Selection of Base Period for IOP Analysis

Criteria & Factors

- Prefer wide range of hydrologic conditions
- Operating conditions uniform & typical of late 1990's
- Degrees of freedom for statistical analysis
- Data quality improved in recent years
- EAA BMP implementation in 1994-1995
- High Lake regulatory release in 1993

Selected 1994-2003 Period

- Base period (1994-1999) had average to very wet years
- IOP period (2000-2003) had very dry to average years
- Collinearity of rainfall & IOP effects limit the analysis
- Sensitivity analysis 1988-2003 to include drought
- 6 years pre-IOP vs 4 years post IOP

Summary of IOP Analysis

Water Years: 1994 - 2003

	Flow (kac-ft/yr)								Total P Load (kg/yr)								Mean Total P Conc (ppb)								Flow-Weighted Total P (ppb)							
Term	Pre-	IOP	R2	Incr	SE	p	n	%I	Pre-	IOP	R2	Incr	SE	p	n	%I	Pre-	IOP	R2	Incr	SE	p	n	%I		Pre-	IOP	R2	Incr	SE	p	n	%I	
LAKE_TOTAL	227	219	0.37	-8	93	0.94	1	-3%	29695	40491	0.23	10797	17762	0.56	2	36%	101	144	0.44	42.5	18.1	0.05	4	42%	*	107	156	0.96	49.3	11.9	0.00	4	46%	*
LAKE_S352	80	126	0.22	45	63	0.50	1	56%	15691	28014	0.14	12324	14930	0.44	2	79%	156	179	0.26	22.9	24.8	0.39	3	15%		155	188	0.97	32.9	15.8	0.04	3	21%	*
LAKE_S2	93	71	0.65	-22	32	0.52	2	-24%	8567	8882	0.56	315	3696	0.93	3	4%	75	106	0.47	30.7	12.4	0.04	4	41%	*	76	107	0.84	31.2	20.2	0.16	4	41%	*
LAKE_S3	53	22	0.24	-31	21	0.19	1	-58%	5437	3595	0.10	-1841	2744	0.52	1	-34%	83	103	0.40	20.1	13.1	0.17	3	24%		86	117	0.95	31.8	11.5	0.01	2	37%	*
EAA_SOUTH	1222	1251	0.84	29	144	0.85	2	2%	159668	167296	0.82	7628	23564	0.76	3	5%	105	105	0.18	-0.2	7.4	0.98	2	0%		107	107	0.96	-0.5	6.2	0.90	1	0%	
S10X	528	355	0.91	-173	77	0.06	1	-33%	* 45024	31094	0.81	-13930	11931	0.28	1	-31%	71	65	0.02	-6.3	17.0	0.72	2	-9%		71	66	0.90	-4.5	15.6	0.97	2	-6%	
WCA-3A_WEST	305	278	0.91	-27	32	0.42	1	-9%	39072	35573	0.80	-3500	7311	0.65	2	-9%	104	102	0.00	-1.1	16.7	0.95	2	-1%		105	102	0.89	-2.8	13.9	0.88	2	-3%	
WCA-3A_NORTH	398	364	0.64	-34	68	0.63	2	-9%	43261	41587	0.68	-1675	10242	0.87	3	-4%	86	84	0.31	-1.4	13.8	0.92	2	-2%		91	87	0.79	-4.1	15.9	0.87	1	-4%	
S11X	574	443	0.90	-130	74	0.12	1	-23%	18443	12659	0.90	-5784	1966	0.02	0	-31%	* 28	22	0.22	-6.0	4.3	0.21	1	-22%		25	24	0.74	-1.1	4.9	0.64	1	-4%	
S9	235	267	0.70	32	17	0.11	4	13%	* 4091	6975	0.66	2885	788	0.01	4	71%	* 14	22	0.54	7.4	2.8	0.03	4	52%	*	14	22	0.56	7.5	2.6	0.02	4	53%	*
WCA-3A IN	1512	1352	0.94	-160	114	0.20	1	-11%	104868	96794	0.82	-8074	16501	0.64	2	-8%	56	56	0.04	0.1	8.0	0.99	2	0%		57	57	0.87	-0.2	7.3	0.86	2	0%	
S343	79	44	0.71	-35	26	0.23	1	-44%	846	522	0.72	-323	267	0.26	1	-38%	9	11	0.42	2.0	1.8	0.30	3	22%		9	10	0.99	1.4	0.9	0.08	3	17%	*
S12A	156	144	0.86	-11	39	0.78	1	-7%	1190	1597	0.84	406	315	0.24	3	34%	7	10	0.72	2.8	0.8	0.01	4	40%	*	6	10	0.97	3.7	0.7	0.00	4	59%	*
S12B	134	141	0.87	7	28	0.81	3	5%	1049	1270	0.77	221	290	0.47	3	21%	7	8	0.42	1.1	0.8	0.19	4	17%	*	6	8	0.95	1.3	0.6	0.05	4	20%	*
S12C	281	260	0.92	-21	35	0.56	2	-8%	2467	2446	0.90	-21	298	0.94	1	-1%	8	8	0.56	0.7	0.7	0.35	3	10%		7	8	0.93	1.0	0.6	0.11	4	14%	*
S12D	354	303	0.93	-51	40	0.25	1	-14%	3685	3701	0.82	16	581	0.98	3	0%	9	11	0.74	1.8	0.8	0.06	4	20%	*	8	11	0.90	2.3	1.0	0.06	4	28%	*
S12X	925	849	0.93	-76	119	0.54	1	-8%	8391	9013	0.88	622	1223	0.63	2	7%	8	9	0.69	1.5	0.7	0.08	4	19%	*	7	9	0.94	1.9	0.7	0.02	4	27%	*
S333	166	185	0.02	20	54	0.72	3	12%	2345	3093	0.12	747	897	0.43	3	32%	11	14	0.73	2.3	0.8	0.02	4	20%	*	11	14	0.95	2.3	0.8	0.05	4	20%	*
WCA-3A_OUT	1169	1078	0.93	-91	129	0.50	1	-8%	11582	12628	0.83	1046	1612	0.54	3	9%	9	10	0.81	1.8	0.6	0.02	4	21%	*	8	10	0.89	2.3	0.9	0.02	4	29%	*
S12X+S333	1090	1034	0.94	-56	107	0.62	1	-5%	10736	12106	0.82	1369	1512	0.40	3	13%	9	10	0.82	1.9	0.6	0.02	4	22%	*	8	10	0.87	2.4	0.9	0.02	4	30%	*
NESRS	157	141	0.02	-15	49	0.77	2	-10%	2127	2518	0.05	391	884	0.67	2	18%	11	14	0.72	3.4	0.9	0.01	4	31%	*	11	14	0.95	3.5	0.9	0.01	4	32%	*
SRS_ENP	1081	990	0.93	-91	118	0.46	1	-8%	10518	11531	0.81	1013	1561	0.54	2	10%	8	10	0.81	2.0	0.7	0.02	4	24%	*	8	10	0.88	2.4	0.9	0.02	4	31%	*
L31N_IN	63	135	0.74	72	19	0.01	4	115%	* 1133	2091	0.66	959	406	0.05	4	85%	* 13	12	0.46	-0.9	2.4	0.71	1	-7%		14	13	0.79	-0.9	2.5	0.51	1	-6%	
S174+S332D	87	139	0.50	51	20	0.04	4	59%	* 1030	1546	0.14	516	498	0.33	3	50%	9	9	0.07	-0.4	2.3	0.88	1	-4%		9	9	0.63	0.1	2.1	0.97	2	1%	
TAYLOR_OUT	89	185	0.72	97	23	0.00	4	109%	* 1048	1962	0.35	914	506	0.11	4	87%	* 9	8	0.09	-0.8	2.2	0.74	1	-8%		9	9	0.74	-0.5	1.8	0.74	2	-5%	
S176	89	60	0.49	-30	16	0.11	1	-33%	1125	614	0.15	-511	474	0.32	1	-45%	10	8	0.06	-1.7	3.0	0.58	1	-18%		10	9	0.46	-1.0	3.9	0.83	1	-10%	
S177	131	135	0.39	4	23	0.86	2	3%	1140	1653	0.19	513	409	0.25	3	45%	7	10	0.42	2.6	1.8	0.20	3	36%		7	10	0.60	3.7	1.5	0.03	3	54%	*
S18C	190	180	0.65	-10	24	0.69	2	-5%	2616	1925	0.55	-691	882	0.46	1	-26%	10	8	0.36	-2.4	2.6	0.39	1	-23%		12	8	0.63	-4.1	3.2	0.17	0	-35%	*
S18C-S197	158	152	0.37	-6	32	0.84	2	-4%	1958	1511	0.39	-447	822	0.60	1	-23%	9	8	0.24	-1.8	2.4	0.47	1	-20%		10	7	0.64	-3.3	3.0	0.20	0	-31%	*
L31N+C111_OUT	279	366	0.53	87	42	0.08	4	31%	* 3663	3886	0.32	223	1185	0.86	2	6%	10	8	0.20	-1.7	2.3	0.50	1	-17%		11	8	0.56	-2.7	2.1	0.18	0	-25%	*

