UNRBA Monitoring Program

Path Forward Committee Meeting

May 2016

May 25, 2016

FY2016 Annual Report

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FY 2016 Annual Report

- Comments from all reviewers addressed
- Overview presented to UNRBA Board of Directors on May 17
- Report finalized
- Posted to UNRBA website

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FY2017 Monitoring Contract Scope and Budget Development

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Recommendations for Routine Monitoring Data Acquisition

EFFORT	RECOMMENDATION FOR FY2017	
Lake Loading Stations	13 Stations sampled monthly 5 Stations sampled twice monthly No change in stations or schedule from FY2016	
	16 parameters to be measured **Suspend analysis of DOC, CBOD5, Pt-Co color**	
Jurisdictional Stations	20 Stations sampled monthly No change in stations from FY2016	
	10 parameters to be measured **Reduce analysis of TOC to quarterly**	
In-Lake Monitoring (data acquisition by others)	DWR Monitoring	12 Stations sampled monthly
	City of Durham	2 Stations sampled weekly April-October
	NSCU CAAE	**Evaluating program data for potential inclusion**

Recommendations for Routine Monitoring Data Management, Analysis, QA/QC, Reporting and Communication

EFFORT	RECOMMENDATION FOR FY 2017
Data Management	Protocol unchanged from FY2016
QA/QC	Protocol unchanged from FY2016
Data Analysis	Protocol unchanged from FY2016 **Additional hours/budget due to increasing data volume**
Reporting	Protocol unchanged from FY2016 **Additional hours/budget due to increasing data volume**
Meetings & Client Communication	Protocol unchanged from FY2016
Monitoring Plan Management	Protocol unchanged from FY2016

Recommended Routine Monitoring Budget Summary

Task	FY 2016 Budget	% of total Cardno budget	Proposed FY 2017 Budget	% of total Cardno budget
Lake Loading Stations (no CBOD, DOC, Pt-Co color in FY 2017)	$ 224,100	27%	$ 182,380	26%
Jurisdictional Boundary Stations (quarterly TOC only in FY 2017)	$ 75,900	9%	$ 61,238	9%
DWR Lake Monitoring	$ 14,000	2%	$ 13,234	2%
Data Management	$ 33,900	4%	$ 33,010	5%
Data Analysis	$ 59,800	7%	$ 73,700	10%
Reporting	$ 27,100	3%	$ 33,695	5%
Communication, Project Management, ad hoc issues/events	$ 40,900	5%	$ 50,480	7%
UNRBA Meetings (including site tours)	$ 24,800	3%	$ 26,864	4%
QA/QC of lab activities	$ 24,000	3%	$ 20,806	3%
QAPP Updates	$ 14,500	2%	$ 11,310	2%
Monitoring Plan Updates	$ 36,000	4%	$ 34,416	5%
Totals	**$ 575,000**	**71%**	**$ 541,133**	**77%**

Budget reduction from FY 2016 to FY 2017: **$33,867**

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Recommendations for Special Studies

SPECIAL STUDY	INITIATED IN	RECOMMENDATION
Storm Event Sampling	FY2015	Suspend
High Flow Sampling	FY2015	**Modify and Augment**
Falls Lake Sediment Sampling	FY2015	Complete FY2016 efforts then suspend
Regulatory Alternatives Support	FY2015	**Small supplemental effort**
Falls Lake Constriction Point Study	FY2016	Suspend
Measure VSS at Lake Loading and In-lake stations	FY2016	Incorporated into Routine Monitoring
Light Extinction Data Evaluation	FY2016	Completed
Basic Evaluation of Model Performance	FY2016	Completed by end of FY2016
Recreational Use Assessment	FY2016	Suspend (but re-visit)

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New Proposed Special Study

Bathymetry and Sediment Mapping

- Bathymetry (underwater topography) is essential for lake response modeling
  - Existing bathymetry from the USACE is dated and incomplete
- Knowledge of sediment distribution in the lake can be coupled with nutrient flux data (from Dr. Alperin) to improve understanding of the contribution of sediments to overall nutrient loading
- Bathymetric and sediment data can be obtained simultaneously with Sonar equipment available from the experts Cardno used for the Constriction Point Evaluation
- The Modeling Team will provide input to ensure collection of suitable information

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Recommended Special Studies Budget Summary

Task	FY 2016 Budget	% of total Cardno budget	Proposed FY 2017 Budget	% of total Cardno budget
Storm Event Sampling	$ 62,000	8%		0%
Sediment Evaluation	$ 20,000	2%		0%
Bathymetry and sediment mapping			$ 80,000	11%
High Flow Sampling (8 fixed sites, 2 events)	$ 16,000	2%		0%
High Flow Sampling (5+ sites per event, 6-10 events)		0%	$ 70,000	10%
Regulatory Process Support		0%	$ 14,000	2%
Constriction Point Sampling	$ 70,000	9%		0%
VSS Measurement	$ 8,000	1%		0%
Historic Light Extinction Data	$ 4,000	0%		0%
Model Performance Evaluation	$ 40,000	5%		0%
Recreational Uses	$ 20,000	2%		0%
Totals	**$ 240,000**	**29%**	**$ 64,000**	**23%**

Budget reduction from FY 2016 to FY 2017: **$76,000**

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Summary of Monitoring Program Efforts & Budget

BUDGET ITEM	AMOUNT
FY2017 Contribution from UNRBA Members	$ 800,000
Projected Unencumbered FY2016 Carry-Forward	$ 20,000
FY2017 Routine Monitoring	$ (541,133)
FY2017 Special Studies	$ (164,000)
FY2017 Subject Matter Experts	$ (40,000)
Budget Available for Modeling Contract in FY2017	**$ 74,866**

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Supplemental slides for discussion – as needed

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Reasons for Reductions in Routine Monitoring Parameters

Lake Loading Stations:

- **DOC** – Can be estimated with high degree of precision from TOC data that is still to be collected
- **CBOD5** – Mostly below detection limit; additional data would not further improve modeling efforts
- **Pt-Co Color** – Two methods are being used to evaluate color; this one is more expensive, it is more subject to variability in laboratory analysis

Jursidictional Stations

- **TOC** – Relatively expensive parameter to measure; additional data would not substantially improve modeling efforts; quarterly sampling will provide data through periods of extended drought or excessive rainfall

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High Flow Sampling

Purpose and Recommendations

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Two Goals of High Flow Sampling

- Collect discrete samples during relatively rare events which contribute large volumes of water to Falls Lake.
- Ensure collection of samples during full range of flow conditions to identify any relationships between flow and water quality concentrations. This will be used during the modelling effort to improve load calculations.

