Using synthesized data to quantify surface water-groundwater relationships at Madison Blue Spring and the Withlacoochee River of North Florida

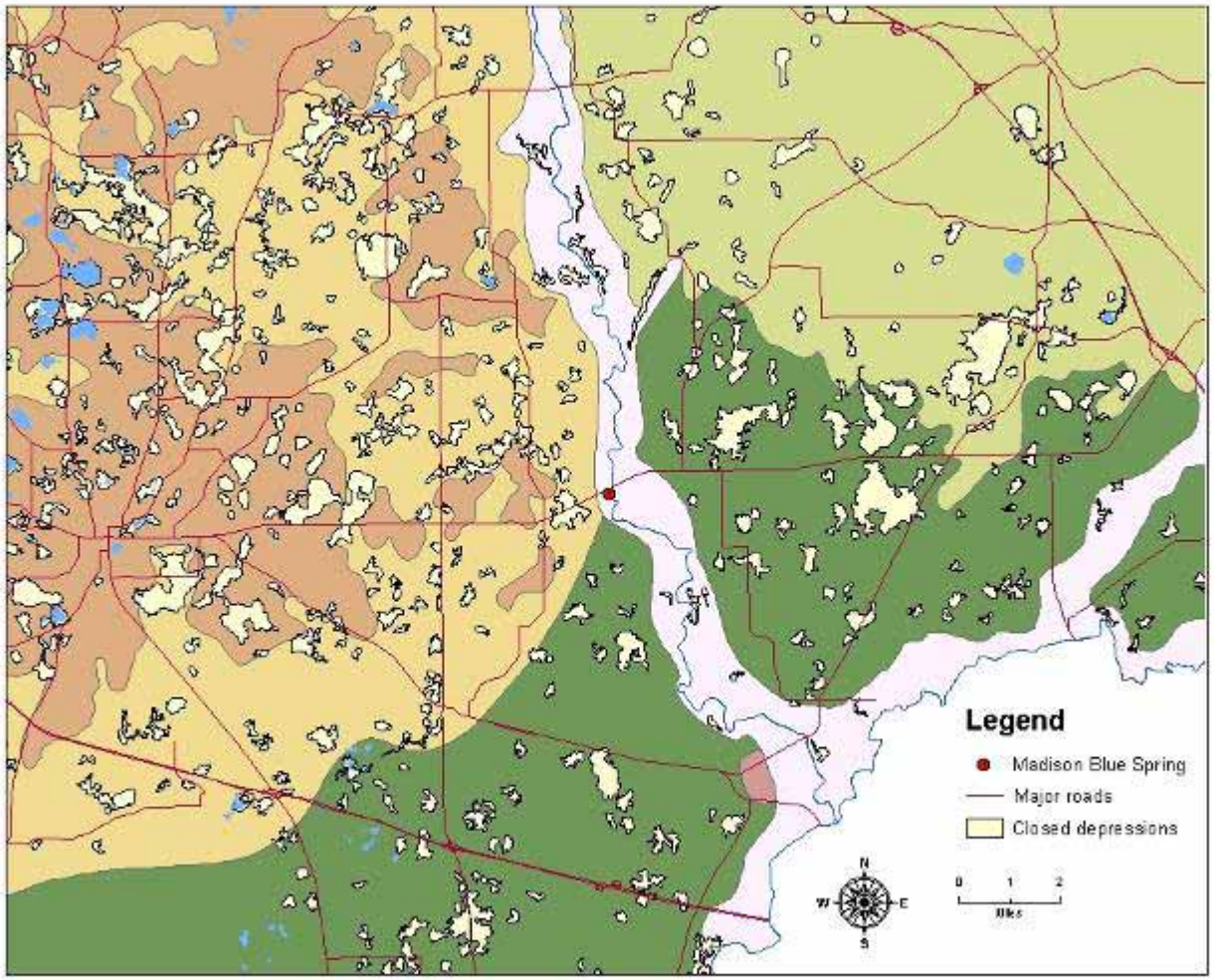
J.C. Schneider, S.B. Upchurch, K.M. Champion, J.C. Good, and D. Hornsby

Madison Blue Spring

- First magnitude spring on Withlacoochee river
- MFL focused on springs contribution to flow in river
- Complicating factors
  - MBS is an estavelle
  - Very little data