Flow-Weighted Concentrations Are Observed Values; Flows, Loads, & Mean Concentrations Are Adjusted to Mean Rainfall, Data Source = WCA+EAA

Time Intervals	Pre-	IOP	All
First Year	1994	2000	1994
Last Year	1999	2003	2003
Rainfall (in/yr)	55.9	51.5	54.1
Years	6	4	10

Water years ending month: 5

PreIOP Rain-Adjusted Mean, pre-IOP Years

IOP Rain-Adjusted Mean, IOP Years

R2 Coef of Determination for Multiple Regression vs. Rain & IOP

Incr Increase in Mean = IOP Mean - pre-IOP Mean

SE Standard Error of increase

p Significance level for IOP term in multiple regression Y = f (rainfall, IOP)

n Number of IOP years above pre-IOP regression line vs. rainfall

%I % Increase = (IOP - pre-IOP) / pre-IOP mean

* Change "significant" if (a) p < 0.1 or (b) n = 0 or 4 out of 4 IOP years

Pre-IOP Means - IOP Means **Water Years: 1994 - 2003**

Term	Flow kac-ft/yr	Load kg/yr	Conc (ppb) Mean	Conc (ppb) FW	Term Description
LAKE_TOTAL	-8	10797	**42.5**	**49.3**	Total Lake Okee Release to WCA's & STA's
LAKE_S352	45	12324	22.9	**32.9**	Lake Okee Release @ S352 to WPB Canal
LAKE_S2	-22	315	**30.7**	**31.2**	Lake Okee Release @ S2 to HILLS & NNR Canals
LAKE_S3	-31	-1841	20.1	**31.8**	Lake Okee Release @ S3 to Miami Canal
EAA_SOUTH	29	7628	-0.2	-0.5	EAA Pump Stations S5A+S6+S7+S8+S150+G404
S10X	**-173**	-13930	-6.3	-4.5	WCA-1 Outflows to WCA-2A: S10A+C+D+E
WCA-3A_WEST	-27	-3500	-1.1	-2.8	Inflow to WCA-3A from Western Basins = G155+S140+S190
WCA-3A_NORTH	-34	-1675	-1.4	-4.1	Inflow to WCA-3A from North = S8+S150+G404
S11X	-130	**-5784**	-6.0	-1.1	WCA-2A Outflow to WCA-3A: S11A+B+C
S9	**32**	**2885**	**7.4**	**7.5**	S9
WCA-3A IN	-160	-8074	0.1	-0.2	Total Inflow to WCA-3A
S343	-35	-323	2.0	**1.4**	S343A + S343B
S12A	-11	406	**2.8**	**3.7**	S12A
S12B	7	221	**1.1**	**1.3**	S12B
S12C	-21	-21	0.7	**1.0**	S12C
S12D	-51	16	**1.8**	**2.3**	S12D
S12X	-76	622	**1.5**	**1.9**	Shark Slough: S12 A + B + C + D
S333	20	747	**2.3**	**2.3**	S333
WCA-3A_OUT	-91	1046	**1.8**	**2.3**	Outflow from WCA-3A: S343X + S12X + S333
S12X+S333	-56	1369	**1.9**	**2.4**	Shark River Slough Total: S12X + S333
NESRS	-15	391	**3.4**	**3.5**	Northeast Shark Slough: S333-S334
SRS_ENP	-91	1013	**2.0**	**2.4**	Shark Slough Total to ENP = S12X + NESRS
L31N_IN	**72**	**959**	-0.9	-0.9	Net Inflow to L31N from North: S334+S335-S336
S174+S332D	**51**	516	-0.4	0.1	Outflow from L31N to L31W/ S332D Detention Area
TAYLOR_OUT	**97**	**914**	-0.8	-0.5	L31-N Outflow to TS/Buffer = S332B+S332D+S174
S176	-30	-511	-1.7	-1.0	S176
S177	4	513	2.6	**3.7**	S177
S18C	-10	-691	-2.4	**-4.1**	S18C
S18C-S197	-6	-447	-1.8	**-3.3**	Inflow to ENP Panhandle from C111: S18C - S197
L31N+C111_OUT	**87**	223	-1.7	**-2.7**	Total L31N/C111 Out =S332B+S332D+S174+S18C

Bold Value Change significant if (a) p<.1 for regression or (b) 0 or 4 IOP years above pre-IOP regression

Percent Change = (IOP - PreIOP) / PreIOP x 100 **Water Years: 1994 - 2003**

Term	Flow	Load	Conc	FWC	Term Description
LAKE_TOTAL	-3	36	**42**	**46**	Total Lake Okee Release to WCA's & STA's
LAKE_S352	56	79	15	**21**	Lake Okee Release @ S352 to WPB Canal
LAKE_S2	-24	4	**41**	**41**	Lake Okee Release @ S2 to HILLS & NNR Canals
LAKE_S3	-58	-34	24	**37**	Lake Okee Release @ S3 to Miami Canal
EAA_SOUTH	2	5	0	0	EAA Pump Stations S5A+S6+S7+S8+S150+G404
S10X	**-33**	-31	-9	-6	WCA-1 Outflows to WCA-2A: S10A+C+D+E
WCA-3A_WEST	-9	-9	-1	-3	Inflow to WCA-3A from Western Basins = G155+S140+S190
WCA-3A_NORTH	-9	-4	-2	-4	Inflow to WCA-3A from North = S8+S150+G404
S11X	-23	**-31**	-22	-4	WCA-2A Outflow to WCA-3A: S11A+B+C
S9	**13**	**71**	**52**	**53**	S9
WCA-3A IN	-11	-8	0	0	Total Inflow to WCA-3A
S343	-44	-38	22	**17**	S343A + S343B
S12A	-7	34	**40**	**59**	S12A
S12B	5	21	**17**	**20**	S12B
S12C	-8	-1	10	**14**	S12C
S12D	-14	0	**20**	**28**	S12D
S12X	-8	7	**19**	**27**	Shark Slough: S12 A + B + C + D
S333	12	32	**20**	**20**	S333
WCA-3A_OUT	-8	9	**21**	**29**	Outflow from WCA-3A: S343X + S12X + S333
S12X+S333	-5	13	**22**	**30**	Shark River Slough Total: S12X + S333
NESRS	-10	18	**31**	**32**	Northeast Shark Slough: S333-S334
SRS_ENP	-8	10	**24**	**31**	Shark Slough Total to ENP = S12X + NESRS
L31N_IN	**115**	**85**	-7	-6	Net Inflow to L31N from North: S334+S335-S336
S174+S332D	**59**	50	-4	1	Outflow from L31N to L31W/ S332D Detention Area
TAYLOR_OUT	**109**	**87**	-8	-5	L31-N Outflow to TS/Buffer = S332B+S332D+S174
S176	-33	-45	-18	-10	S176
S177	3	45	36	**54**	S177
S18C	-5	-26	-23	**-35**	S18C
S18C-S197	-4	-23	-20	**-31**	Inflow to ENP Panhandle from C111: S18C - S197
L31N+C111_OUT	**31**	6	-17	**-25**	Total L31N/C111 Out =S332B+S332D+S174+S18C

Bold Value Change significant if (a) p<.1 for regression or (b) 0 or 4 IOP years above pre-IOP regression

