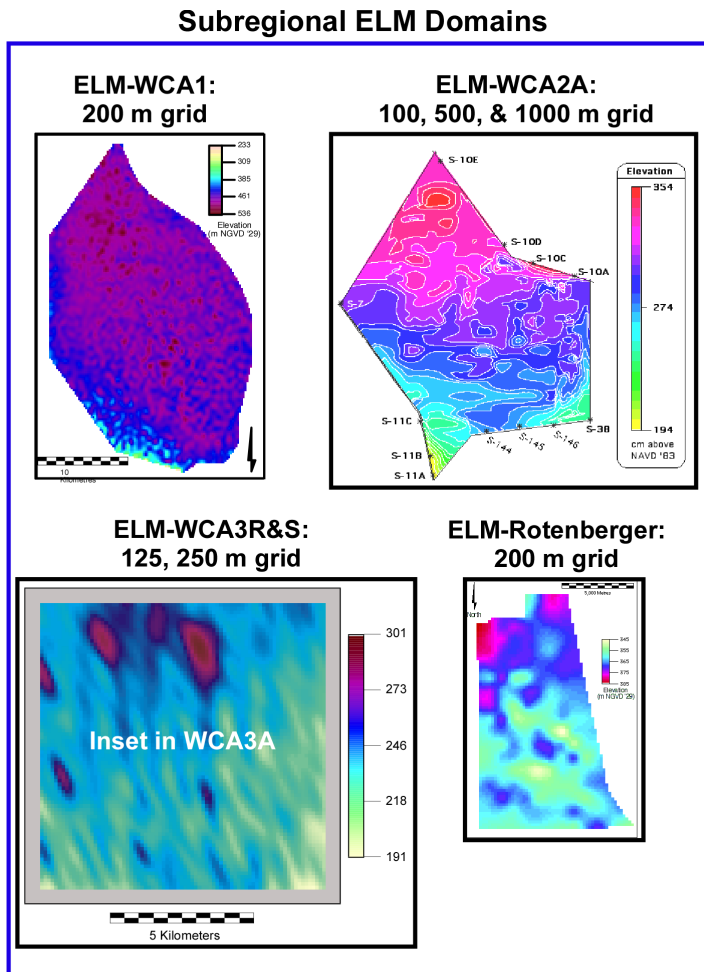
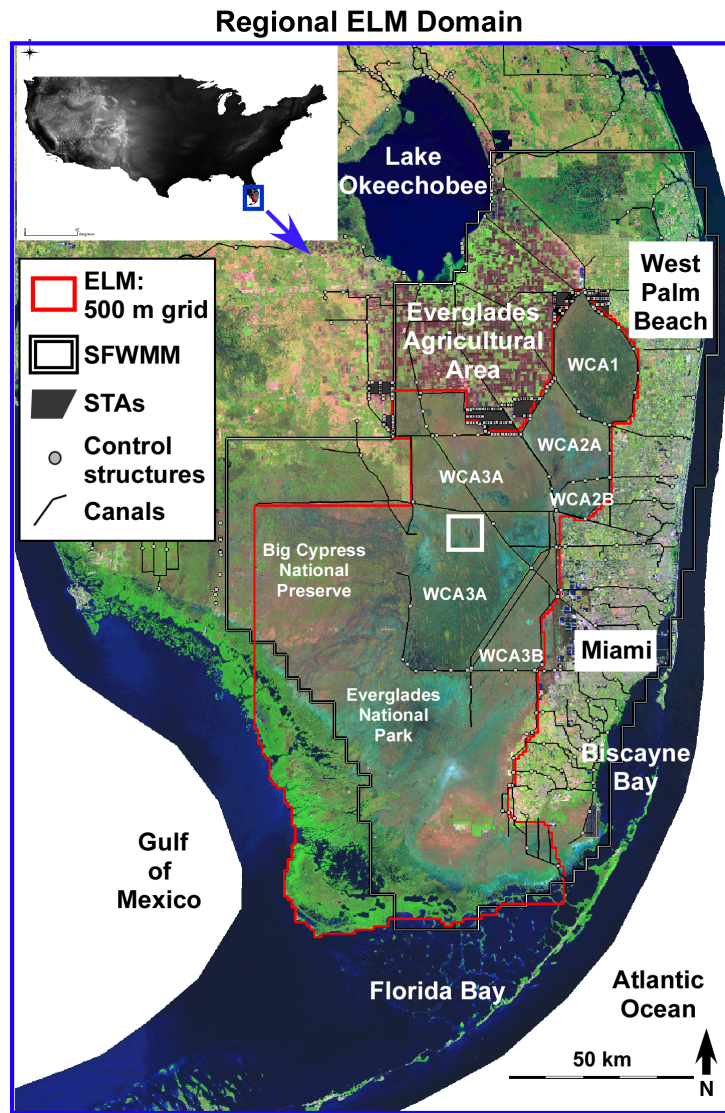
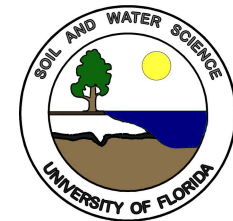
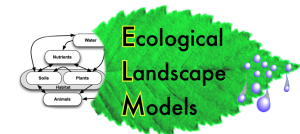


Everglades Landscape Model: Initial Results for DECOMP PIR 1 Phase 1 Base Runs



**June 20, 2011
H. Carl Fitz**



Fort Lauderdale
Research & Education Center

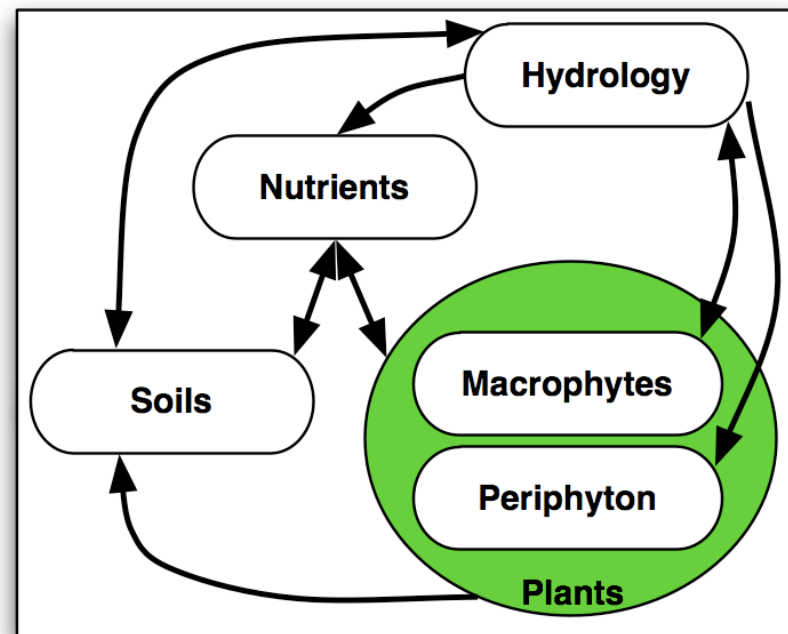


Presentation:

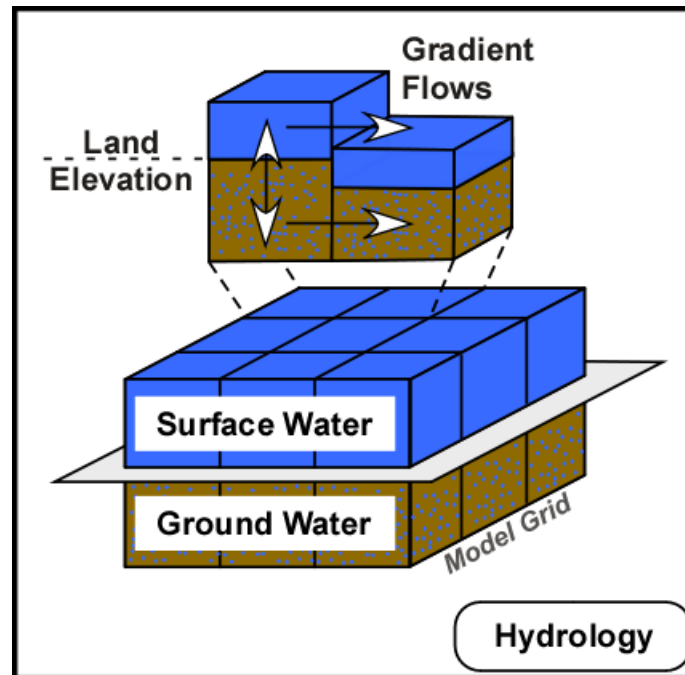
- 1. Reminder of model design, performance**
- 2. Linkages among SFWMM, RSM, ELM (grids, flows)**
- 3. Existing Condition Base (ECB), Future Without Project Base (FWO)**
 - 1. Basic differences, basin-wide water and phosphorus inflows-outflows**
 - 2. Differences in P accumulation rates in some Indicator Regions**
 - 3. Differences in monthly time series of hydro-ecological variables (water, nutrients, plants, soils) in some Indicator Regions**
- 4. ECB vs. FWO Performance Measure results**
 - 1. Difference maps during different seasons, years, for TP surface water, TP soil, TP accumulation rate**
- 5. Suggestions for improvement, in order to finalize runs & Performance Measures**

ELM Design: Integrating ecological interactions

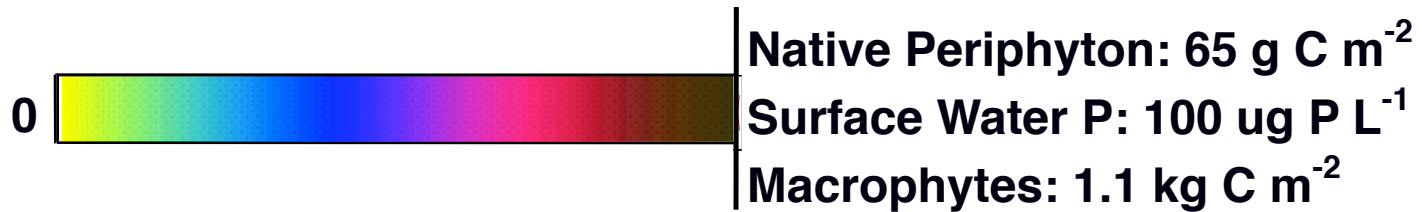
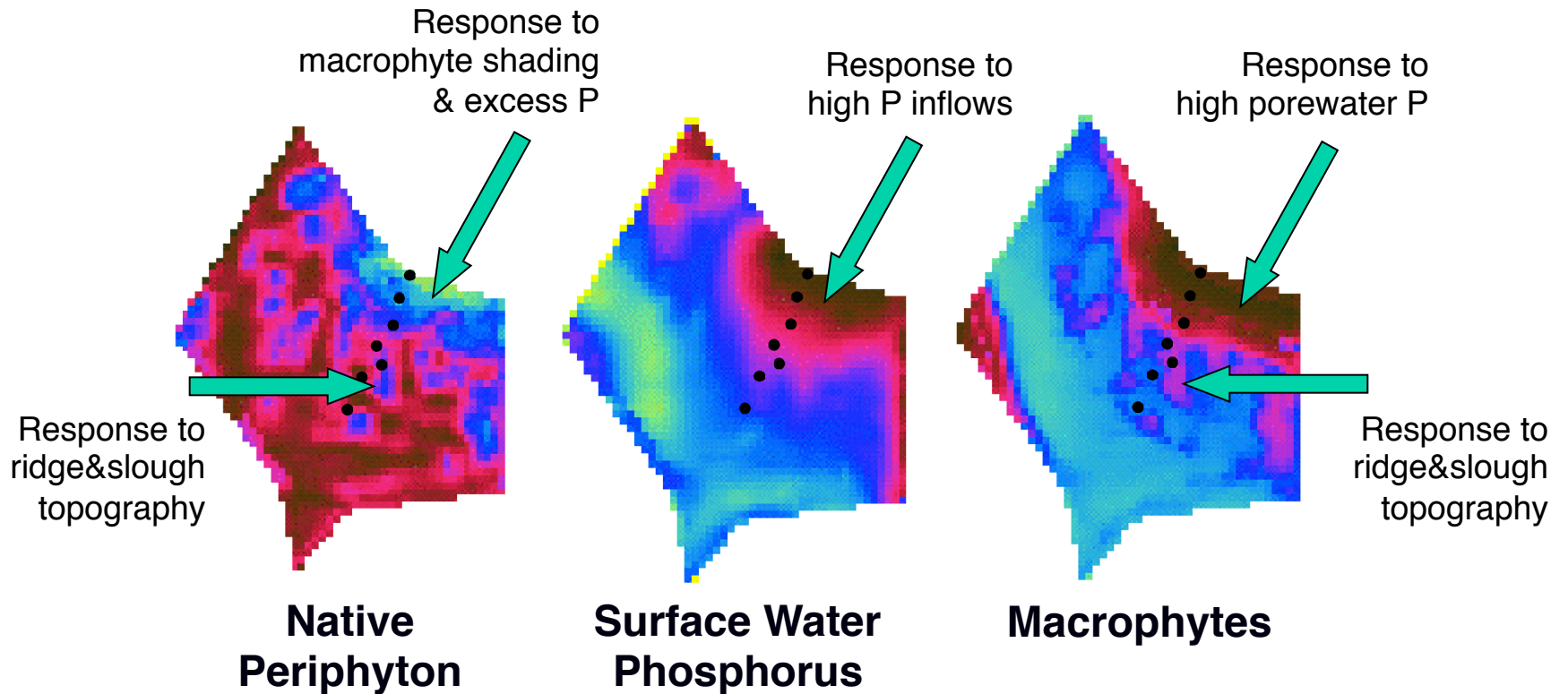
1. Boxes change in response to each other
2. Arrows denote simple model “mechanisms” of WHY things change
3. Using simple “WHYs”, model is not restricted to statistical “fits” of past behavior
4. Thus, apply understanding to predict relative performance of future restoration scenarios



ELM Design: Hydrologic framework



ELM Modeling: Patterns of Ecological Interactions



ELM v1.5

**Model Performance:
1981-2000, 500 m resolution
regional ELM v2.8**

Simulated vs. observed stage:

Median bias = 0 cm

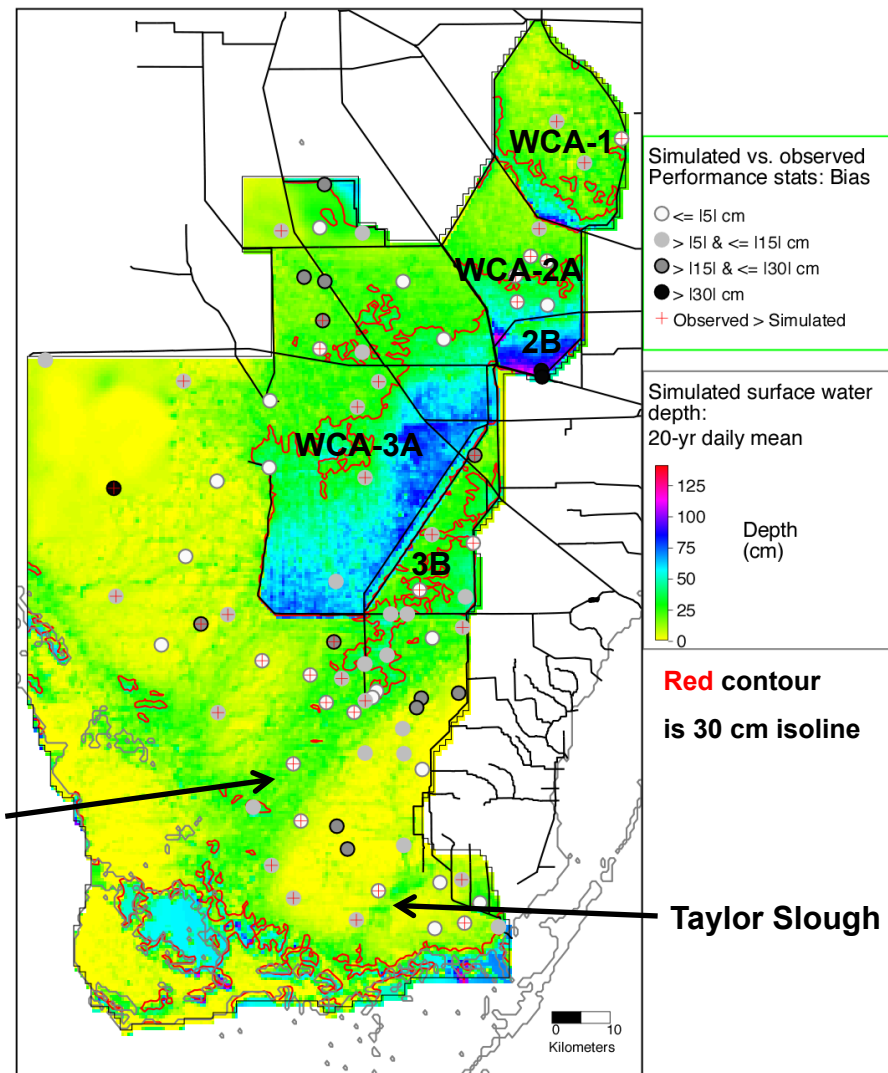
Median NS Efficiency = 0.61

Hydrologic gradients:

- water ponds in downslope regions of impounded WCAs
- deeper regions along Shark & Taylor sloughs, finer-scaled slough features

Shark River Slough

Taylor Slough



ELMreg500m
v2.8.3

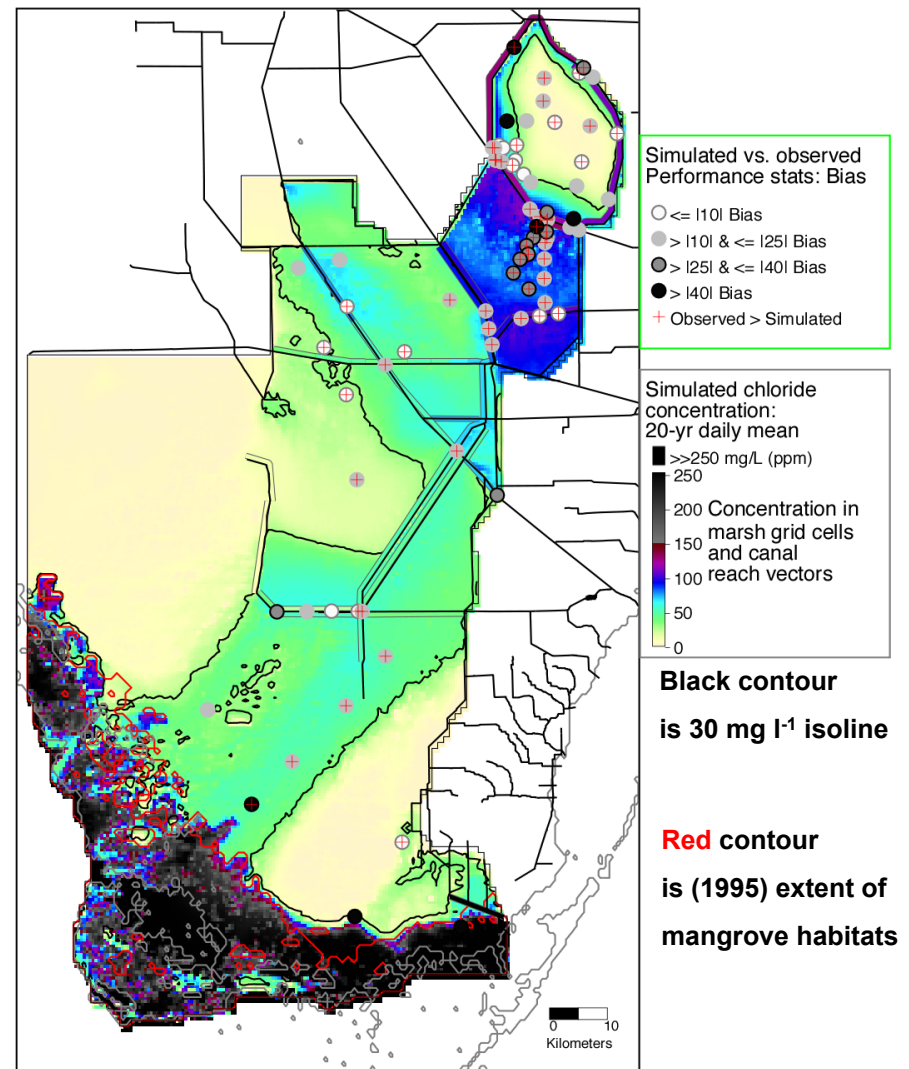
**Model Performance:
1981-2000, 500 m resolution
regional ELM v2.8**

**Simulated vs. observed Cl
concentration in surface water:**

**Median bias in marsh = 6 mg l⁻¹
Median bias in canals = 13 mg l⁻¹**

Chloride gradients:

- “ring” around WCA1 perimeter
- high concentrations throughout WCA2A&B
- canal-driven Cl tracer down eastern WCA3A&B, then down Shark River Slough
- off the “color” scale within estuarine habitats



**ELMreg500m
v2.8.3**

**Model Performance:
1981-2000, 500 m resolution
regional ELM v2.8**

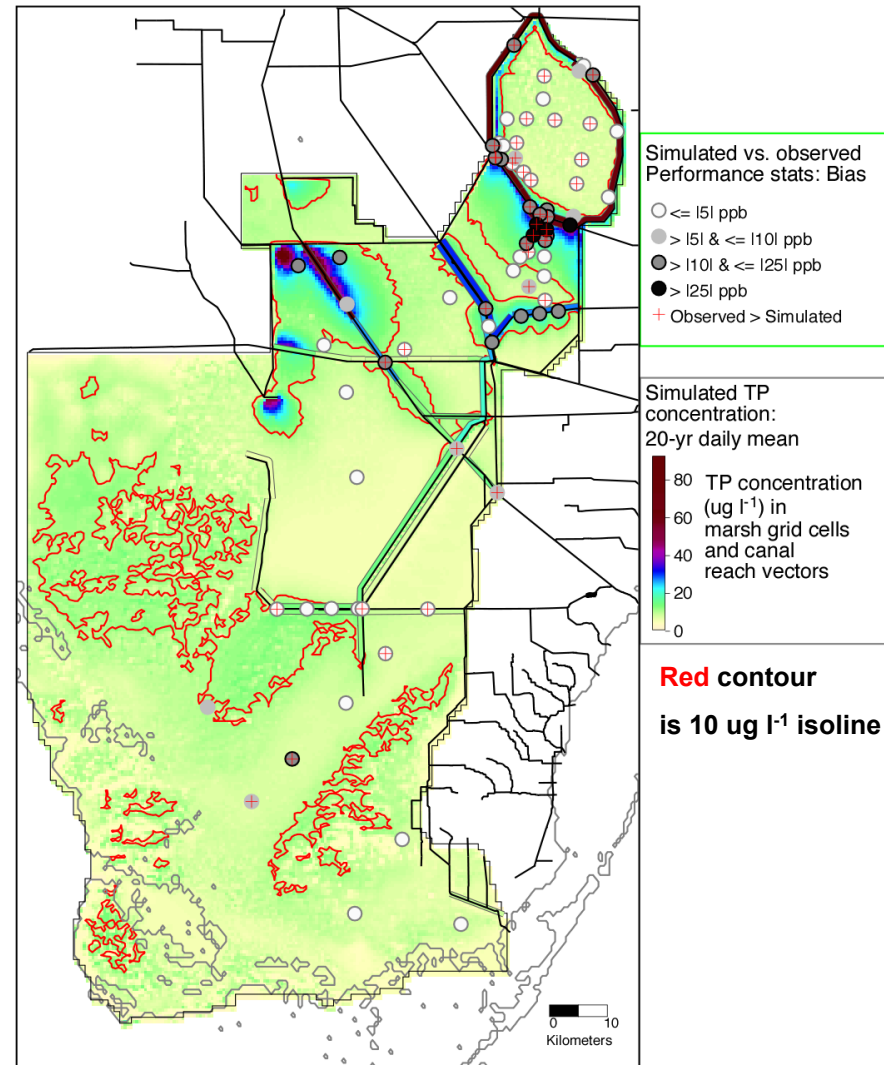
**Simulated vs. observed TP
concentration in surface water:**

