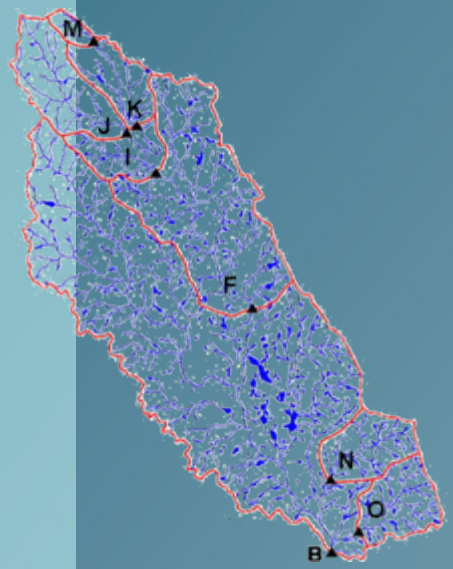

Long-Term Water Quality Responses to Conservation Practices in Nested Coastal Plain Watersheds

George Vellidis

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Partners

- University of Georgia
  - Susan Crow, Gary Hawkins
- USDA-ARS Southeast Watershed Research Lab.
  - David Bosch, Richard Lowrance, Dana Sullivan, Gary Feyereisen
- USDA-NRCS
  - Jimmy Bramblett
- South Georgia Regional Development Center
  - Emily Perry Davenport

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Funding

- USDA-CSREES Integrated Research, Education, and Extension CEAP Competitive Grants Program
- State and federal funds allocated to the University of Georgia Agricultural Experiment Stations
- CRIS project funds allocated to the USDA-ARS Southeast Watershed Research Laboratory

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Objectives

- To evaluate the effects of past and potential conservation practices on water quality in a coastal plain watershed;
- To evaluate social and economic factors influencing implementation and maintenance of these conservation practices; and
- Train and educate stakeholders about these issues and the effects that their actions have on watershed-scale water quality.

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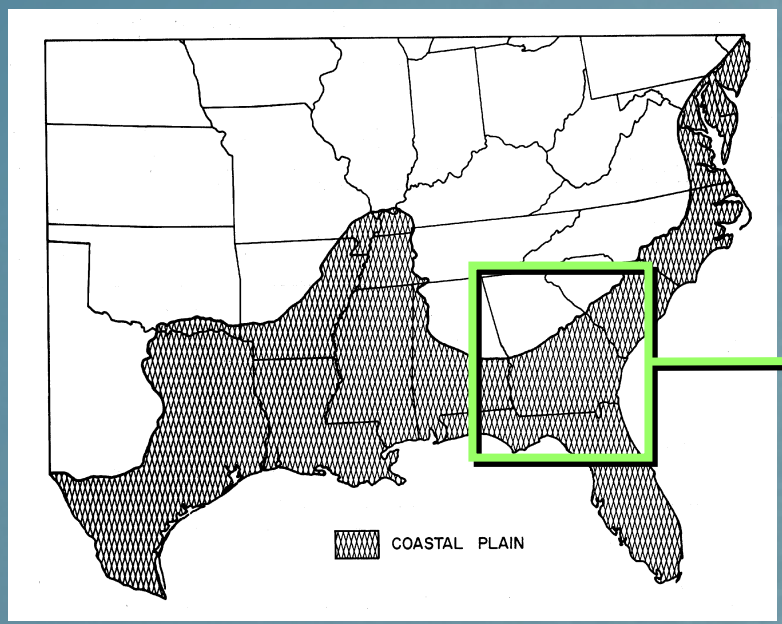
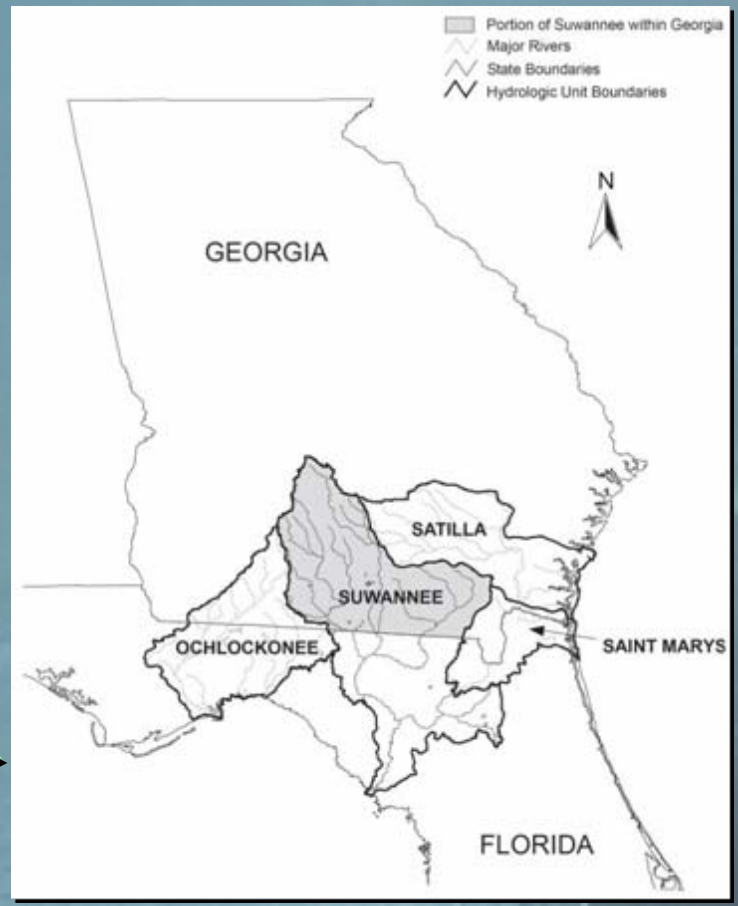
Where?

