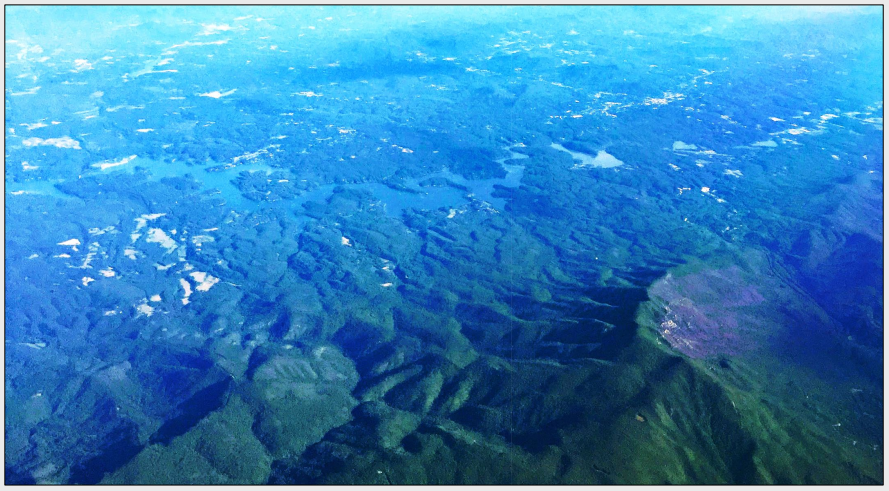
VWIN Water Monitoring at Lake James

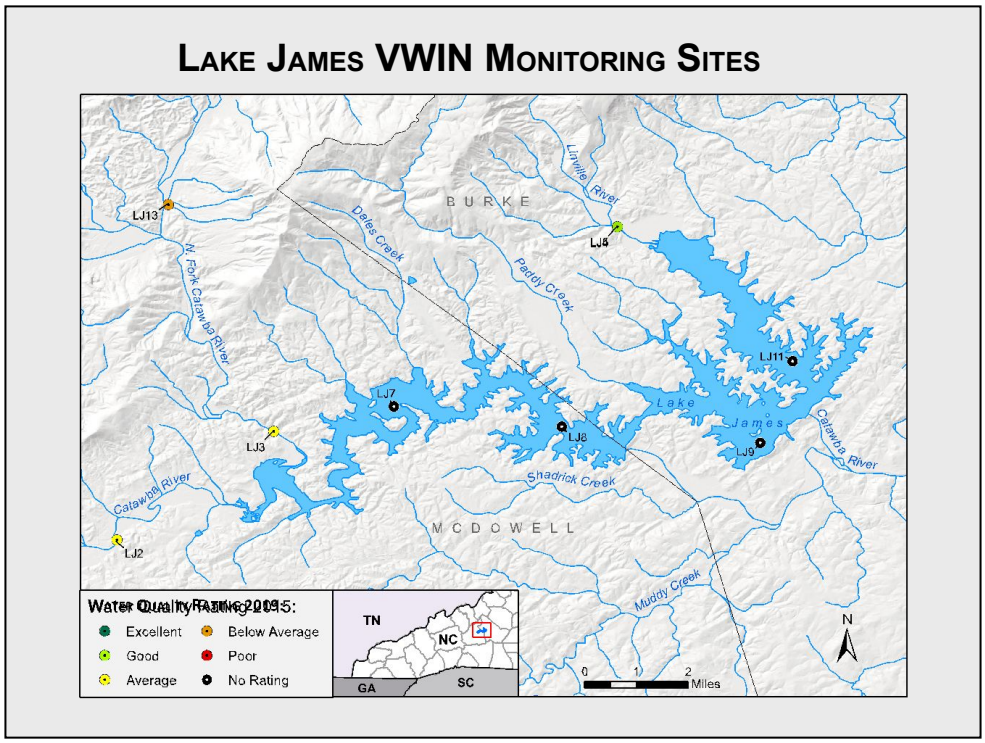


Ann Marie Traylor, The Environmental Quality Institute

November 21, 2019

The Environmental Quality Institute

VWIN: Chemical stream monitoring – 30 years
SMIE: Biological stream monitoring – 15 years
LJEA VWIN monitoring – since May 2001 (17.5 years)



Three long-term VWIN stream sites with ratings – Catawba, NF, Linville.

WQ Ratings are using past 3 years of data (Dec 2016-Oct 2019)

Catawba & NF site score = 79 – ALMOST GOOD. #13 was Below Ave for last presentation in 2017.

LJ3 hwas discontinued – no current rating.

Newer stream sites:

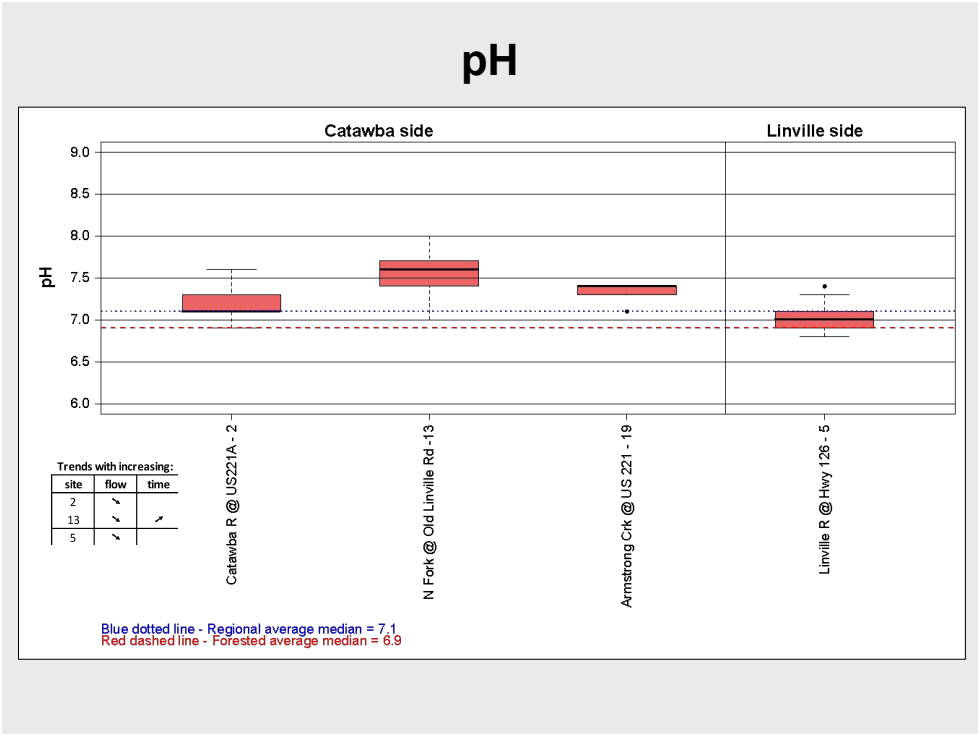
#17 - N Fork @ ONCS Rd upstream of Baxter- 2/17 - 10/19 - PO4 & Cond only (can't compare with other regional VWIN sites)

#16 – NF @ Pitt Station Rd just downstream of Baxter - 2/17 - 4/19 - PO4 & Cond only (can't compare with other regional VWIN sites)

#19 - Armstrong Cr - May-Oct 2019 so far –tested for all parameters - a NF trib

#7, 8, 9, 11 – lake sites all years, nutrients, secchi depths, DO & temp - no ratings

Added #6 – Lake at Plantation Pt - only 2018-19 summer so far



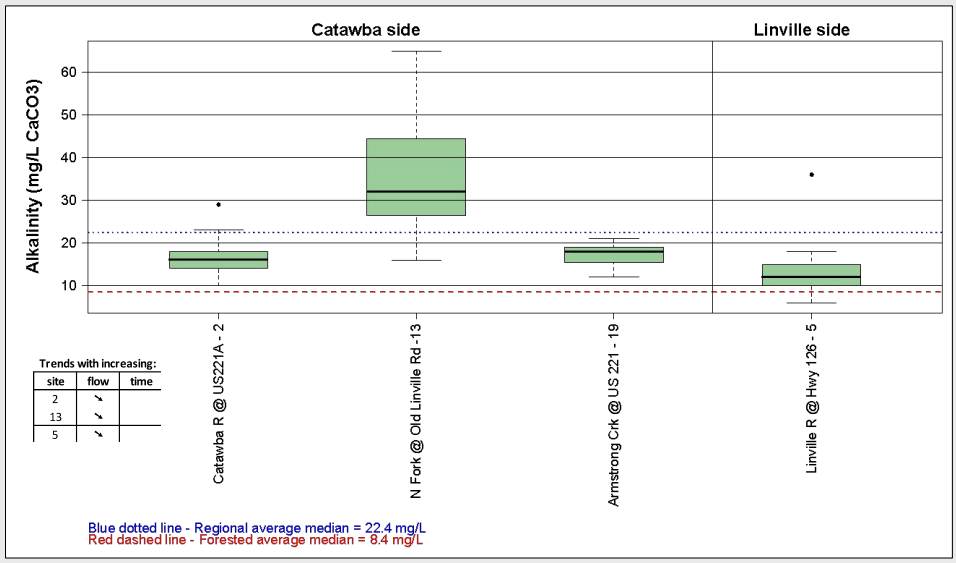
All boxplots are past 3 years from Dec 2017-Oct 2019

Reading boxplots: dark middle line= median, "box" represents 25%-75% (1st & 3rd quartiles), "whiskers" = min & max (i.e. range), individual points = outliers "outside 1.5 times the interquartile range above the upper quartile and bellow the lower quartile"

NF higher but not unusually high, with slight increase with time.

