Lake Okeechobee Protection Plan Update

Northern Everglades Interagency Meeting
August 30, 2010

Pinar Balci, Director, State and Federal Policy Division,
South Florida Water Management District

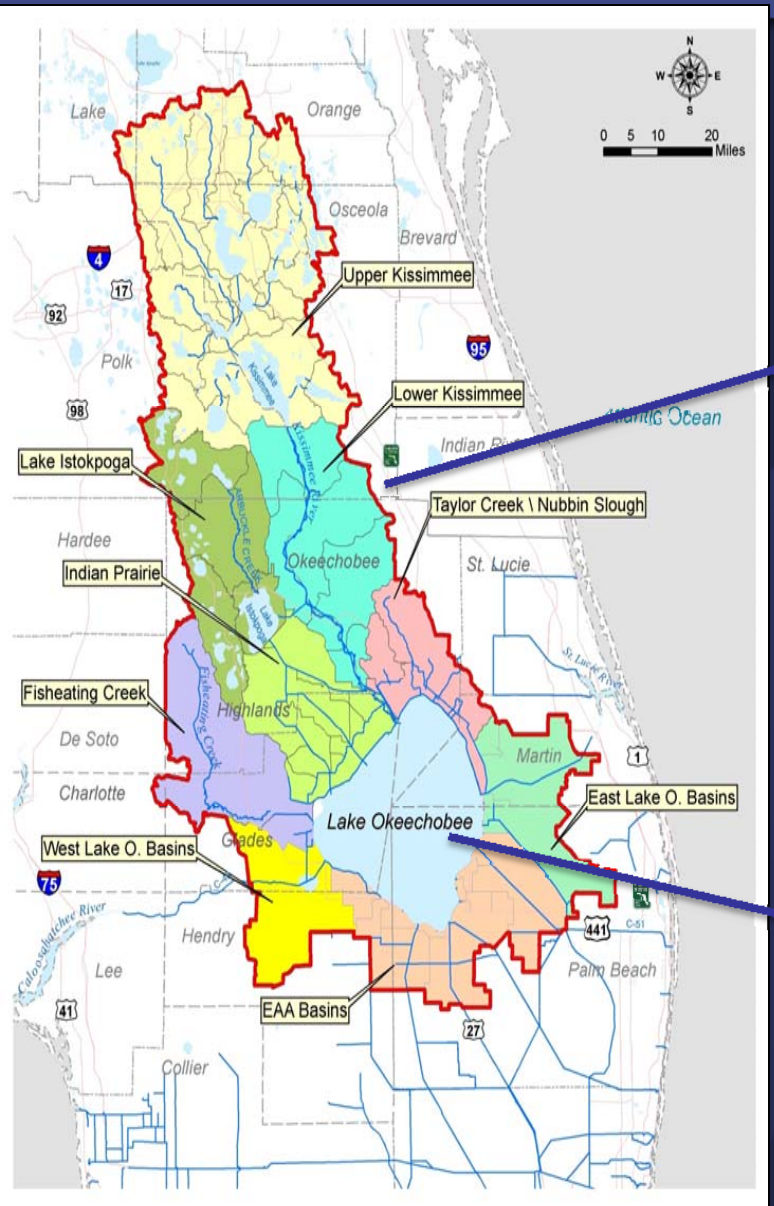
Presentation Outline

SFWMD

- Section 4 (Challenges) & Section 6 (Strategies Moving Forward)
- Legacy Phosphorus and Strategies - Odi Villapando
- Nutrient Imports and Controls - Joyce Zhang
- In-lake Issues and Management Options - Dave Unsell
- Water Storage and Strategies - Pinar Balci
- Sub-watershed Conceptual Plans and Modeling - Armando Ramirez

Action Plan Summary

SFWMD



WATERSHED ISSUES	STRATEGIC PROJECTS
STORAGE • Lack of Stormwater Storage	• **Shallow Storage** Dispersed Water Management (Easements, Cost Share, Payment for Services) • **Regional Storage** (Reservoirs, Aquifer Storage Recovery, (Deep Injection Wells)
WATER QUALITY • Excessive Phosphorus Loads (Nutrient Import/Export Balance) • Legacy Phosphorus (Soil Saturation, Mobility)	• **Agricultural & Urban Best Management Practices** (BMPs) • **Edge of Field/Farm Treatment Technology** • **Best Available Technologies** (BATs) • **Hybrid Wetland Treatment Technology** • **Permeable Reactive Barriers** (PRBs) • **Residential and Urban Practices** • **Stormwater Treatment Areas** (STAs) • **Chemical Treatment** • **New Alternative Technologies Assessment** (NATA) • **BMP Research & Coordination Committee Proposals**

IN-LAKE ISSUES	STRATEGIC SOLUTIONS
WATER QUALITY • Sediments (Turbidity, Internal Loading)	• **Chemical Treatment** • **Muck Removal** (Dredging, Scraping & Tilling) • **Littoral Zone Habitat Creation with Dredged Sediments**
EXOTIC SPECIES • Exotic Snail Population Increase • Exotic Vegetation	• **Restocking Native Apple Snail** • **Treatment/Management of Exotic Vegetation**

LOPP Update Schedule

SFWMD

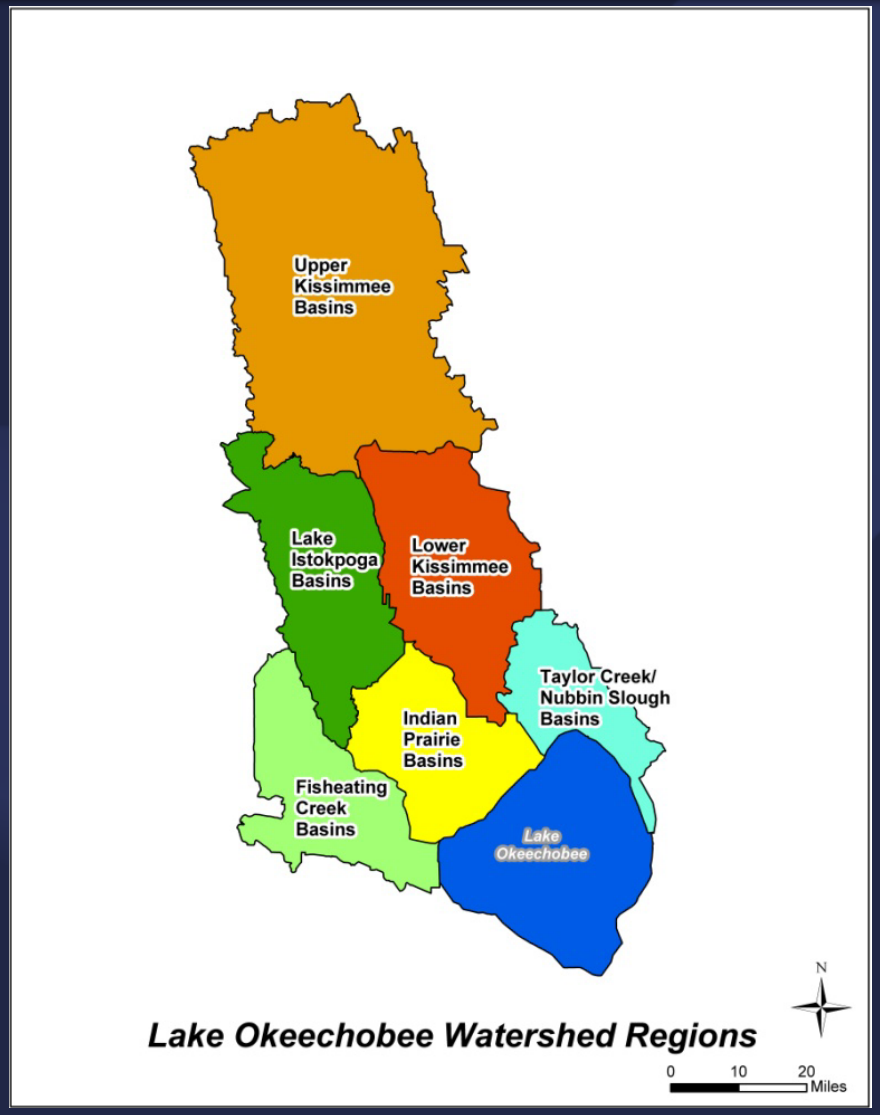
- WRAC Meeting - Draft LOPP 10/10
- Draft LOPP Public Release - 10/10
- GB Meeting - Draft LOPP 10/10
- End Public Comment Review Period - 11/10
- WRAC/GB Meetings - Final LOPP 1/11
- Final LOPP to the Legislature - 3/11

Management of Legacy Phosphorus in the Lake Okeechobee Watershed

Odi Villapando, Sr. Environmental Scientist
Lake Okeechobee Division
Restoration Sciences Department

Legacy Phosphorus (P) Study (SWET, 2008)

- Quantify the amount of legacy P
- Identify where legacy P is stored
- Identify cost-effective strategies to control legacy P



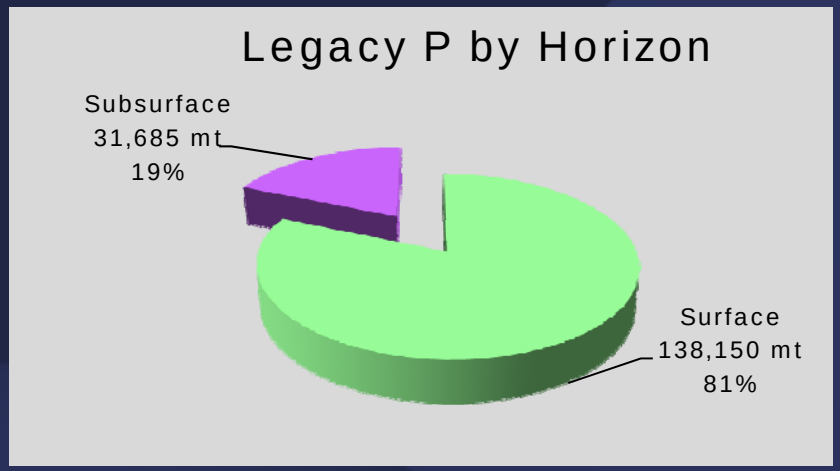
What is Legacy P?

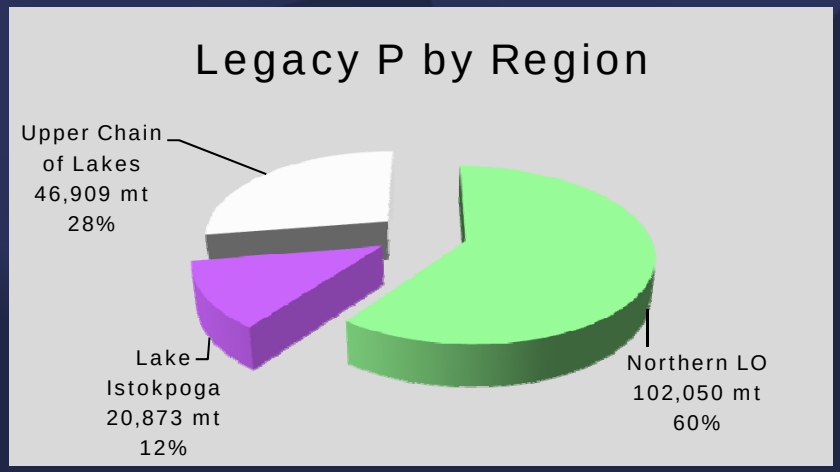
SFWMD

- Any phosphorus in the watershed that is present, as the result of anthropogenic activities and has transport potential
- Sourced primarily from animal feeds, fertilizers, and domestic products (generated locally or imported)
- An important source of P to the lake that must be addressed

Legacy P in Soils

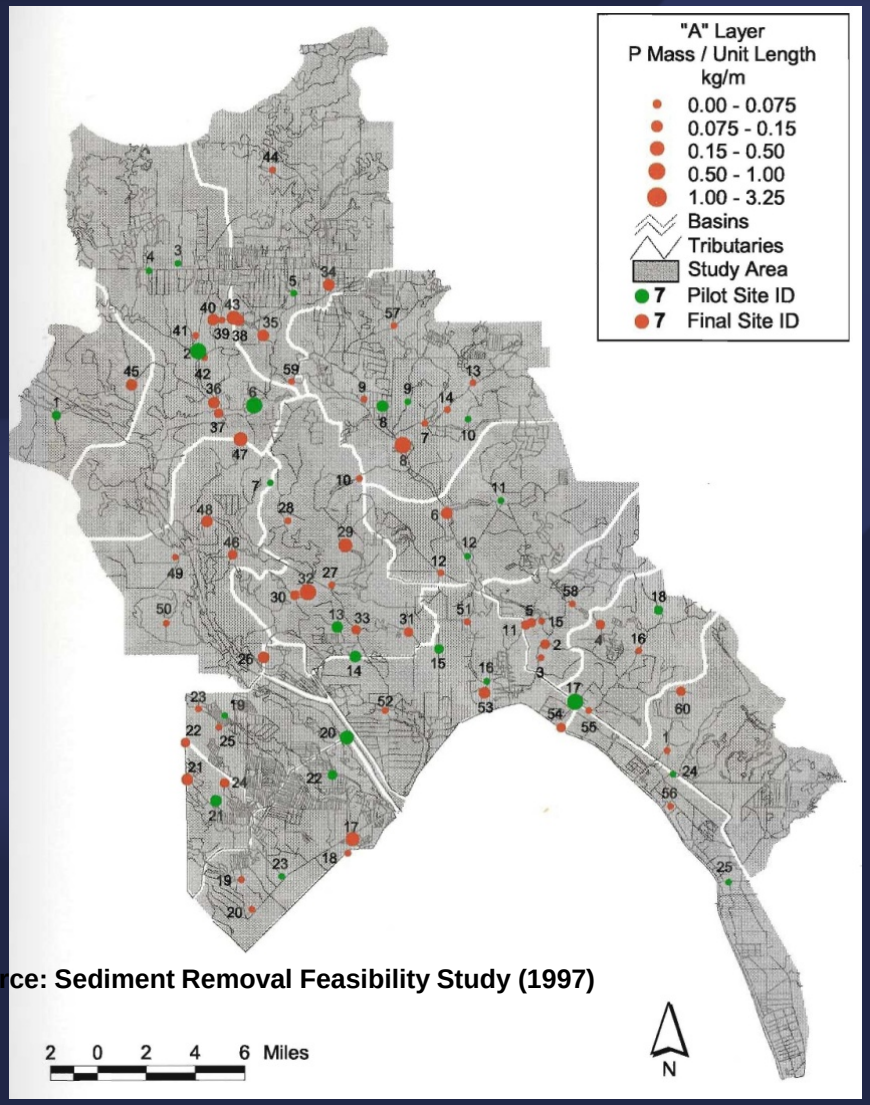
- Based on soil test data from various studies and routine sampling programs
- Quantified using legacy P concentration, bulk density and horizon thickness
- Legacy P in soils estimated at about 170,000 mt.





