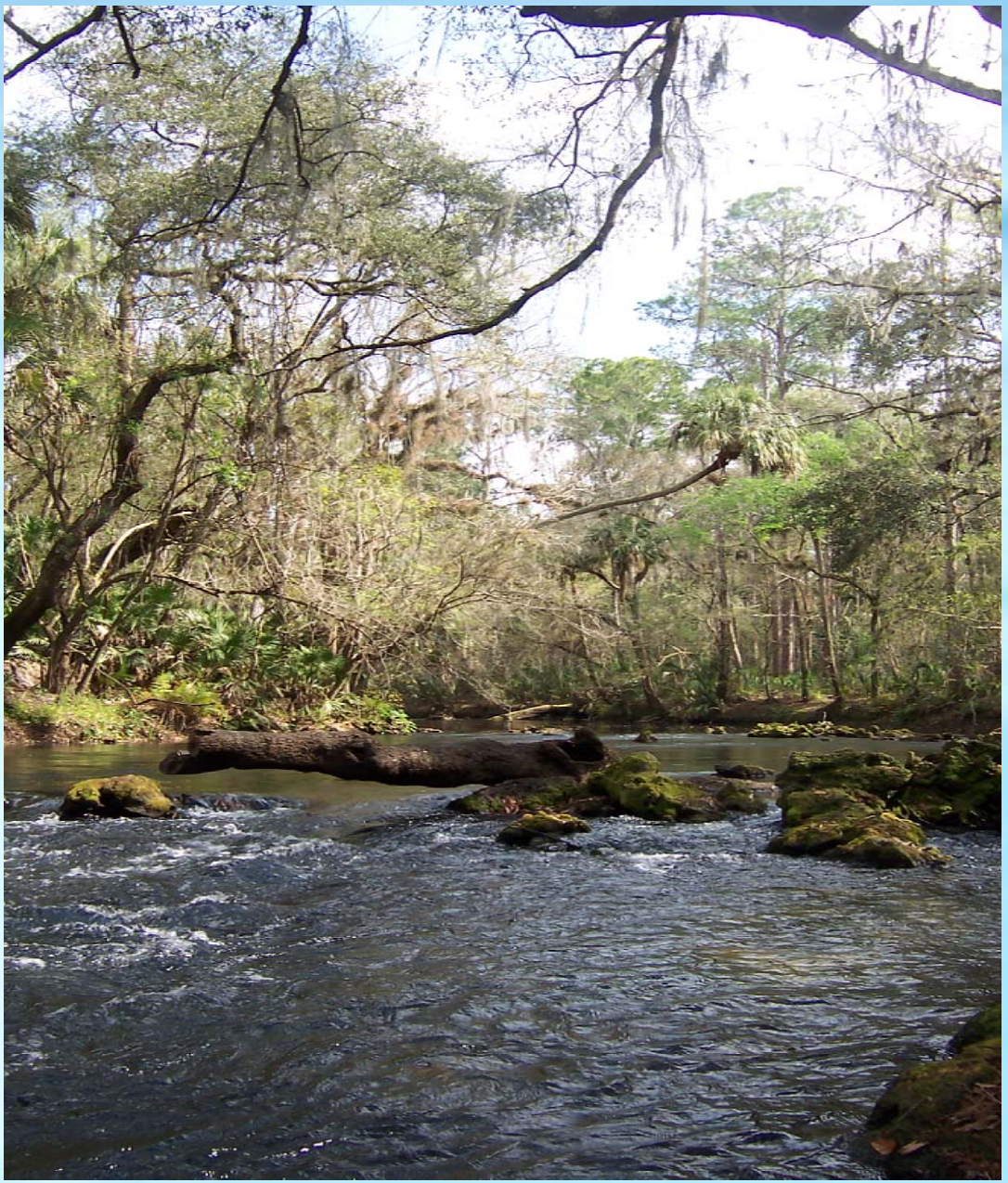


Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs

Internal Draft

Presentation to
NTB Phase II Group

Marty Kelly

August 9, 2006

Discharge = Rainfall – ET

Rainfall = 50 inches

ET = 40 inches

Discharge = 10 inches

Rainfall = 45 inches

ET = 40 inches

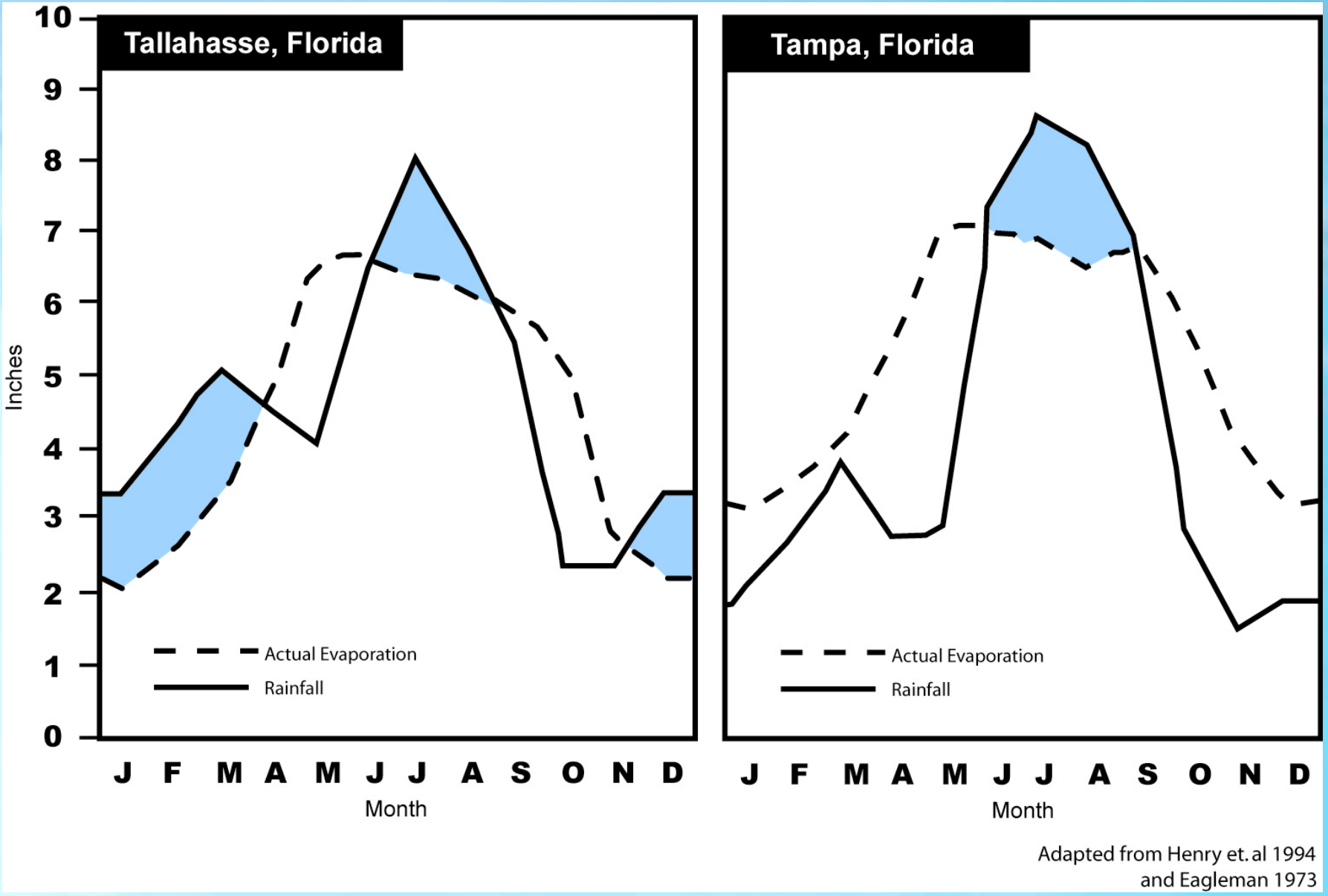
Discharge = 5 inches

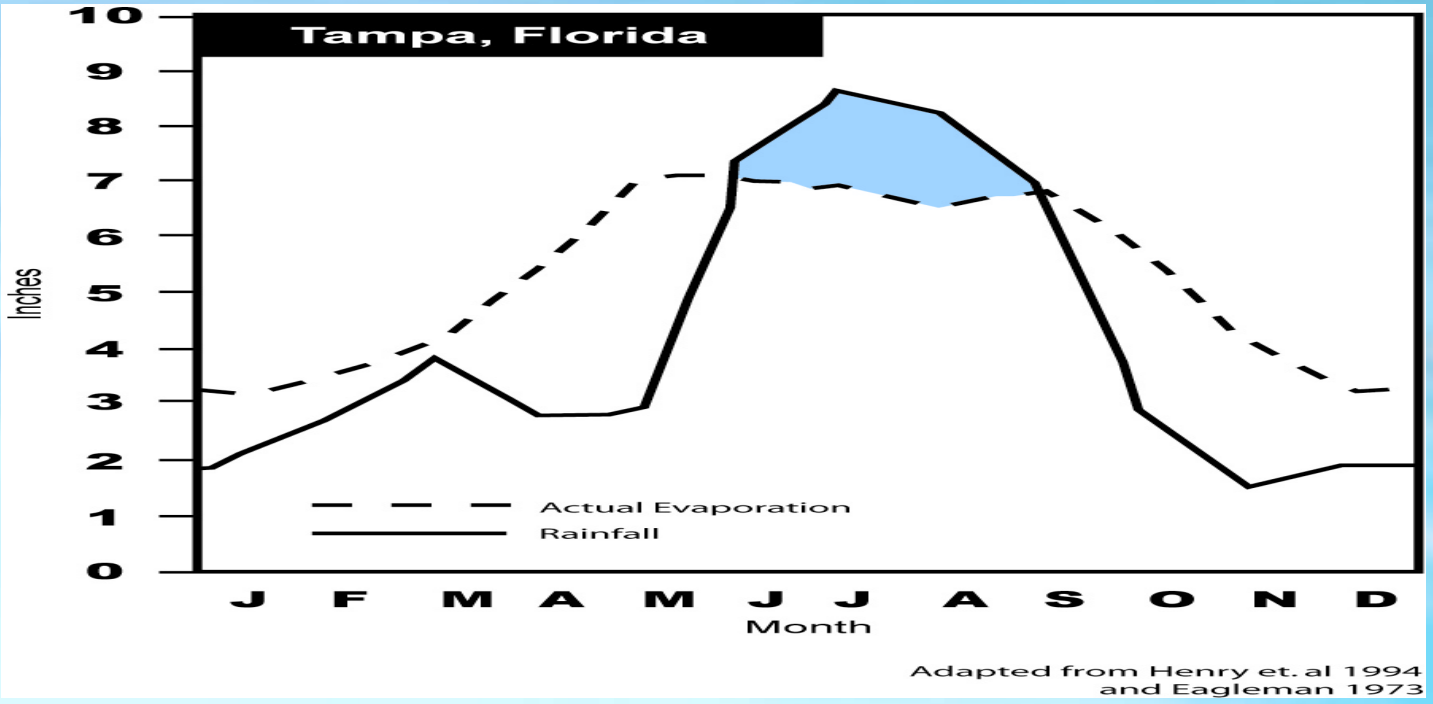
POP QUIZ: what are typically the biggest two terms in this equation?

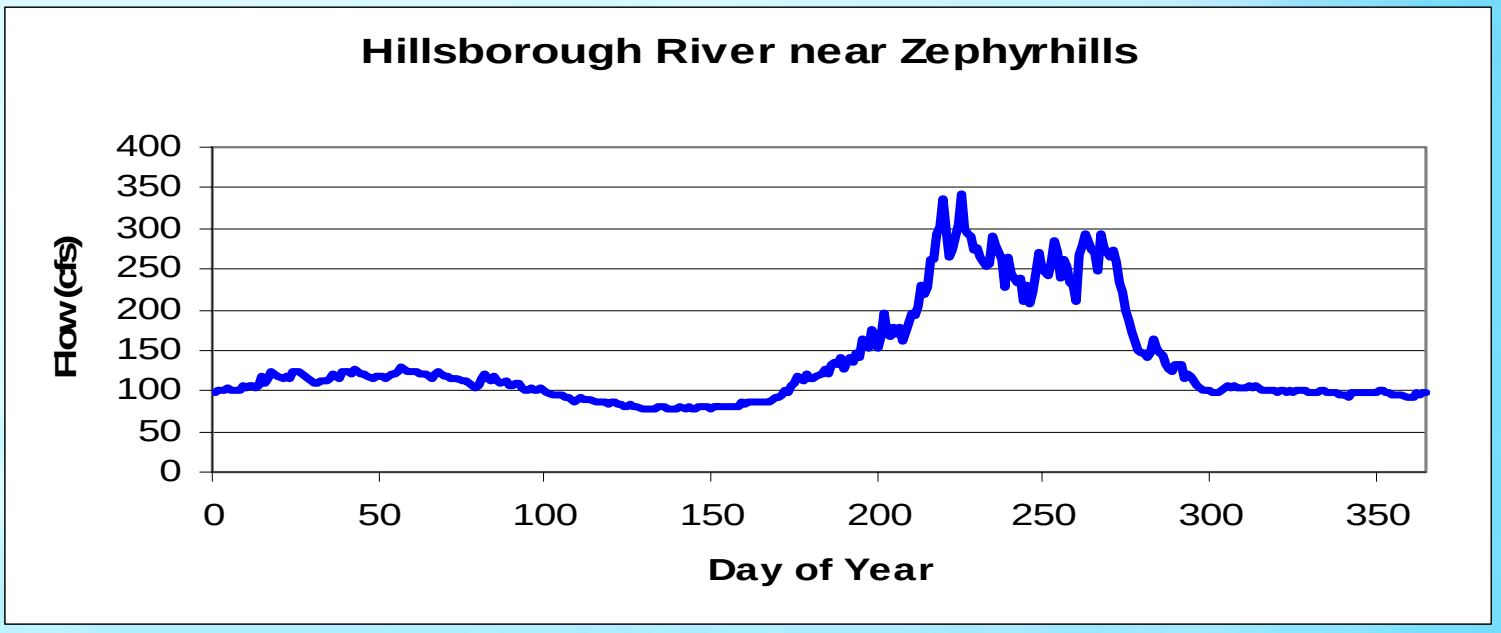
New Math

10% decrease in rainfall

50% decrease in discharge


Tallahasse, Florida
Tampa, Florida
Inches
10
9
8
7
6
5
4
3
2
1
0
Actual Evaporation
Rainfall
J F M A M J J A S O N D
Month
Adapted from Henry et. al 1994
and Eagleman 1973


Tampa, Florida
Inches
10
9
8
7
6
5
4
3
2
1
0
Actual Evaporation
Rainfall
J F M A M J J A S O N D
Month
Adapted from Henry et. al 1994
and Eagleman 1973


Hillsborough River near Zephyrhills
Flow (cfs)
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
Day of Year

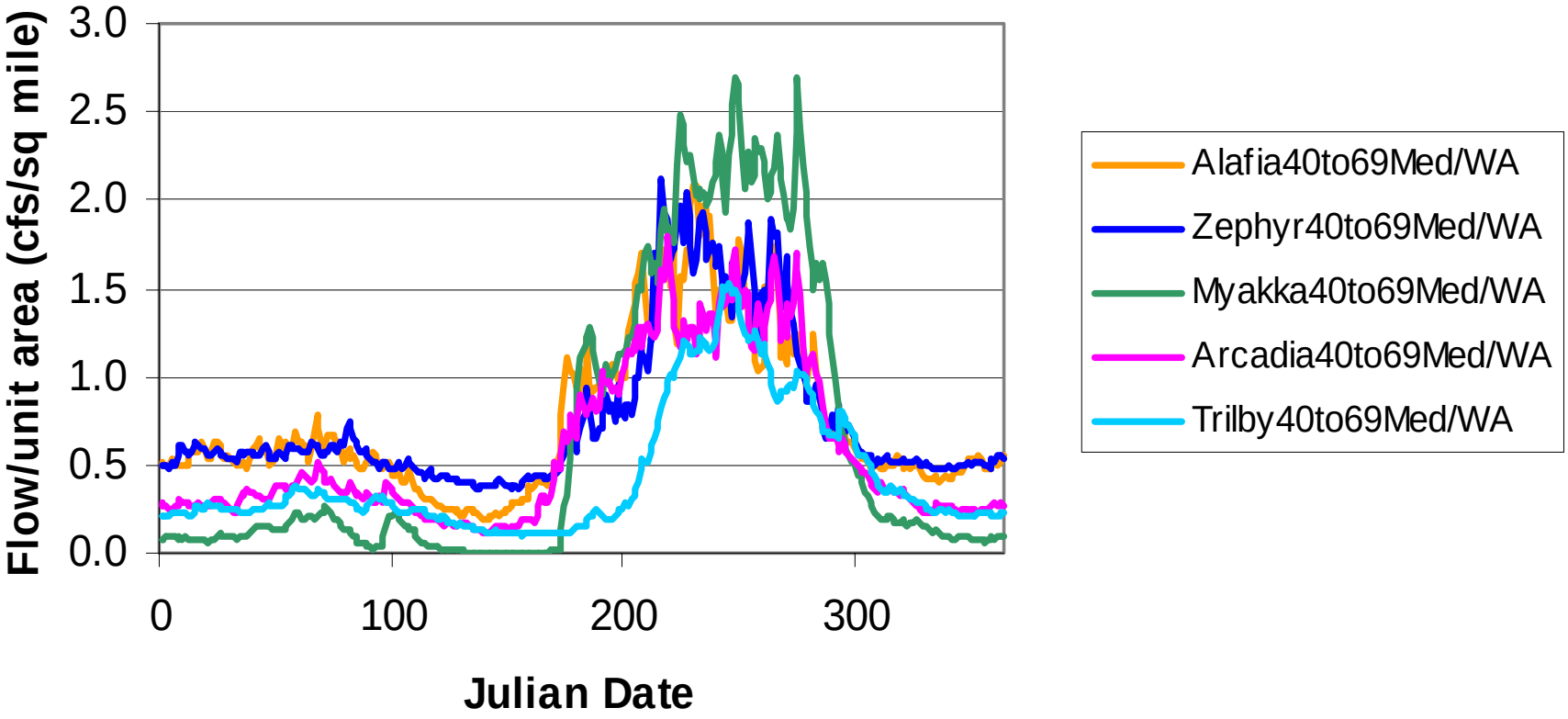
River MFL Approach

- ***Flow Regime – Building Block Approach***
- ***Two benchmark periods***
- ***Multiple MFLs - address seasonality***
- ***Percent of Flow Reduction Technique***
- ***PHABSIM– first application in Florida***
- ***Significant Harm - 15% reduction in available habitat***
- ***River-floodplain connection***

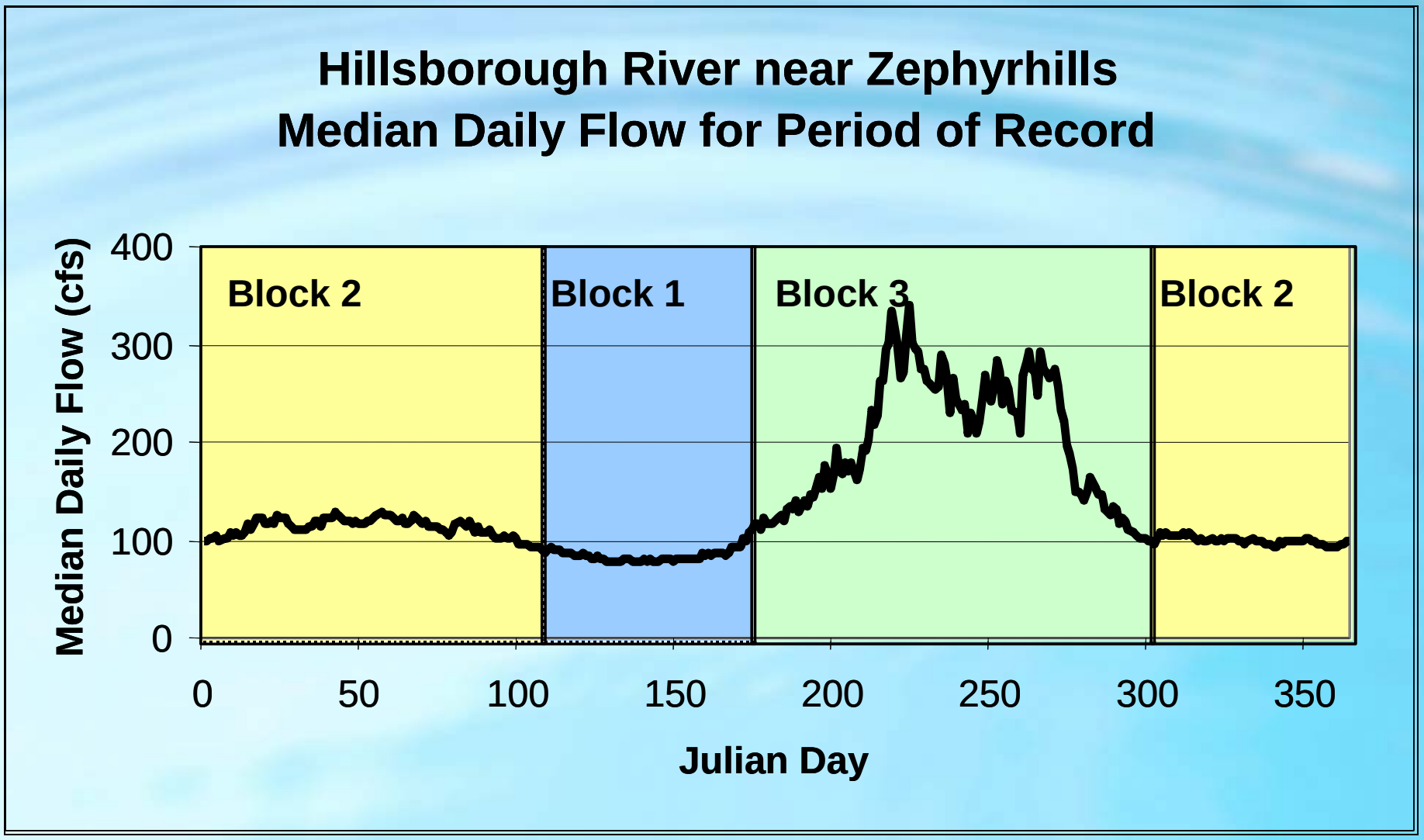
Approach

- Flow Regime versus Minimum Flow
- Benchmark Period
- Building Blocks (Peer Review Recommendation)
- % of Flow Reduction / Flow Prescription