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The load to Falls Lake is strongly influenced by discharge (flow). Greater confidence in water quality concentrations during periods of high flow yields greater confidence in load estimates to Falls Lake.

Flow (volume/time)	X	Concentration (mass/volume)	=	Load to Falls Lake (mass/time)
10		1		10
10		2		20
1000		1		1000
1000		2		2000

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	Flow Range (cfs)	Percent of load	Percent of time	Number of Samples	Percent of Samples
Flat River	0 - 88	20%	71%	23	66%
	88 - 181	20%	18%	5	14%
	181 - 462	20%	8%	5	14%
	462 - 1290	20%	3%	2	6%
	1290 - 5300	20%	1%	0	0%
Eno River	0 - 76	20%	69%	22	63%
	76 - 133	20%	18%	5	14%
	133 - 357	20%	9%	4	11%
	357 - 847	20%	3%	3	9%
	847 - 3630	20%	1%	1	3%
Little River	0 - 43	20%	75%	23	66%
	43 - 79	20%	13%	5	14%
	79 - 153	20%	7%	4	11%
	153 - 330	20%	3%	2	6%
	330 - 2480	20%	1%	1	3%

	Flow Range (cfs)	Percent of load	Percent of time	Number of Samples	Percent of Samples
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	462 - 1290	20%	3%	2	6%
	1290 - 5300	20%	1%	0	0%
Eno River	0 - 76	20%	69%	22	63%
	76 - 133	20%	18%	5	14%
	133 - 357	20%	9%	4	11%
	357 - 847	20%	3%	3	9%
	847 - 3630	20%	1%	1	3%
Little River	0 - 43	20%	75%	23	66%
	43 - 79	20%	13%	5	14%
	79 - 153	20%	7%	4	11%
	153 - 330	20%	3%	2	6%
	330 - 2480	20%	1%	1	3%

60%

20%

60%

23%

60%

20%

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High Flow Recommendations

- Increase effort to include 6-10 events per year on multiple tributaries with samples collected on rising and falling limbs of hydrographs when possible (1 to 4 samples per site per event).
- Sampling conducted by local Cardno staff to facilitate sampling on short notice and on weekends to improve coverage of rare events.
- Focus effort on the tributaries contributing largest volume of water to Falls Lake with event-specific flexibility in site inclusion.

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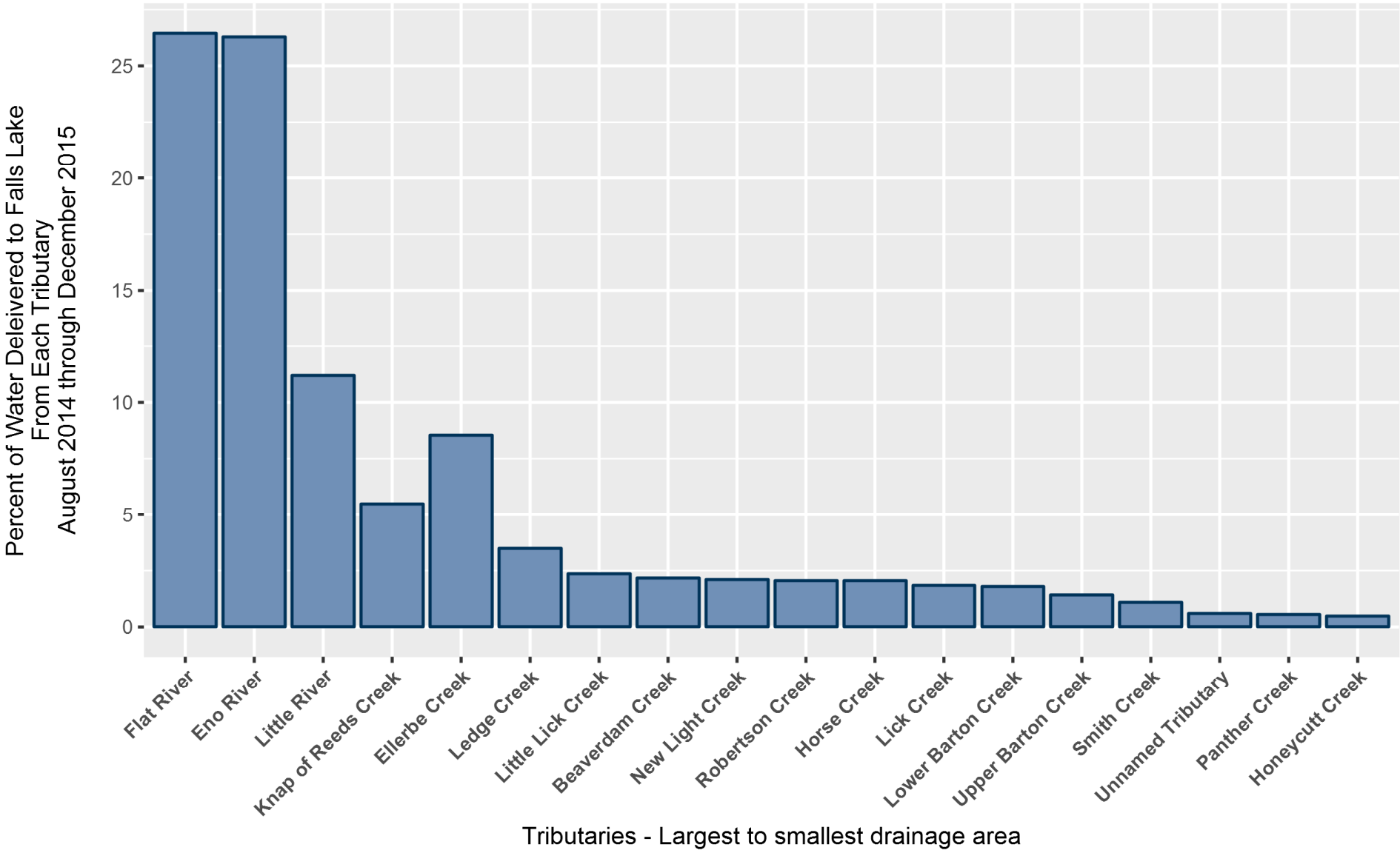