Post IOP Means, Adjusted to Mean Rainfall **Water Years: 1994 - 2003**

Term	Flow kac-ft/yr	Load kg/yr	Conc (ppb) Mean	FW	Term Description
LAKE_TOTAL	219	40491	144	156	Total Lake Okee Release to WCA's & STA's
LAKE_S352	126	28014	179	188	Lake Okee Release @ S352 to WPB Canal
LAKE_S2	71	8882	106	107	Lake Okee Release @ S2 to HILLS & NNR Canals
LAKE_S3	22	3595	103	117	Lake Okee Release @ S3 to Miami Canal
EAA_SOUTH	1251	167296	105	107	EAA Pump Stations S5A+S6+S7+S8+S150+G404
S10X	355	31094	65	66	WCA-1 Outflows to WCA-2A: S10A+C+D+E
WCA-3A_WEST	278	35573	102	102	Inflow to WCA-3A from Western Basins = G155+S140+S190
WCA-3A_NORTH	364	41587	84	87	Inflow to WCA-3A from North = S8+S150+G404
S11X	443	12659	22	24	WCA-2A Outflow to WCA-3A: S11A+B+C
S9	267	6975	22	22	S9
WCA-3A IN	1352	96794	56	57	Total Inflow to WCA-3A
S343	44	522	11	10	S343A + S343B
S12A	144	1597	10	10	S12A
S12B	141	1270	8	8	S12B
S12C	260	2446	8	8	S12C
S12D	303	3701	11	11	S12D
S12X	849	9013	9	9	Shark Slough: S12 A + B + C + D
S333	185	3093	14	14	S333
WCA-3A_OUT	1078	12628	10	10	Outflow from WCA-3A: S343X + S12X + S333
S12X+S333	1034	12106	10	10	Shark River Slough Total: S12X + S333
NESRS	141	2518	14	14	Northeast Shark Slough: S333-S334
SRS_ENP	990	11531	10	10	Shark Slough Total to ENP = S12X + NESRS
L31N_IN	135	2091	12	13	Net Inflow to L31N from North: S334+S335-S336
S174+S332D	139	1546	9	9	Outflow from L31N to L31W/ S332D Detention Area
TAYLOR_OUT	185	1962	8	9	L31-N Outflow to TS/Buffer = S332B+S332D+S174
S176	60	614	8	9	S176
S177	135	1653	10	10	S177
S18C	180	1925	8	8	S18C
S18C-S197	152	1511	8	7	Inflow to ENP Panhandle from C111: S18C - S197
L31N+C111_OUT	366	3886	8	8	Total L31N/C111 Out =S332B+S332D+S174+S18C

Summary of Differences in Mean Flows between pre-IOP & IOP Periods

Location	Mean Flow (kac-ft/yr) pre-IOP	IOP	Change	%	IOP	Potential Causal Factors
S10's	528	355	-173	-33%		Diversion of S-6 to WCA-2A via STA_2
S9	235	267	32	13%		Increased Development / Runoff
L31-N Inflows from North S334+S335-S336	63	135	72	115%	*	Diversions from WCA's & Shark Slough
L31-N Outflows to L31-W S332D+S174	87	139	51	59%	* *	Increased L31-N Inflows S332D Pump
L31-N Outfl to Taylor S/Buffer S332D+S174+S332B	89	185	97	109%	*	" " + S332B Pump
Total L31N/C111 Outflow S332D+S174+S332B+S18C	279	366	87	31%	*	""""
Net Inflow to C111 Panhandle S18C-S197	158	152	-6	-4%		No Significant Change

Adjusted for Variations in Rainfall, Water Years 1994-1999 vs. 2000-2003
Changes Statistically Significant at $p < .10$

Increases in Total P Concentrations at ENP Inflow Structures

Flow-Weighted TP (ppb)

Structures	pre-IOP	IOP	Increase	%
S12A	7.0	9.8	2.8	40%
S12B	6.6	7.7	1.1	17%
S12C	7.6	8.3	0.7	10%
S12D	9.0	10.9	1.8	20%
S12 A+B+C+D	7.9	9.4	1.5	19%
S333	11.3	13.7	2.3	20%
S12X + S333	8.6	10.4	1.9	22%
NESRS (S333-S334)	10.8	14.2	3.4	31%
ENP (S12X+S333-S334)	8.4	10.4	2.0	24%

Potential Causal Mechanisms:

- IOP- WCA-3A drawdown and release below Zone E
- IOP- Increasing proportion of flow thru S333 vs. S12s
- Increasing trends in S9 flow, TP load, & TP conc

Changes adjusted for rainfall & significant at $p < .10$, except for S12C

Apparent Impacts of Change in WCA-3A Regulation under IOP

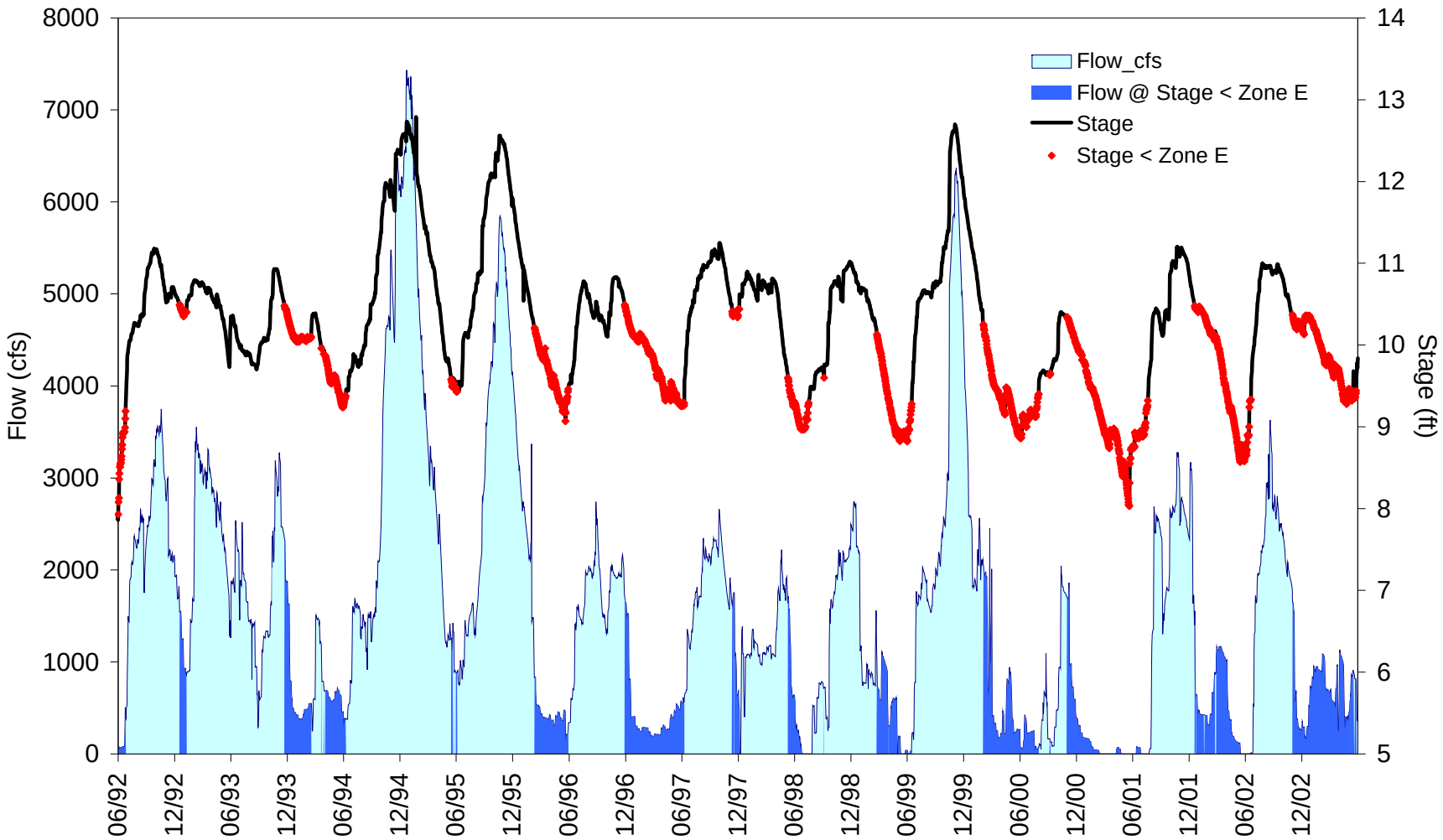
Schedule dropped by 0.5 feet in Feb- mid July (Zone E1)