Median bias in marsh = 0 $\mu\text{g l}^{-1}$

Median bias in canals = 6 $\mu\text{g l}^{-1}$

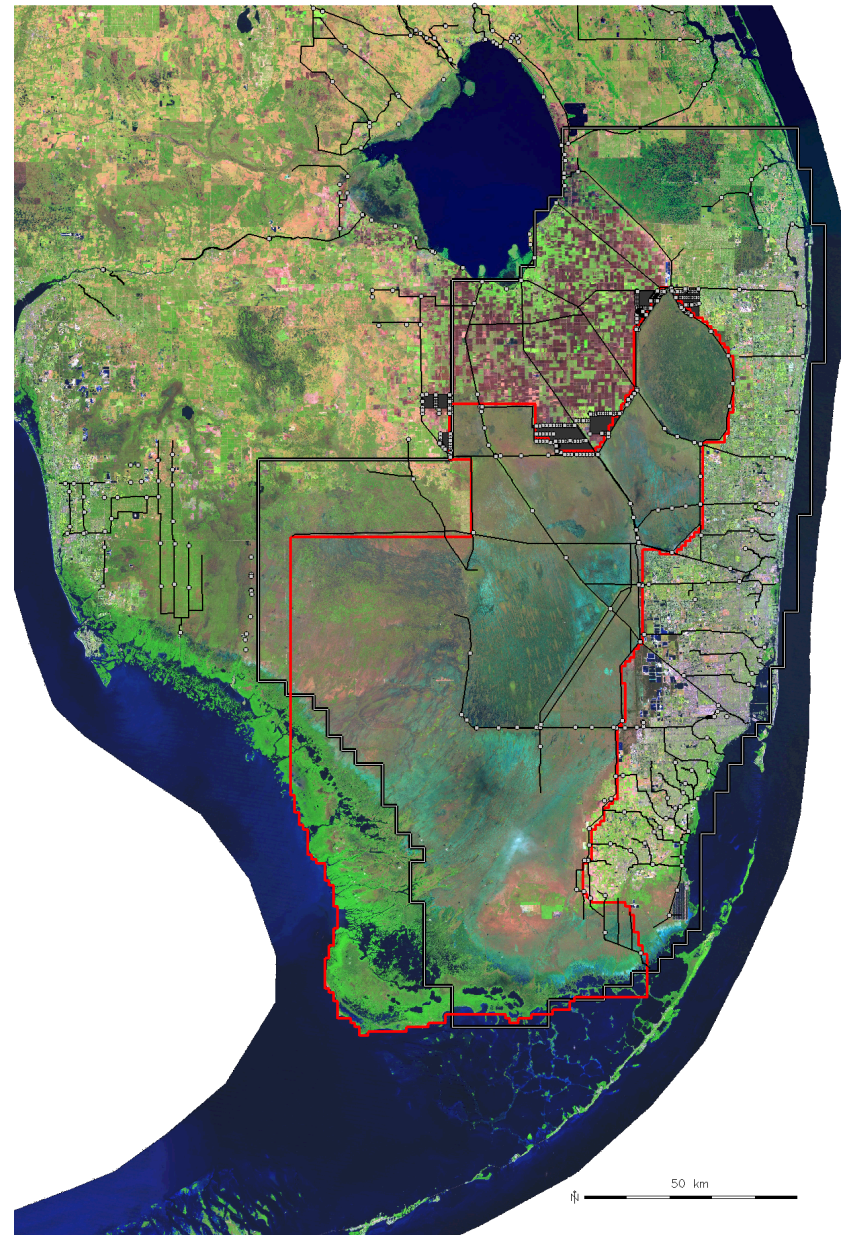
Phosphorus gradients:

- “ring” around WCA1 perimeter
- strong eutrophication gradients in WCA2A & WCA3A
- other regions of P conc. slightly over 10 $\mu\text{g l}^{-1}$ are very shallow habitats (concentration-effect)



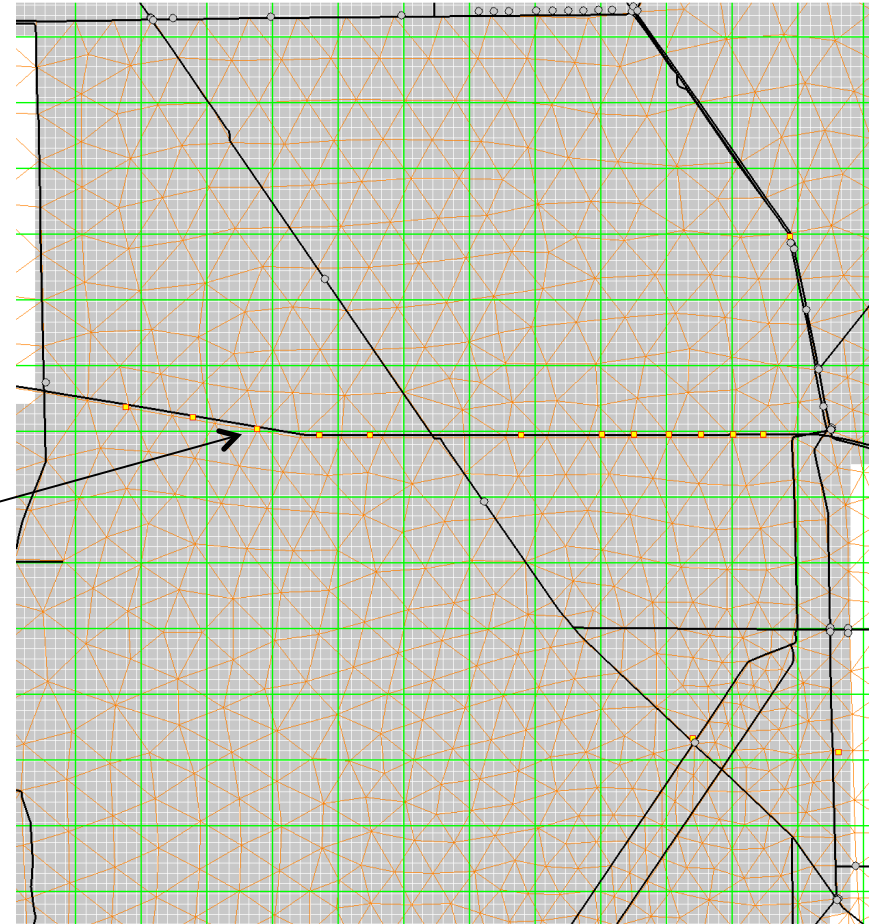
**ELMreg500m
v2.8.3**

ELM, SFWMM domains



ELM, RSM, SFWMM grids in northern WCA-3A

Alligator Alley, multiple bridges



View the Water Control Structure Database (go to Filemaker Pro)

