Implementation and verification of BMPs to reduce farm P loads: A long-term collaborative effort

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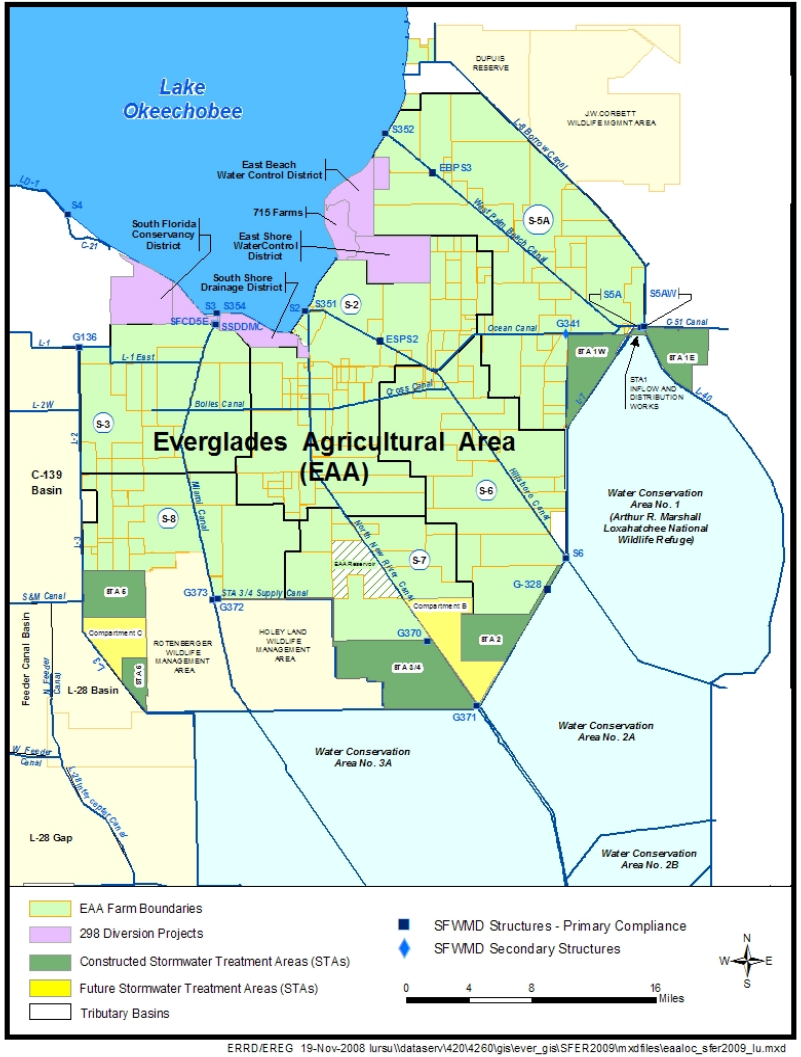
IFAS

The Everglades Agricultural Area

- 220,000 ha of organic soils with about 80% used to farm sugarcane.
- Flat topography, shallow soils and an impermeable marl/limestone.
- Soils are actively drained by pumping water through a system of farm and main basin canals.
- Water leaving the EAA is routed through STA to remove P before being delivered to WCA.