Legacy P in Flow Conveyance Systems

- Based on vertical distribution of P in various stream types (sloughs, streams, primary canals and ditches), sediment bulk density and channel length
- Legacy P in tributary sediments ~ 860 mt



Source: Sediment Removal Feasibility Study (1997)

Legacy P in Lakes

SFWMD

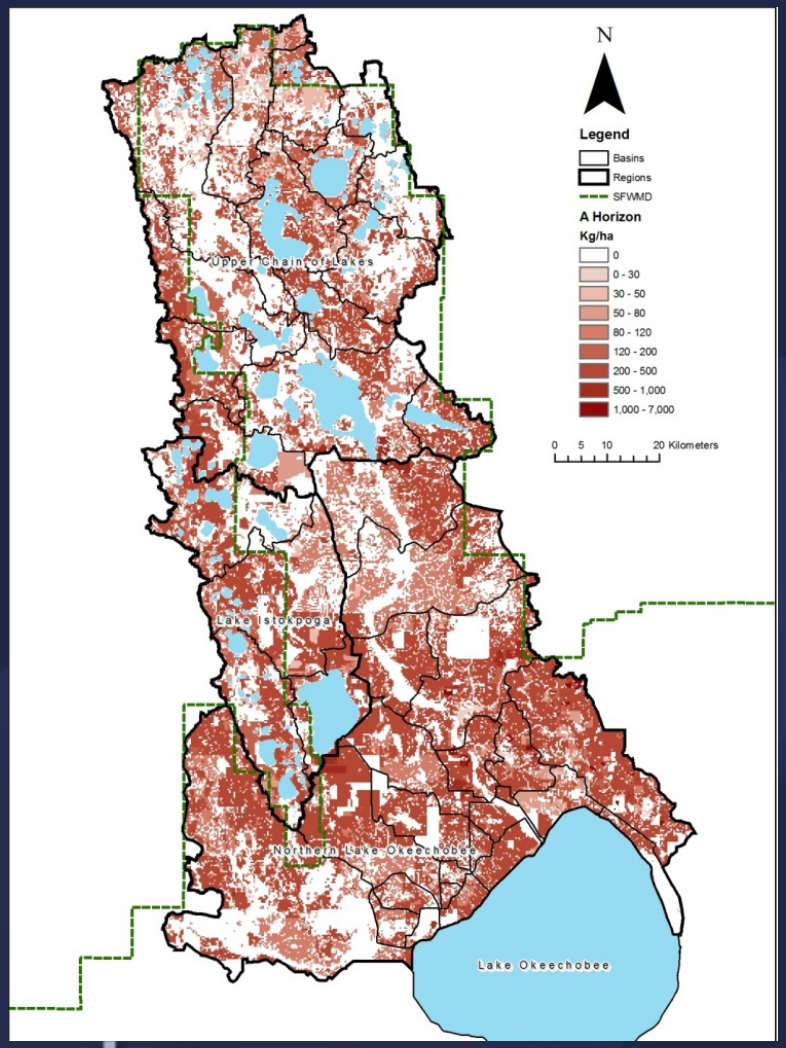
- Estimated based on net P balance (inputs minus outputs)
- Annual P accumulation rates, assuming 50% TP reduction ~ 20 mt/yr for Lake Istokpoga and 80 mt/yr for Upper Chain of Lakes
- Assuming a 50-yr period of accumulation, legacy P estimates in these lakes would be 5,000 mt.

Legacy P by Land Use

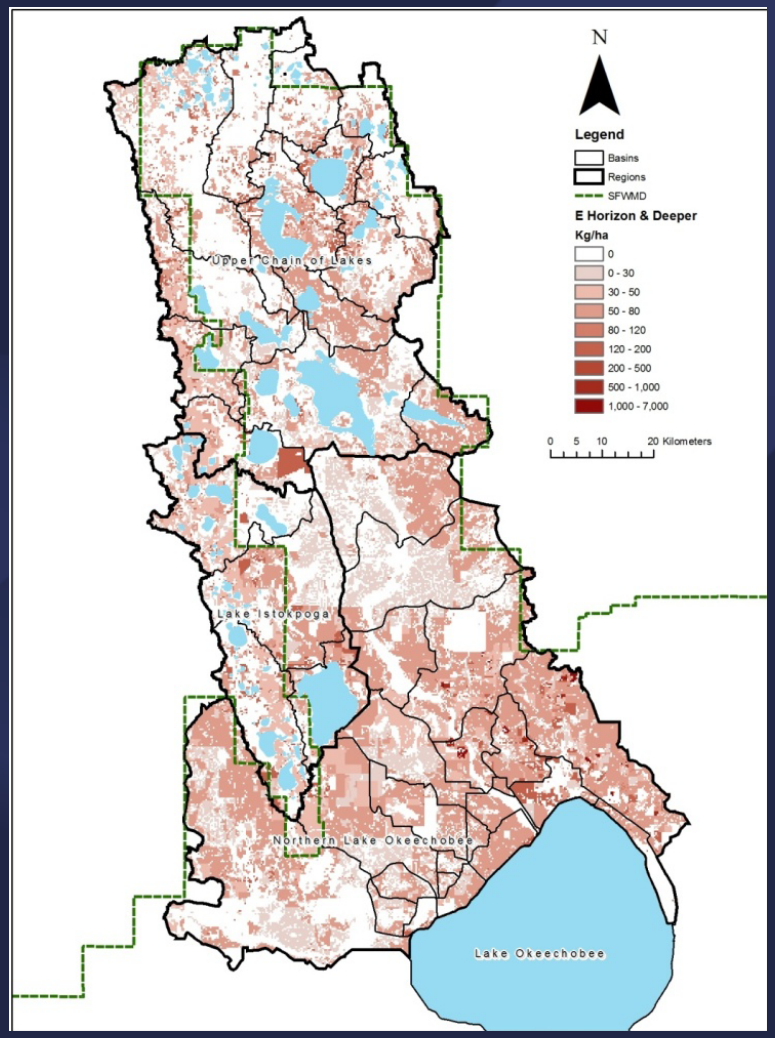
Land Use	Area (ha)	Legacy P (mt)
Other, Non-relevant	124,741	.
Low Density Residential	30,197	8,395
Medium Density Residential, central	30,566	5,502
High Density Residential, central	10,307	1,268
Industrial, central	3,430	168
Commercial, central	20,879	1,044
Recreational	4,446	1,316
Native Areas	320,661	.
Isolated Wetlands in Pastures	14,799	1,598
Impacted Sloughs	2,837	199
Semi-Improved Beef Pasture	124,617	14,331
Improved Beef Pasture	252,832	94,808
Hayland	11,196	2,105
Dairy Dry Cow Pastures	1,627	610
Dairy Sprayfields	1,064	231
Dairy Intensive Lactating Pastures	881	1,610
Dairy High Intensive Holding Pastures	561	4,676
Abandoned Dairy Intensive	362	2,765
Vegetables	6,790	4,753
Citrus	70,989	21,297
Overall Dairy - Active	2,043	1,430
Overall Dairy - Abandoned	742	467
Sod	9,515	190
Ornamentals	2,336	818
Sugarcane	9,727	.
Poultry	55	12
Isolated Wetlands in Dairy Pastures	474	446

Spatial Distribution of Legacy P

Surface Horizon



Subsurface Horizons



Legacy P Implications

SFWMD

- Legacy P in the studied basins ~ 176,000 mt
- At current P discharge levels (~500 mt/yr), it would take ~350 years to wash out the existing legacy P
- Assuming that only 50% of this amount is mobile, there is abundance of legacy P in the watershed to sustain current P loads for many years
- Reduction of new sources that contribute to legacy P and its mobility through abatement practices

Legacy P Abatement Plan

- *Recommended Approach:* First meet the tributary TMDL followed by regional treatment to obtain the additional reductions needed to meet the Lake TMDL

Phosphorus Control Practices

SFWMD

- In-field – use of soil amendments and Best Management Practices (BMPs) developed for cow-calf operations and various crops
- Edge-of-Field/Farm (EOF) – treat and/or retain runoff as it leaves the farm or field
- Residential/Urban – include site level and EOF systems
- Regional – treat and/or retain stream flows within the tributary system i.e., reservoir-assisted STAs, chemical treatment

Thank You!

SFWMD

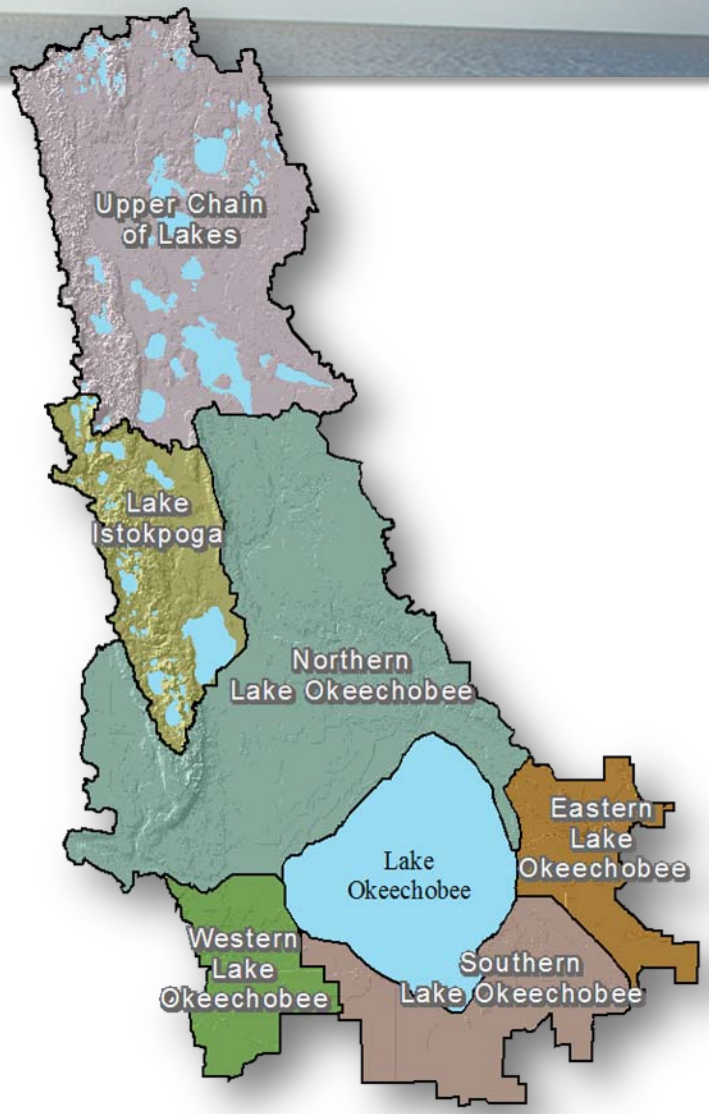
Nutrient Budget Analysis for the Lake Okeechobee Watershed

Joyce Zhang
Principal Engineer
Restoration Sciences Department

Northern Everglades Interagency Meeting
August 30, 2010

Phosphorus Budget Tool

- Background
  - Northern Lake Okeechobee Study (IFAS, 1991)
  - Northern Lake Okeechobee Update (Mock Roos Team, 2002)
  - Lake Istokpoga and Upper Chain of Lakes (Mock Roos Team, 2003)
  - Southern and Eastern Lake Okeechobee (SFWMD, 2004)



Nutrient Budget Analysis

Objective:

To estimate the total amount of Phosphorus (P) and Nutrient (N) that are imported, exported and stored in the watershed

Approach:

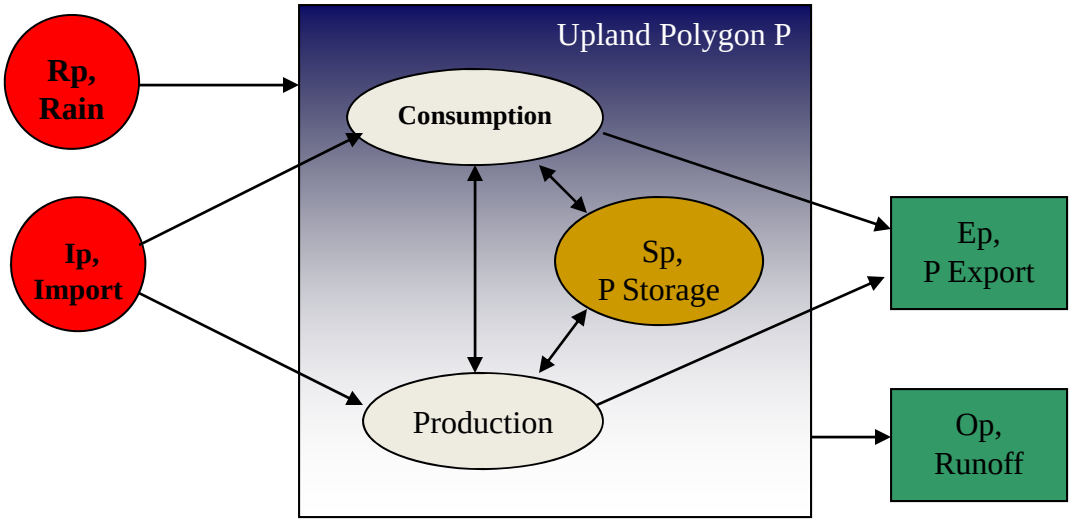
Determine the relative contribution of P and N from all identifiable sources

Methodology- Upland Analysis

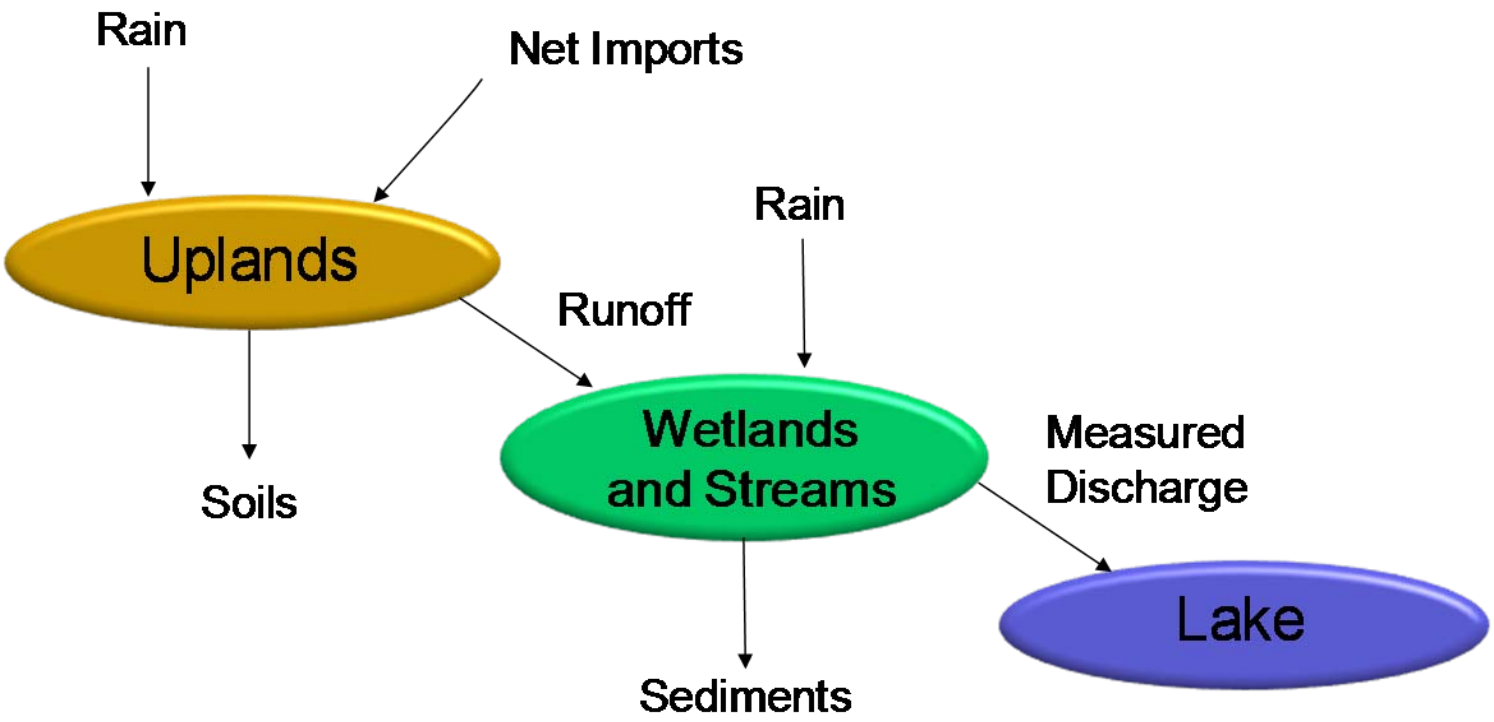
$$\Delta Sp = \Sigma Ip + Rp - \Sigma Ep - Op$$

where:

Sp = average annual phosphorus storage in polygon p, tons/yr
Ip = average annual phosphorus imports to polygon p, tons/yr
Rp = average annual rainfall phosphorus for polygon p, tons/yr
Ep = average annual phosphorus exports from polygon p, tons/yr
Op = average annual runoff phosphorus from polygon p, tons/yr



Methodology- Watershed Budget



Land Use Coefficients

- **Imports Components**
  - Fertilizer: Nutrients delivered to the land in fertilization practices
  - Feed: Nutrients consumed and deposited by livestock, people and pets
  - Cleaners: Nutrients in products used to disinfect livestock

- **Exports Components**
  - Livestock: Sale and culling of livestock
  - Harvest: Removal and sale of Crops
  - Hay: Production of hay for feed
  - Sod: Sod sold
  - Milk: Milk production sold
  - Septic: Cleaning of septic tanks and removal of waste

Nutrient Budget Analysis

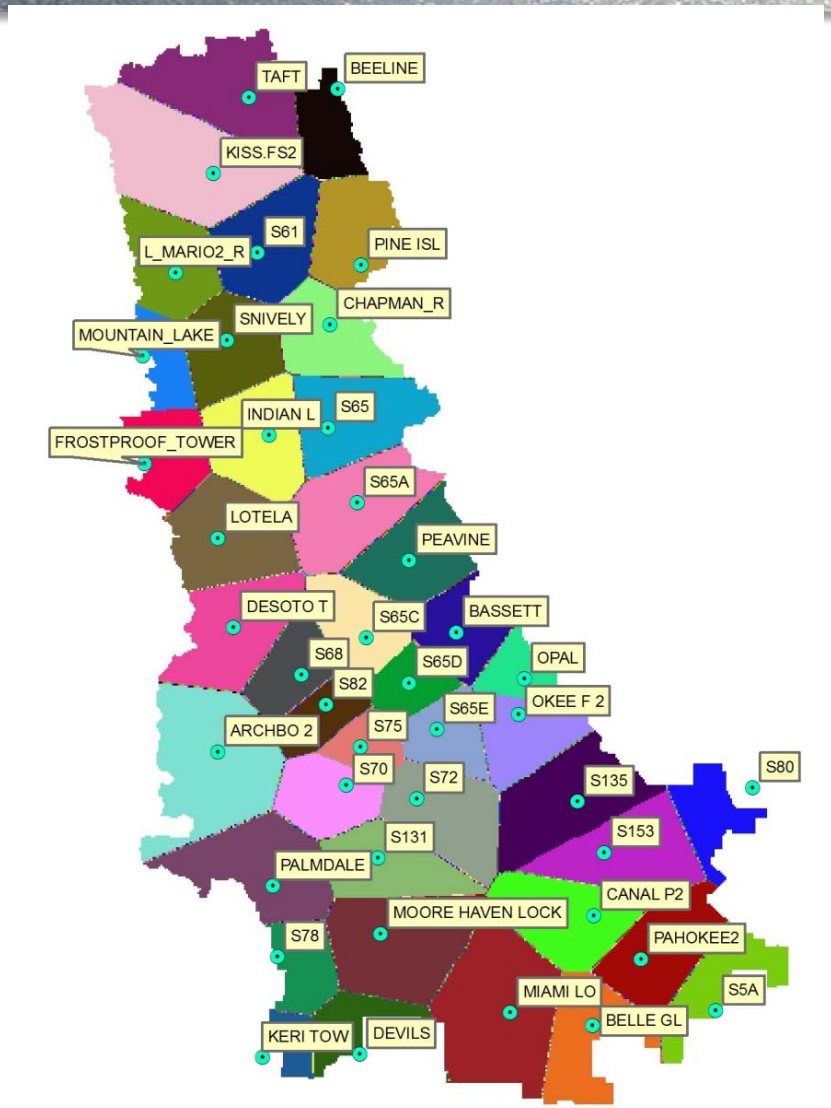
Data Sources

- Surveys - Sample Questions:
  - What type and quantity of fertilizer is used?
  - What type and quantity of feed is used?
  - Is sludge or gray water used?
  - What is the average harvest rate?
  - If other crops are sold what are the types and quantity?
- **Agencies**

Nutrient Budget Analysis

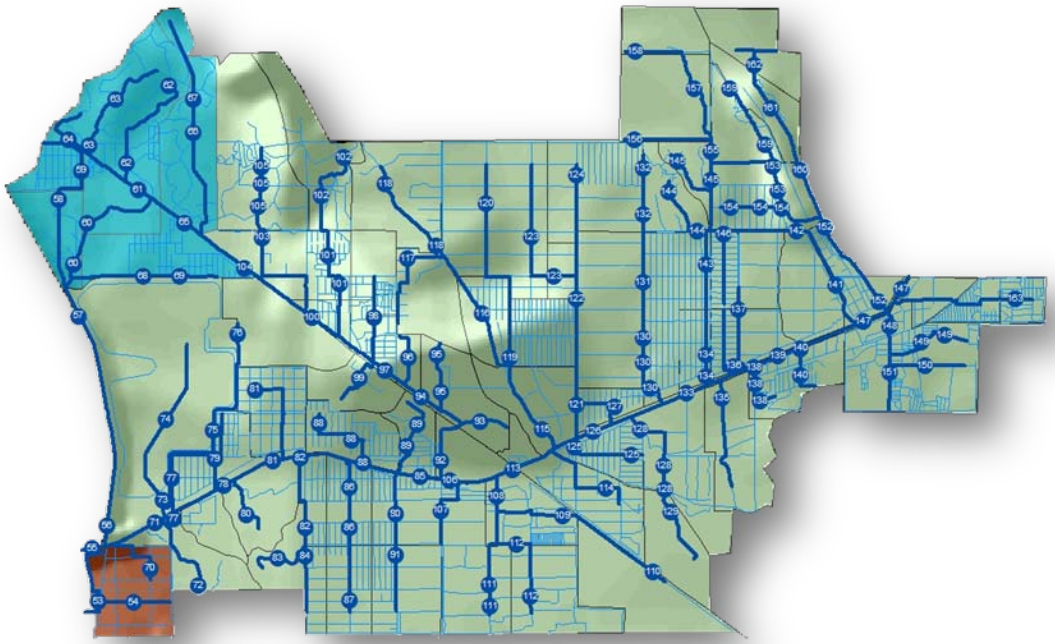
- Net P Import = Total P import - Total P export
- Net P Import Coefficient = Net P import/ Area

P Input by Rainfall



- Thiessen's method
- 42 Rainfall Zones
- 0.0159 mg/l P
- 0.54 mg/l N

P Output in Surface Discharge



- Watershed Assessment Model (WAM)
- Calibrated for LOW in 2009

Discharge Assimilation

The assimilation algorithm for nutrient attenuation:

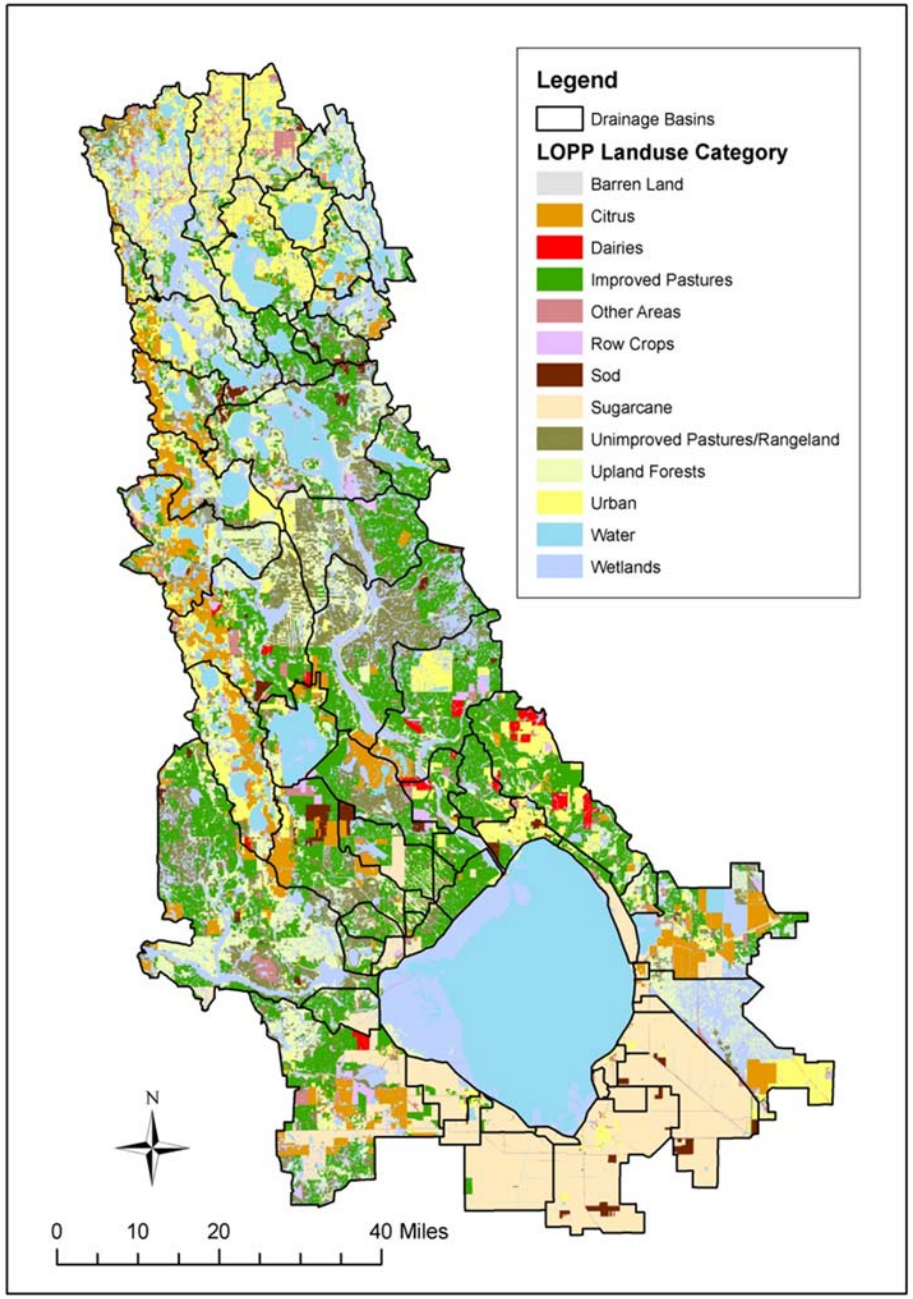
$$C_{out} = (C_{in} - C_b) * e^{-a*K*D} + C_b \qquad \text{[Eq. 1]}$$