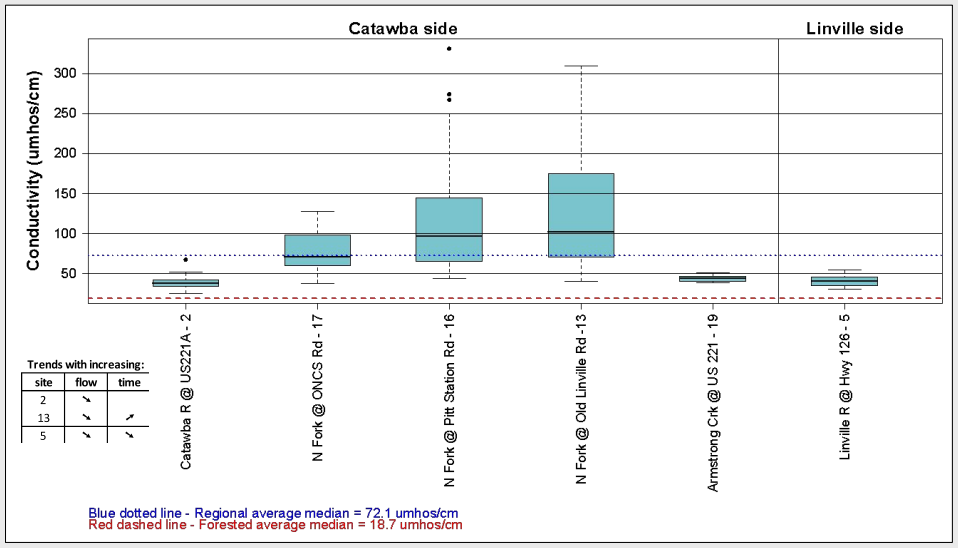
#19 - Armstrong Cr data only from May-Oct 2019 so far

ALKALINITY



NF highest above the regional average – more variability than other sites. Not bad to have alkalinity which provides buffer to fluctuations in pH but levels are unnaturally high for this region.

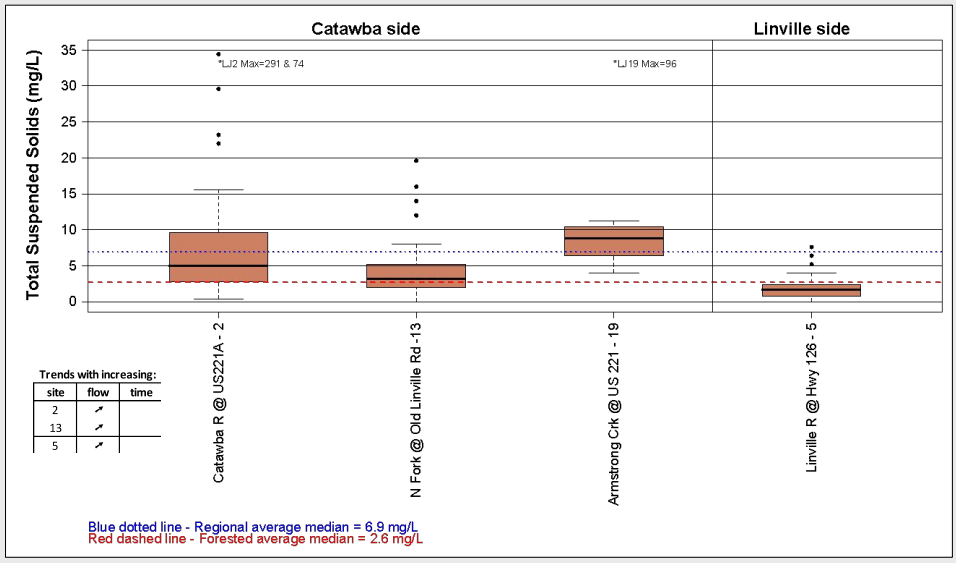
CONDUCTIVITY



NF high medians and outliers, and most variability of the sites.

No regulatory limits for conductivity, which can have natural variability, but in this region, conductivity is naturally low.

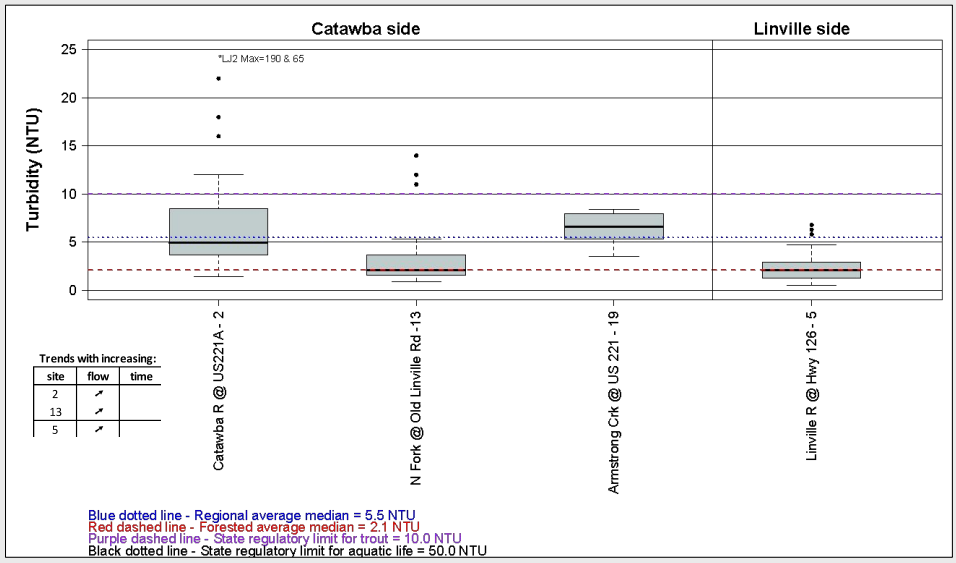
Total Suspended Solids



Catawba highest outliers – 291 mg/L on 10/27/19 with 10X flow on the river, 74 mg/L on 11/24/18 with 4X flow indicating nonpoint-source.

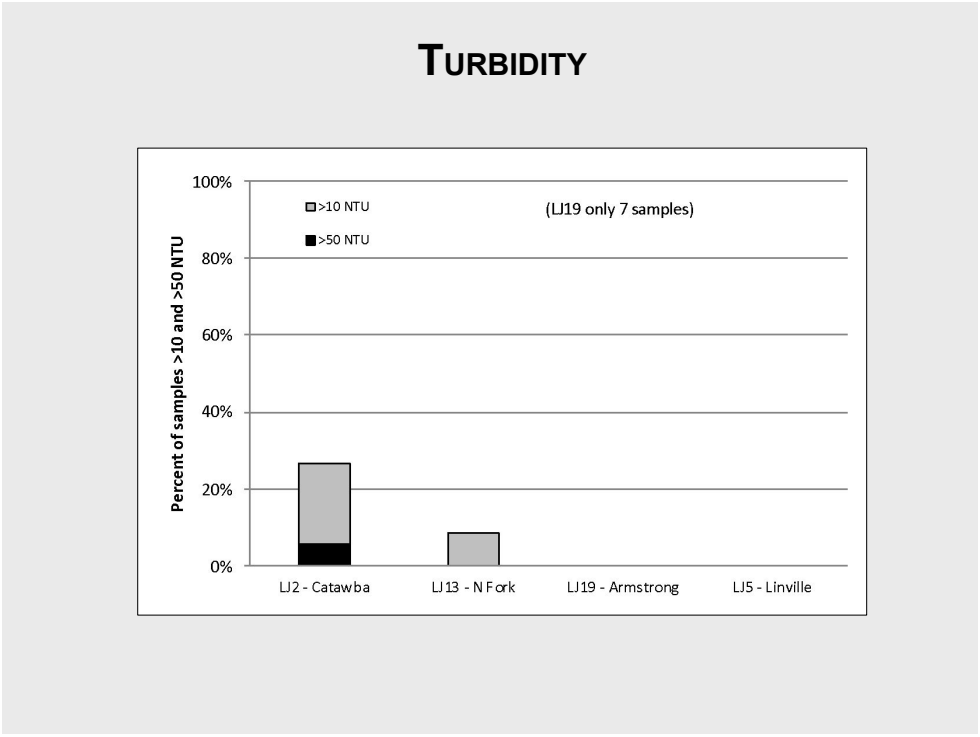
Armstrong's highest = 96 on 7/28/19 with normal flow. (only sampled May-Oct 20191 so far)

TURBIDITY



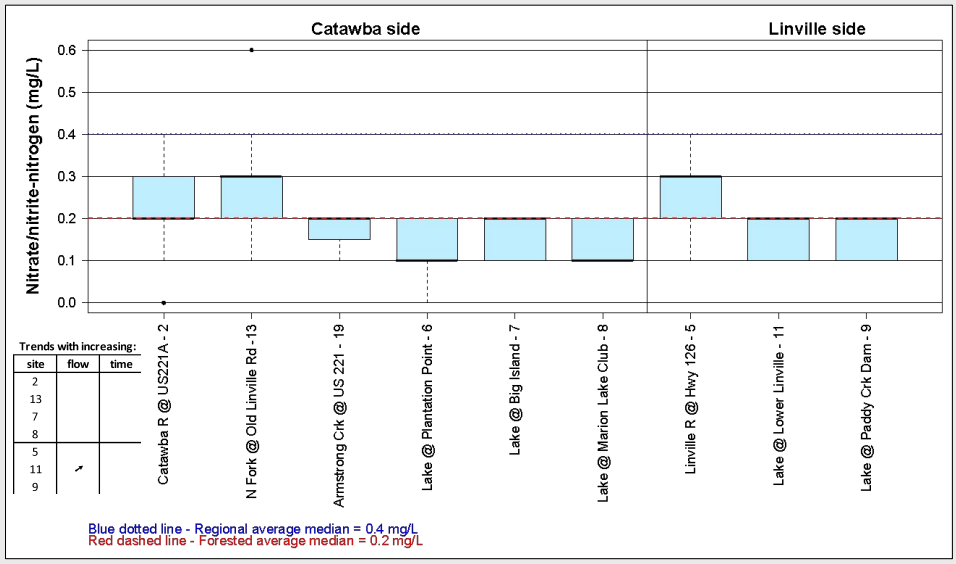
Similar pattern as TSS (sediment related)

Catawba highest outliers – 190 NTU on 10/27/19 with 10X flow, 65 NTU on 11/24/18 with 4X flow indicating nonpoint-source.