- Southeastern Coastal Plain
  - Suwannee River Basin





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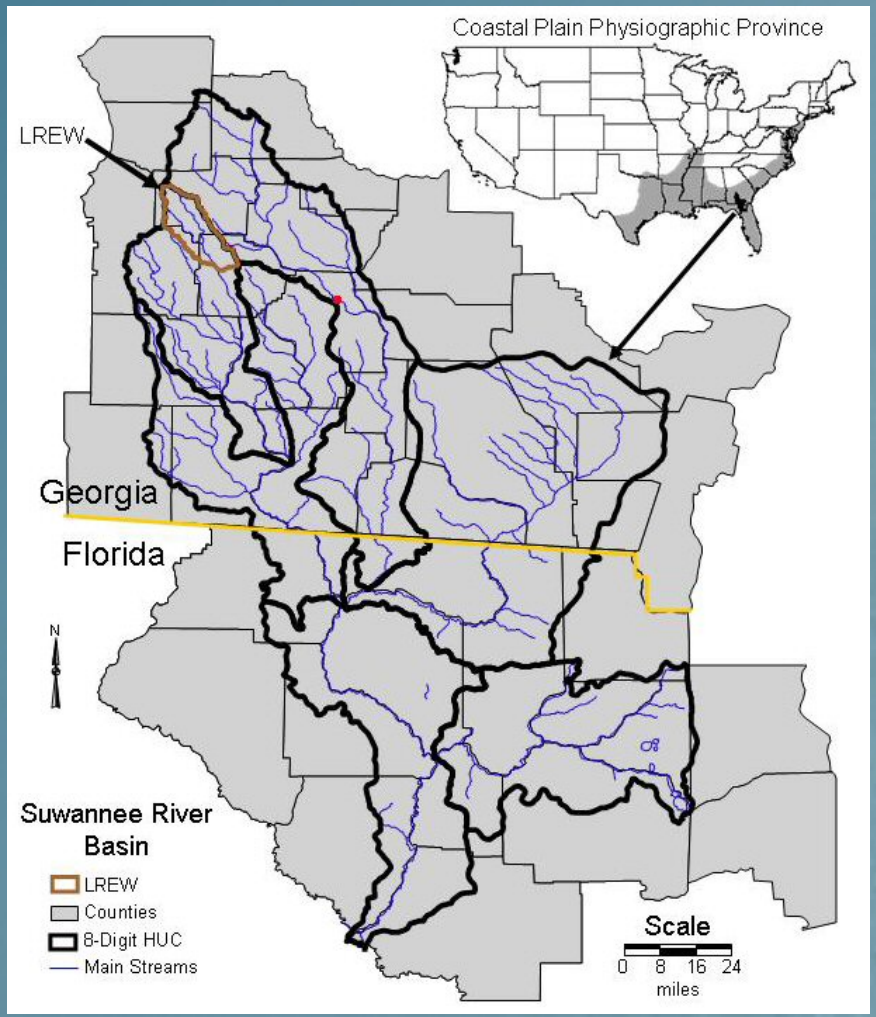
Suwannee River Basin



- Representative of Coastal Plain ecoregions
- 60% in Georgia, 40% in Florida
- Priority watershed
- LREW

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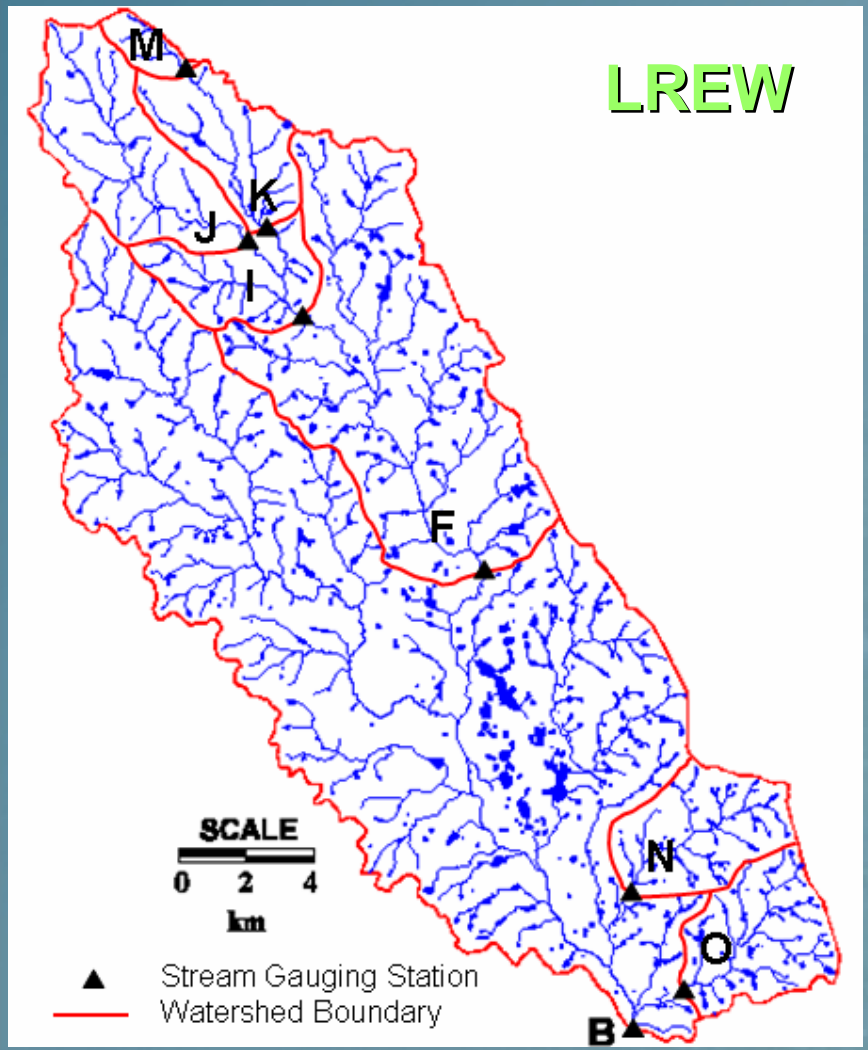
Little River Experimental Watershed



- 334 km^2 (82,500 ac)
- USDA-ARS regional experimental watershed
- Established in late 1960s
- 5th order stream

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LREW Impairments

- Main stem
  - low DO
- Tributaries
  - low DO, fecal coliform, and sediment
- Typical of impairments in Coastal Plain
- No point sources

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LREW Landcover

During late 1970s (windshield surveys)

- Agricultural land – 36% to 54%
- Row crops – 31% to 41%

- Most pasture land used for cow-calf operations
- Remainder of the watershed in upland pine forest
  - both natural regeneration and pine plantation