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Storm Event Sampling

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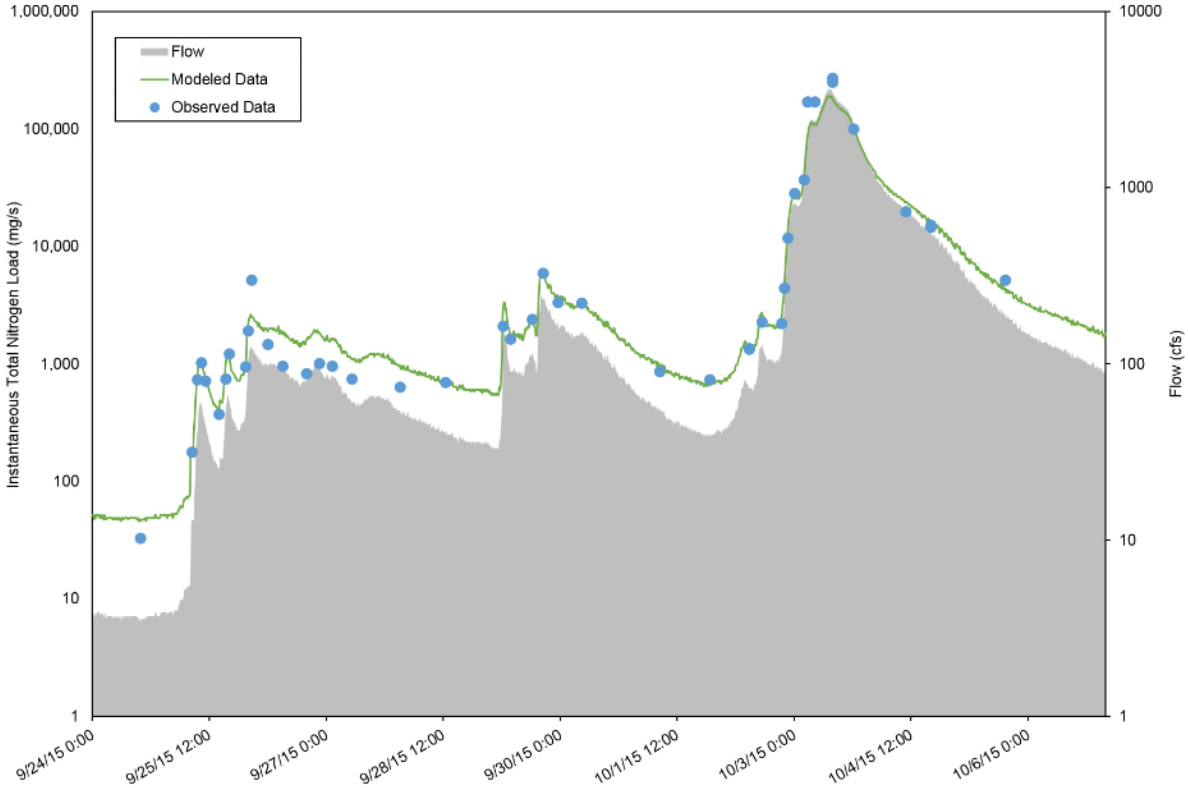
Storm Event Sampling

- Provide high frequency data sets to test various load estimation models
- Status: 6-7 storm events have been sampled on each of Eno River and Ellerbe Creek through May 2015.



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Storm Event Sampling Recommendations

- Suspend Storm Event Sampling in favor of increased effort on high flow sampling in more tributaries.
  - Existing storm event data sufficient for model development and testing.
  - High Flow effort provides data at more sites and over more events to better identify the water quality-flow relationships used in developing load models.
  - High Flow effort provides direct measurements of water quality at more times when loading is likely to be high providing more certainty to overall loading to Falls Lake.

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Supplemental Slides & Graphics

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Additional Storm Event Figures