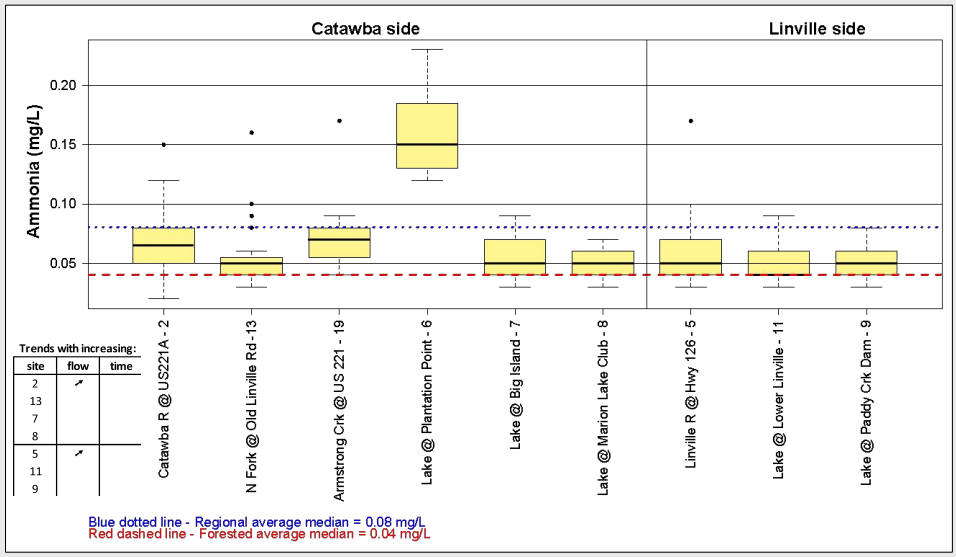
Catawba showing most exceedances of turbidity regulatory limits (10 NTU for trout waters, 50 NTU for other aquatic life).

NITRATE/NITRITE-NITROGEN



One 0.6mg/L event was in 11/2017. From 2015-17 (last presentation), site #13 had 6 outliers >0.5mg/L so it may be improving in 2018-19. Reg limit is 5 mg/L.

AMMONIA-NITROGEN



Ammonia is highest, well above regional average, at Plantation Point. All other sites are below the region.

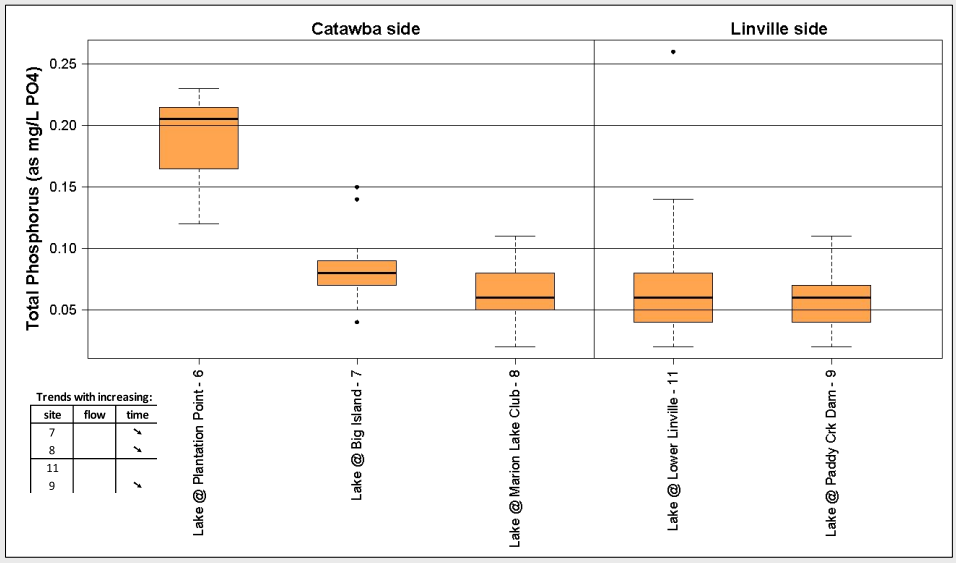
DO drops off quickly in the summer months at that site.

Ammonia can accumulate in the hypolimnion as a result of bacterial decomposition of organic material in the sediments.

Low DO can also allow phosphorus to separate from compounds in the sediments and re-dissolve in the water.

So plant/algae decay (warm-weather only samples)? Or fertilizers/manure downstream of Catawba & NF stream sites?

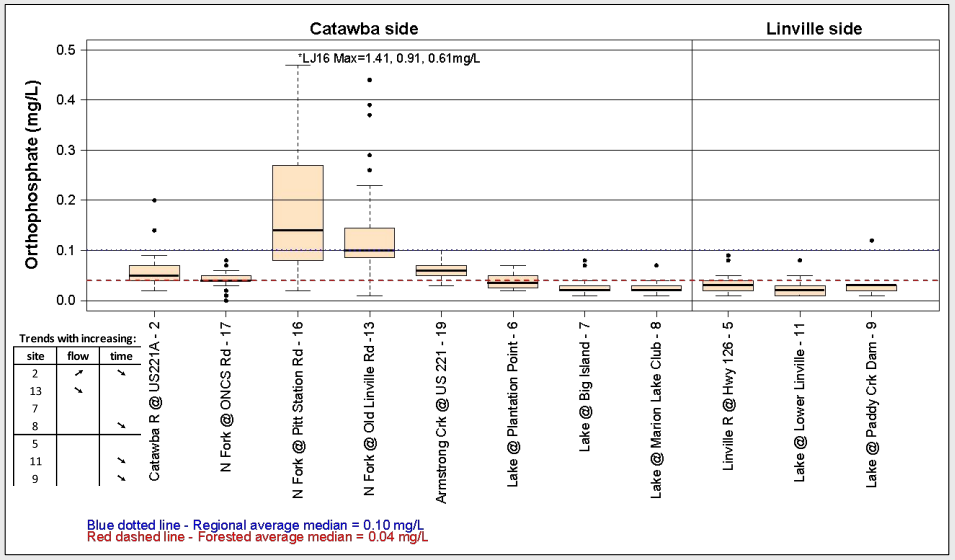
Total Phosphorus



Similar to ammonia with the lake sites. Plantation Point has higher values. Staying below 0.15mg/L (as PO4) is recommended to prevent downstream eutrophication.

One high outlier at Linville lake site: 6/26/17, flow just slightly lower than average. Wouldn't worry unless we see more instances.

ORTHOPHOSPHATE



PO4 - Pitt Station showing very high outliers & highest median. Old Linville Rd also high outliers. Aim for <0.15mg/L PO4 to prevent downstream eutrophication.

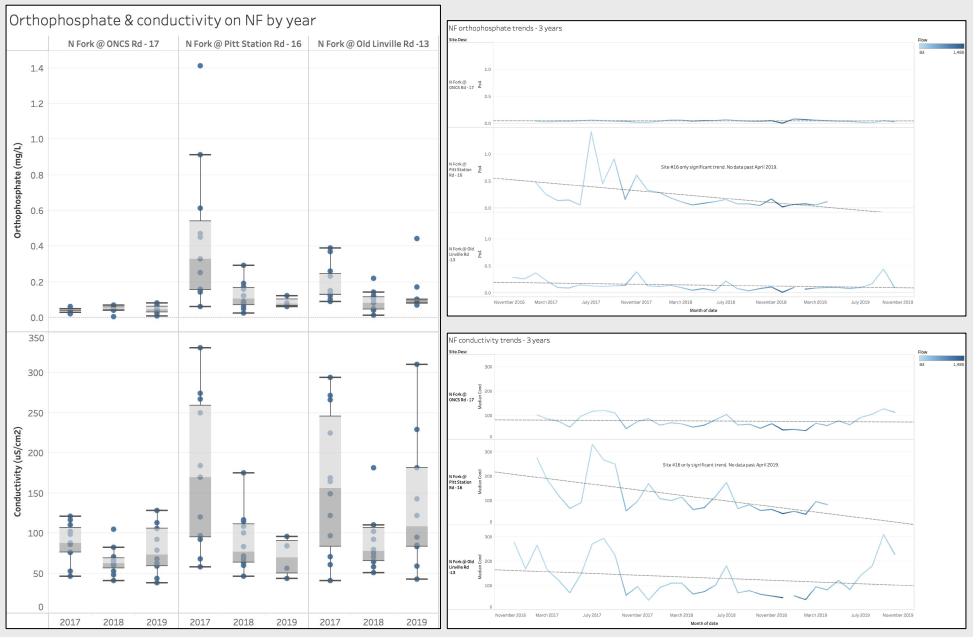
Monitoring at Pitt Station ended in April 2019. Downstream at Old Linville Rd also includes May-Oct 2019.

#13 high value of 0.44mg/L happened on 9/28/19 at less than half average daily flow (drought) which indicates point source. – No data available for #16 upstream on that date.

Don't have enough data (<5yrs) to see trends in #16 or #17. – All lake sites except Big Island show declines in PO4 over past 10 years. Not enough years yet for Plantation Point.

High value on Catawba R (#2) was on Oct 27, 2019 during ~10X average daily flow, indicating non-point source. Sampled day after all other sites which were sampled before major rainfall so that prevents allow comparisons among sites.

PO4 & Cond on North Fork – 3 Years



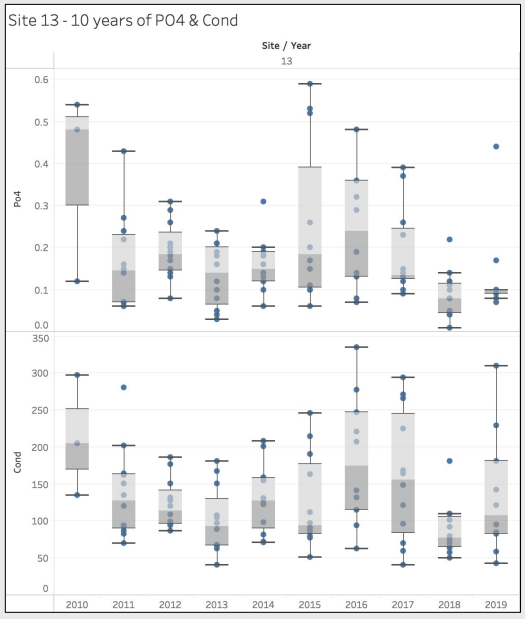
Looking at past 3 years of data at NF.

PO4 & cond decrease by year significantly at Pitt Station Rd #16. But yr2019 doesn't have data past 2019 for that site. Site #13 would have shown significant declines if we didn't include this summer's data.

From trend lines on right, cond & PO4 are lower in times of higher flow (where the lines get darker blue). 2018 was a year with higher precipitation.

High PO4 & Cond at site #13 happened on Sept 2019, but there's no accompanying data upstream at Pitt Station Rd so it's hard to tease out what that was. Flow was about half of normal, so likely point-source from somewhere.