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LREW Landcover

- Forested riparian areas
  - natural regeneration
- Some landcover changes from 1975 to 2005
- Minor increases in suburban development

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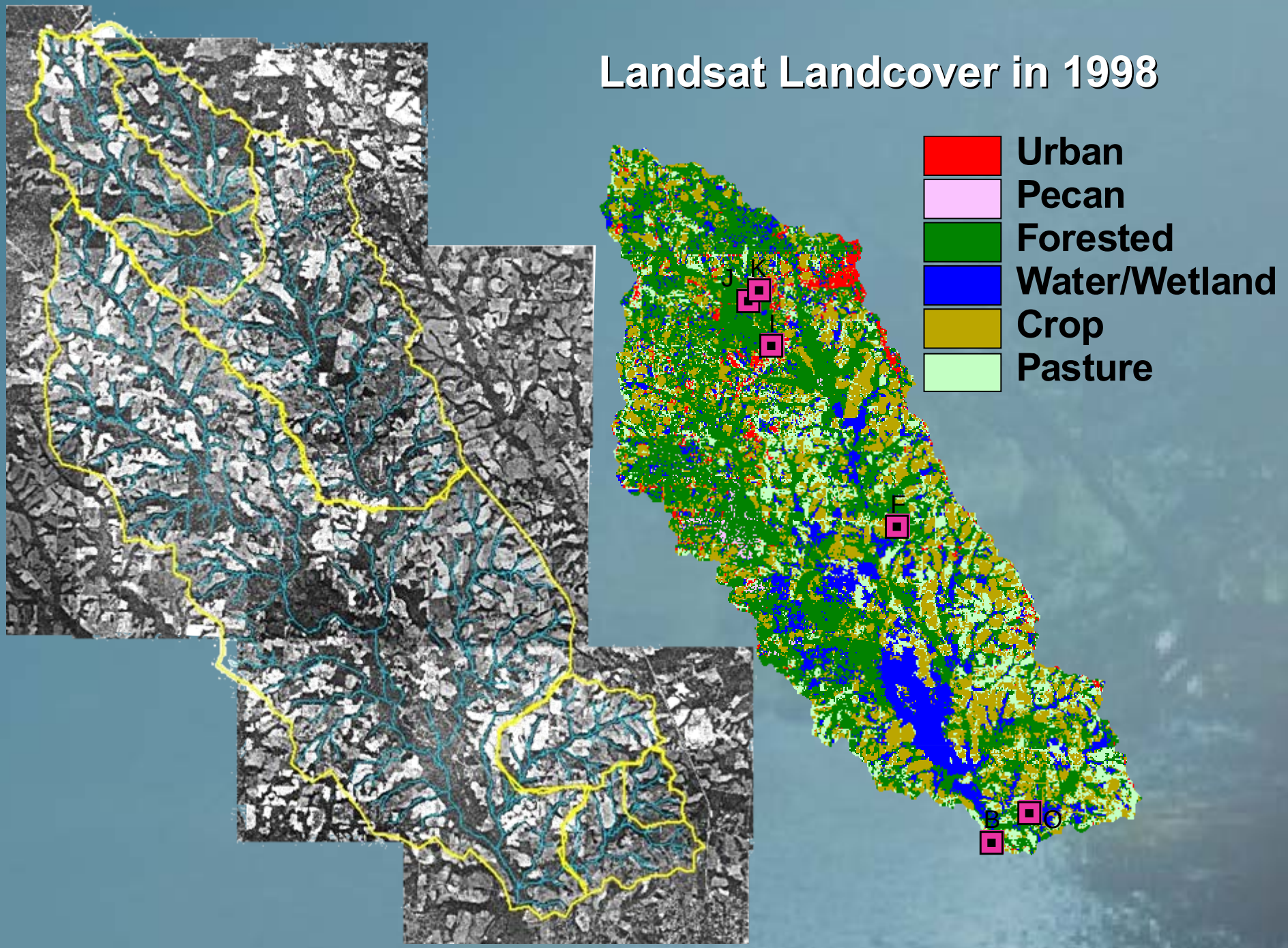
Landsat Landcover in 1998
Urban
Pecan
Forested
Water/Wetland
Crop
Pasture
J
K
I
F
B
C

Landsat Landcover in 1998

Landcover	Percentage of Area
Urban	2.7
Pecan	0.5
Mature Deciduous	35.5
Mature Planted Pine	2.8
Mixed Deciduous and Pine	5.2
Young Planted Pine	0.3
Water	1.4
Wetland	9.1
Forested Wetland	2.8
Crop	24.7
Pasture	15.0

LREW Cropping History

- Important changes – decrease in corn acreage and an increase in cotton
- Middle 1970's – major crops, roughly in order of acreage
  - corn, soybeans, peanuts, sorghum, tobacco, and vegetables
  - no cotton

LREW Cropping History

Percent of Total Crops

	1995	1996	1997	1998	1999	2000
Cotton	54.1	55.8	59.7	57.1	61.5	64.5
Peanuts	43.6	39.7	36.9	34.8	38.5	34.7
Corn	2.3	4.5	3.4	8.1	0.0	0.7

- While small, vegetable acreage is increasing
- No soybeans grown in the watershed over the past few years

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USDA Conservation Practices

- 1970s
  - terraces on highly erodible land
  - drainage of wet field margins (typically less than 10 acres) through the early 1980s
- 1980s and 1990s
  - continued installation of terraces
  - more emphasis on grass waterways and cover crops
  - Conservation Reserve Program (CRP)

USDA Conservation Practices

- Late 1990s – present
  - nutrient management
  - manure management
  - conservation tillage (cotton)
  - cover crops
  - filter strips
  - farm ponds