Related Hydrologic changes detected in raw & rainfall-adjusted data
- Decreased yearly mean stage vs. 1993-1999
- Increased frequency of stage < 9.5 ft & stage < Zone E
- Increased proportion of outflow at stage < Zone E

Patterns in TP data from WCA-3A marsh & outflow sites
- Inverse conc vs. stage relationship (daily, monthly, yearly)
- Concentration increases sharply at stage < 9.5 ft (10-30 ppb)
- Load spikes under high rainfall & rising flows after severe drawdown

Increase in Yearly Flow-Wtd TP Conc at S12X & S333 inflows (2-3 ppb)

Increase in Marsh Yearly Geometric Mean TP Concentrations
- WCA-3A southern marsh
- Big Cypress Sites (TAMBR105, S343X)
- ENP inflow structures
- ENP marsh immediately downstream of structures (presumed)
- No apparent effect at WCA-3A northern marsh sites


Flow_cfs
Flow @ Stage < Zone E
Stage
Stage < Zone E
Flow (cfs)
Stage (ft)
8000
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3000
2000
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14
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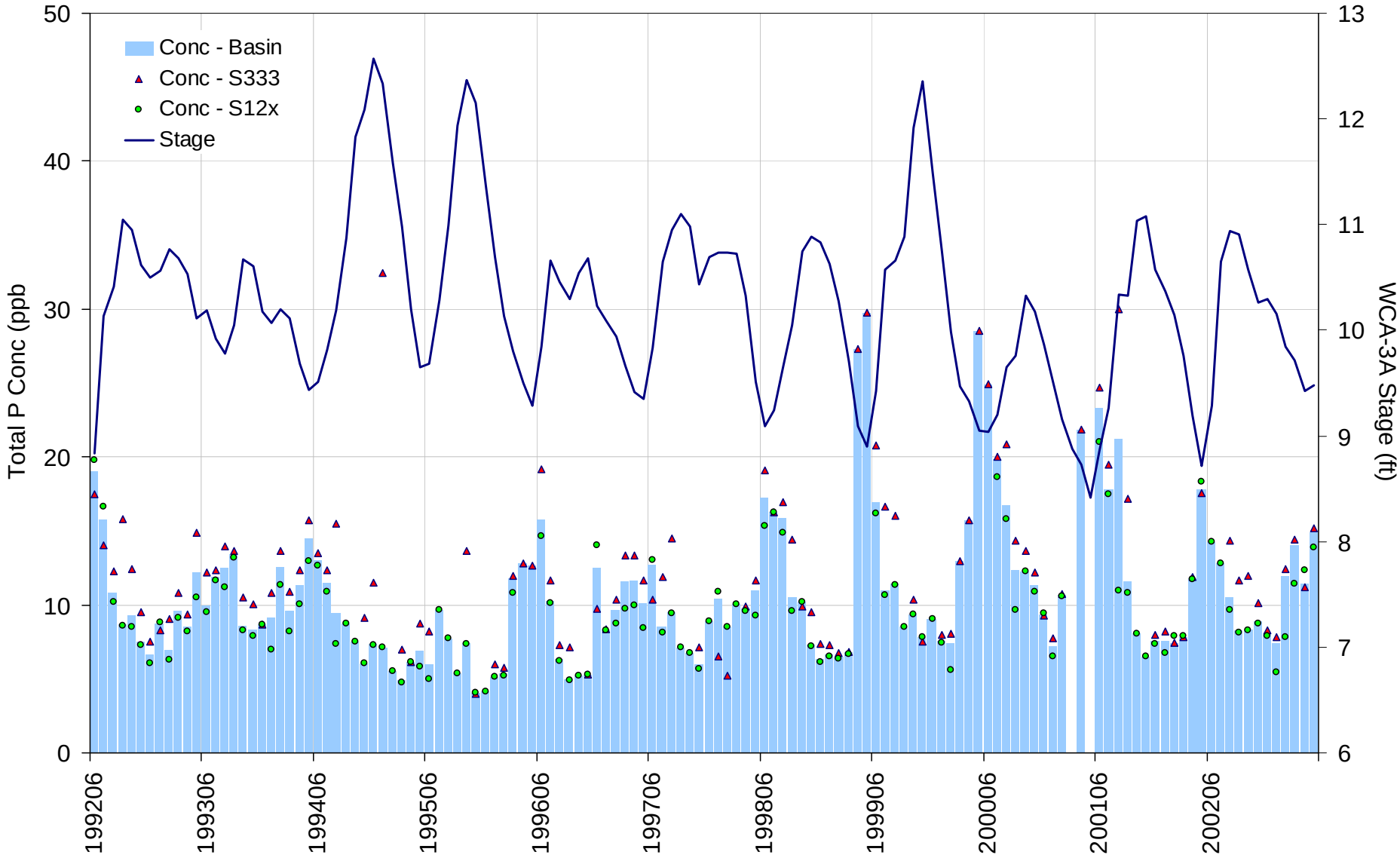
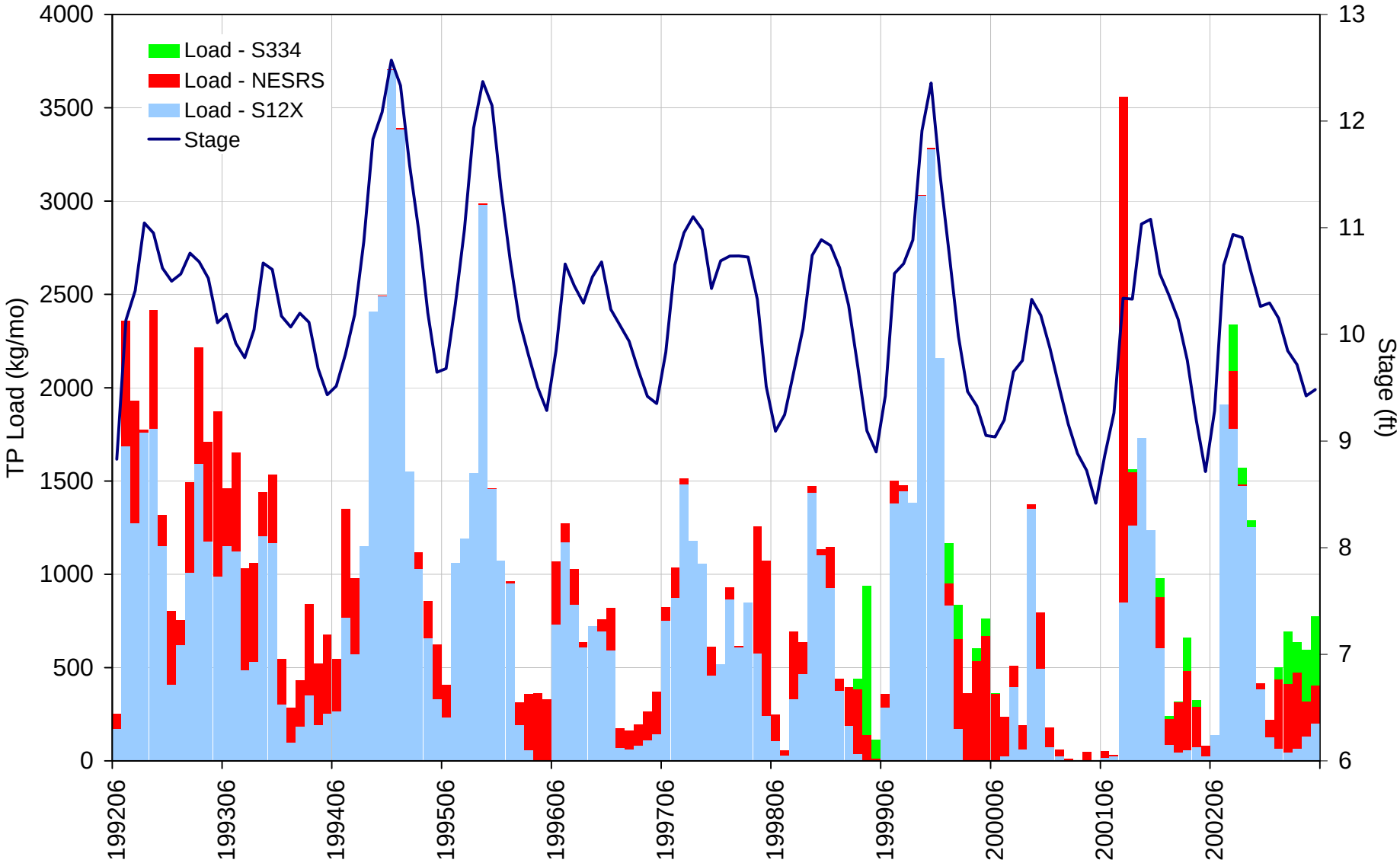
12/94
06/95
12/95
06/96
12/96
06/97
12/97
06/98
12/98
06/99
12/99
06/00
12/00
06/01
12/01
06/02
12/02


