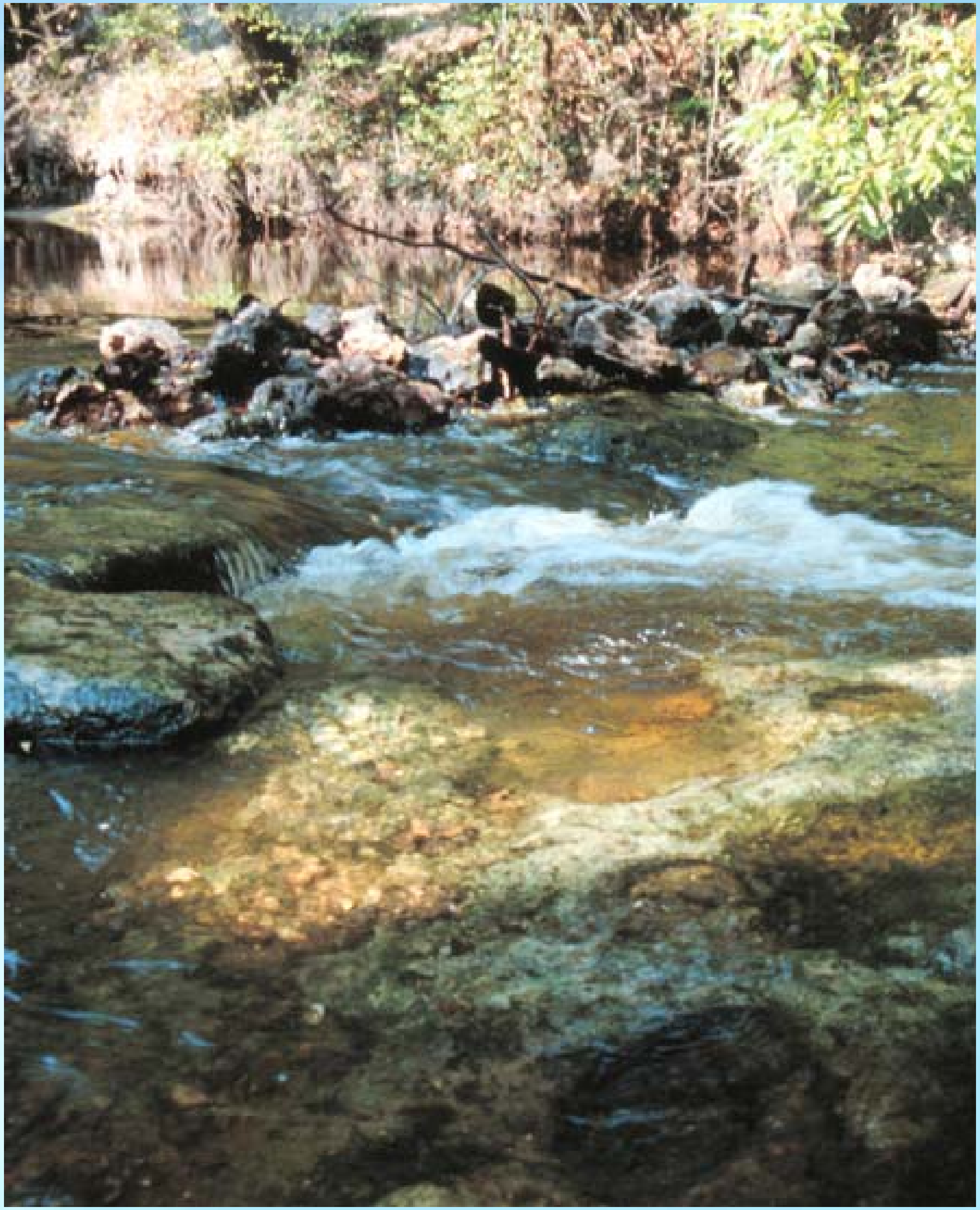


Development of MFLs on Freshwater River Segments with Emphasis on Alafia River

Presentation to NTB II LTPRG

Keystone Civic Center
February 2, 2005

Approach

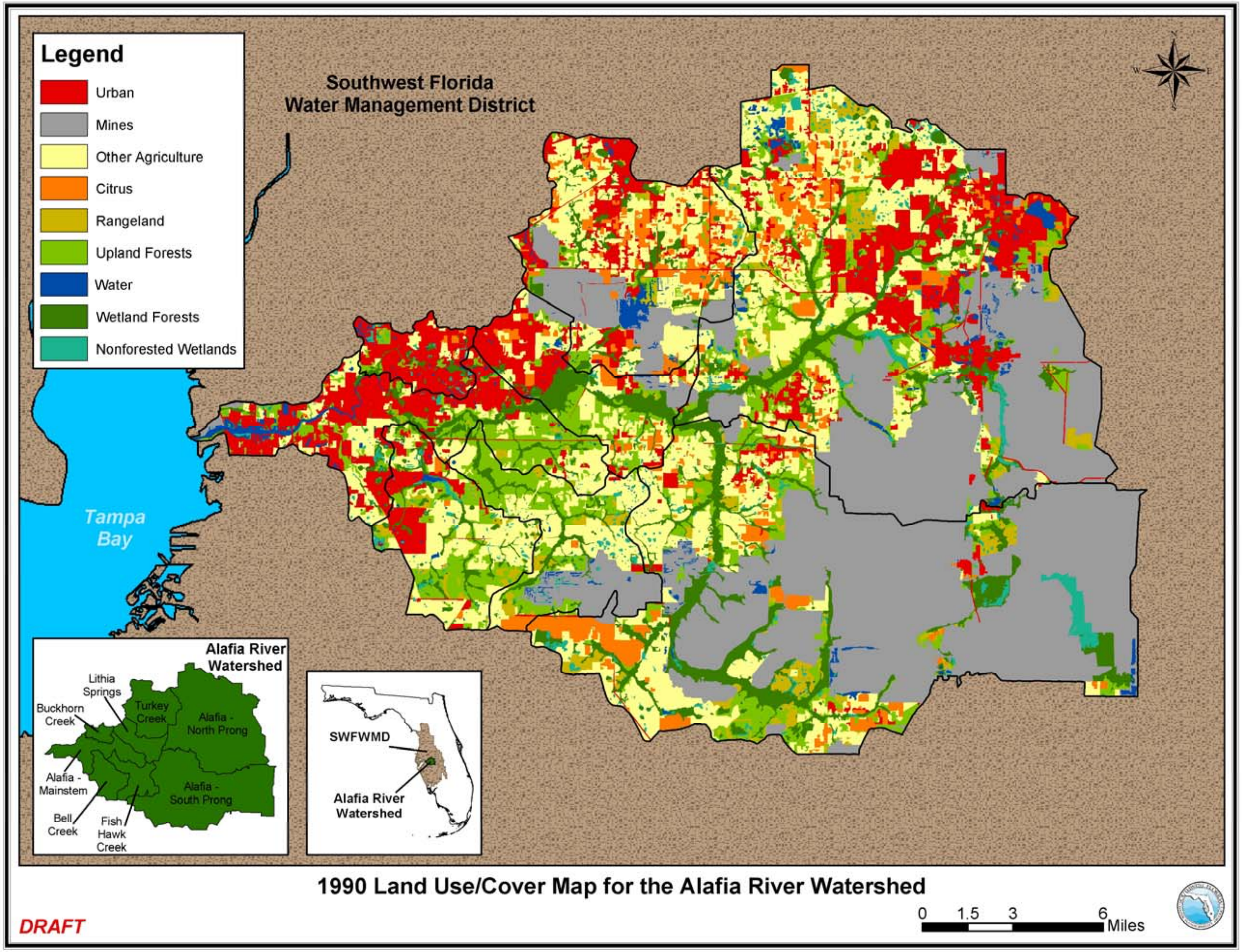
- Flow Regime versus Minimum Flow
- Benchmark Period
- Building Block Approach
- Flow Prescription

Tools

- HEC-RAS
- PHABSIM
- RALPH Analysis
- Prescribed Flow Hydrograph

Application / Examples

- Block 1
  - Low Flow Threshold (LFT) – aka. “minimum flow”
  - Physical Habitat Simulation (PHABSIM) – fish and macroinvertebrate habitat suitability curves
- Block 2
  - LFT
  - PHABSIM
  - Woody Habitat – Analysis of Recent and Longterm Positional Hydrographs (RALPH Analysis)
- Block 3
  - LFT
  - Floodplain Inundation – RALPH Analysis

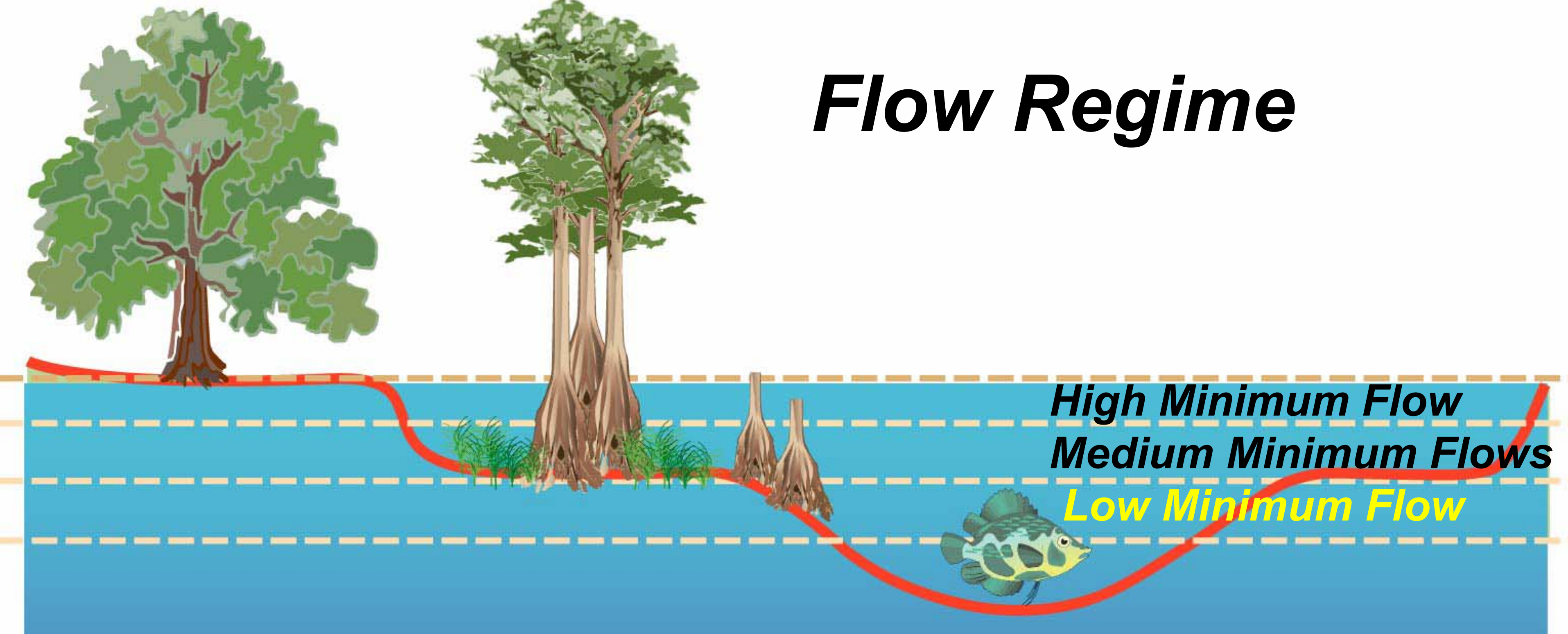


1990 Land Use/Cover Map for the Alafia River Watershed

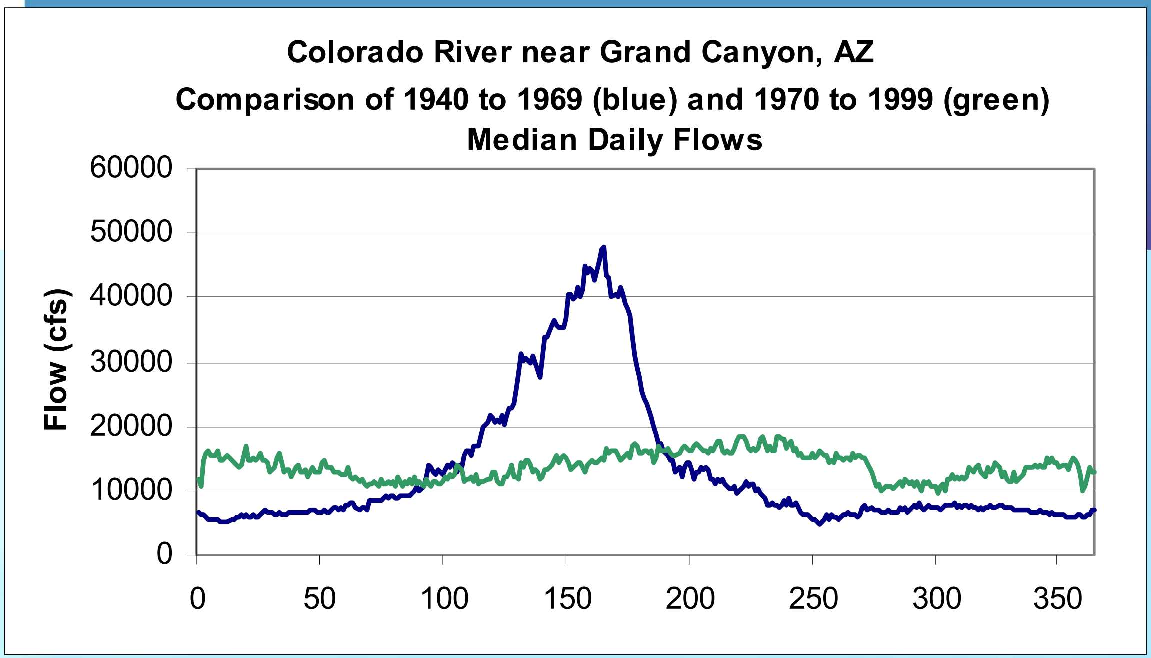
Approach

- Flow Regime versus Minimum Flow
- Benchmark Period
- Building Blocks
- Flow Prescription