Where,

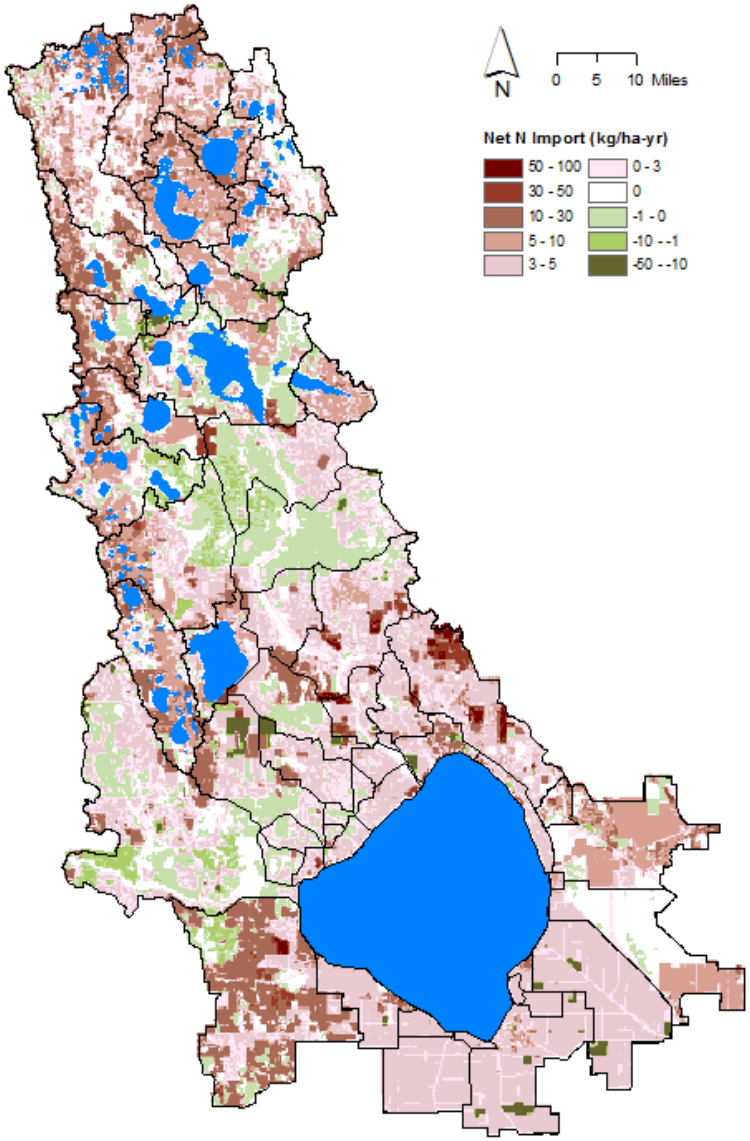
$$K = a * q^{-b} \qquad \text{[Eq. 2]}$$

C_{out} = Concentration at the outlet of the flow conveyance reach (mg/l)
C_{in} = Concentration at the inflow of the flow conveyance reach (mg/l)
C_b = Concentration for the background condition for the reach (mg/l)
D = Distance along the flow path (miles)
a = linear coefficient
b = exponential coefficient
q = flow rate (inches/year)

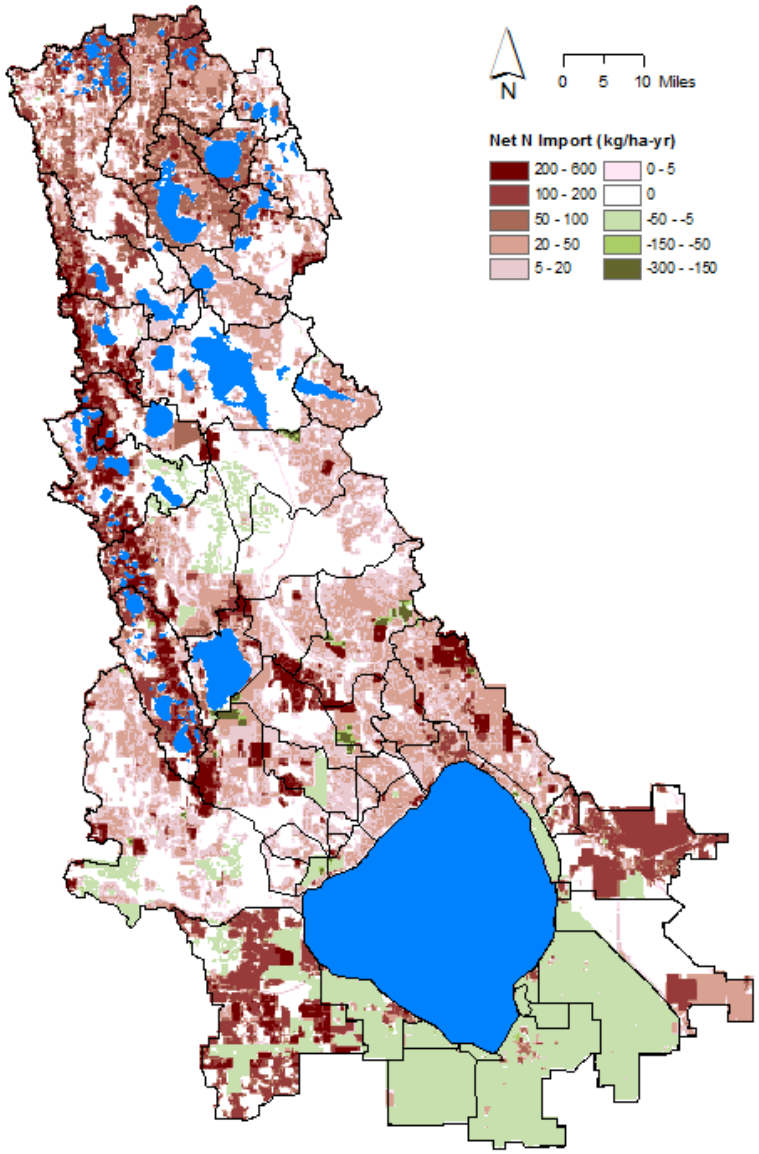
Land Use Data



Barren Land	1.2%
Citrus	7.1%
Dairies	0.7%
Improved Pasture	19.7%
Other Areas	0.9%
Row Crops	0.7%
Sod	1.1%
Sugarcane	11.6%
Unimproved Pastures	9.4%
Upland Forests	11.4%
Urban	11.9%
Water Bodies	6.4%
Wetlands	17.9%
Total Acreage	**100.0%**



Net Phosphorus Import Spatial Distribution



Net Nitrogen Import Spatial Distribution

Results by Sub-watershed

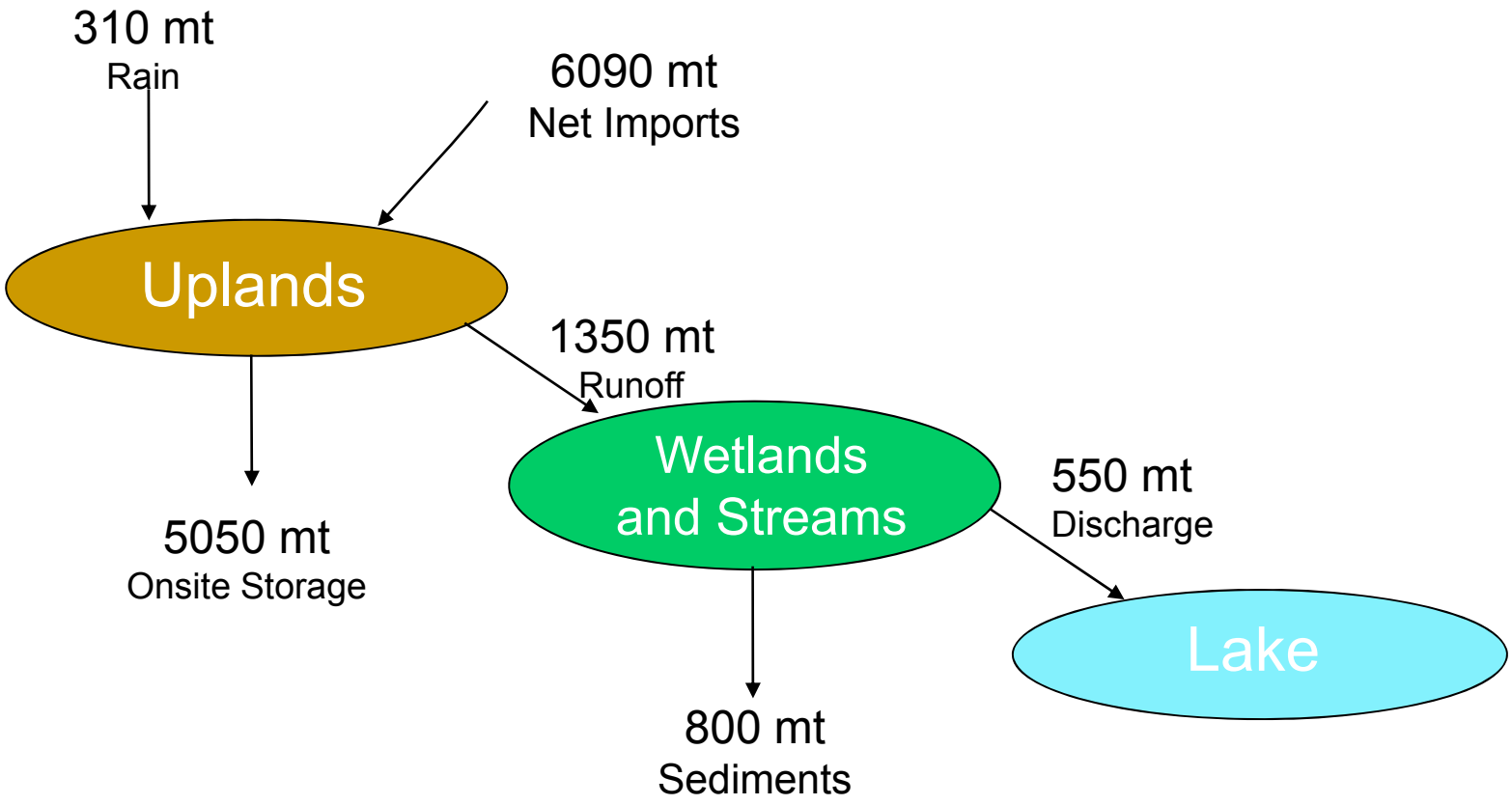
Total Phosphorus Budget (in Metric Tons per Year)

Subwatershed	Area (ha)	Imports	Exports	Net Imports	Rainfall	Source Discharge	Onsite Storage	Outlet Discharge	Attenuated
East Lake Okeechobee	96,635	576.8	205.5	371.4	21.3	56.3	336.4	36.9	19.4
Fisheating Creek	115,037	463.0	269.3	193.6	26.6	70.7	149.6	15.2	55.5
Indian Prairie	117,443	896.5	508.1	388.4	21.3	97.1	312.5	23.9	73.2
Lake Istokpoga	157,837	1,029.6	382.4	647.2	32.9	132.4	547.7	31.2	101.2
Low er Kissimmee	171,692	1,064.8	489.8	575.1	38.8	119.8	494.1	52.4	67.4
South Lake Okeechobee	147,327	2,749.3	2,329.2	420.1	31.9	146.3	305.7	109.3	37.0
Taylor Creek/Nubbin Slough	80,076	1,059.7	424.2	635.5	16.1	119.1	532.5	79.6	39.6
Upper Kissimmee	416,556	2,360.4	544.1	1,816.3	100.9	464.1	1,453.1	122.4	341.7
West Lake Okeechobee	90,270	1,604.8	563.8	1,041.1	21.5	146.8	915.8	83.7	63.0
Total	**1,392,873**	**11,804.9**	**5,716.3**	**6,088.5**	**311.5**	**1,352.5**	**5,047.4**	**554.6**	**798.0**