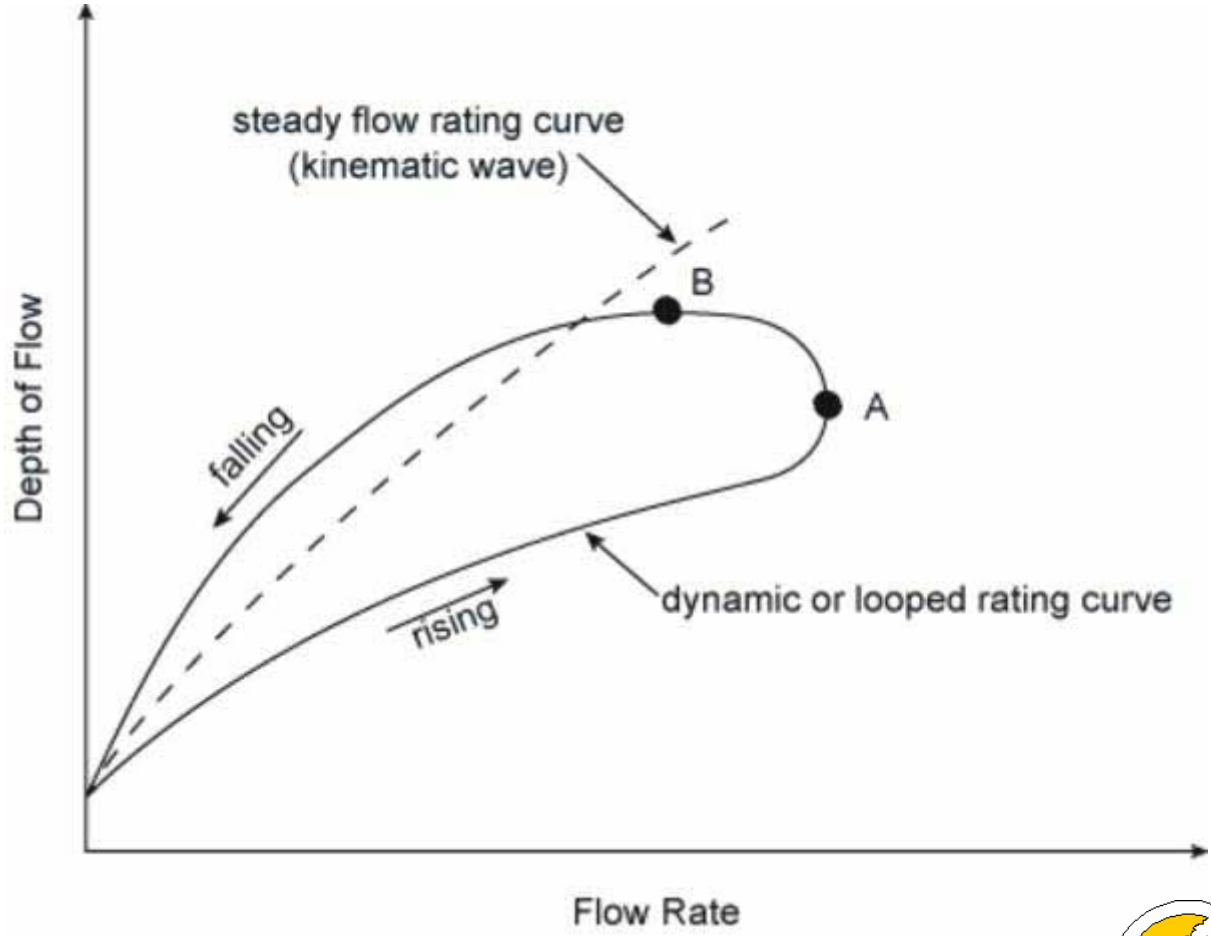
Surface water-groundwater interactions

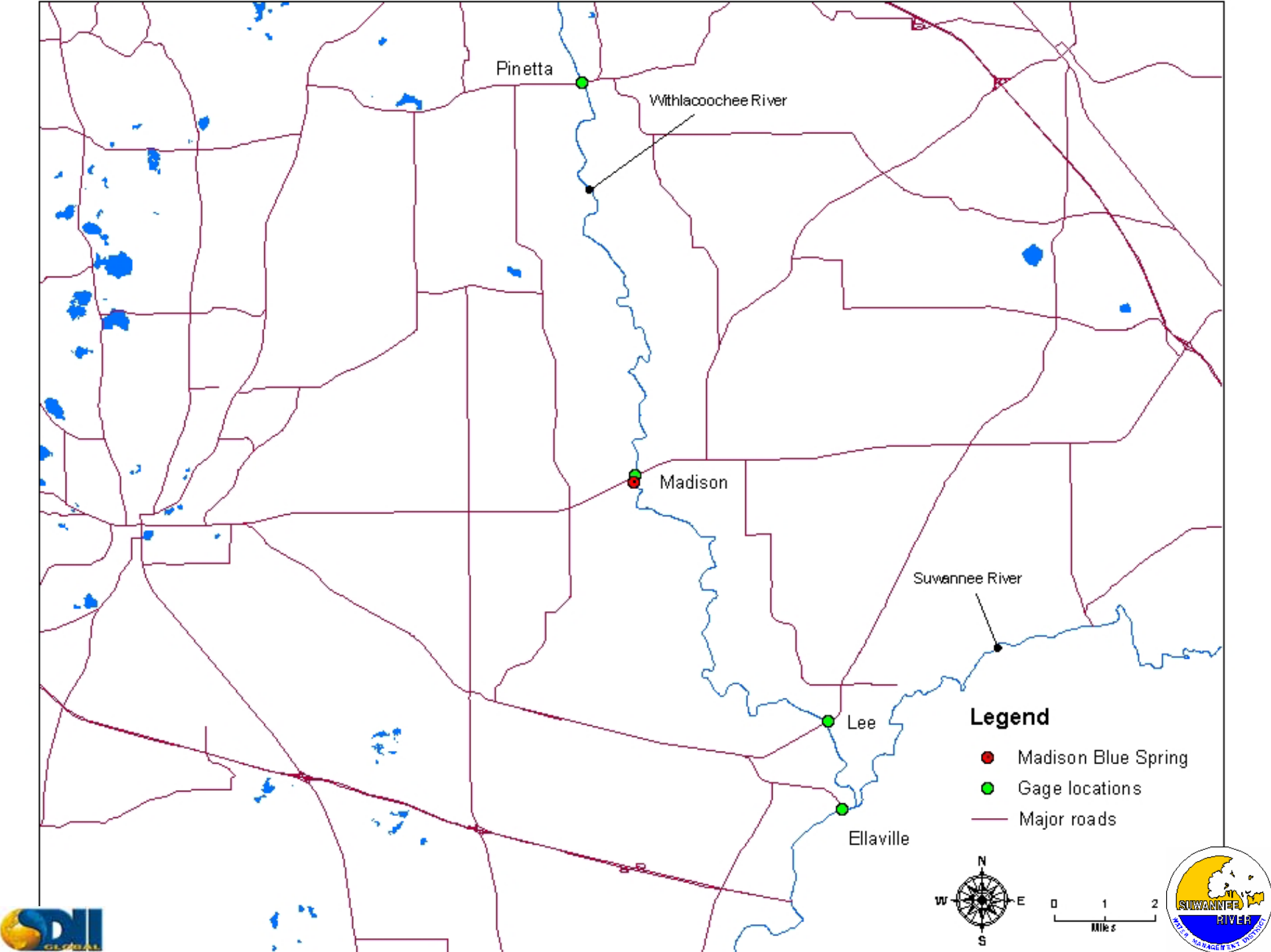
- Well developed karst terrain
- River flows along Ocala Limestone
- Essentially all inflow is through ground



Backwater Conditions

- Floods are larger and longer on the Suwannee River (larger basin)
- Creates a hysteresis curve for stage-discharge data from gauges on Withlacoochee River




Pinetta
Withlacoochee River
Madison
Suwannee River
Lee
Ellaville
Legend
Madison Blue Spring
Gage locations
Major roads
N
W
E
S
0
1
2
Miles
SUWANNEE RIVER
WATER MANAGEMENT DISTRICT

Summary of River and Spring Gauge Data

Station	Period of Record	Basin Size (mi^2)	Number of stage readings		Number of discharge readings	
			Measured values	Daily Values	Measured Values	Daily Values
Madison Blue Spring	03/16/32-07/31/03	--------	--------	352	22	210
Withlacoochee River near Pinetta	12/11/31-08/25/03	2120	N/A	26081	N/A	25930
Withlacoochee River near Madison	04/11/60-03/25/98	2240	486	--------	10	--------
Withlacoochee River near Lee	11/01/00-8/24/03	2330	19	1021	19	1027
Suwannee River at Ellaville	02/01/27-08/25/03	6970	N/A	27589	N/A	27966