PO4 & Cond on North Fork – 10 Years



Looking at past 10 years of data. Only available for site #13 (downstream NF)

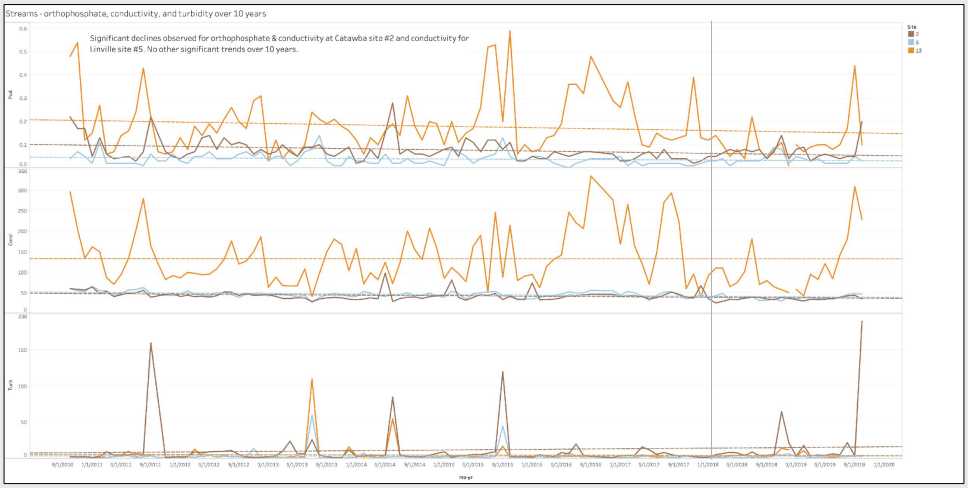
PO4 & cond show fluctuations over the years. Almost two distinct cycles of improvement/decline.

2010 – only Oct-Dec, but they were high.

Dryer years = 2011, 2012

Wetter years = 2013, 2018* (years with lowest results)

Comparing Stream Sites – 10 Years



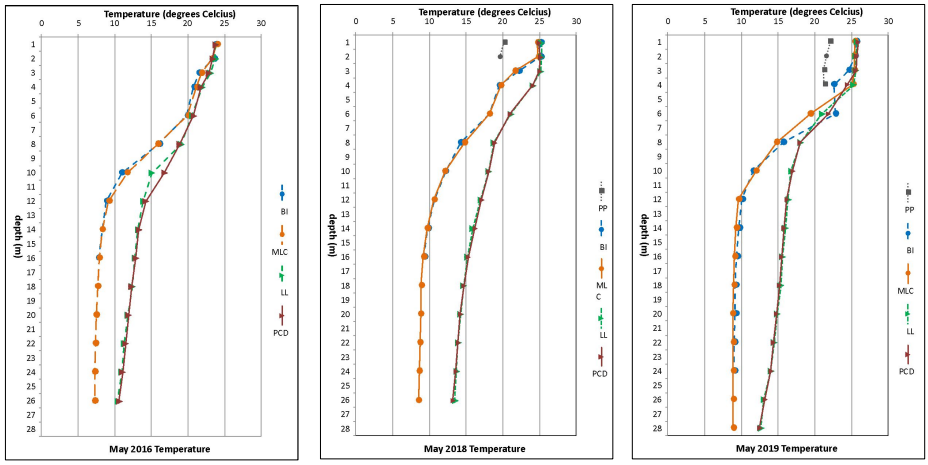
Comparing the past 10 years of data from Catawba, downstream NF, and Linville – orthophosphate, conductivity, turbidity

PO4 & cond show large fluctuations over the years for NF, no significant trend over 10 yrs.

Catawba usually has highest peaks during high flow events, indicating stormwater runoff.

Vertical line at Jan 2018 – still lots of variation in PO4 & cond at NF site after that.

Temperature Profiles – May



76% flow
2016

378% flow
2018

129% flow
2019

Dark Gray = Plantation Point (2018-19 only)

Blue = Big Island

Green = Lower Linville

Brown – Paddy Creek Dam

Flow listed at bottom is discharge taken from Catawba River USGS gauge to indicate discharge that month compared to the average discharge for that month in history.

2016 = lower flow

2018 = higher flow

2019 = mostly average flow during summer months.

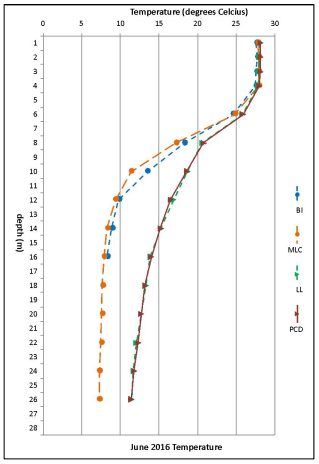
Two sides of lake show distinct temp profiles – pattern continues throughout summer.

Oxygenated top water flows into Linville side while cold low-O2 water is trapped on Catawba side.

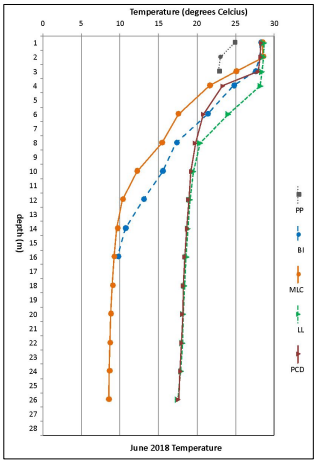
And cold deep water is withdrawn from dam. So Linville side is staying warmer.

Plantation Point (sampled only in 2018-19) always has lower temperatures, possibly due to input of cooler stream water (or groundwater) into shallow lake area.