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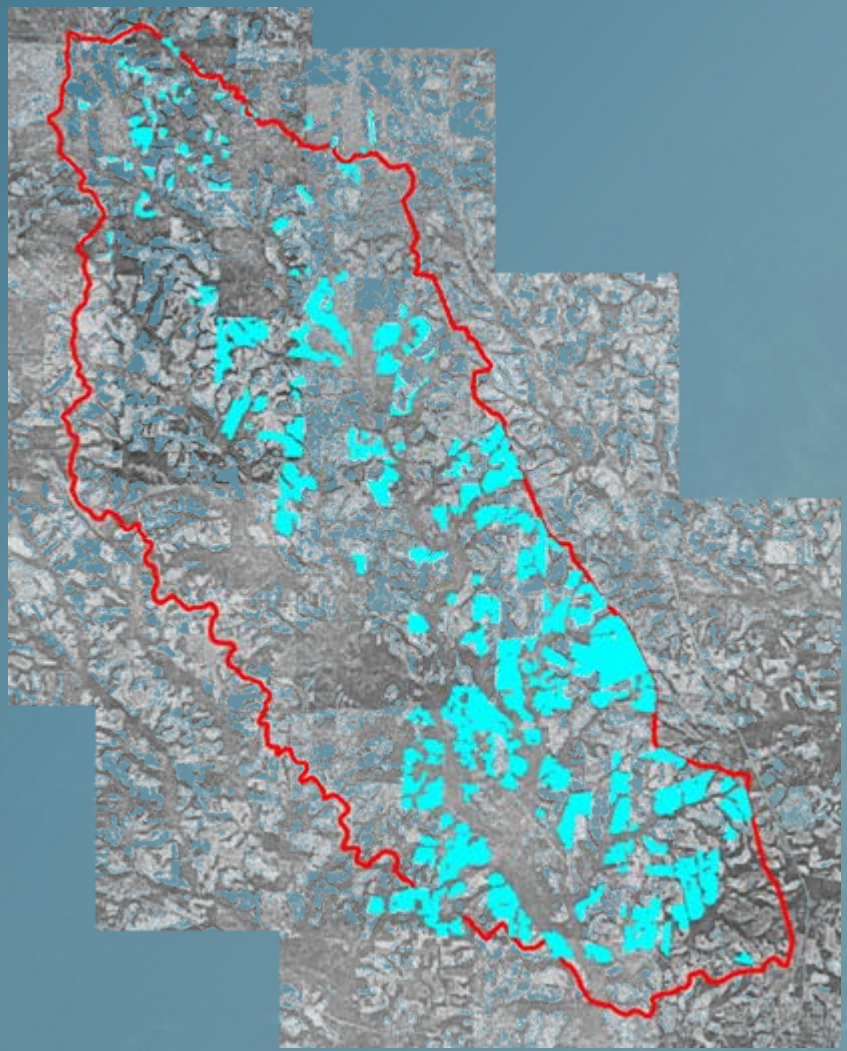
Inventory of Conservation Practices



- Available – historical database within LREW for 1985 - 2005
  - entered into GIS
- Extend record to 1975

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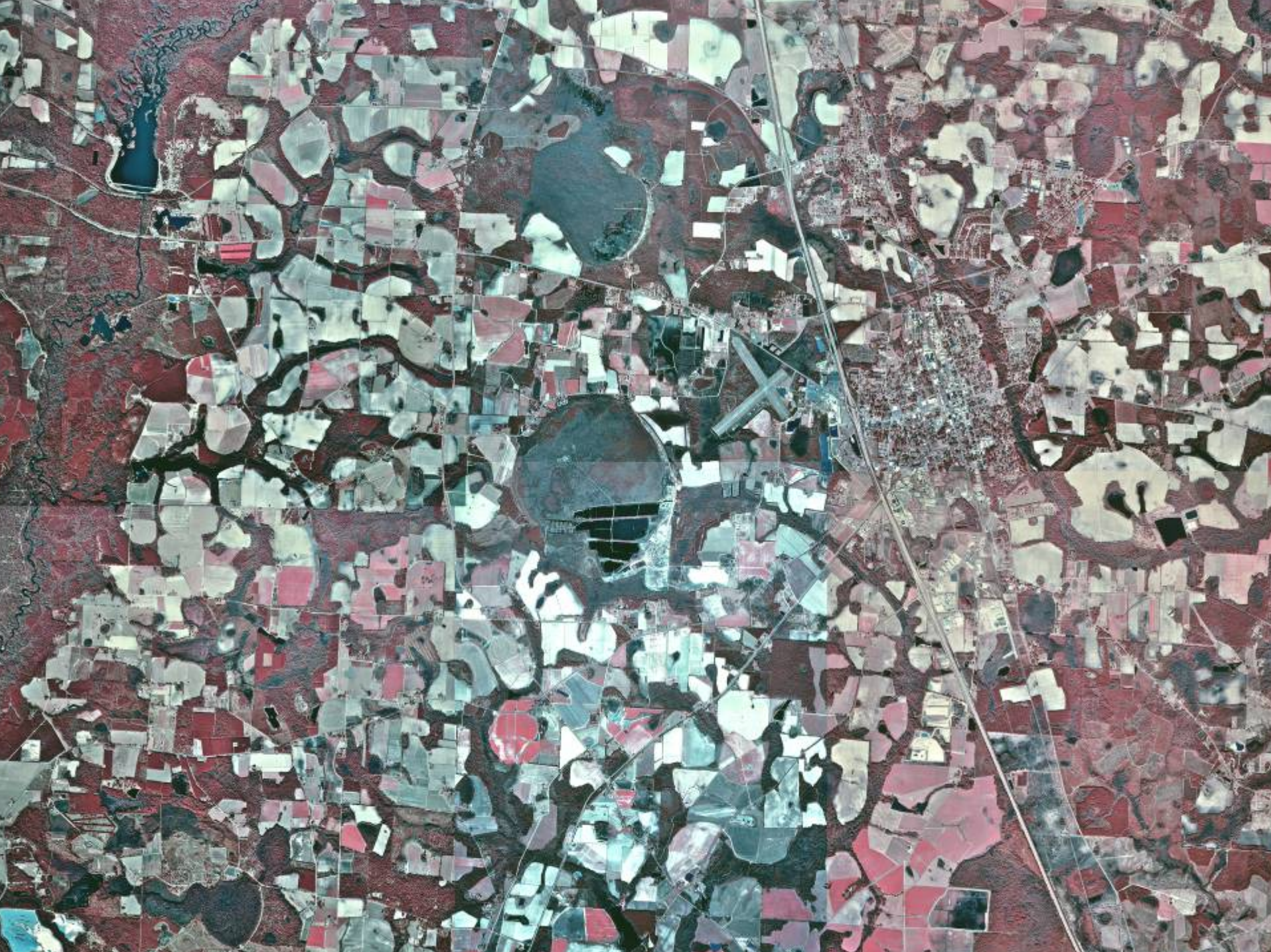
Riparian Forests