Pointing out flows for one inflow structure (e.g., S-8) can have multiple source waters (and thus inflow TP concentrations)

ELM Water Control Structure Attributes						Fr: Cell_X Cell_Y CanallD	Click Alt button for structure list		GO TO: Details
Model ID	Name	TP (ppb)	CI (ppt)	Basin From	To	Cell_X	Cell_Y	CanallD	
WMM	<input type="text" value="HLYL4"/>			Holey L	WCA3A			32	<input type="checkbox"/> Calib 2.8 <input type="checkbox"/> LOR S07 <input checked="" type="checkbox"/> Dcmp ECB <input checked="" type="checkbox"/> Dcmp FWO <input checked="" type="checkbox"/> Dcmp AltA <input type="checkbox"/> Dcmp <input type="checkbox"/> Dcmp <input type="checkbox"/> Dcmp <input type="checkbox"/> Dcmp <input type="checkbox"/> Dcmp AltE
ELM	<input type="text" value="HLYL4"/>							60	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Portion of Holey outflow routed via L-4 and L-28, into small C-60 north of Alligator Alley in western WCA-3A. Struct moved in CERP. S140A = (ROTOL4+HLYL4+ ST3TL4+ST6TL4+S140FC).									
WMM	<input type="text" value="ROTOL4"/>			Rot	WCA3A			64	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="ROTOL4"/>							60	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Portion of Rotenberger outflow routed via L-4 and L-28, into small C-60 north of Alligator Alley in western WCA-3A. S140A = (ROTOL4+HLYL4+ ST3TL4+ST6TL4+S140FC). ROTOT1-3 == ROTTS8+RTTHLY +RTTSEM+RTTWCA+ROTOL4									
WMM	<input type="text" value="ROTTS8"/>			Rot	WCA3A	95	81		<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="ROTTS8"/>							41	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Rotenberger contribution to S-8 flows into Miami Canal. S8=(ROTTS8+WLC354+ST3TS8+S8BPMR+WLES8) ROTOT1-3 == ROTTS8+RTTHLY+RTTSEM+RTTWCA+ROTOL4									
WMM	<input type="text" value="S140"/>			L28	WCA3A	1	1		<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="S140"/>							60	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Flow into small C-60 north of Alligator Alley in western WCA-3A. (Inactive, but in Alt's list to verify flow sum): S140A = (ROTOL4+HLYL4+ ST3TL4+ST6TL4+S140FC).									
WMM	<input type="text" value="S140FC"/>	98	0.13	L28	WCA3A	1	1		<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="S140FC"/>							60	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Flood control runoff from the C-139 Annex basin, routed down L-28, into small C-60 north of Alligator Alley in western WCA-3A. S140A = (ROTOL4+HLYL4+ ST3TL4+ST6TL4+S140FC). 1995-2004 historical TP at USSO =98 ug/L (EAA Regional Feasibility Study, 2005)									
WMM	<input type="text" value="S8"/>			EAA	WCA3A	1	1		<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="S8"/>							41	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Total S-8 flow from EAA Miami Canal reach to WCA3A Miami Canal (C-123) reach, or to Hydropattern Restoration spreader in northern WCA-3A. (Inactive, but in Alt's list to verify flow sum): S8=(ROTTS8+WLC354+ST3TS8+S8BPMR+WLES8)									
WMM	<input type="text" value="S8BPMR"/>	82	0.13	EAA	WCA3A	1	1		<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="S8BPMR"/>							41	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
EAA S-8/S-3 basin runoff, bypassing STA3/4, and is contribution to S-8 flows into Miami Canal S8=(ROTTS8+WLC354+ST3TS8+S8BPMR+WLES8). 1995-2004 historical TP = 82 ug/L (EAA Regional Feasibility Study, 2005)									
WMM	<input type="text" value="ST3TL4"/>	20	0.13	STA	WCA3A	1	1		<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="ST3TL4"/>							60	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
Portion of STA 3/4 outflow routed down L-28, into small C-60 north of Alligator Alley in western WCA-3A. Struct moved in CERP. S140A = (ROTOL4+HLYL4+ ST3TL4+ST6TL4+S140FC). Germain etal 2011 SFER: 1994-2010 FWMean TP=18 ug/L; Kui 2004									
WMM	<input type="text" value="ST3TS8"/>	20	0.13	STA	WCA3A	1	1		<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
ELM	<input type="text" value="ST3TS8"/>							41	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
STA 3/4 contribution to S-8 flows into Miami Canal S8=(ROTTS8+WLC354+ST3TS8+S8BPMR+WLES8) Germain etal 2011 SFER: 1994-2010 FWMean TP=18 ug/L; Kui 2004									

Basin-wide water budgets

Water inflows and outflows for selected basins, in units of annual mean flows per basin (thousands of acre-feet). Future bases and alternatives encompass the 1965-2000 climate years.

	569.2 km ² WCA1	429.0 km ² WCA2A	1977.8 km ² WCA3A	2976 km ² 3Basins	2976 km ² Net 3Basins
Hist_IN	1,260	1,250	3,773	6283.2	
Hist_OUT	1,248	1,247	3,771	6265.3	17.9
ECB_IN	1,016	1,195	3,710	5920.2	
ECB_OUT	1,012	1,195	3,703	5910.0	10.2
FWO_IN	939	1,199	3,681	5818.8	
FWO_OUT	937	1,199	3,673	5808.8	10.0

ELM v2.8.4 run name: Description of run name

Hist:	Historical simulation, driven with 1981-2000 observed data (ELM v2.8.3 calibration/validation run). Not directly comparable to 36-yr future base/alternative simulations.
ECB:	Existing Condition Base. Simulation shown here is ECB_STAhistTS; see separate table describing TP inflow boundary conditions. Hydrologic flows effectively the same among simulation runs with different TP inflow boundary conditions.
FWO:	Future Without Project Base. Simulation shown here is FWO_STA10ppb; see separate table describing TP inflow boundary conditions.

Phosphorus inflows and outflows for selected basins, in units of annual mean metric tons per basin. Atmospheric loading is the same for all 36-yr (1965-2000) future bases and alternatives; inflows for all cases exclude those common atmospheric loads.

	569.2 km ² WCA1	429.0 km ² WCA2A	1977.8 km ² WCA3A	2976 km ² 3Basins	2976 km ² Net 3Basins
Atmosphere_IN	15.0	10.9	49.4	75.3	
Hist_IN	110.8	95.7	139.0	345.6	
Hist_OUT	81.3	41.0	31.9	154.2	191.3
ECB_STAhistStat_IN	28.4	28.2	61.8	118.3	
ECB_STAhistStat_OUT	20.5	15.0	19.2	54.7	63.6
ECB_STAhistTS_IN	28.4	28.1	61.3	117.8	
ECB_STAhistTS_OUT	20.5	14.9	19.2	54.6	63.2
ECB_STA10ppb_IN	5.2	9.6	41.9	56.6	
ECB_STA10ppb_OUT	5.0	7.8	16.3	29.1	27.5
FWO_STA10ppb_IN	5.1	11.0	41.8	57.9	
FWO_STA10ppb_OUT	4.8	8.4	16.8	29.9	28.0

Basin-wide TP budgets

For ECB, ran several examples with different assumptions for STA outflow concentrations; PDT has consensus (?) to use the 6-yr time series of recent STA performance (for Existing Conditions Base only)