Building Block Approach



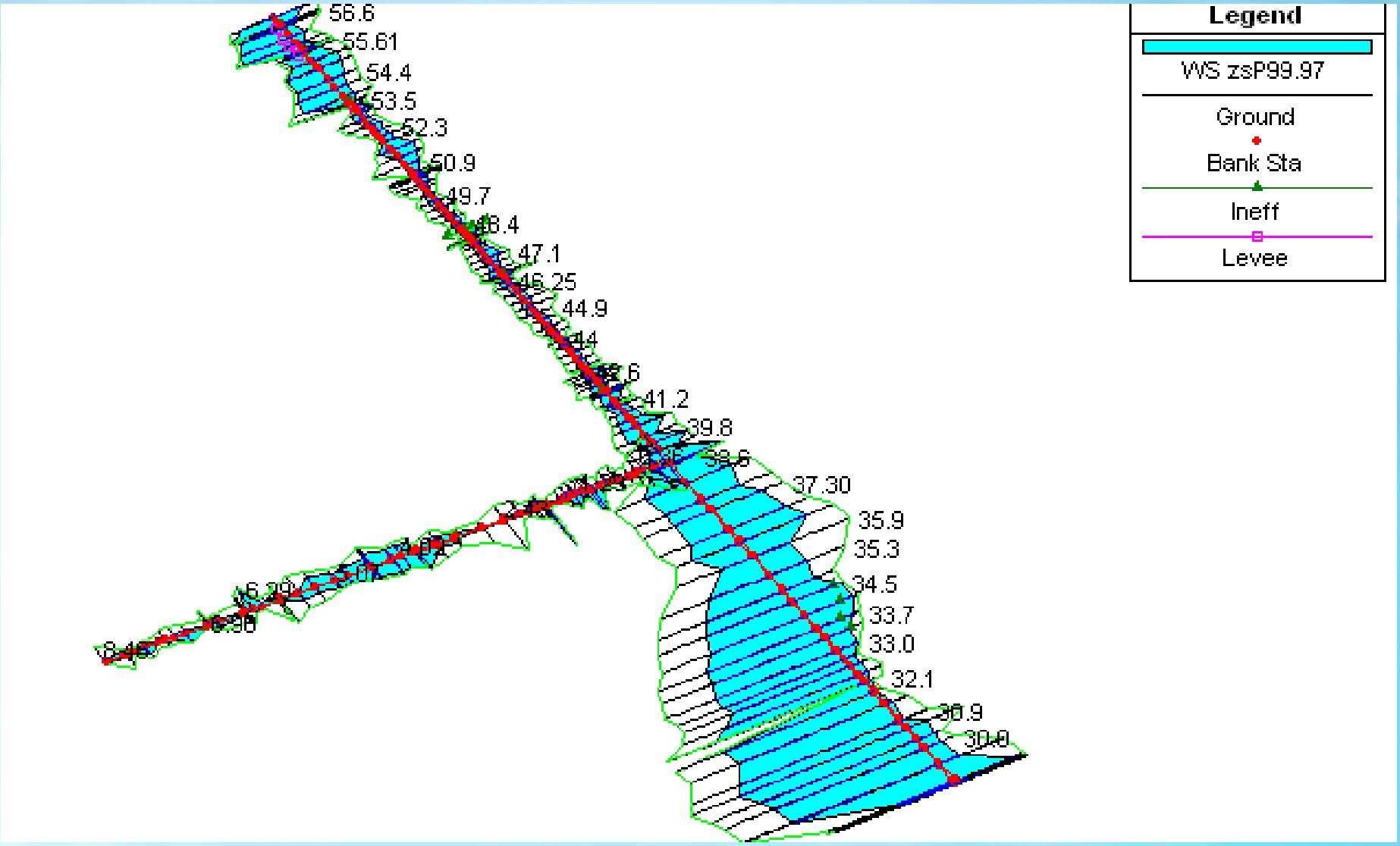
	Begin Dry (Block 1)	Begin Wet (Block 3)	End Wet (Block 3)
Alafia at Lithia	106	175	296
Hillsborough at Zephyr Hills	112	176	296
Myakka at Sarasota	115	181	306
Peace at Arcadia	110	174	299
Withlacoochee at Croom	130	208	306
Mean w/o Withlacoochee	110	177	300
Mean with Withlacoochee	114	183	301


Hillsborough River near Zephyrhills
Median Daily Flow for Period of Record
Median Daily Flow (cfs)
400
300
200
100
0
Block 2
Block 1
Block 3
Block 2
0
50
100
150
200
250
300
350
Julian Day

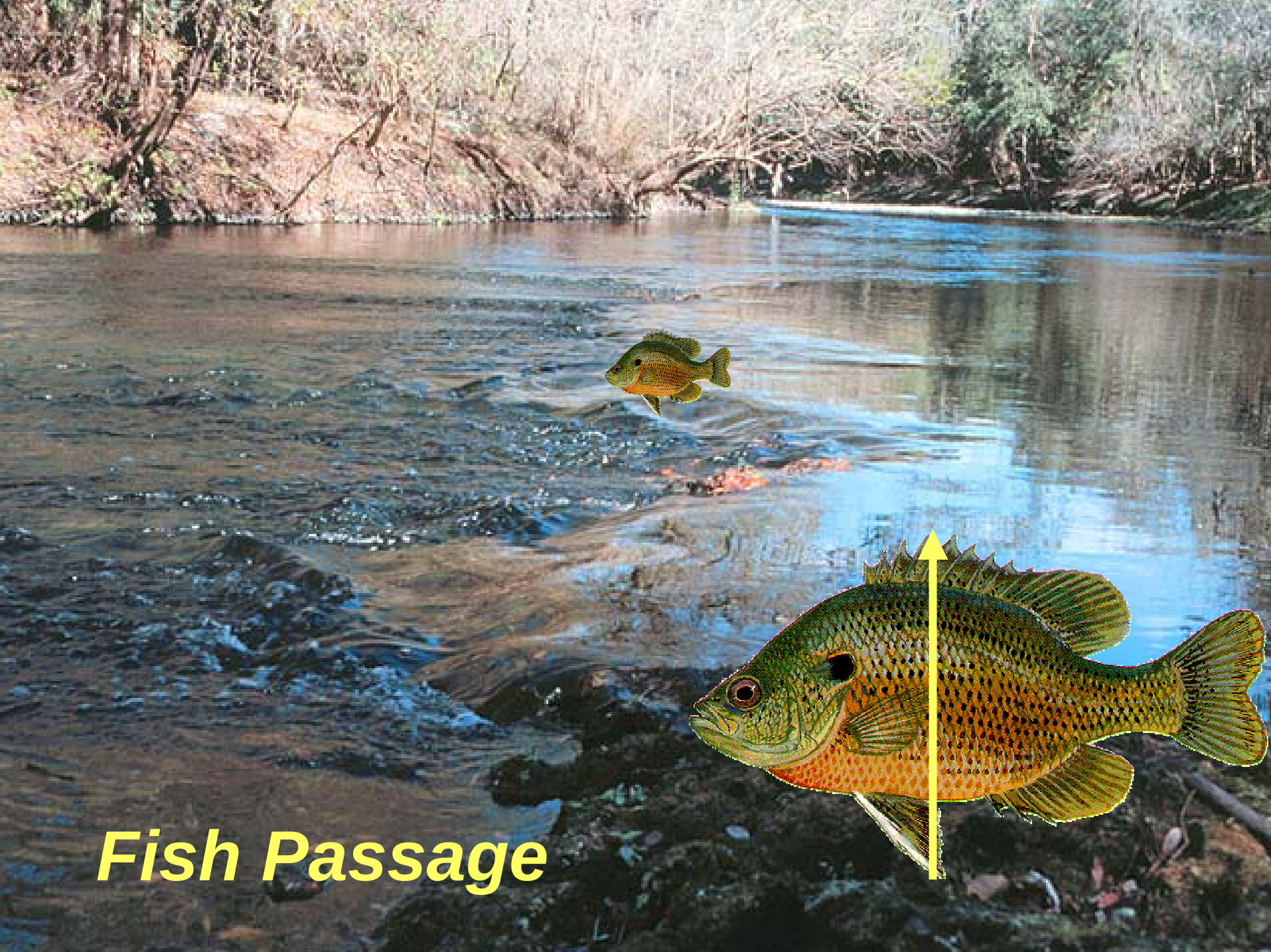
Tools

- HEC-RAS
- Physical Habitat Simulation Analysis (peer review recommendation)
- Inundation Analysis
- Prescribed Flow Hydrographs

HEC-RAS Modeling



Wetted Perimeter

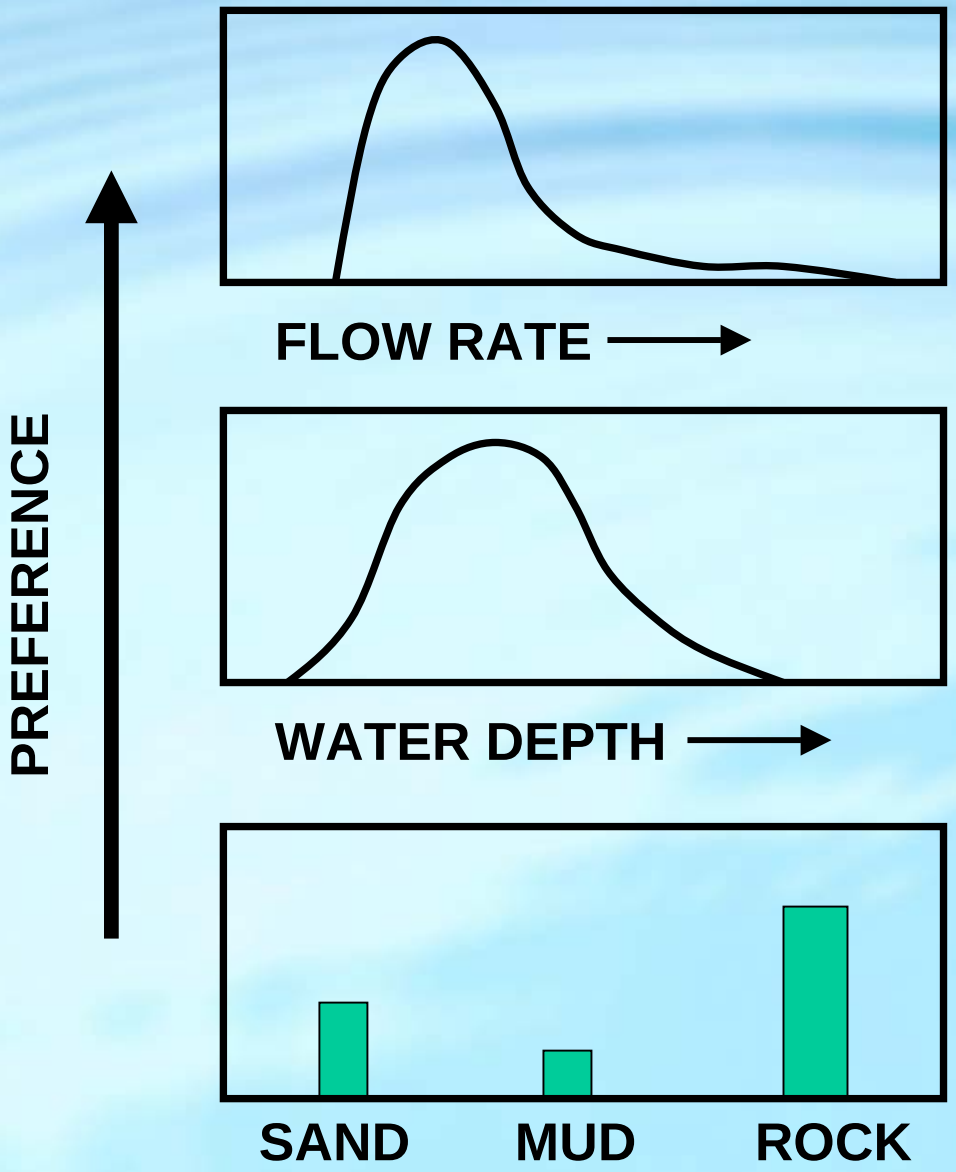

Fish Passage

Habitat Suitability Curves

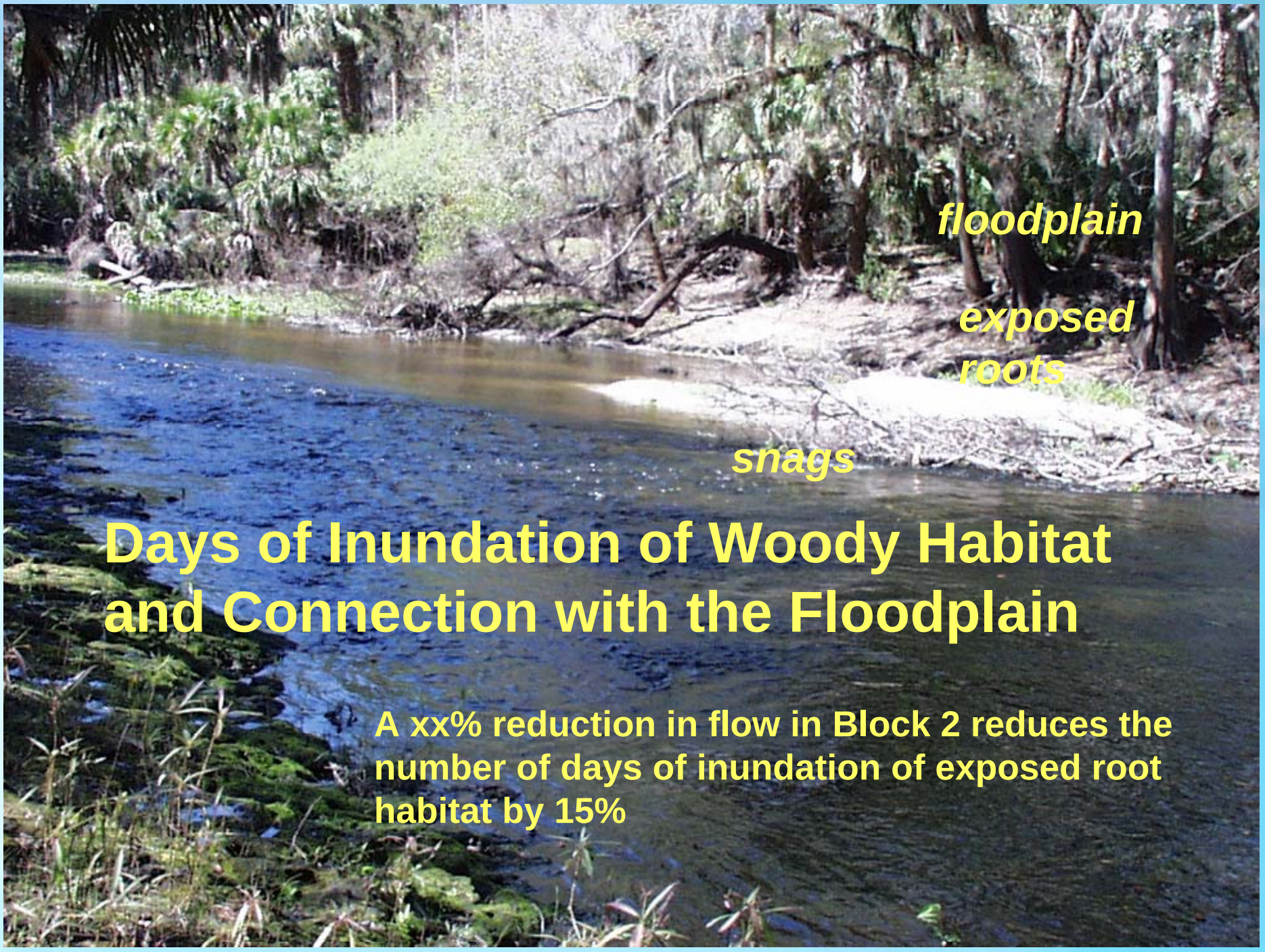
- Macroinvertebrate Diversity
- Largemouth Bass
- Bluegill Sunfish
- Spotted Sunfish

Spotted sunfish (*Lepomis punctatus*)
taken from FFWCC website

PHABSIM – Physical Habitat Simulation System

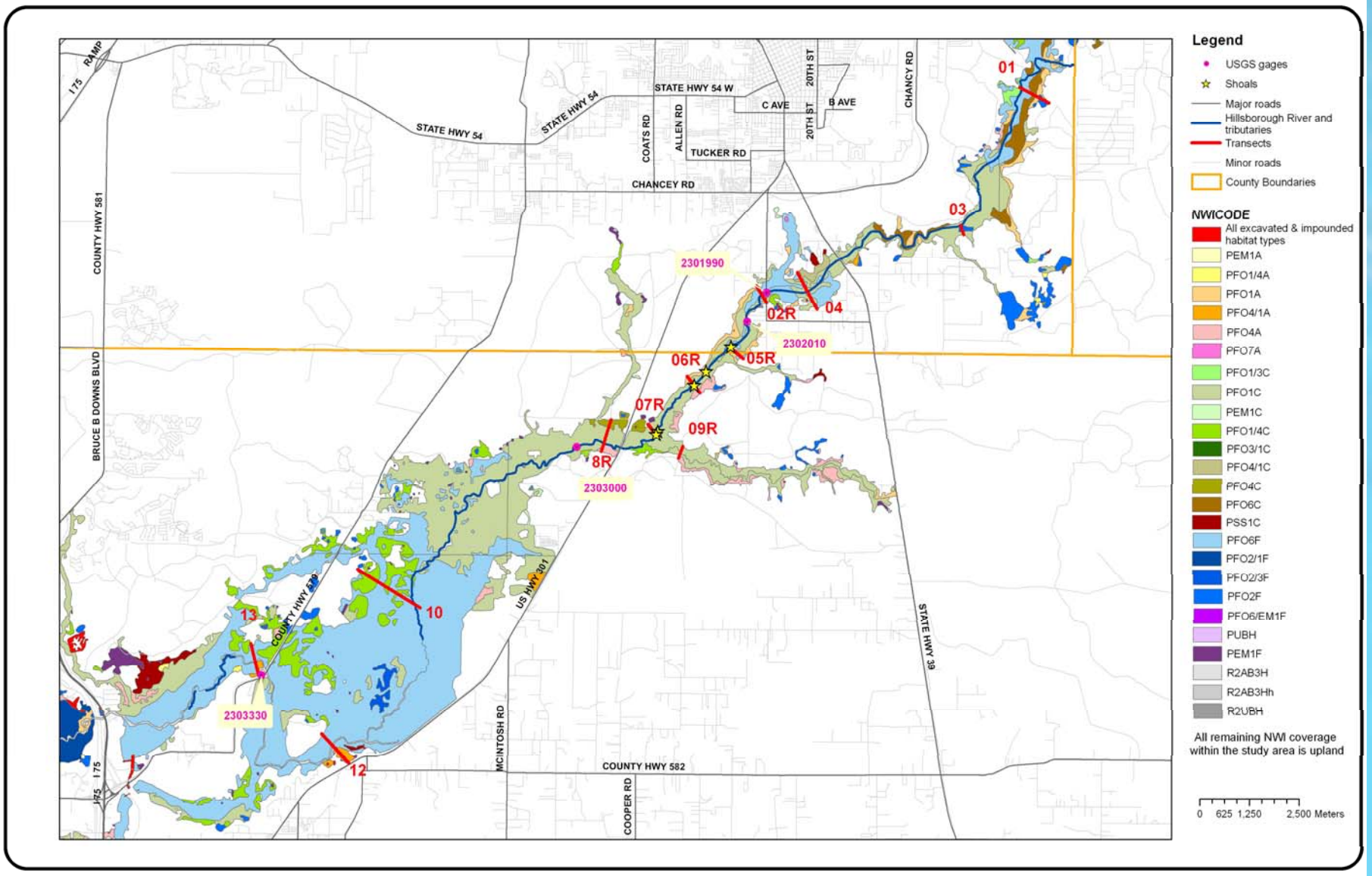


HABITAT SUITABILITY



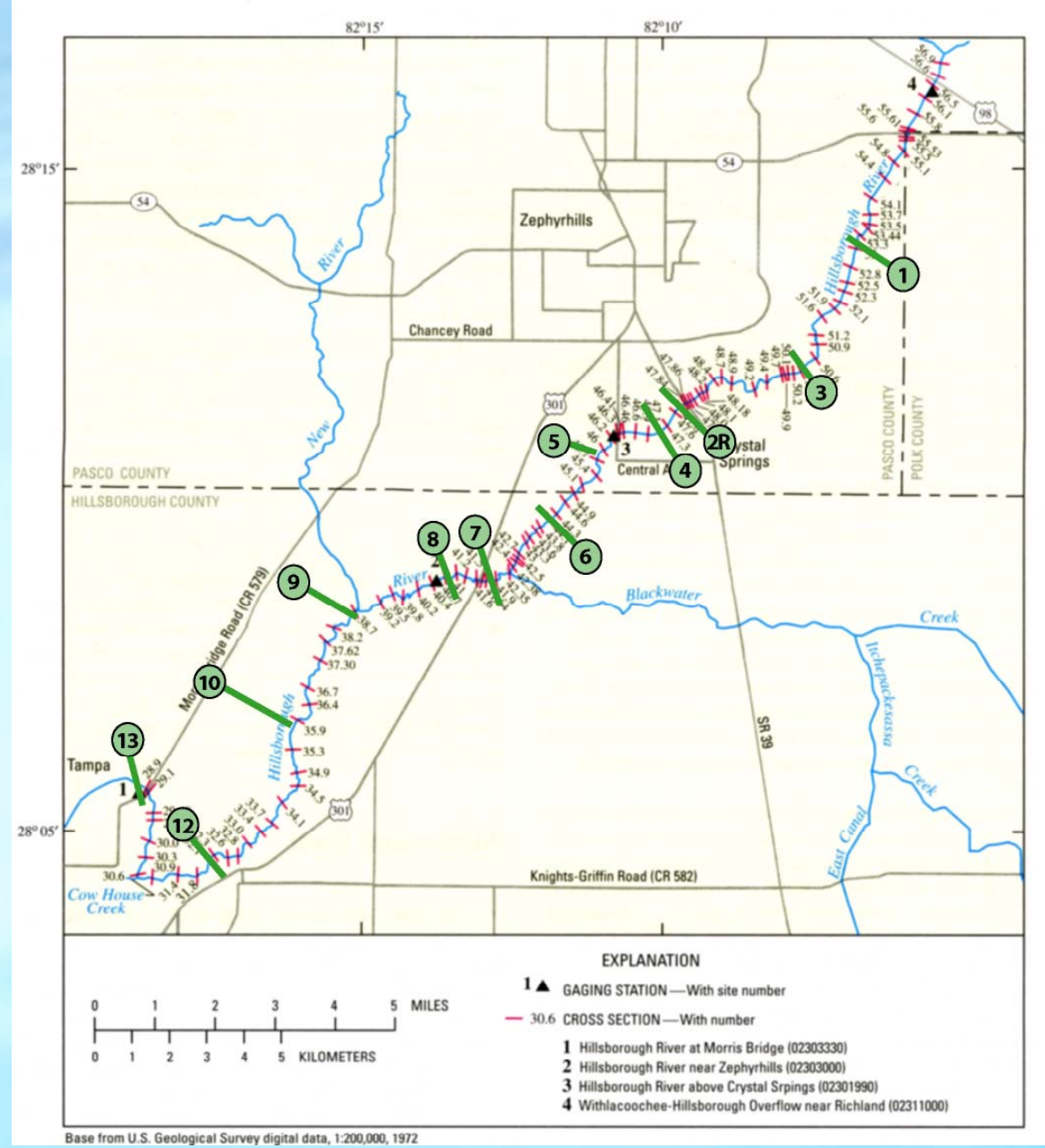
Days of Inundation of Woody Habitat and Connection with the Floodplain