Conc - Basin
Conc - S333
Conc - S12x
Stage
Total P Conc (ppb
WCA-3A Stage (ft)
0
10
20
30
40
50
6
7
8
9
10
11
12
13
199206
199306
199406
199506
199606
199706
199806
199906
200006
200106
200206


Load - S334
Load - NESRS
Load - S12X
Stage
TP Load (kg/mo)
Stage (ft)
4000
3500
3000
2500
2000
1500
1000
500
0
13
12
11
10
9
8
7
6
199206
199306
199406
199506
199606
199706
199806
199906
200006
200106
200206

Data Limitations Potentially Influencing the Analysis

Phosphorus Data

- Structure analysis based on SFWMD data (except S332B)
- Mix of grab vs. composite samples (L31N/C111)
- SFWMD change in detection limits (4 -> 2 ppb) in 2000
- Different labs (SFWMD, SFWMD Contractors, COE)
- SFWMD TP data bias (-20%) in 1996-1997
- COE data bias <2001 (data not used)

Flow & Rainfall Data

- Many sites not QA/QC'd (no preferred DBKEY)
- Multiple DBKEYS for same data
- Missing data

Regional Variations in Rainfall

- WCA/EAA average used in analysis (''watershed')
- Decreasing rainfall gradient (south->north) in 1996-2003
- Results may be sensitive to regional averaging

IOP Effect Confounded with Rainfall Effect

- Base Period (1994-1999) average to wet rainfall
- IOP Period (2000-2003) dry to average rainfall

Total P Concentration Changes in L31N/C111 Basin

	Rainfall-Adjusted Values				
	pre-IOP	IOP	Increase	%	
L31N_IN	13.1	12.2	-0.9	-7%	
S174+S332D	9.1	8.7	-0.4	-4%	
TAYLOR_OUT	9.1	8.3	-0.8	-8%	
S176	9.8	8.1	-1.7	-18%	
S177	7.2	9.8	2.6	36%	*
S18C	10.5	8.1	-2.4	-23%	*
S18C-S197	9.4	7.6	-1.8	-20%	*
L31N+C111_OUT	10.1	8.5	-1.7	-17%	*

Changes in rainfall-adjusted values not significant
* Changes in flow-adjusted values are significant

Potential Causal Mechanisms

P removal in groundwaters circulating between buffer & canal
Limited removal in buffer cells because of low detention time

Monitoring Needs

Preferred DBKEYS for flow & rainfall data
Regional-average rainfall DBKEYS
Investigate Differences between Grab & Composites
Composite Sampling to Capture Transient Conc Spikes
    L31N/C111 Mainstem
    Buffer Inflows & Outflows
    Eastern L31/C111 Canals (C102, C103, C113)
    S333?
Source of high-flow P spikes at S18C
Route monitoring at S335
Composite or real-time monitoring of Pumps & Canals
    Tracers for urban/agric inputs
    vs. canal drawdown /flood control events
Marsh transects downstream of ENP inflow points

Operational Recommendations

Shark River Slough

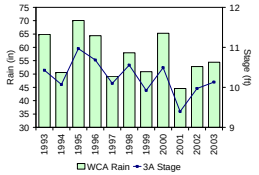
- Eliminate Zone E1 of WCA-3A Regulation Schedule
- Avoid Release below Zone E or Stage < 9.5 feet

L31N/C111 Basin

- Operate buffer to minimize direct overflow to ENP
- Refine operations based upon monitoring results

Assessment Needs

- P Transport & Fate in Buffer
  - Mechanisms for P Removal
  - Fate in groundwater
  - Groundwater flow to east vs. west?
- Continue to Track Regional Water & P Budgets
  - Water & Mass Balances
  - Trends in Flow, Concentration, Load
  - Correlations with Operations
- Empirical & Mechanistic Models for P Transport
- Assess Factors Controlling P Levels at S12s & S333
  - Relative importance of S9 vs. Other WCA Inflows
  - Effects of drawdown
  - Effects of flow distribution across structures
  - Increasing P concentrations at S12A
  - Relate to WCA-3A marsh & canal data