ELM v2.8.4 run name: Description of run name

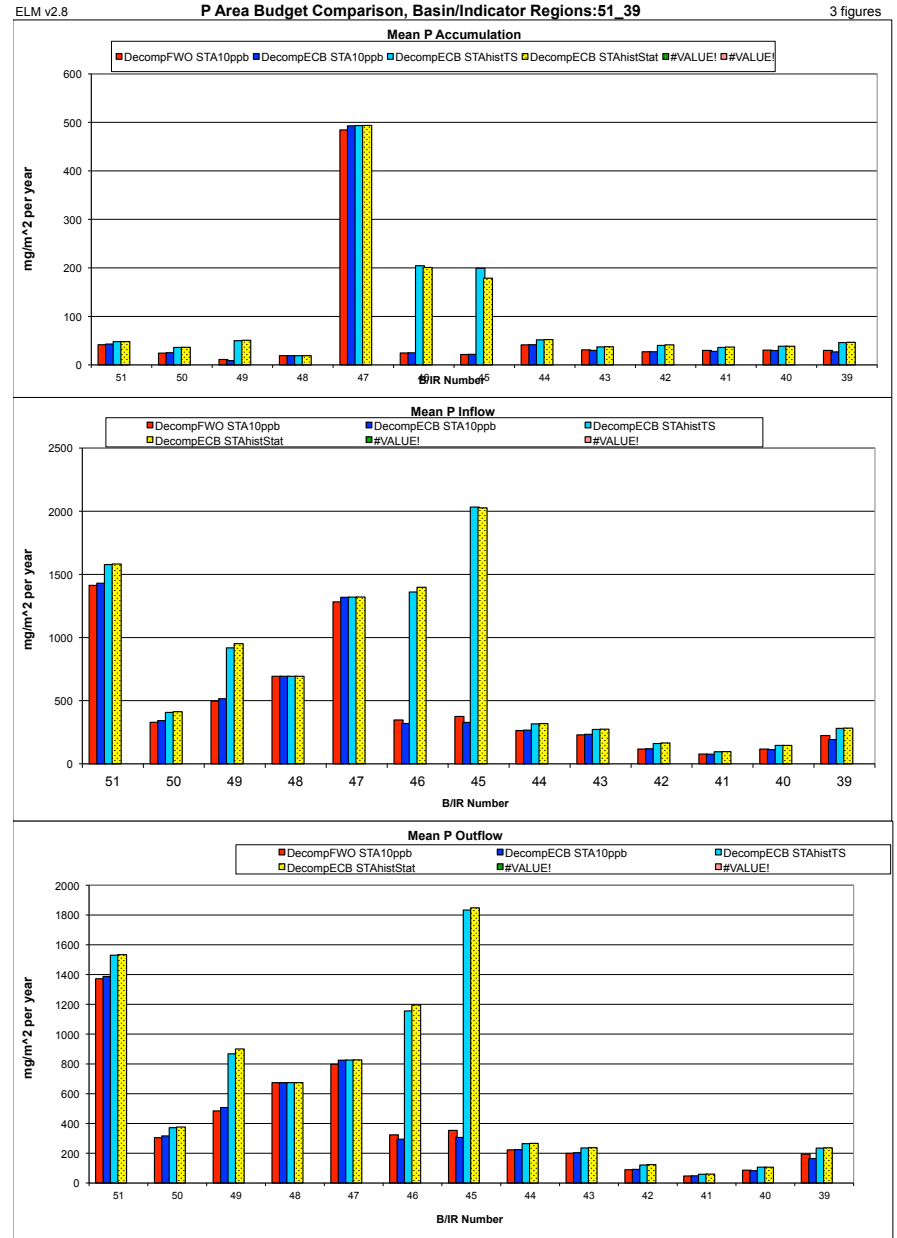
Hist:	Historical simulation, driven with 1981-2000 observed data (ELM v2.8.3 calibration/validation run). Not directly comparable to 36-yr future base/alternative simulations.
ECB_STAhistStat:	Existing Condition Base, with STA outflow TP concentration set to single, static mean observation (for each STA) from 2004-2010 (STA3/4, 5, & 6) or 1994-2010 (other STAs)
ECB_STAhistTS:	Existing Condition Base, with STA outflow TP concentrations using daily time series of interpolated observations from 2004-2010 (for each of STA3/4, 5, & 6, concatenated to 36 yr) or single, static mean observation from 1994-2010 (for each of the other STAs)
ECB_STA10ppb:	Existing Condition Base, with all STA outflow TP concentrations fixed at 10 ppb (ug/L)
FWO_STA10ppb:	Future Without Project Base, with all STA outflow TP concentrations fixed at 10 ppb (ug/L)



VOID	9478.00				
1	371.00	WCA1			
2	279.50	WCA2A			
3	977.25	WCA3A			
4	114.75	WCA2B			
5	274.25	WCA3B			
6	60.50	L67 gap			
7	146.00	Holey Land			
8	99.00	Rotenberger			
11	79.50	C111 North			
12	606.25	BCNP NW			
13	1482.75	BCNP SE			
14	203.50	Misc.			
15	502.25	3A - North			
16	202.25	3A - S9			
17	64.75	3A- L67			
18	32.50	3A-Tamiami			
19	484.25	ENP - W. Marl			
20	559.00	ENP - Shark			
21	176.00	ENP - NESS			
22	423.00	ENP - E. Marl			
23	145.00	ENP - DoNut			
24	170.25	ENP - South			
25	26.50	ENP - Taylor N.			
26	82.75	ENP - Taylor S.			
27	40.00	WCA1 - North1			
28	26.00	WCA1 - North2			
29	14.00	WCA1 - West			
30	61.25	WCA1 - East			
31	48.00	WCA1 - South			
32	9.00	WCA1 - Mid			
33	16.25	2A - NWest1			
34	12.00	2A - NWest2			
35	9.00	2A - NWest3			
36	26.75	2A - F0-F1			
37	25.00	2A - F2-F3			
38	29.00	2A - F3-F5			
39	22.50	2A - SWest			
40	9.00	2A - Mid			
41	23.00	3A - NEast L5_1			
42	21.75	3A - NEast L5_2			
43	40.25	3A - NEast L38			
44	4.00	3A - Alley N			
45	5.50	3A - NWest 1			
46	6.50	3A - NWest 2			
47	9.00	3A - NWest S140			
48	12.75	3A - L28I			
49	21.25	3A-N. Miami C.			
50	18.50	3A-Mid Miami C.			
51	22.25	3A-S. Miami C.			
52	7.00	3A-TransA			
53	7.00	3A-TransB			
54	54.75	3B - S349s			
55	5.50	3B-TransC			
56	5.50	3B-TransD			
57	26.25	ENP NESS 1			
58	26.25	ENP NESS 2			
59	24.00	ENP S12s 1			
60	23.50	ENP S12s 2			
61	41.00	ENP buffer			
62	136.75	ENP - Panhandle			
63	474.50	ENP - estuarine water			
64	1466.75	ENP - mangrove hab			