Flow Regime



High Minimum Flow
Medium Minimum Flows
Low Minimum Flow



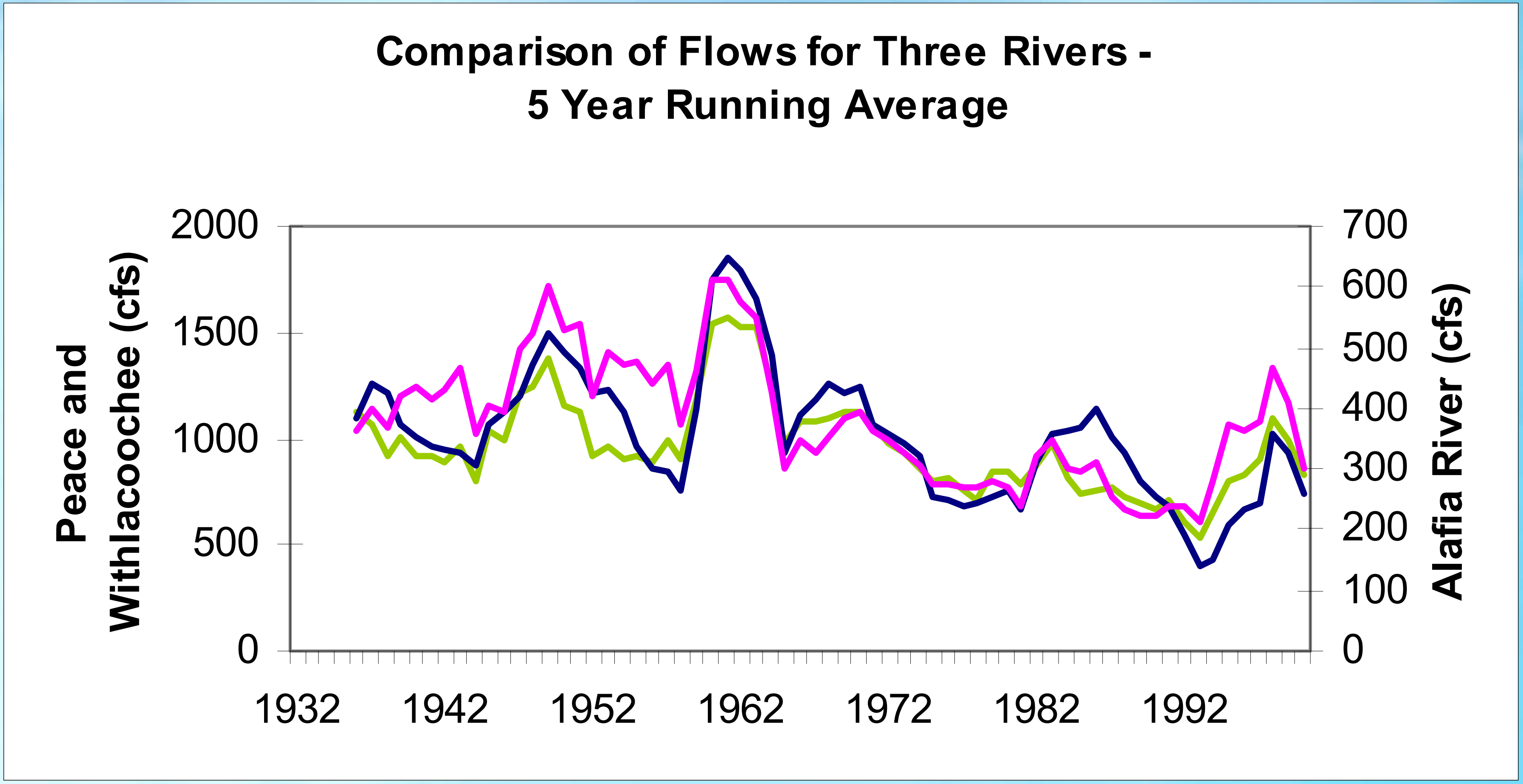
Colorado River near Grand Canyon, AZ
Comparison of 1940 to 1969 (blue) and 1970 to 1999 (green)
Median Daily Flows
Flow (cfs)
60000
50000
40000
30000
20000
10000
0
0
50
100
150
200
250
300
350

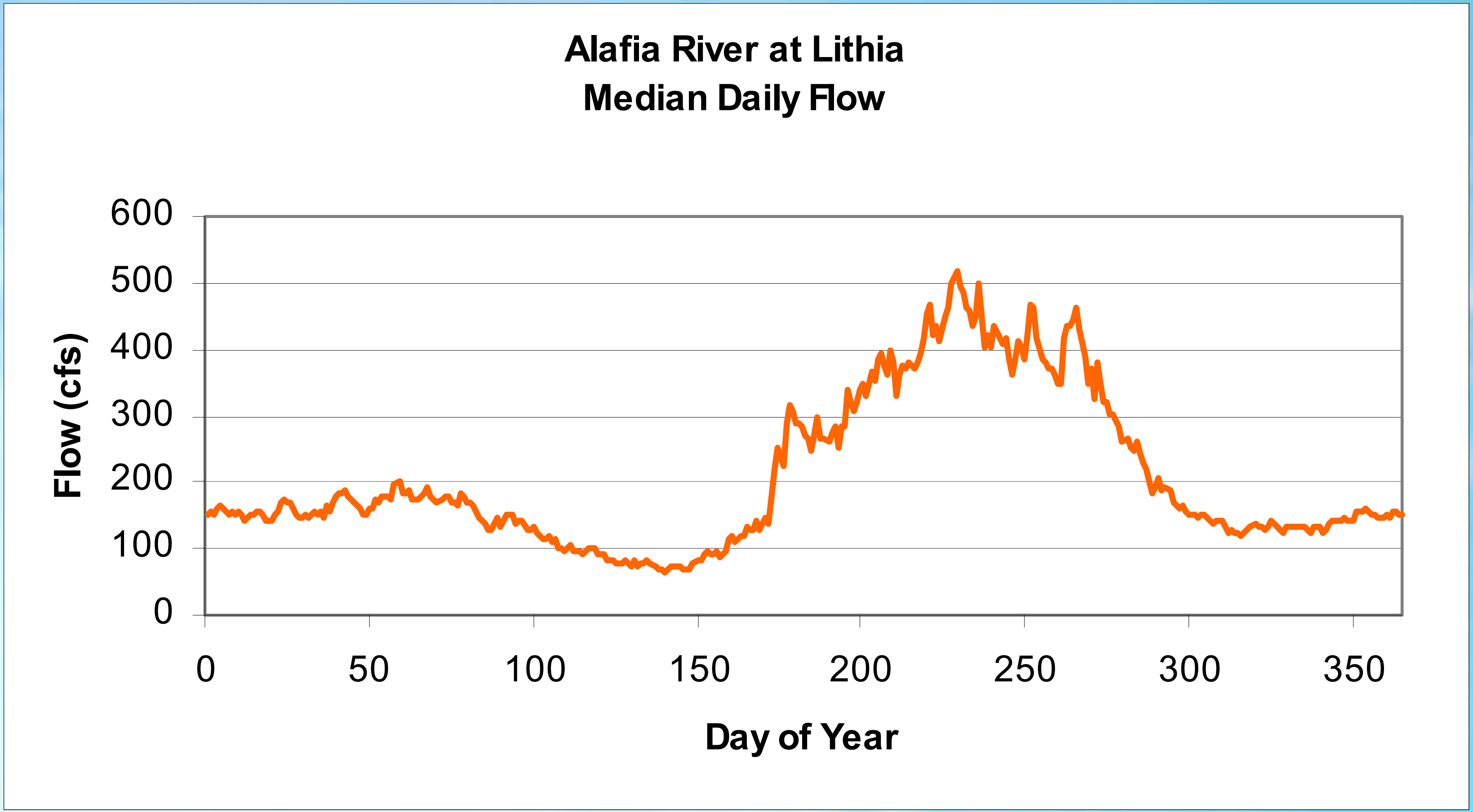
Minimum Flows and Levels

Components of an MFL (from Beecher 1990)

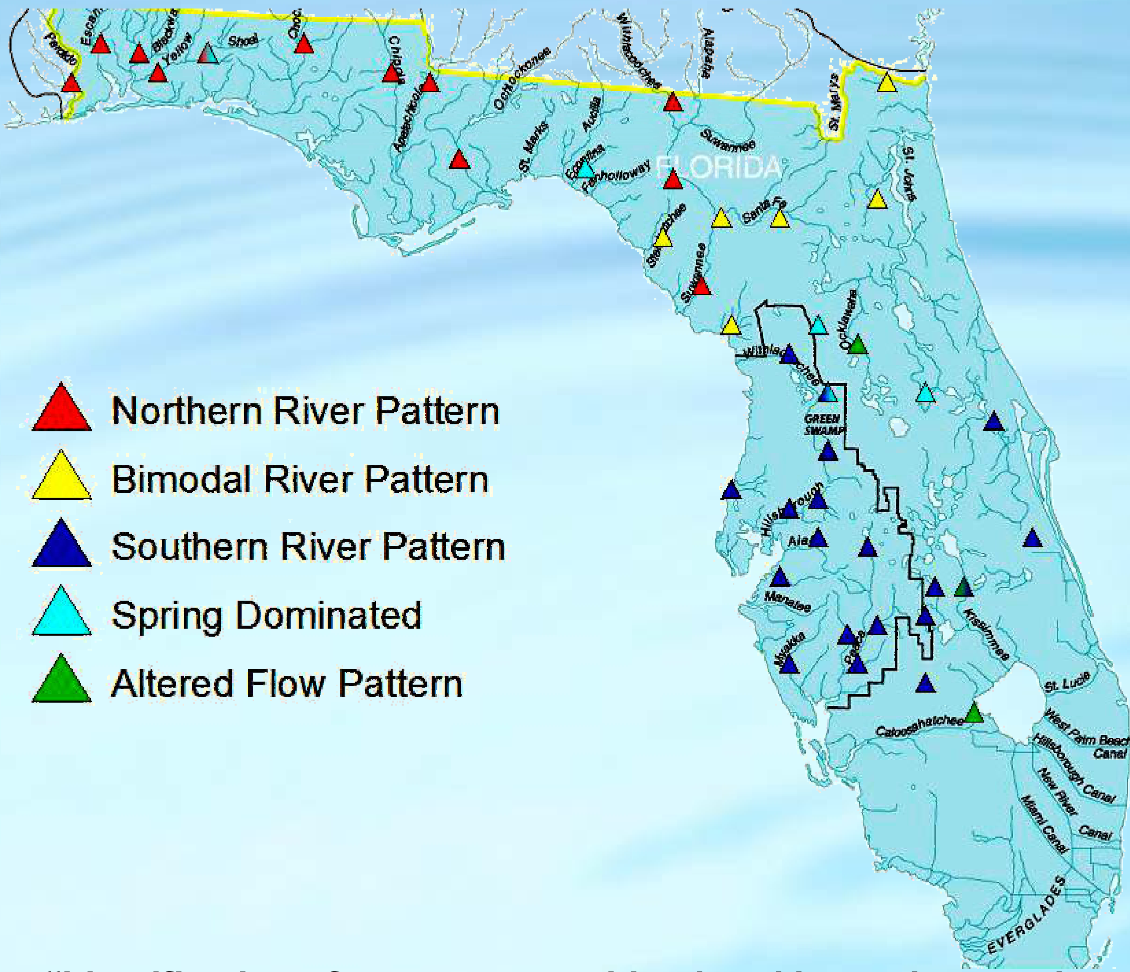
1. a goal – (e.g., non-degradation or, for the District’s purpose, protection from significant harm
2. identification of resources of interest to be protected
3. a unit of measure (e.g., flow in cfs, habitat in useable area, etc.)
4. **a benchmark period**, and
5. a protection standard statistic.