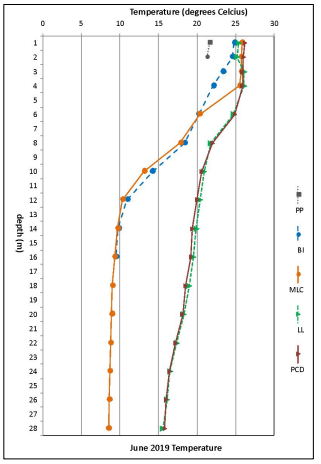
Temperature Profiles – June



64% flow
2016

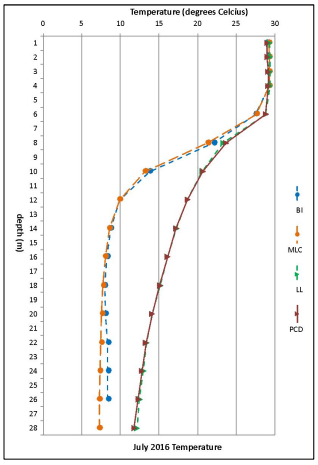


236% flow
2018

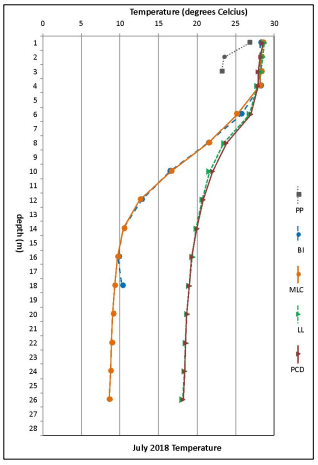


251% flow
2019

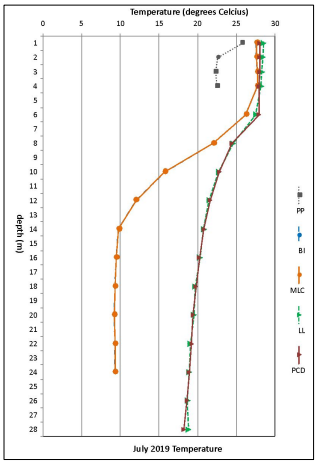
Temperature Profiles – July



64% flow
2016

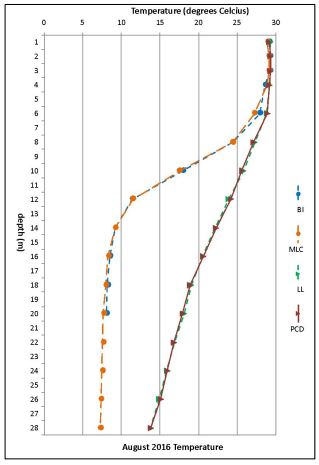


147% flow
2018

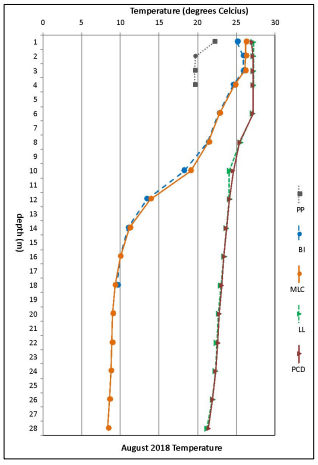


124% flow
2019

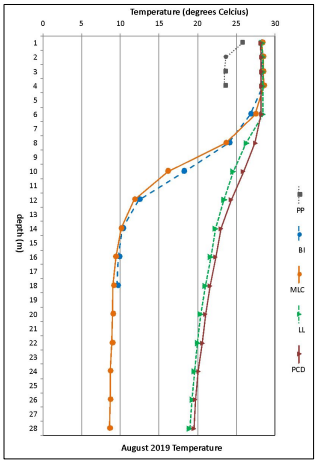
TEMPERATURE PROFILES – AUGUST



122% flow
2016

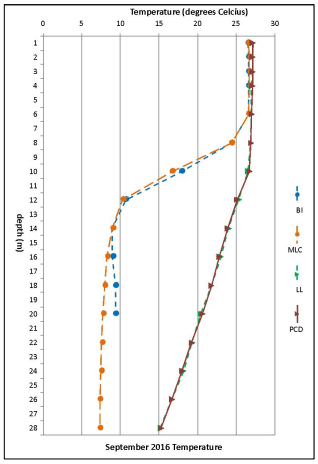


256% flow
2018

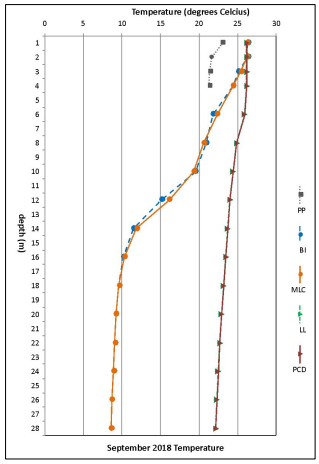


89% flow
2019

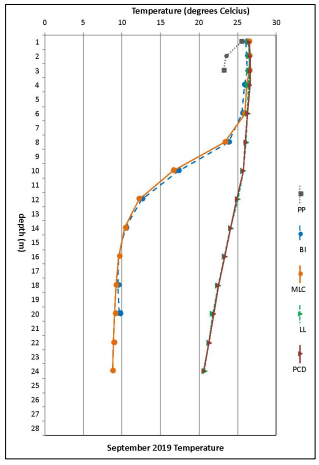
Temperature Profiles – September



56% flow
2016



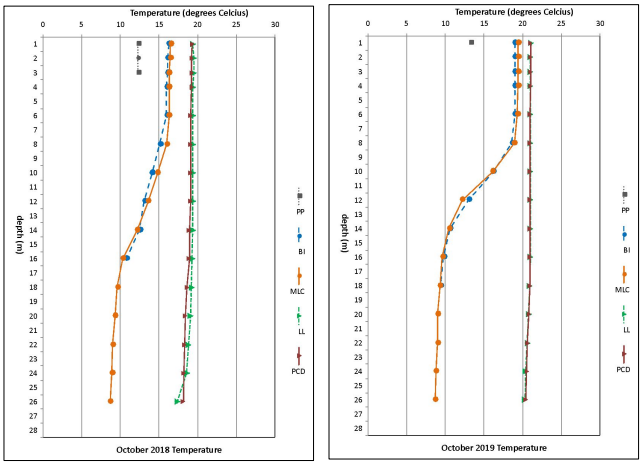
249% flow
2018



62% flow
2019

Temperature Profiles – October

2016
No Data



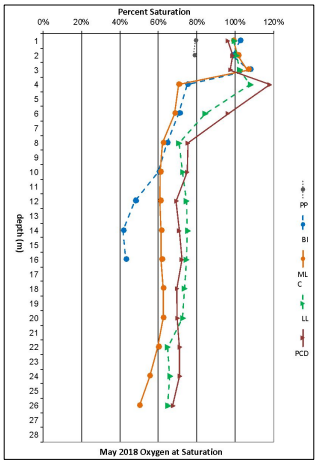
411% flow
2018

100% flow
2019

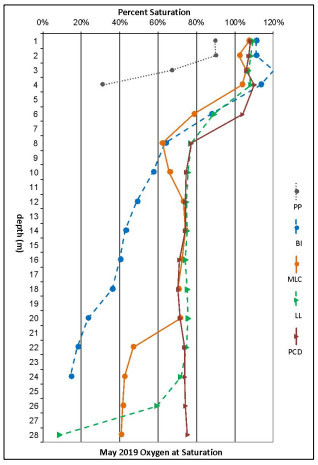
October lake sampling began in 2018. – Shows less stratification, esp on Linville side indicating that turnover has happened.

Dissolved Oxygen Profiles – May

2016
No Data



378% flow
2018



129% flow
2019

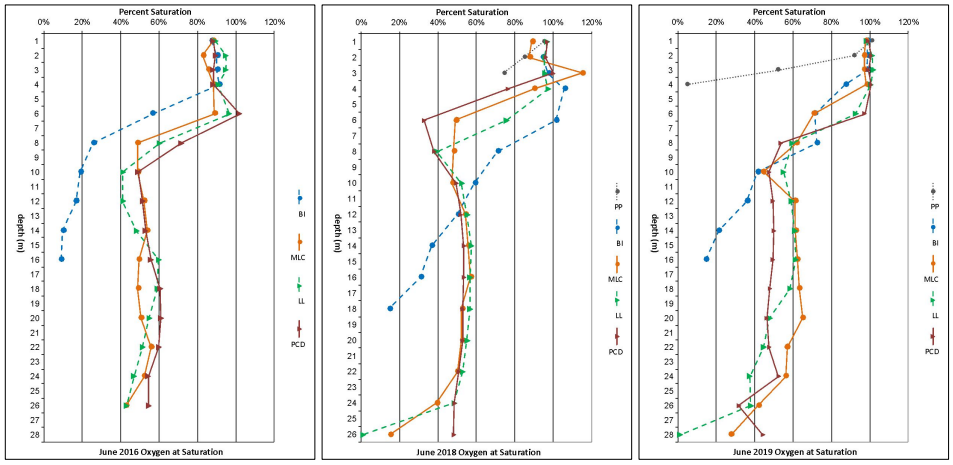
Dissolved oxygen is temperature dependent – more O2 in cold water.

Percent oxygen saturation takes temperature into account to allow comparisons between months, rather than actual DO values.

Plantation Point started in 2018. O2 drops off first and stays that way all summer.

% Sat – Big Island tapering off more than other deep sites.

Dissolved Oxygen Profiles – June



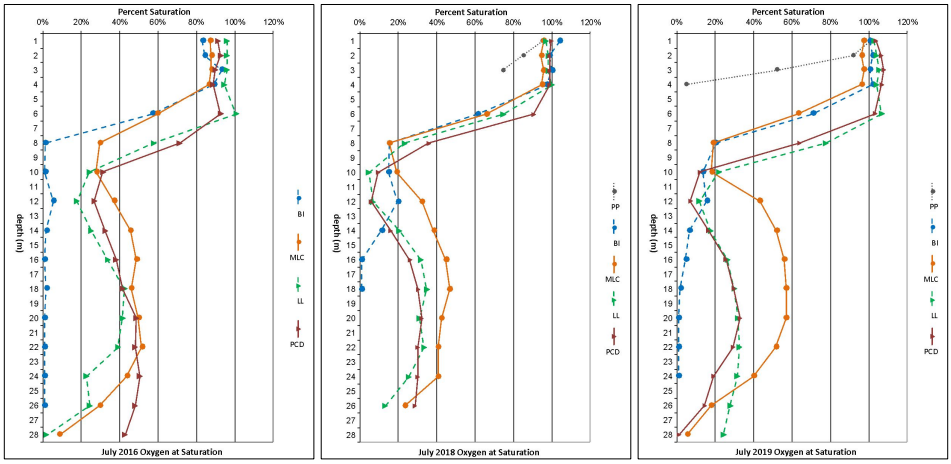
64% flow
2016

236% flow
2018

251% flow
2019

Low DO at Plantation Point might add to high total P and ammonia values.

Dissolved Oxygen Profiles – July



64% flow
2016

147% flow
2018

124% flow
2019

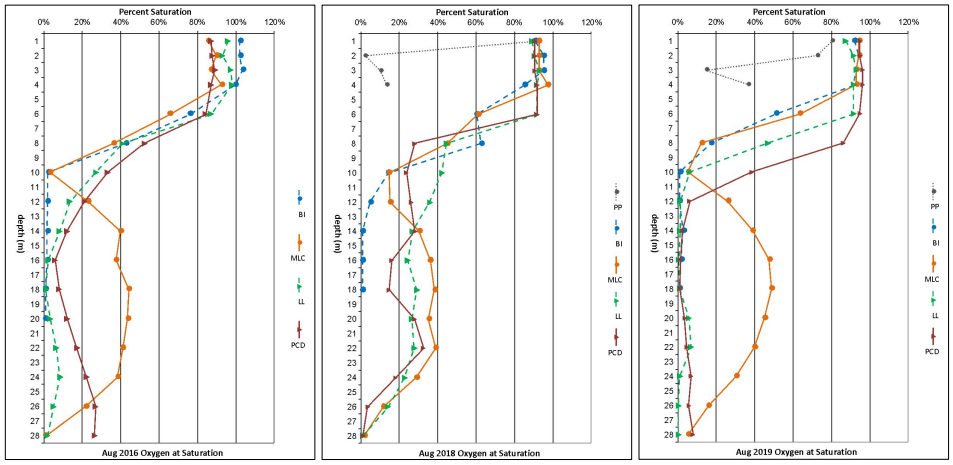
Catawba side gets low on oxygen at a shallower depth.

What is that hump of %sat with increasing depth? MLC & Linville side of lake.

Likely stream or groundwater inflow with the cool, oxygenated water sinking beneath warmer lake water.

Marion Lake Club site has always shown that pattern.

Dissolved Oxygen Profiles – August



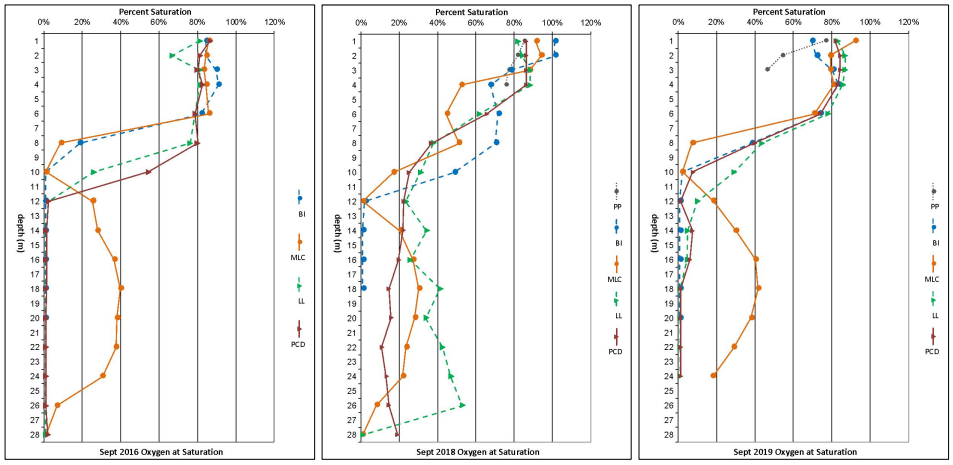
122% flow
2016

256% flow
2018

89% flow
2019

Higher flow/precipitation in 2018 likely kept most sites from reaching 0% DO like in 2016 & 2019.