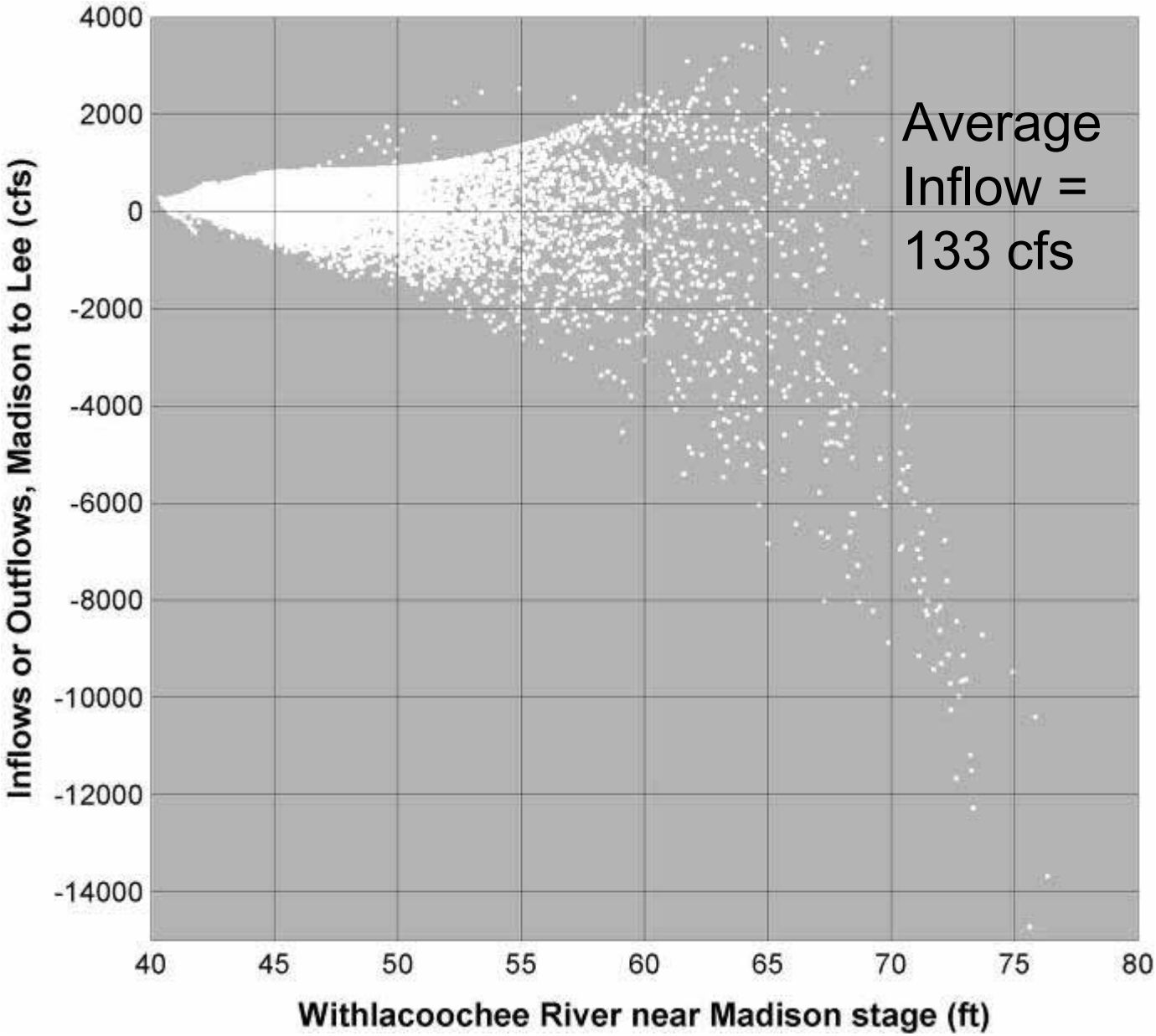
Simulating Lee and Madison Gauge Data

- Step-wise, multiple linear regressions to simulate stage data
  - $Lee_{Stage} = -7.053 + 0.195Pinetta_{Stage} + 0.887Ellaville_{Stage}$
  - $Madison_{Stage} = -3.198 + 0.588Pinetta_{Stage} + 0.428Lee_{Stage}$
- Develop Stage-Fall-Discharge rating for each gauge
- Result: 70+ years of simulated stage-discharge data for Madison and Lee gauges