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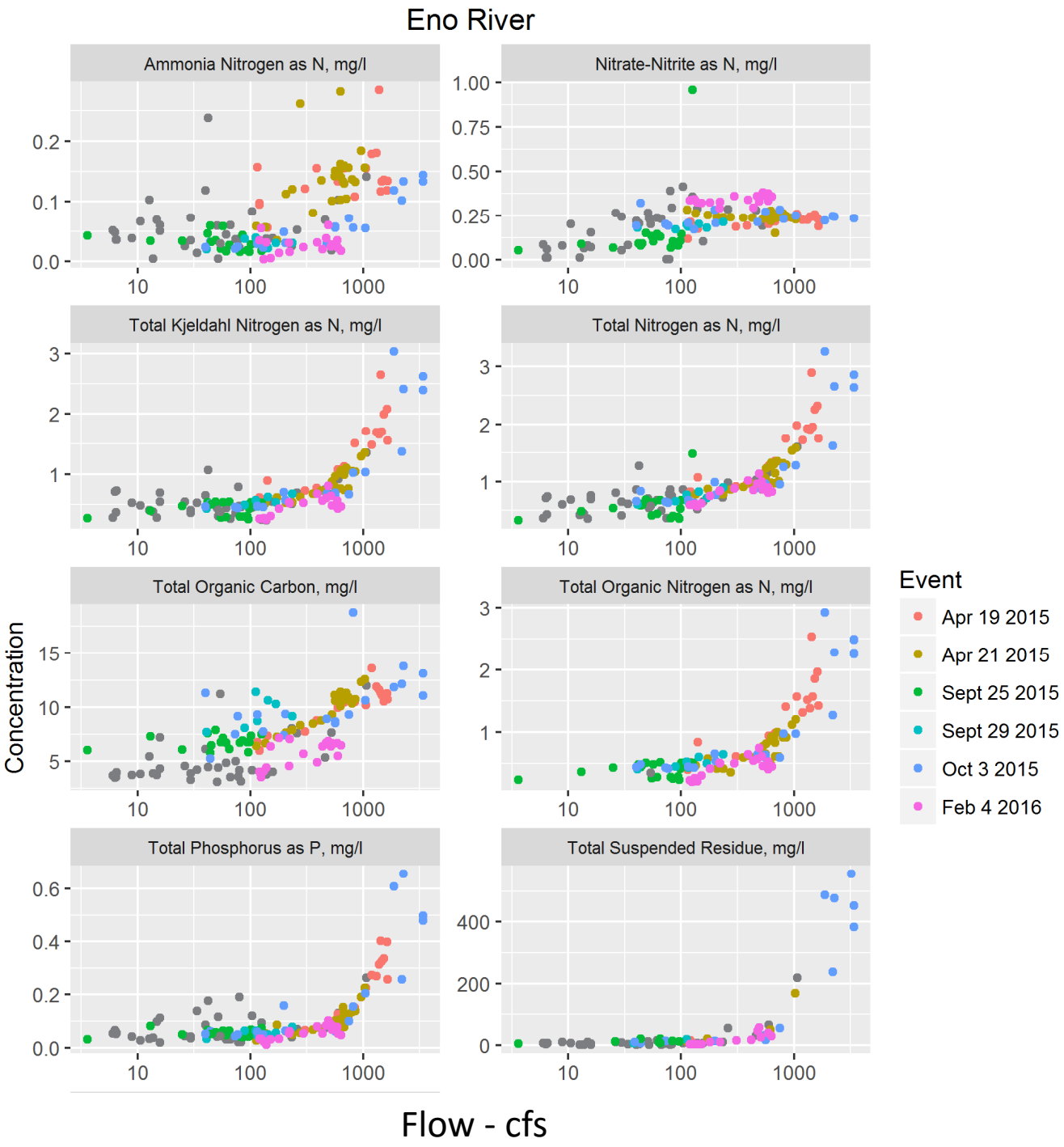
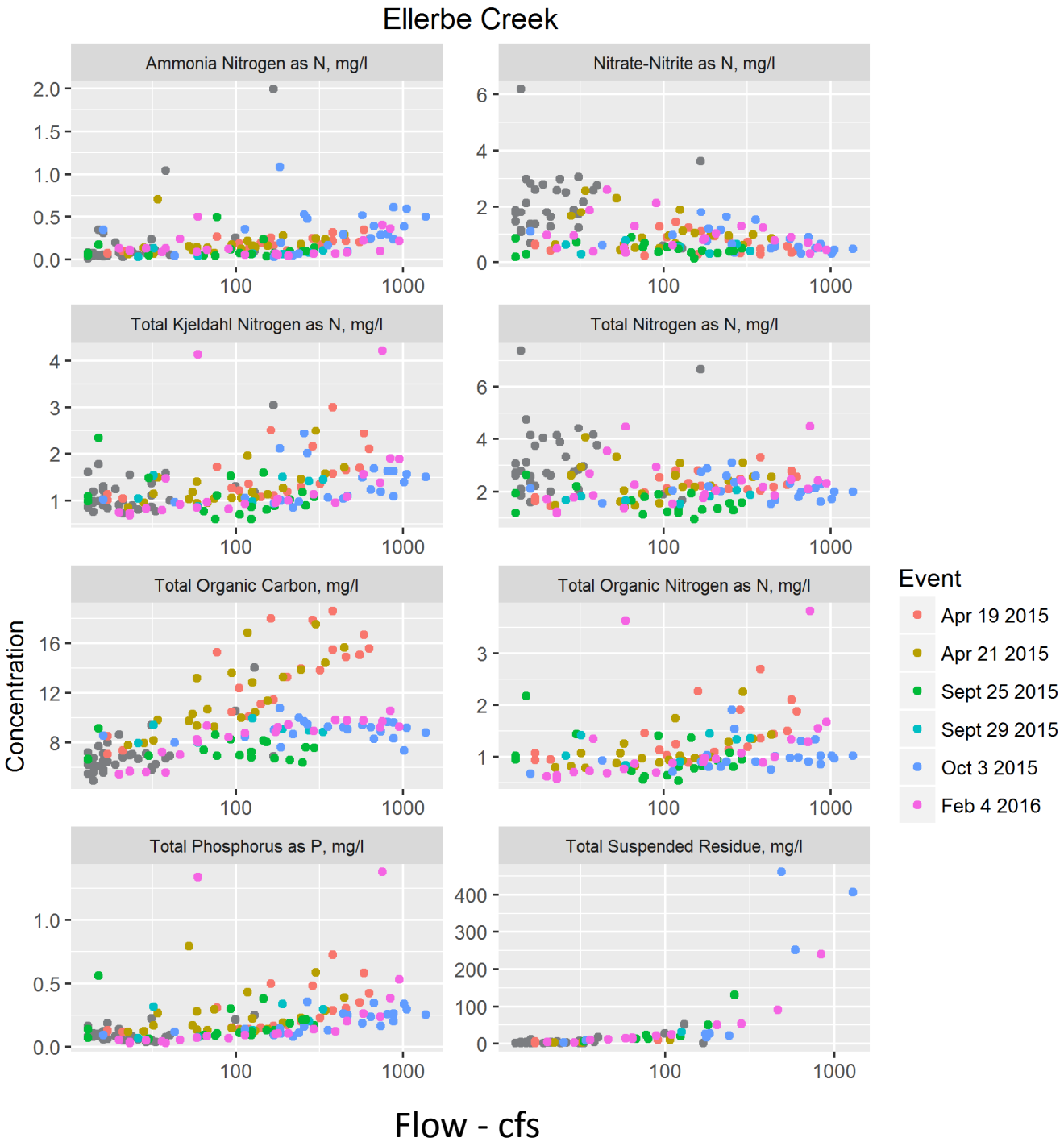


