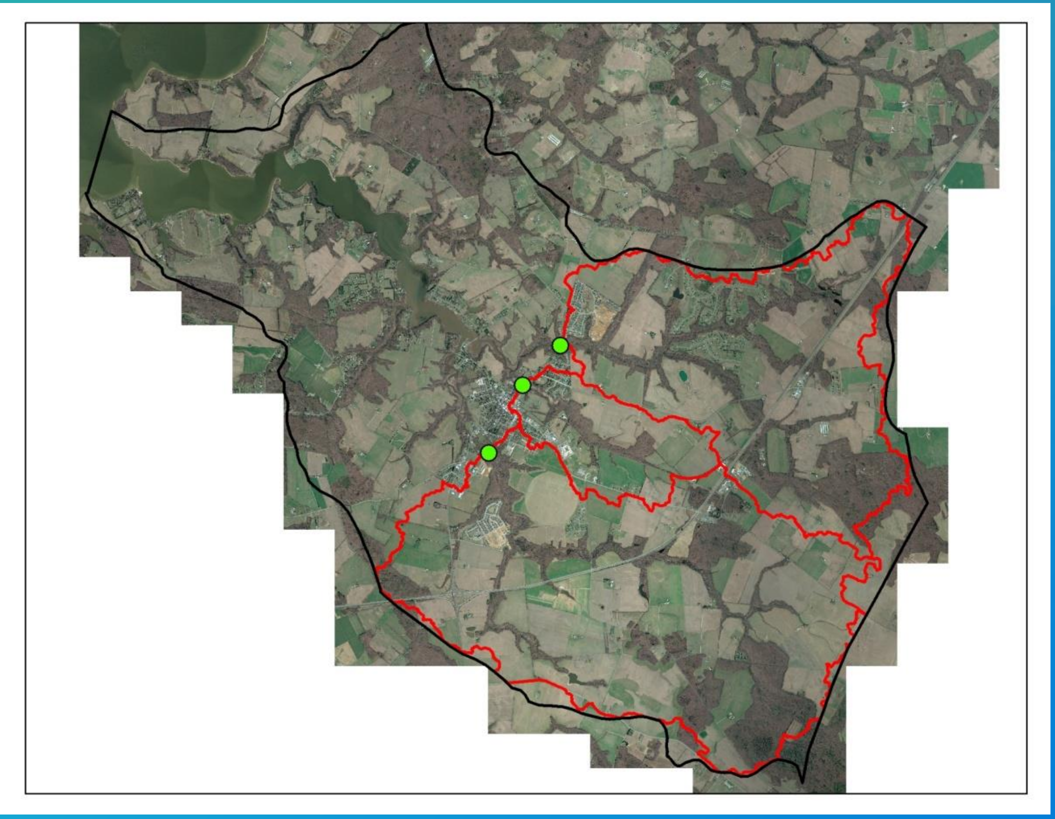
Analysis of Corsica River Maryland, Water Quality Data



Jean Spooner
North Carolina State University

Quentin Forest and Ian Spotts Maryland Department of the Environment

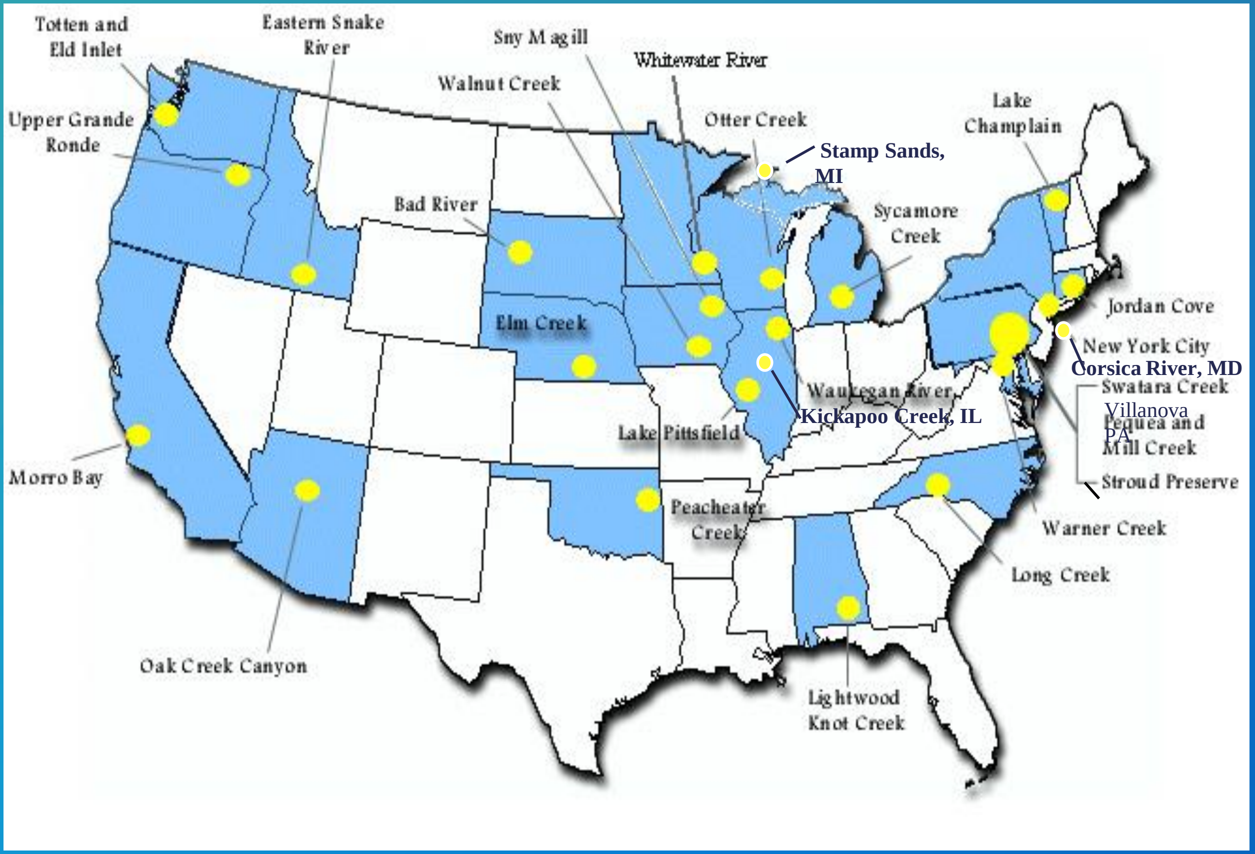
National Nonpoint Source Monitoring Program (NNPSMP) Project

USEPA Section 319 National Nonpoint Source Monitoring Program (NNPSMP)