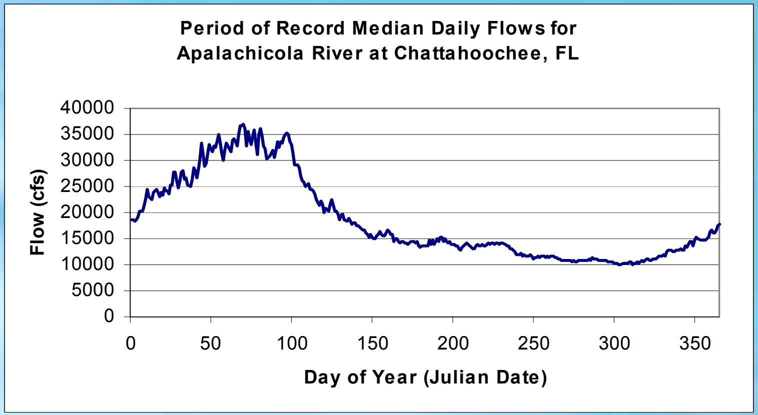
Moore's Observation

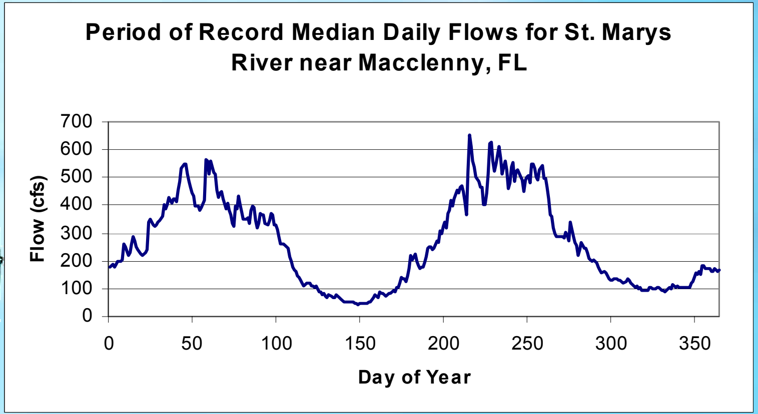


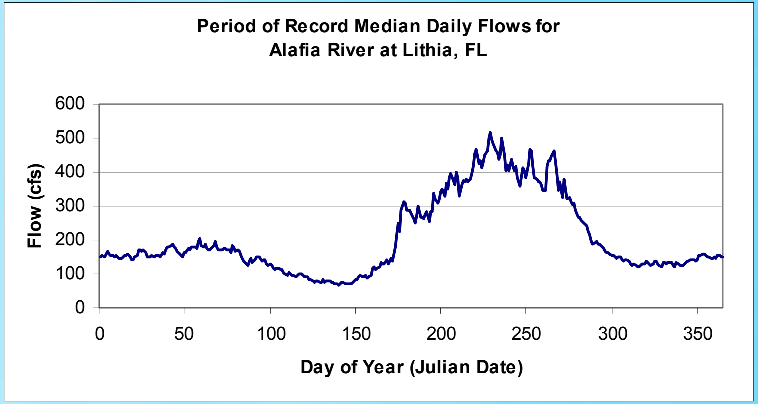


"Depicting long-term annual streamflow hydrograph patterns using the Medium Daily Flow (MDQ) plots is a sound and particularly illuminating approach for demonstrating spatial and temporal patterns of the type discussed in this report" - Shaw et al. 2004



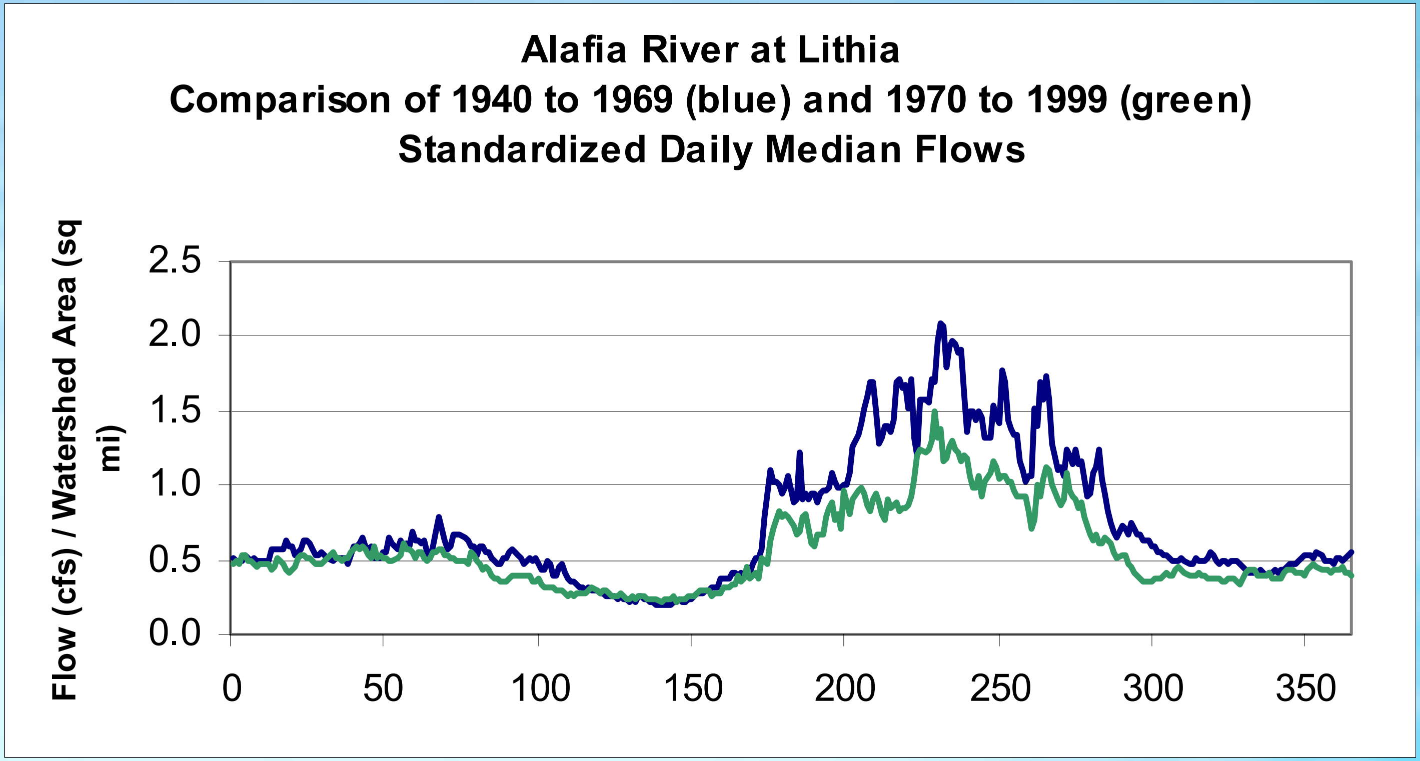






"Identification of a narrow transition band in north central Florida where a bimodal MDQ pattern is found is a striking find. Although the 'bimodality' of certain rivers in the region (e.g., the Santa Fe) is well known, the existence of a spatially explicit transition zone between the northern (temperate) and southern (subtropical) flow patterns has not been previously identified to our knowledge."

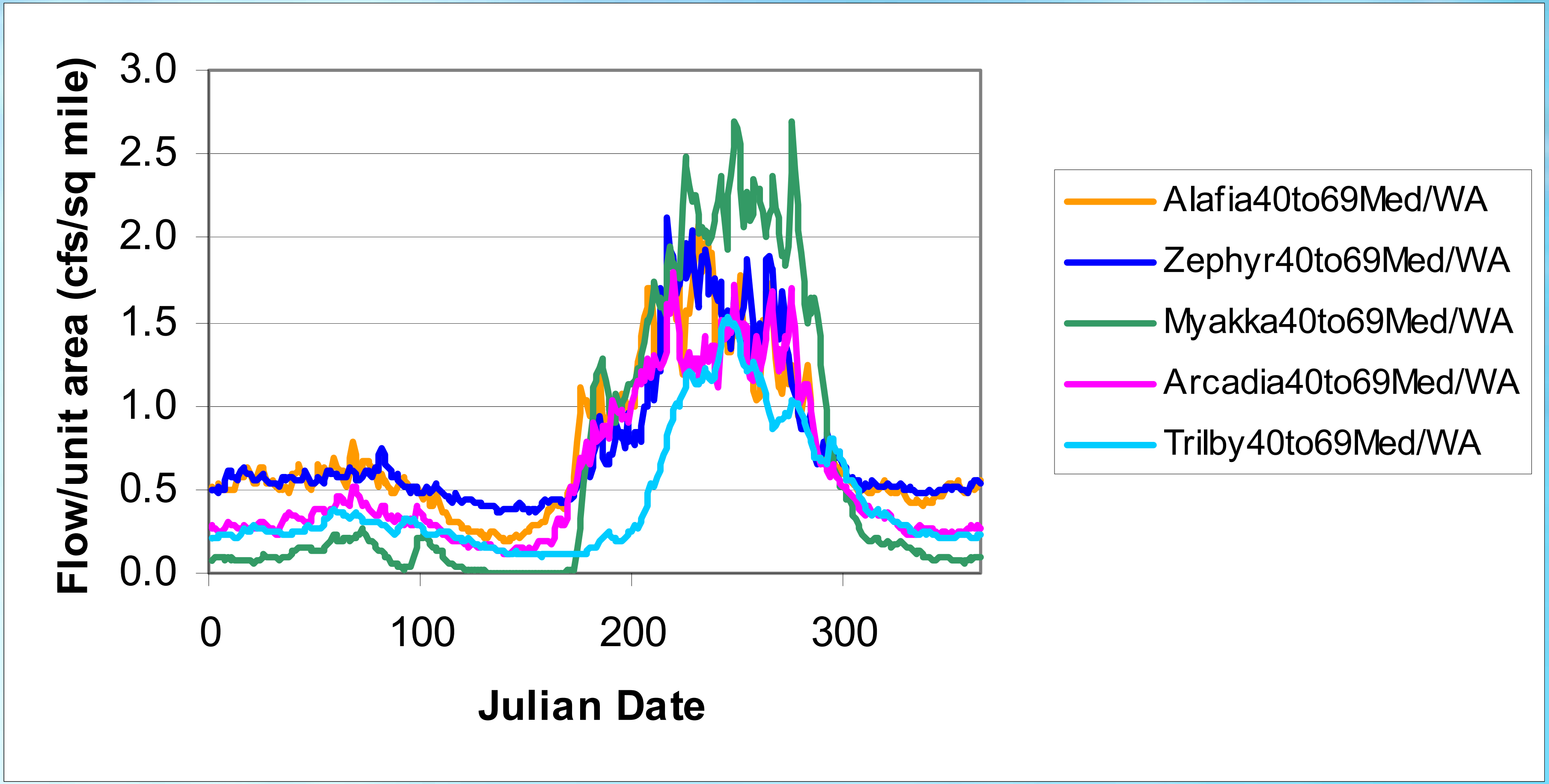
- Shaw et al. 2004



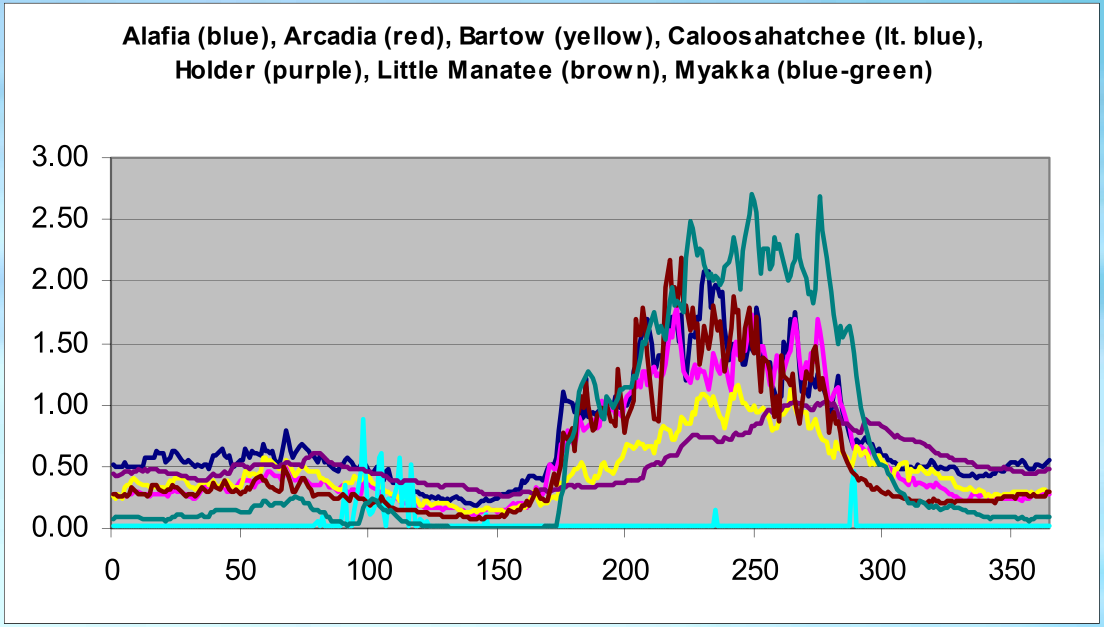
"MDQ hydrographs are derived for various sets of years and are considered using previously defined shifts in the AMO. This analysis procedure allows examination of the role of climate variability as a potential influence on long-term shifts in river flows in Florida. The report provides a convincing argument that much of the variability in streamflow hydrographs is strongly related to long-term climate oscillations associated with the AMO." **– Shaw et al. 2004**