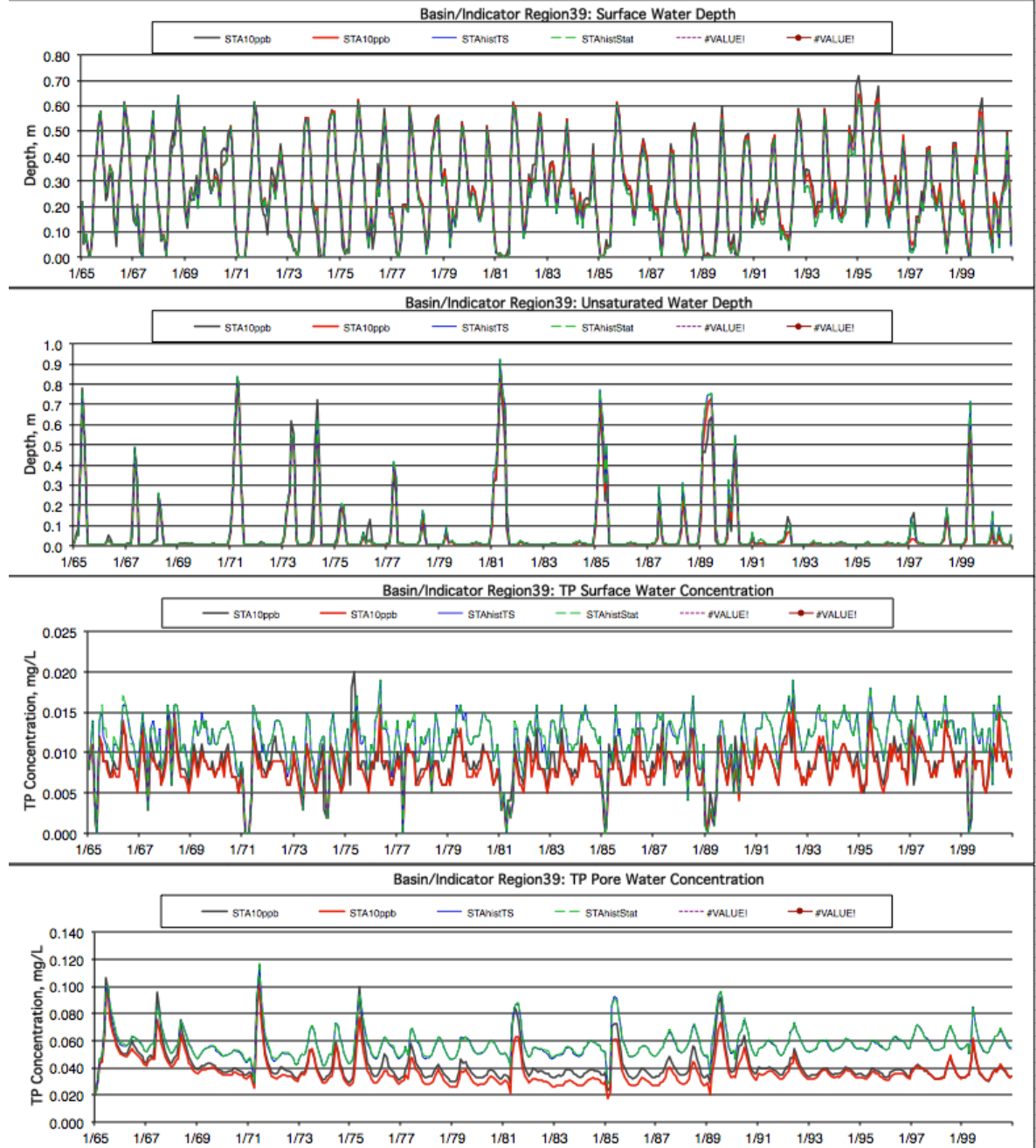
Indicator Regions, to demonstrate model characteristics

Example Indicator Region TP budgets



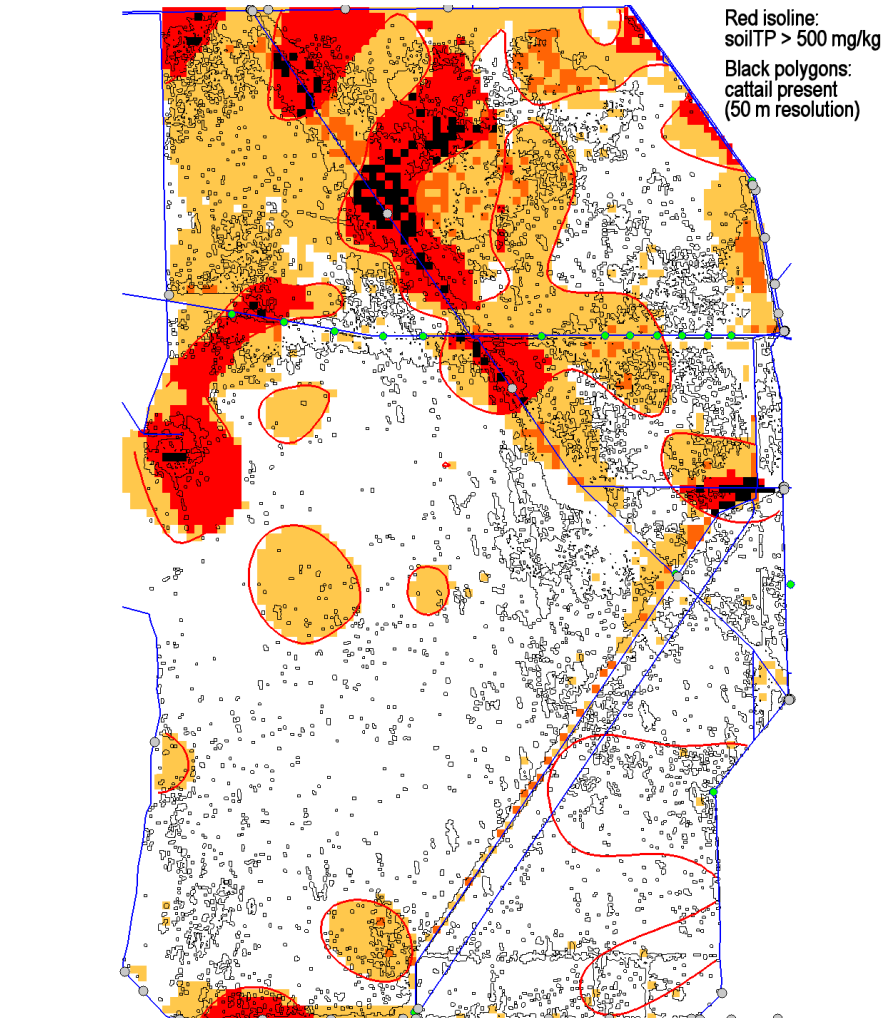
Example Indicator Region Ecosystem Dynamics

Go to Excel spreadsheet...



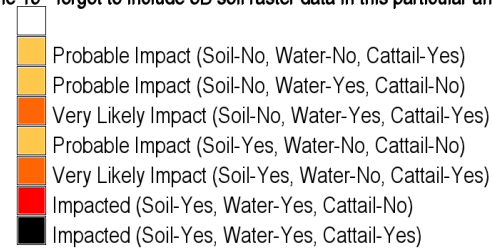
What marsh areas are P-impacted in WCA-3?

Evaluate each 500-m grid cell:
 1981-2000 mean surface water TP concentration (ELM calibration),
 2003 soilTP (0-10 depth), and 2004 cattail-dominant vegetation



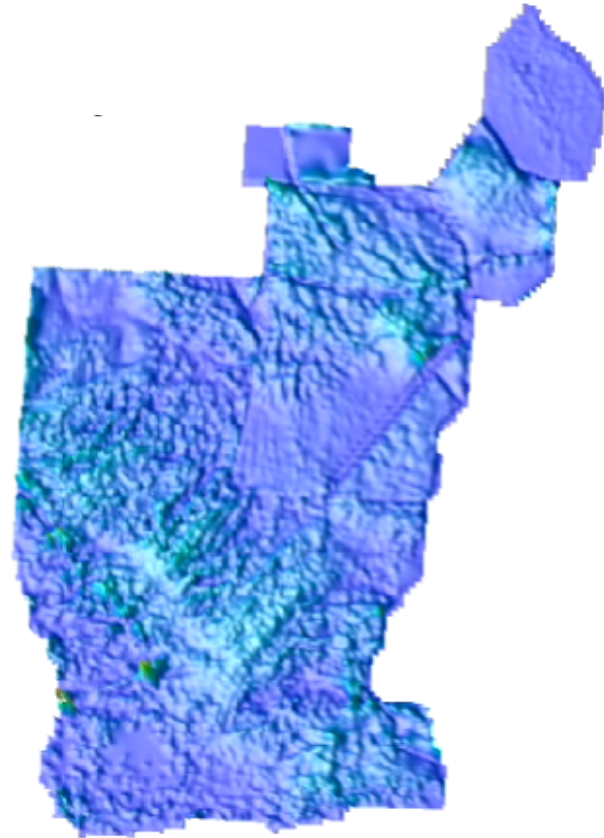
Probabilities of existing P-impacted regions