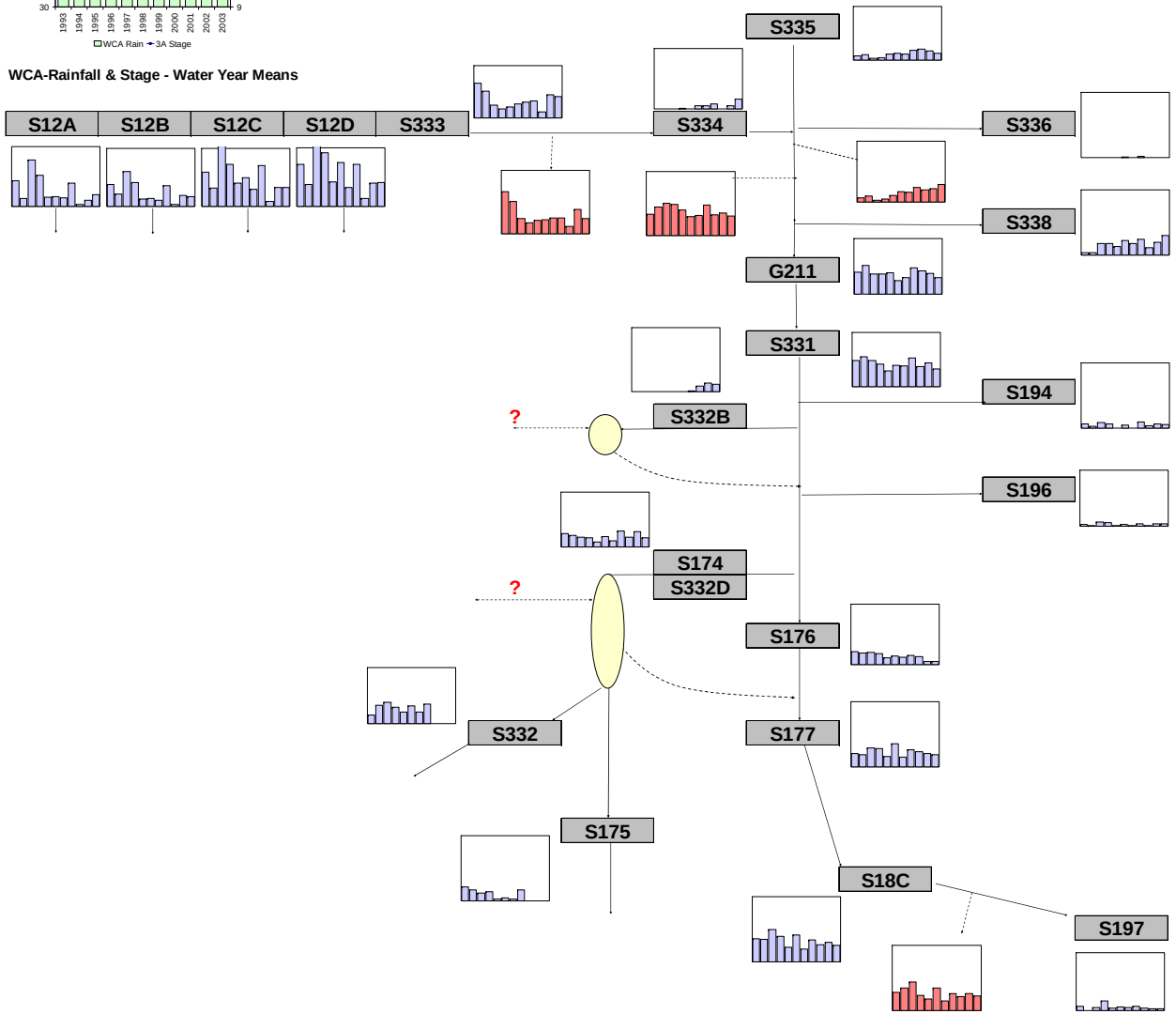


WCA-Rainfall & Stage - Water Year Means

Mean Flows **Max Scale =** **800** **cfs**

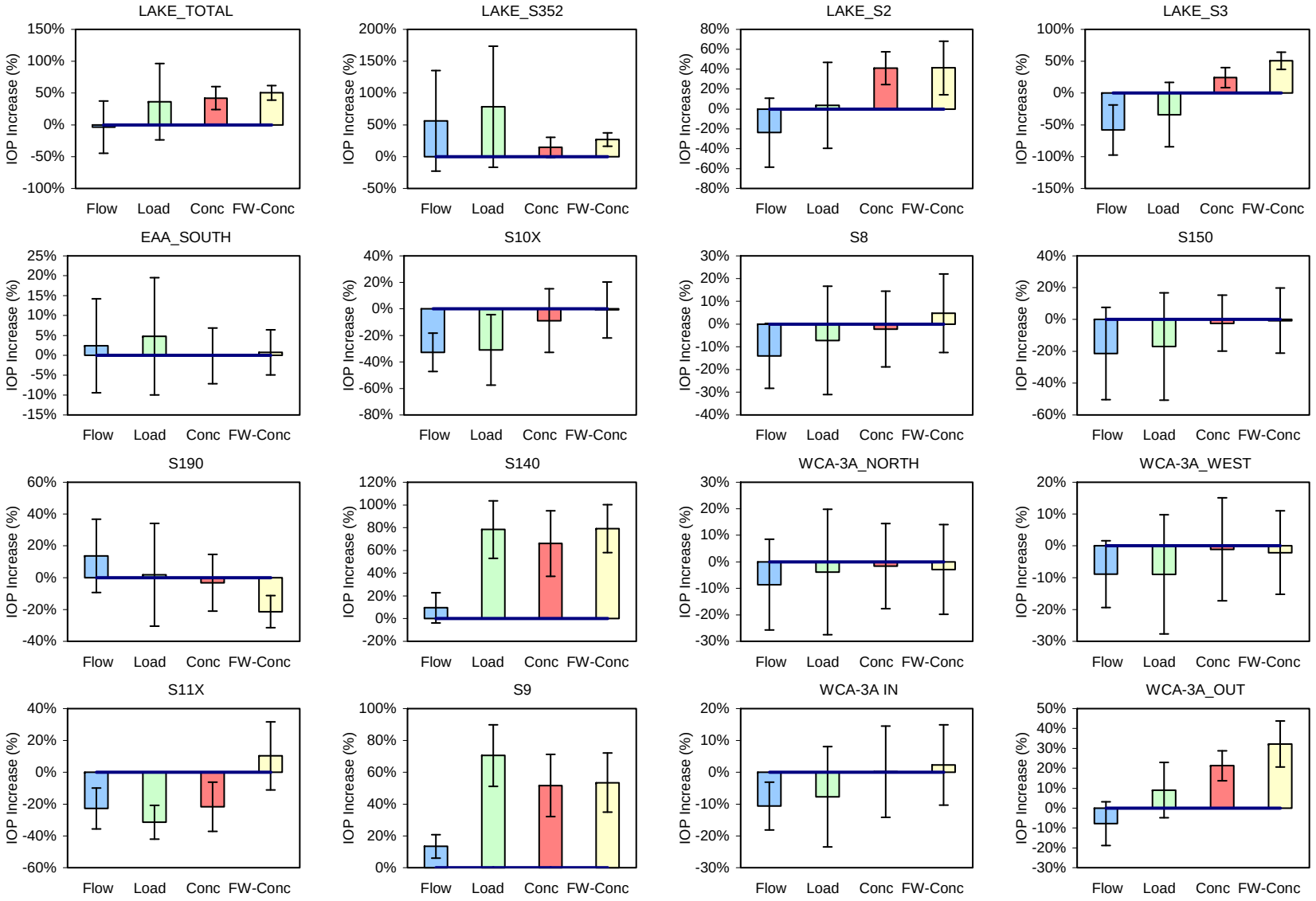
Water Years: **1993** **thru** **2003**

Season: **(All)** **June - May**



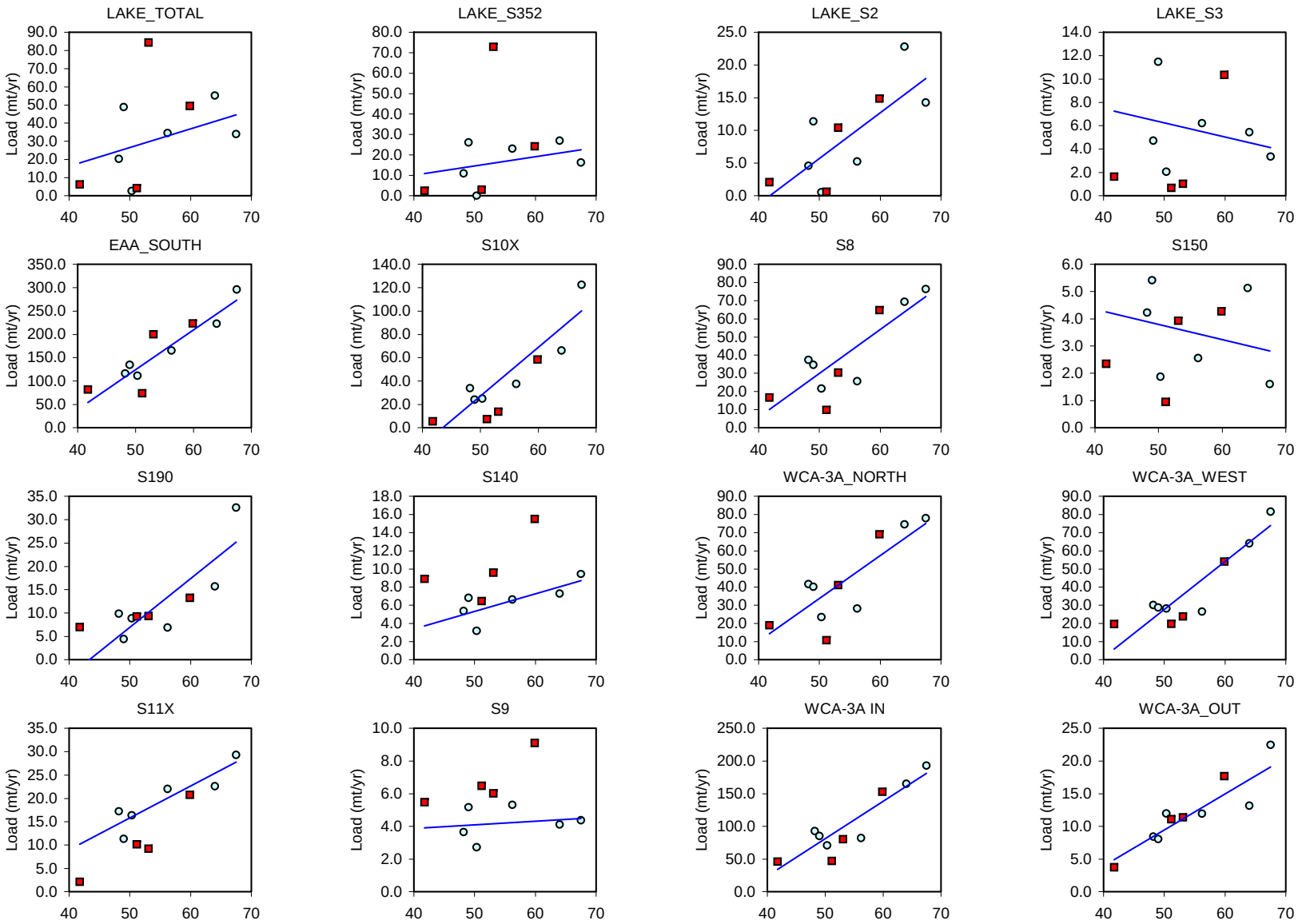
Percent Increase in Flow, TP Load, Concentration, & Flow-Weighted Mean Concentration