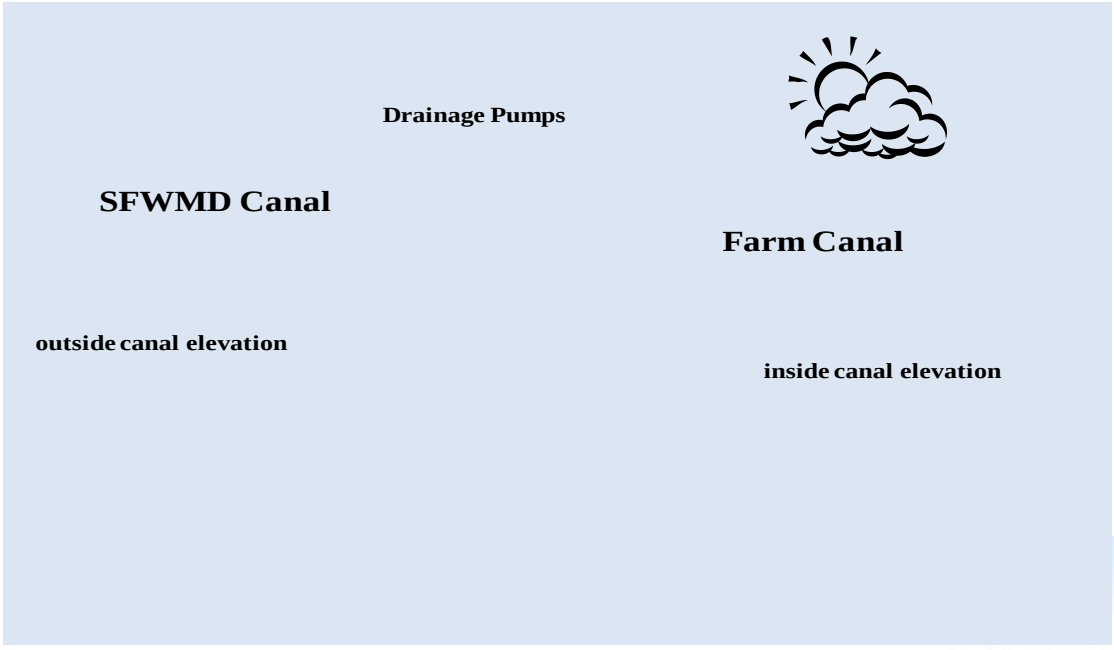


Crops of the EAA

- Main crop is Sugarcane
- Vegetables, sod, and rice also grown
- Annual value ~ $2 billion

Soils in the EAA

- Histosol (organic soil)- predominant soil order in the EAA
- Limestone bedrock- neutral to basic pH
- Soils were drained in the early 1900's for agricultural production
- Soil oxidation (subsidence)

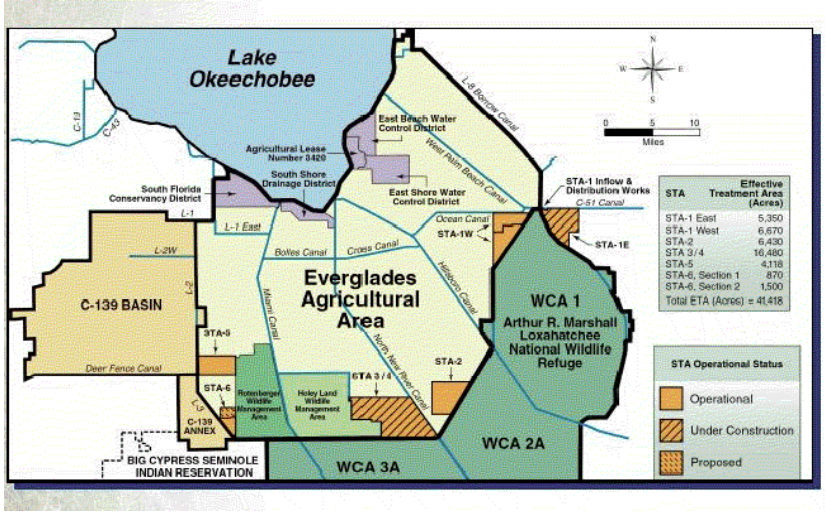


Drainage

The responsibility for supplying irrigation and removing excess water for the basin lies with the SFWMD.