Relevant Publications

- Lowrance, R., G. Vellidis, R.D. Wauchope, P. Gay, and D.D. Bosch. 1997. Herbicide transport in a riparian forest buffer system in the coastal plain of Georgia. *Transactions of the ASAE* 40(4):1047-1057.
- Perry, C.D., G. Vellidis, R. Lowrance, and D.L. Thomas. 1999. Watershed-scale water quality impacts of riparian forest management. *J. Water Resour. Plng. and Mgmt.*, ASCE, 125(3):117-125.
- Vellidis, G., R. Lowrance, P. Gay, and R.D. Wauchope. 2002. Herbicide transport in a restored riparian forest buffer system. *Transactions of the ASAE* 45(1):89-97.
- Vellidis G., R. Lowrance, P. Gay, R.W. Hill, and R.K. Hubbard. 2004. Nutrient transport in a restored riparian wetland. *Journal of Environmental Quality* 32(2):711-726.
- Gay, P., G. Vellidis, and J.J. Delfino. 2006. The Attenuation of Atrazine and It's Major Degradation Products in a Forested Riparian Buffer: I. Ground Water and Soils. *Transactions of the* ASABE (in review).
- Gay, P., G. Vellidis, and J.J. Delfino. 2006. The Attenuation of Atrazine and It's Major Degradation Products in a Forested Riparian Buffer: II. Surface Runoff Water. *Transactions of the* ASABE (in review).

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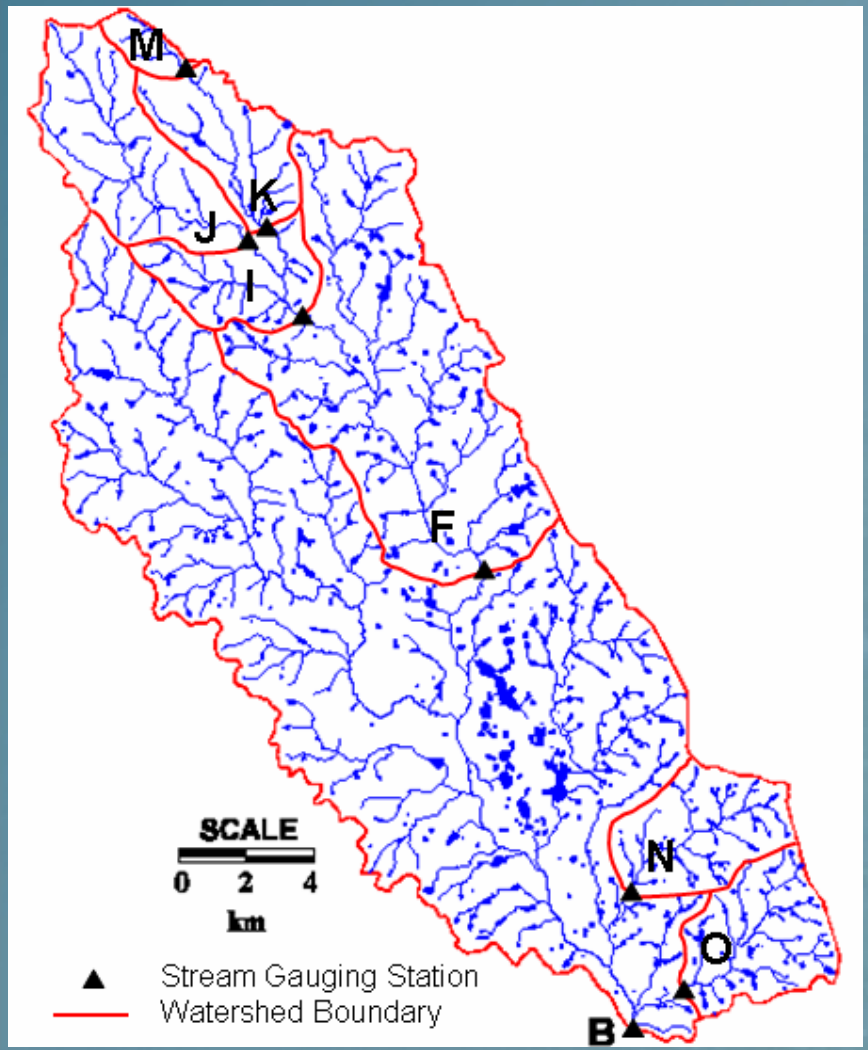
Nutrient Retention by a Forested Riparian Buffer

Position	Water (m^3/year)	Nutrients (kg/year)						
		NO_3-N	NH_4-N	TKN	TN	Cl	PO_4-P	TP
Original Total Entering	28,875	30.71	16.40	108.42	139.13	315.1	12.01	20.97
Original Total Leaving	22,125	5.15	5.99	38.73	43.88	240.2	3.23	5.41
Difference (In – Out)	4,430	25.55	10.41	69.69	95.25	75.16	8.77	15.56
Percent Retention	15.34	83.22	63.47	64.28	68.46	23.8	73.06	74.21
Total Leaving	29,047	6.77	7.86	50.84	57.61	315.4	4.25	7.10
Difference	-172	23.94	8.53	57.58	81.52	0.0	7.76	13.87
Percent Retention	-0.60	77.97	52.04	53.11	58.59	0.0	64.64	66.14

Vellidis G., R. Lowrance, P. Gay, R.W. Hill, and R.K. Hubbard. 2004. Nutrient transport in a restored riparian wetland. *Journal of Environmental Quality* 32(2):711-726.