- At Eno River, there is generally agreement between storm events, though more event-to-event variability in ammonia and TOC than other parameters.



- Some parameters show little relationship to flow, while others do.
- Event-to-event variability supports more sampling of distinct events
- Differences between these two sites support sampling of high flows on other influential tributaries to identify patterns there.

Hysteresis in Ellerbe Creek

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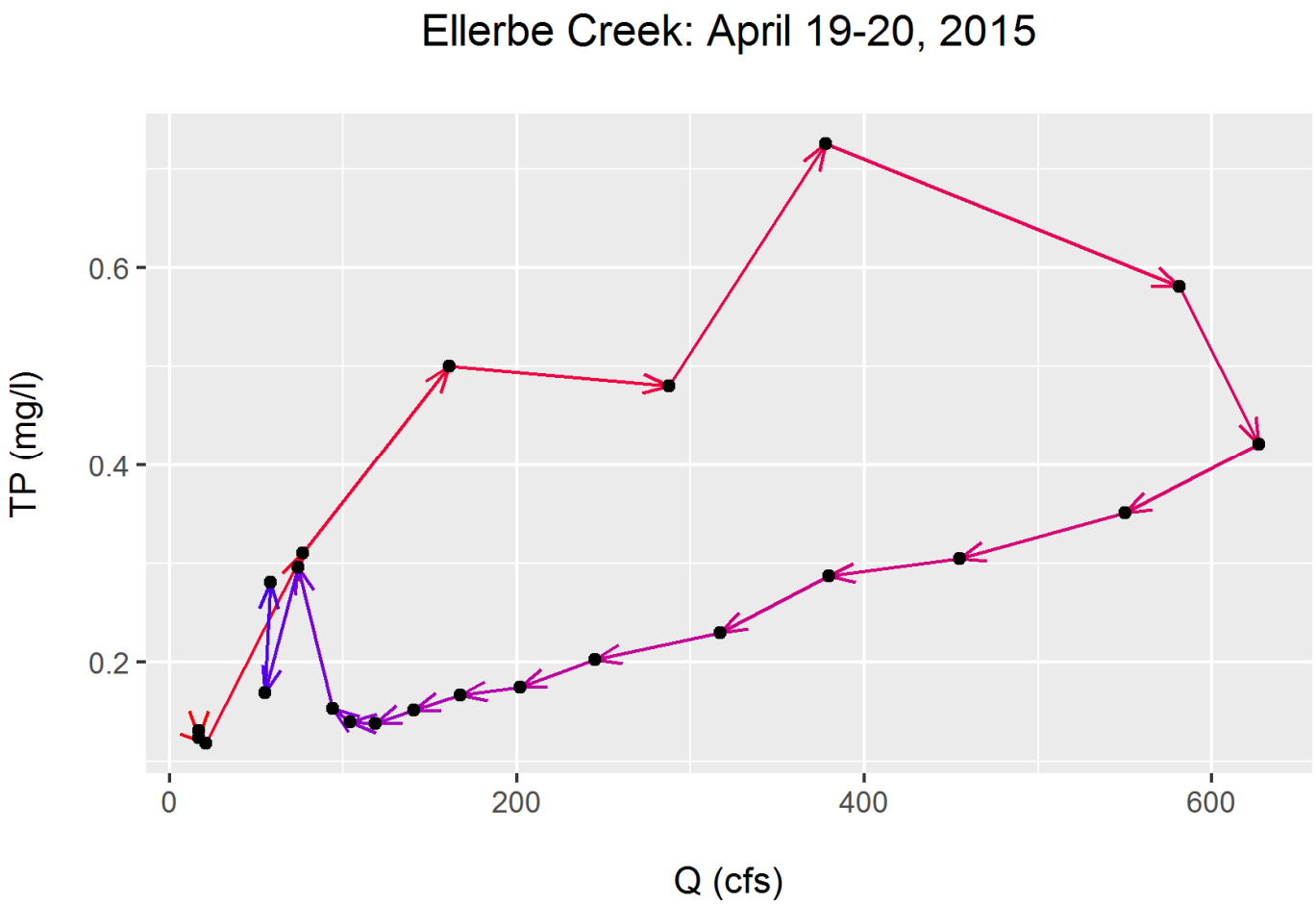

- Hysteresis not present in all events (most noticeable in the April 2015 event).
- Load estimates of TP using (a) average flow-TP relationship, versus (b) different relationships defined for the rising and falling limbs, differ by less than 5%
- Rising limb on Ellerbe often very short-lasting due to its flashiness.