Everglades Regulatory Program

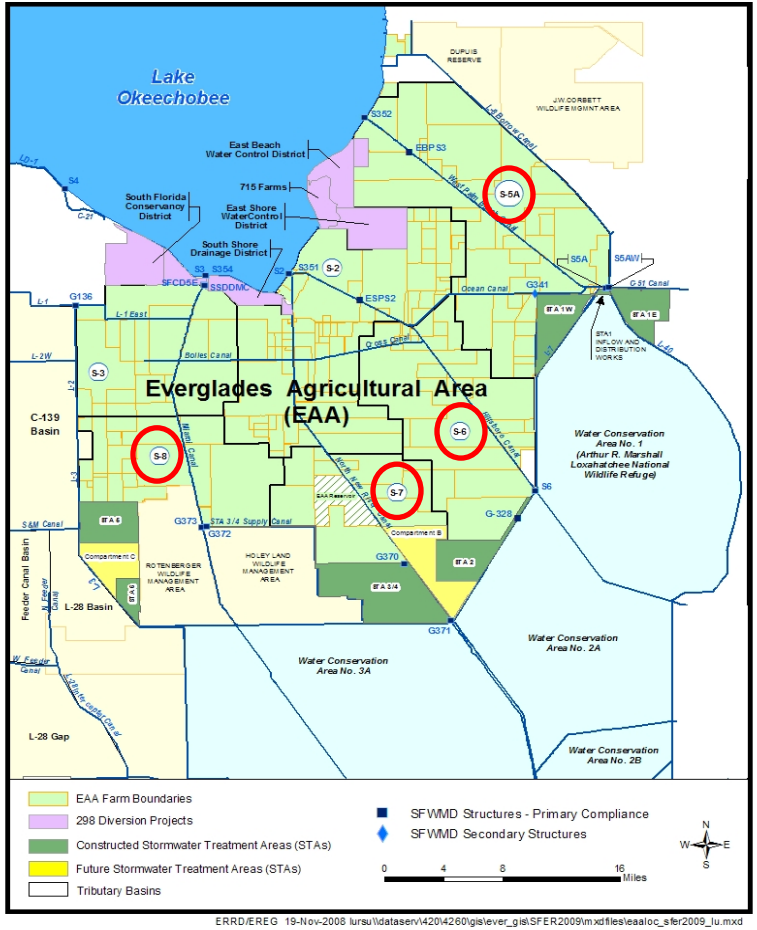
- Concerns about P leaving the EAA in drainage water south to the Everglades ecosystem
- Everglades Forever Act 1994
- Goal of the regulatory program is to reduce P loads out of the EAA by 25% compared to a pre-BMP base period
- BMP program started in 1995



Objective

- Determine long term trends in P concentrations and loads at the drainage outlet of EAA basin and associated four sub-basins after 10 years of implementing BMPs

Study Location



Methods

- Study Areas – EAA basin, sub-basins (S5A, S6, S7, S8)
- Statistical Analyses
  - Seasonal Mann-Kendall trend analysis
- Data Set