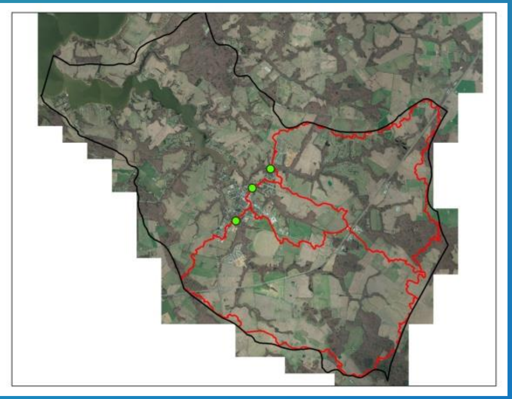
28 projects in U.S. (24 completed monitoring)

"Long-term"

BMPs, land use tracking, and water quality monitoring



Project Objectives
Corsica River Watershed



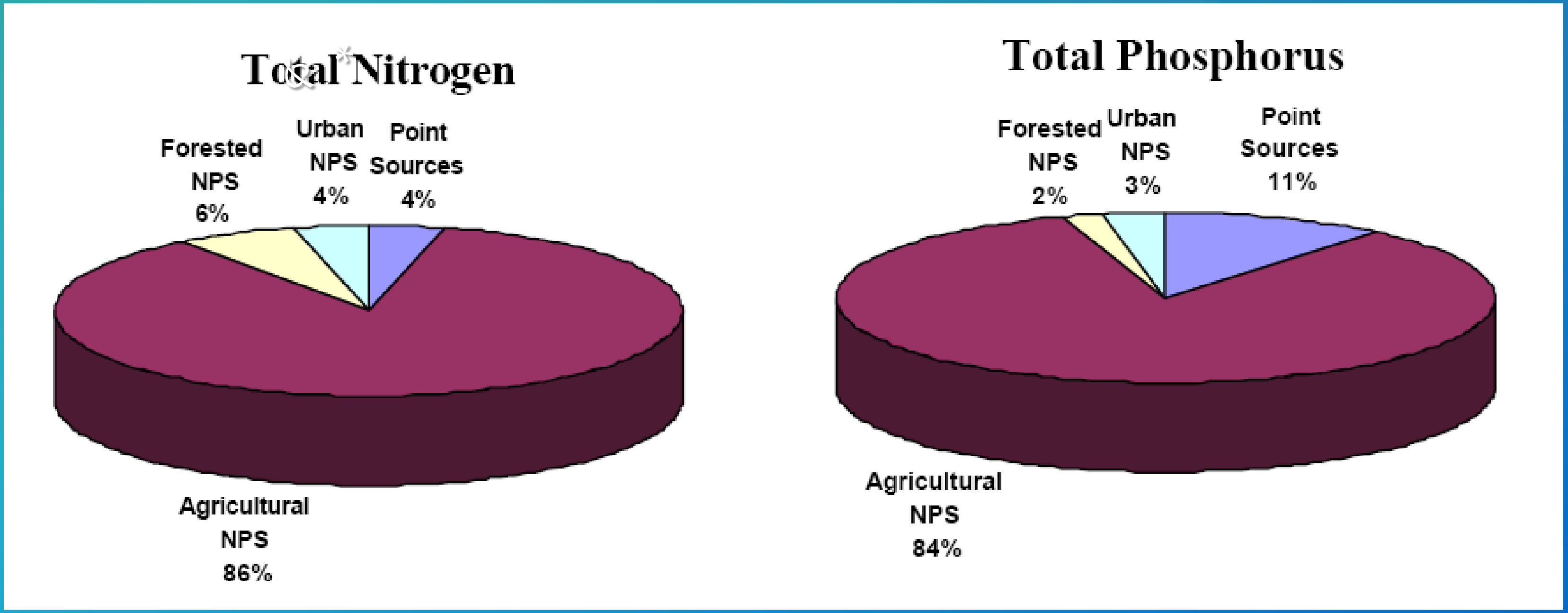
Water Quality Impairment:

- Estuary Fisheries
- Low DO and High chlorophyll a
- High bacteria

Land Treatment Objectives:

- Reduction in tidal nutrient loadings (nitrogen, phosphorus) during "Low Flow" (May – Oct) period
- Reduce **non-tidal** nutrient loadings
- 3,000 acres cover crop and small grain
- Bioretension and other stormwater controls
- Wetlands
- On-site wastewater upgrades

Nutrient Loads by Land Use

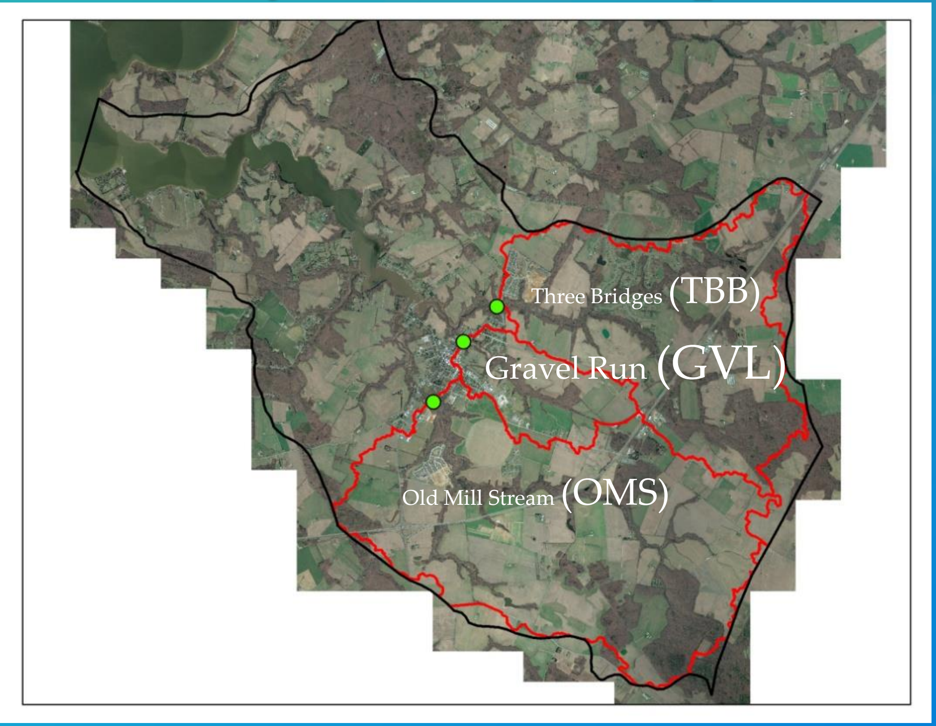


(MDE 2000)

Water Quality Monitoring Corsica River Watershed

Non-Tital:

- On-Site wastewater treatment train (pre- and post- upgrade)
- Synoptic (Spring, Fall), with discharge
- Weekly grab, with discharge (3 main tribs, plus control)
- **Weekly nutrient composite (3 main tribs), with discharge**