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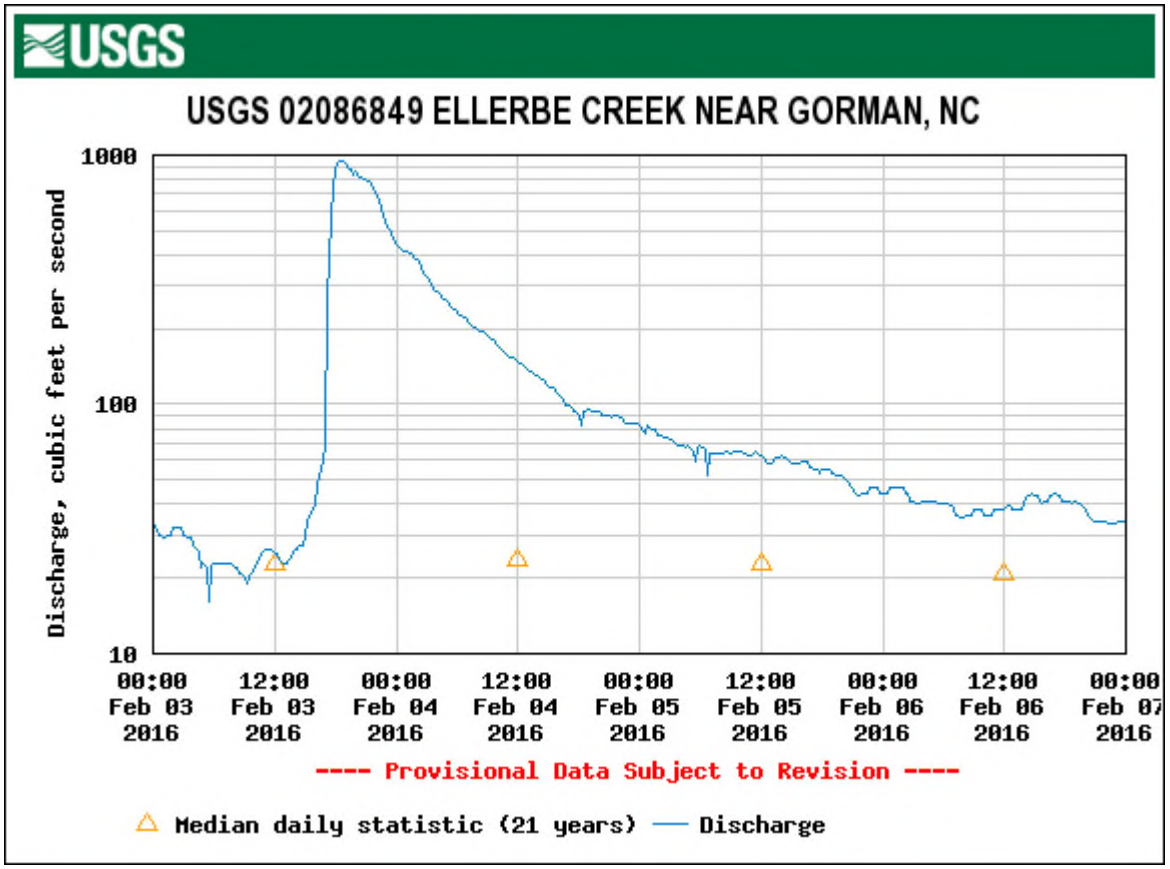

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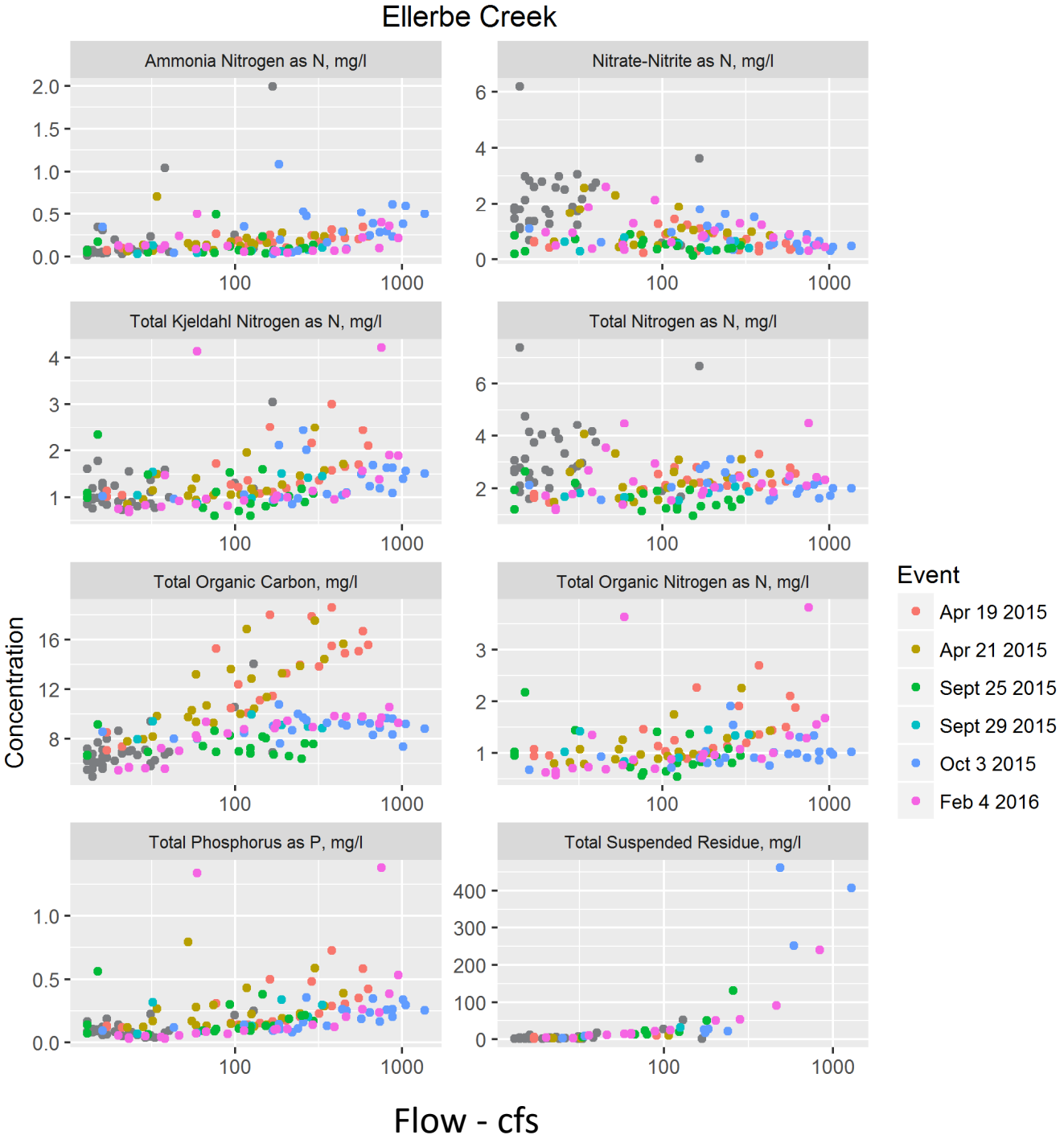
Ellerbe Creek
Ammonia Nitrogen as N, mg/l
Nitrate-Nitrite as N, mg/l
Total Kjeldahl Nitrogen as N, mg/l
Total Nitrogen as N, mg/l
Total Organic Carbon, mg/l
Total Organic Nitrogen as N, mg/l
Total Phosphorus as P, mg/l
Total Suspended Residue, mg/l
Concentration
Flow - cfs
Event
Apr 19 2015
Apr 21 2015
Sept 25 2015
Sept 29 2015
Oct 3 2015
Feb 4 2016