A xx% reduction in flow in Block 2 reduces the number of days of inundation of exposed root habitat by 15%


Legend
USGS gages
Shoals
Major roads
Hillsborough River and tributaries
Transects
Minor roads
County Boundaries
NWICODE
All excavated & impounded habitat types
PEM1A
PFO1/4A
PFO1A
PFO4/1A
PFO4A
PFO7A
PFO1/3C
PFO1C
PEM1C
PFO1/4C
PFO3/1C
PFO4/1C
PFO4C
PFO6C
PSS1C
PFO6F
PFO2/1F
PFO2/3F
PFO2F
PFO6/EM1F
PUBH
PEM1F
R2AB3H
R2AB3Hh
R2UBH
All remaining NWI coverage within the study area is upland
0 625 1,250 2,500 Meters
01
03
04
02R
05R
06R
07R
09R
8R
10
12
13
2301990
2302010
2303000
2303330
STATE HWY 54
STATE HWY 54 W
C AVE
B AVE
20TH ST
CHANCY RD
COATS RD
ALLEN RD
TUCKER RD
CHANCEY RD
COUNTY HWY 581
BRUCE B DOWNS BLVD
I 75 RAMP
I 75
COUNTY HWY 579
US HWY 301
MCINTOSH RD
COUNTY HWY 582
COOPER RD
STATE HWY 39

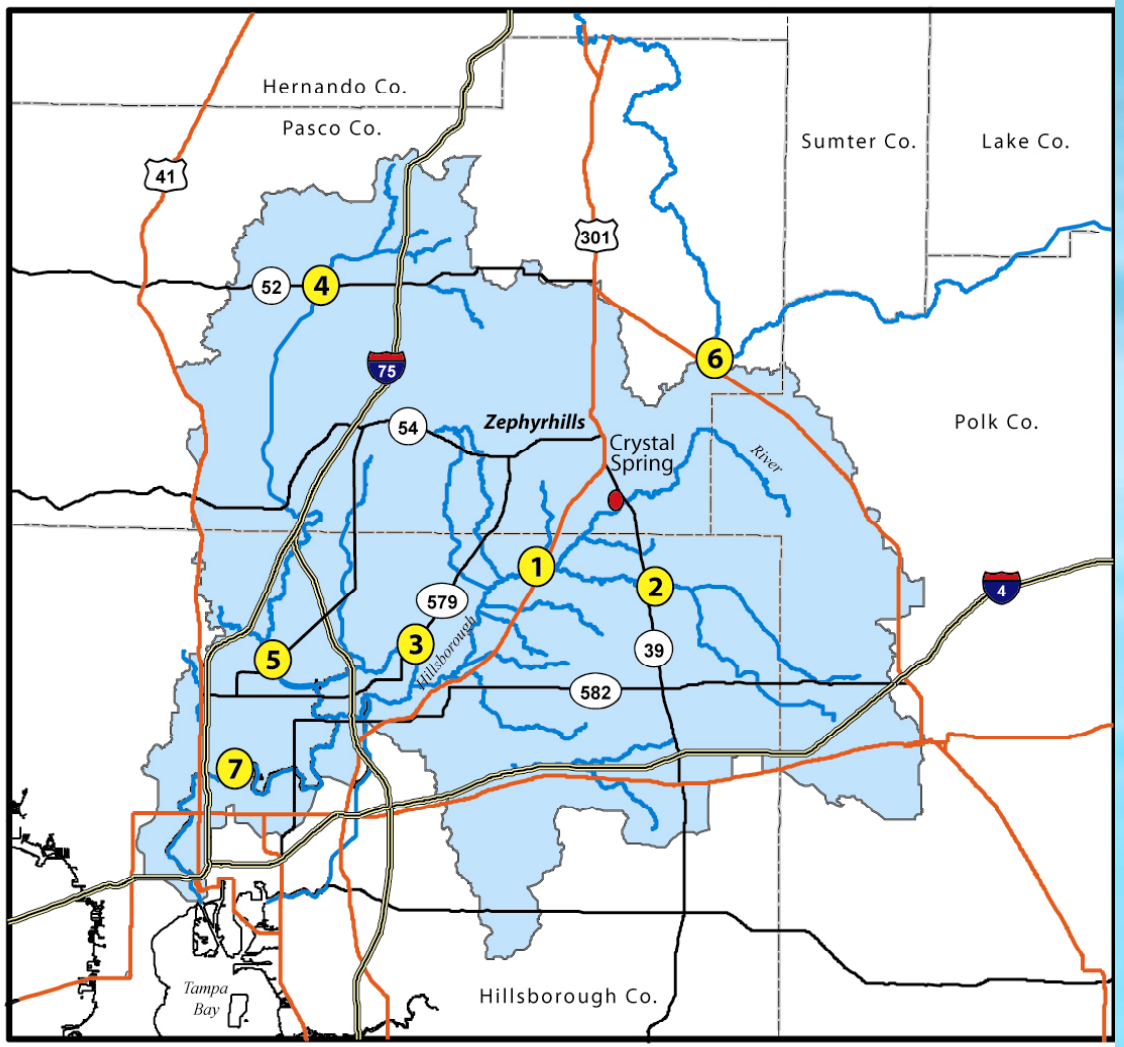
Habitat type relative coverage along transects on the upper Hillsborough River.

Transect	% Bottomland Forest	% Floodplain Swamp
01	50.00	50.00
02R	60.00	40.00
03	40.00	60.00
04	75.00	25.00
05R	62.50	37.50
06R	100.00	0.00
07R	100.00	0.00
08R	100.00	0.00
09R	88.89	11.11
10	70.59	29.41
12	42.86	57.14
13	56.25	43.75
ALL	70.51	29.49



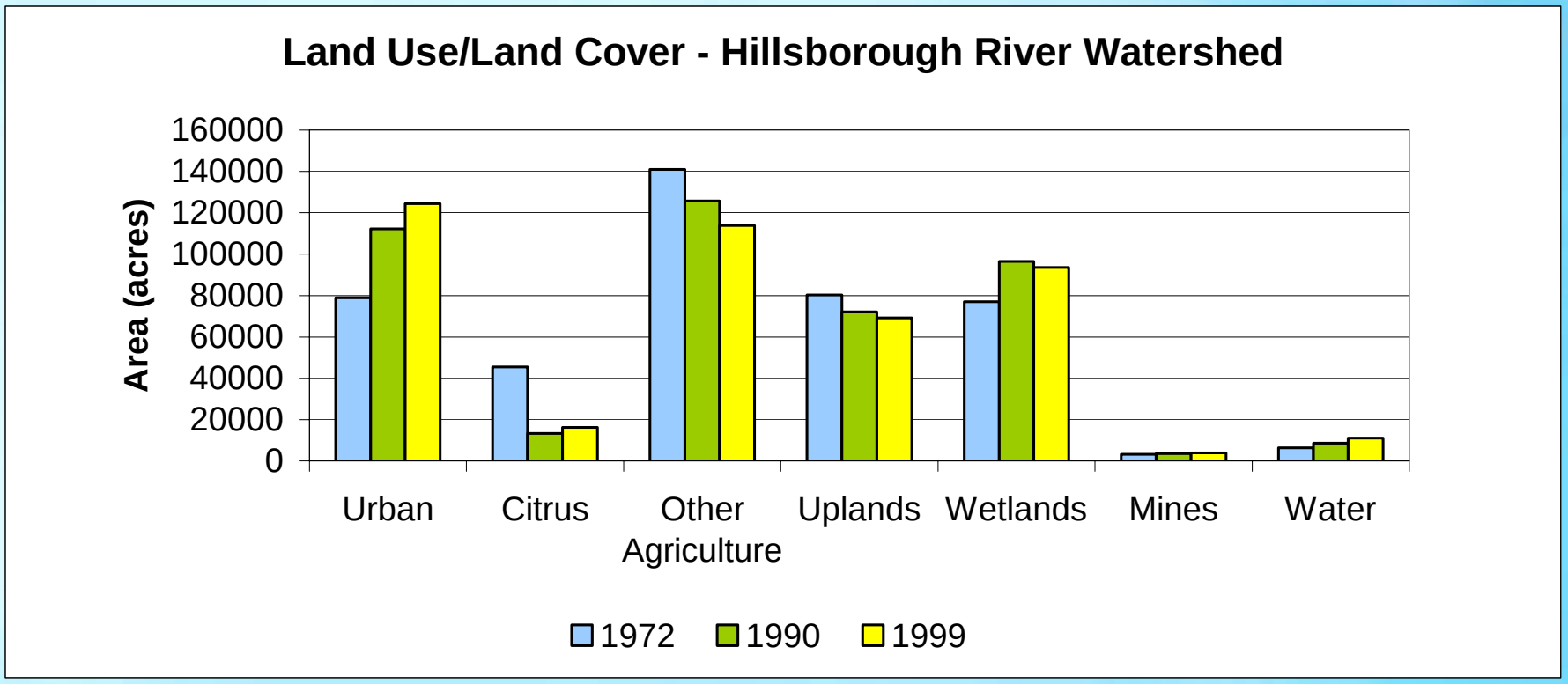
Base from U.S. Geological Survey digital data, 1:200,000, 1972

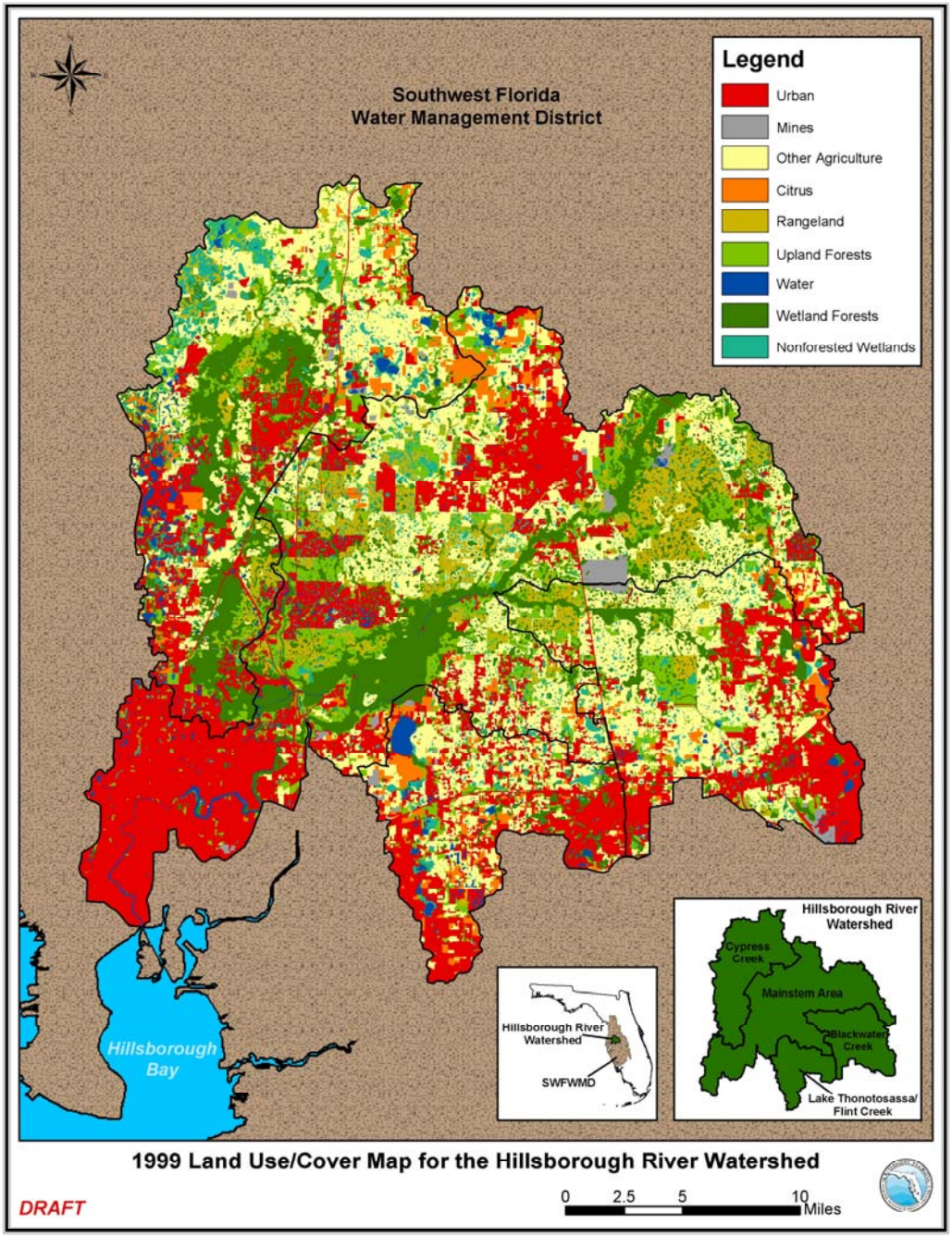
Hillsborough River Watershed *Gaging Stations*



1. *Hillsborough River near Zephyrhills*
2. *Blackwater Creek near Knights, Florida*
3. *Hillsborough River @ Morris Bridge near Thonotosassa*
4. *Cypress Creek near San Antonio*
5. *Cypress Creek near Sulphur Springs*
6. *Withlacoochee-Hillsborough overflow near Richland*
7. *Hillsborough River @ Rowlett Park Drive near Tampa*

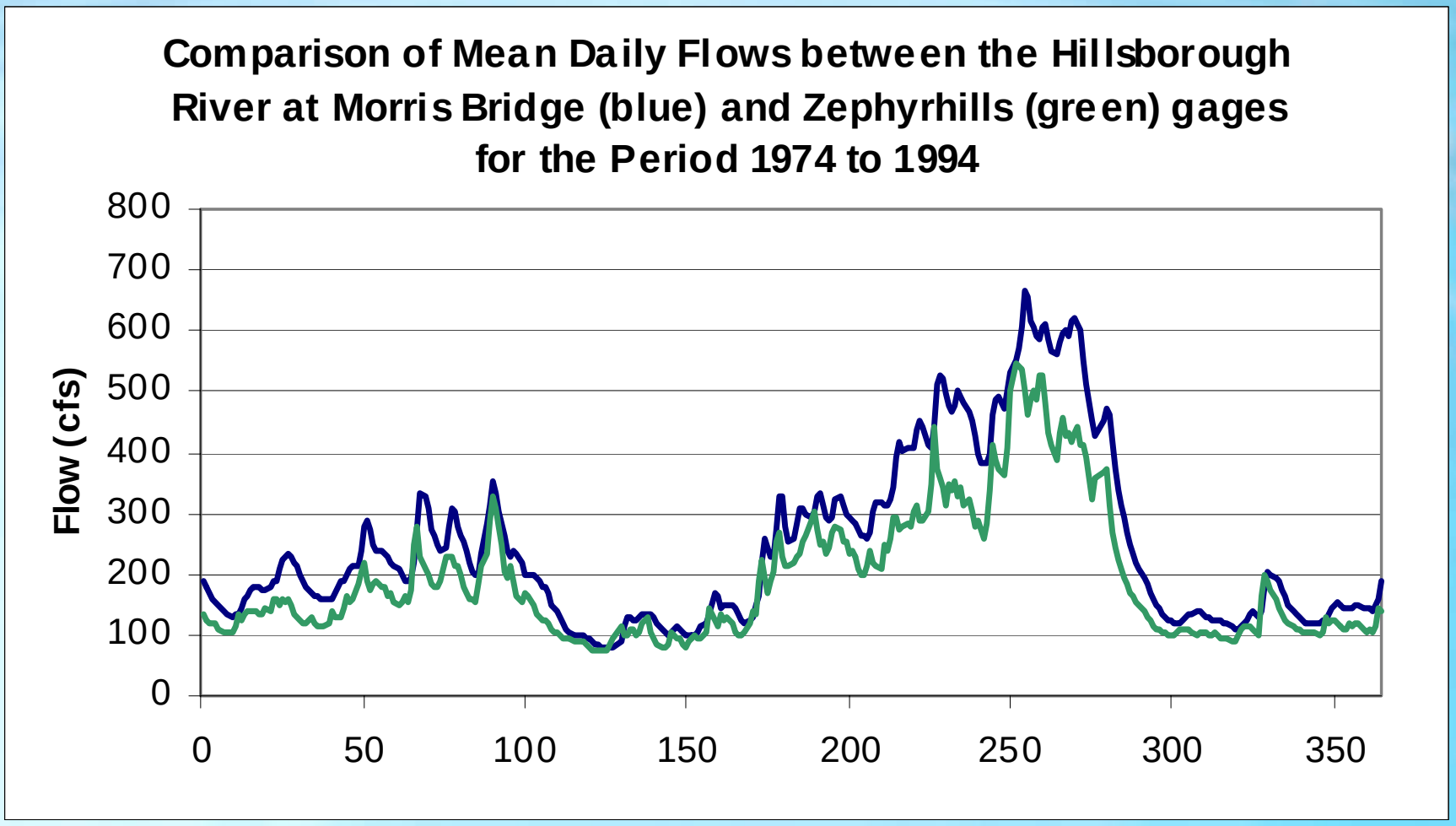
Hillsborough River Watershed	1972	1990	1999
Urban	18.28%	25.99%	28.78%
Citrus	10.53%	3.07%	3.76%
Other Agriculture	32.61%	29.11%	26.35%
Uplands	18.56%	16.67%	16.02%
Wetlands	17.80%	22.34%	21.64%
Mines	0.76%	0.84%	0.89%
Water	1.46%	1.98%	2.56%
Total acreage	432176	432176	432176

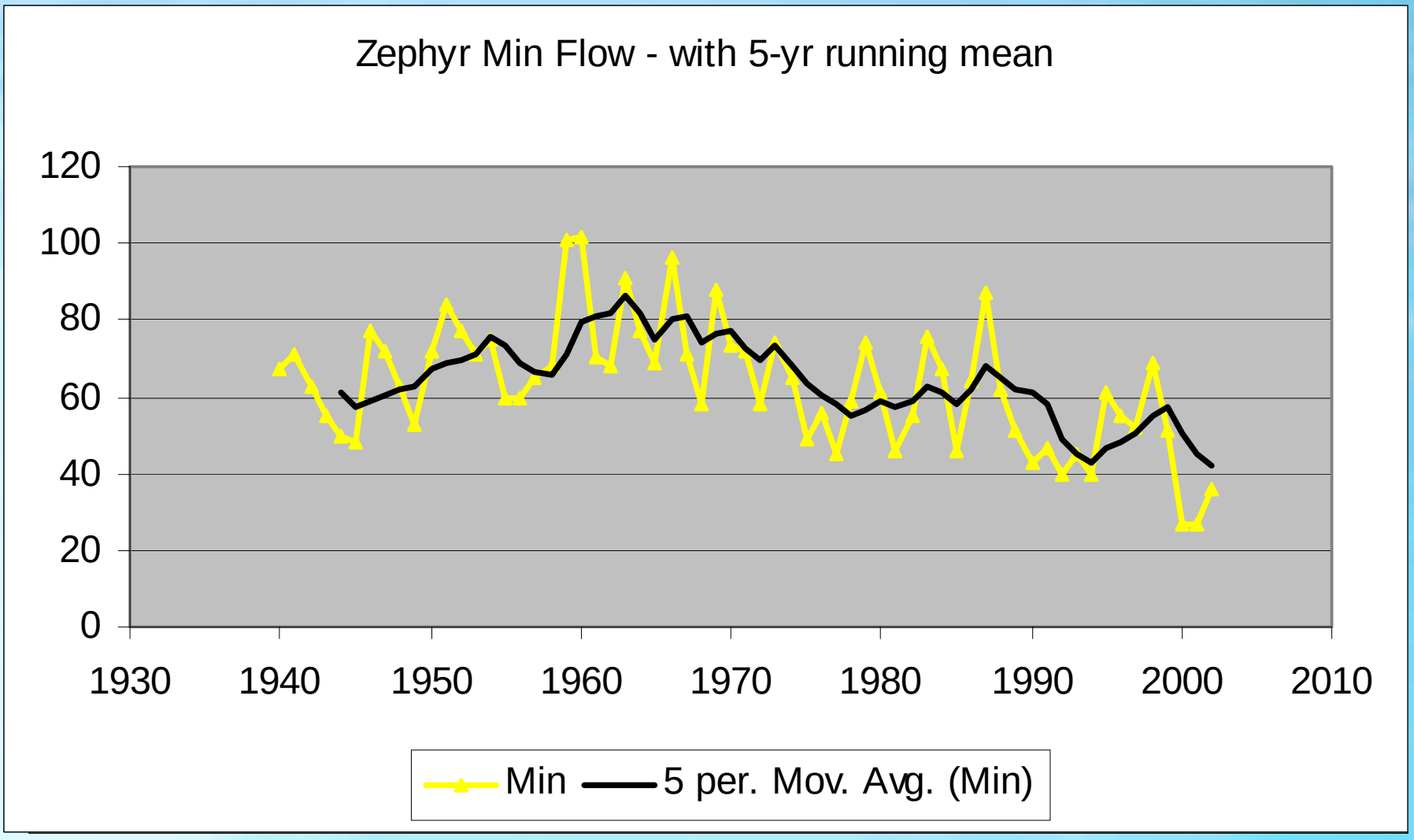



Southwest Florida
Water Management District
Legend
Urban
Mines
Other Agriculture
Citrus
Rangeland
Upland Forests
Water
Wetland Forests
Nonforested Wetlands
Hillsborough Bay
Hillsborough River Watershed
SWFWMD
Hillsborough River Watershed
Cypress Creek
Mainstem Area
Blackwater Creek
Lake Thonotosassa/ Flint Creek
1999 Land Use/Cover Map for the Hillsborough River Watershed
DRAFT
0 2.5 5 10 Miles

Percent Coverages Based on 1999 Landuse Maps

	Hillsborough	Myakka	Alafia	Peace
Urban	29	14	18	11
Citrus	4	2	5	15
Other Agriculture	26	26	18	29
Uplands	16	34	10	16
Wetlands	22	21	11	16
Mines	1	1	36	10
Water	3	3	3	4
Total Acres	432176	382764	269986	1501318
Square Miles	675	598	422	2346


Comparison of Mean Daily Flows between the Hillsborough River at Morris Bridge (blue) and Zephyrhills (green) gages for the Period 1974 to 1994
Flow (cfs)
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
350


Zephyr Min Flow - with 5-yr running mean
120
100
80
60
40
20
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
Min
5 per. Mov. Avg. (Min)