“The identification of an abrupt increase [or decrease] in streamflow rather than a gradual increasing [decreasing] trend is important because the implications of a step change are different from those of a gradual trend. The identification of a gradual trend is that the trend is likely to continue into the future, whereas the interpretation of a step change is that the climate system has shifted to a new regime that will likely remain relatively constant until a new shift or step change occurs.” -- McCabe and Wolock 2002

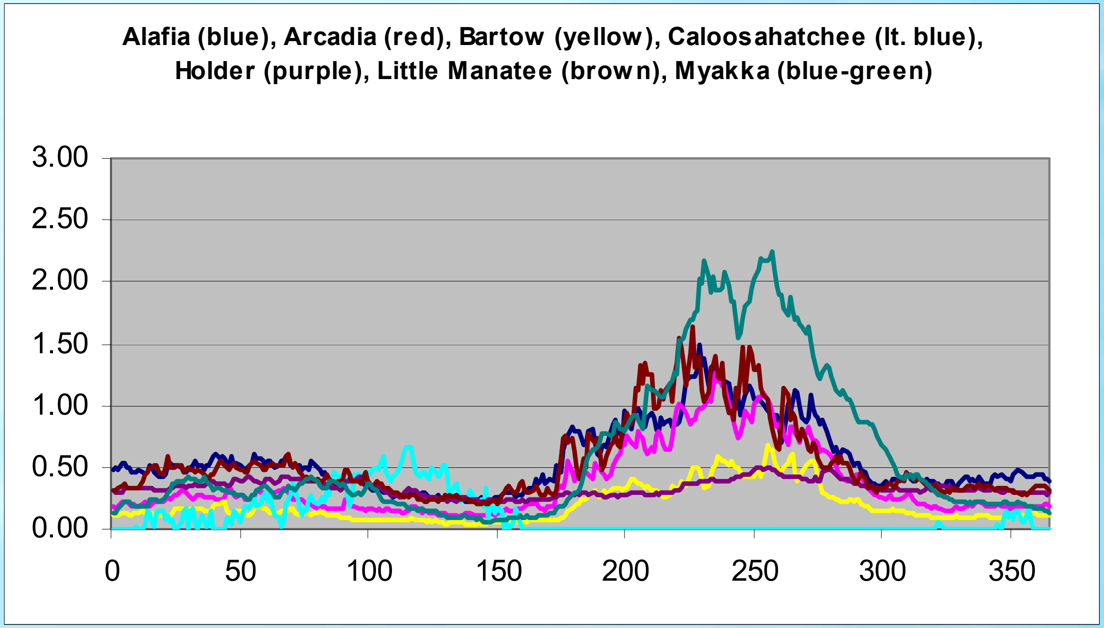
Building Block Approach

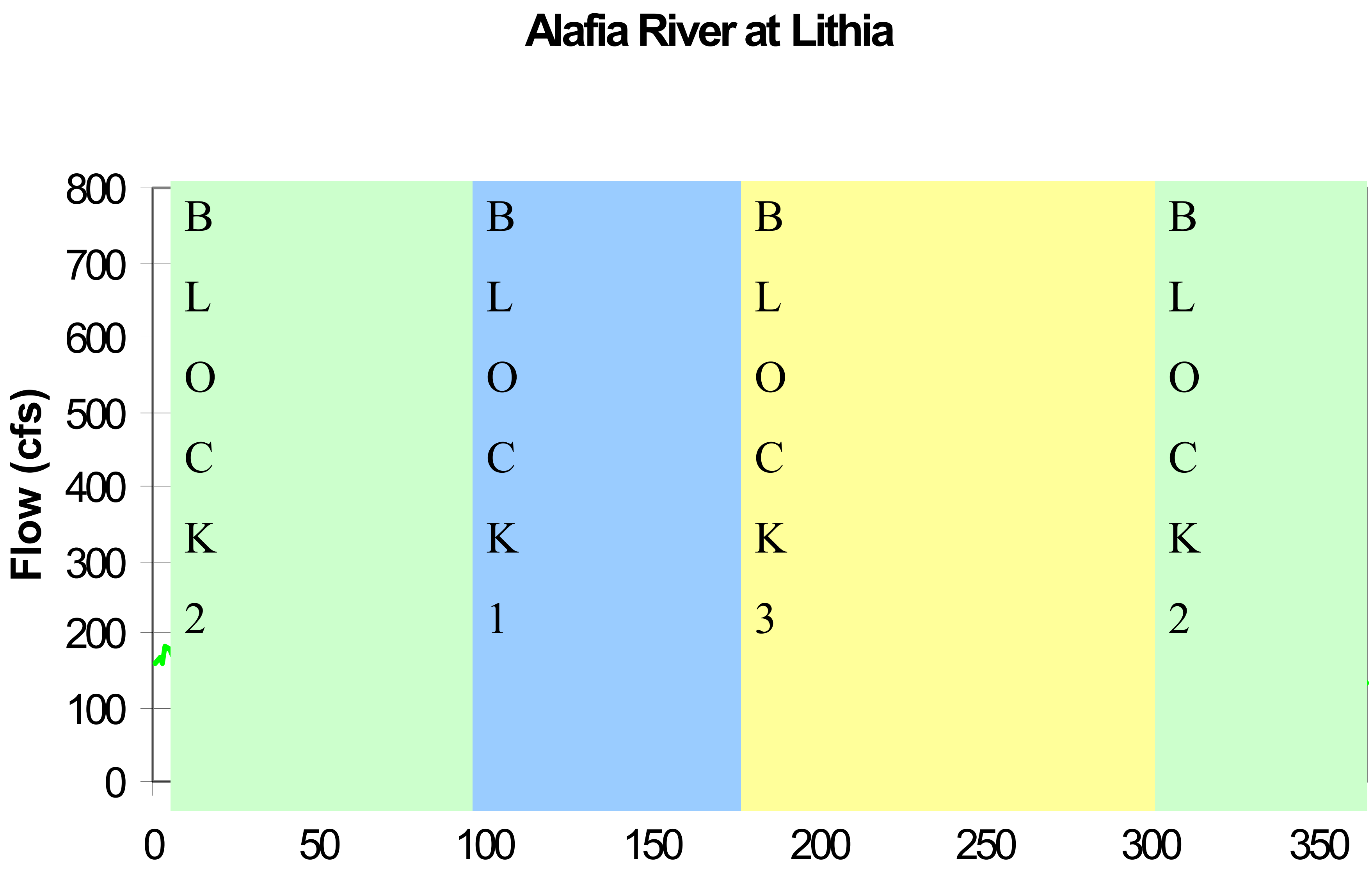


Comparison based on flows from 1940 to 1969



Comparison based on flows from 1970 to 1999




Alafia River at Lithia
Flow (cfs)
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
350
BLOCK 2
BLOCK 1
BLOCK 3
BLOCK 2

Tools

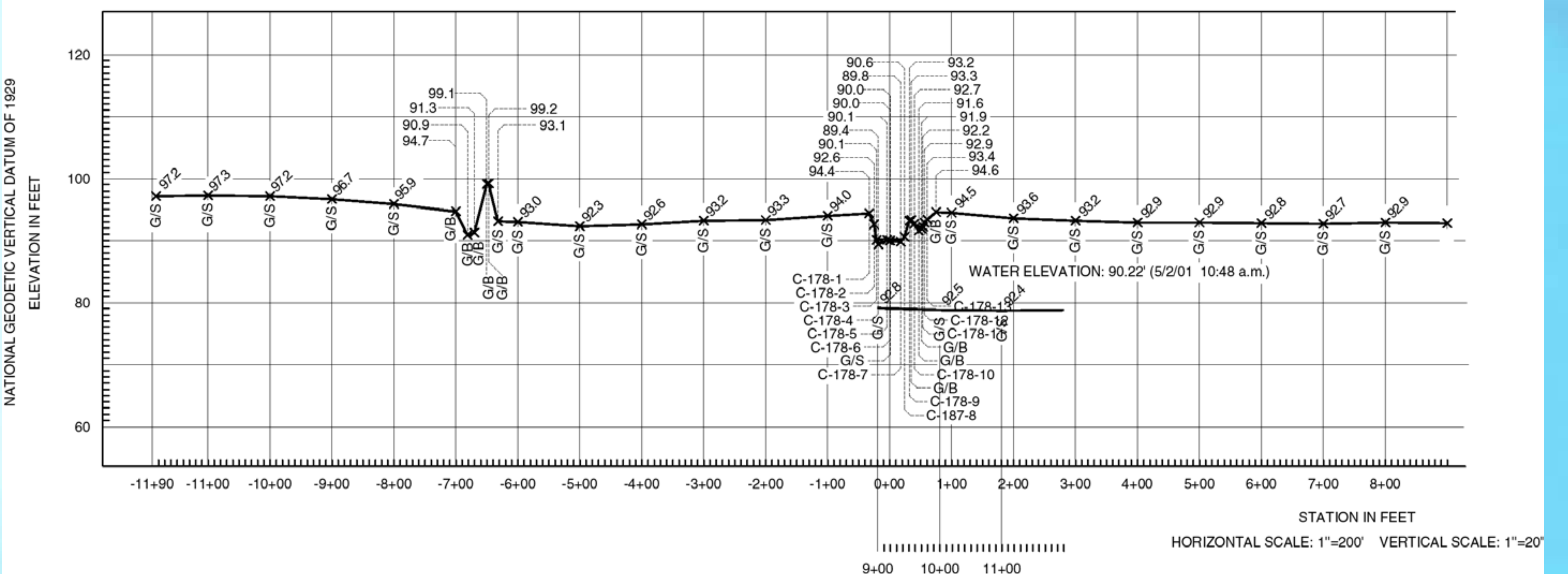
- HEC-RAS
- PHABSIM
- RALPH Analysis
- Prescribed Flow Hydrograph