Hydrology & Water Quality



- 8 nested watersheds with v-notch weirs
- 334 km^2 (82,500 ac) at Station B
- continuous hydrologic record since 1974
- mostly continuous water quality record since 1974

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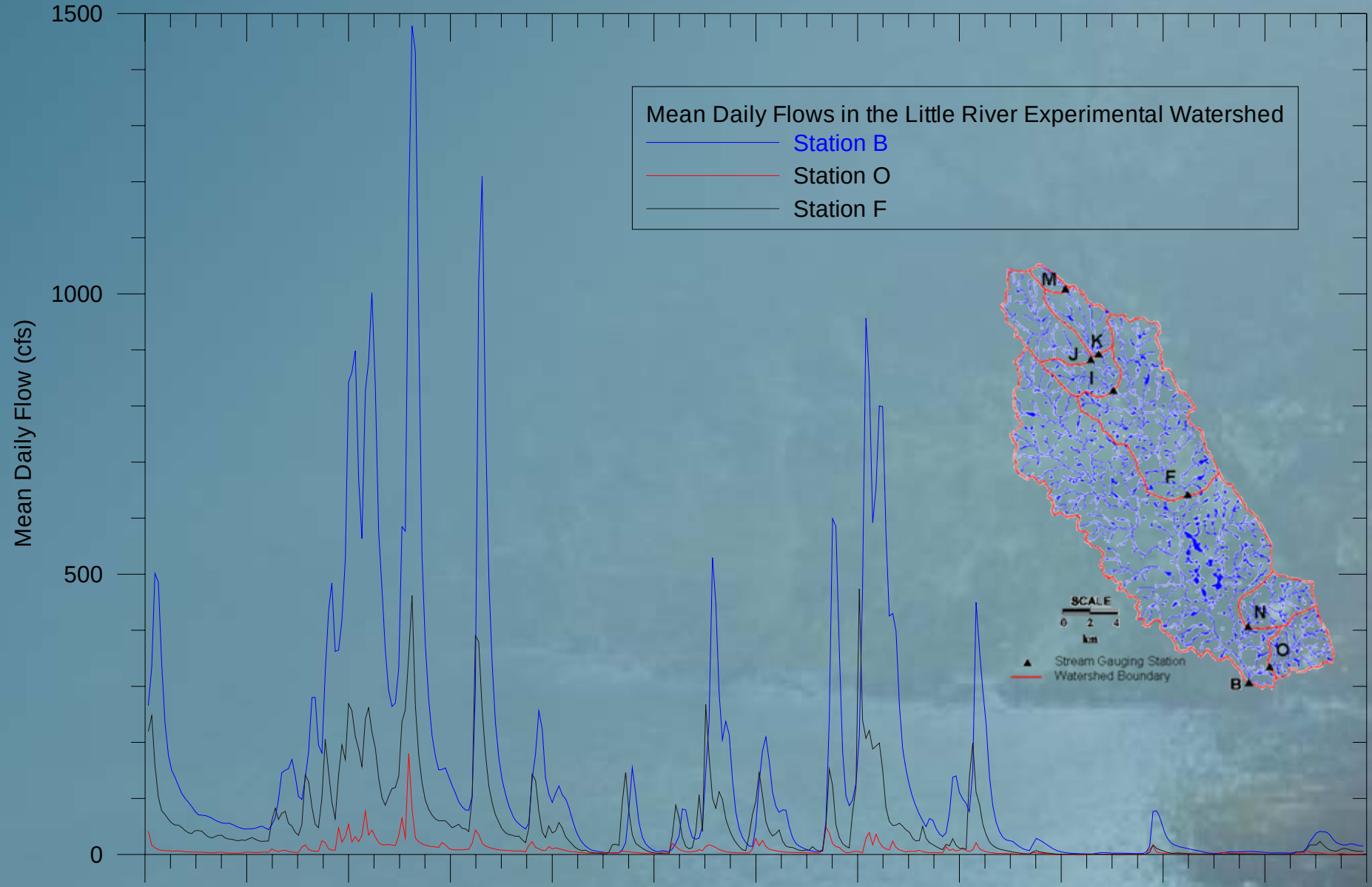
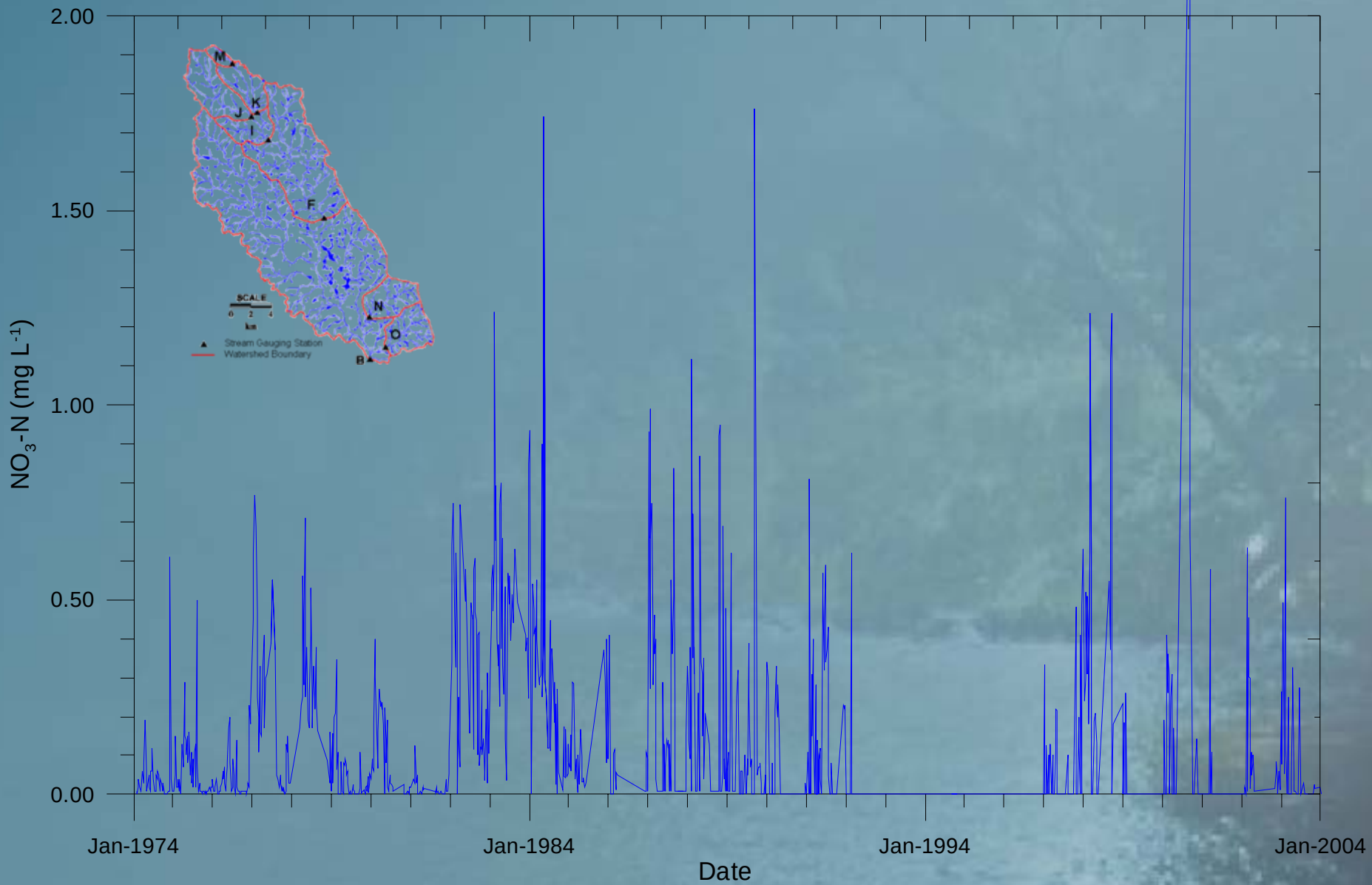
30-Year Hydrologic & Water Quality Record