Dissolved Oxygen Profiles – September



56% flow
2016

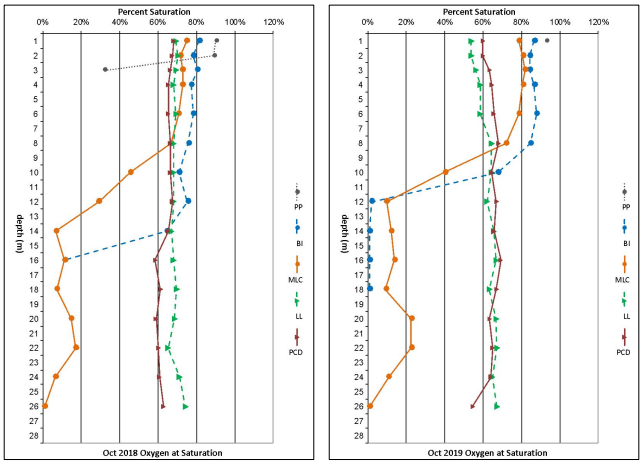
249% flow
2018

62% flow
2019

Higher flow/precipitation in 2018 likely kept most sites from reaching no DO like in 2016 & 2019.

Dissolved Oxygen Profiles – October

2016
No Data



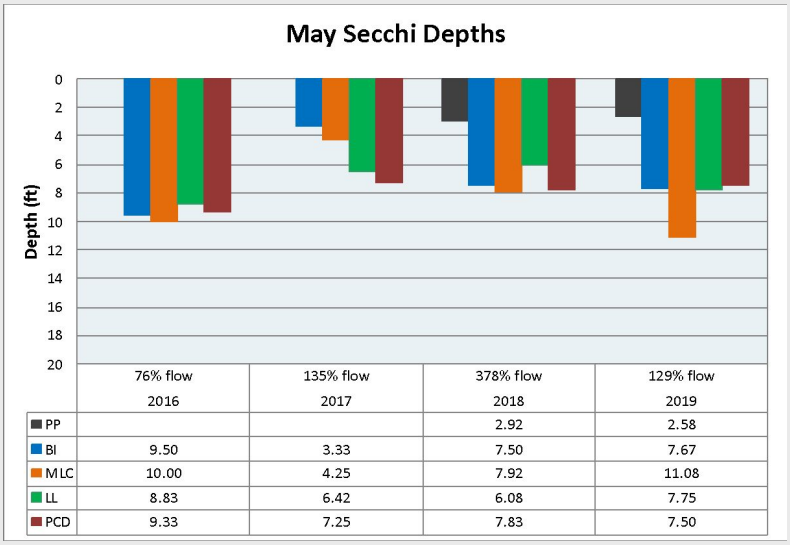
411% flow
2018

100% flow
2019

See in October turnover happening with Linville & Catawba sides separating.

Linville looks uniform throughout, while warmer Catawba side still has stratification but it occurs deeper than in September.

Lake Secchi Depths



	76% flow 2016	135% flow 2017	378% flow 2018	129% flow 2019
PP			2.92	2.58
BI	9.50	3.33	7.50	7.67
MLC	10.00	4.25	7.92	11.08
LL	8.83	6.42	6.08	7.75
PCD	9.33	7.25	7.83	7.50

Showing 2017-19 new in this presentation. 2016 is also included to compare a dry year. 2018 was the wetter year.

Secchi depth reported/displayed in FEET not meters.

Area of light penetration usually 2X secchi depth

Dark Gray = Plantation Point (2018-19 only)

Blue = Big Island

Green = Lower Linville

Brown – Paddy Creek Dam

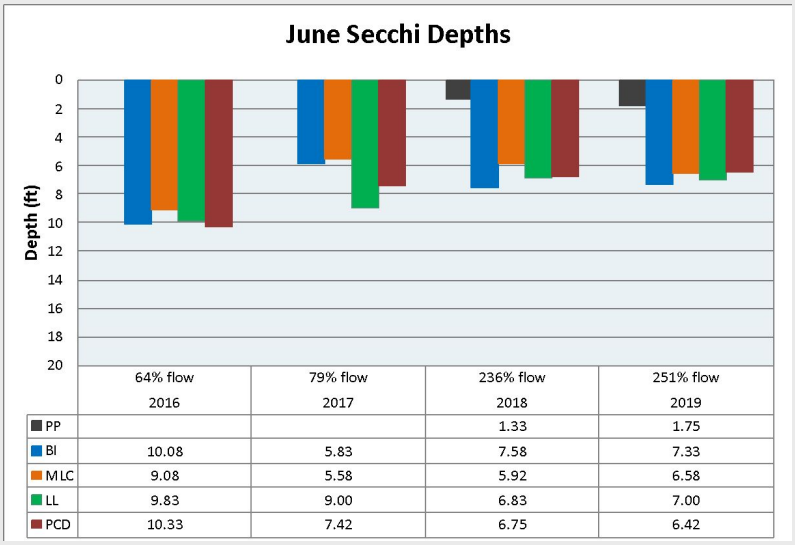
(upstream to downstream)

Wet years – more sediment runoff

Mark Brenner's chlorophyll-a data - pretty low except site 6 - shallow end - 13ug/L - even that highest is in mesotrophic range

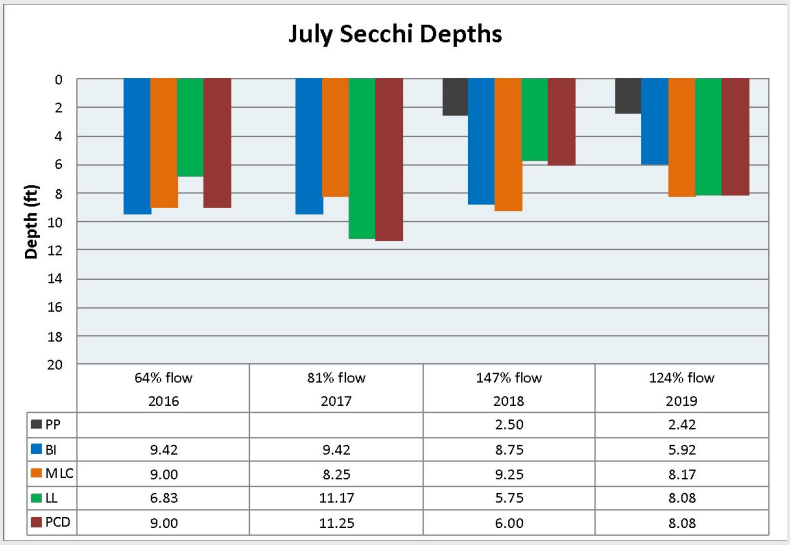
mostly oligotrophic, clear - lower numbers than observed water clarity indicates - maybe boat traffic kicking up mud - suspended sediment

Lake Secchi Depths



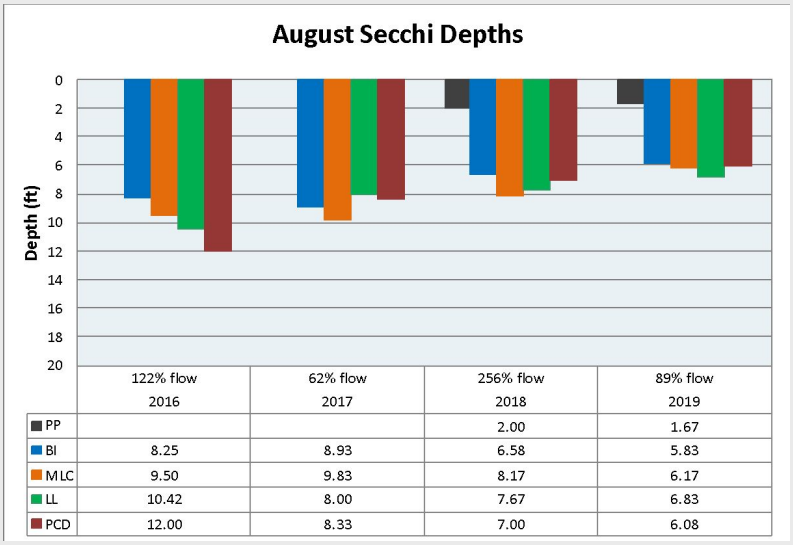
	64% flow 2016	79% flow 2017	236% flow 2018	251% flow 2019
PP			1.33	1.75
BI	10.08	5.83	7.58	7.33
MLC	9.08	5.58	5.92	6.58
LL	9.83	9.00	6.83	7.00
PCD	10.33	7.42	6.75	6.42

Lake Secchi Depths



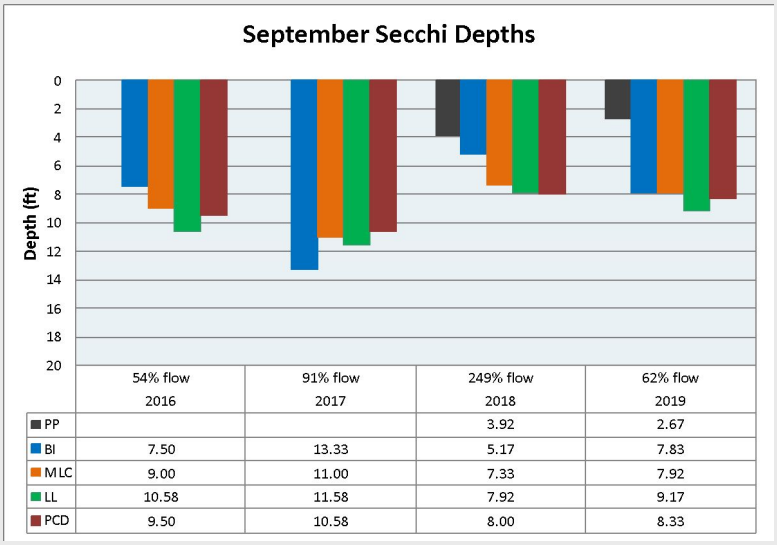
	64% flow 2016	81% flow 2017	147% flow 2018	124% flow 2019
PP			2.50	2.42
BI	9.42	9.42	8.75	5.92
MLC	9.00	8.25	9.25	8.17
LL	6.83	11.17	5.75	8.08
PCD	9.00	11.25	6.00	8.08

Lake Secchi Depths



	122% flow 2016	62% flow 2017	256% flow 2018	89% flow 2019
PP			2.00	1.67
BI	8.25	8.93	6.58	5.83
MLC	9.50	9.83	8.17	6.17
LL	10.42	8.00	7.67	6.83
PCD	12.00	8.33	7.00	6.08