EAA basin and sub basins monitoring program

  - SFWMD monthly flow, flow-weighted P concentrations, P loads 1992-2002

Basin Trend Results- Inflow from Lake Okeechobee

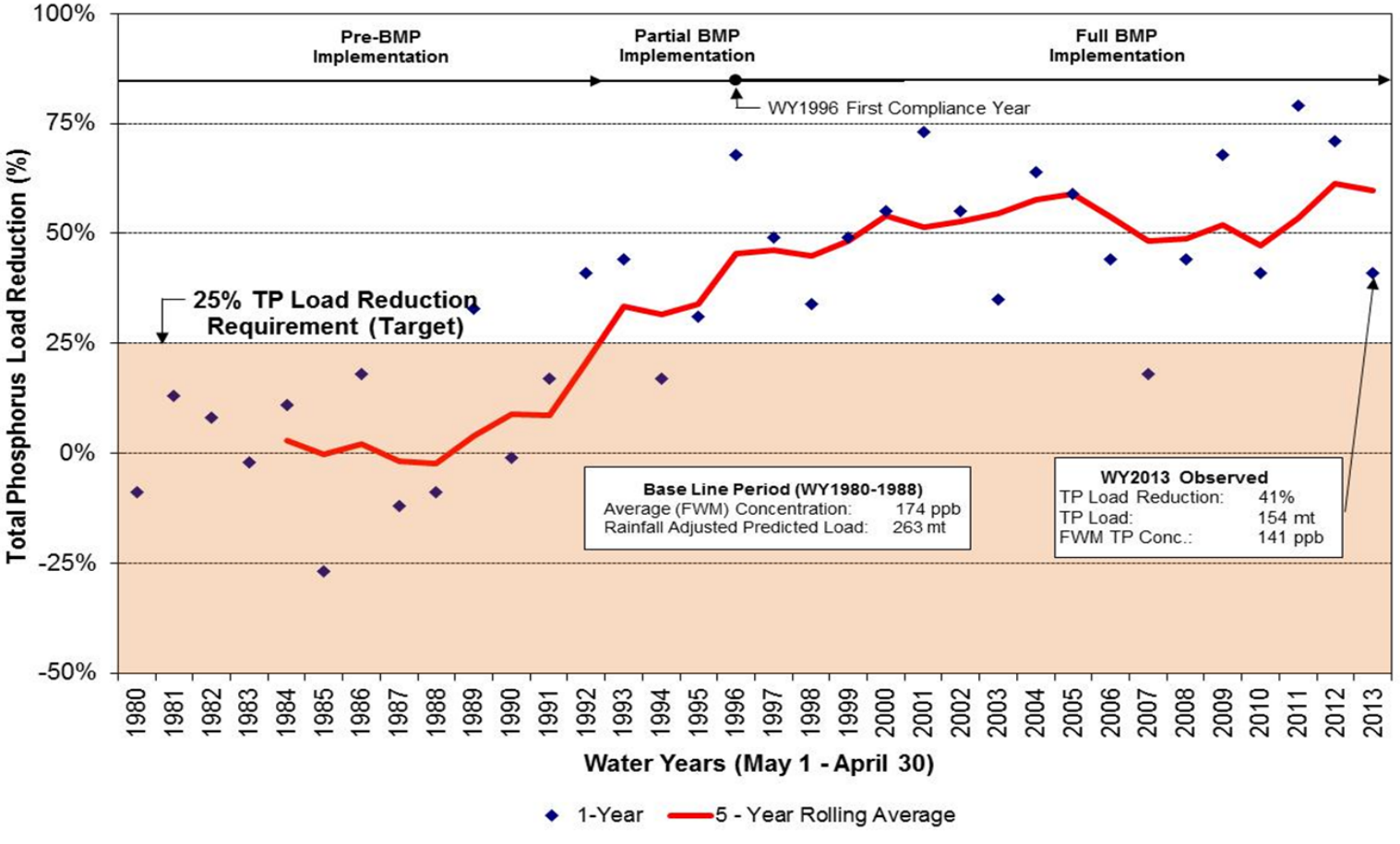
Basin	Months	Kendall K	z-Score	z-Prob	Trend
		Inflow Flow			
S5A	117	-267	-1.198	0.231	insignificant
S6/7	117	-289	-1.299	0.194	insignificant
S8	117	-715	-1.682	0.093	insignificant
EAA Basin	117	-385	-1.728	0.084	insignificant
		Inflow Concentration			
S5A	105	1128	5.898	0.001	increasing
S6/7	101	175	0.927	0.354	insignificant
S8	117	-175	-0.783	0.434	insignificant
EAA Basin	117	692	1.628	0.104	insignificant
		Inflow Load			
S5A	117	24	0.104	0.918	insignificant
S6/7	117	-190	-0.853	0.394	insignificant
S8	117	-425	-1.908	0.056	insignificant
EAA Basin	117	-192	-0.860	0.390	insignificant

EAA Basin Outflow Trend Results

Basin	Months	Kendall K	z-Score	z-Prob	Trend
		Outflow Flow			
S5A	117	-772	-3.471	0.001	Decreasing
S6/7	117	-545	-2.448	0.014	Decreasing
S8	117	-330	-1.481	0.139	Insignificantt
EAA basin	117	-599	-2.691	0.007	Decreasing
		Outflow Concentration			
S5A	115	-1993	-4.815	0.001	Decreasing
S6/7	115	388	0.935	0.35	Insignificant
S8	117	-541	-2.43	0.015	Decreasing
EAA basin	117	-745	-2.12	0.034	Decreasing
		Outflow Load			
S5A	117	-799	-3.592	0.001	Decreasing
S6/7	117	-340	-1.526	0.127	Insignificantt
S8	117	-584	-2.624	0.009	Decreasing
EAA basin	117	-662	-2.975	0.003	Decreasing

Daroub et al., JEQ 2009

EAA Basin Performance



SFWMD, 2013

Communication with growers and their involvement is the key to success....