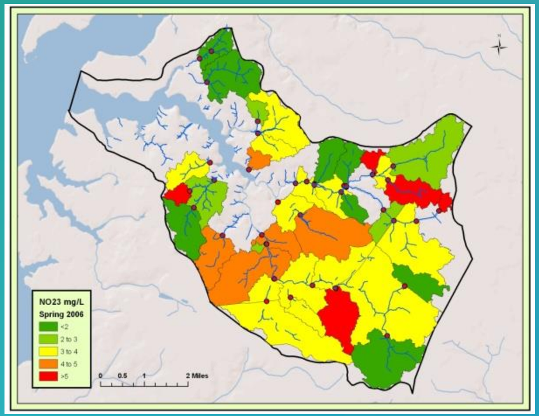
Tidal

- Fisheries
- Nutrients
- DO and chlorophyll a
- High bacteria

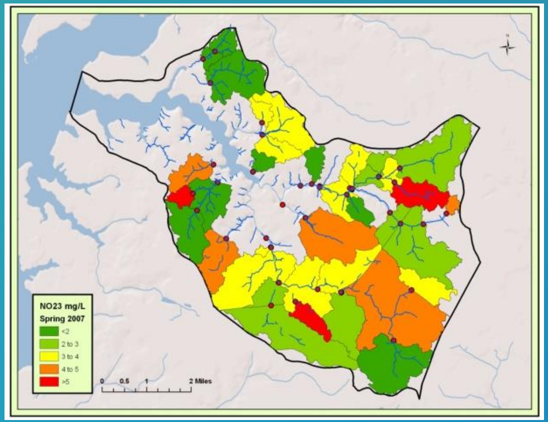
Corsica Synoptics

- Conducted Spring and Fall
- Sampling consists of:
  - Nutrient Analysis (TN/TP, NO_2^-+ NO_3^-, NH_4^+, PO_4^{-3})
  - Flow Measurements
  - In-situ measurements (D.O., Conductivity, pH, temperature)
- Quick and relatively inexpensive for the information provided
- Tracking land use changes/impacts
- Potential targeting tool for BMP implementation

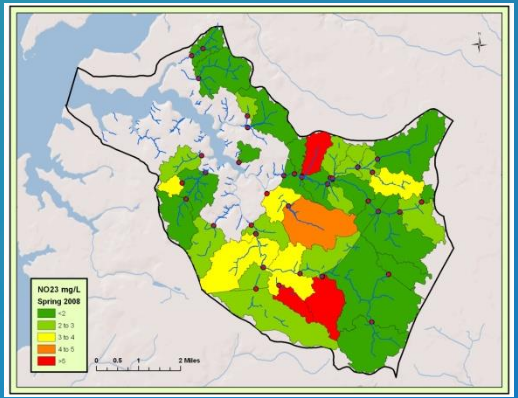
Corsica River, Synptic Data, Spring Sampling