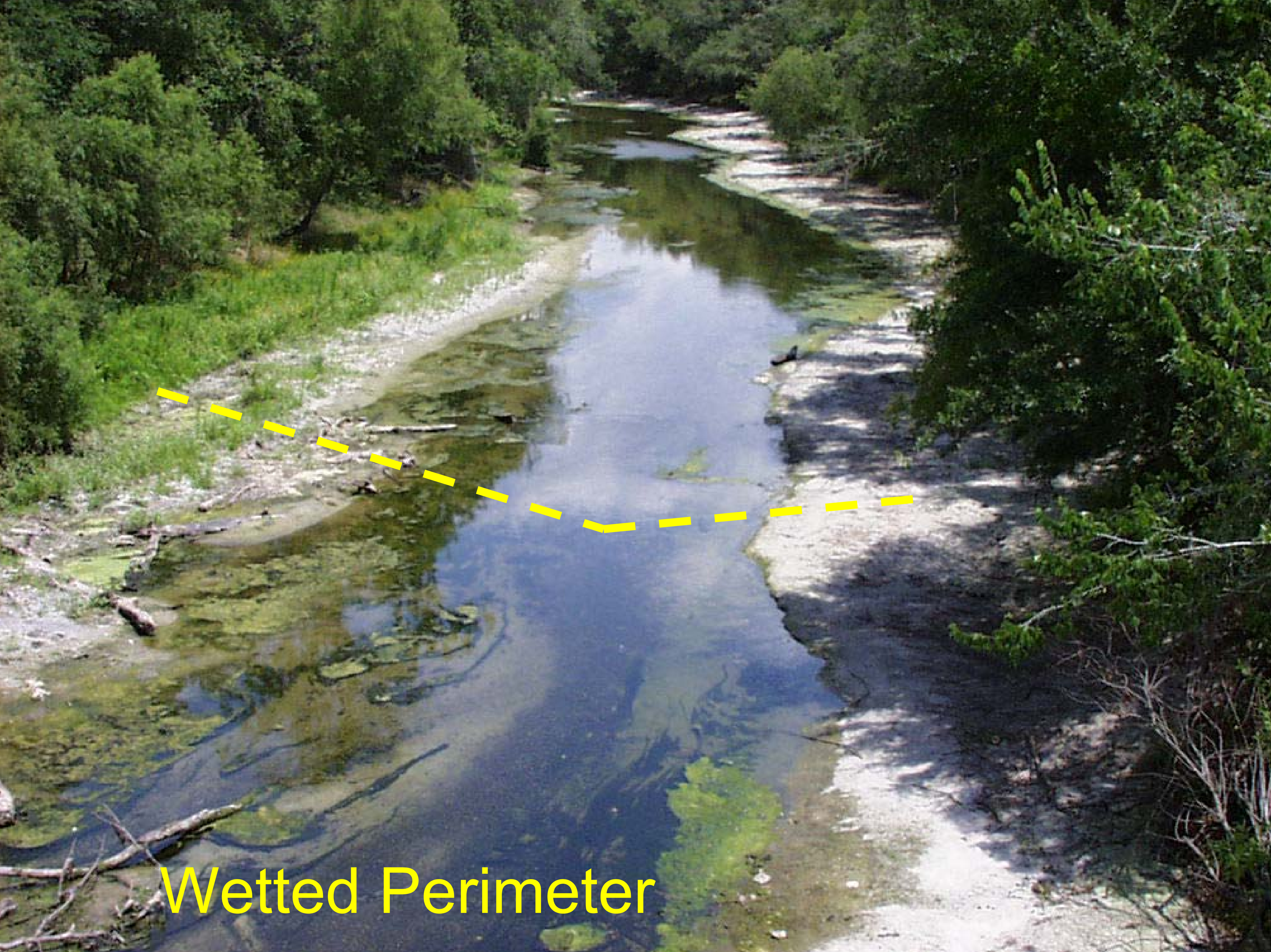
HEC-RAS Model

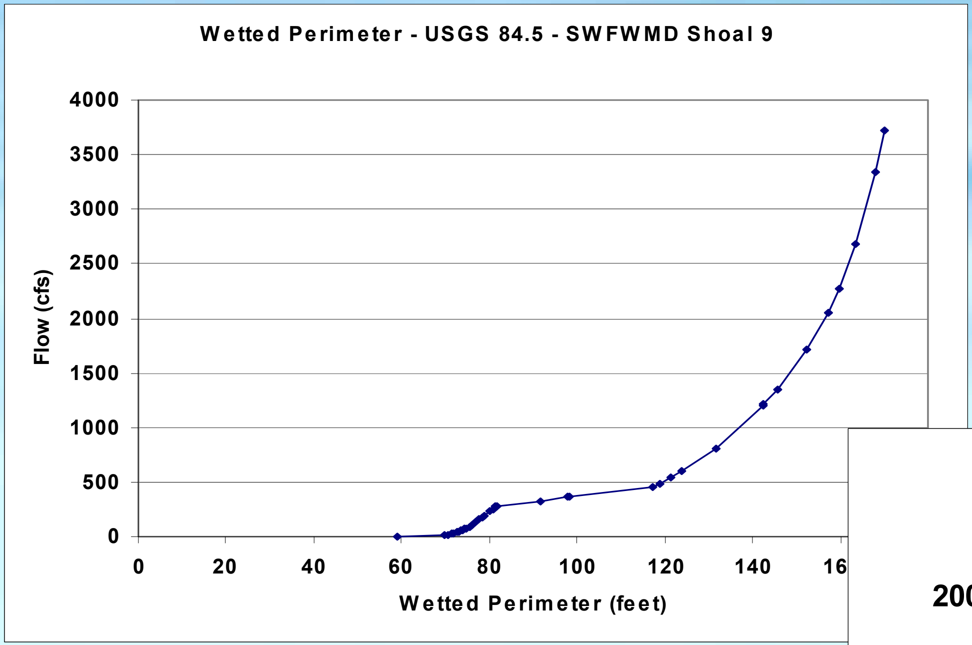
Used to relate flows and elevations at any transect site to a gage site – used for a number of analyses

LINE #178

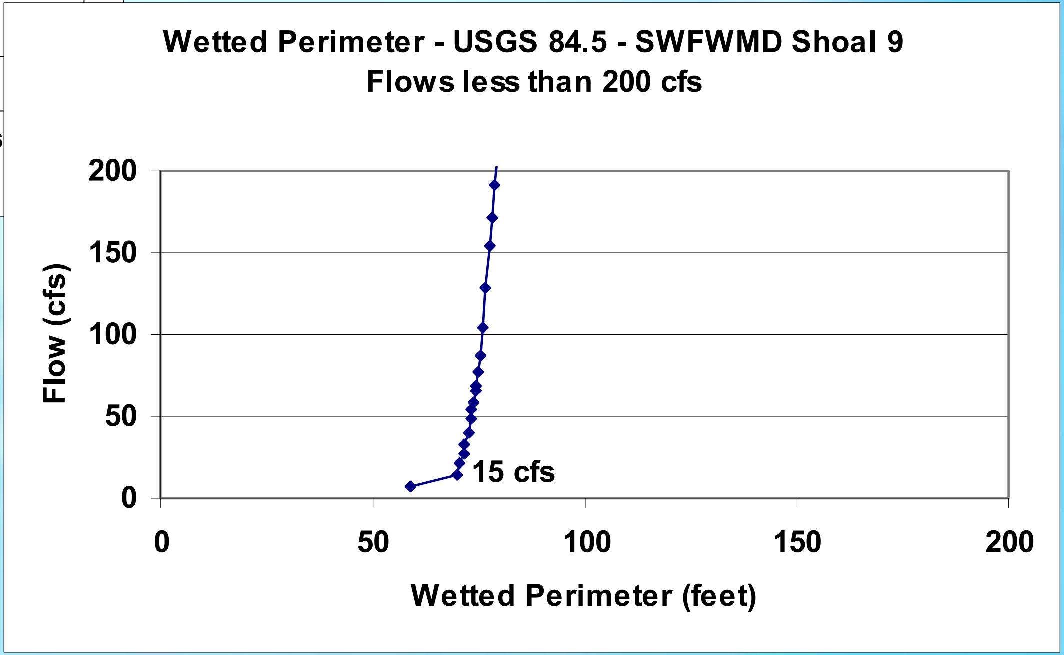
TRANSECT C-178




Wetted Perimeter

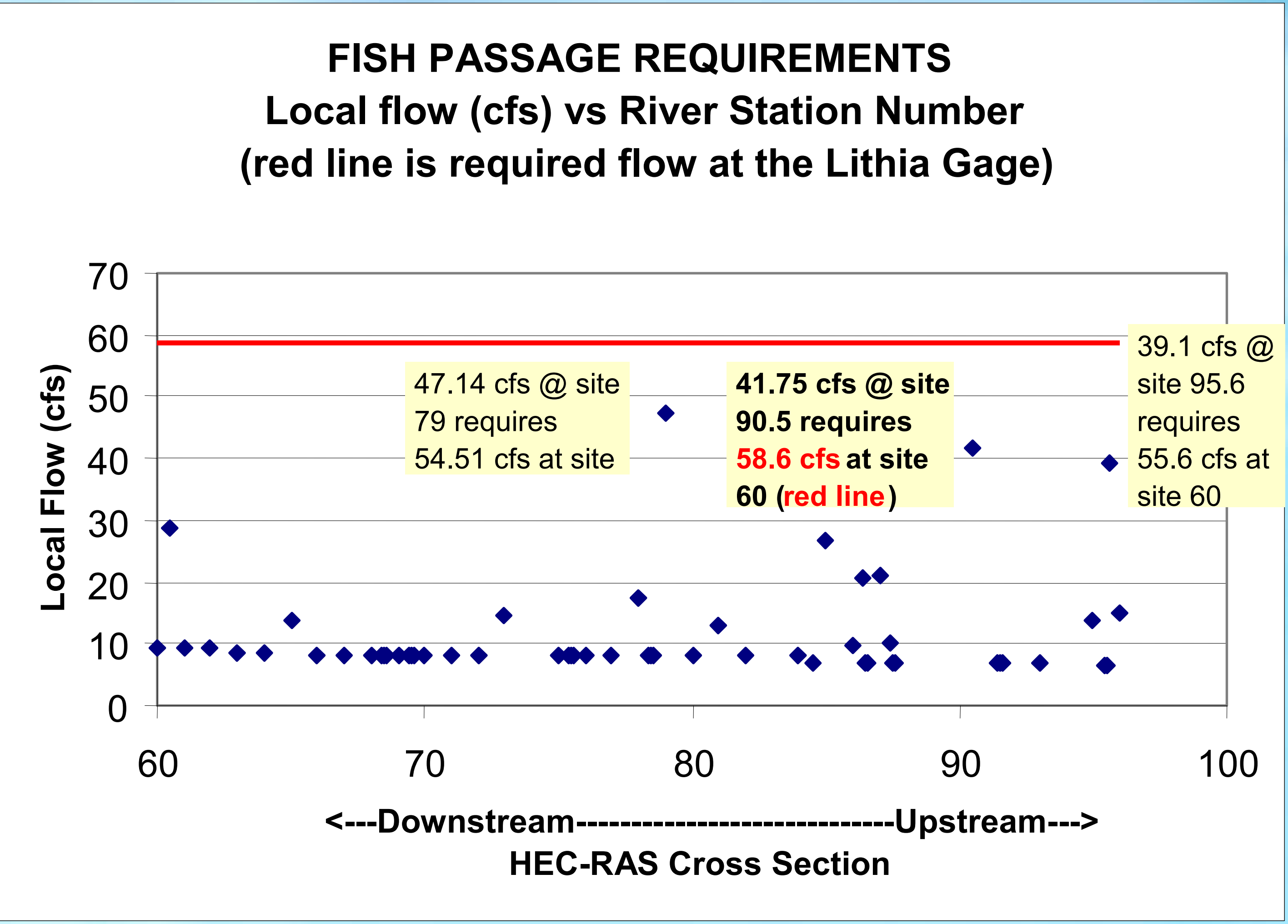


Wetted Perimeter - USGS 84.5 - SWFWMD Shoal 9
Flow (cfs)
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
16
Wetted Perimeter (feet)

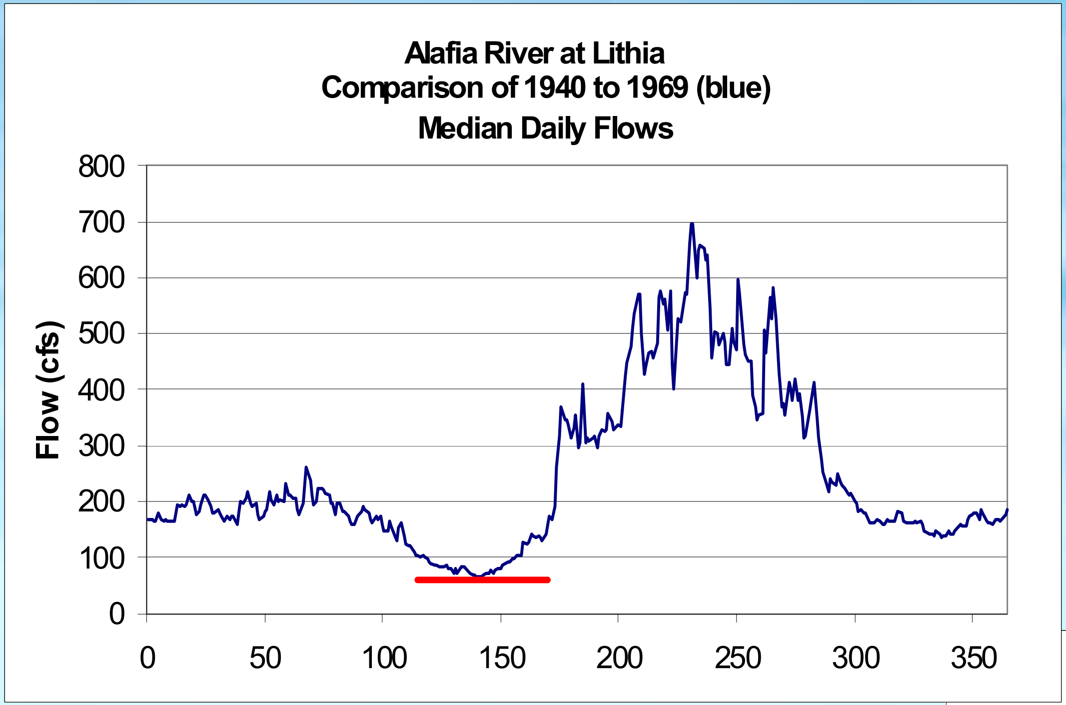


Wetted Perimeter - USGS 84.5 - SWFWMD Shoal 9
Flows less than 200 cfs
Flow (cfs)
200
150
100
50
0
15 cfs
0
50
100
150
200
Wetted Perimeter (feet)