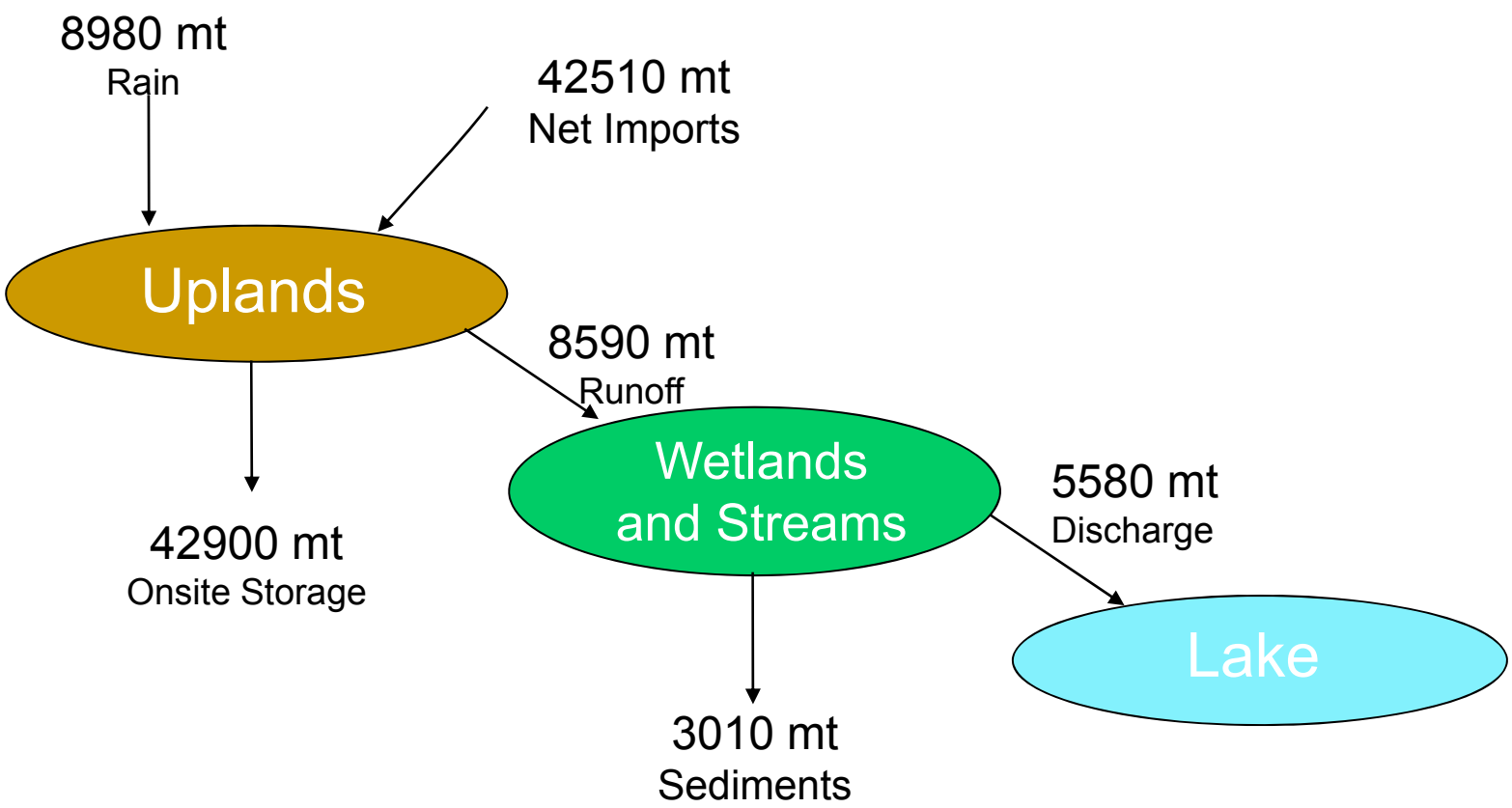
Total Nitrogen Budget (in Metric Tons per Year)

Subwatershed	Area (ha)	Imports	Exports	Net Imports	Rainfall	Source Discharge	Onsite Balance	Outlet Discharge	Attenuated
East Lake Okeechobee	96,635	6,040.3	552.3	5,488.1	615.2	542.5	5,560.8	423.7	118.8
Fisheating Creek	115,037	2,895.7	1,157.1	1,738.6	766.4	331.9	2,173.1	244.5	87.5
Indian Prairie	117,443	5,454.5	2,062.2	3,392.3	611.6	684.4	3,319.5	373.2	311.2
Lake Istokpoga	157,837	8,968.8	1,150.8	7,818.0	948.3	888.8	7,877.4	397.9	491.0
Low er Kissimmee	171,692	5,465.8	2,359.5	3,106.4	1,119.7	667.9	3,558.1	194.3	473.7
South Lake Okeechobee	147,327	5,564.2	11,049.8	-5,485.7	920.6	1,820.7	-6,385.7	1,639.6	181.1
Taylor Creek/Nubbin Slough	80,076	6,531.9	2,133.0	4,399.0	463.9	601.1	4,261.8	405.6	195.4
Upper Kissimmee	416,556	17,518.8	1,679.5	15,839.3	2,910.8	2,520.9	16,229.2	1,434.1	1,086.8
West Lake Okeechobee	90,270	8,473.0	2,256.2	6,216.8	620.4	534.8	6,302.4	463.8	71.0
Total	**1,392,873**	**66,913.1**	**24,400.2**	**42,512.7**	**8,976.8**	**8,593.0**	**42,896.5**	**5,576.7**	**3,016.4**

Total Phosphorus Budget Results



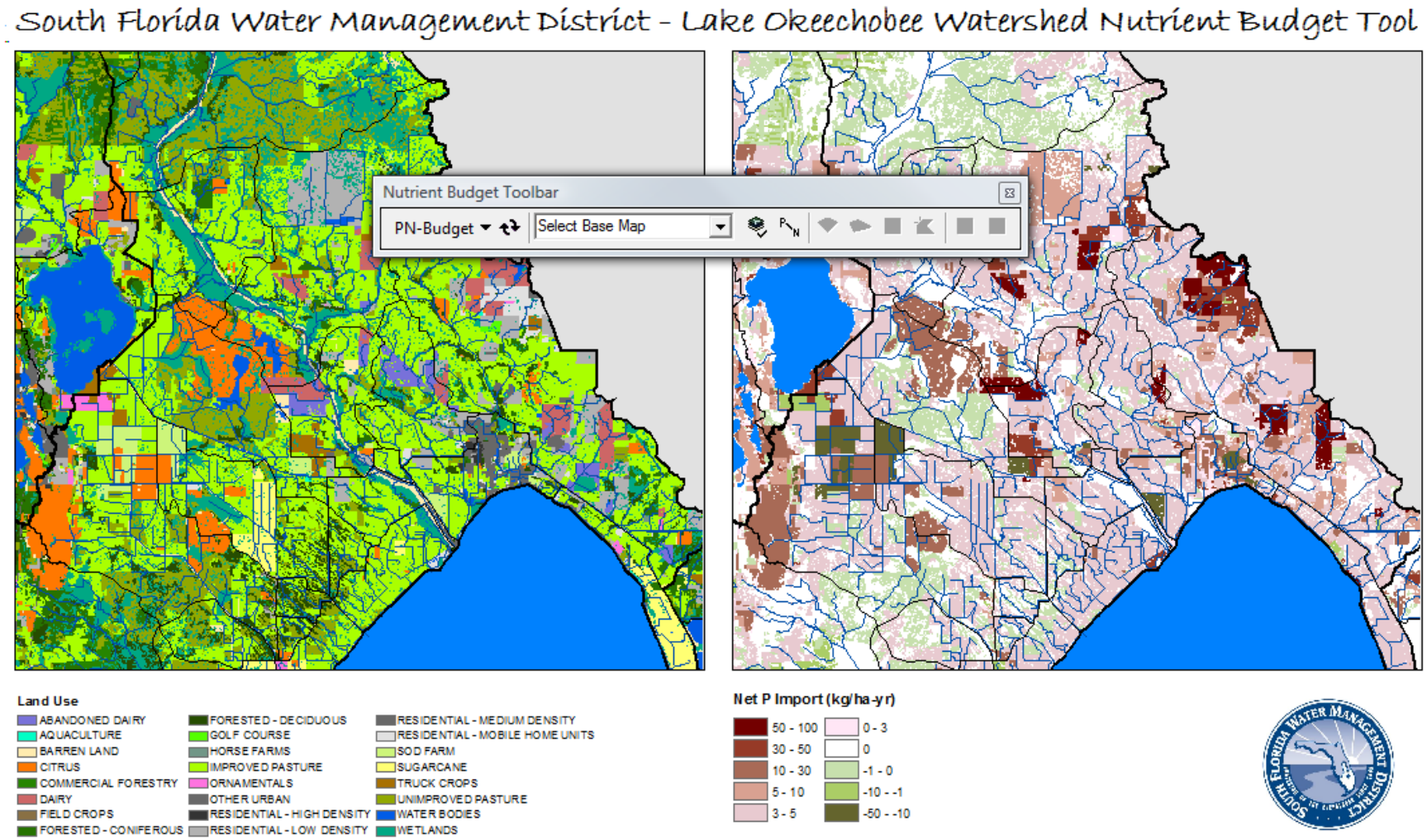
Total Nitrogen Budget Results



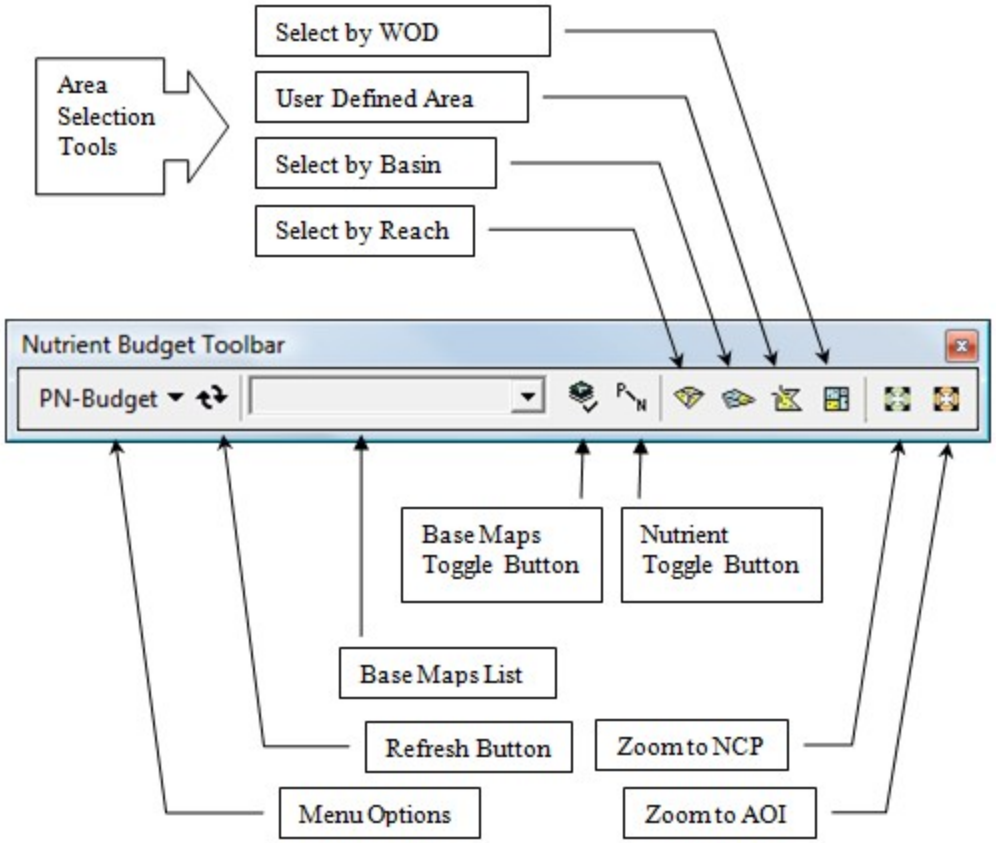
Graphical User Interface

- PN-Budget: LOW Nutrient Budget Tool
- Update of P-Budget to C#.Net
- Includes results of current budget analysis
- Allows users to create Nutrient Control Plans (NCPs) by changing nutrient-related land use practices to user-defined areas
- Provides maps, tables and reports displaying results of current or NCP budget analyses