Pre-IOP: 1994 1999 IOP Pd: 2000 2003 Flow, Load Conc Adjusted for Rainfall Flow-Wtd Conc Adjusted for Flow



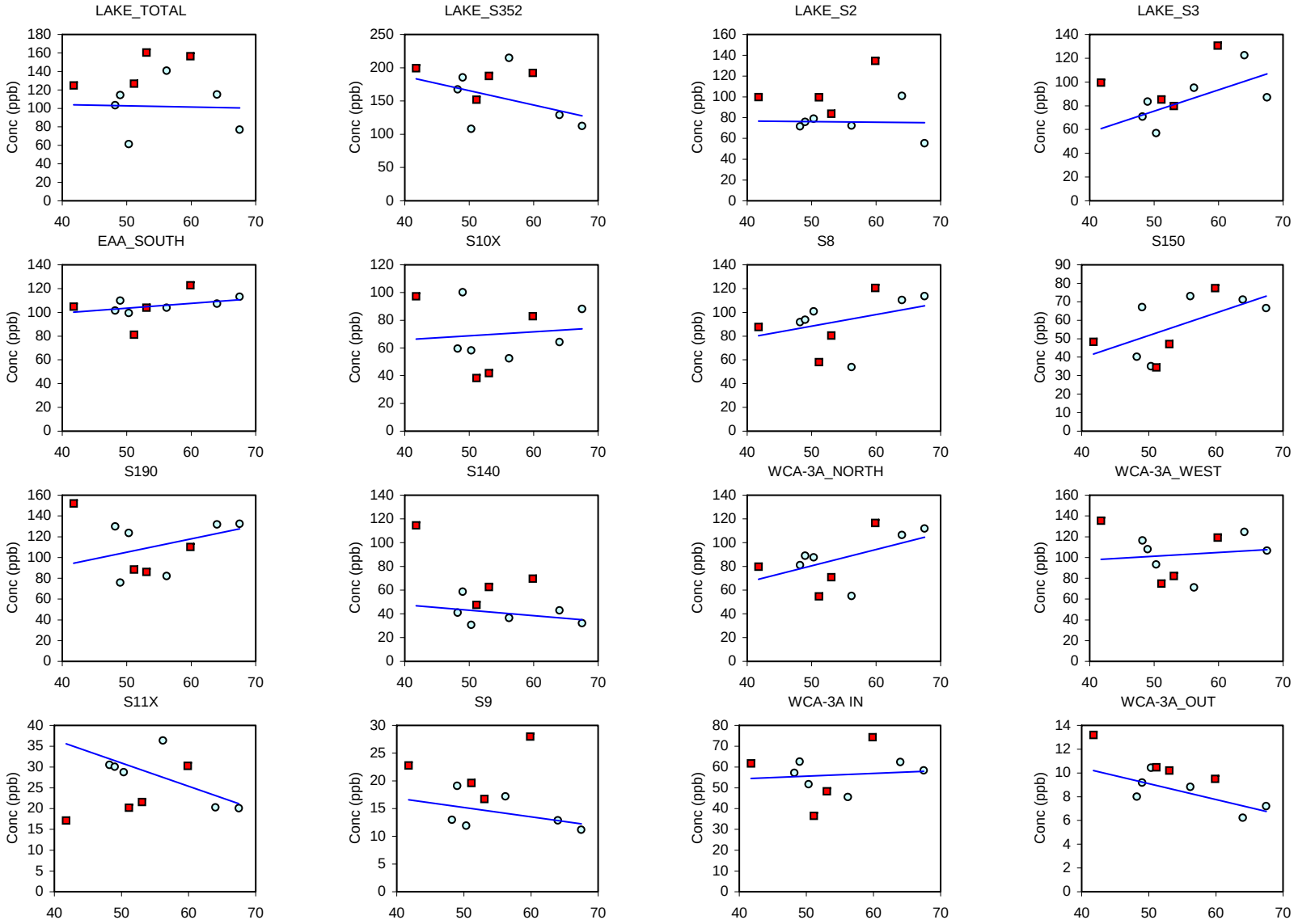
IOP vs. Base Period Regressions **TP Load** **Base Pd:** **1994** **1999**

x = WCA+EAA Lines = pre-IOP Regressions



IOP vs. Base Period Regressions **TP Conc** **Base Pd:** **1994** **1999**

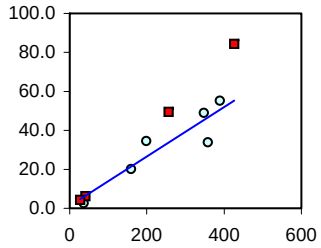
x = WCA+EAA Lines = pre-IOP Regressions



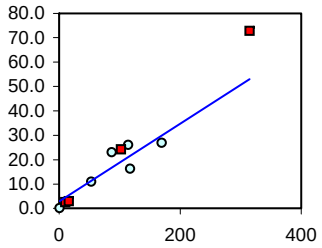
Yearly Load (mt / yr) vs. Flow (kac-ft/yr) **Water Years** **1994** **2003**