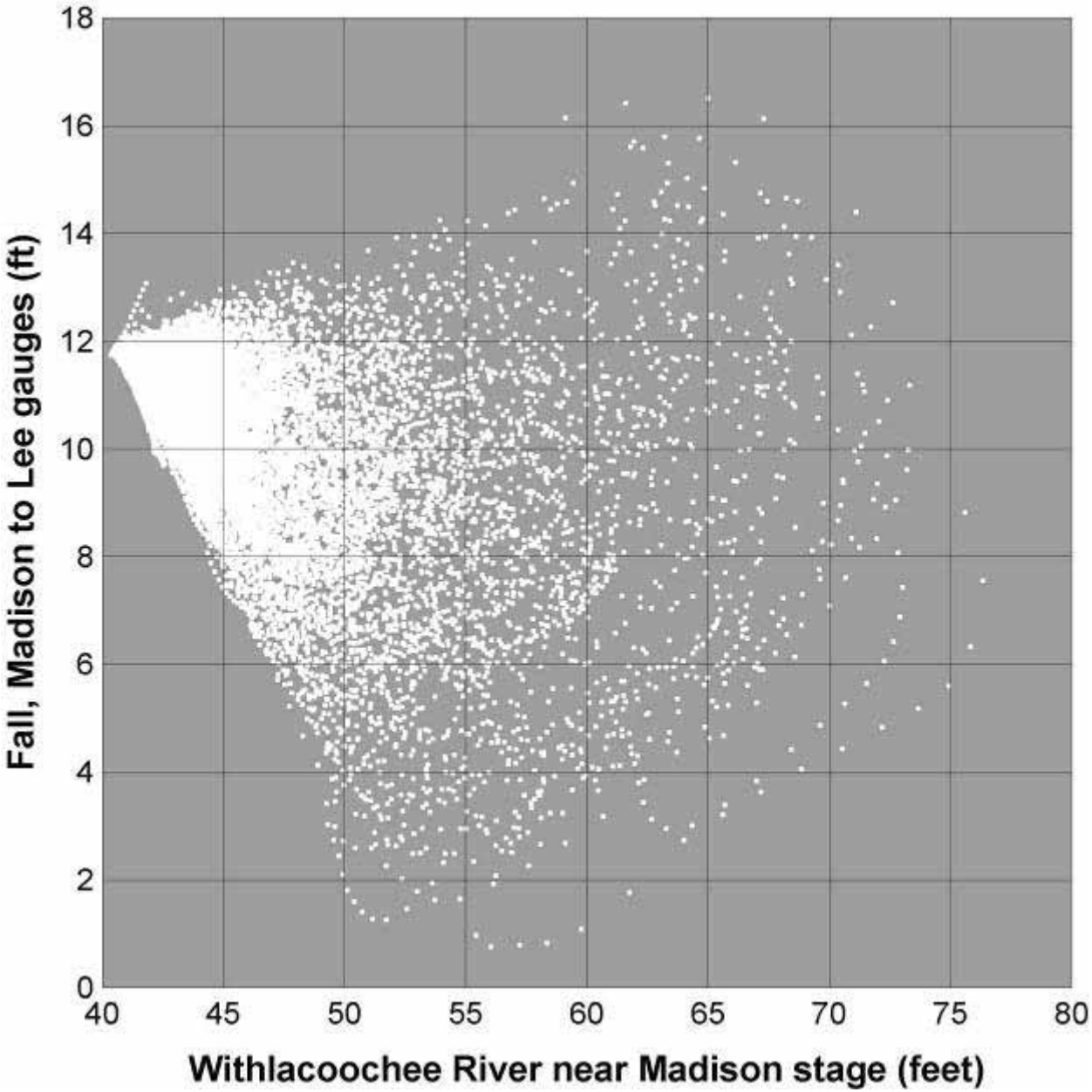
With simulated Madison and Lee data we can examine the relationships between:

- Discharge and/or stage
- Inflows/outflows
- Fall or backwater conditions

Inflows vs. Stage

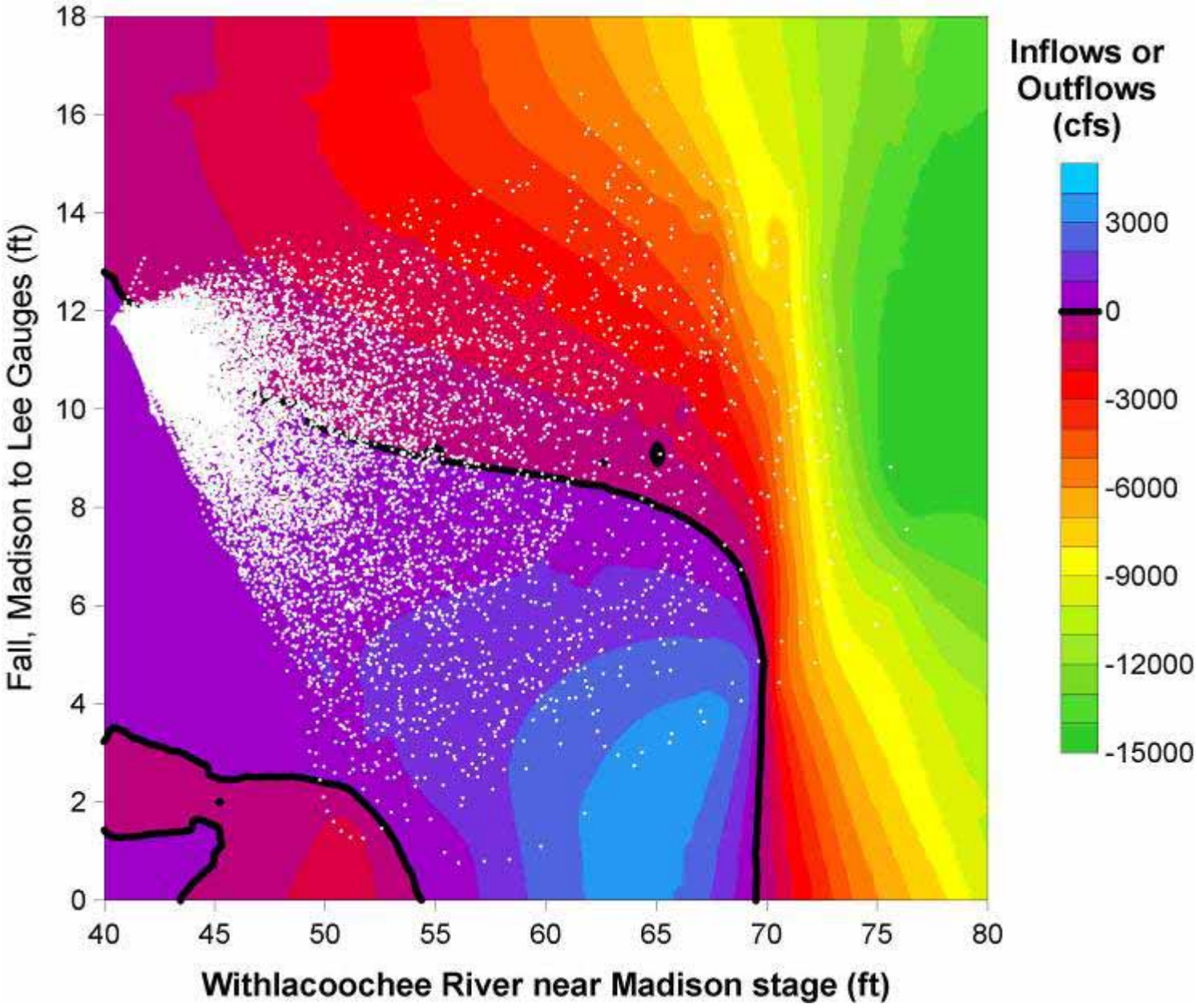


Fall vs. Stage

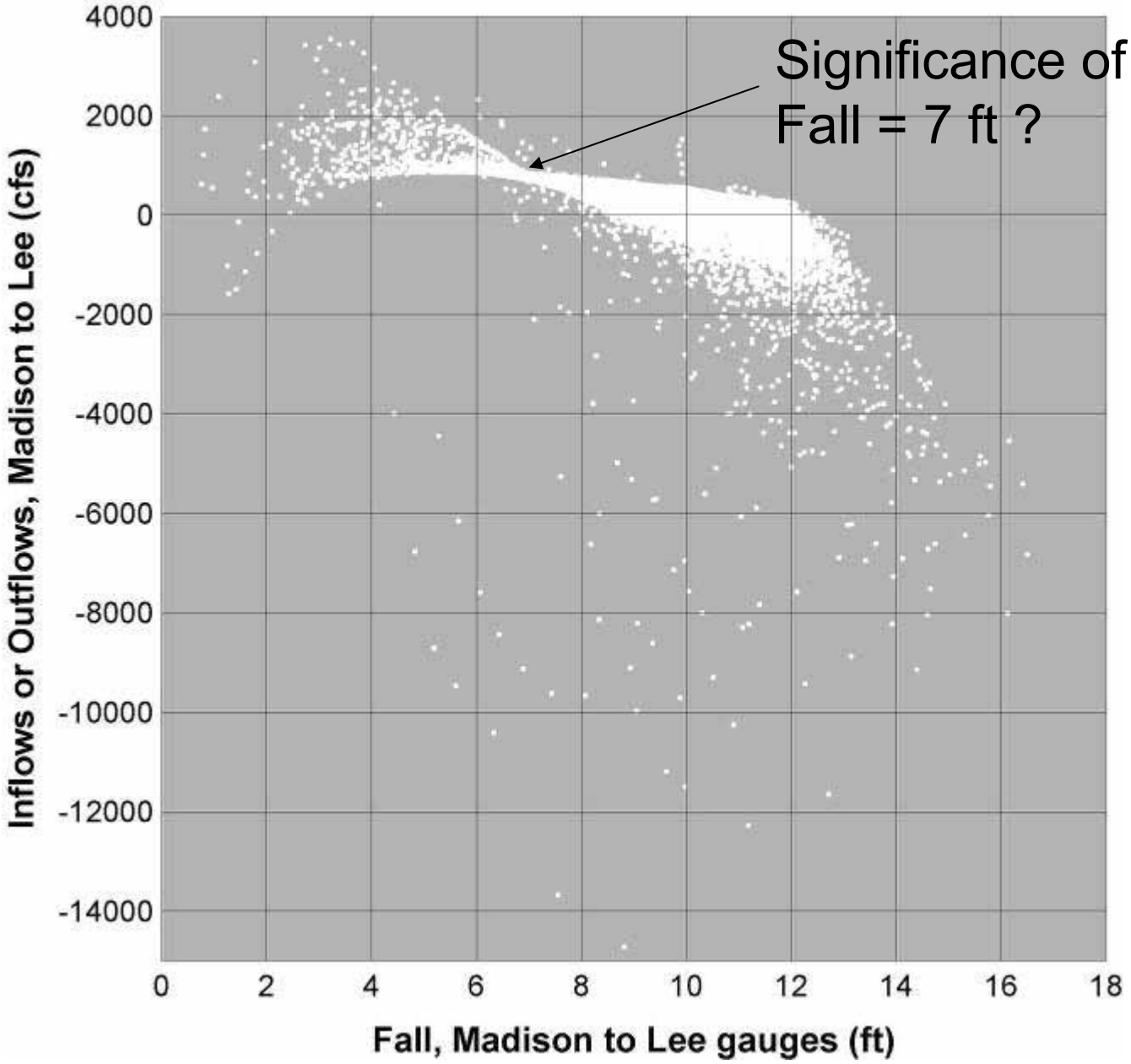


Average Fall = 10.6 ft

Fall vs. Stage vs. Inflows

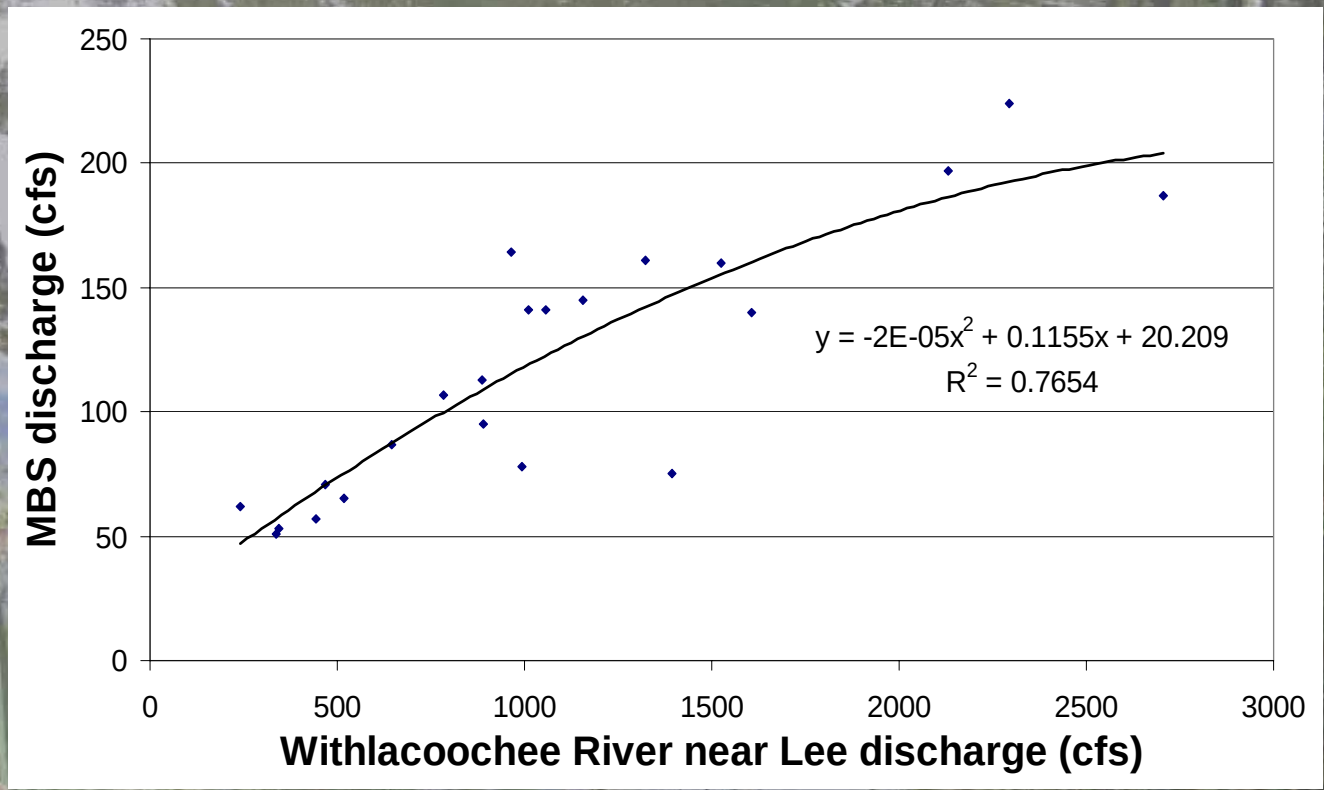


Inflows vs. Fall



Synthesizing Data for Madison Blue Spring

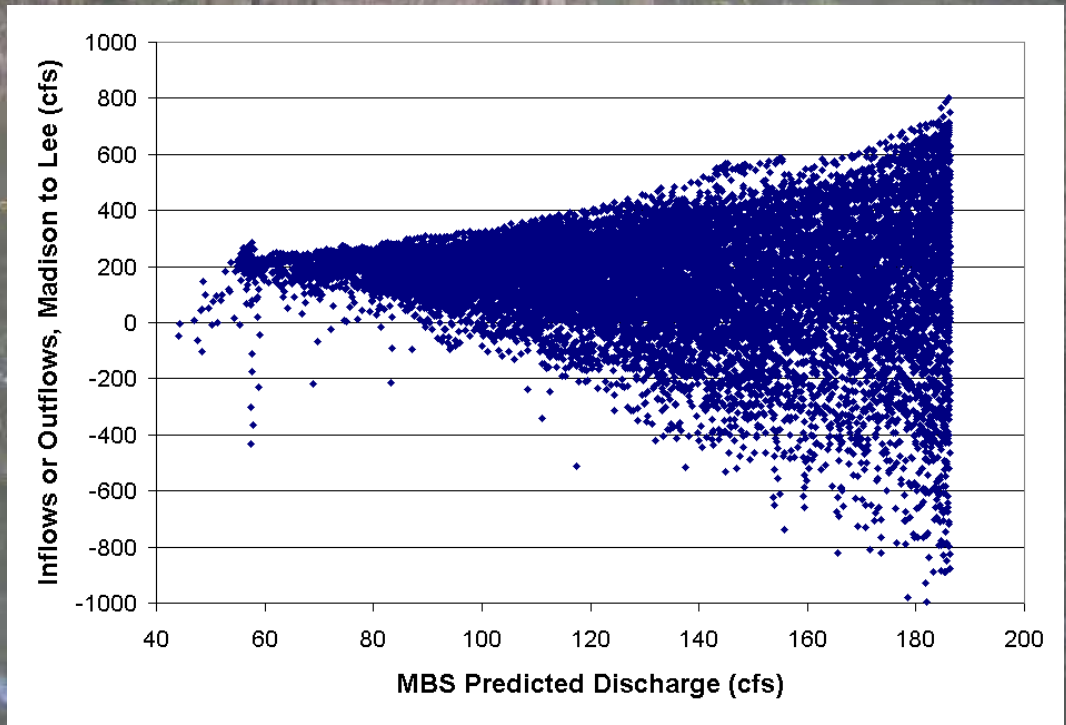
- Is there a relationship between the flow in the Withlacoochee River and the discharge of Madison Blue Spring?