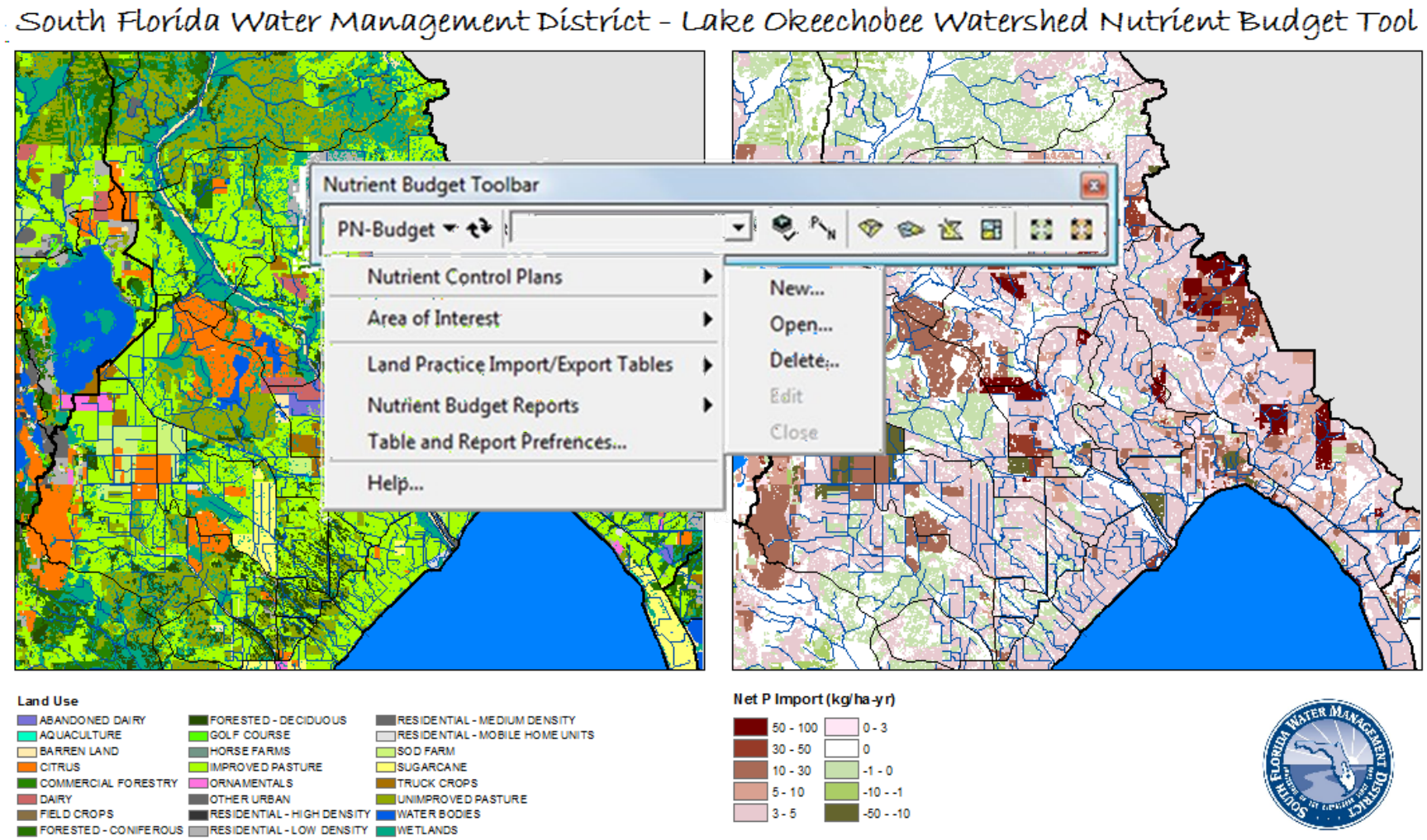
Graphical User Interface



Graphical User Interface

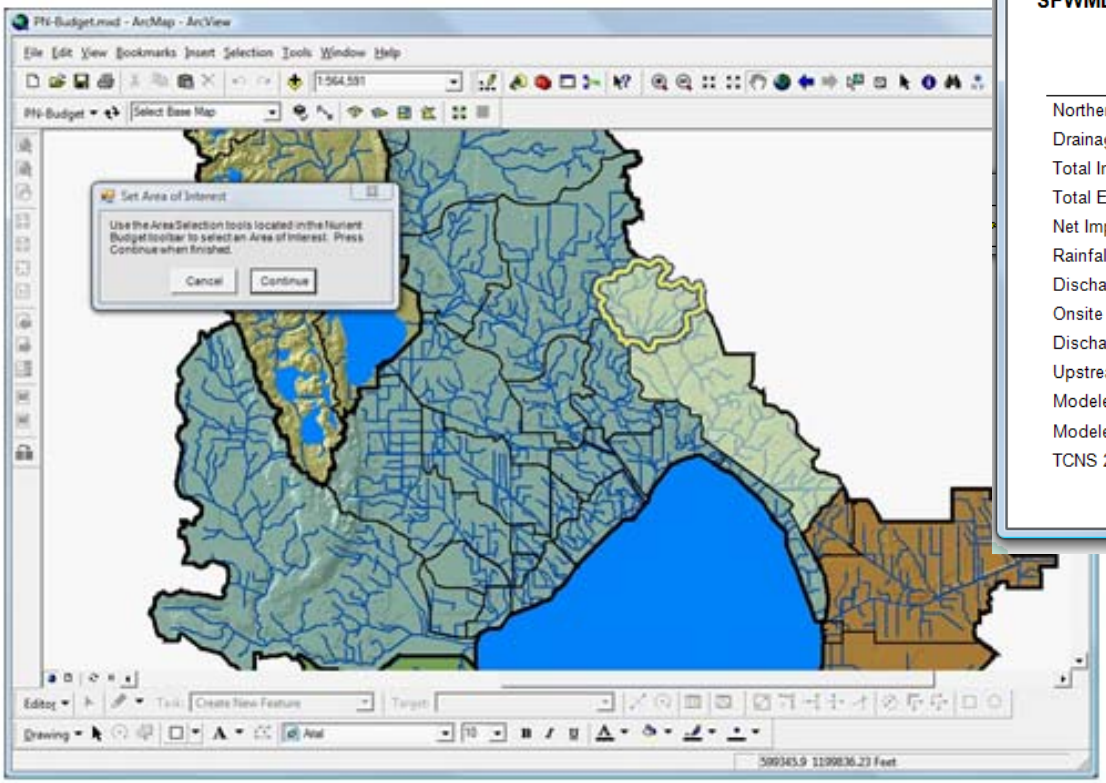


Graphical User Interface



Graphical User Interface

- Drainage Area Summaries for user-defined Areas of Interest (AOIs)



Drainage Area Summary Table

1 of 1

SFWMD Lake Okeechobee Watershed Nutrient Budget
Drainage Area Annual Summary

Properties	Values
Northern Lake Okeechobee, Reach No.	472
Drainage Area (ha)	12,857
Total Imports (kg)	315,716
Total Exports (kg)	120,528
Net Imports (kg)	195,189
Rainfall (kg)	2,466
Discharge at Source (kg)	13,174
Onsite Storage (kg)	184,480
Discharge at Outlet (kg)	6,286
Upstream Storage (kg)	6,888
Modeled flow at Outlet (m3)	20,568,900
Modeled Avg. Concentration (ppb)	306
TCNS 213 Measured Avg. TP Conc. (ppb)	225

Graphical User Interface

- Report Output

Nutrient Budget Report

1 of 1 100% Find | Next

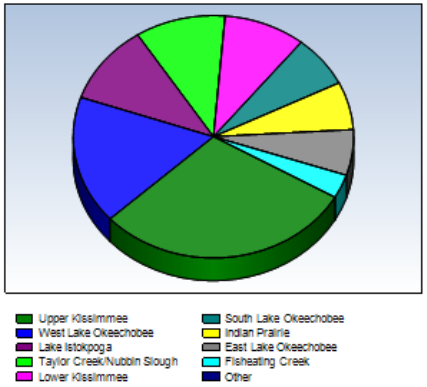
SFWMD Lake Okeechobee Watershed Nutrient Budget Report

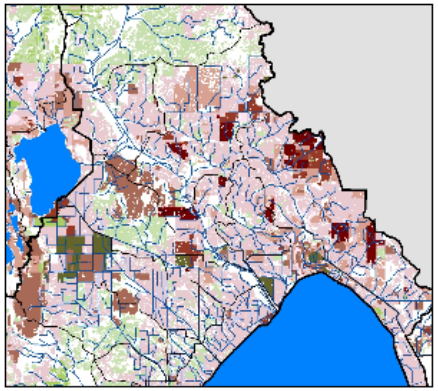
Existing Conditions

Total Annual Phosphorus Budget by Subwatershed (in Metric Tons)

Subwatershed	Area (ha)	Imports	Exports	Net Imports	Rainfall	Source Discharge	Onsite Deposit
East Lake Okeechobee	96,635	576.8	205.5	371.4	21.3	56.3	336.4
Fisheating Creek	115,037	463.0	269.3	193.6	26.6	70.7	149.6
Indian Prairie	117,443	896.5	508.1	388.4	21.3	97.1	312.5
Lake Istokpoga	157,837	1,029.6	382.4	647.2	32.9	132.4	547.7
Lower Kissimmee	171,692	1,064.8	489.8	575.1	38.8	119.8	494.1
South Lake Okeechobee	147,327	2,749.3	2,329.2	420.1	31.9	146.3	305.7
Taylor Creek/Nubbin Slough	80,076	1,059.7	424.2	635.5	16.1	119.1	532.5
Upper Kissimmee	416,556	2,360.4	544.1	1,816.3	100.9	464.1	1,453.1
West Lake Okeechobee	90,270	1,604.8	563.8	1,041.1	21.5	146.8	915.8
Total	**1,392,873**	**11,804.9**	**5,716.3**	**6,088.5**	**311.5**	**1,352.5**	**5,047.4**

Breakdown of Net Imports





Nutrient Budget Analysis

Summary

- Overall, compared to the 2002 study, there is a 25% decrease in net P imports and a 29% decrease in onsite storage.
- The net P imports for citrus increased, primarily due to changed coefficients in the Lake Istokpoga and Upper Kissimmee sub-watersheds.
- Obtained the TN budget results for the Lake Okeechobee Watershed.

Strategy for Excess Phosphorus

Strategies Include: enhanced source control, wetland restoration, reservoir / stormwater treatment areas, advanced technologies, sediment removal feasibility analysis

Challenges: high cost, residual phosphorus in the watershed, uncertainties about possible extent of control with different technologies

THANK YOU!

Nutrient Budget Analysis for the Lake Okeechobee Watershed

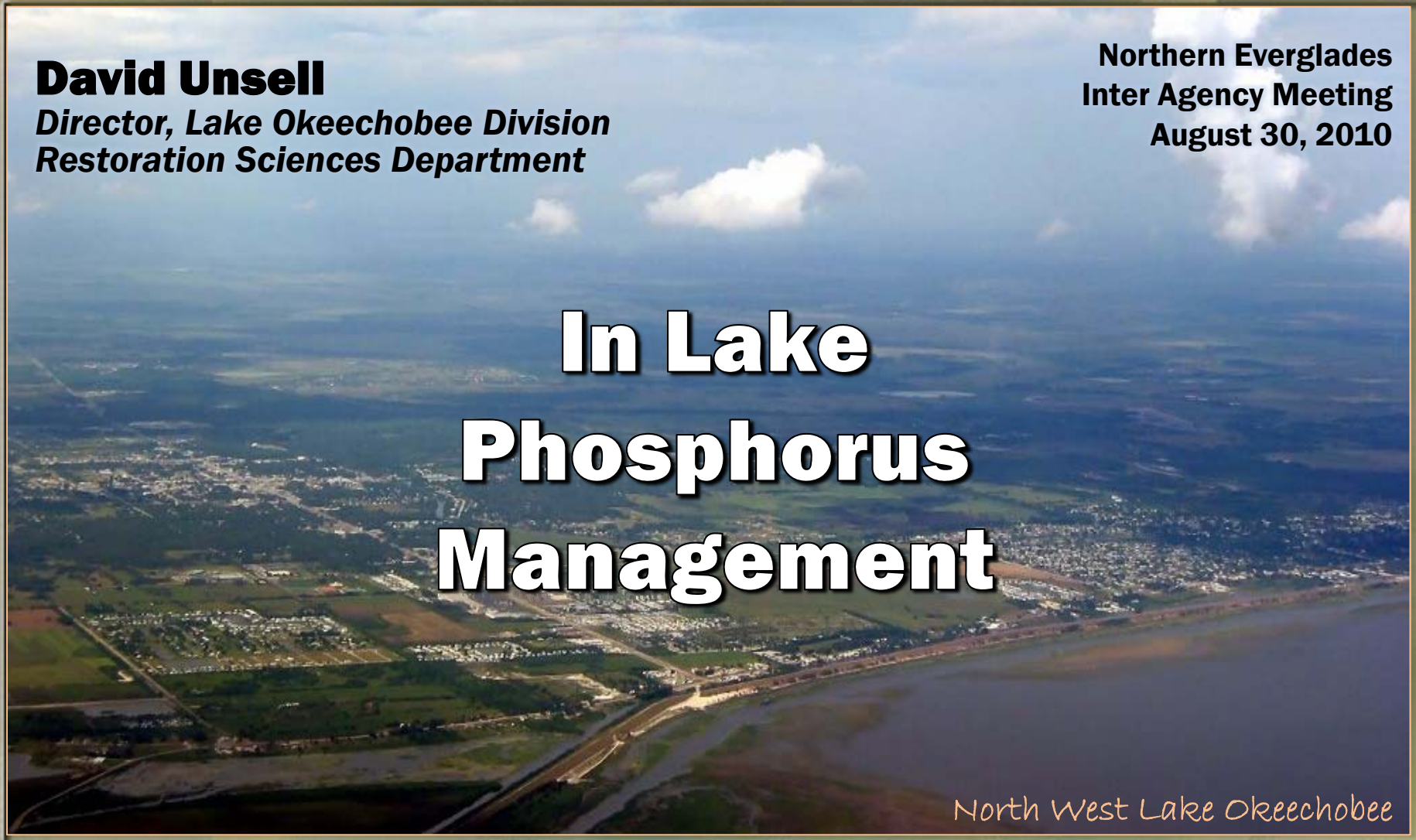
Joyce Zhang
Principal Engineer
Restoration Sciences Department