Lake Secchi Depths

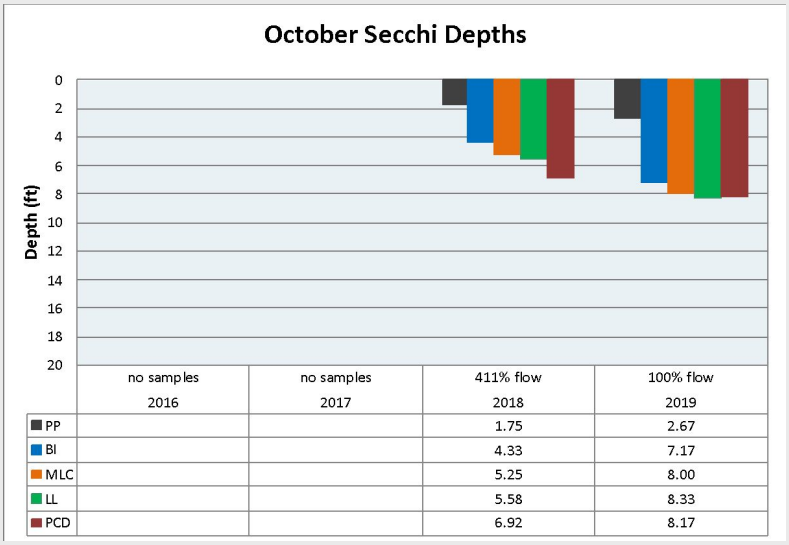


	54% flow 2016	91% flow 2017	249% flow 2018	62% flow 2019
PP			3.92	2.67
BI	7.50	13.33	5.17	7.83
MLC	9.00	11.00	7.33	7.92
LL	10.58	11.58	7.92	9.17
PCD	9.50	10.58	8.00	8.33

By later in the summer, wet years are more staggered from upstream to downstream.

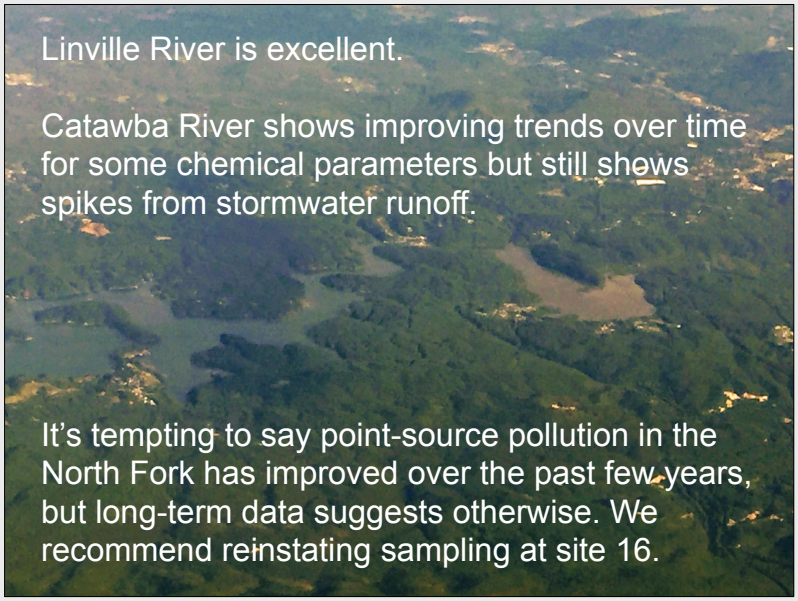
More sediment & phosphorus coming from Catawba & NF rivers causing slight algae, more turbidity. Boat traffic or wind in shallower areas stirring up bottom sediment.

Lake Secchi Depths



	no samples 2016	no samples 2017	411% flow 2018	100% flow 2019
PP			1.75	2.67
BI			4.33	7.17
MLC			5.25	8.00
LL			5.58	8.33
PCD			6.92	8.17

TAKEAWAY


Linville River is excellent.
Catawba River shows improving trends over time for some chemical parameters but still shows spikes from stormwater runoff.
It's tempting to say point-source pollution in the North Fork has improved over the past few years, but long-term data suggests otherwise. We recommend reinstating sampling at site 16.

SMIE sampling to detect other problems

Every Spring and Fall

- Kicknet
- Leaf Pack
- Visual Inspection
- Habitat Survey
- Quality Assurance

Some notes about EQI's SMIE program…

SMIE Training

Laboratory training with presentations and microscope

Field training to practice ID skills and sampling protocols

Group Leaders – extra training & tests

Online training videos as refresher: www.eqilab.org

SMIE Taxa

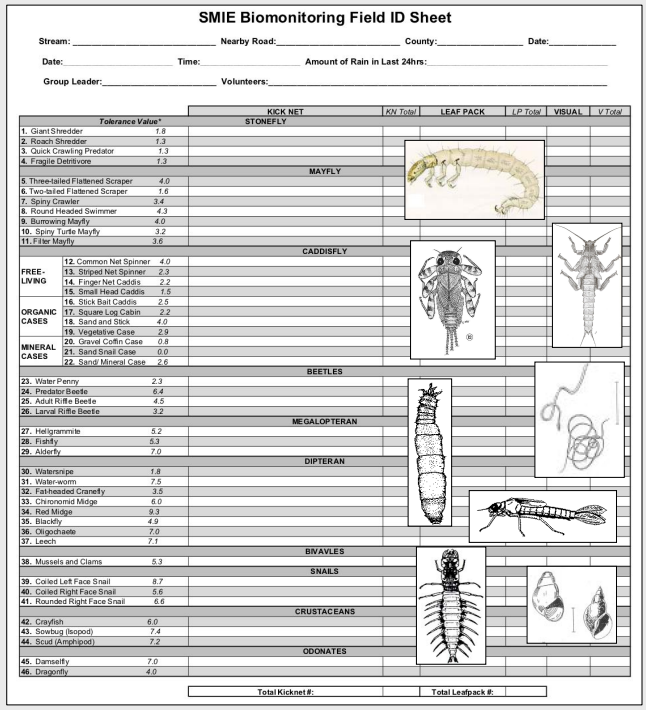
ID to family level at best

No microscopes necessary

46 total taxa – each with a tolerance value

22 EPT taxa

13 taxa with tolerance values <2.5 (sensitive)



SMIE Biomonitoring Field ID Sheet

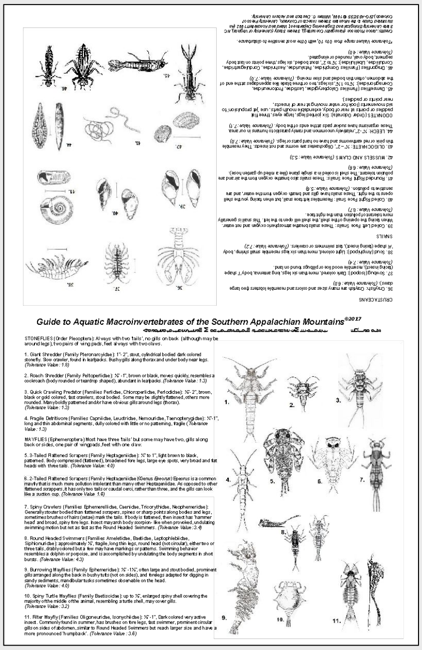
Stream: _____ Nearby Road: _____ County: _____ Date: _____

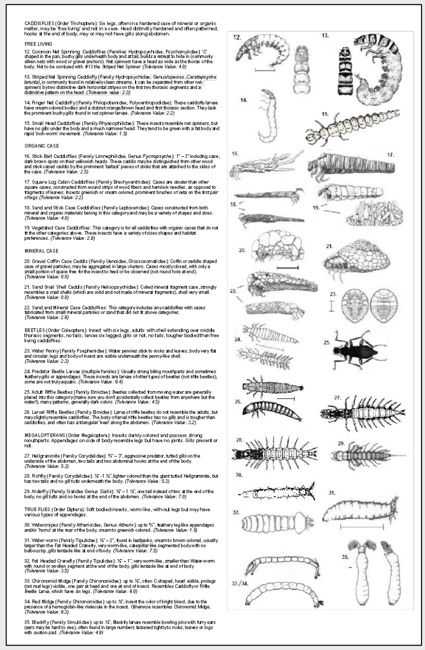
Date: _____ Time: _____ Amount of Rain in Last 24hrs: _____

Group Leader: _____ Volunteers: _____

		Tolerance Value*	KICK NET	KN Total	LEAF PACK	LP Total	VISUAL	V Total
			STONEFLY					
	1. Giant Shredder	1.8						
	2. Roach Shredder	1.3						
	3. Quick Crawling Predator	1.3						
	4. Fragile Detritivore	1.3						
			MAYFLY					
	5. Three-tailed Flattened Scraper	4.0						
	6. Two-tailed Flattened Scraper	1.6						
	7. Spiny Crawler	3.4						
	8. Round Headed Swimmer	4.3						
	9. Burrowing Mayfly	4.0						
	10. Spiny Turtle Mayfly	3.2						
	11. Filter Mayfly	3.6						
			CADDISFLY					
FREE-LIVING	**12.** Common Net Spinner	4.0						
FREE-LIVING	**13.** Striped Net Spinner	2.3						
FREE-LIVING	**14.** Finger Net Caddis	2.2						
FREE-LIVING	**15.** Small Head Caddis	1.5						
ORGANIC CASES	**16.** Stick Bait Caddis	2.5						
ORGANIC CASES	**17.** Square Log Cabin	2.2						
ORGANIC CASES	**18.** Sand and Stick	4.0						
ORGANIC CASES	**19.** Vegetative Case	2.9						
MINERAL CASES	**20.** Gravel Coffin Case	0.8						
MINERAL CASES	**21.** Sand Snail Case	0.0						
MINERAL CASES	**22.** Sand/ Mineral Case	2.6						
			BEETLES					
	23. Water Penny	2.3						
	24. Predator Beetle	6.4						
	25. Adult Riffle Beetle	4.5						
	26. Larval Riffle Beetle	3.2						
			MEGALOPTERAN					
	27. Heligrammite	5.2						
	28. Fishfly	5.3						
	29. Alderfly	7.0						
			DIPTERAN					
	30. Watersnipe	1.8						
	31. Water-worm	7.5						
	32. Fat-headed Cranefly	3.5						
	33. Chironomid Midge	6.0						
	34. Red Midge	9.3						
	35. Blackfly	4.9						
	36. Oligochaete	7.0						
	37. Leech	7.1						
			BIVAVLES					
	38. Mussels and Clams	5.3						
			SNAILS					
	39. Coiled Left Face Snail	8.7						
	40. Coiled Right Face Snail	5.6						
	41. Rounded Right Face Snail	6.6						
			CRUSTACEANS					
	42. Crayfish	6.0						
	43. Sowbug (Isopod)	7.4						
	44. Scud (Amphipod)	7.2						
			ODONATES					
	45. Damselfly	7.0						
	46. Dragonfly	4.0						
			Total Kicknet #:		**Total Leafpack #:**			