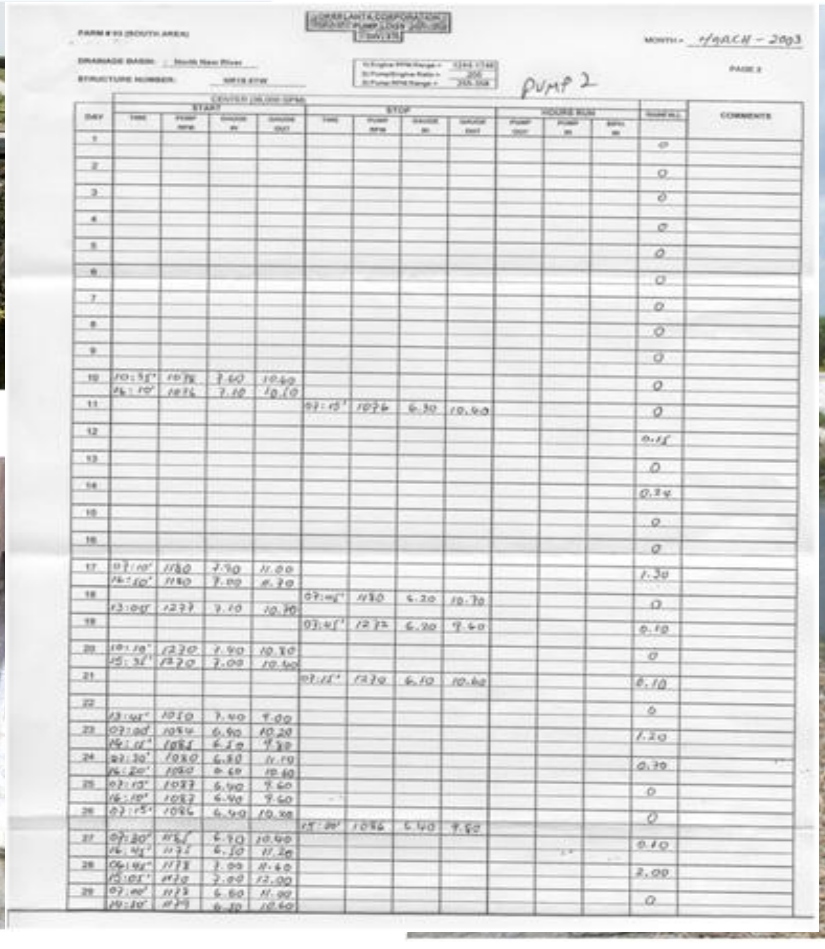
BMP	PTS	DESCRIPTION
WATER DETENTION ½ Inch Detained 1 Inch Detained	5 10	• water table management by controlling levels in canals, field ditches, soil profile, fallow fields, aquatic cover crop fields, prolonged crop flood; • measured on a per event basis – rainfall vs. runoff
FERTILIZER APPLICATION CONTROL	2 ½	uniform and controlled boundary fertilizer application (e.g. direct application to plant roots by banding or side-dressing; pneumatic controlled-edge application such as AIRMAX)
FERTILIZER CONTENT CONTROLS		
Fertilizer Spill Prevention	2 ½	• formal spill prevention protocols (handling and transfer) • side-throw broadcast spreading near ditch banks
Soil Testing	5	avoid excess application by determining P levels needed
Plant Tissue Analysis	2 ½	avoid excess application by determining P levels needed
Split P Application	5	apply small P portions at various times during the growing season vs. entire application at beginning to prevent excess P from washing into canals (rarely used on cane in EAA)
Slow Release P Fertilizer	5	avoid flushing excess P from soil by using specially treated fertilizer which breaks down slowly thus releasing P to the plant over time (rarely used in EAA)
SEDIMENT CONTROLS		EACH SEDIMENT CONTROL MUST BE CONSISTENTLY IMPLEMENTED OVER THE ENTIRE ACREAGE
Any 2 Any 4 Any 6	2 ½ 5 10	• leveling fields • cover crops • ditch bank berm • raised culvert bottoms • sediment sump in canal • veg. on ditch banks • strong canal cleaning program • other BMP • field ditch drainage sump • slow field ditch drainage near pumps • sump upstream of drainage pump intake
OTHER Pasture Management	5	reduce cattle waste nutrients in surface water runoff by "hot spot" fencing, provide watering holes, low cattle density, shade, pasture rotation, feed & supplement rotation, etc.
Improved Infrastructure	5	uniform drainage by increased on-farm control structures
Urban Xeriscape	5	lower runoff & P by using plants that require less of each
Det. Pond Littoral Zone	5	vegetative filtering area for property stormwater runoff
Other BMP Proposed	TBD	proposed by permittee and accepted by SFWMD