SITE	er Pat	40-69 MeanRank	70-94 MeanRank	95-05 MeanRank
BIG CREEK NR CLERMONT, FLA.	SRP	1	1	1
WITHLACOOCHEE RIVER NR HOLDER, FLA.	SRP	2	5	3
WITHLACOOCHEE RIVER AT TRILBY, FLA.	SRP	3	4	4
PEACE RIVER AT BARTOW FL	SRP	4	2	5
JOSHUA CREEK AT NOCATEE FL	SRP	5	12	15
PEACE RIVER AT ZOLFO SPRINGS FL	SRP	6	6	6
BLACKWATER CREEK NEAR KNIGHTS FL	SRP	7	7	7
FISHEATING CREEK AT PALMDALE, FLA.	SRP	8	13	10
HORSE CREEK NEAR ARCADIA FL	SRP	9	9	11
CHARLIE CREEK NEAR GARDNER FL	SRP	10	10	12
HILLSBOROUGH RIVER NEAR TAMPA FL	SRP	11	3	2
ARBUCKLE CREEK NR DE SOTO CITY, FLA.	SRP	12	8	8
ST. JOHNS RIVER NR DELAND, FLA.	SRP	13	16	14
MYAKKA RIVER NEAR SARASOTA FL	SRP	14	18	19
ANCLOTE RIVER NEAR ELFERS FL	SRP	15	11	9
ALAFIA RIVER AT LITHIA FL	SRP	16	14	13
ECONLOCKHATCHEE RIVER NR. CHULUOTA	SRP	17	20	20
LITTLE MANATEE RIVER NEAR WIMAUMA FL	SRP	18	19	18
HILLSBOROUGH RIVER NEAR ZEPHYRHILLS	SRP	19	15	16
NORTH PRONG ALAFIA RIVER AT KEYSVILLE	SRP	20	17	17

highlight changes of 4 or more place jump from one end to other

SITE	er Pat	Mea	Mea	Mea	40-69 MedianRank	70-94 MedianRank	95-05 MedianRank	Period Begins
BIG CREEK NR CLERMONT, FLA.	SRP	1	1	1	1	1	2	1958
WITHLACOOCHEE RIVER NR HOLDER, FLA.	SRP	2	5	3	10	11	7	
WITHLACOOCHEE RIVER AT TRILBY, FLA.	SRP	3	4	4	5	5	3	
PEACE RIVER AT BARTOW FL	SRP	4	2	5	6	3	5	
JOSHUA CREEK AT NOCATEE FL	SRP	5	12	15	2	10	12	1951
PEACE RIVER AT ZOLFO SPRINGS FL	SRP	6	6	6	13	12	10	
BLACKWATER CREEK NEAR KNIGHTS FL	SRP	7	7	7	3	6	6	
FISHEATING CREEK AT PALMDALE, FLA.	SRP	8	13	10	4	9	11	
HORSE CREEK NEAR ARCADIA FL	SRP	9	9	11	7	7	8	1951
CHARLIE CREEK NEAR GARDNER FL	SRP	10	10	12	8	8	9	1951
HILLSBOROUGH RIVER NEAR TAMPA FL	SRP	11	3	2	11	2	1	
ARBUCKLE CREEK NR DE SOTO CITY, FLA.	SRP	12	8	8	16	13	17	
ST. JOHNS RIVER NR DELAND, FLA.	SRP	13	16	14	20	20	19	
MYAKKA RIVER NEAR SARASOTA FL	SRP	14	18	19	14	17	18	
ANCLOTE RIVER NEAR ELFERS FL	SRP	15	11	9	9	4	4	1946
ALAFIA RIVER AT LITHIA FL	SRP	16	14	13	17	16	14	
ECONLOCKHATCHEE RIVER NR. CHULUOTA	SRP	17	20	20	15	19	20	
LITTLE MANATEE RIVER NEAR WIMAUMA FL	SRP	18	19	18	12	14	15	
HILLSBOROUGH RIVER NEAR ZEPHYRHILLS	SRP	19	15	16	18	15	13	
NORTH PRONG ALAFIA RIVER AT KEYSVILLE	SRP	20	17	17	19	18	16	1951

highlight changes of 4 or more place jump from one end to other

Period Tested	Mean	Median	corr_val	p_value	intercept	slope
1939 to 2004	246	209	-0.1207	0.1534	1914.37	-0.8648
1939 to 1994	242	206	-0.2182	0.0179	3205.49	-1.5252
1939 to 1969	287	231	0.1097	0.3954	-3068.16	1.6884
1970 to 1994	187	187	-0.0067	0.9814	308.586	-0.0615
1995 to 2004	265	279	0.1556	0.5915	-21177	10.7310

Kendall's tau & Mann Whitney – Zephyr Annual Flows

			Significance level
1970 to 1994 median = 186.7	less than	1939 to 1969 median = 230.9	0.0008
1995 to 2004 median = 279.7	not equal	1939 to 1969 median = 230.9	0.9395
1970 to 1994 median = 186.7	less than	1995 to 2004 median = 279.7	0.0855

Kendall Tau Analysis of Zephyrhills % Exceedance Flow Data

Period Tested		Mean	Median	corr_val	p_value	intercept	slope
1939 to 2004							
	95%	70	70	-0.2098	0.0129	607.455	-0.2727
	90%	75	75	-0.1706	0.0432	568.125	-0.2500
	75%	89	85	-0.1608	0.0568	587.794	-0.2549
	50%	126	121	-0.1226	0.1469	748.114	-0.3182
	30%	209	186	-0.1128	0.1822	1425.86	-0.6286
	10%	258	215	-0.1040	0.2192	1895.28	-0.8519
1939 to 1969							
	95%	78	75	0.2598	0.0456	-1321.57	0.7143
	90%	83	79	0.2966	0.0222	-1484.6	0.8000
	75%	98	95	0.2575	0.0475	-1493.53	0.8125
	50%	144	127	0.1963	0.1337	-0.481481	0.8889
	30%	251	194	0.0598	0.6555	-1543.33	0.8889
	10%	660	548	0.0161	0.9148	-2441.74	1.5294
1970 to 1994							
	95%	64	62	-0.3000	0.0373	1658.61	-0.8056
	90%	69	70	-0.2100	0.1470	1391.33	-0.6667
	75%	82	80	-0.1633	0.2619	982.911	-0.4556
	50%	108	103	0.0133	0.9441	-29.1333	0.0667
	30%	162	141	-0.0234	0.8885	768.633	-0.3167
	10%	385	370	-0.0200	0.9070	1640.51	-0.6410
1995 to 2004							
	95%	63	60	0.1091	0.6962	-2340	1.2000
	90%	68	66	0.0545	0.8763	-2134	1.1000
	75%	81	82	0.0909	0.7555	-1473.56	0.7778
	50%	116	121	0.0727	0.8148	-2323.44	1.2222
	30%	203	189	-0.0364	0.9378	1300.11	-0.5556
	10%	574	543	0.0182	1.0000	-3012.56	1.7778

Mann-Whitney Test of Zephyrhills % Exceedance Flow Data

	1939 to 1969	**greater than**	**1970 to 1994**	Significance level
95% Exceed	median = 75		median = 62	0.0012
90% Exceed	median = 79		median = 70	0.0029
75% Exceed	median = 95		median = 80	0.0049
50% Exceed	median = 127		median = 103	0.0033
30% Exceed	median = 194		median = 141	0.0084
10% Exceed	median = 548		median = 370	0.0094

	1939 to 1969	**not equal**	**1995 to 2004**	
95% Exceed	median = 74.5		median = 60	0.0852
90% Exceed	median =79		median = 66	0.1224
75% Exceed	median = 94.5		median = 82	0.1334
50% Exceed	median = 127		median = 121	0.2895
30% Exceed	median = 194		median = 189	0.5464
10% Exceed	median = 548		median = 543	0.8368

 # USGS 02303000 HILLSBOROUGH RIVER NEAR ZEPHYRHILLS FL

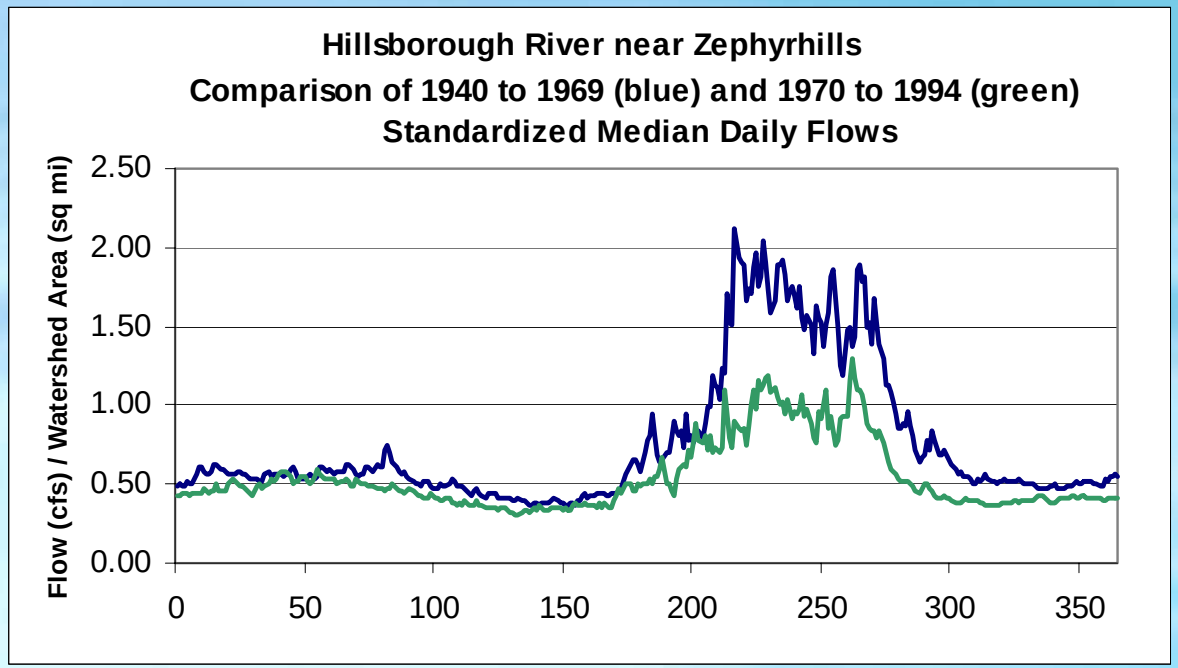
	Block 1	Block 2	Block 3	Year	
Mean of 40 to 69 Daily Median Flow/WA:	0.44	0.55	1.36	0.81	
Mean 40 to 69 Daily Median Flow (inches)	1.11	3.61	6.22	10.94	10.94
Percentage of annual flow	10.13	33.01	56.86	100.00	
Mean of 70 to 99 Daily Median Flow/WA:	0.36	0.45	0.76	0.54	
Mean 70 to 94 Daily Median Flow (inches)	0.91	2.93	3.50	7.34	7.34
Percentage of annual flow	12.35	39.92	47.73	100.00	
Mean of 40 to 69 Daily Mean Flow/WA:	0.66	0.80	2.28	1.27	
Mean of 40 to 69 Mean Daily Flow in inches	1.64	5.23	10.44	17.31	17.31
Percentage of annual flow	9.46	30.24	60.30	100.00	
Mean of 70 to 94 Daily Mean Flow/WA:	0.48	0.69	1.28	0.85	
Mean of 70 to 94 Mean Daily Flow in inches	1.20	4.48	5.88	11.56	11.56
Percentage of annual flow	10.38	38.72	50.89	100.00	

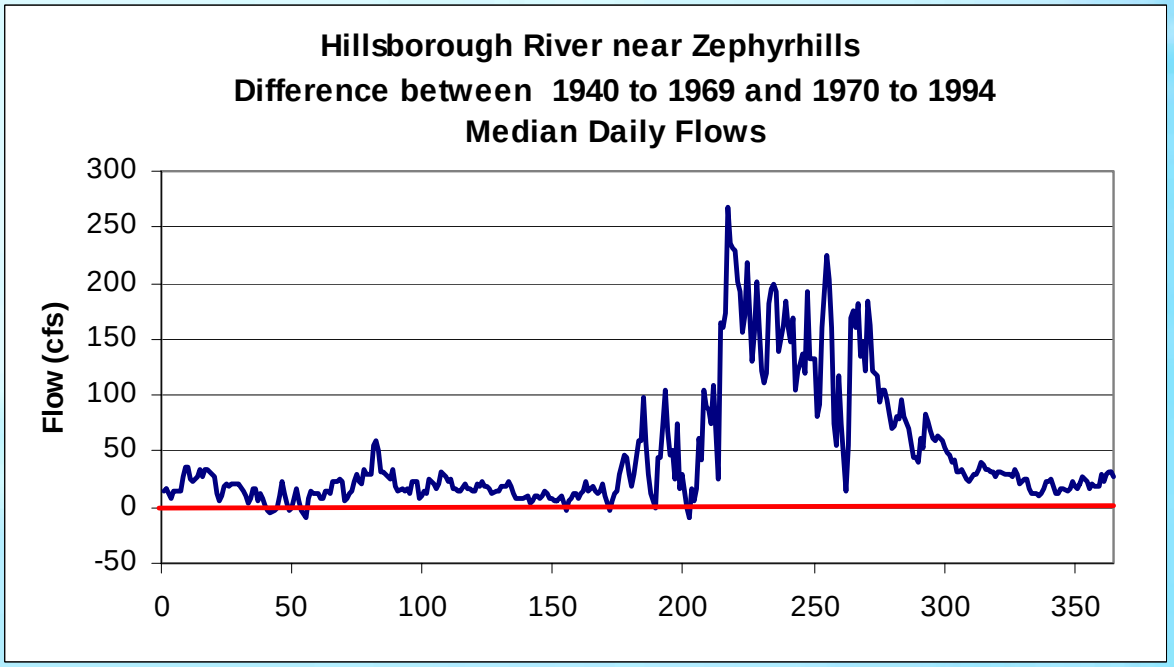
Percent Change between periods	Block 1	Block 2	Block 3	Year
40 to 69 versus 70 to 94 Median Daily Flows	18.27547	18.91031	43.69994	32.94053
40 to 69 versus 70 to 94 Mean Daily Flows	26.66714	14.48546	43.62907	33.21078

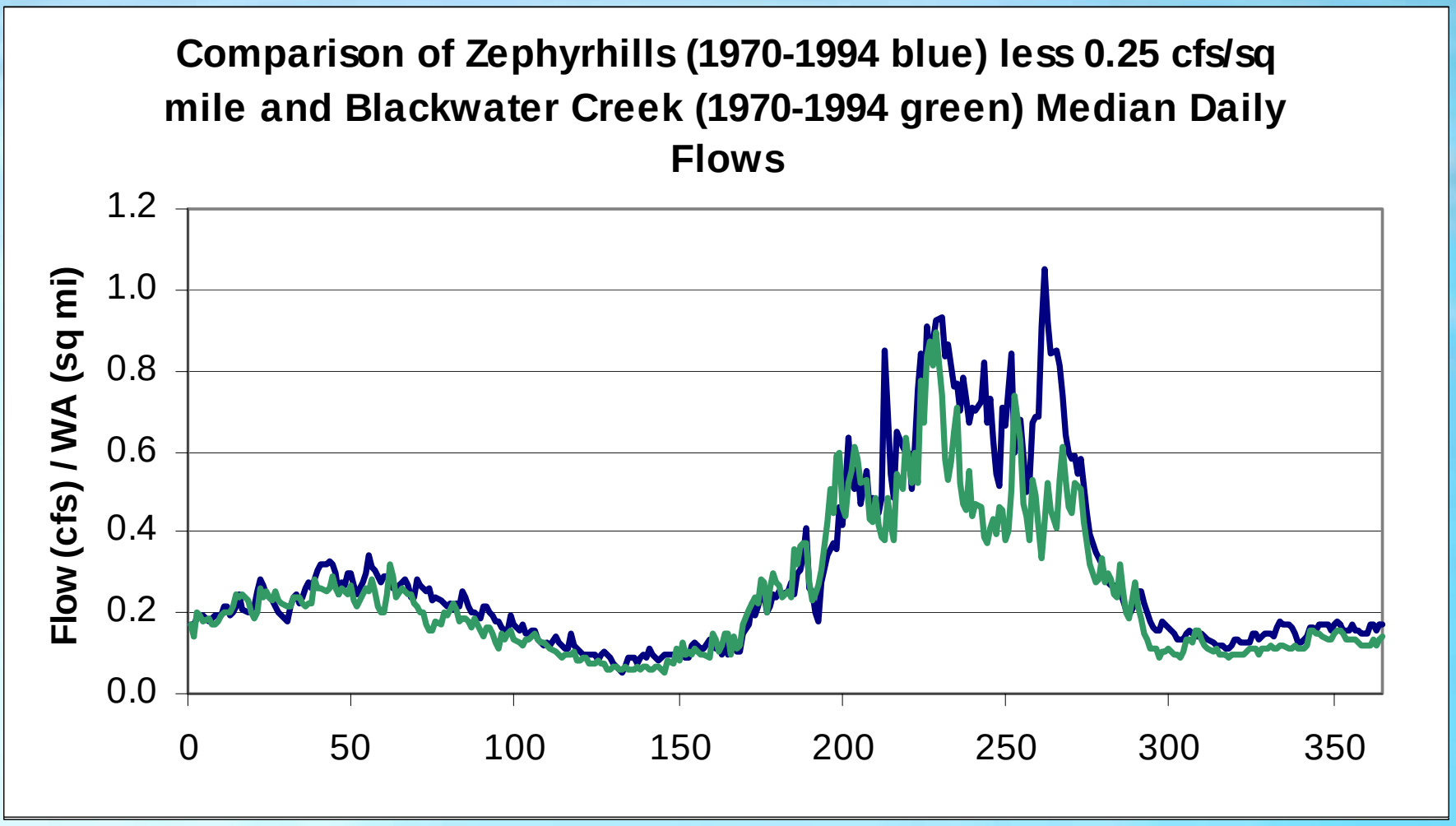
USGS 02303000 HILLSBOROUGH RIVER NEAR ZEPHYRHILLS FL

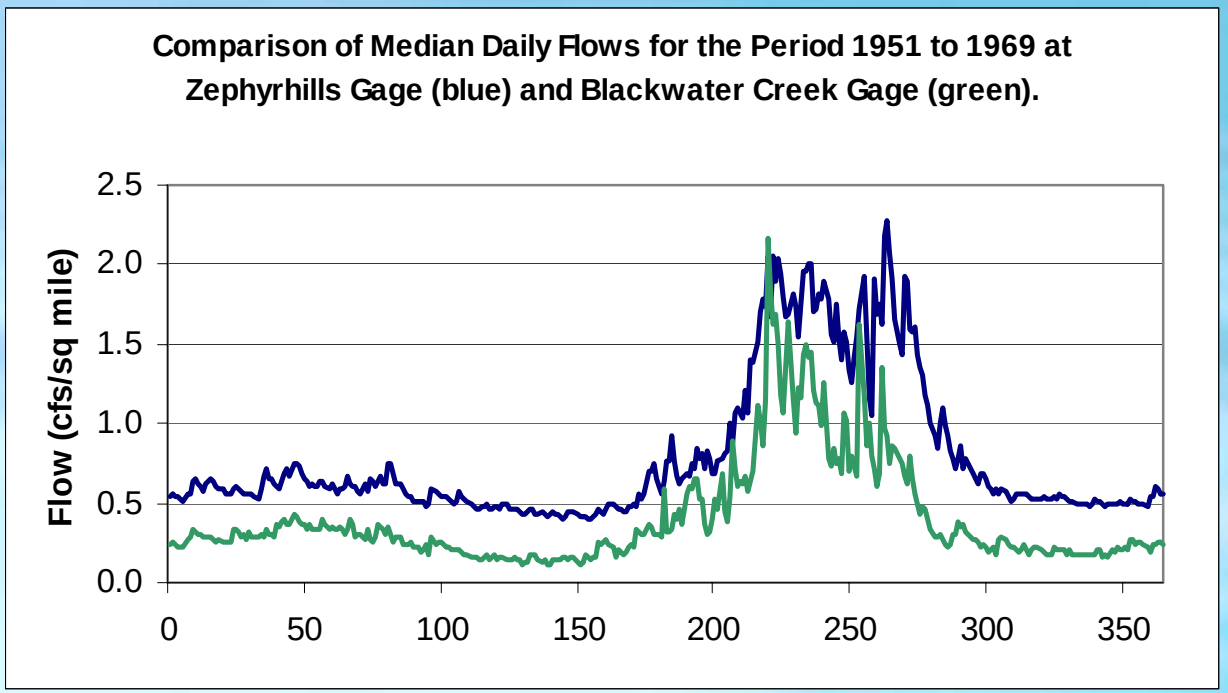
	Block 1	Block 2	Block 3	Year	
Mean of 70 to 94 Daily Median Flow/WA:	0.36	0.45	0.76	0.54	
Mean 70 to 94 Daily Median Flow (inches)	0.91	2.93	3.50	7.34	7.34
Percentage of annual flow	12.35	39.92	47.73	100.00	
Mean of 95 to 05 Daily Median Flow/WA:	0.38	0.49	0.88	0.60	
Mean 95 to 05 Daily Median Flow (inches)	0.96	3.16	4.03	8.15	8.15
Percentage of annual flow	11.78	38.80	49.41	100.00	
Mean of 70 to 94 Daily Mean Flow/WA:	0.48	0.69	1.28	0.85	
Mean of 70 to 94 Mean Daily Flow in inches	1.20	4.48	5.88	11.56	11.56
Percentage of annual flow	10.38	38.72	50.89	100.00	
Mean of 95 to 05 Daily Mean Flow/WA:	0.49	1.04	1.69	1.16	
Mean of 95 to 05 Mean Daily Flow in inches	1.22	6.78	7.76	15.76	15.76
Percentage of annual flow	7.75	43.01	49.25	100.00	