Development of Low Flow Threshold – Fish Passage Standard

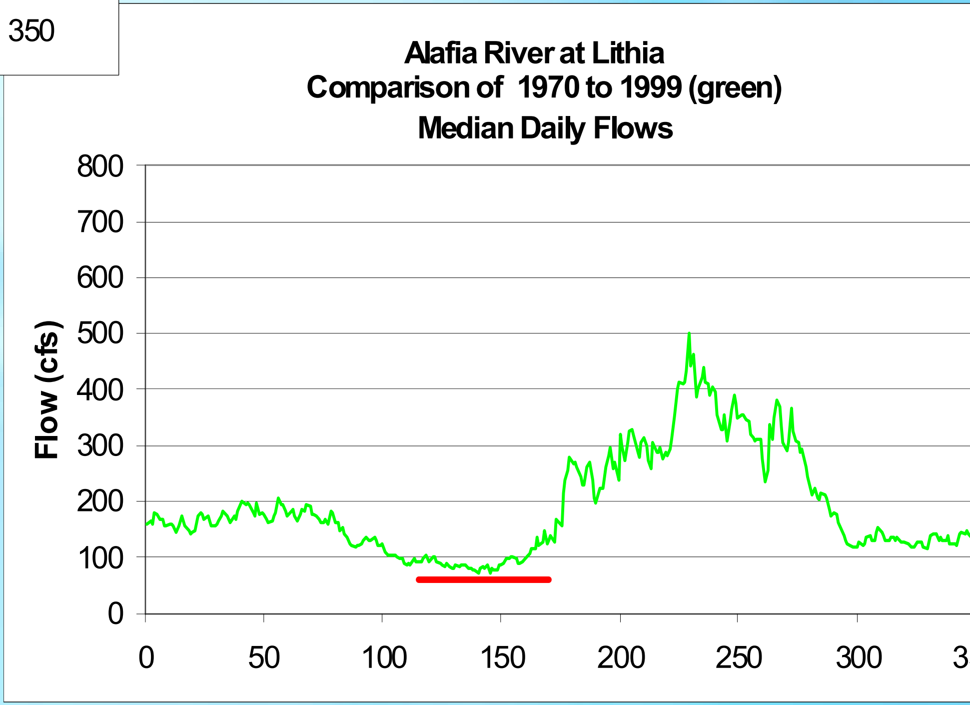


Lowest point in a cross section + 0.6 ft is plotted in terms of flow requirement to maintain fish passage (i.e. river connectivity)



FISH PASSAGE CRITERIA

Defined by maintaining 0.6 over all surveyed shoals which requires a flow of 58.6 cfs at the Lithia gage

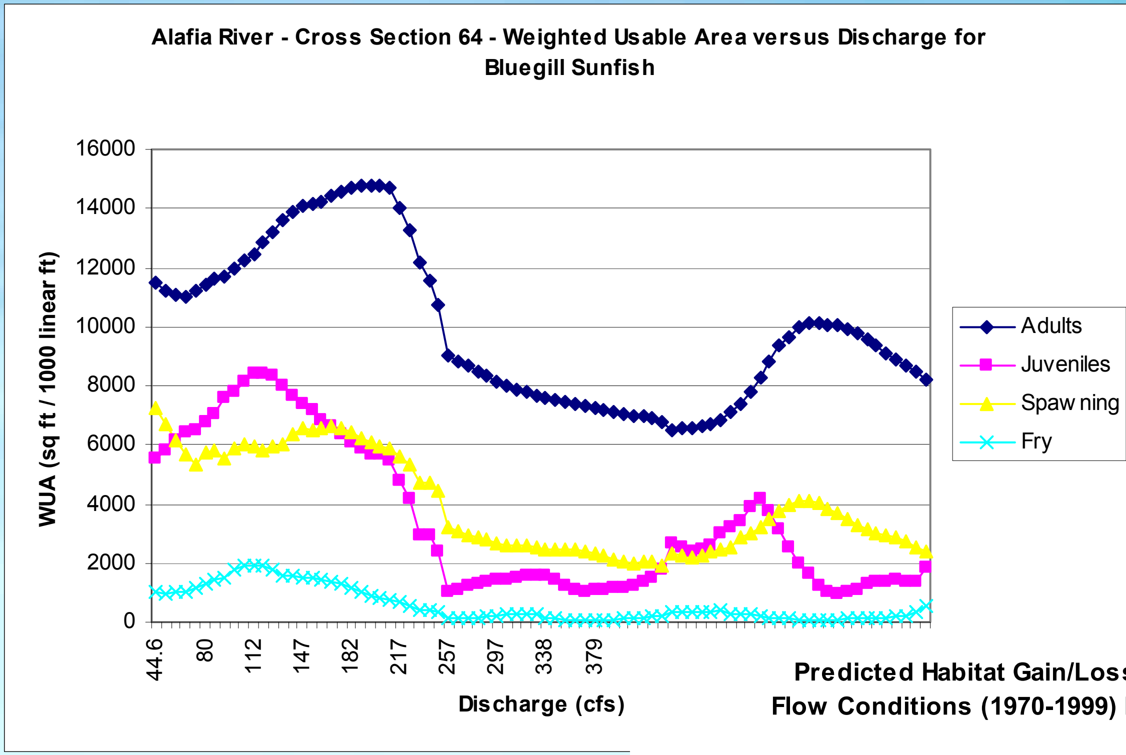


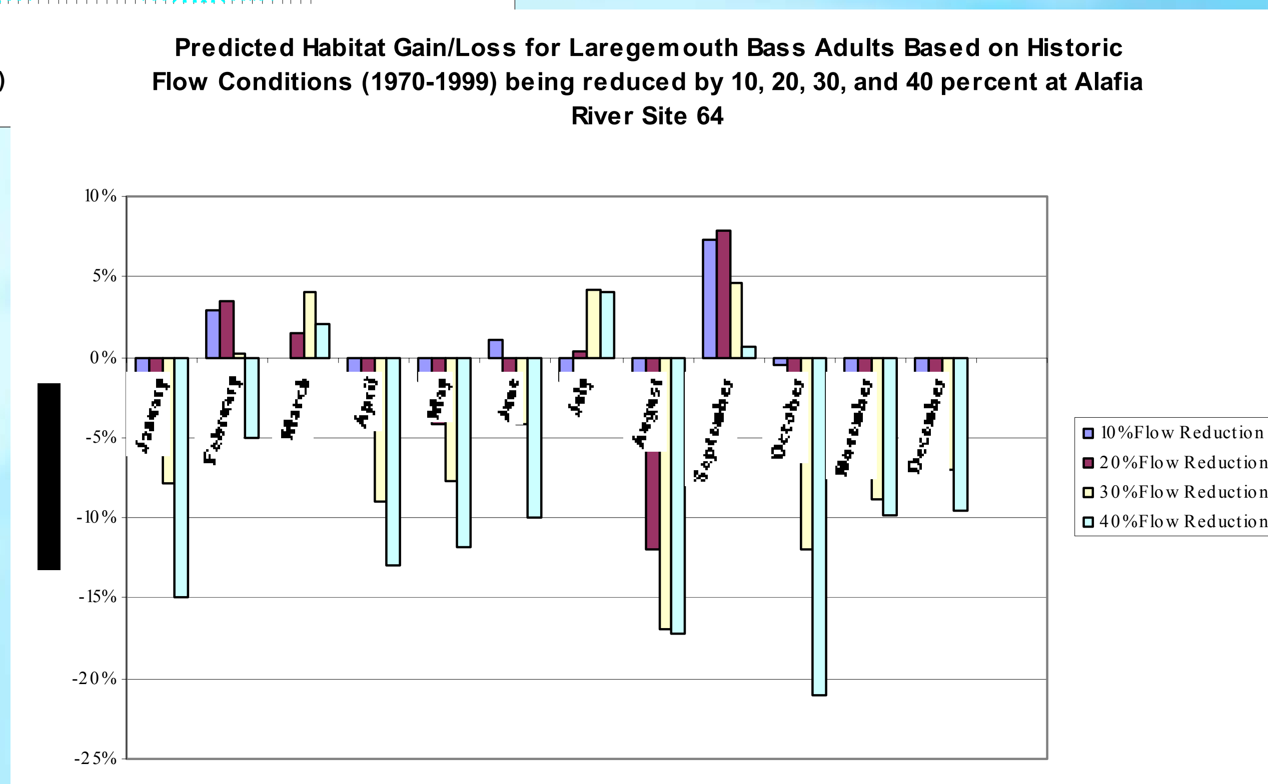
PHABSIM – Physical Habitat Simulation Model

For in channel use – used in Block 1 to determine allowable percentage withdrawals above the LFT

Used in Block 2 as one criteria for developing allowable percent withdrawal

Examples of PHABSIM output

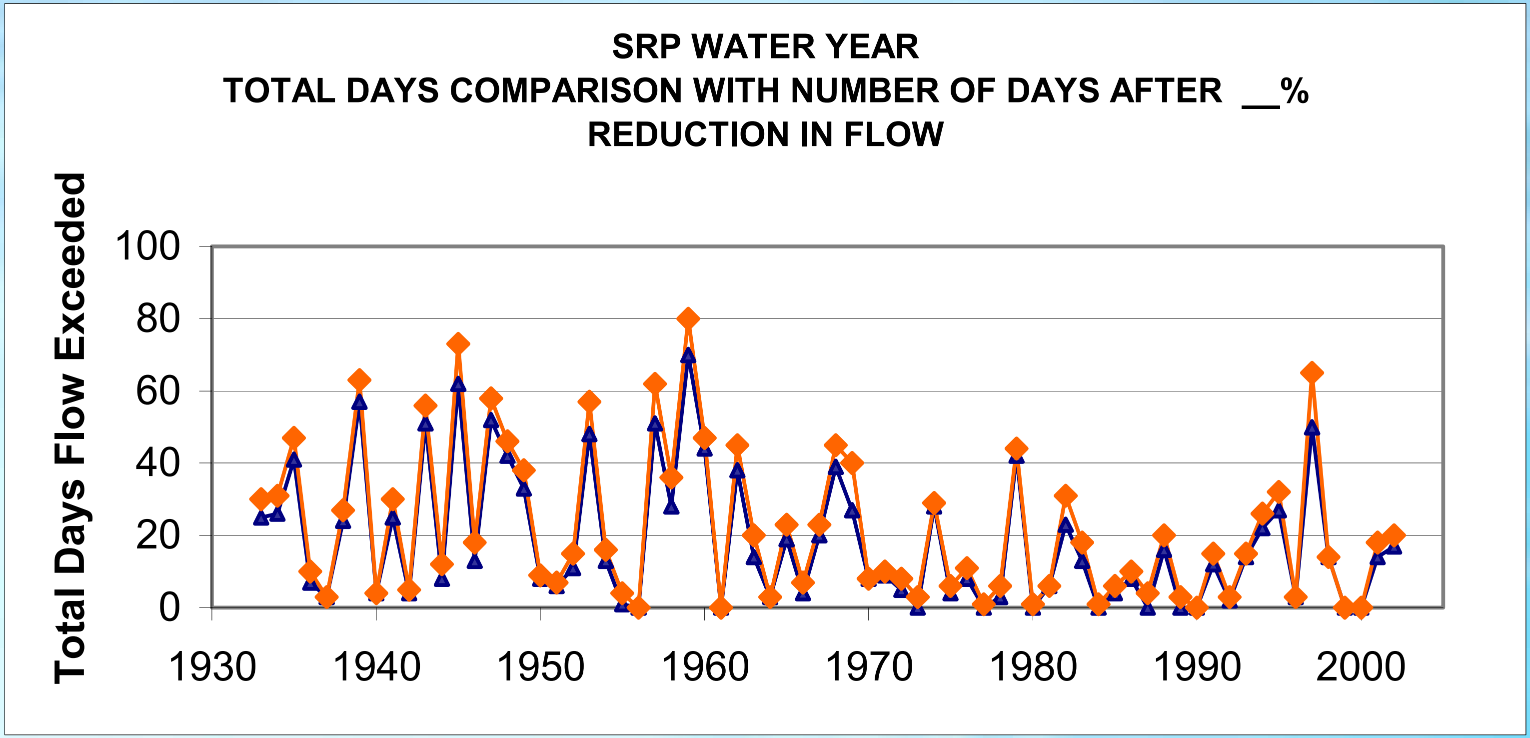




Analysis of Recent and Long-term Positional Hydrographs (RALPH Plot Analyses)