EAA BMP Table

- Minimum 25 points needed
- Typical BMP farm permit includes:
  - **water detention**
  - **fertilizer spill prevention**
  - **fertilizer application control**
  - **sediment controls**

Fertilizer Controls

Water Controls



FARM # 93 (SOUTH AREA)

DRAINAGE BASIN: North New River

STRUCTURE NUMBER: S913 STR

MONTH:- MARCH - 2003

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PUMP 2

DAY	START TIME	START PUMP RPM	START GAUGE IN	START GAUGE OUT	STOP TIME	STOP PUMP RPM	STOP GAUGE IN	STOP GAUGE OUT	HOURS RUN PUMP OUT	HOURS RUN PUMP IN	HOURS RUN BATT. IN	RAINFALL	COMMENTS
1												0	
2												0	
3												0	
4												0	
5												0	
6												0	
7												0	
8												0	
9												0	
10	10:55'	1078	7.60	10.60								0	
	24:10'	1076	7.10	10.10									
11					07:15'	1076	6.30	10.60				0	
12												0.15	
13												0	
14												0.34	
15												0	
16												0	
17	07:10'	1180	7.90	11.00								1.30	
	16:50'	1180	7.00	8.20									
18					07:45'	1180	6.20	10.70				0	
	13:05'	1277	7.10	10.70									
19					03:45'	1272	6.20	9.40				0.10	
20	10:10'	1230	7.40	10.30								0	
	15:35'	1220	7.00	10.40									
21					07:15'	1230	6.10	10.60				0.10	
22												0	
23	13:45'	1050	7.40	9.00								1.20	
	07:00'	1094	6.90	10.20									
24	16:15'	1084	6.10	9.30								0.70	
	21:30'	1080	6.80	11.10									
25	06:20'	1080	6.60	10.60								0	
	07:15'	1092	6.90	9.60									
26	16:10'	1092	6.90	9.60								0	
	07:15'	1096	6.40	10.30									
27	07:30'	1165	6.90	10.40	15:00'	1096	6.40	9.60				0.10	
	16:45'	1175	6.50	11.20									
28	06:45'	1178	7.00	11.40								2.00	
	15:05'	1170	7.00	12.00									
29	07:00'	1175	6.60	11.00								0	
	20:30'	1179	6.30	10.60									

Sediment Controls

Conclusions

- BMP program since inception has been a success
- Basin P load reductions have averaged >50% compared to baseline period
- Trend analysis confirmed decreasing P loads at the farm level and at the basin level
- Farm trend differences likely due to crop, management, irrigation water quality and environmental factors

Current Research Initiatives

Our goal is to transform canals by implementing BMPs which would reduce floating aquatic vegetation and subsequent buildup of organic sediments from occurring in the farm canals.

CANAL WITH HIGH FLOATING AQUATIC VEGETATION

CANAL WITH NO FLOATING AQUATIC VEGETATION

Current Research Initiatives

BMP Training

Twice Yearly Sessions

- September 27, 2012 -117 Participants
- April 11, 2012 -115 Participants
- September 26, 2013

Training evaluation feedback:

- modify and/or add BMP topics
- modify content of training modules

Speaker	Presentation Title
Samira Daroub, PhD	Everglades Program Chapter 40E-63, F.A.C.
Timothy Lang, PhD	BMP Research Update
Paul Grose, MS	Grower's Experience with BMPs
Jehangir Bhadha, PhD	Nutrient Cycling in South Florida
Les Baucum, MS	Wise Use of Atrazine and Ametryn
Doug Pescatore, MS	EAA Basin Phosphorus Loads
Bill Donovan, PhD	BMP Verification Methodology
Lyn Gettys, PhD	Managing Aquatic Weeds in Farm Canals
Tom MacVicar, MS	What's Going On With Lake Okeechobee?
Barry Glaz, MS	Sugarcane Production and BMPs
Mike Jerauld, MS	Stormwater Treatment Areas Research
Kim O'Dell, PhD	Alternative Treatment Technologies
Mark Howell, BS	Pumping/Discharge Methods

Thank You.