Circles = pre-IOP, Squares = IOP, Lines = pre-IOP Regressions

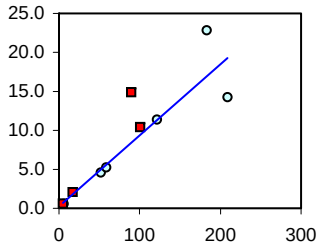
LAKE_TOTAL



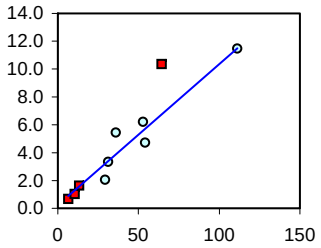
LAKE_S352



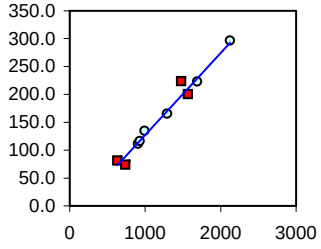
LAKE_S2



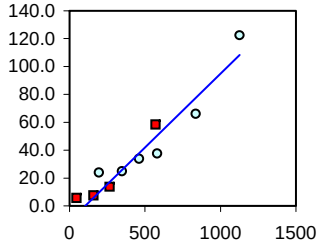
LAKE_S3



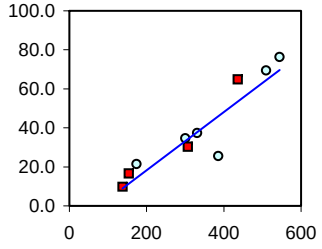
EAA_SOUTH



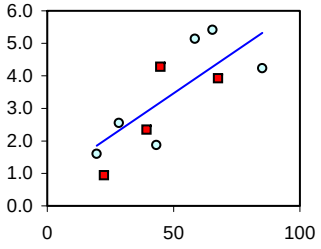
S10X



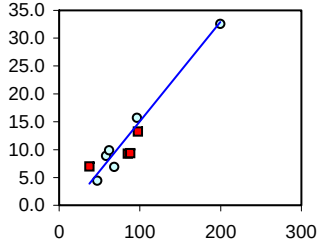
S8



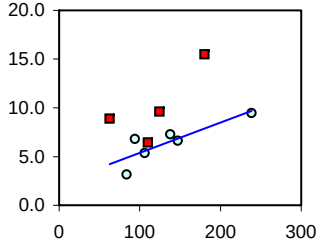
S150



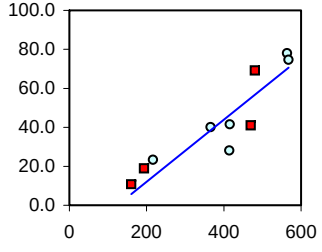
S190



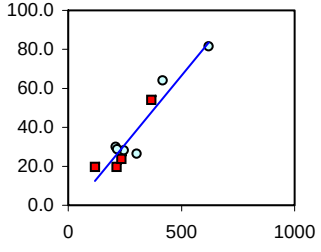
S140



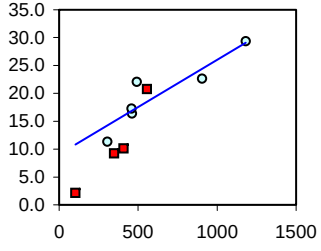
WCA-3A_NORTH



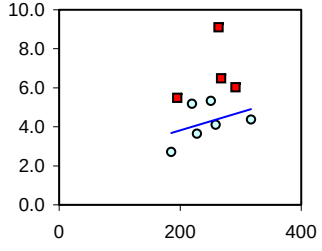
WCA-3A_WEST



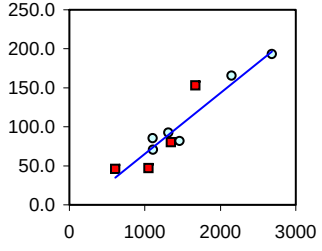
S11X



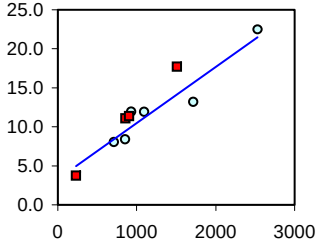
S9



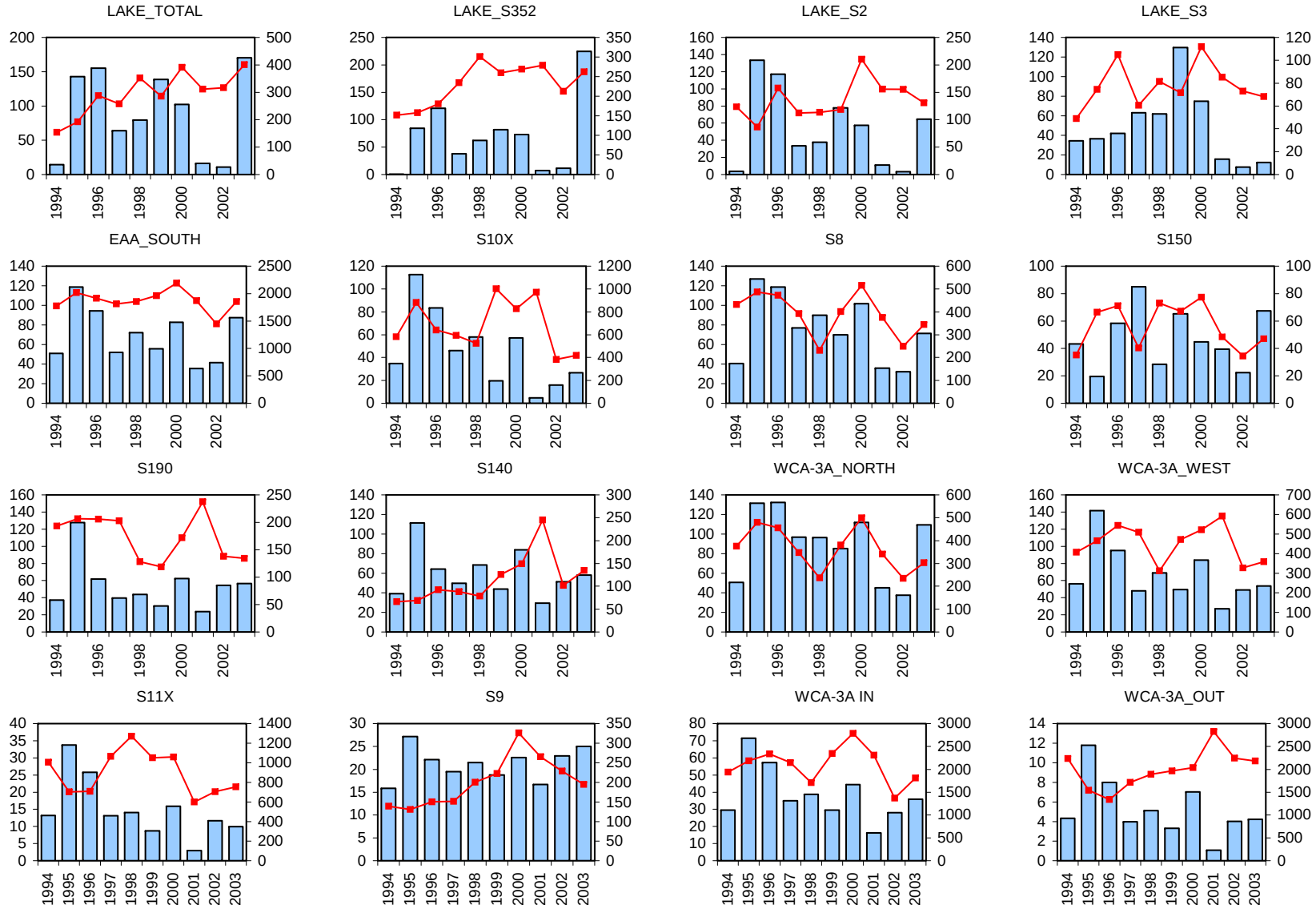
WCA-3A IN



WCA-3A_OUT



TP Concs (ppb) & Flows (kac-ft) **Water Years** **1994** **2003**



Regression Model R^2 **Water Years: 1994 - 2003**

Term	Flow	Load	Conc	FWC	Term Description
LAKE_TOTAL	0.37	0.23	0.44	0.96	Total Lake Okee Release to WCA's & STA's
LAKE_S352	0.22	0.14	0.26	0.97	Lake Okee Release @ S352 to WPB Canal
LAKE_S2	0.65	0.56	0.47	0.84	Lake Okee Release @ S2 to HILLS & NNR Canals
LAKE_S3	0.24	0.10	0.40	0.95	Lake Okee Release @ S3 to Miami Canal
EAA_SOUTH	0.84	0.82	0.18	0.96	EAA Pump Stations S5A+S6+S7+S8+S150+G404
S10X	0.91	0.81	0.02	0.90	WCA-1 Outflows to WCA-2A: S10A+C+D+E
WCA-3A_WEST	0.91	0.80	0.00	0.89	Inflow to WCA-3A from Western Basins = G155+S140+S190
WCA-3A_NORTH	0.64	0.68	0.31	0.79	Inflow to WCA-3A from North = S8+S150+G404
S11X	0.90	0.90	0.22	0.74	WCA-2A Outflow to WCA-3A: S11A+B+C
S9	0.70	0.66	0.54	0.56	S9
WCA-3A IN	0.94	0.82	0.04	0.87	Total Inflow to WCA-3A
S343	0.71	0.72	0.42	0.99	S343A + S343B
S12A	0.86	0.84	0.72	0.97	S12A
S12B	0.87	0.77	0.42	0.95	S12B
S12C	0.92	0.90	0.56	0.93	S12C
S12D	0.93	0.82	0.74	0.93	S12D
S12X	0.93	0.88	0.69	0.90	Shark Slough: S12 A + B + C + D
S333	0.02	0.12	0.73	0.94	S333
WCA-3A_OUT	0.93	0.83	0.81	0.95	Outflow from WCA-3A: S343X + S12X + S333
S12X+S333	0.94	0.82	0.82	0.89	Shark River Slough Total: S12X + S333
NESRS	0.02	0.05	0.72	0.87	Northeast Shark Slough: S333-S334
SRS_ENP	0.93	0.81	0.81	0.95	Shark Slough Total to ENP = S12X + NESRS
L31N_IN	0.74	0.66	0.46	0.88	Net Inflow to L31N from North: S334+S335-S336
S174+S332D	0.50	0.14	0.07	0.79	Outflow from L31N to L31W/ S332D Detention Area
TAYLOR_OUT	0.72	0.35	0.09	0.63	L31-N Outflow to TS/Buffer = S332B+S332D+S174
S176	0.49	0.15	0.06	0.74	S176
S177	0.39	0.19	0.42	0.46	S177
S18C	0.65	0.55	0.36	0.60	S18C
S18C-S197	0.37	0.39	0.24	0.63	Inflow to ENP Panhandle from C111: S18C - S197
L31N+C111_OUT	0.53	0.32	0.20	0.64	Total L31N/C111 Out =S332B+S332D+S174+S18C

Flow, Load, Conc Regression: $Y = B0 + B1\ Rain + B2 \times IOP$

FWC Regression: $Load = B1\ Flow + B2\ Flow \times IOP$

IOP = 0 before, 1= during IOP