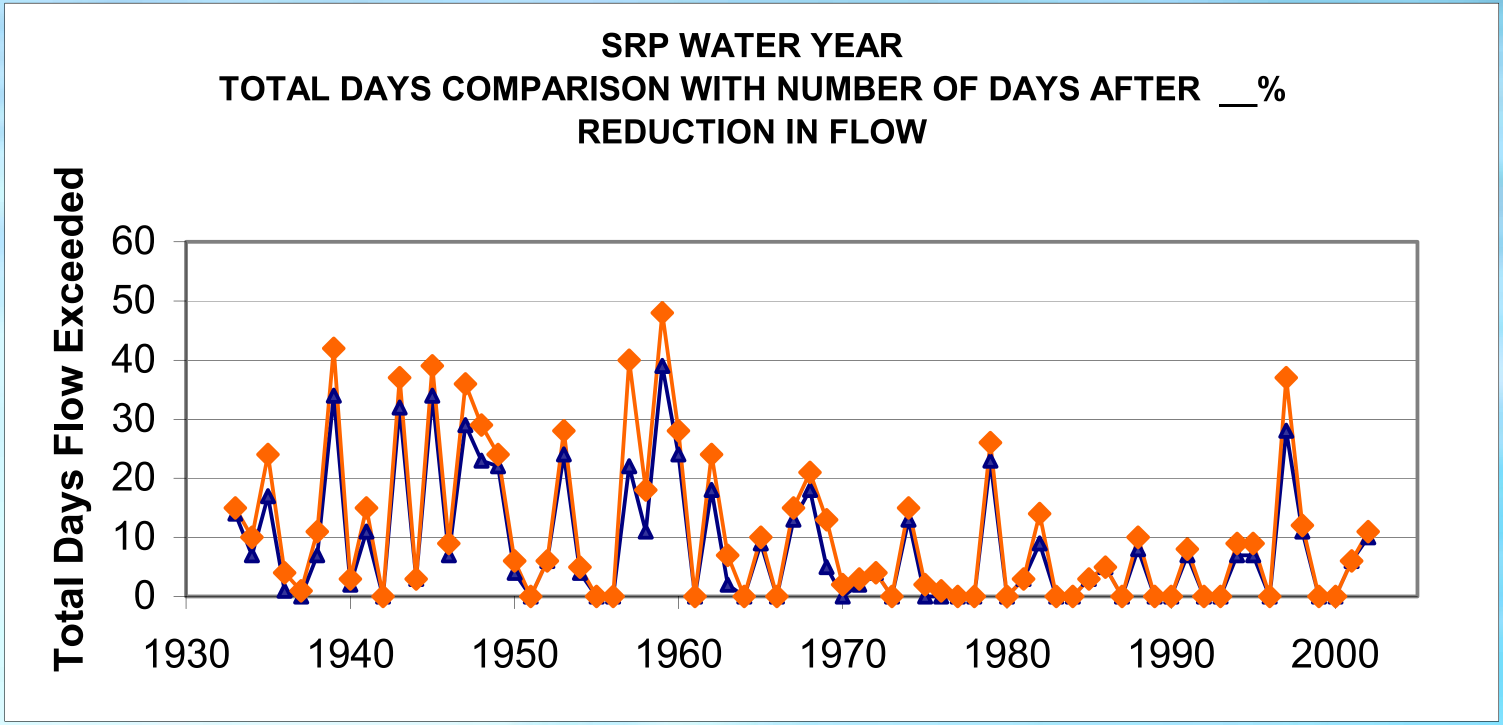
HEC-RAS is used to relate desired flow (resultant elevation) at a particular site to a gage site

The gage site flow record is then used to determine the number of days per year that desired flow was reached or exceeded. This analysis is used to examine how much % of days achieved is reduced by incremental decreases in flow



FISH PASSAGE WP FLOW	**59**	**10**	**%Reduction LOW**
		19	**%Reduction MEDIUM**
Target Flow (cfs)	**1000**	**8**	**%Reduction HIGH**

FISH PASSAGE WP FLOW			**59**		**10**	**%Reduction LOW**						
					19	**%Reduction MEDIUM**						
Target Flow (cfs)		**1000**			**8**	**%Reduction HIGH**						
	Total Days	TD%Red	TD%Chan	Low Days	LD%Red	LD%Chan	Med Days	Med%Rec	Med%Cha	High Days	HD%Red	HD%Change
POR												
Mean	21.8	18.2	16.6	1.5	1.2	21.4	4.7	3.2	30.8	15.7	13.8	12.0
Median	15.0	13.0	13.3	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	8.0	7.0	12.5
1940 to 1969												
Mean	29.3	24.6	16.0	1.6	1.2	26.5	5.3	3.6	32.1	22.4	19.8	11.5
Median	23.0	19.5	15.2	0.0	0.0	#DIV/0!	1.5	0.0	100.0	17.5	15.5	11.4
1970 to 1999												
Mean	13.3	10.7	19.5	1.1	0.9	18.2	4.1	2.8	30.3	8.1	7.0	14.3
Median	8.0	7.0	12.5	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	3.5	3.0	14.3
1980 to 1999												
Mean	14.4	11.5	20.4	0.3	0.1	60.0	5.2	3.7	28.2	8.9	7.6	14.3
Median	10.0	8.0	20.0	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	5.0	4.0	20.0
1940 to 1954												
Mean	29.6	25.3	14.4	0.7	0.5	30.0	3.5	2.3	32.7	25.5	22.5	11.5
Median	18.0	13.0	27.8	0.0	0.0	#DIV/0!	1.0	0.0	100.0	16.0	13.0	18.8



FISH PASSAGE WP FLOW	59	10	%Reduction LOW
		19	%Reduction MEDIUM
Target Flow (cfs) 1500		7	%Reduction HIGH

FISH PASSAGE WP FLOW	**59**	**10**	**%Reduction LOW**
		19	**%Reduction MEDIUM**
Target Flow (cfs)	**1500**	**7**	**%Reduction HIGH**

	Total Days	TD%Red	TD%Chan	Low Days	LD%Red	LD%Chan	Med Days	Med%Red	Med%Cha	High Days	HD%Red	HD%Change
POR												
Mean	10.7	8.4	21.7	0.6	0.5	23.8	2.3	1.4	40.2	7.8	6.5	16.0
Median	6.0	4.5	25.0	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	3.0	3.0	0.0
1940 to 1969												
Mean	15.5	12.1	22.0	0.6	0.4	27.8	2.7	1.3	51.3	12.2	10.3	15.3
Median	11.5	8.0	30.4	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	8.0	6.5	18.8
1970 to 1999												
Mean	5.4	4.3	20.2	0.4	0.2	45.5	2.0	1.4	30.5	3.1	2.8	10.8
Median	2.0	0.0	100.0	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!
1980 to 1999												
Mean	6.2	5.1	18.3	0.0	0.0	#DIV/0!	2.8	2.1	23.8	3.4	2.9	13.7
Median	3.0	3.0	0.0	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!
1940 to 1954												
Mean	16.0	13.4	16.3	0.3	0.1	75.0	1.3	0.7	45.0	14.4	12.6	12.5
Median	9.0	7.0	22.2	0.0	0.0	#DIV/0!	0.0	0.0	#DIV/0!	9.0	7.0	22.2

Application / Examples

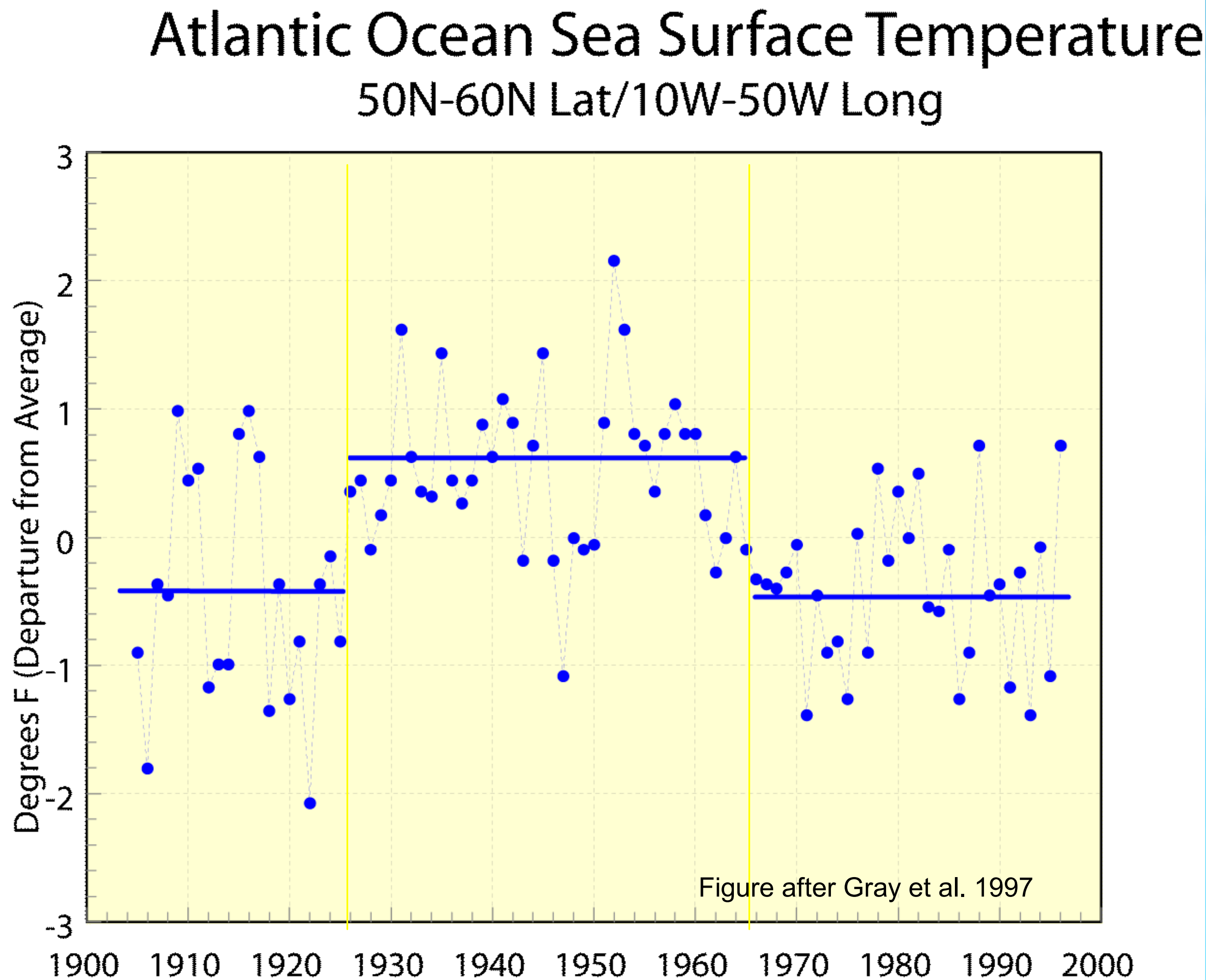
- Block 1
  - Low Flow Threshold (LFT) – aka. "minimum flow"
  - Physical Habitat Simulation (PHABSIM) – fish and macroinvertebrate habitat suitability curves
- Block 2
  - LFT
  - PHABSIM
  - Woody Habitat – Analysis of Recent and Longterm Positional Hydrographs (RALPH Analysis)
- Block 3
  - LFT
  - Floodplain Inundation – RALPH Analysis

Long Term Flow Prescription – apply Block 1, 2 and 3 allowable reductions to benchmark hydrograph

SRP Year	Min	Max
10yr Mean	163	349
10yr Median	89	198
5yr Mean	140	415
5yr Median	75	224
Block 1		
10yr Mean	73	224
10yr Median	35	122
5yr Mean	48	265
5yr Median	27	146
Block 2		
10yr Mean	120	274
10yr Median	72	175
5yr Mean	97	318
5yr Median	59	233
Block 3		
10yr Mean	265	609
10yr Median	154	368
5yr Mean	231	794
5yr Median	140	544

Example run for Alafia River flow record using 25% reductions in all Blocks after allowing for LFT of 59 cfs

QUESTIONS ???