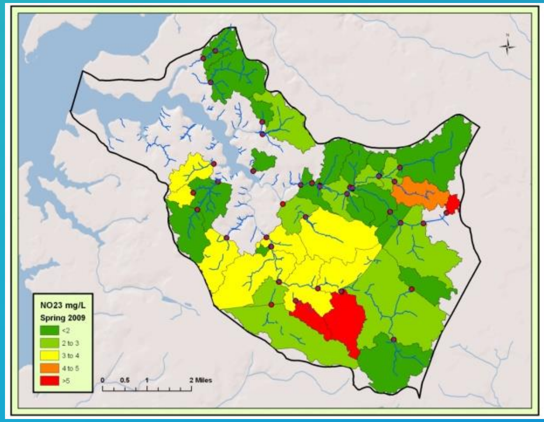
2006



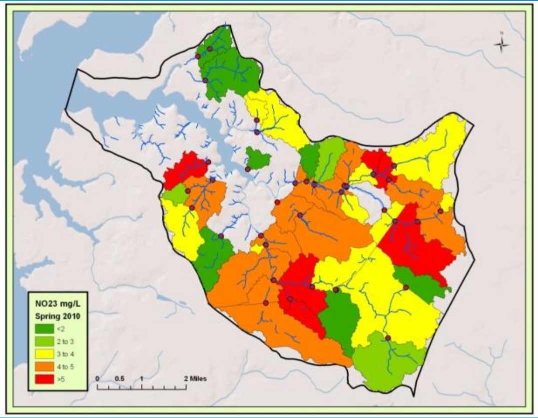
2007



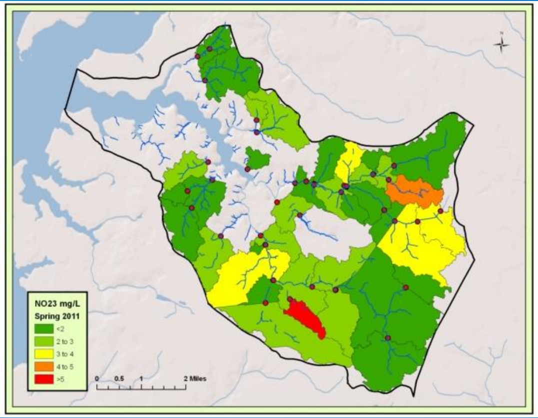
2008



2009

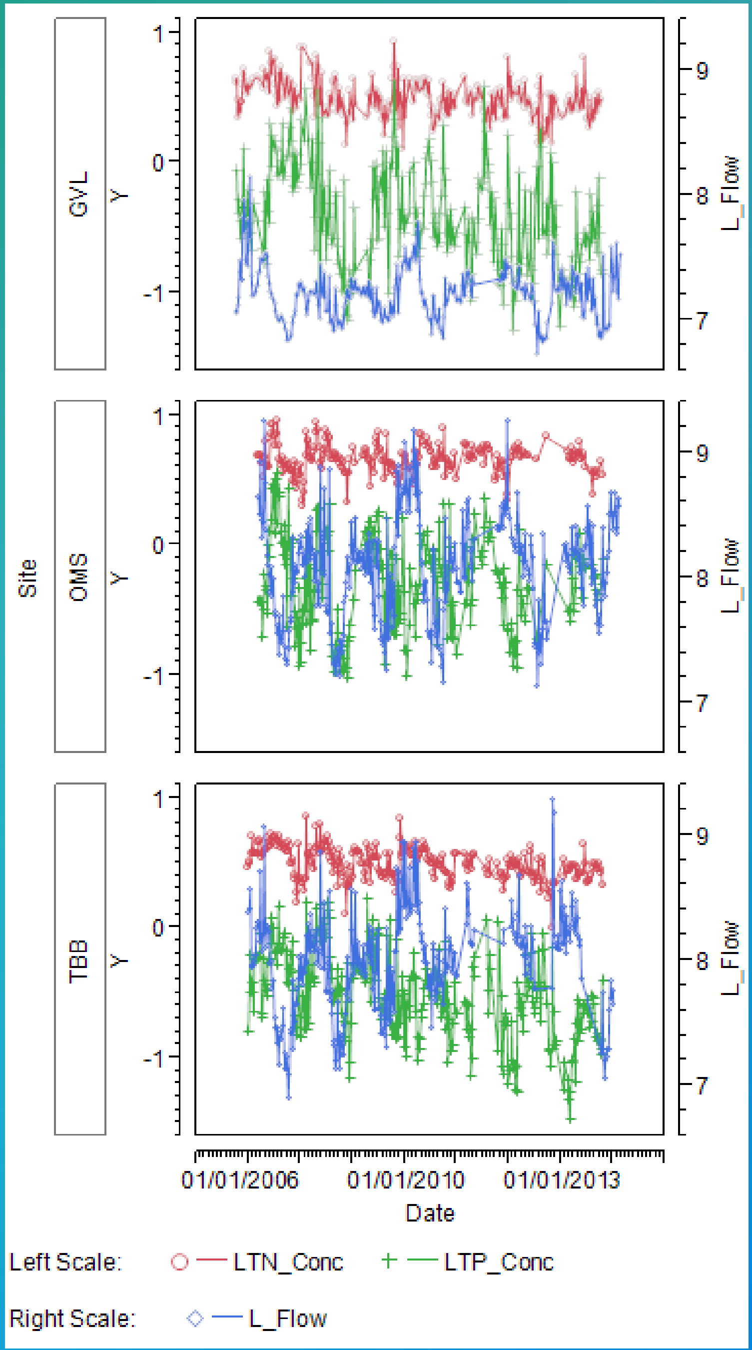


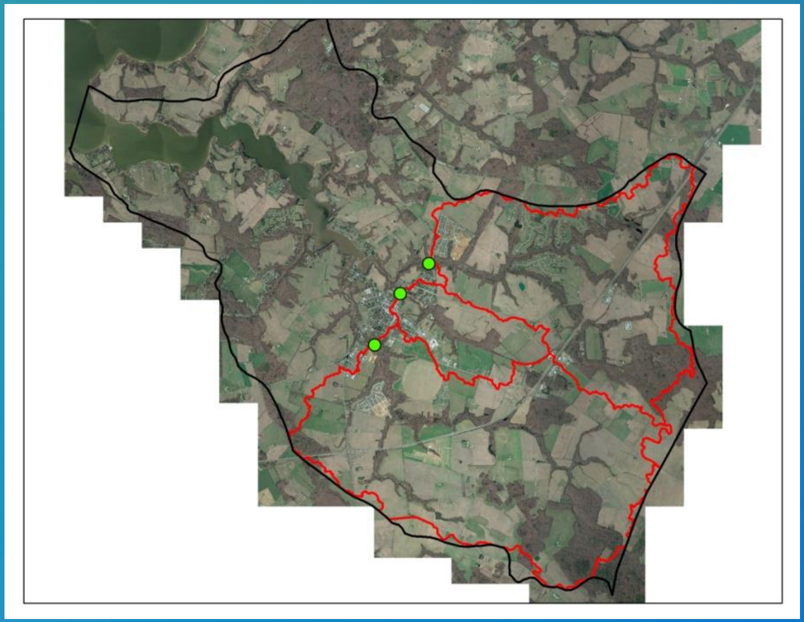
2010



2012

Total N time plots





Gravel Run
(Smallest)

Old Mill Stream
(Largest)

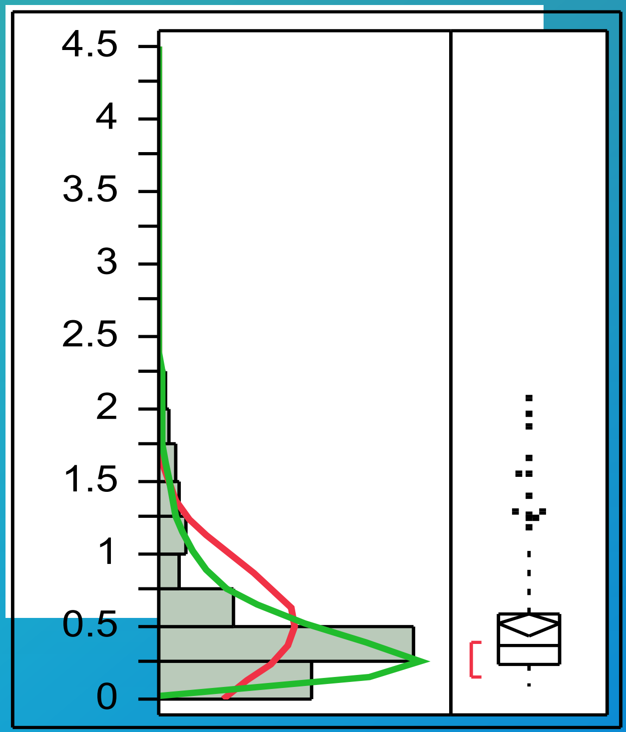
Three Bridges

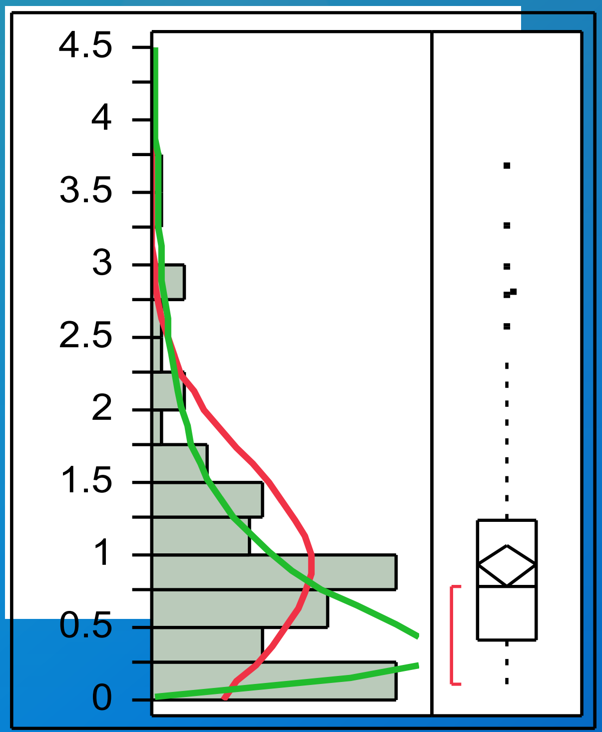
Log Normal Distribution

High Flow, Nov-April

"Low" Flow May-Oct (TMDL period)

TP (mg/l)