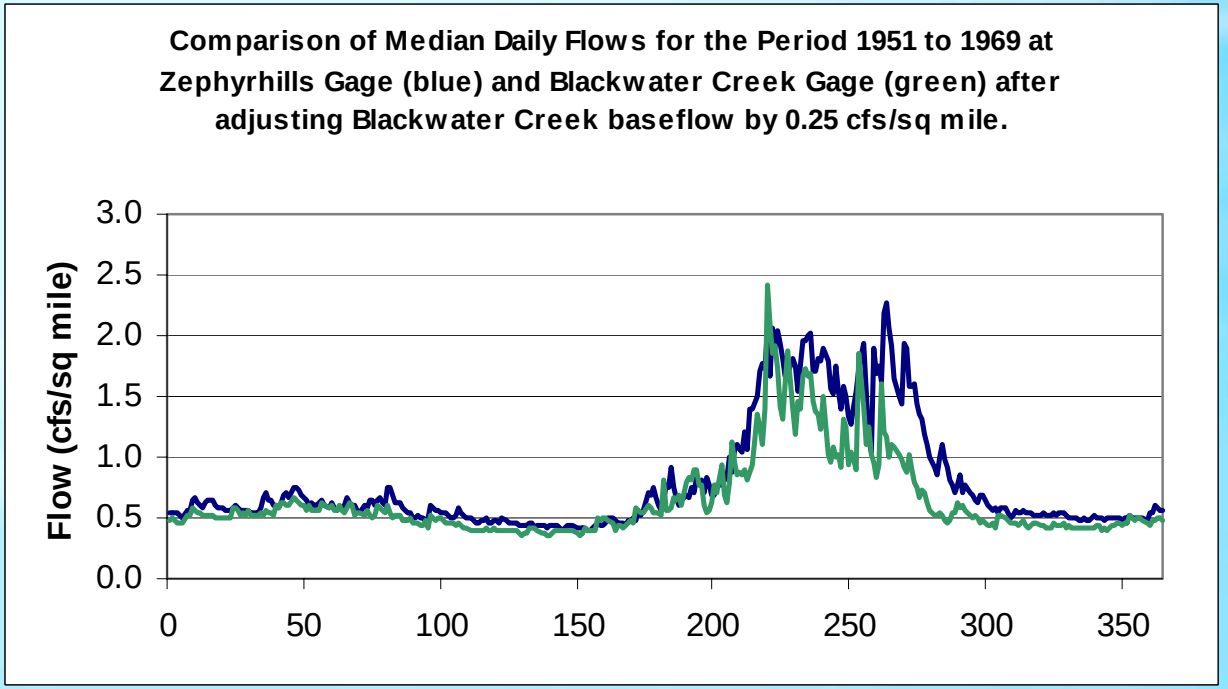
Percent Change between periods	Block 1	Block 2	Block 3	Year
40 to 69 versus 70 to 94 Median Daily Flows	-5.919701	-7.917846	-14.91376	-11.01054
40 to 69 versus 70 to 94 Mean Daily Flows	-1.737597	-51.38778	-31.90431	-36.31736


Hillsborough River near Zephyrhills
Comparison of 1940 to 1969 (blue) and 1970 to 1994 (green)
Standardized Median Daily Flows
Flow (cfs) / Watershed Area (sq mi)
2.50
2.00
1.50
1.00
0.50
0.00
0
50
100
150
200
250
300
350


Hillsborough River near Zephyrhills
Difference between 1940 to 1969 and 1970 to 1994
Median Daily Flows
Flow (cfs)
300
250
200
150
100
50
0
-50
0
50
100
150
200
250
300
350

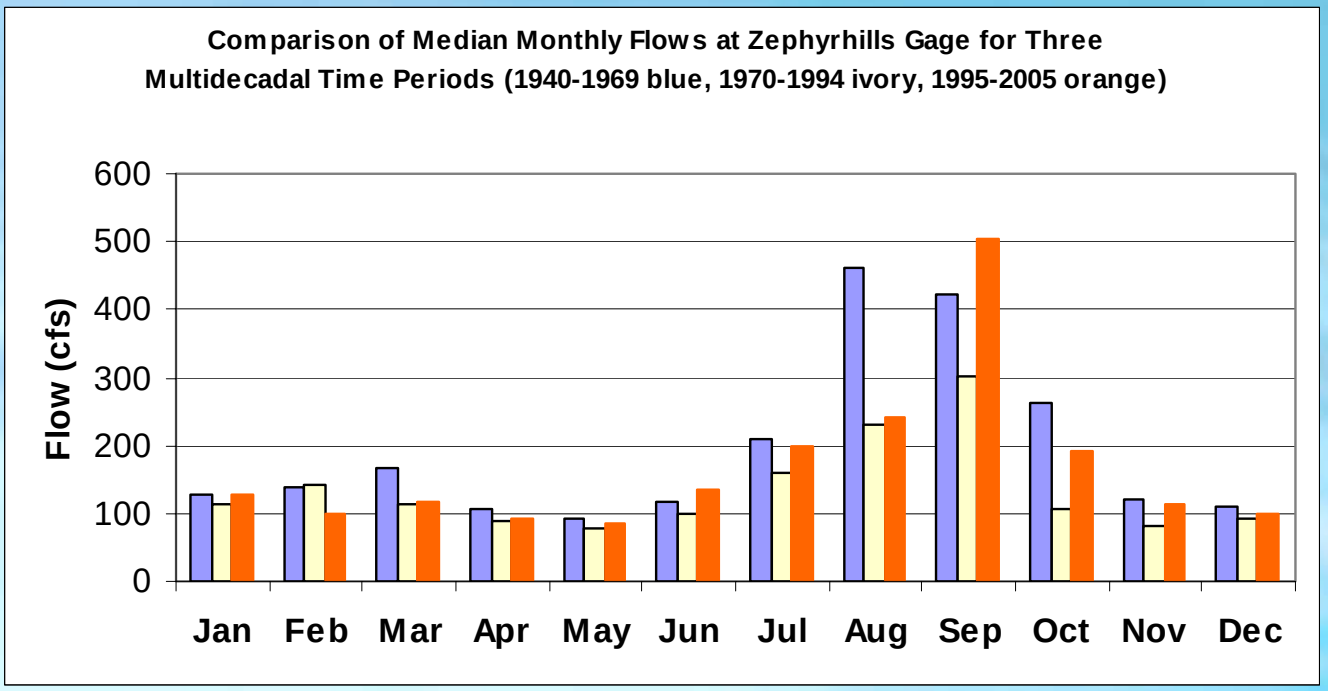

Comparison of Zephyrhills (1970-1994 blue) less 0.25 cfs/sq mile and Blackwater Creek (1970-1994 green) Median Daily Flows
Flow (cfs) / WA (sq mi)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250
300
350

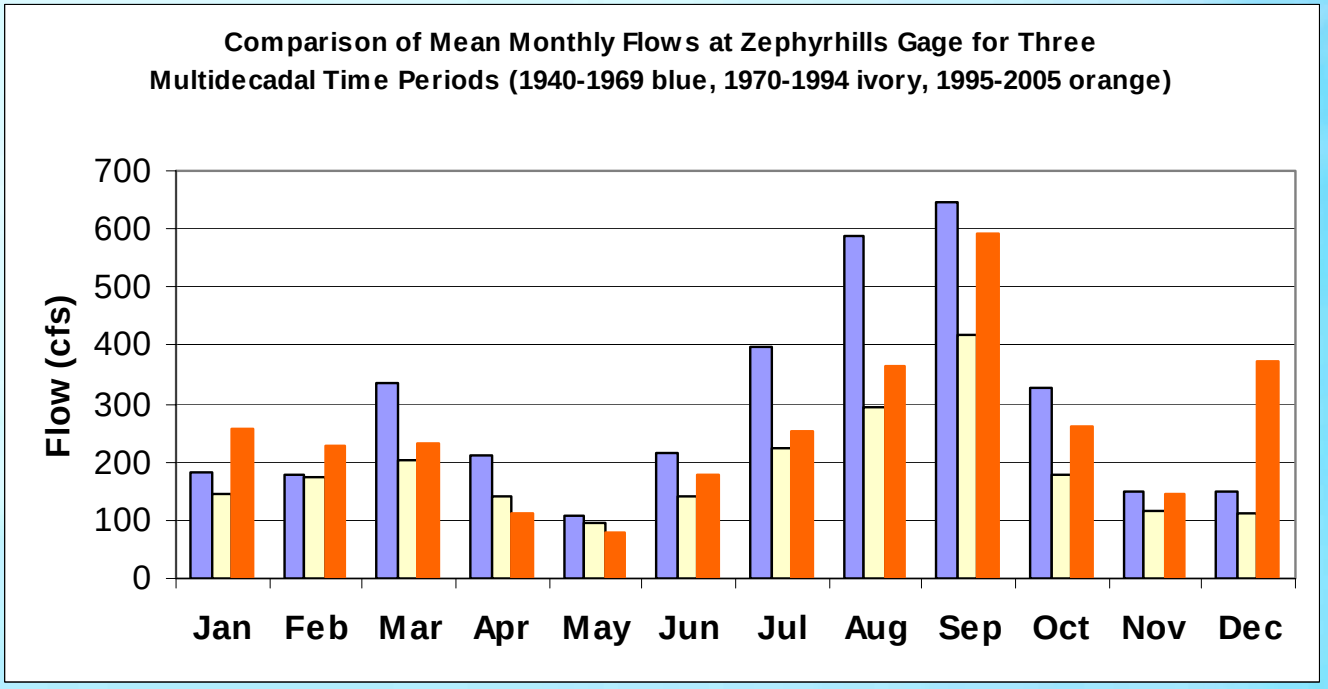

Comparison of Median Daily Flows for the Period 1951 to 1969 at Zephyrhills Gage (blue) and Blackwater Creek Gage (green).
Flow (cfs/sq mile)
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
350

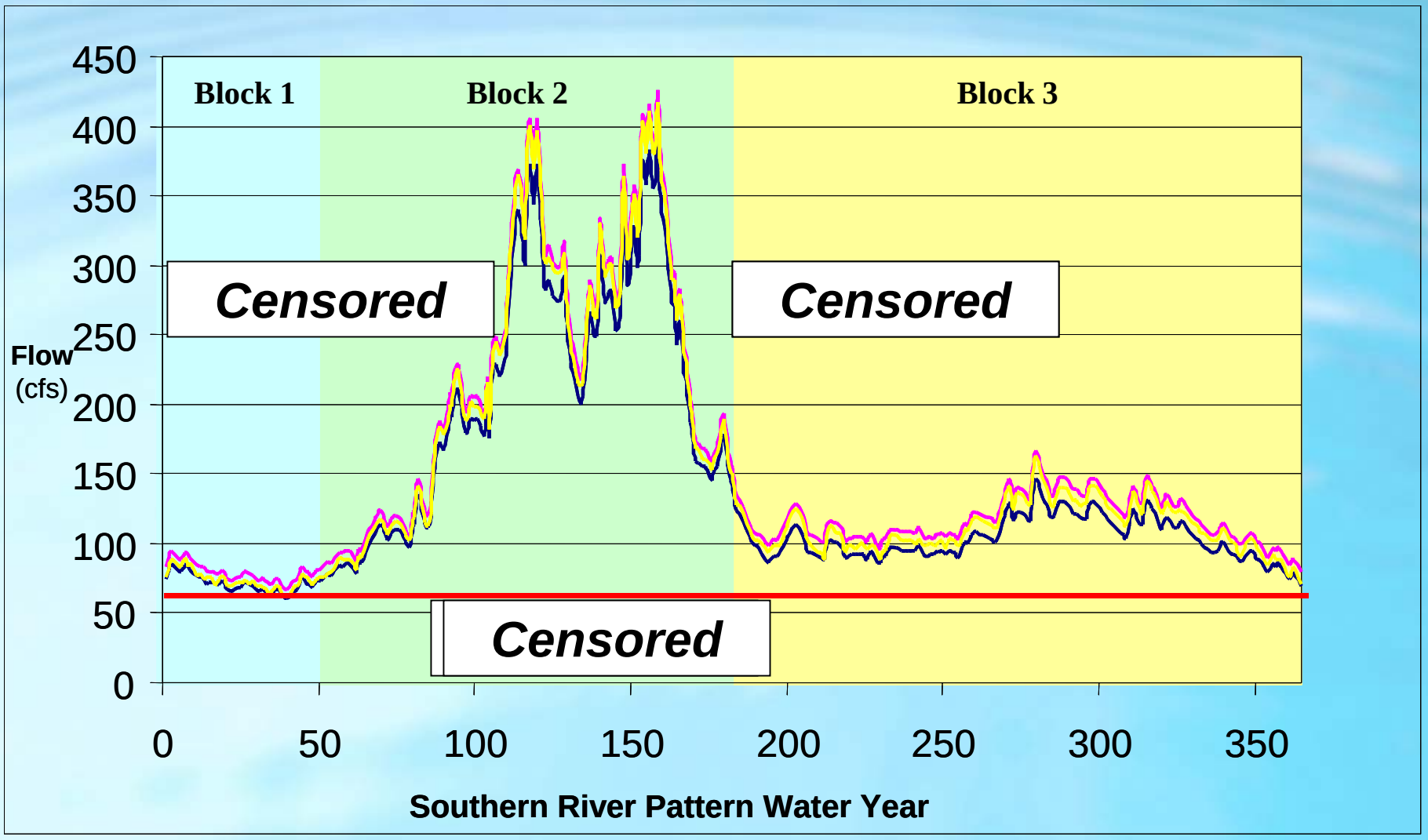

Comparison of Median Daily Flows for the Period 1951 to 1969 at Zephyrhills Gage (blue) and Blackwater Creek Gage (green) after adjusting Blackwater Creek baseflow by 0.25 cfs/sq mile.
Flow (cfs/sq mile)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
350

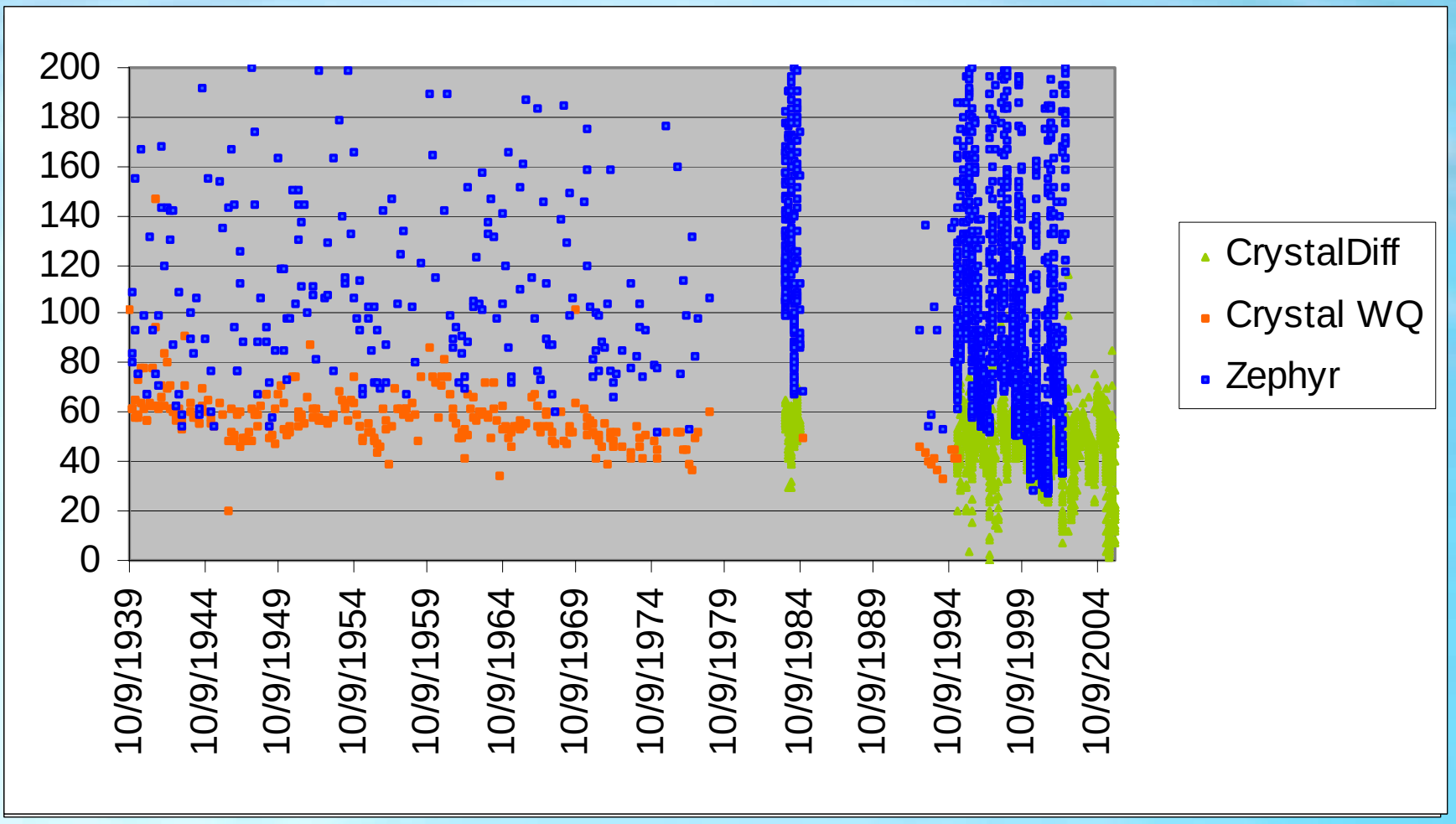
Period	Zephyrhills Gage (ZHGQ) 220 sq miles		Blackwater Creek Gage (BWCQ) 110 sq miles		ZHGQ-60cfs-BWCQ 110 sq miles		ZHGQ-60cfs-BWCQ-OF 110 sq miles	
1940 to 1969	18.03							
1951 to 1969	18.35		12.35		24.21			
1960 to 1969	17.31		11		22.14		17.96	
		5.75		3.44		11.50		9.27
1970 to 1994	11.56		7.56		10.64		8.69	
		-4.2		-4.12		-8.61		-6.74
1995 to 2005	15.76		11.68		19.25		15.43	

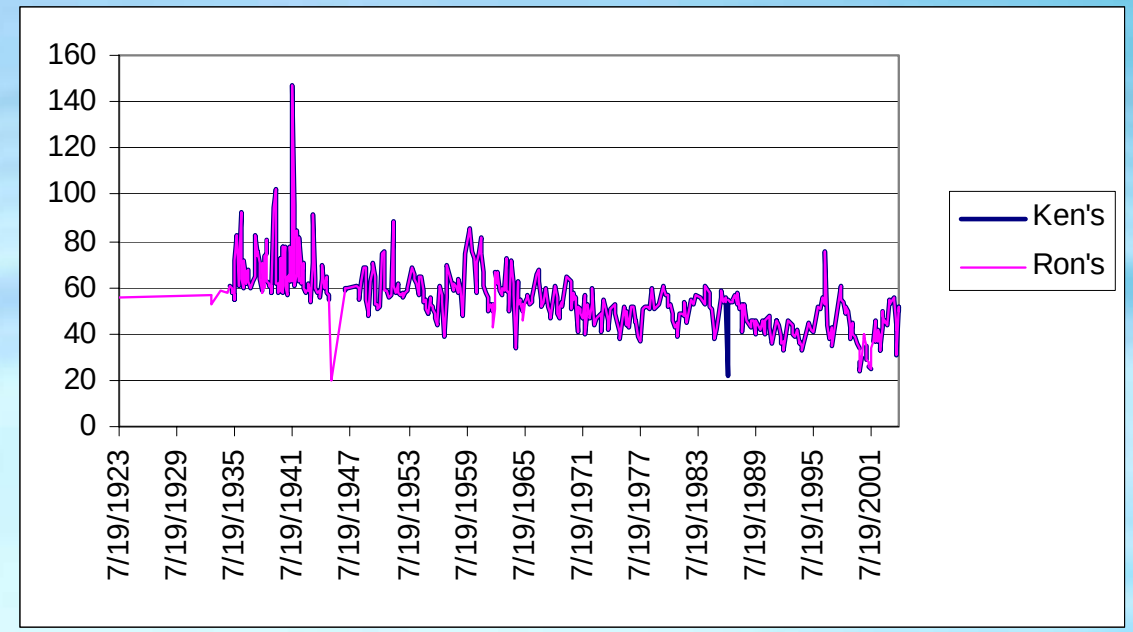
Period	Mean ZHQ	Median ZHQ	Minimum ZHQ	Maximum ZHQ	StLeoRainfall	PCRainfall	HRSPRainfall
1940 to 2005	246	126	64	2424	55.5	53.8	54.0
1940 to 1969	292	144	71	2893	56.3	55.8	55.0
1951 to 1969	297	155	76	2680	54.5	56.2	55.8
1960 to 1969	279	138	78	2857	54.2	54.0	56.2
1970 to 1994	187	108	58	1634	54.4	50.9	52.8
1995 to 2005	257	116	55	2941	56.1	54.8	54.4

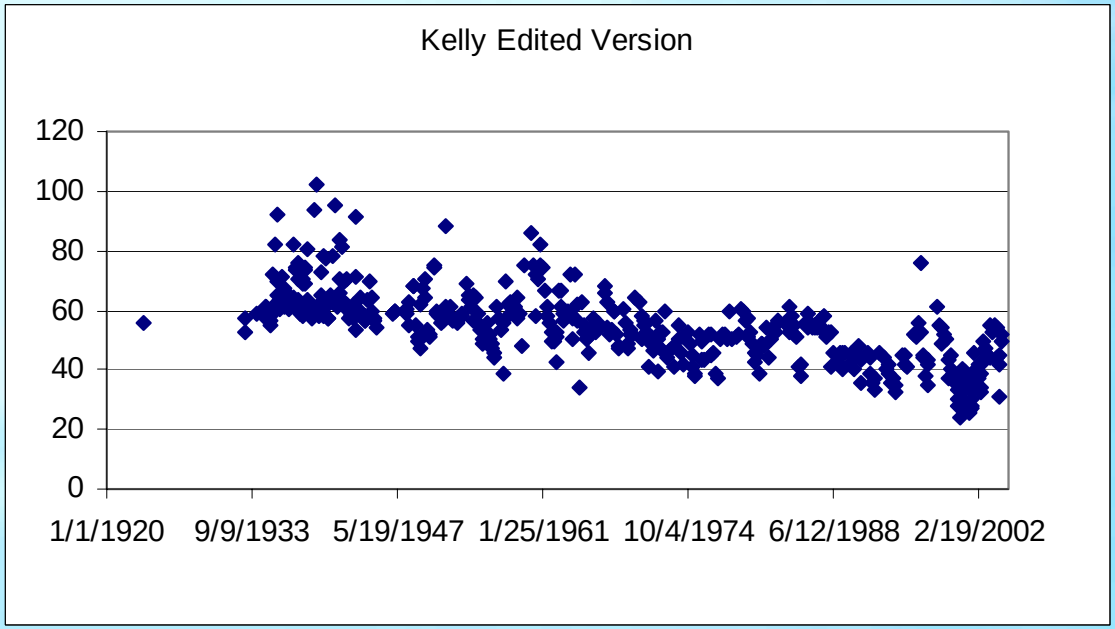

Comparison of Median Monthly Flows at Zephyrhills Gage for Three Multidecadal Time Periods (1940-1969 blue, 1970-1994 ivory, 1995-2005 orange)
Flow (cfs)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