Northern Everglades Interagency Meeting
August 30, 2010

David Unsell
Director, Lake Okeechobee Division
Restoration Sciences Department

Northern Everglades
Inter Agency Meeting
August 30, 2010

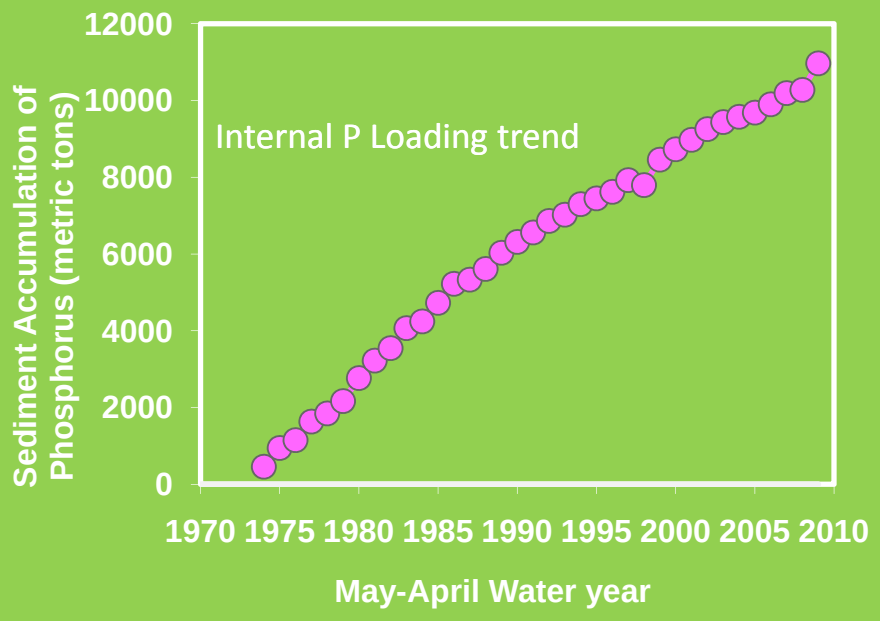
In Lake Phosphorus Management



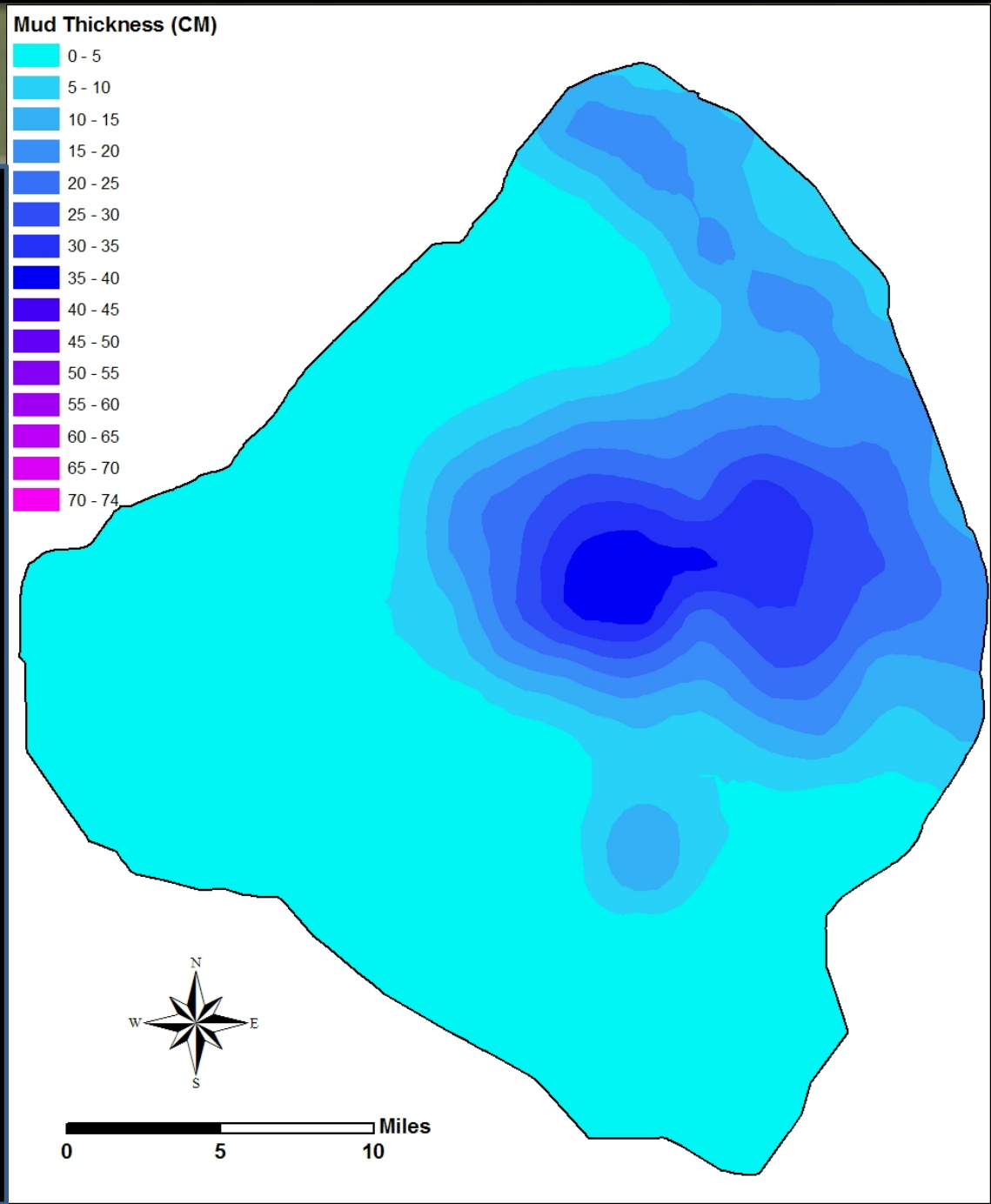
North West Lake Okeechobee

Internal P Loading Trends

- Decades of excessive P loads have accumulated in Lake sediments that are currently near saturation with P
- Sediment P moves into water column through diffusion and re-suspension
- Results from previous studies concluded that sediment removal (dredging) is not practical or cost-effective. However, the problem of internal P loading remains a significant challenge
- Previous studies recommend external P load reduction as most feasible, cost-effective alternative



Sediment Location



Internal Lake Phosphorus Management Program

- 80,000 hectares of lake bottom covered by 260 million cubic yards of P-enriched mud sediment
- If Internal P loading is not addressed, the lake may not fully respond to external P load reductions
- In 2003, the District conducted a study addressing the feasibility of removing or treating the Lake's P-enriched mud sediments

New Considerations

- Could take decades to experience restored water quality conditions within the Lake
- Sediments also contribute to high turbidity that affects SAV and downstream receiving water bodies
- Everglades and estuary restoration more difficult to achieve without improving the quality of water discharged from the Lake
- Release of P from lake sediments will remain a large source of P for many decades regardless of how the upstream watershed is managed

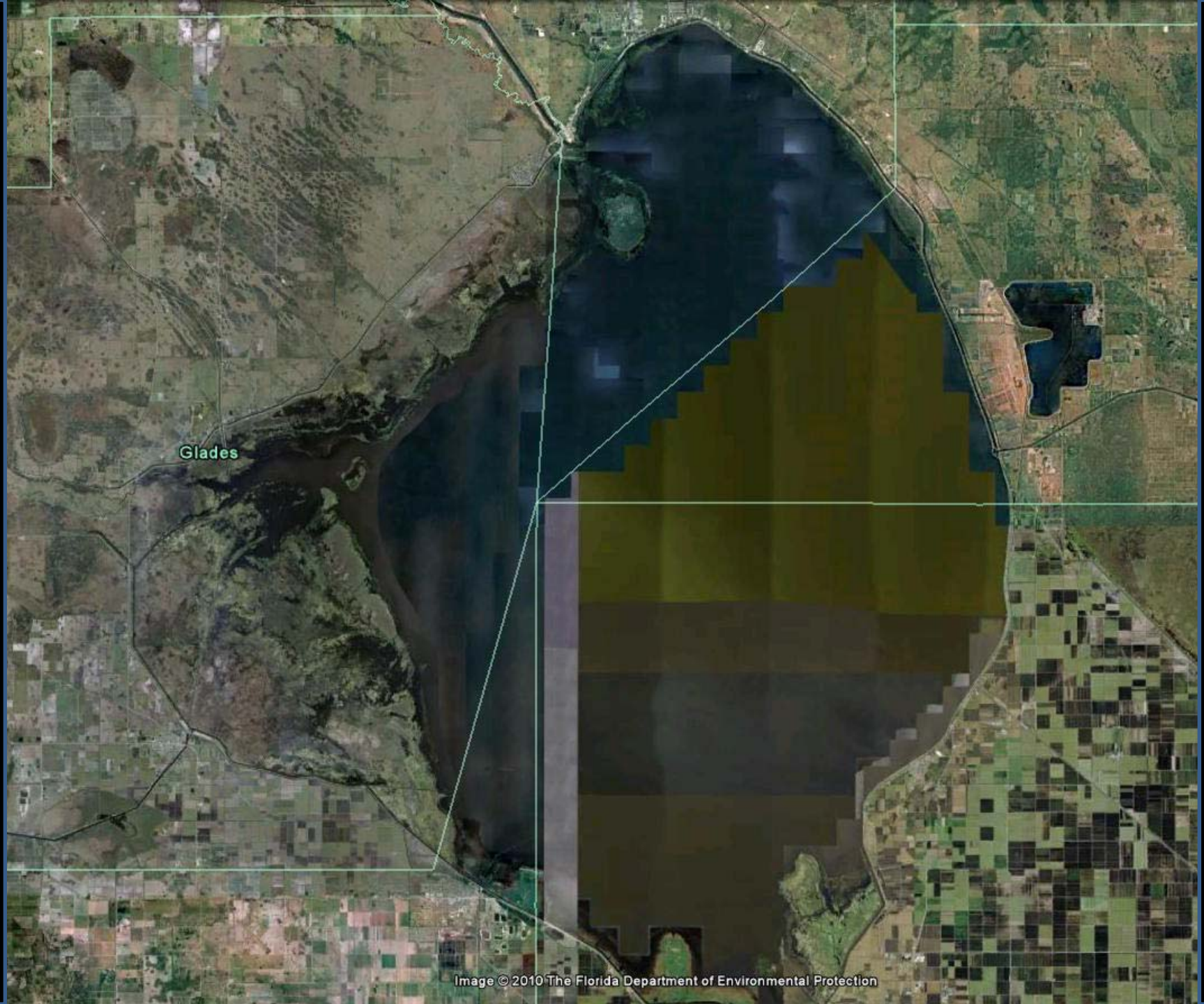
Internal Lake Phosphorus Management Program (continued)

New Technologies

- Consideration of deep-well disposal of effluent water or the sediments themselves
- Construction of in-lake islands or littoral zones near outlets

Proposed In-Lake P Management Study

- Review the recommendations from the 2003 feasibility study
- New concepts and technologies would be evaluated and then compared against those from the previous report
- Finally, new recommendations would be made for implementation


Glades
Image © 2010 The Florida Department of Environmental Protection

Thank You!

Lake Okeechobee Ecological Update

David Unsell
Director, Lake Okeechobee Division
Restoration Sciences Department

Heron & Fish

SFWMD

WATER STORAGE AND STRATEGIES

Pinar Balci, Director, State and Federal Policy Division,
South Florida Water Management District

Storage Goal
Lake Okeechobee Phase II Technical Plan

- Analyses performed to determine amount of water needed to be stored in watershed to:
  - Improve lake stage management
  - Reduce excess damaging freshwater releases to estuaries
  - While meeting other water related needs
- Analyses indicate there is a breakpoint between 900,000 - 1.3 million acre-ft
- Plan identifies a water quantity storage goal with an upper ceiling of approximately 1.3 million acre-ft
- Storage need for north of the Lake is further evaluated and refined through River of Grass planning process

Strategies
Strategic Projects

SFWMD

- Mixture of regional and dispersed water management projects
- Dispersed Water Management
  - Most promising near-term option
  - Continue to investigate use of additional public lands
  - Implement more projects on private/tribal lands
  - Optimize projects currently in place

Strategies
Strategic Projects (Cont.)

SFWMD

- Dispersed Water Management (Cont.)
  - Northern Everglades Dispersed Water Management Payment for Environmental Services Solicitation
    - Applies to low intensity agriculture
    - Top-ranked projects will move forward with design, permitting, construction, monitoring
  - Proposal for pilot projects for intensive agricultural operations
    - Identify key issues and differences

Strategies
Strategic Projects (Cont.)

SFWMD

- Dispersed Water Management (Cont.)
  - Istokpoga Dispersed Water Management and Stormwater Recycling Project
    - Approximately 1,200 acres of above-ground impoundments
    - At completion, the project is estimated to reduce the volume of stormwater and amount of phosphorus discharged by the IMWID by an estimated 60% and 70%, respectively
    - State and federal grant funding is being pursued to allow for the detailed design & construction of facilities on the acquired land

Strategies
Strategic Projects (Cont.)

SFWMD

- Dispersed Water Management (Cont.)
  - Fisheating Creek Wetland Reserve Special Project
    - One of the largest contiguous easement acquisition creating
    - USDA's Natural Resources Conservation Service will provide $89 million through the WRP to acquire easements on almost 26,000 acres of land
    - SFWMD is in process of developing a Memorandum of Understanding with NRCS to provide assistance with land acquisitions, agricultural engineering, permitting, land management and monitoring activities

Strategies
Strategic Projects (Cont.)

SFWMD

- Regional Storage
  - Reservoirs
  - Aquifer Storage and Recovery
  - Deep well injection
- CERP Lake Okeechobee Watershed Project
- River of Grass Phase I planning indicated a storage of 450,000-575,000 ac-ft for Northern Everglades but this will be revisited in Phase II planning

Questions?