Cattail: using dominant veg in 500m cell (not just presence)
 (June 19 - forgot to include 3B soil raster data in this particular analysis)



Understanding dynamic spatio- temporal flows

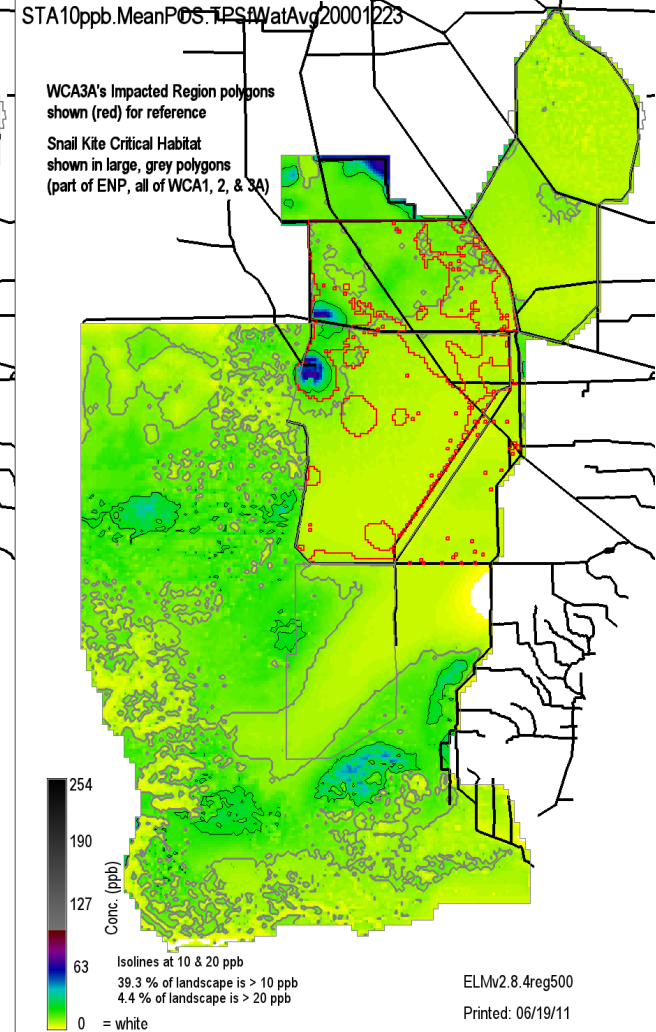
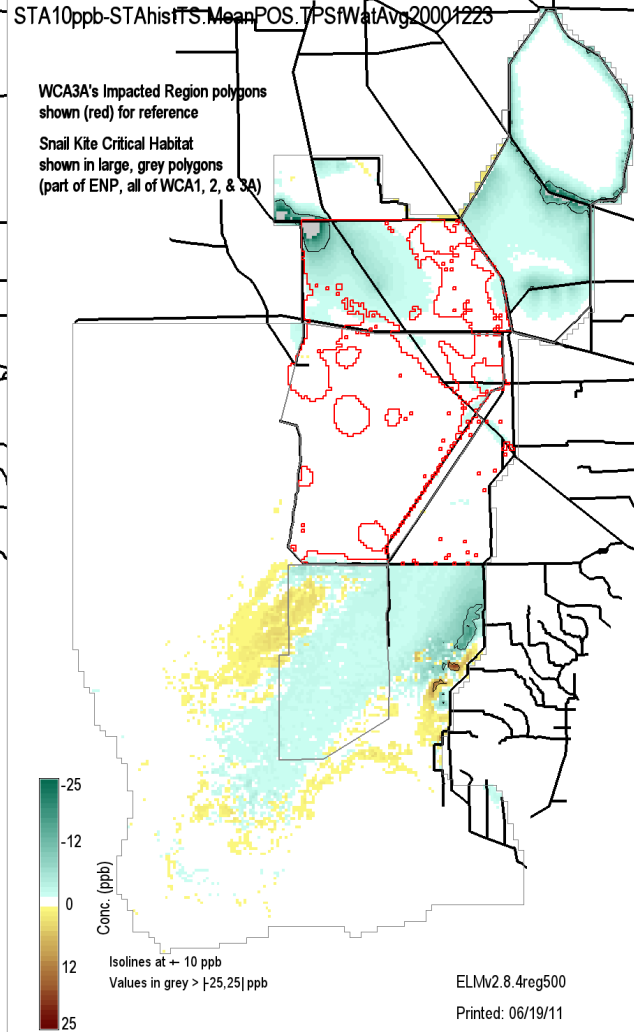
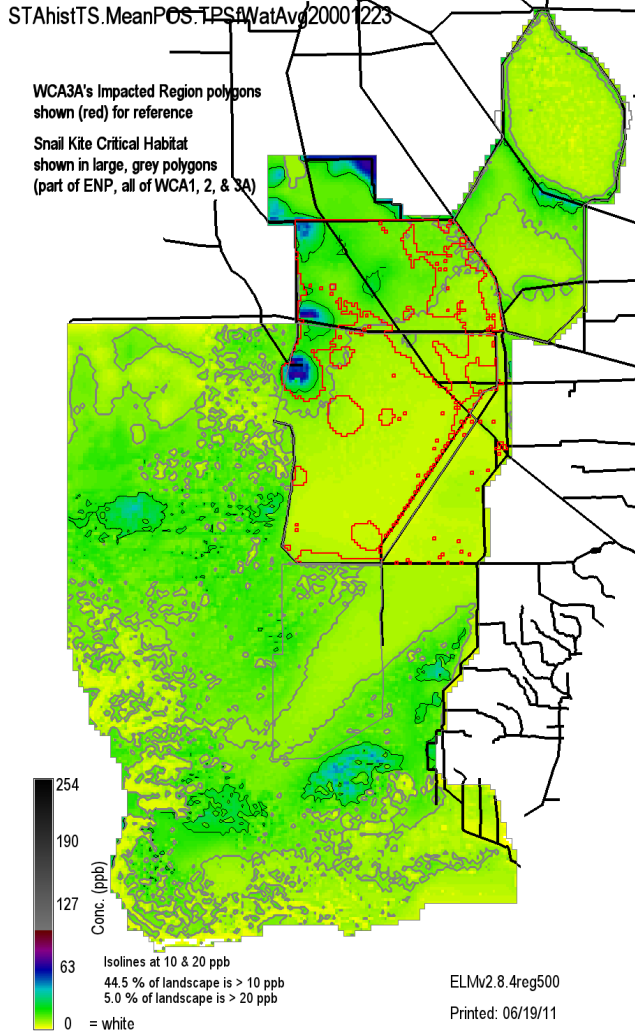
Go to OpenDX
animation tool...



Example Difference Map

Go to graphics viewer for Performance Measures:

- TP Surface Water (seasonal)
- TP Accumulation rate (POR)
- TP Soil (seasonal)



Wrap Up:

Suggestions for improvement...

...in order to finalize runs & Performance Measures

Outstanding questions and To-Do's:

- **Performance Measure spatial regions (i.e., WCA-3A exactly, or...?)**
- **Geometric Mean values at point/cell locations – scripts functional, but have not processed data. What spatial, temporal aggregations?**
- **Current runs utilize a new 0-10 cm active zone of soil (instead of 0-30 cm used previously – have evaluated it, but needs further checks)**
- **Current runs do not have the 5-year “spin-up” to get system “acquainted with” it's new soil map**
- **Current runs not initialized with new cattail maps (but are complete, ready)**
- **Currents runs use SFWMM flows exclusively; for consistency with Alts, will re-run using RSM structure-flows (very similar)**