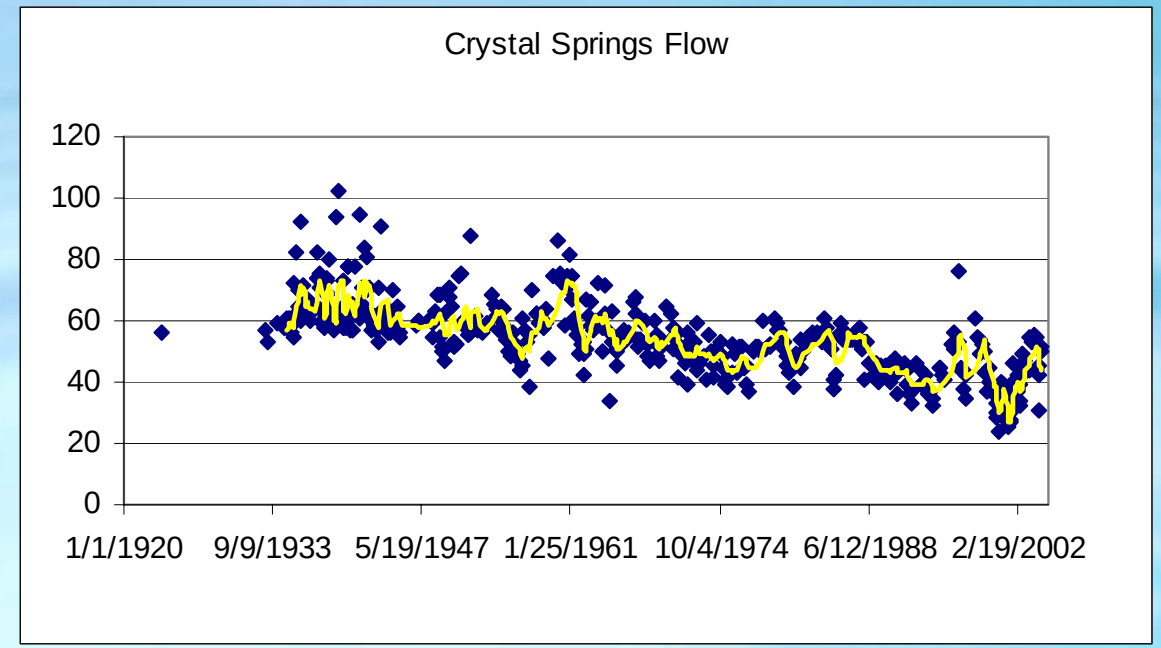

Comparison of Mean Monthly Flows at Zephyrhills Gage for Three Multidecadal Time Periods (1940-1969 blue, 1970-1994 ivory, 1995-2005 orange)
Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

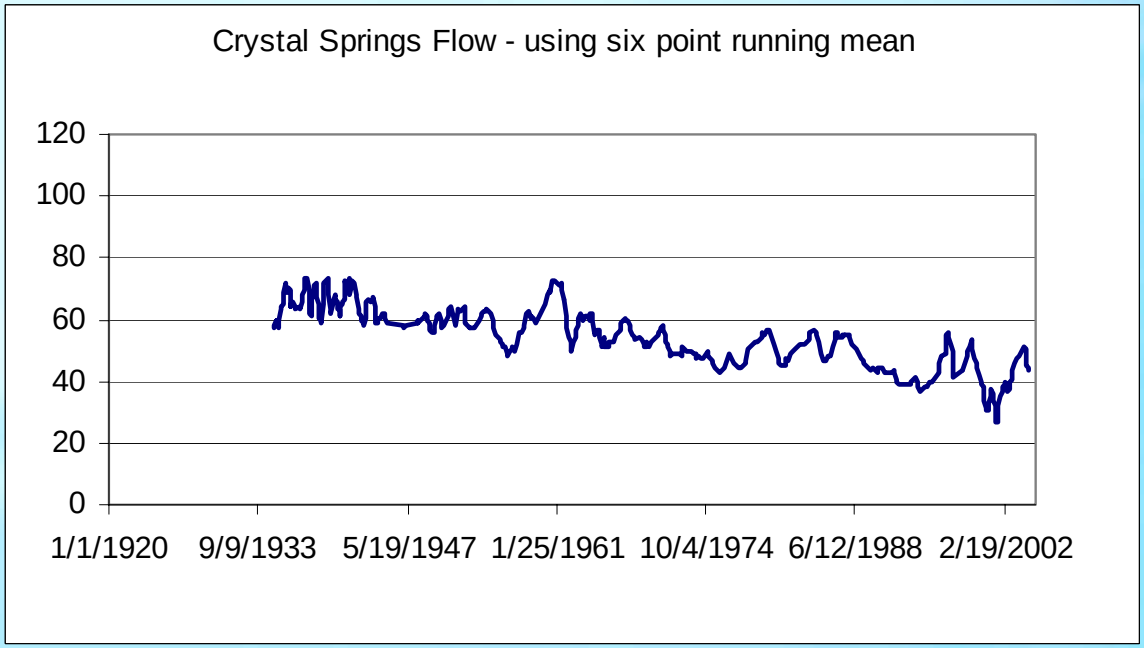

Block 1
Block 2
Block 3
Censored
Censored
Censored
Flow
(cfs)
450
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
Southern River Pattern Water Year

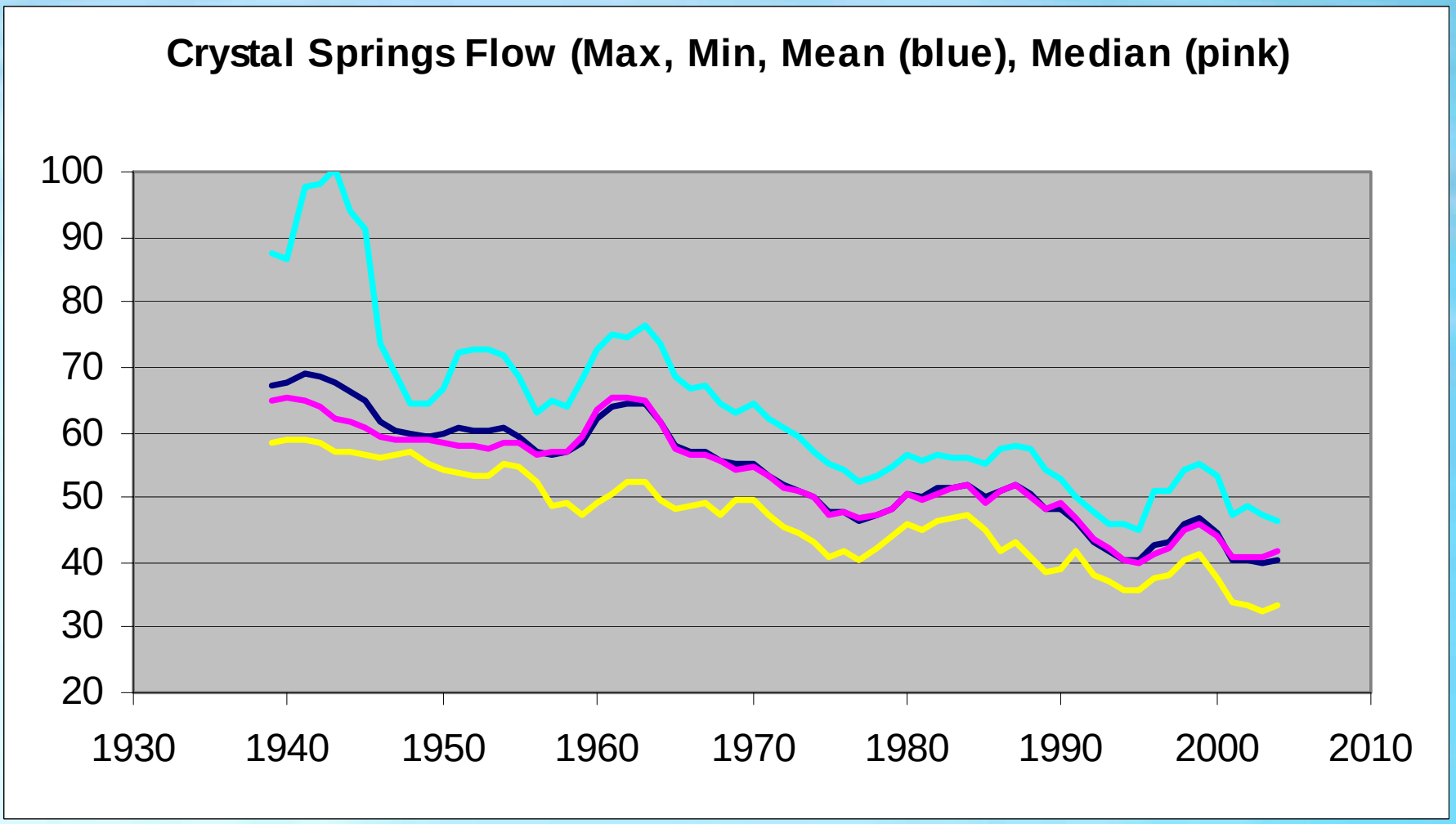

200
180
160
140
120
100
80
60
40
20
0
10/9/1939
10/9/1944
10/9/1949
10/9/1954
10/9/1959
10/9/1964
10/9/1969
10/9/1974
10/9/1979
10/9/1984
10/9/1989
10/9/1994
10/9/1999
10/9/2004
CrystalDiff
Crystal WQ
Zephyr

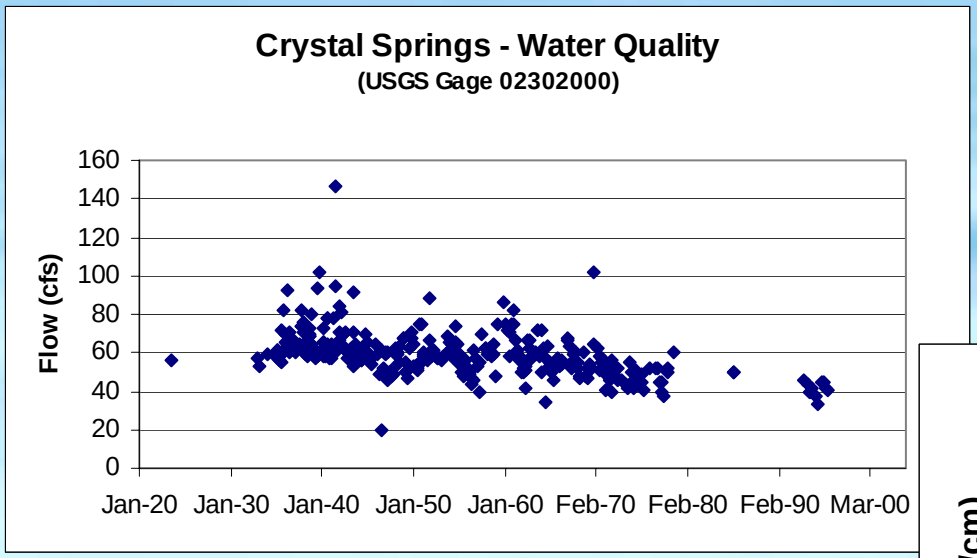

160
140
120
100
80
60
40
20
0
7/19/1923
7/19/1929
7/19/1935
7/19/1941
7/19/1947
7/19/1953
7/19/1959
7/19/1965
7/19/1971
7/19/1977
7/19/1983
7/19/1989
7/19/1995
7/19/2001
Ken's
Ron's

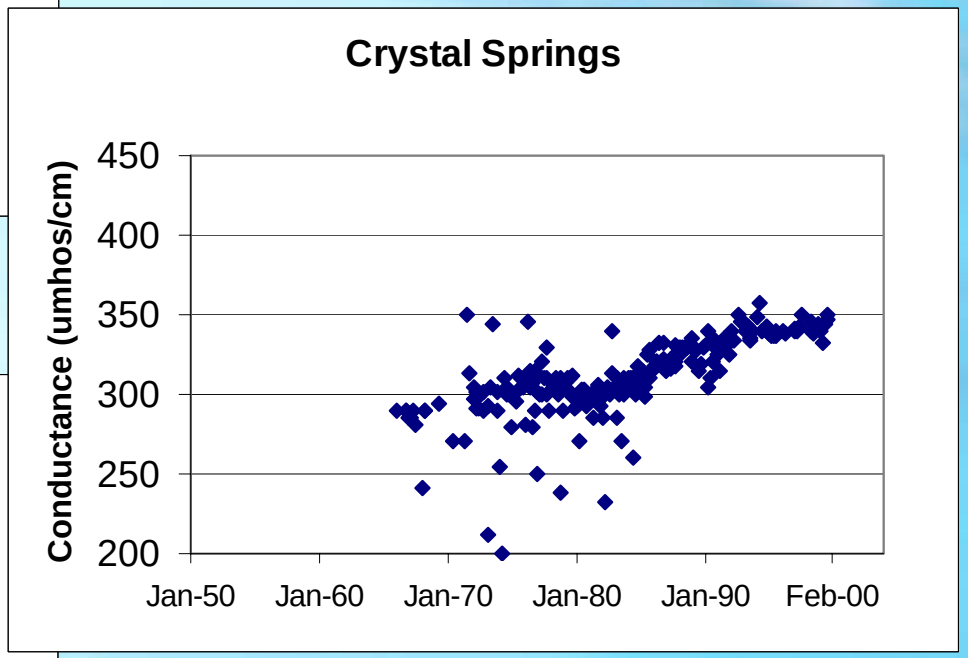

Kelly Edited Version
120
100
80
60
40
20
0
1/1/1920
9/9/1933
5/19/1947
1/25/1961
10/4/1974
6/12/1988
2/19/2002

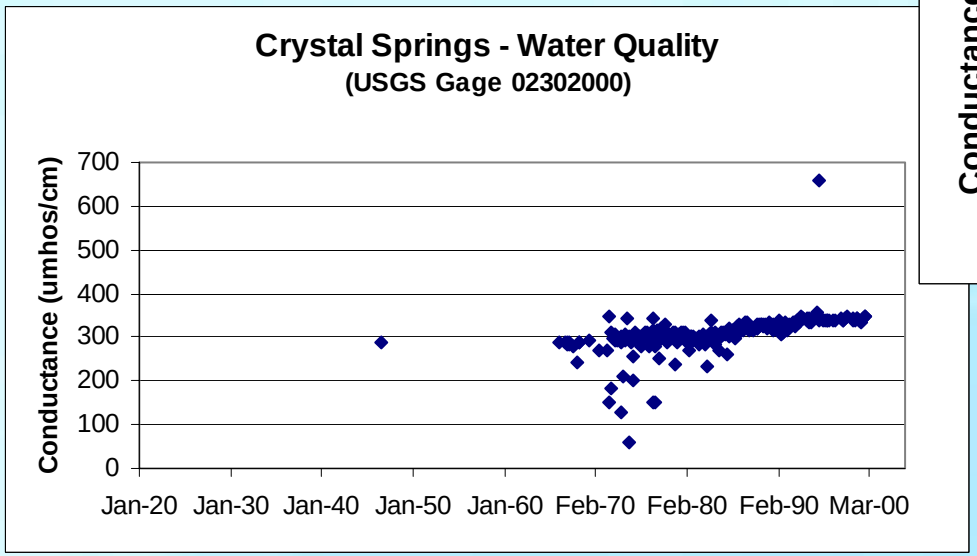

Crystal Springs Flow
120
100
80
60
40
20
0
1/1/1920
9/9/1933
5/19/1947
1/25/1961
10/4/1974
6/12/1988
2/19/2002

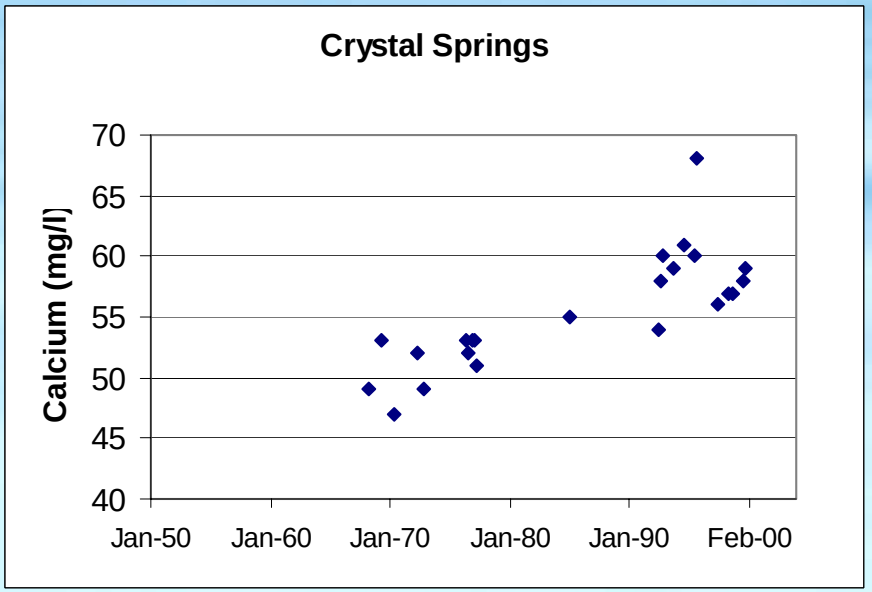

Crystal Springs Flow - using six point running mean
120
100
80
60
40
20
0
1/1/1920
9/9/1933
5/19/1947
1/25/1961
10/4/1974
6/12/1988
2/19/2002

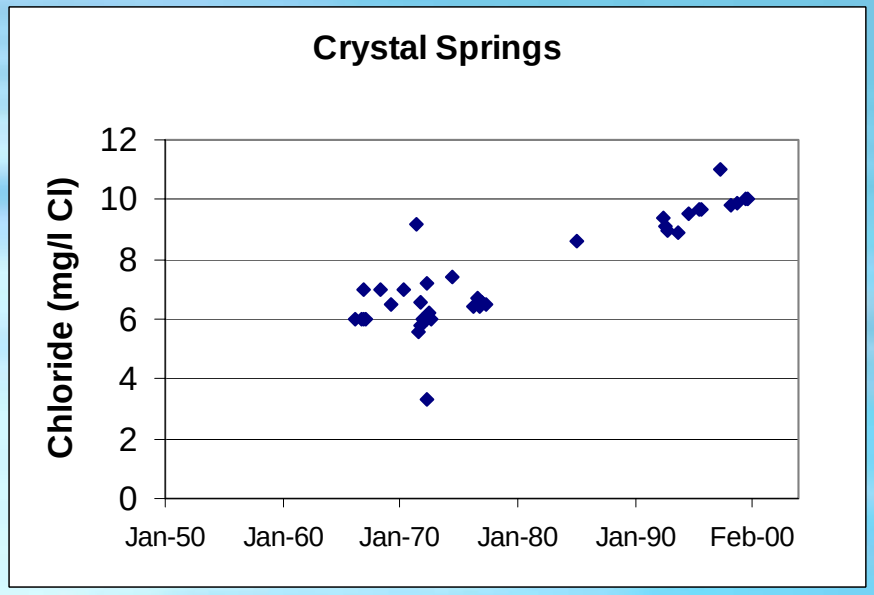

Crystal Springs Flow (Max, Min, Mean (blue), Median (pink)
100
90
80
70
60
50
40
30
20
1930
1940
1950
1960
1970
1980
1990
2000
2010

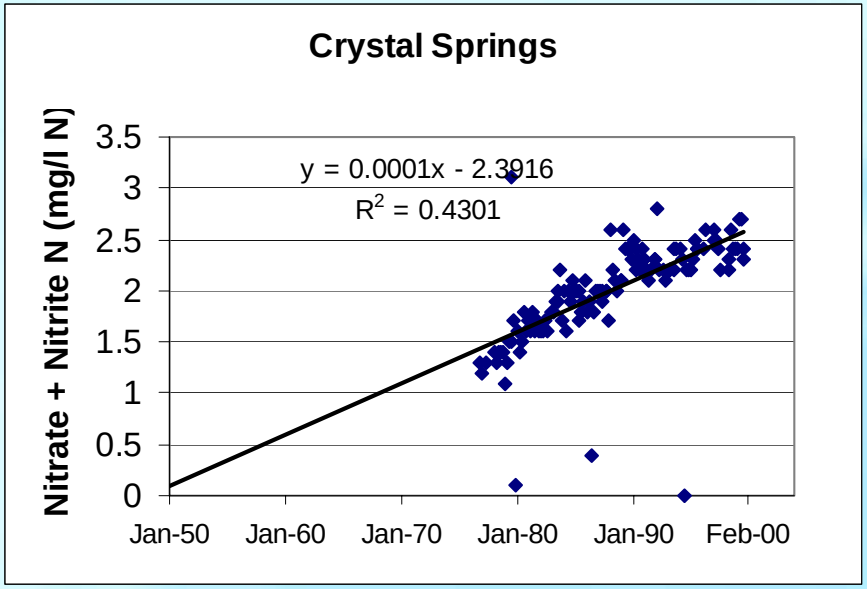

Crystal Springs - Water Quality
(USGS Gage 02302000)
Flow (cfs)
160
140
120
100
80
60
40
20
0
Jan-20
Jan-30
Jan-40
Jan-50
Jan-60
Feb-70
Feb-80
Feb-90
Mar-00

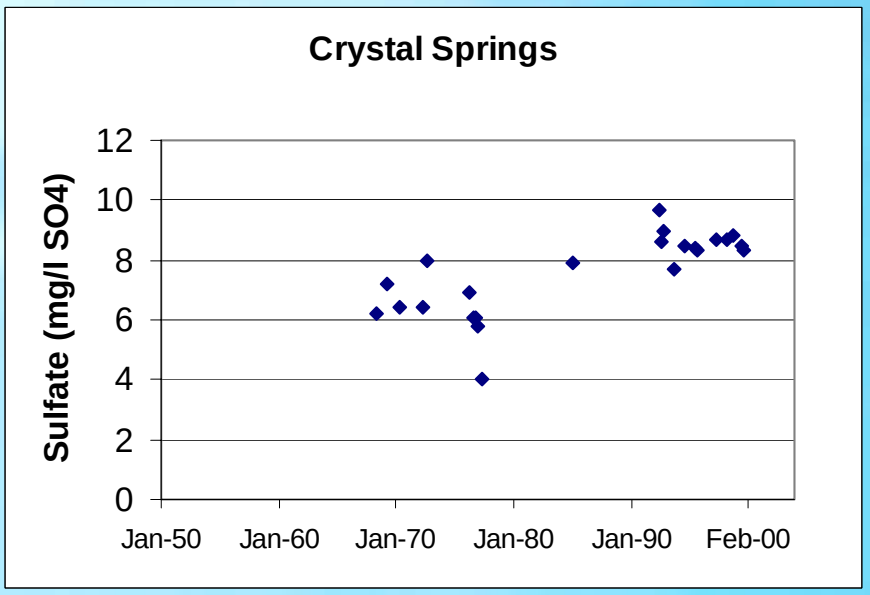

Crystal Springs
Conductance (umhos/cm)
450
400
350
300
250
200
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

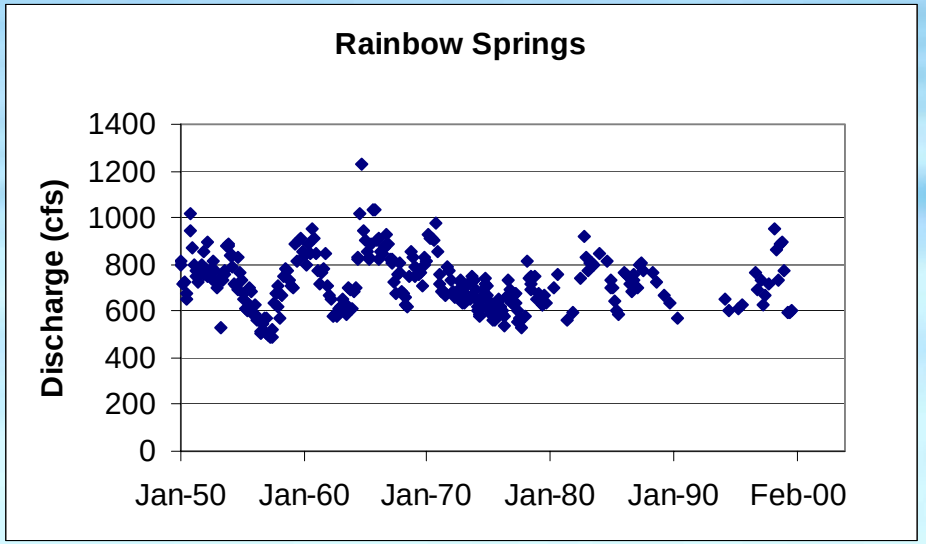

Crystal Springs - Water Quality
(USGS Gage 02302000)
Conductance (umhos/cm)
700
600
500
400
300
200
100
0
Jan-20
Jan-30
Jan-40
Jan-50
Jan-60
Feb-70
Feb-80
Feb-90
Mar-00