"North Atlantic sea surface temperatures for 1856-1999 contain a 65-80 year cycle with a 0.4 C range, referred as the Atlantic Multidecadal Oscillation (AMO) by Kerr [2000]."

from Enfield et al. 2001

Peer Review Comments on: "Florida River Flow Patterns and the Atlantic Multidecadal Oscillation"

Draft Report
Ecologic Evaluation Section
Southwest Florida Water Management District (SWFWMD)
Draft report version dated August 10, 2004

Reviewers: Douglas T. Shaw, Ph.D. (dshaw@tnc.org)

David S. Gutzler, Ph.D. (gutzler@unm.edu)

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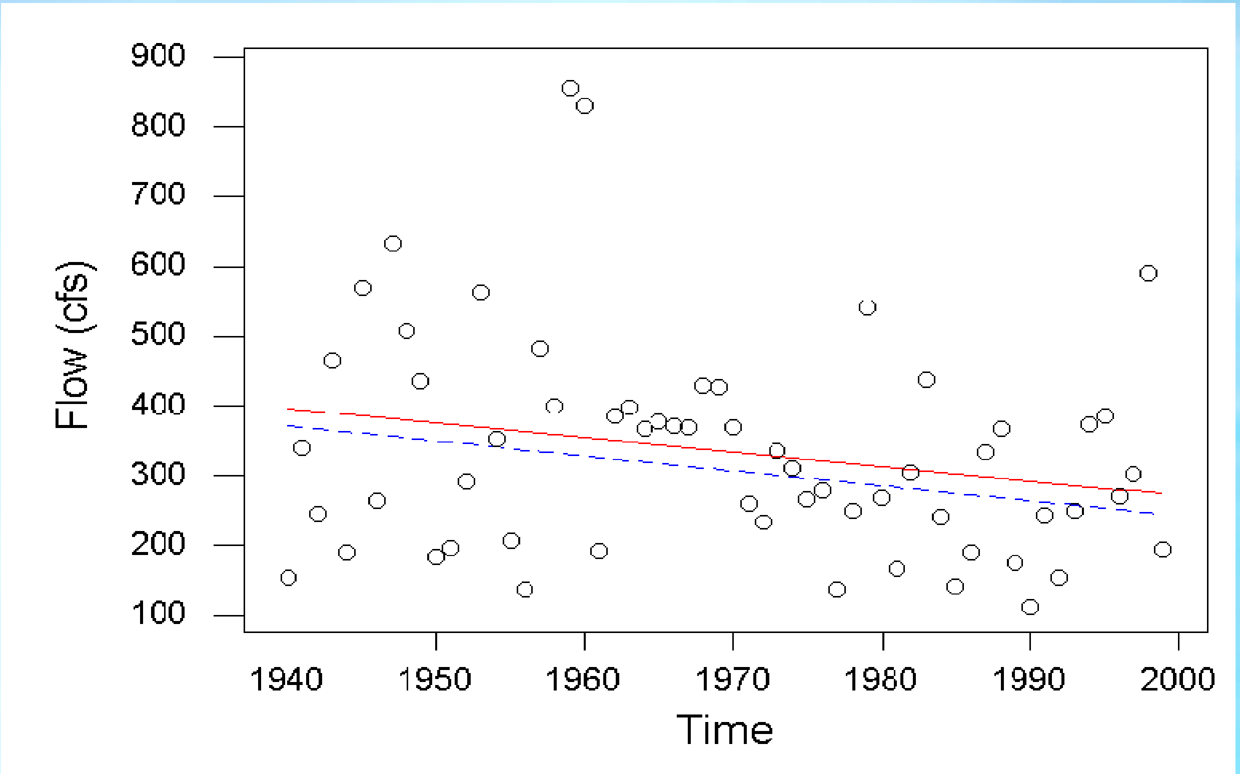
Date: December 3, 2004

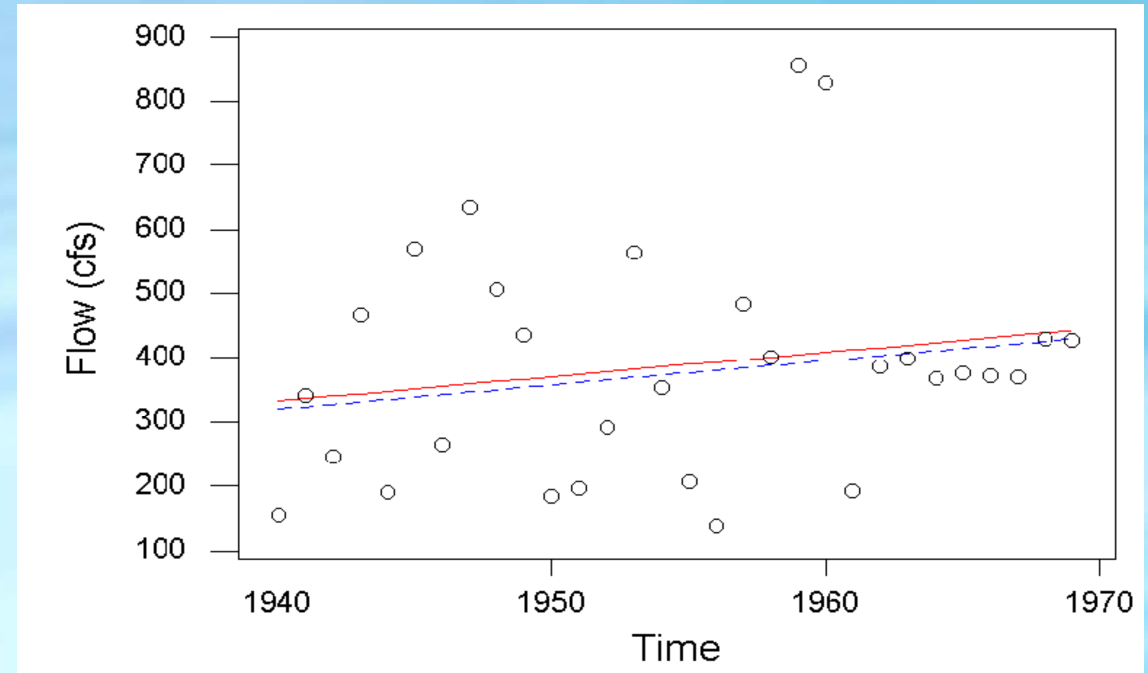
Summary

This draft report presents a persuasive and thoroughly documented illustration of the spatial patterns of annual streamflow hydrographs in Florida rivers. Evidence for the existence of shifts in these streamflow patterns from wetter to drier conditions and vice versa on a multidecadal time span is produced from daily streamflow records by calculating the daily median average flow (MDQ) for each calendar day in multi-year time series. MDQ hydrographs are derived for various sets of years and are considered using previously defined shifts in the "Atlantic Multidecadal Oscillation" (or AMO). This analysis procedure allows examination of the role of climate variability as a potential influence on long-term shifts in river flows in Florida. The report provides a convincing argument that much of the variability in streamflow hydrographs is strongly related to long-term climate oscillations associated with the AMO. The draft report concludes with a persuasive argument that this climate-driven variability in streamflow is a major factor influencing observed hydrologic changes in particular rivers in southwest Florida, even in cases with known anthropogenic sources of hydrologic alteration.

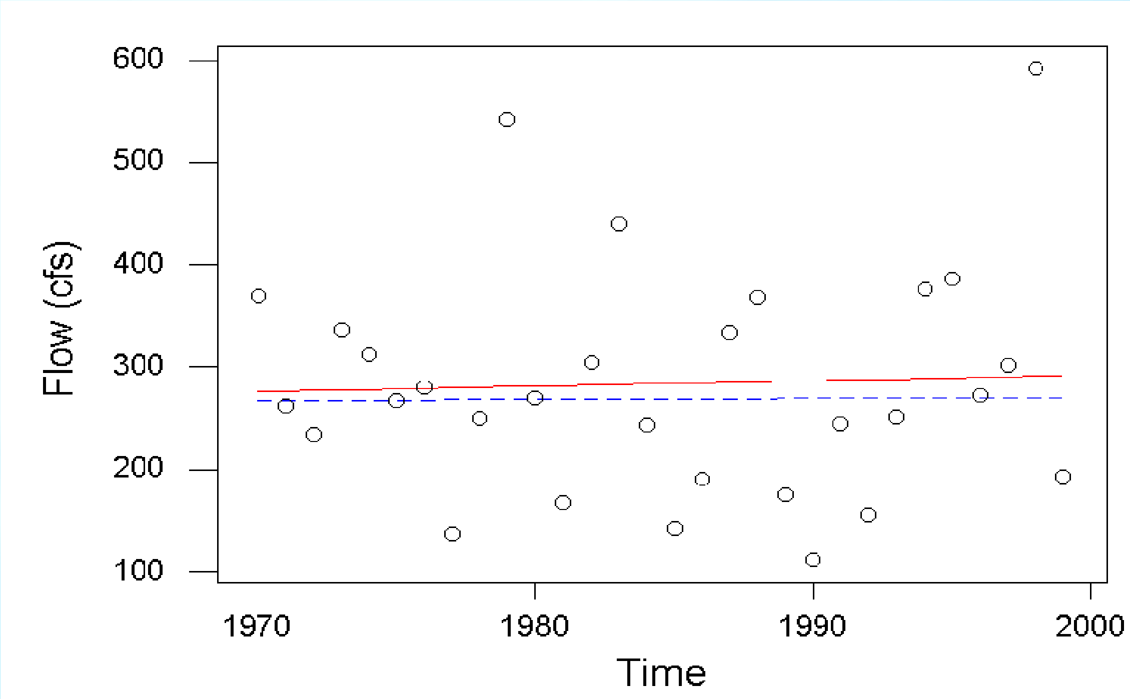
"Overall, we find the arguments in the report persuasive, the methods sound, and the conclusions well founded. We find no serious scientific flaws or technical errors in the work. The results have profound implications for water management, especially the establishment of instream flows (Minimum Flows and Levels, abbreviated MFLs) and water allocation, and for our understanding of the hydrology and long-term ecosystem dynamics of Florida's rivers."

Figure 34. Graphical results of Kendall's tau test of mean annual flows for the Alafia River for the period 1940 to 1999, the period 1940 to 1969, and the period 1970 to 1999. Red line is the Ordinary Least Squares line and the blue line is the Kendall's tau tiel line.

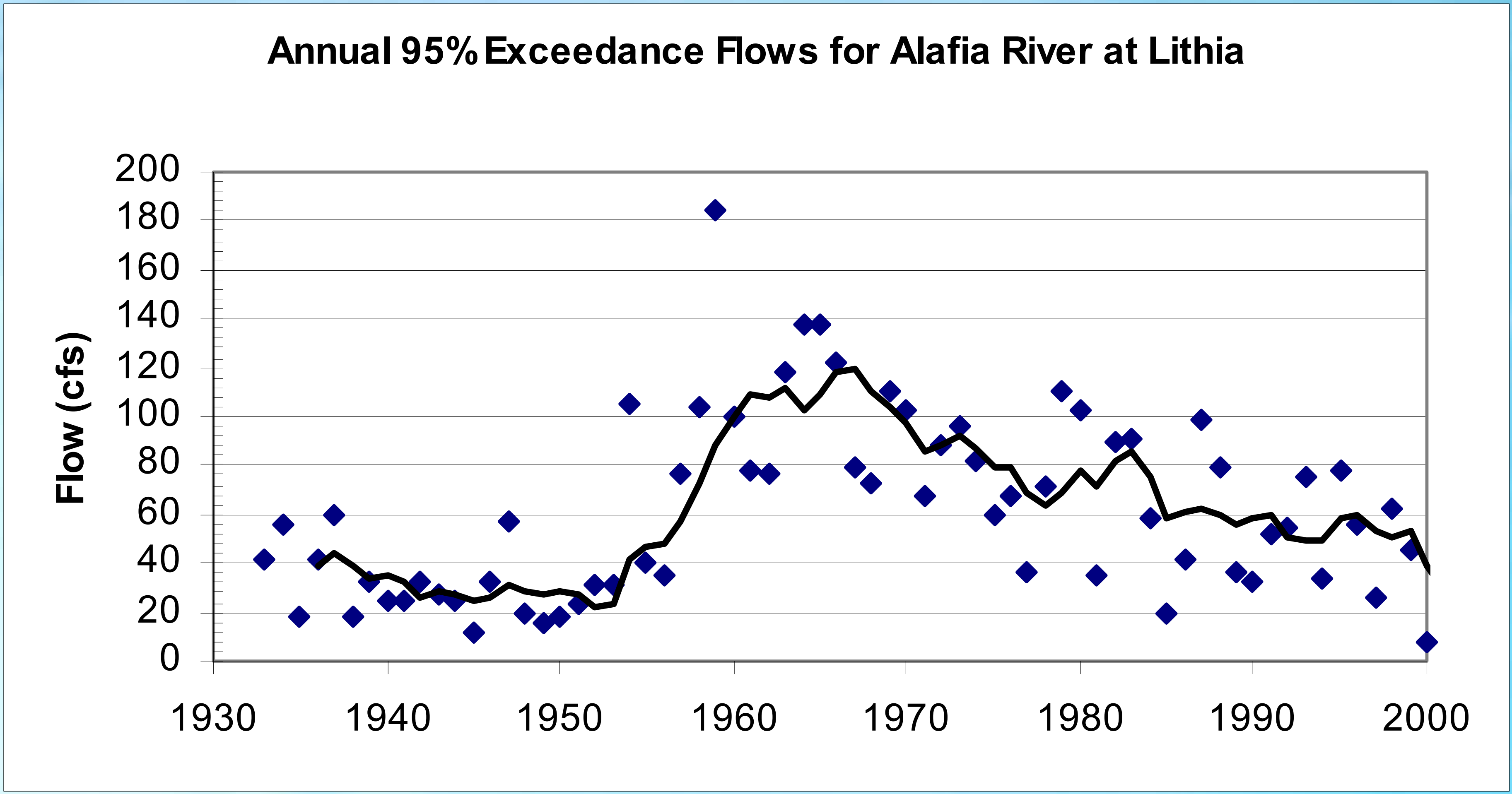




900
800
700
600
500
400
300
200
100
Flow (cfs)
1940
1950
1960
1970
Time



600
500
400
300
200
100
Flow (cfs)
1970
1980
1990
2000
Time



Annual 95% Exceedance Flows for Alafia River at Lithia
Flow (cfs)
200
180
160
140
120
100
80
60
40
20
0
1930
1940
1950
1960
1970
1980
1990
2000