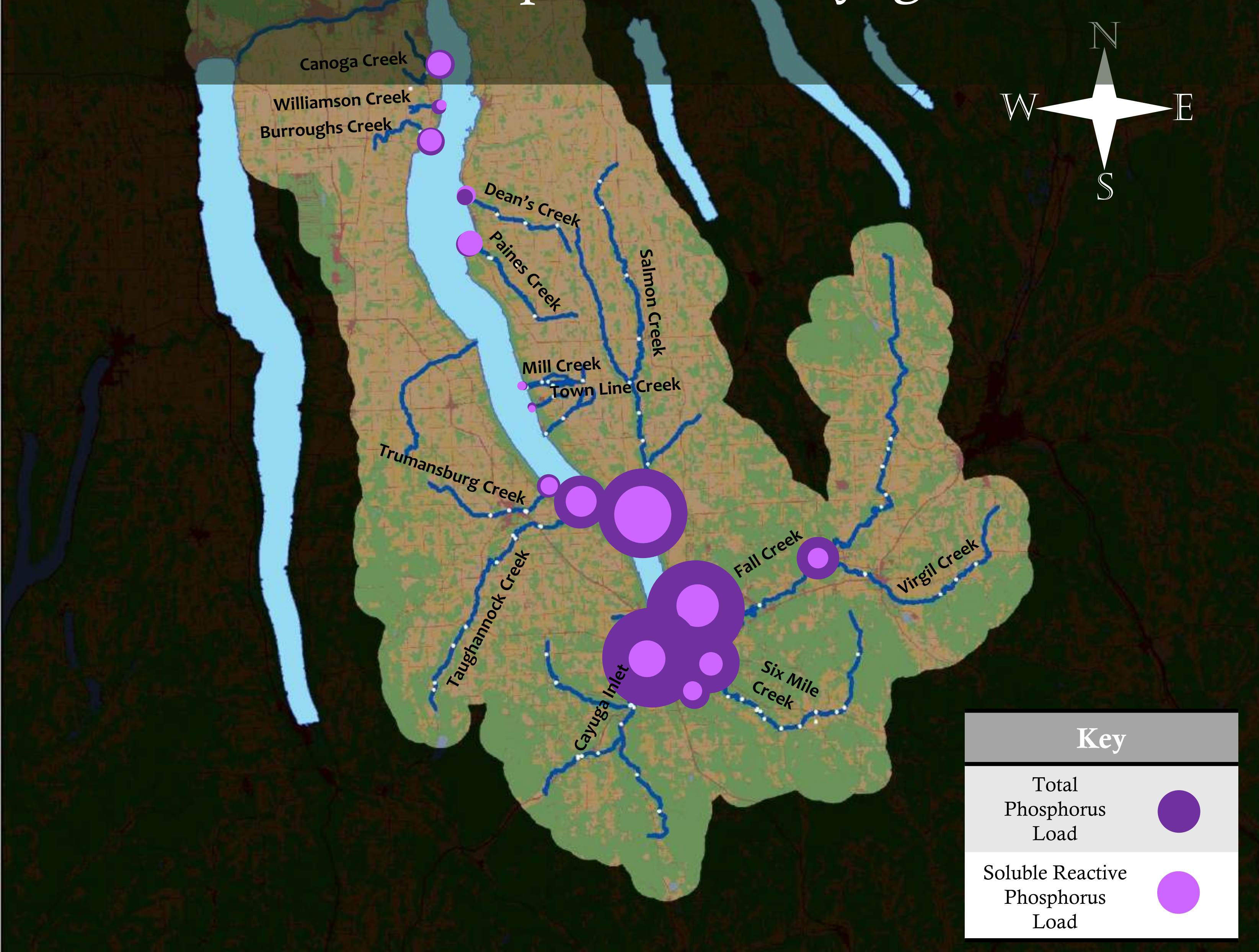
Key	
Baseflow	
Stormwater	

Stream (North to South)	Baseflow Soluble Reactive Phosphorus (µgP/L)	Stormwater Soluble Reactive Phosphorus (µgP/L)
Canoga Creek	26.58	169.98
Williamson Creek	104.00	129.00
Burroughs Creek	28.50	241.00
Deans Creek	138.95	189.00
Paines Creek	24.10	100.40
Mill Creek	26.66	73.37
Town line creek	70.66	64.23
Trumansburg Creek	36.70	41.06
Taughannock Creek	10.70	25.74
Salmon Creek	6.01	63.34
Fall Creek	13.78	25.06
Virgil Creek	10.37	24.77
Stewart Park Visitor's Center	59.92	62.20
Cayuga Inlet	12.70	14.80
Six Mile Creek	12.35	17.07
Cascadilla Creek*	18.81	37.59