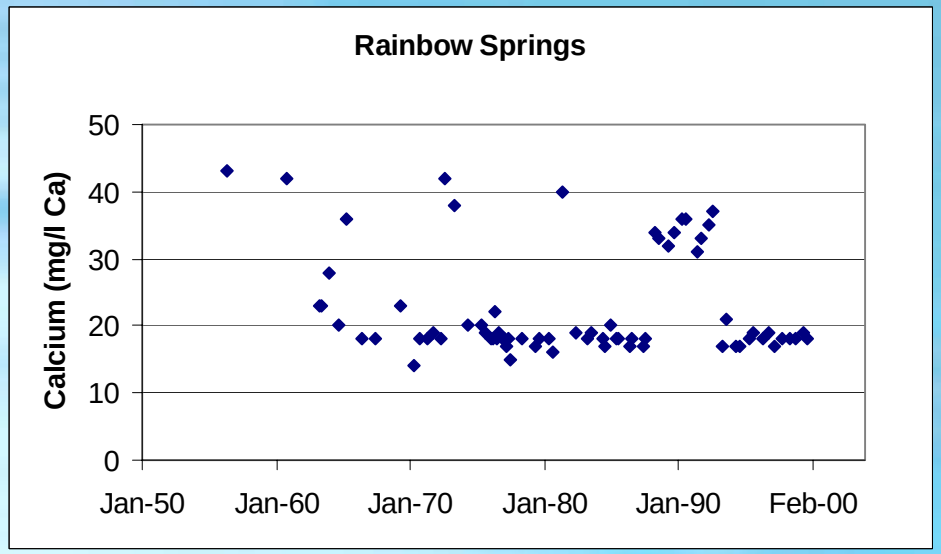

Crystal Springs
Calcium (mg/l)
70
65
60
55
50
45
40
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

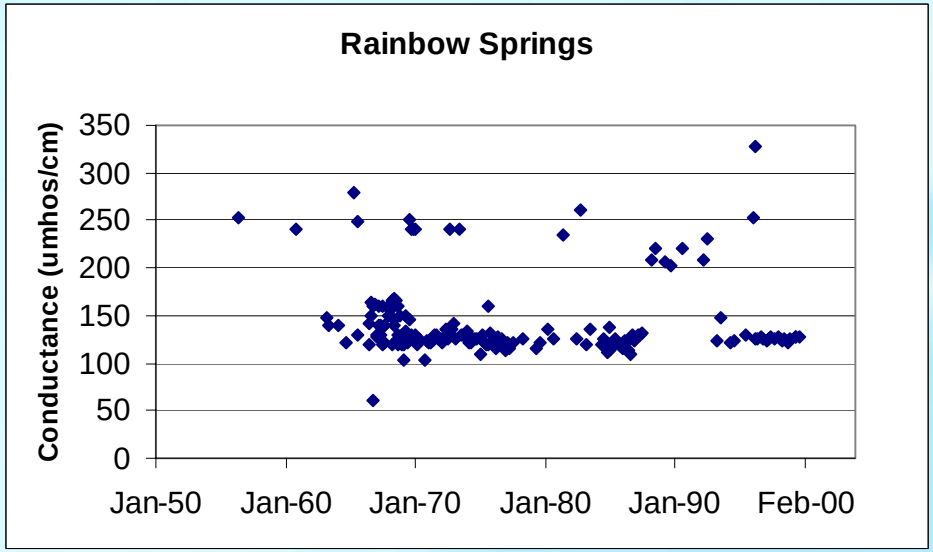

Crystal Springs
Chloride (mg/l Cl)
12
10
8
6
4
2
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

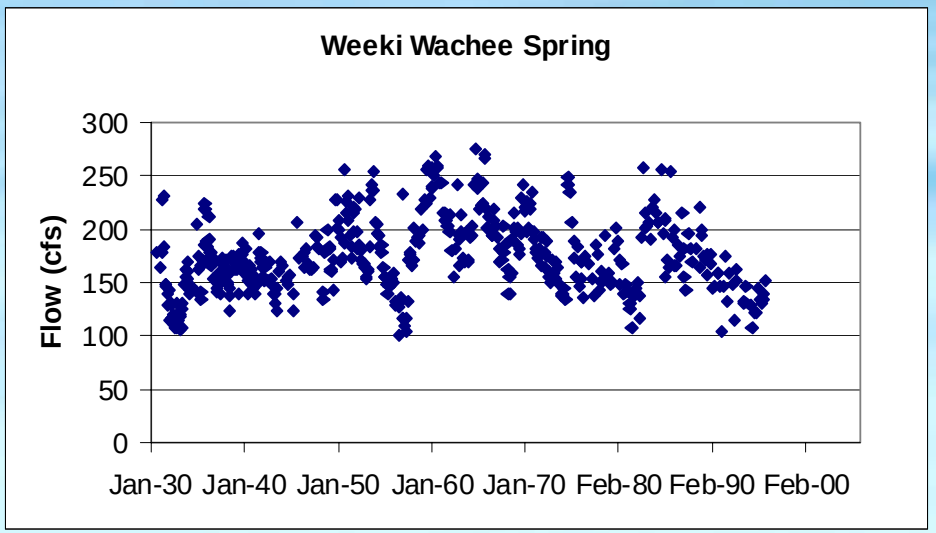

Crystal Springs
Nitrate + Nitrite N (mg/l N)
y = 0.0001x - 2.3916
R2 = 0.4301
3.5
3
2.5
2
1.5
1
0.5
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

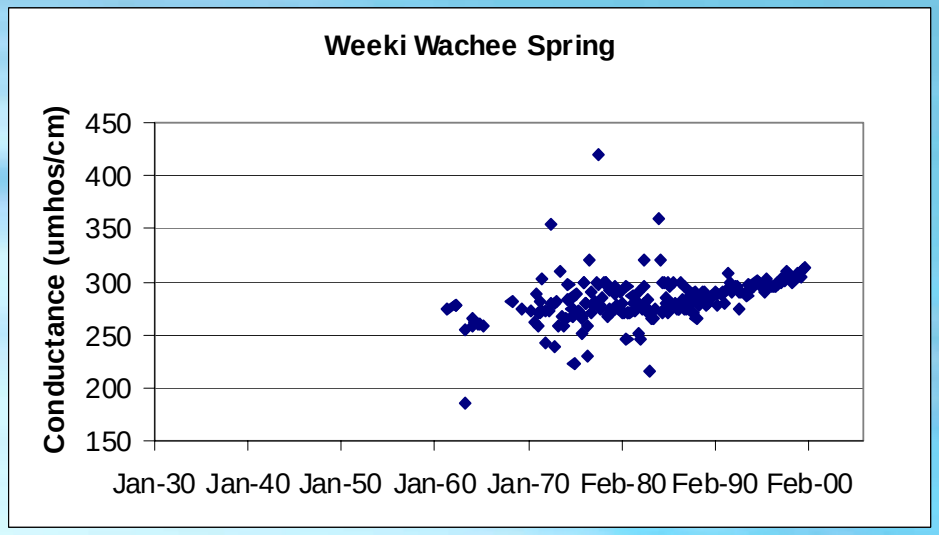

Crystal Springs
Sulfate (mg/l SO4)
12
10
8
6
4
2
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

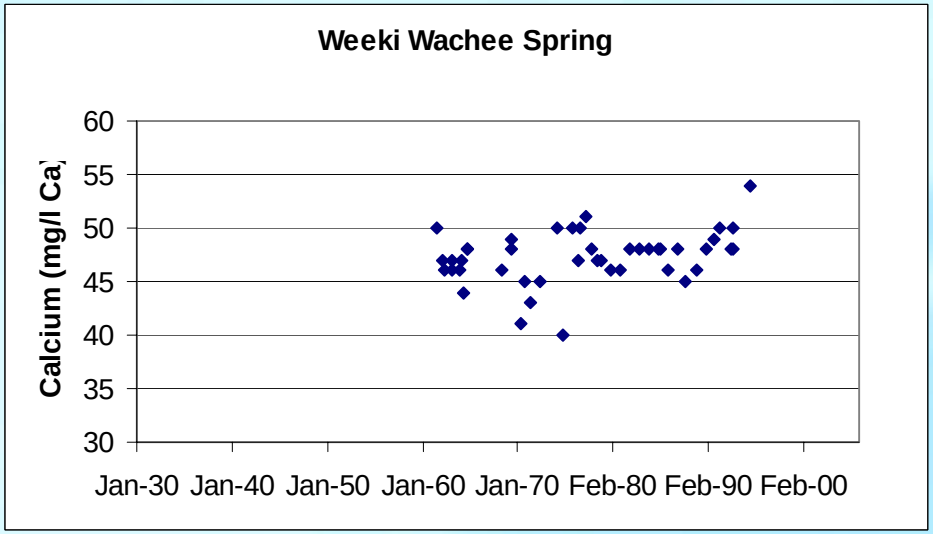

Rainbow Springs
Discharge (cfs)
1400
1200
1000
800
600
400
200
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

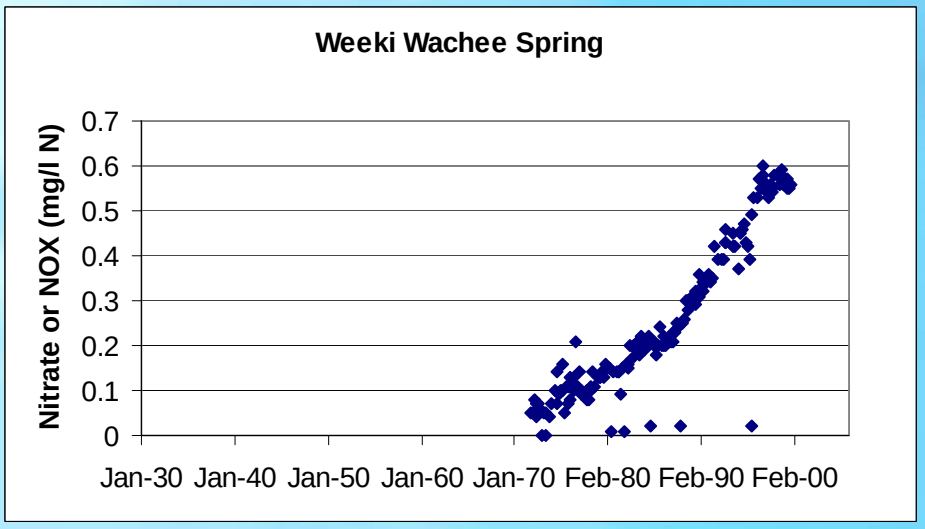

Rainbow Springs
Calcium (mg/l Ca)
50
40
30
20
10
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

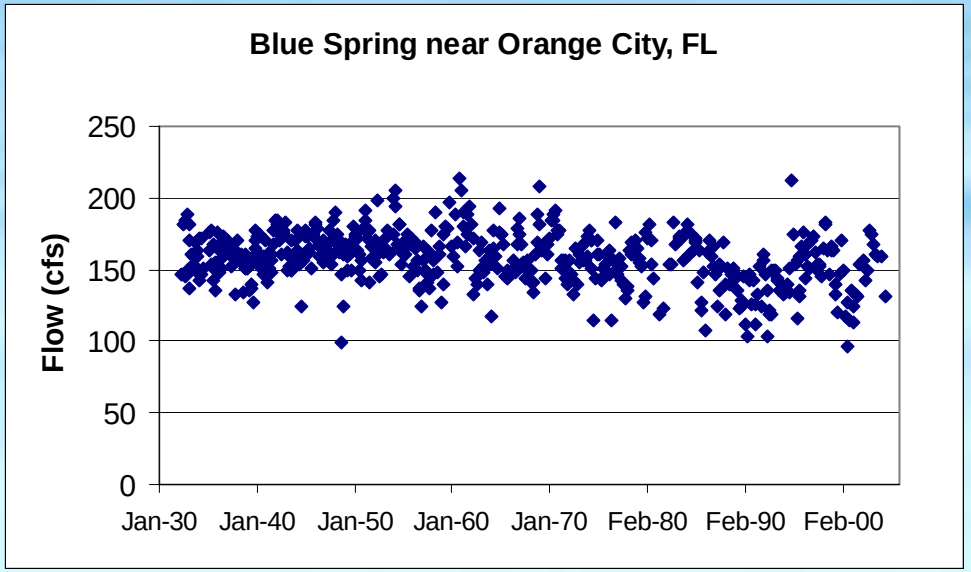

Rainbow Springs
Conductance (umhos/cm)
350
300
250
200
150
100
50
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

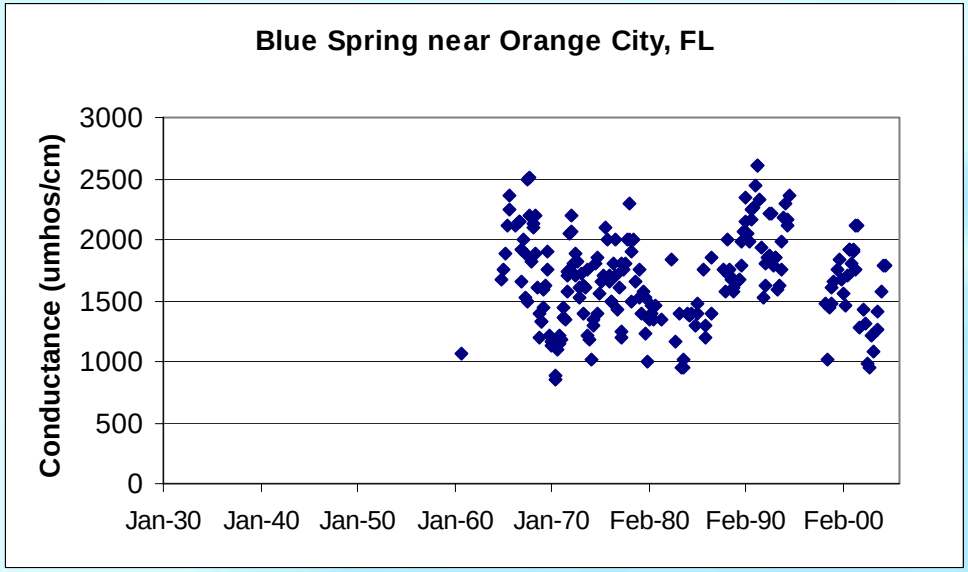

Weeki Wachee Spring
Flow (cfs)
300
250
200
150
100
50
0
Jan-30 Jan-40 Jan-50 Jan-60 Jan-70 Feb-80 Feb-90 Feb-00

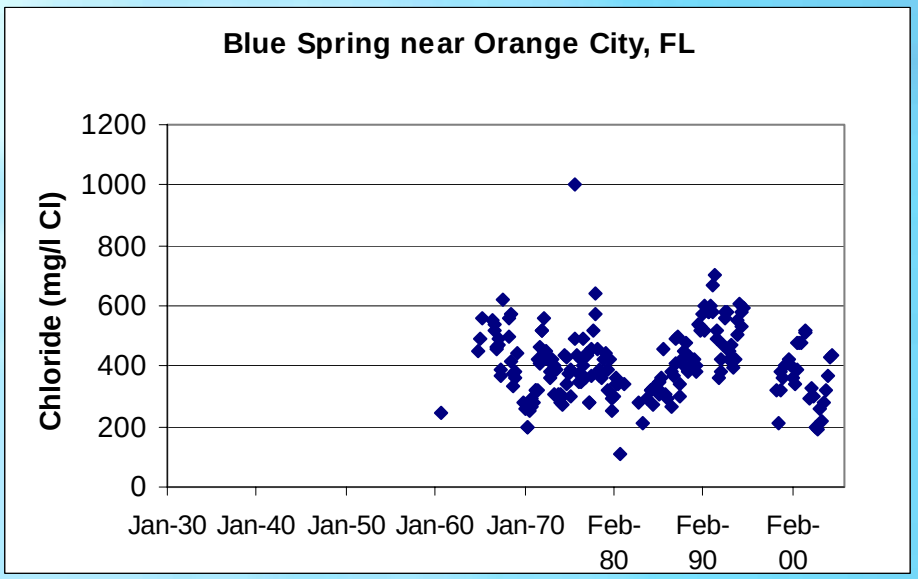

Weeki Wachee Spring
Conductance (umhos/cm)
450
400
350
300
250
200
150
Jan-30 Jan-40 Jan-50 Jan-60 Jan-70 Feb-80 Feb-90 Feb-00

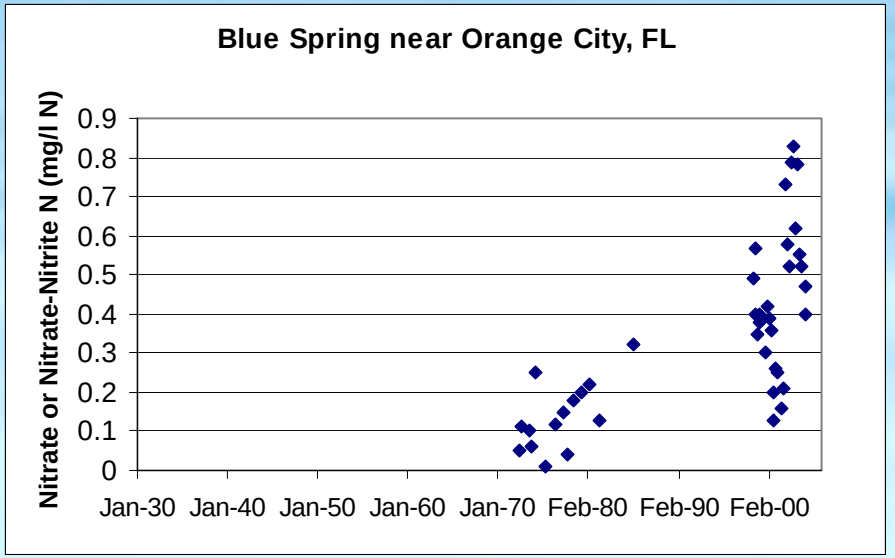

Weeki Wachee Spring
Calcium (mg/l Ca)
60
55
50
45
40
35
30
Jan-30 Jan-40 Jan-50 Jan-60 Jan-70 Feb-80 Feb-90 Feb-00

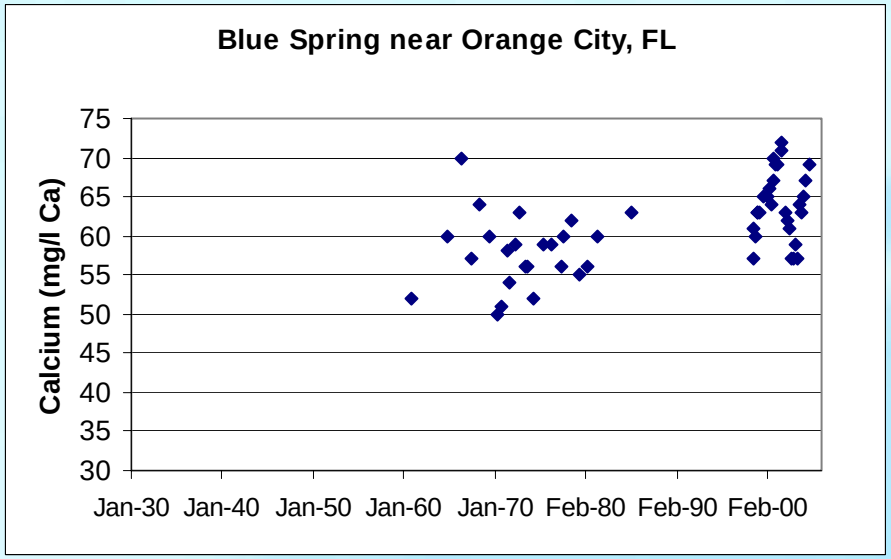

Weeki Wachee Spring
Nitrate or NOX (mg/l N)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan-30 Jan-40 Jan-50 Jan-60 Jan-70 Feb-80 Feb-90 Feb-00

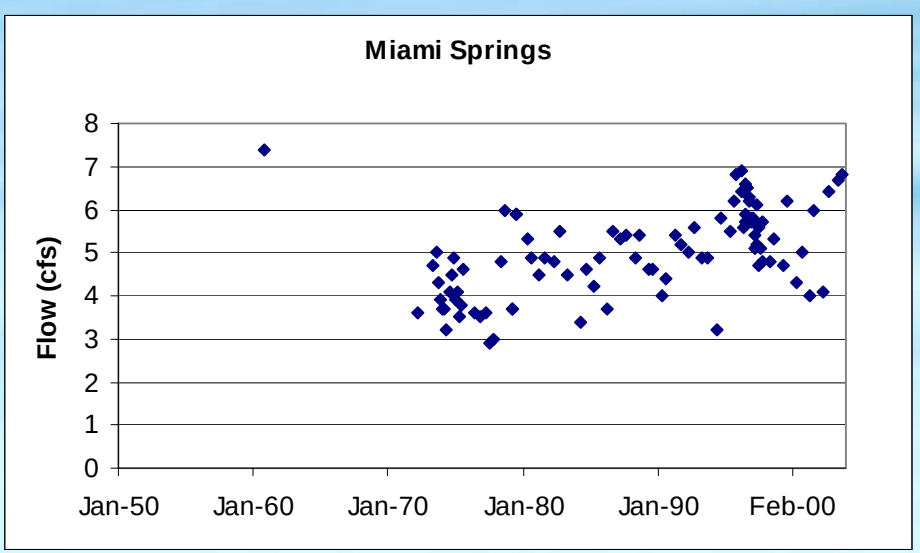

Blue Spring near Orange City, FL
Flow (cfs)
250
200
150
100
50
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