VOLUNTEER FIELD GUIDE





Quality Assurance

Identify potential problems

Misidentification
- – QCP & FD stoneflies
- – unknowns preserved separately

Miscounting

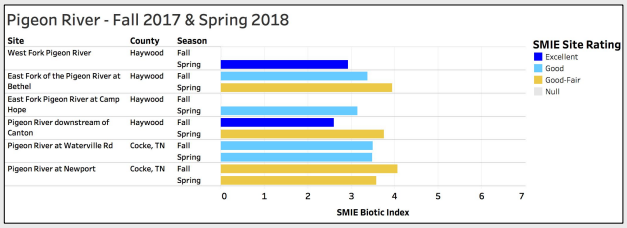
Hitchhiker specimens
- – midge,blackfly

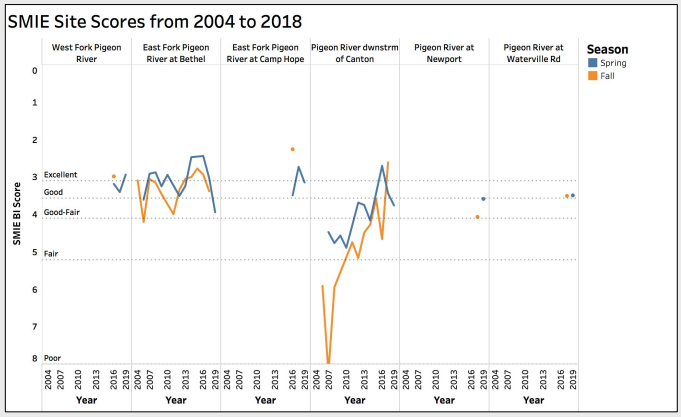
Data recorded wrong or hard to read
- – dragonfly?

Data entry incorrect (double check)

Location: Beetree Creek						Date: 4/16/19											
Group Leader: Ann Marie Traylor		Kick Net				Leaf Pack						Visual					
Biologist: Dave Penrose		Volunteer		Biologist			Volunteer		Biologist			Volunteer		Biologist			
Taxa #	Taxa Description	Count	% Spp	Count	% Spp	Mn %	Count	% Spp	Count	% Spp	Mn %	Count	% Spp	Count	% Spp	Mn %	
1	Giant Shredder		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
2	Roach Shredder		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
3	Quick Crawling Predator	21	0.16	24	0.18	15.67%	7	0.28	10	0.37	28.00%		0.00		0.00	0.00%	
4	Fragile Detritivore	4	0.03		0.00	0.00%	3	0.12		0.00	0.00%		0.00		0.00	0.00%	
5	Three Tailed Flattened Scraper	11	0.08	12	0.09	8.21%	1	0.04	1	0.04	3.70%		0.00		0.00	0.00%	
6	Two Tailed Flattened Scrapers	4	0.03	4	0.03	2.94%		0.00		0.00	0.00%	2	0.40	2	0.50	40.00%	
7	Spiny Crawler	56	0.42	56	0.41	41.18%	10	0.40	11	0.41	40.00%		0.00	1	0.25	0.00%	
8	Round Headed Swimmer		0.00	1	0.01	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
9	Burrowing Mayflies		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
10	Spiny Turtle Mayfly		0.00		0.00	0.00%		0.00		0.00	0.00%	1	0.20		0.00	0.00%	
11	Filter Mayfly		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
12	Common Net Spinner	12	0.09	10	0.07	7.35%	1	0.04	1	0.04	3.70%	1	0.20	1	0.25	20.00%	
13	Striped Net Spinner	6	0.04	7	0.05	4.48%		0.00		0.00	0.00%		0.00		0.00	0.00%	
14	Fingernet Caddis	18	0.13	18	0.13	13.24%	1	0.04	1	0.04	3.70%		0.00		0.00	0.00%	
15	Small Head Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
16	Stick Bait Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
17	Square Log Cabin Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
18	Sand and Stick Case Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
19	Vegetative Case Caddis	1	0.01	1	0.01	0.74%		0.00		0.00	0.00%		0.00		0.00	0.00%	
20	Gravel Coffin Case Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%	1	0.20		0.00	0.00%	
21	Sand Snail Case		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
22	Sand or Mineral Case Caddis		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
23	Water Penny	1	0.01	1	0.01	0.74%		0.00		0.00	0.00%		0.00		0.00	0.00%	
24	Predator Beetle		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
25	Adult Riffle Beetle		0.00		0.00	0.00%	1	0.04	1	0.04	3.70%		0.00		0.00	0.00%	
26	Larval Riffle Beetle		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
27	Heligrammite		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
28	Fishfly		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
29	Alderfly		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
30	Watersnipe		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
31	Water-worm	0	0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
32	Fat-head Cranefly		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
33	Chironomid Midge		0.00	1	0.01	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
34	Red Midge		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
35	Blackfly		0.00		0.00	0.00%		0.00	1	0.04	0.00%		0.00		0.00	0.00%	
36	Oligochaete		0.00		0.00	0.00%	1	0.04	1	0.04	3.70%		0.00		0.00	0.00%	
37	Leech		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
38	Mussels and Clams		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
39	Coiled Left Face Snail		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
40	Coiled Right Face Snail		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
41	Rounded Right Face Snail		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
42	Crayfish		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
43	Sowbug (Isopod)		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
44	Scud (Amphipod)		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
45	Damselfly		0.00		0.00	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
46	Dragonfly		0.00	1	0.01	0.00%		0.00		0.00	0.00%		0.00		0.00	0.00%	
	Total count:	134		136			25		27			5		4			
	Percent similarity:	94.53%					86.52%					60.00%					

Pigeon River – poor site improving

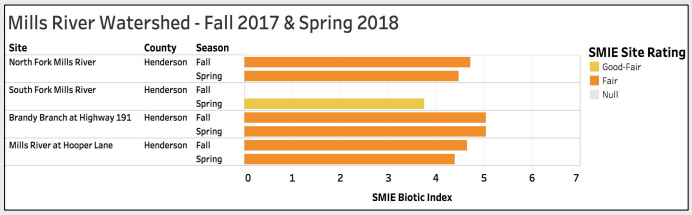


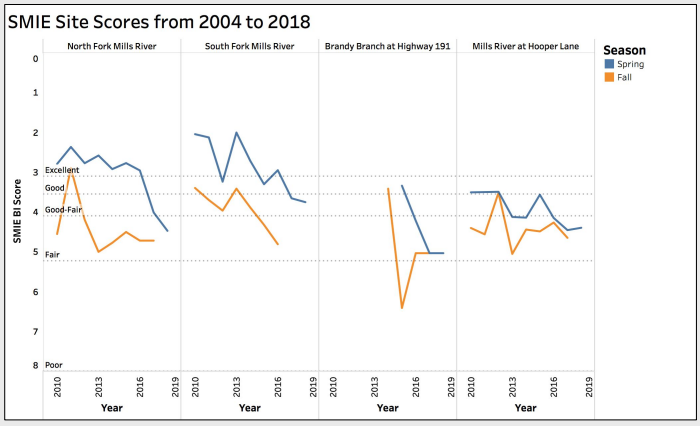


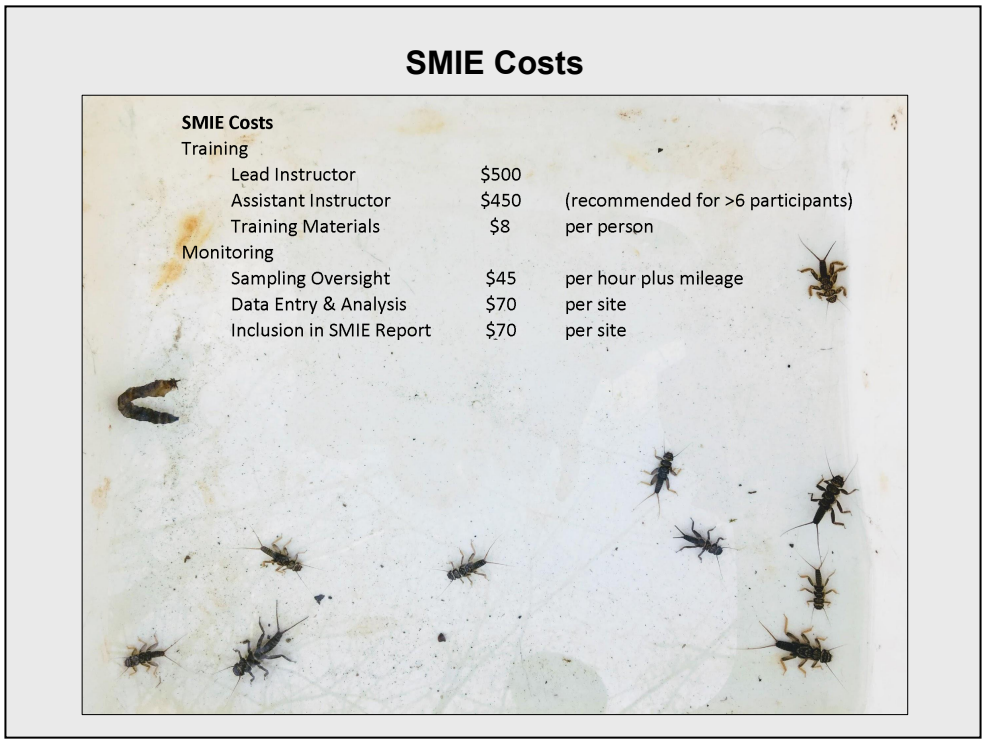
A couple examples of SMIE monitoring results…

Ratings usually better in the spring - separate seasons for analysis.

Mills River – excellent sites declining







Fees for technical help to help raise a little money for the program.


THANK YOU for LJEA's continued partnership in the VWIN program!
Questions?
Requests?
Insights or wisdom to impart?
EQI
ENVIRONMENTAL QUALITY INSTITUTE