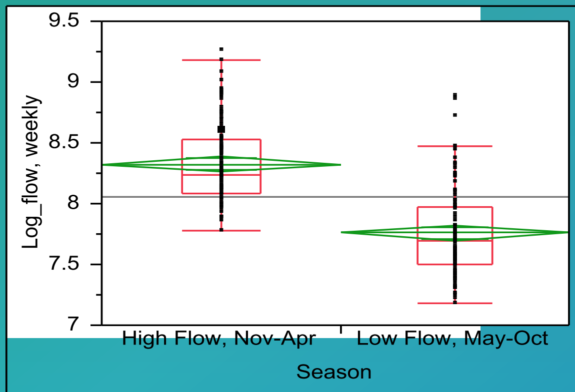


Normal

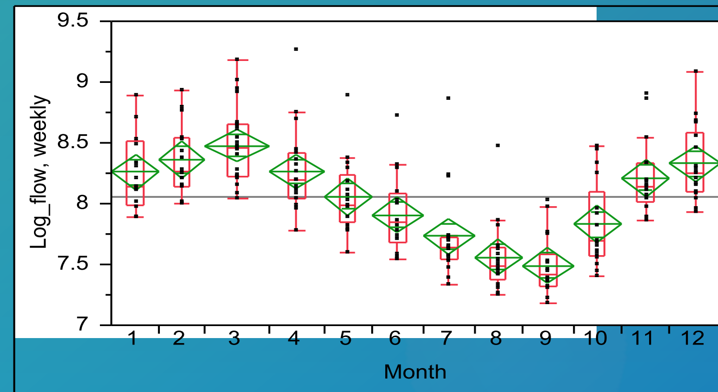
LogNormal

Corsica River, Old Mill Stream

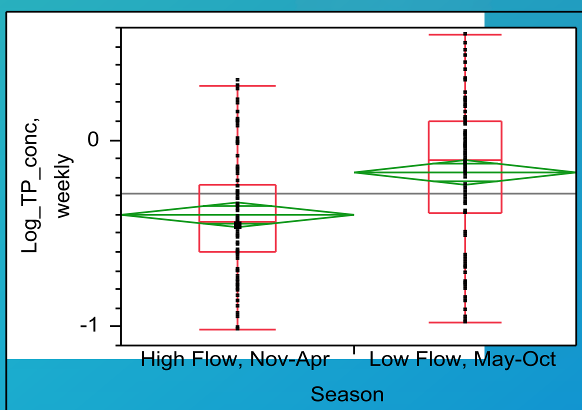
Seasonal Pattern



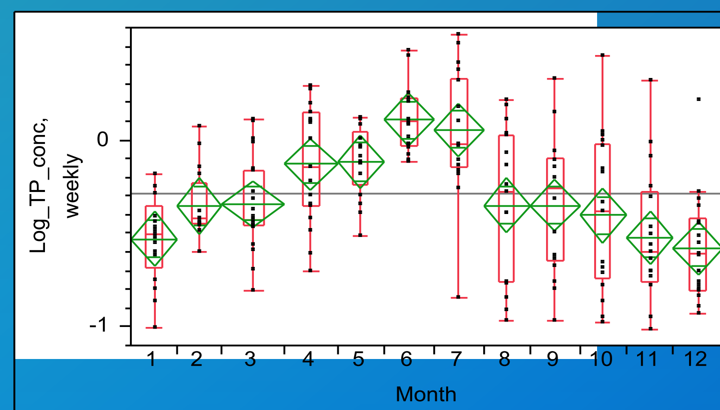
R^2=.41 (seasonal significance Prob>F = <.0001)



R2=.53 (“month” significance Prob>F = <.0001, significant)



R^2=.10 (seasonal significance Prob>F = <.0001)



R^2=.35 (“month” significance Prob>F = <.0001, significant)

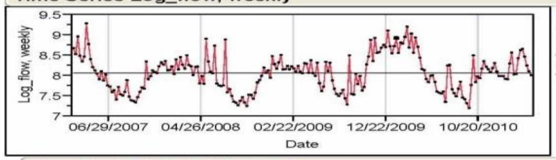
- Monthly better than TMDL period
- Flow and concentration ~ opposite pattern

Corsica River, Old Mill Stream

Autocorrelation

Where(:Site == "OMS")

Time Series Log_flow, weekly



Mean	8.0490084
Std	0.441348
N	215
Zero Mean ADF	-0.438002
Single Mean ADF	-5.785516
Trend ADF	-5.827099

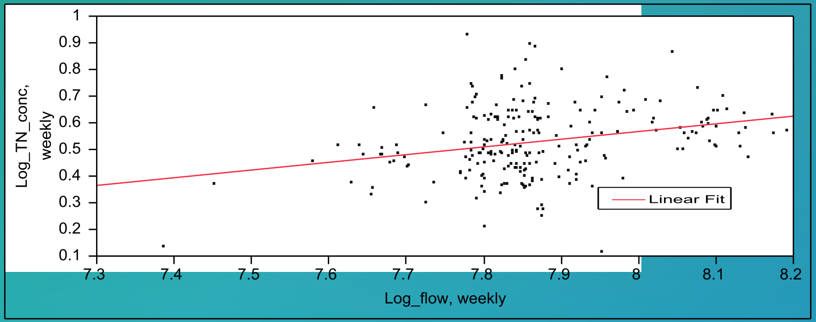
Time Series Basic Diagnostics

Lag	AutoCorr	Ljung-Box Q	p-Value	Lag	Partial	Lag	AR Coef
0	1.0000	.	.	0	1.0000	1	0.4273
1	0.7317	116.717	<.0001*	1	0.7317	2	0.1829
2	0.6566	211.151	<.0001*	2	0.2609	3	0.0183
3	0.6064	292.066	<.0001*	3	0.1394	4	0.1144
4	0.5755	365.302	<.0001*	4	0.1079	5	0.2124
5	0.5361	429.163	<.0001*	5	0.0462	6	-0.0724
6	0.4528	474.932	<.0001*	6	-0.0874	7	-0.0623
7	0.3834	507.901	<.0001*	7	-0.0753	8	0.0774
8	0.3287	532.259	<.0001*	8	-0.0450	9	0.1200
9	0.2876	550.997	<.0001*	9	-0.0135	10	-0.2913
10	0.1617	556.950	<.0001*	10	-0.2111	11	0.0735
11	0.1322	560.945	<.0001*	11	0.0197	12	0.0470
12	0.0745	562.219	<.0001*	12	-0.0382	13	-0.1614
13	-0.0052	562.226	<.0001*	13	-0.1126	14	-0.0679
14	-0.0587	563.026	<.0001*	14	-0.0410	15	0.1546
15	-0.1002	565.368	<.0001*	15	0.0103	16	-0.0722
16	-0.1540	570.931	<.0001*	16	-0.0673	17	-0.0409
17	-0.1864	579.118	<.0001*	17	-0.0149	18	0.1598
18	-0.2055	589.122	<.0001*	18	0.0317	19	0.0347
19	-0.2705	606.542	<.0001*	19	-0.0903	20	-0.1756
20	-0.3216	631.287	<.0001*	20	-0.1377	21	0.1348
21	-0.3377	658.711	<.0001*	21	0.0030	22	-0.0165
22	-0.3961	696.634	<.0001*	22	-0.1259	23	-0.0914
23	-0.4121	737.907	<.0001*	23	-0.0735	24	-0.1013
24	-0.4455	786.378	<.0001*	24	-0.0672	25	0.0703
25	-0.4486	835.793	<.0001*	25	0.0136	26	-0.1264
26	-0.4584	887.653	<.0001*	26	-0.0673	27	-0.0803
27	-0.4414	935.997	<.0001*	27	0.0275	28	0.1358
28	-0.3959	975.103	<.0001*	28	0.1414	29	0.1205
29	-0.3568	1007.04	<.0001*	29	0.0630	30	-0.1605
30	-0.3607	1039.85	<.0001*	30	-0.0988	31	0.1259
31	-0.3183	1065.53	<.0001*	31	0.0995	32	0.0736
32	-0.2836	1086.04	<.0001*	32	-0.0267	33	-0.1136
33	-0.2722	1105.03	<.0001*	33	-0.1348	34	-0.0180
34	-0.2271	1118.32	<.0001*	34	-0.0004	35	0.0785
35	-0.1887	1127.55	<.0001*	35	0.0333	36	-0.0182
36	-0.1332	1132.18	<.0001*	36	-0.0431	37	-0.0470
37	-0.0974	1134.67	<.0001*	37	-0.0216	38	-0.0403
38	-0.0882	1136.71	<.0001*	38	-0.0093	39	0.0043
39	-0.0509	1137.40	<.0001*	39	0.0010	40	-0.0721
40	0.0053	1137.41	<.0001*	40	-0.0070	41	0.0091
41	0.0393	1137.82	<.0001*	41	0.0768	42	0.0655
42	0.0823	1139.65	<.0001*	42	0.0802	43	0.0073
43	0.1281	1144.10	<.0001*	43	0.0091	44	-0.0664
44	0.1443	1149.78	<.0001*	44	-0.0234	45	-0.0062
45	0.1756	1158.25	<.0001*	45	0.0327	46	0.0566
46	0.2529	1175.90	<.0001*	46	0.0716	47	0.0881
47	0.3126	1203.04	<.0001*	47	0.0847	48	0.0407
48	0.3348	1234.36	<.0001*	48	0.0263	49	0.0770
49	0.3594	1270.67	<.0001*	49	0.0170	50	-0.0457
50	0.3476	1304.83	<.0001*	50	-0.0954	51	-0.0845
51	0.3273	1335.30	<.0001*	51	-0.0988	52	-0.0333
52	0.3294	1366.36	<.0001*	52	-0.0333		