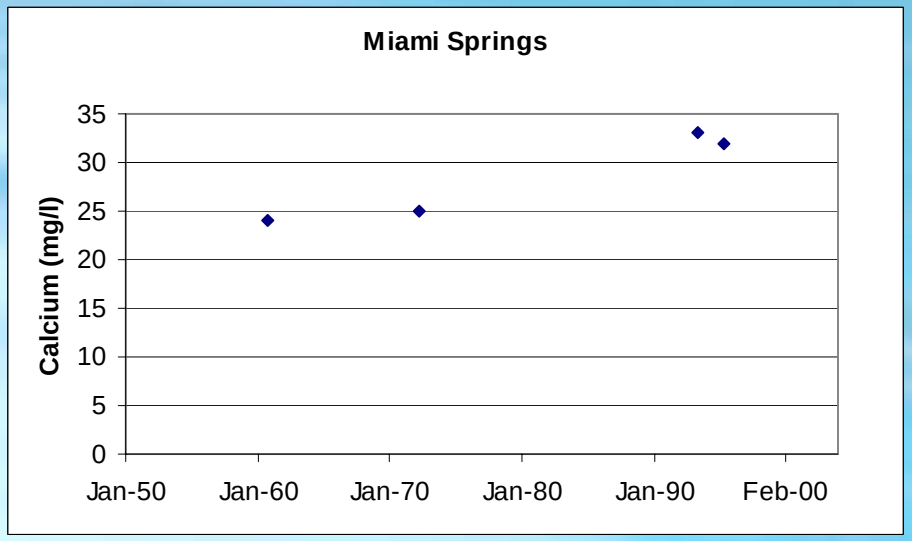

Blue Spring near Orange City, FL
Conductance (umhos/cm)
3000
2500
2000
1500
1000
500
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

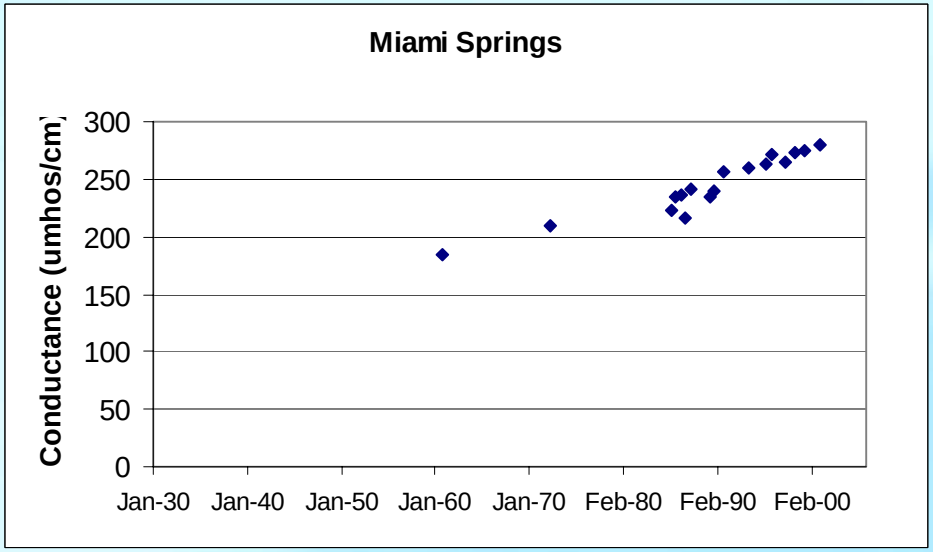

Blue Spring near Orange City, FL
Chloride (mg/l Cl)
1200
1000
800
600
400
200
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

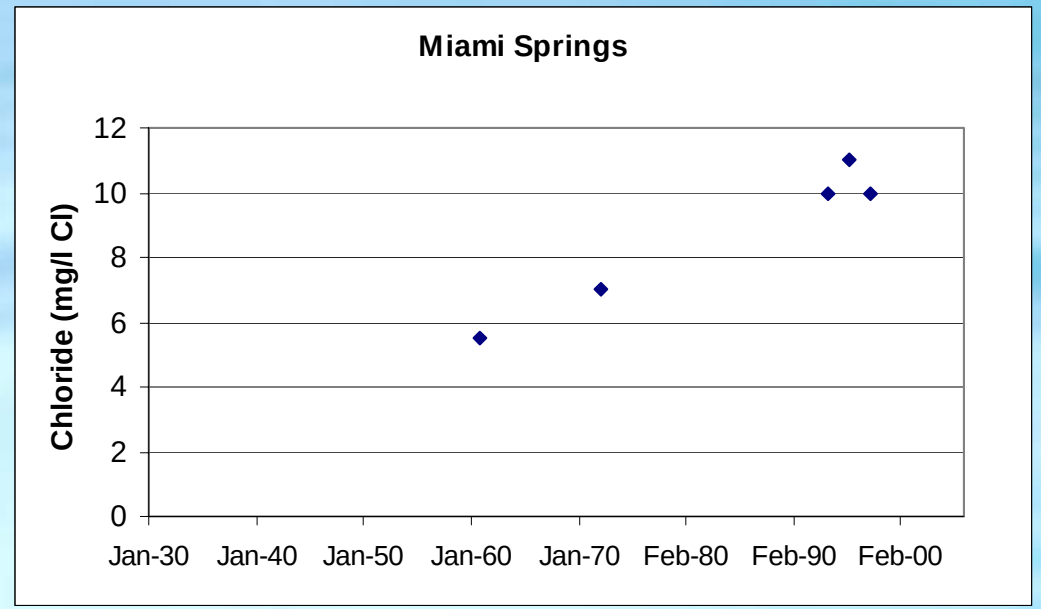

Blue Spring near Orange City, FL
Nitrate or Nitrate-Nitrite N (mg/l N)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

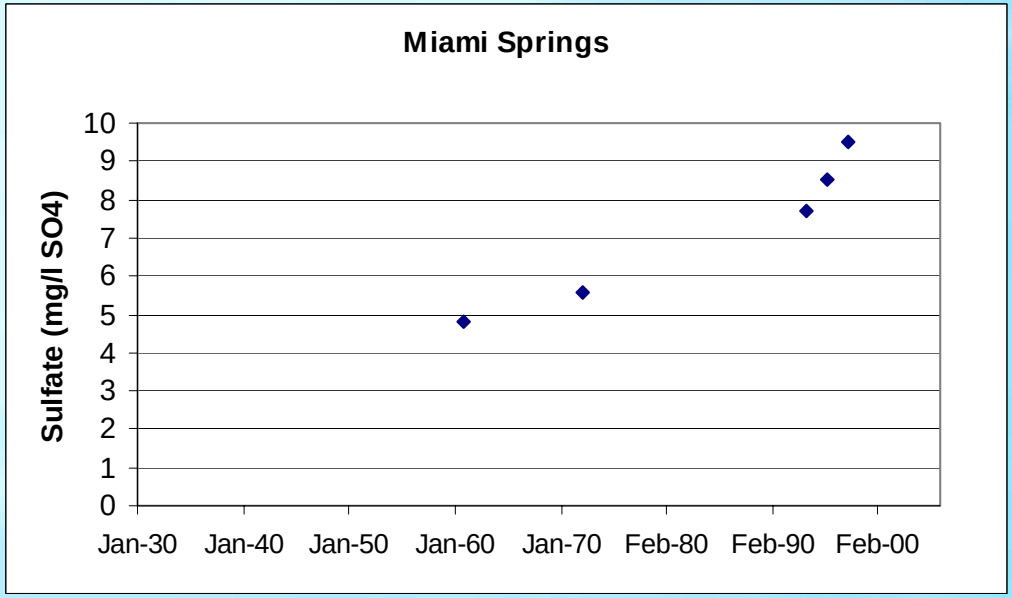

Blue Spring near Orange City, FL
Calcium (mg/l Ca)
75
70
65
60
55
50
45
40
35
30
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

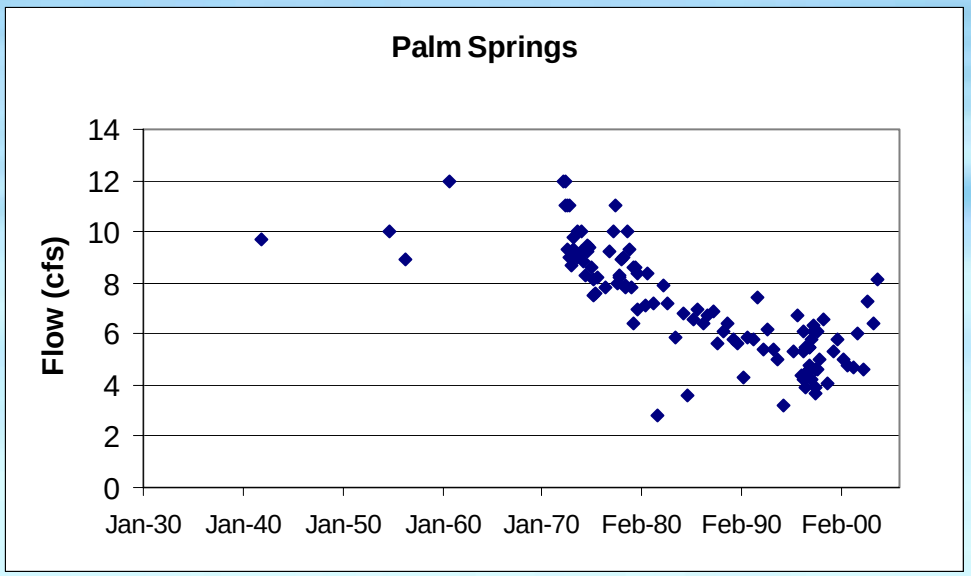

Miami Springs
Flow (cfs)
0
1
2
3
4
5
6
7
8
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

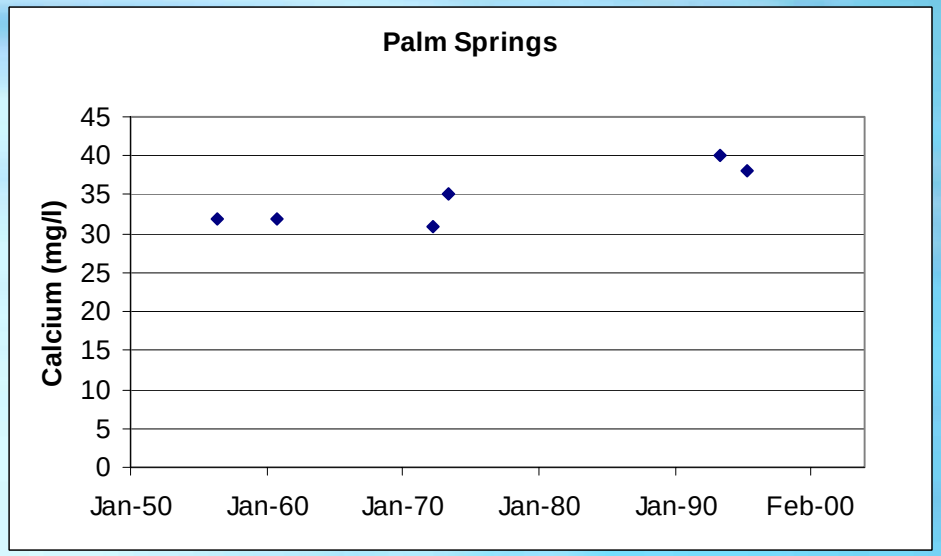

Miami Springs
Calcium (mg/l)
0
5
10
15
20
25
30
35
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00

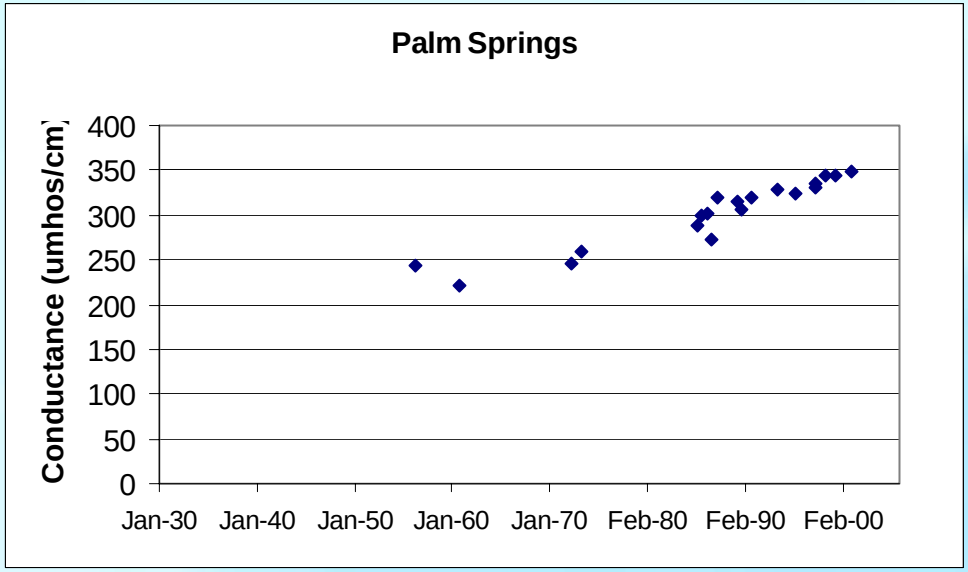

Miami Springs
Conductance (umhos/cm)
0
50
100
150
200
250
300
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

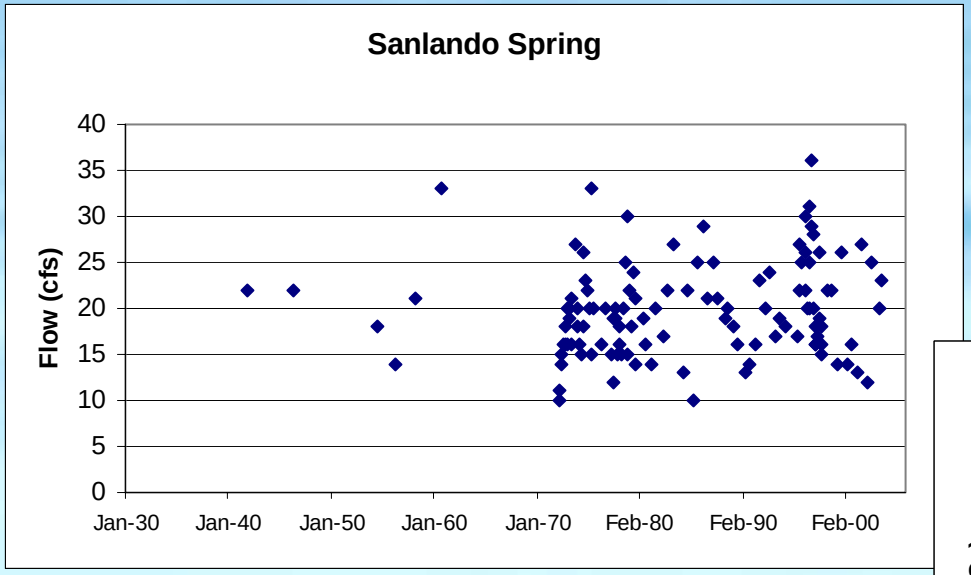

Miami Springs
Chloride (mg/l Cl)
12
10
8
6
4
2
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

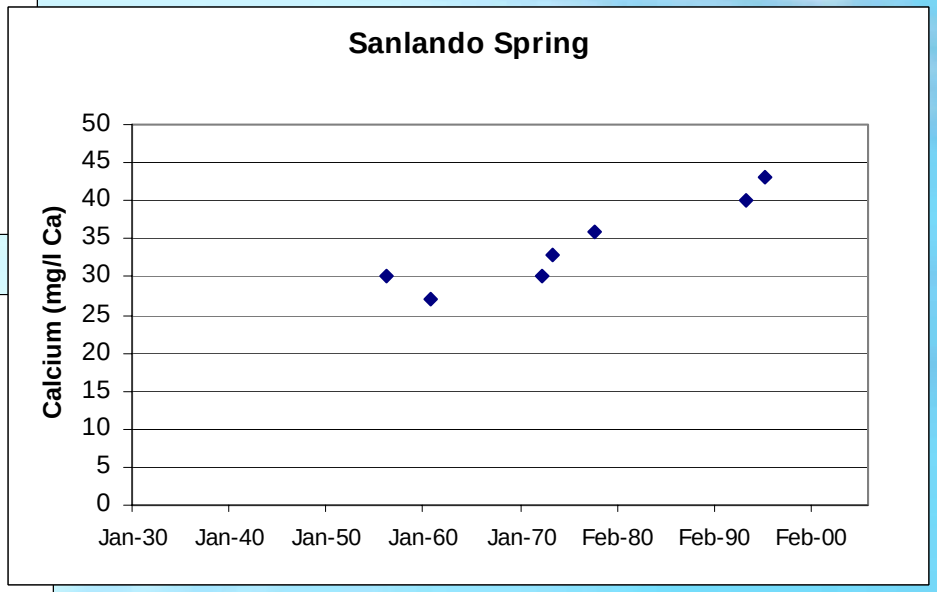

Miami Springs
Sulfate (mg/l SO4)
10
9
8
7
6
5
4
3
2
1
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

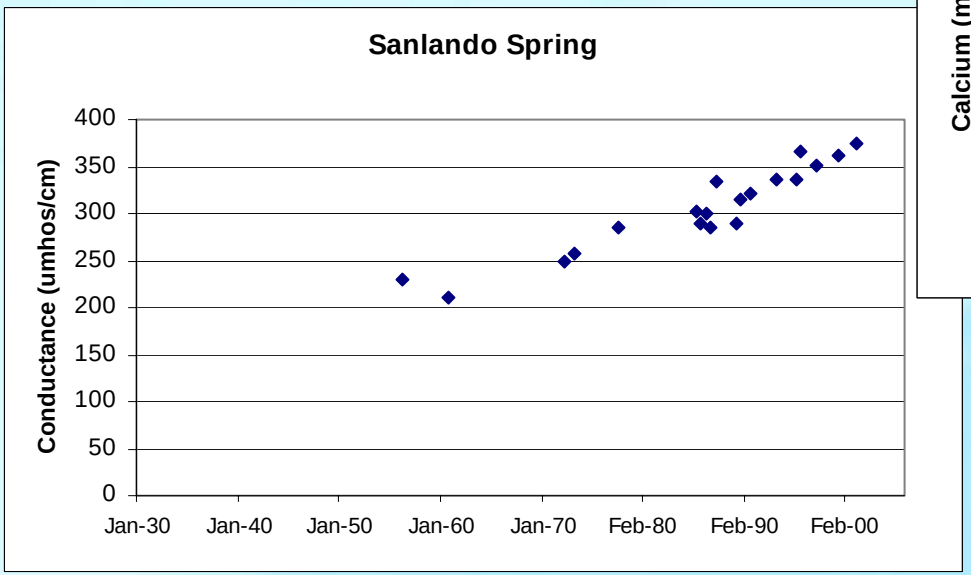

Palm Springs
Flow (cfs)
14
12
10
8
6
4
2
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00

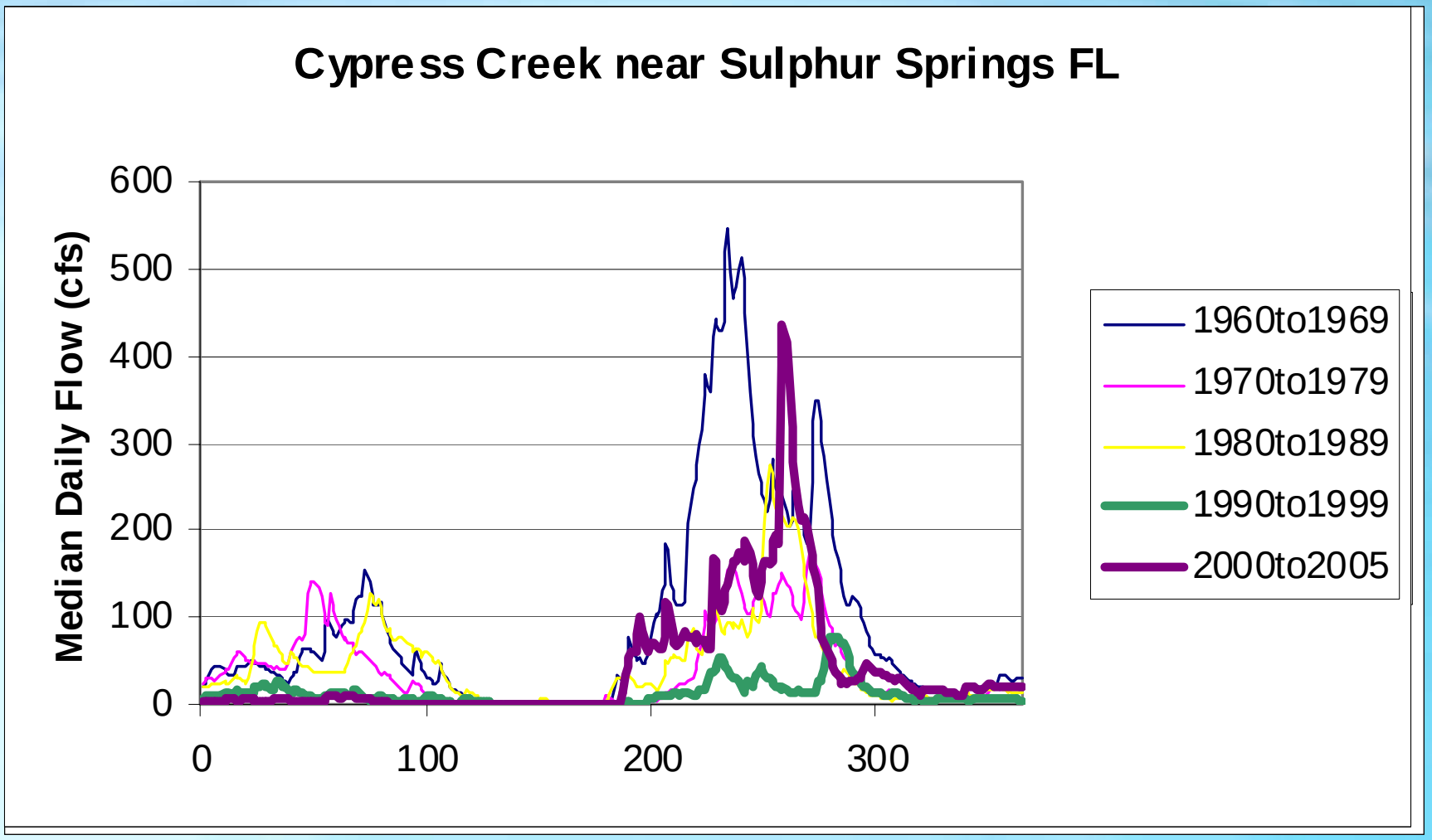

Palm Springs
Calcium (mg/l)
45
40
35
30
25
20
15
10
5
0
Jan-50
Jan-60
Jan-70
Jan-80
Jan-90
Feb-00


Palm Springs
Conductance (umhos/cm)
400
350
300
250
200
150
100
50
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00


Sanlando Spring
Flow (cfs)
40
35
30
25
20
15
10
5
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00


Sanlando Spring
Calcium (mg/l Ca)
50
45
40
35
30
25
20
15
10
5
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00


Sanlando Spring
Conductance (umhos/cm)
400
350
300
250
200
150
100
50
0
Jan-30
Jan-40
Jan-50
Jan-60
Jan-70
Feb-80
Feb-90
Feb-00


Cypress Creek near Sulphur Springs FL
Median Daily Flow (cfs)
600
500
400
300
200
100
0
0
100
200
300
1960to1969
1970to1979
1980to1989
1990to1999
2000to2005