Constriction Point Study

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Constriction Point Study

- Completed one event in January 2016
  - 4 measurements over 10 days at 2 constriction points (Hwy 50 & I-85)
  - ADCP discharge measurements closely match estimates based on water input/output calculations
- One more event to be sampled
- Recommendation: Suspend study; these two events will likely be sufficient to aid in the calibration of hydrodynamic models.

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	Flow Range	Percent of load	Percent of time	Number of Samples	Percent of Samples
Flat River	0 - 88 cfs	20%	71%	23	66%
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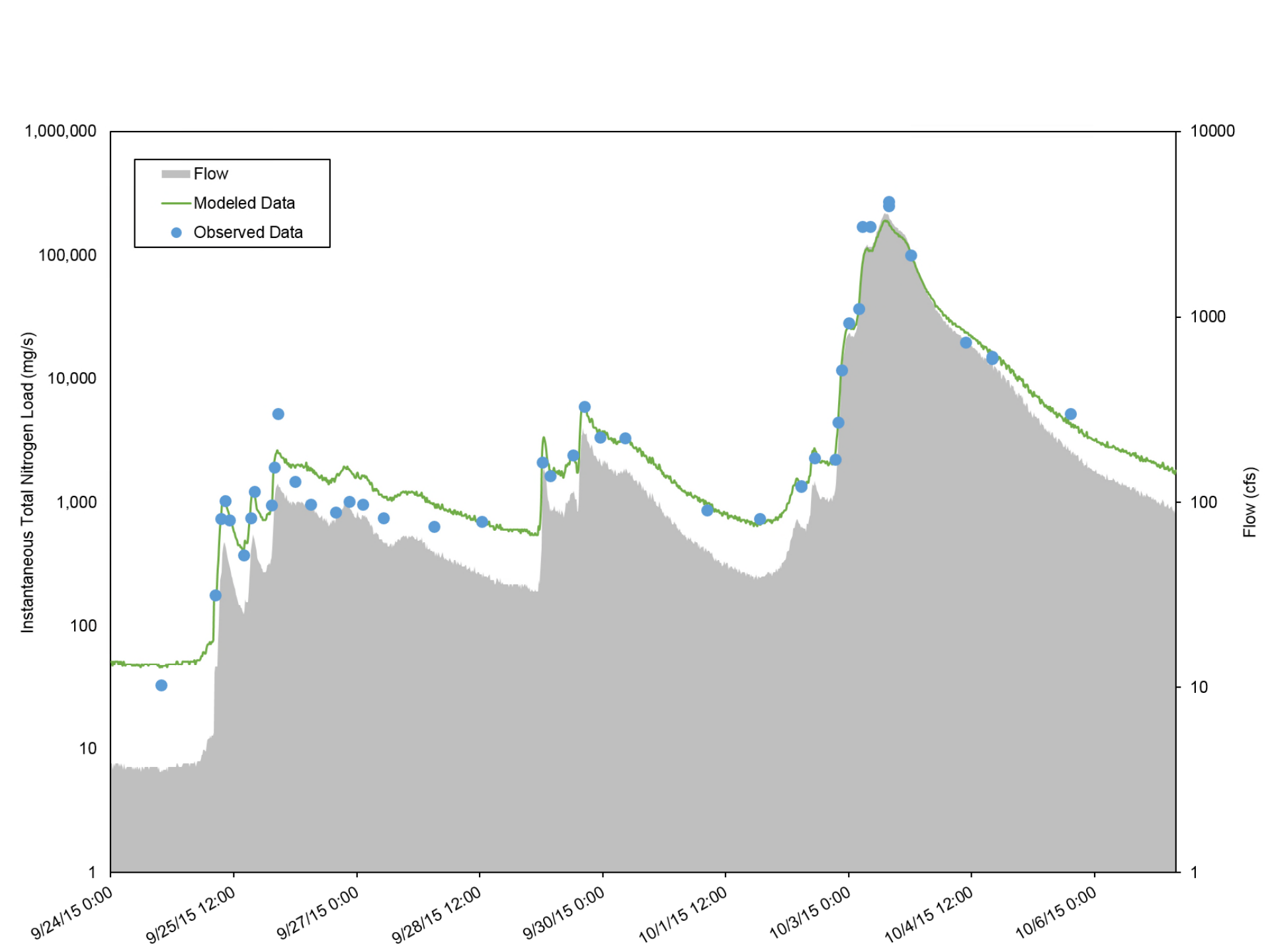
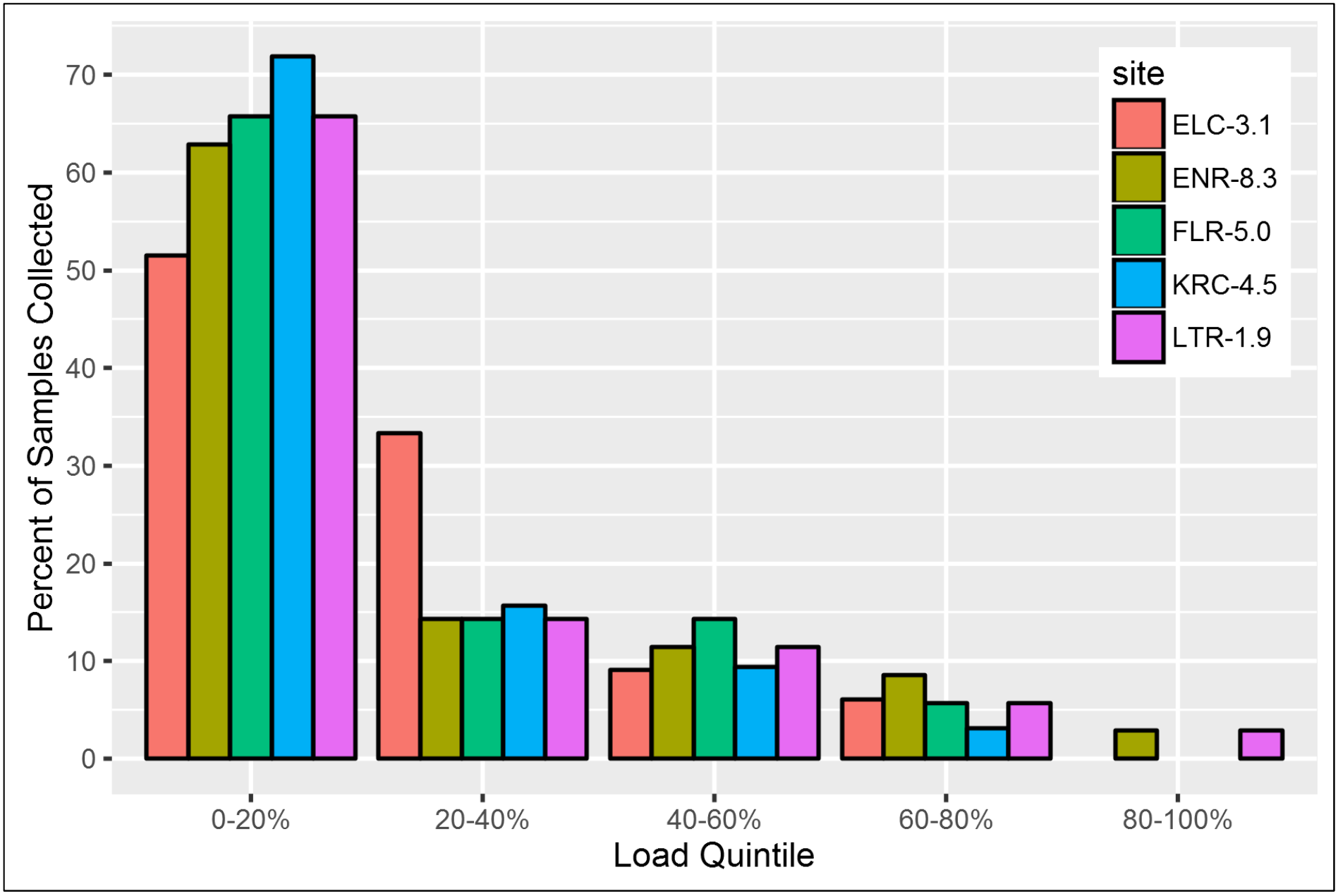
	330 - 2480 cfs	20%	1%	1	3%
Ellerbe Creek	0 - 19 cfs	20%	53%	17	52%
	19 - 36 cfs	20%	30%	11	33%
	36 - 118 cfs	20%	12%	3	9%
	118 - 366 cfs	20%	4%	2	6%
	366 - 1420 cfs	20%	1%	0	0%
Knap of Reeds	0 - 24 cfs	20%	70%	23	72%
	24 - 42 cfs	20%	16%	5	16%
	42 - 98 cfs	20%	9%	3	9%
	98 - 273 cfs	20%	4%	1	3%
	273 - 581 cfs	20%	1%	0	0%


Flow
Modeled Data
Observed Data
Instantaneous Total Nitrogen Load (mg/s)
Flow (cfs)
1,000,000
100,000
10,000