- Yes, but….



Synthesizing Data for Madison Blue Spring

- When we plot the calculated spring discharge versus the total inflows or outflows to the river …

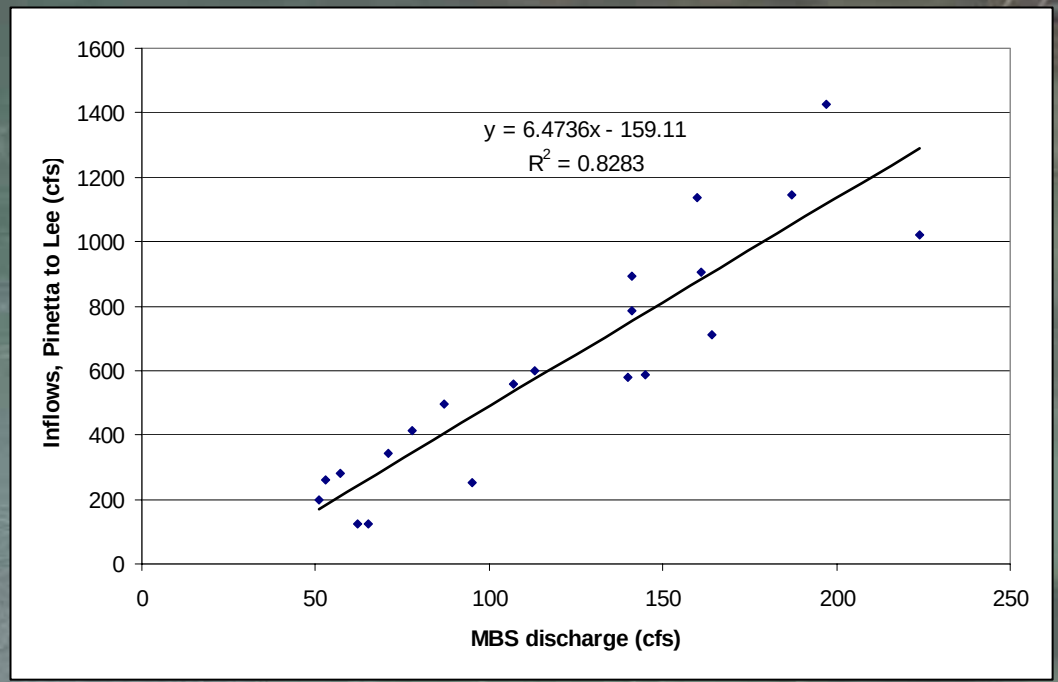
- Not accounting for times when river discharge is controlled by backwater conditions



Synthesizing Data for Madison Blue Spring

- Is there a relationship between total inflows to the Withlacoochee River and discharge at Madison Blue Spring?

- Yes, there is a linear relationship
- Using this relationship, a period of record for Madison Blue Spring was synthesized



Summary and Conclusions

- Simulated period of record for Madison and Lee gauges.
- The backwater effect on the Withlacoochee River controls the relationship between stage/discharge and inflows/outflows.
- A relationship between spring discharge and river discharge does not account for this backwater effect.
- Simulated period of record for spring discharge as a linear function of inflows/outflows to the river.