Sample Date	Sample Type	Flow Depth (mm)	Flow (m^3)	Cl Conc (mg/L)	Cl Load (kg)	NH4-N Conc (mg/L)	NH4-N Load (kg)	NO3-N Conc (mg/L)	NO3-N Load (kg)	Tot-N Conc (mg/L)	Tot-N Load (kg)	Tot-P Conc (mg/L)	Tot-P Load (kg)	OrthoP Conc (mg/L)	OrthoP Load (kg)	Remarks
5/5/2003	AFCR	1.626	545141	7.3	3974	0.02	10.9	0.01	4.9	0.88	479.2	0.40	217.0	0.01	5.5	
5/5/2003	AFCR	1.016	335364	7.3	2445	0.02	6.7	0.01	3.0	0.88	294.8	0.40	133.5	0.01	3.4	
5/5/2003	AFCR	0.787	264754	7.3	1930	0.02	5.3	0.01	2.4	0.88	232.7	0.40	105.4	0.01	2.6	
5/5/2003	AFCR	0.686	227442	7.3	1658	0.02	4.5	0.01	2.0	0.88	199.9	0.40	90.5	0.01	2.3	
5/5/2003	AFCR	0.787	266613	7.3	1944	0.02	5.3	0.01	2.4	0.88	234.4	0.40	106.1	0.01	2.7	
5/5/2003	AFCR	0.889	298909	7.3	2179	0.02	6.0	0.01	2.7	0.88	262.7	0.40	119.0	0.01	3.0	
5/5/2003	AFCR	0.787	261084	7.3	1903	0.02	5.2	0.01	2.3	0.88	229.5	0.40	103.9	0.01	2.6	
5/14/2003	AFCR	0.737	242611	11.9	2875	0.05	12.1	0.01	1.9	0.25	60.9	0.38	92.4	0.03	7.3	
5/14/2003	AFCR	0.610	206278	11.9	2444	0.05	10.3	0.01	1.7	0.25	51.8	0.38	78.6	0.03	6.2	
5/14/2003	AFCR	0.457	151840	11.9	1799	0.05	7.6	0.01	1.2	0.25	38.1	0.38	57.9	0.03	4.6	
5/14/2003	AFCR	0.330	107482	11.9	1274	0.05	5.4	0.01	0.9	0.25	27.0	0.38	41.0	0.03	3.2	
5/14/2003	AFCR	0.229	77706	11.9	921	0.05	3.9	0.01	0.6	0.25	19.5	0.38	29.6	0.03	2.3	
5/14/2003	AFCR	0.152	53509	11.9	634	0.05	2.7	0.01	0.4	0.25	13.4	0.38	20.4	0.03	1.6	
5/14/2003	AFCR	0.102	36602	11.9	434	0.05	1.8	0.01	0.3	0.25	9.2	0.38	13.9	0.03	1.1	
5/14/2003	AFCR	0.076	25323	11.9	300	0.05	1.3	0.01	0.2	0.25	6.4	0.38	9.6	0.03	0.8	
5/14/2003	AFCR	0.051	18497	11.9	219	0.05	0.9	0.01	0.1	0.25	4.6	0.38	7.0	0.03	0.6	
5/27/2003	AFCR	0.051	15145	12.7	192	0.07	1.1	0.00	0.0	1.12	17.0	0.37	5.6	0.02	0.3	
5/27/2003	AFCR	0.051	13090	12.7	166	0.07	0.9	0.00	0.0	1.12	14.7	0.37	4.8	0.02	0.3	
5/27/2003	AFCR	0.025	10912	12.7	139	0.07	0.8	0.00	0.0	1.12	12.2	0.37	4.0	0.02	0.2	
5/27/2003	AFCR	0.025	8490	12.7	108	0.07	0.6	0.00	0.0	1.12	9.5	0.37	3.1	0.02	0.2	
5/27/2003	AFCR	0.025	6997	12.7	89	0.07	0.5	0.00	0.0	1.12	7.8	0.37	2.6	0.02	0.1	
5/27/2003	AFCR	0.025	7267	12.7	92	0.07	0.5	0.00	0.0	1.12	8.1	0.37	2.7	0.02	0.1	
5/27/2003	AFCR	0.025	6802	12.7	86	0.07	0.5	0.00	0.0	1.12	7.6	0.37	2.5	0.02	0.1	
5/27/2003	AFCR	0.025	7218	12.7	92	0.07	0.5	0.00	0.0	1.12	8.1	0.37	2.6	0.02	0.1	
5/27/2003	AFCR	0.051	20992	12.7	267	0.07	1.5	0.00	0.0	1.12	23.5	0.37	7.7	0.02	0.4	
5/27/2003	AFCR	0.152	52236	12.7	663	0.07	3.7	0.00	0.1	1.12	58.5	0.37	19.2	0.02	1.0	
5/27/2003	AFCR	0.610	200798	12.7	2550	0.07	14.1	0.00	0.4	1.12	224.9	0.37	73.7	0.02	4.0	
5/27/2003	AFCR	1.143	379258	12.7	4817	0.07	26.5	0.00	0.8	1.12	424.8	0.37	139.2	0.02	7.6	
5/27/2003	AFCR	0.787	265830	12.7	3376	0.07	18.6	0.00	0.5	1.12	297.7	0.37	97.6	0.02	5.3	

1-Year Hydrologic Record at B, F, O



30-Year NO_3-N Concentrations at Station B



Hypothesis – Nitrogen

- Establishment of trees (under CRP) on highly erodible crop land led to a change in N transport from LREW with larger decreases for watersheds with higher levels of tree establishment.