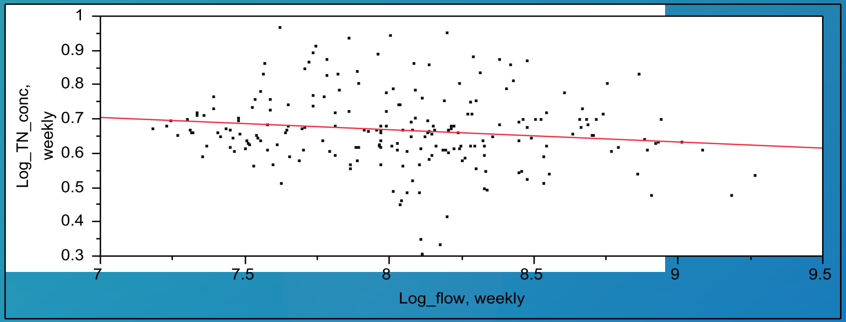
- Autoregressive, Order 1, AR(1) most appropriate (ACF trails to 0, PACF drops to 0 after 1st lag1). Typical of weekly samples)
- Strong seasonal pattern
- Correlation coefficients, r =   0.4 to 0.6 (right column)

Corsica River, Old Mill Stream

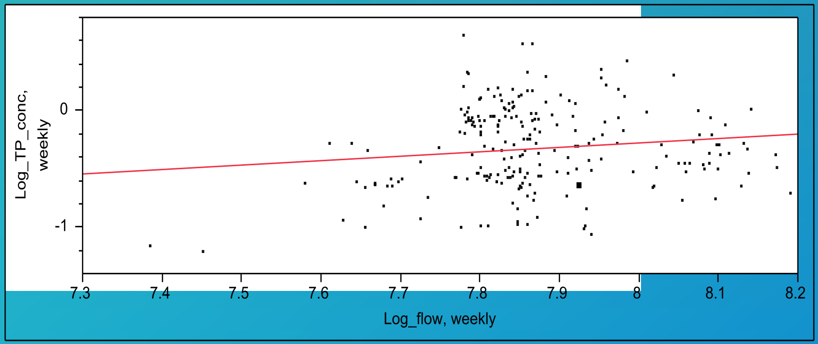
Flow as Explanatory Variable?



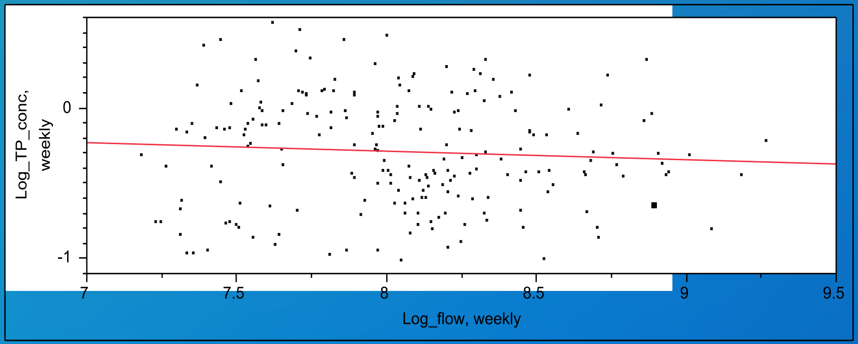
Gravel Branch, TN vs. Flow - Trend statistically significant at 0.0001 level (But R^2=0.08)



Old Mill Stream, TN vs. Flow - Trend statistically significant at 0.05 level (But R^2=0.02)



Gravel Branch, TP vs. Flow - Trend statistically significant at 0.05 level (But R^2=0.02)



Old Mill Stream, TP vs. Flow - Trend not statistically significant

- Flow is a weak explanatory variable (covariate)
- Concentration vs. Flow 'better' for TN as compared to TP

Corsica River

Statistical Trend Model

Log (Concentration) =

$Date_t$, as daily value Log (Load)

Month, 11 df

Log (Weekly Flow, for concentrations)

Cover Crop

Z_t

Where:

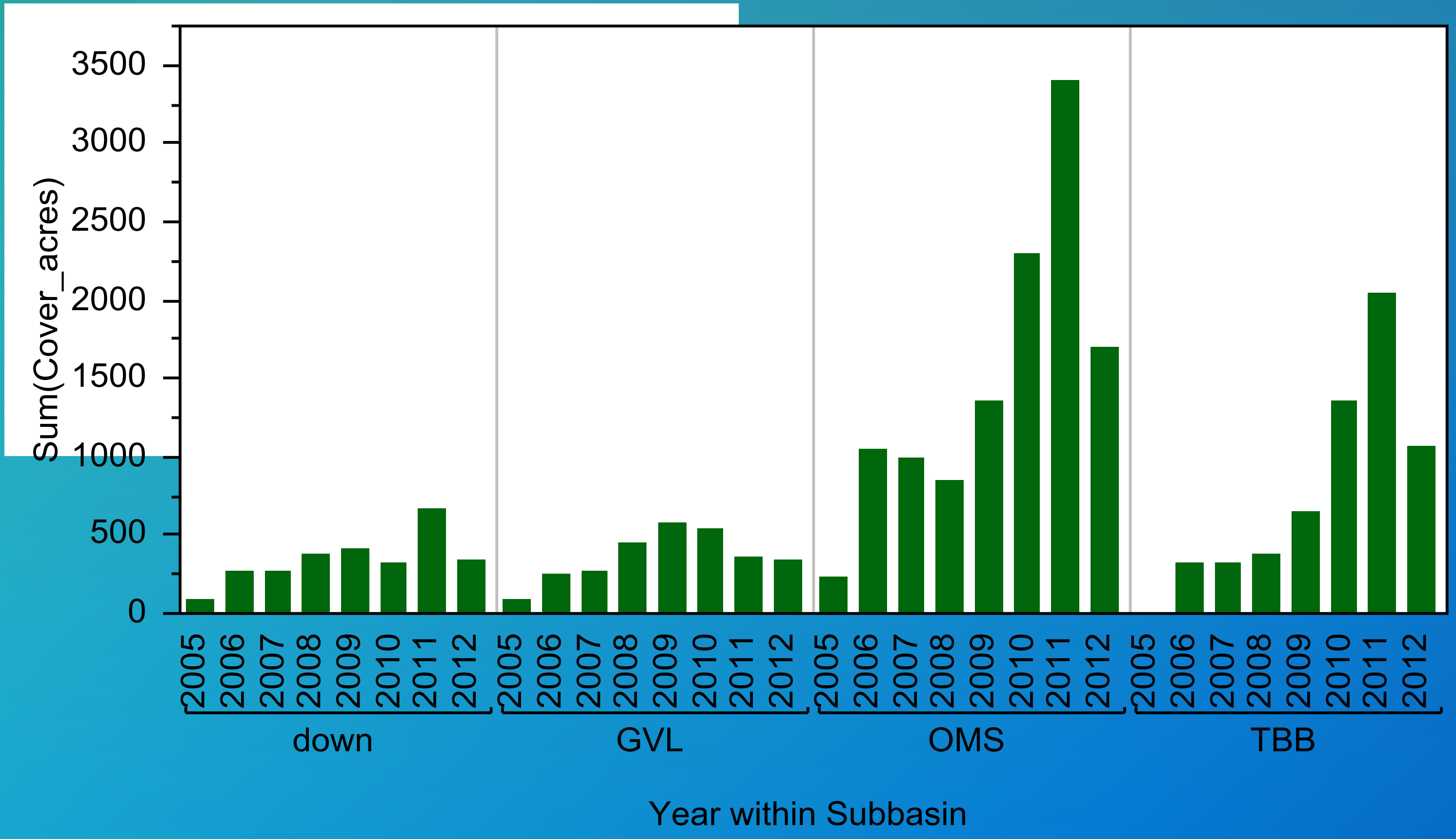
Z_t is AR(1)

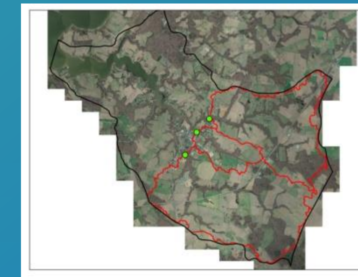
$Date_t$, keep weekly dates with missing values to enable use of PROC AUTOREG in SAS

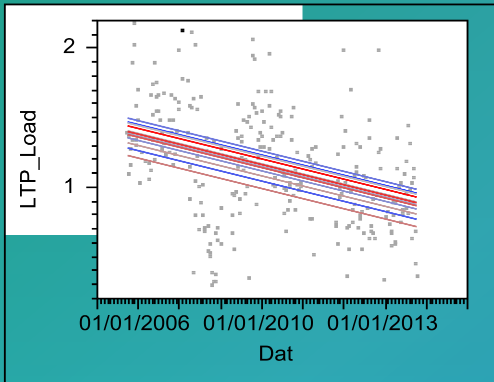
MDC (Minimum Detectable Change), Sample Frequency

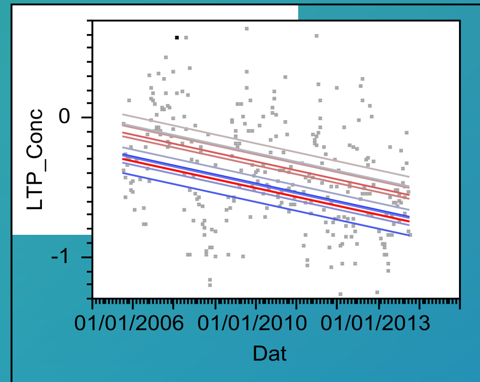
Subbasin	Variable	MDC (%) Weekly Sample	MDC (%) Biweekly Samples	MDC (%) Weekly, Flow Covariate
GVL	LTN_Conc	15 %	20 %	15 %
OMS	LTN_Conc	12	17	13
TBB	LTN_Conc	16	21	16
GVL	LTP_Conc	44	52	44
OMS	LTP_Conc	43	53	43
TBB	LTP_Conc	30	31	32
GVL	LTN_Load	29		
OMS	LTN_Load	40		
TBB	LTN_Load	44		
GVL	LTP_Load	45		
OMS	LTP_Load	54		
TBB	LTP_Load	46		