1,000
100
10
1
10000
1000
100
10
1
9/24/15 0:00
9/25/15 12:00
9/27/15 0:00
9/28/15 12:00
9/30/15 0:00
10/1/15 12:00
10/3/15 0:00
10/4/15 12:00
10/6/15 0:00


site
ELC-3.1
ENR-8.3
FLR-5.0
KRC-4.5
LTR-1.9
Percent of Samples Collected
0
10
20
30
40
50
60
70
0-20%
20-40%
40-60%
60-80%
80-100%
Load Quintile

Potential Special Studies Identified Previously

- Develop recreational use survey (SS.RO.4b)
- **Preparation for and meetings with State and Federal regulators (SS.RO.5)**
- **Conduct bathymetric survey of Falls Lake (SS.LR.5)**
- Sediment partitioning at 8 lake loading stations (SS.LR.9)
- Sediment partitioning at 12 lake monitoring stations (SS.LR.10)
- Streambank erosion study in coordination with City of Durham (SS.SA.2)
- Instantaneous flow measurements at lake loading stations (SS.LR.11)
- Measure algal speciation at lake loading stations (SS.LR.12)
- Replicate DWR lake sampling (SS.LR.13)
- Additional ecological data to understand impacts of water quality on aquatic resources at various trophic levels
- Communication plan to explain the re-examination strategy to the public
- Algal growth potential testing
- Nutrient bioassay testing

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