Multi-year averages of “bioavailable” phosphorus concentrations at mouths of Cayuga Lake tributary streams (SRP) and in Cayuga Lake (TP)



Multi-Year Average Loading of "Bioavailable" and Total Phosphorus to Cayuga Lake



Watershed (North to South)	Drainage Area (mi²)	Loading of Total Phosphorus (tons/yr)	Loading of Soluble Reactive Phosphorus (tons/yr)
Canoga Creek*	5.83	2.05	1.32
Williamson Creek*	1.40	0.51	0.24
Burroughs Creek*	3.7	1.84	1.20
Deans Creek*	3.2	0.71	0.81
Paines Creek*	15.3	1.51	1.51
Mill Creek*	1.4	0.18	0.19
Town Line Creek*	1.7	0.19	0.15
Trumansburg Creek*	13.07	1.30	0.76
Taughannock Creek*	66.8	6.51	2.31
Salmon Creek*	89.2	19.14	7.59
Fall Creek^	129.0	23.11	4.34
Virgil Creek^	**40.6**	**4.35**	**1.08**
Cayuga Inlet^	**158.0**	**23.76**	**3.14**
Six Mile Creek^	**51.5**	**8.89**	**1.33**
Cascadilla Creek^	**13.7**	**2.39**	**0.80**

^Calculated load, average 2011-2013
*Extrapolated from Fall Creek load

Approx. "Bioavailable Phosphorus" Loading to Cayuga Lake

	Sub-Watershed (North to South)	Monitored Drainage Area (mi^2)	Estimated SRP Loading (tons/yr)
Northern Portion	Yawger Creek*	24.9	6.39
	Great Gully*	15.6	2.70
	Canoga Creek*	5.83	1.22
	Williamson Creek*	1.40	0.27
	Burroughs Creek*	3.7	0.95
	Deans Creek*	3.2	1.12
	Paines Creek*	15.3	2.52
	Mill Creek*	1.4	0.24
	Town Line Creek*	1.7	0.20
Southern Portion	Trumansburg Creek*	13.07	0.76
	Taughannock Creek*	66.8	2.31
	Salmon Creek*	89.2	7.59
	Fall Creek^	129.0	4.34
	Cayuga Inlet^	158.0	3.14

^Calculated load, average 2011-2013
*Extrapolated from Fall Creek load

Northern Portion:

Total Monitored Drainage Area	Total Estimated SRP Load
73.03 mi^2	**15.6 tons/yr**

Southern Portion:

Total Monitored Drainage Area	Total Estimated SRP Load
456.07 mi^2	**18.1 tons/yr**

Northern Watershed Loading Extrapolation

Northern Watershed Drainage Area = **332 mi^2**

$(332\ mi^2/73.03\ mi^2) \times 15.62$ tons/yr

=

71.0 tons/yr

Approx. Inorganic Nitrogen Loading to Cayuga Lake

	Watershed (North to South)	Monitored Drainage Area (mi^2)	Estimated Inorganic Nitrogen Loading (tons/yr)
Northern Portion	Yawger Creek*	24.9	131.48
	Great Gully*	15.6	67.44
	Canoga Creek*	5.83	43.00
	Williamson Creek*	1.40	7.46
	Burroughs Creek*	3.7	27.29
	Deans Creek*	3.2	44.51
	Paines Creek*	15.3	129.51
	Mill Creek*	1.4	22.22
	Town Line Creek*	1.7	20.31
Southern Portion	Trumansburg Creek*	13.07	34.07
	Taughannock Creek*	66.8	178.56
	Salmon Creek*	89.2	709.43
	Fall Creek^	129.0	178.80
	Cayuga Inlet^	158.0	70.60

^Calculated load, average 2011-2013
*Extrapolated from Fall Creek load

Total Monitored Drainage Area	Total Estimated Inorganic Nitrogen Load
73.03 mi^2	**493.2 tons/yr**
456.07 mi^2	**1,171.4 tons/yr**

Northern Watershed Loading Extrapolation

Northern Watershed Drainage Area = **332 mi^2**

$(332\ mi^2/73.03\ mi^2) \times 493.22$ tons/yr

=

2,237.7 tons/yr

Conclusions

- Levels of nutrients and E.coli tend to be significantly higher in northern Cayuga Lake tributaries than in southern streams.
- Preliminary estimates suggest that despite their smaller size, northern tributaries, taken together, load 4x more phosphorus and 2x more nitrate to Cayuga Lake than do larger southern streams.
- Only a tiny fraction of Seneca County's tributary streams are currently being monitored, and there is a large data gap and considerable uncertainty about the County's contribution to nutrient loading.
- **Sheldrake Creek** and **Johnsons Creek** are candidates for monitoring.
- One stream would cost ~ $3,500/yr. assuming 4 sites and 3 events