Cover Crop by Subbasin

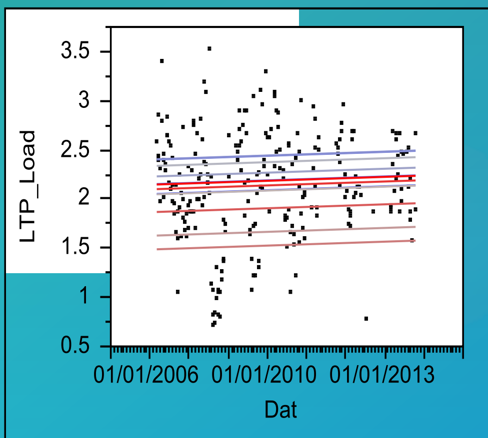


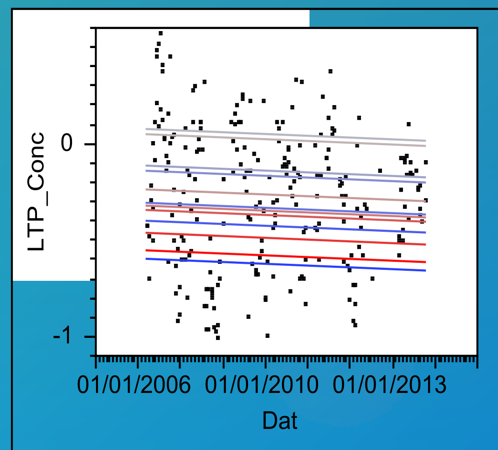




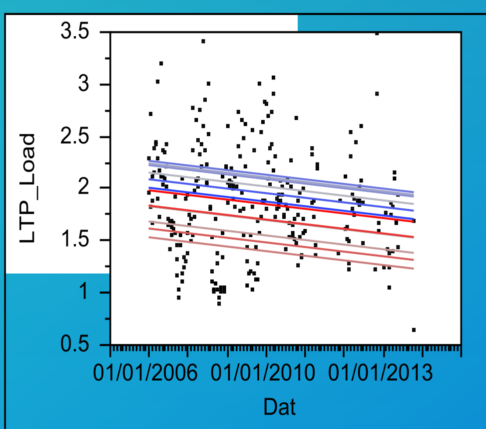


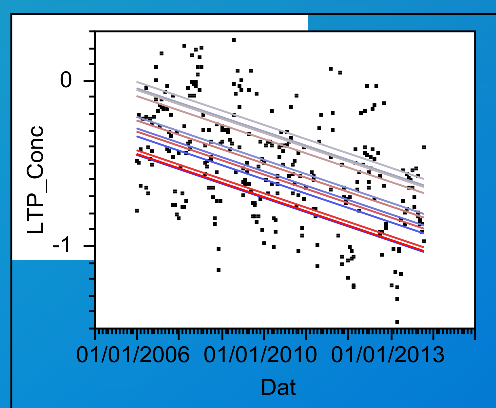
Gravel Run



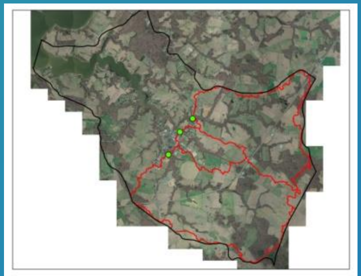


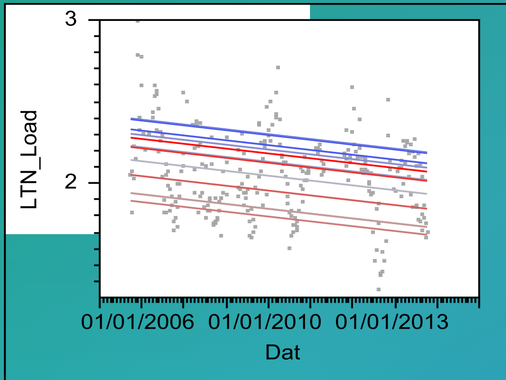
Old Mill Stream

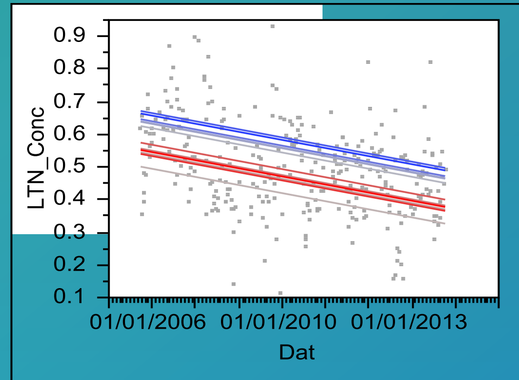




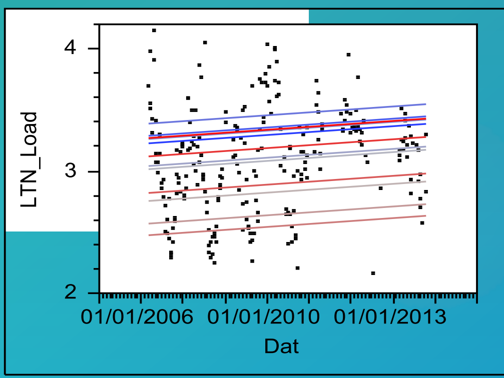
Three Bridges

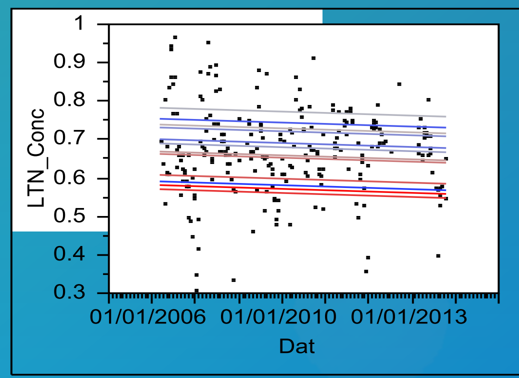




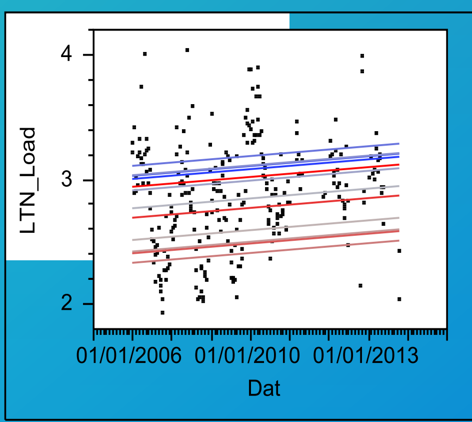


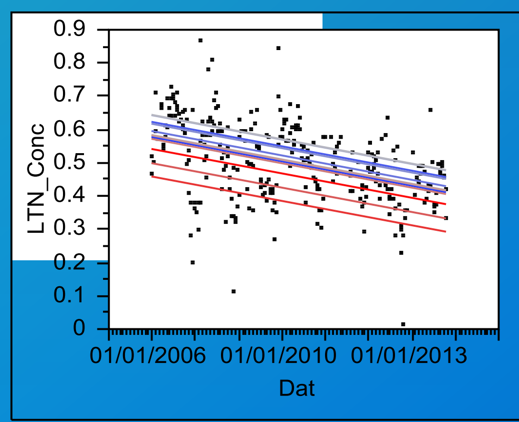
Gravel Run





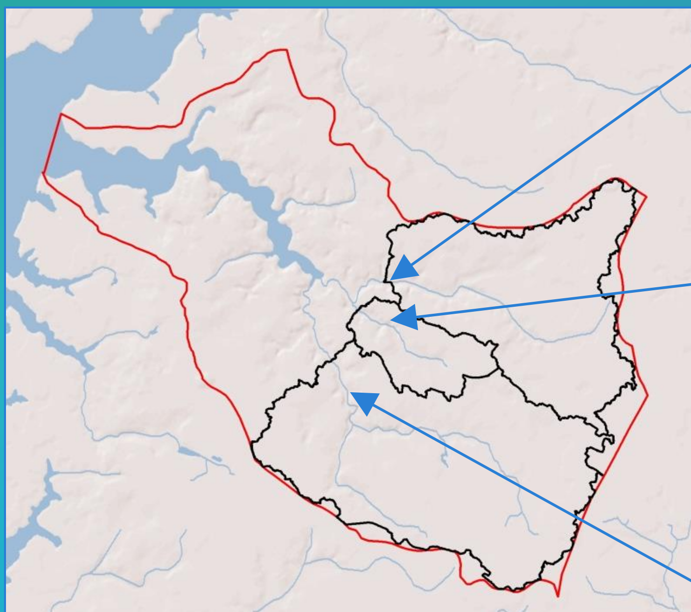
Old Mill Stream





Three Bridges

Corsica River
Nutrient Non-Tidal Trends Summary



TBB

- ⬇ for TP conc; TN conc

GVL

- ⬇ for TP load/conc; TN load/conc

OMS

- ⊠⊠ No trends