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Hypotheses – Nitrogen

- Establishment of trees (under CRP) on highly erodible crop land led to a change in N transport from LREW with larger decreases for watersheds with higher levels of tree establishment.

- Decrease in corn and increase in cotton production led to decreases in N transport from LREW.

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Hypothesis – Buffers

- Riparian forest buffers left voluntarily by farmers have a larger positive impact on water quality than some practices installed under USDA cost-share programs.

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Hypotheses – Buffers

- Riparian forest buffers left voluntarily by farmers have a larger positive impact on water quality than some practices installed under USDA cost-share programs.
- Farmers have left RFBs for a wide variety of reasons.

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Implementation

- Assess water quality effects of conservation practices at multiple temporal and spatial scales in LREW
- Provide a geographic prioritization for future implementation in the watershed and similar watersheds
- Cumulative Effects Analysis

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Cumulative Effects Analysis (CEA)

- **Recommended by the President's Council on Environmental Quality (CEQ)**

> ***"CEA allows analysts to determine the cumulative environmental consequences of actions by delineating the cause-and-effect relationships between multiple actions and the resources, ecosystems, and human communities of concern."***
>
> **(CEQ, 1997)**

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CEA → Conceptual Model

- **Build a Conceptual Model to:**
  - **determine the cumulative water quality consequences of conservation practices**

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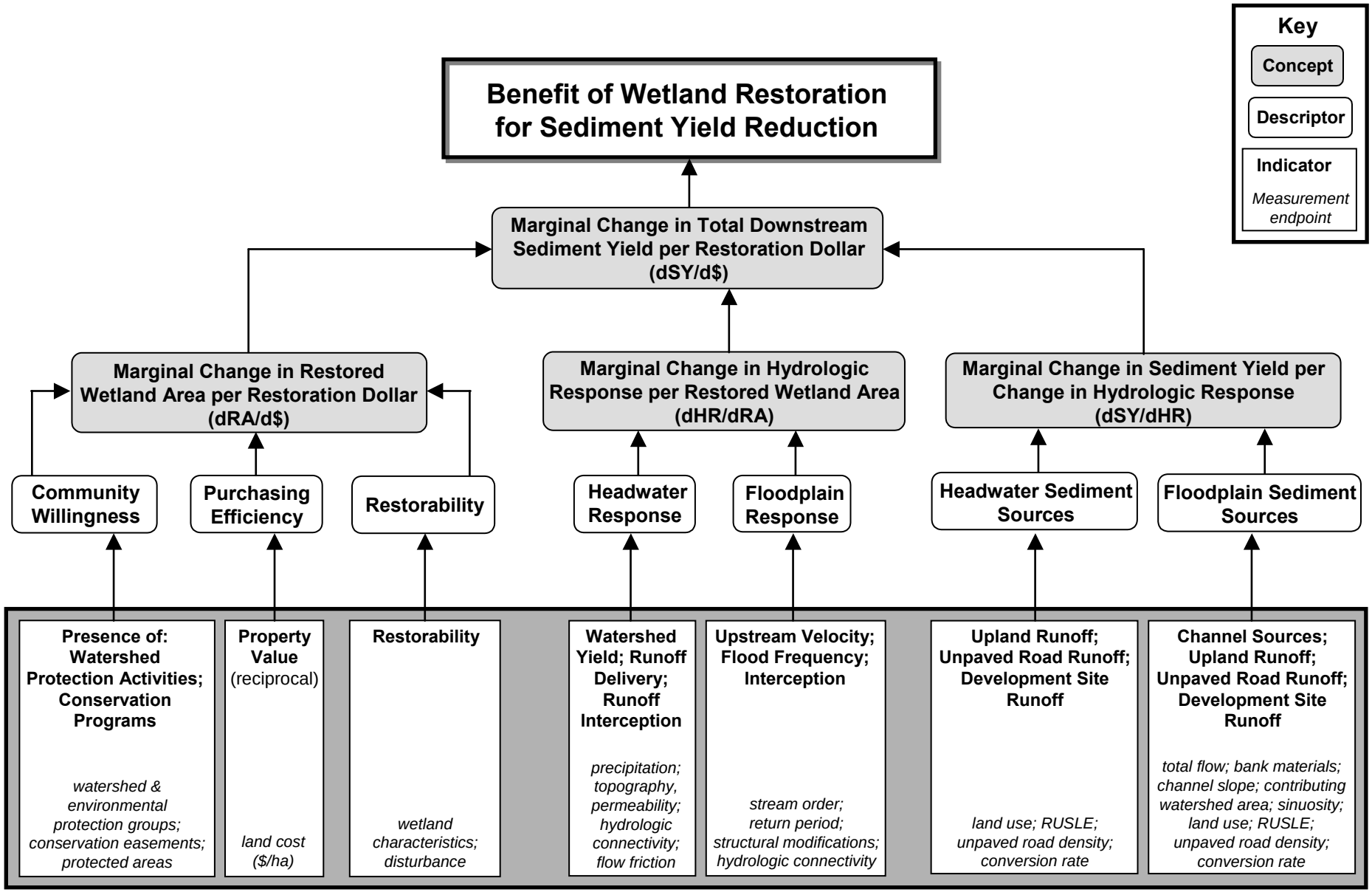
Wetland Restoration for Sediment Yield Reduction: A Conceptual Model



Vellidis et al., 2003. Prioritizing wetland restoration for sediment yield reduction: A conceptual model. *Environmental Management* 31(2):301-312.

Develop Conceptual Model

- Accumulate relevant information
- Panel of Experts
  - biophysical interactions in coastal plain watersheds
  - socioeconomic factors influencing the adoption, implementation, and maintenance of conservation practices

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Implement Conceptual Model

- STELLA – process model
  - www.iseesystems.com
- GIS to aggregate and visualize
- SWAT and REMM to test findings
- Recruiting Post-Doc

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Thank you for your attention !!

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