Lake Okeechobee Protection Plan Update

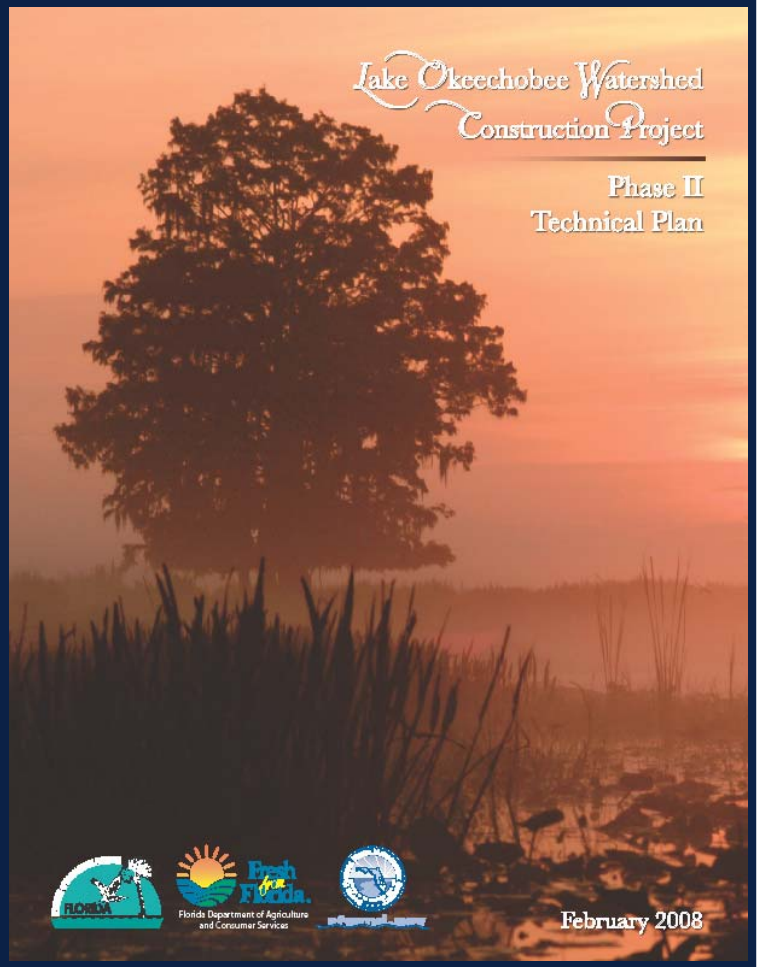
Section 6.2.4 Sub-watershed Conceptual Plans and Modeling

Northern Everglades Interagency Meeting
August 30, 2010

Armando Ramirez, Sr. Project Management Analyst,
Project Coordination Division, Everglades Restoration and Capital Projects

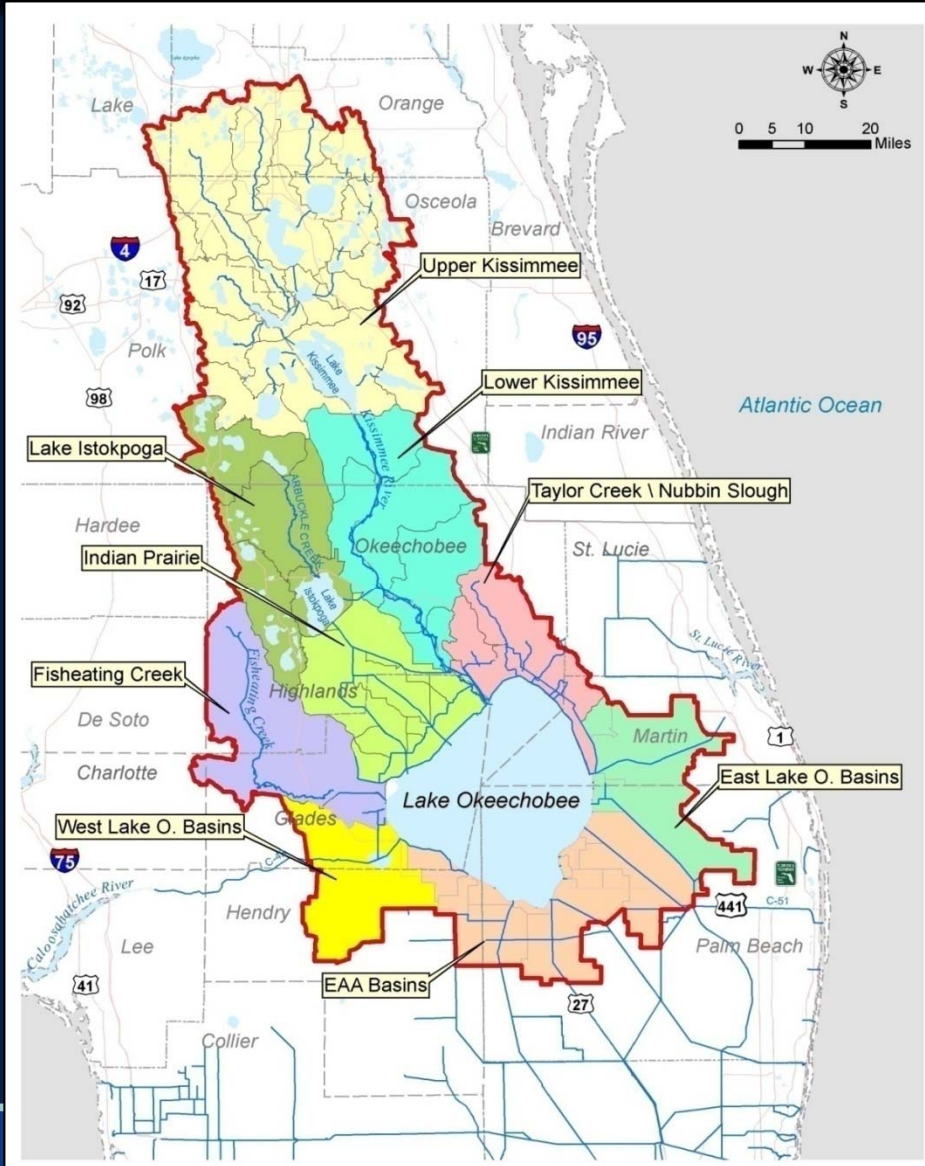
6.2.4 Future Strategies - Projects
Sub-watershed Conceptual Plans and Modeling

- Lake Okeechobee Phase II Technical Plan
  - Conceptual Plan - storage and water quality targets for nine sub-watersheds
  - Detailed studies - still needed for each sub-watershed to better refine targets and strategies
  - Currently undertaking Fisheating Creek (FEC) and Taylor Creek Site Feasibility Studies (FS)
  - Proposal for future funding:
    - Indian Prairie Sub-watershed Feasibility Study
    - LOW Pre-Drainage Characterization



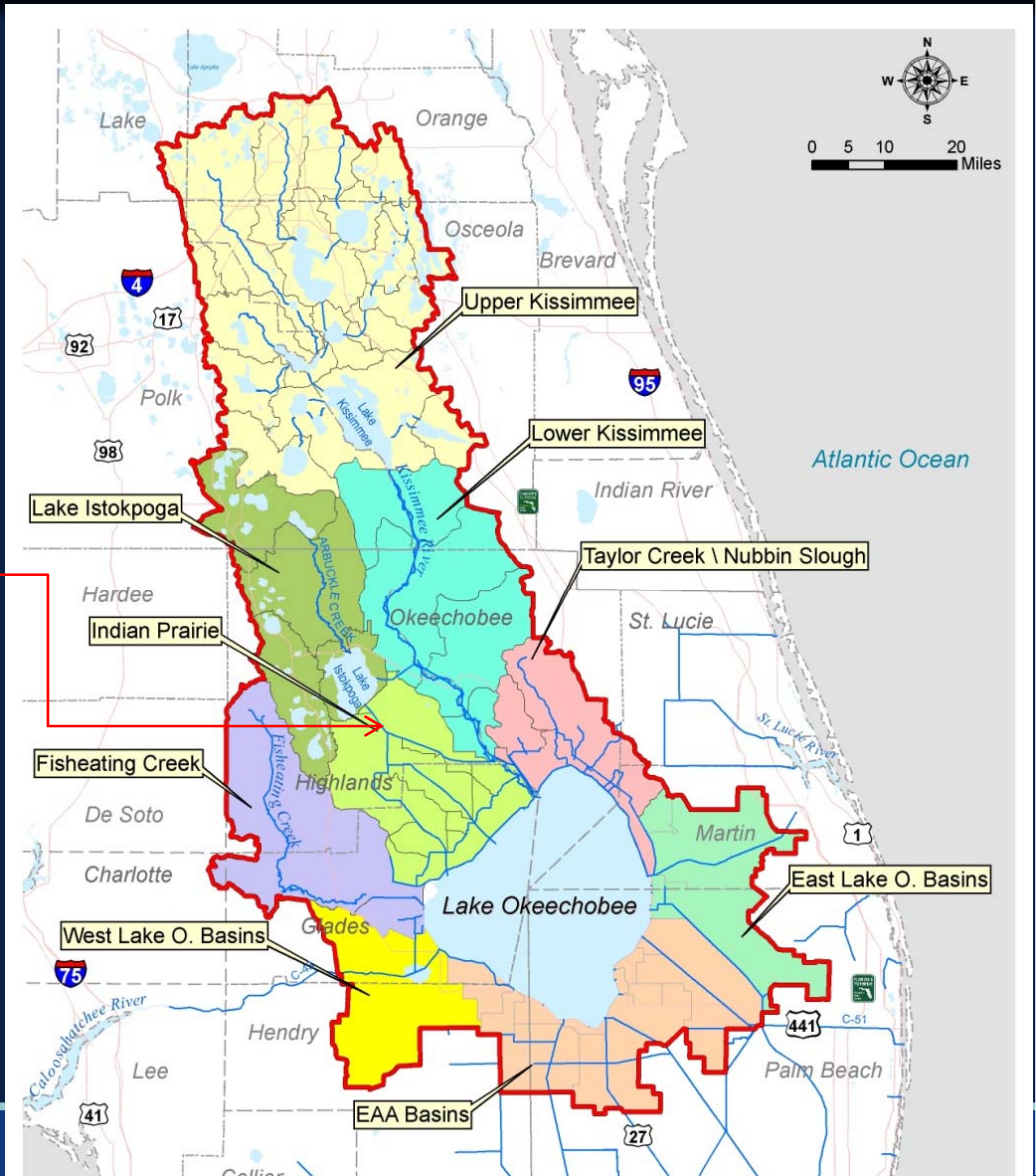
Watershed Description

- The Lake Okeechobee Protection Plan (LOPP) area includes 61 drainage basins, spanning 10 Florida counties with a drainage area of over 5,400 square miles
- The LOPP includes nine sub-watersheds



Future Strategies - Projects
Indian Prairie Feasibility Study

Indian Prairie Sub-watershed



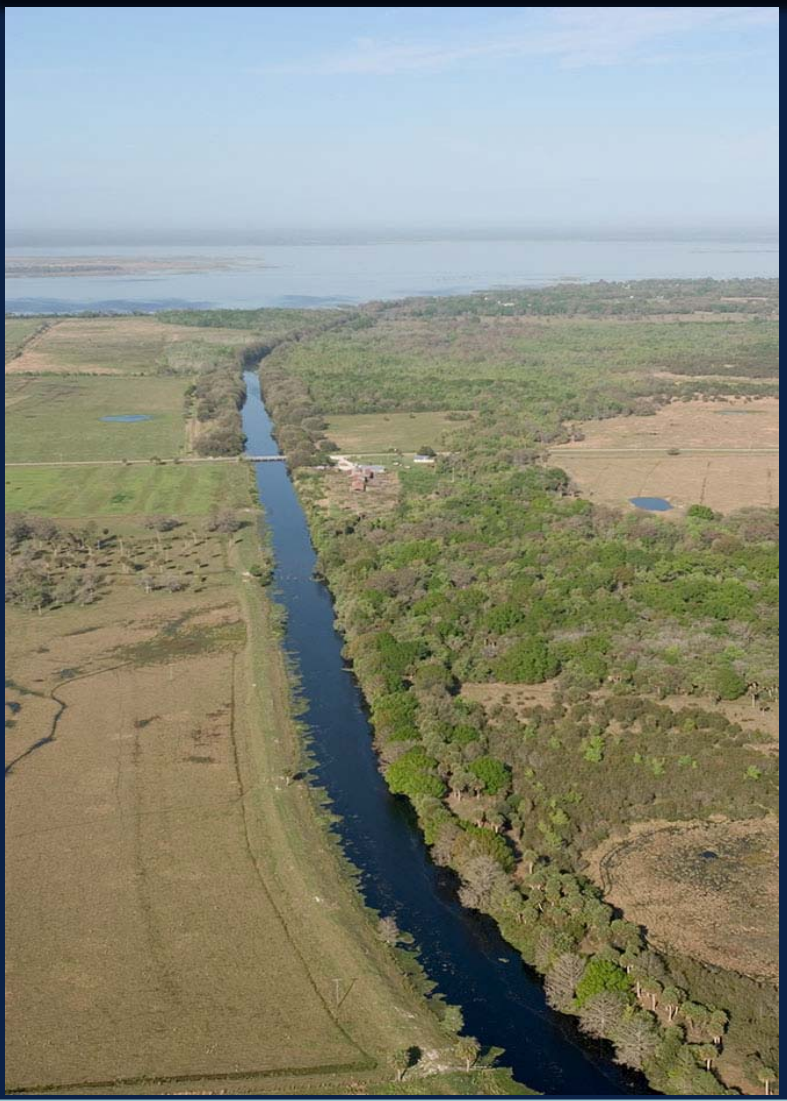
Future Strategies - Projects
Indian Prairie Feasibility Study (Cont.)

- The primary water management features in the sub-watershed:
  - Indian Prairie Canal (C- 40)
  - Harney Pond Canal (C- 41)
  - C- 41A
- Drainage area estimated at 294,147 acres

Future Strategies - Projects
Indian Prairie Feasibility Study (Cont.)

- Indian Prairie: Selected due to challenges associated with this portion of the Watershed
- Objective: To identify the best mix of storage and water quality features to improve the hydrology and water quality within the sub-watershed

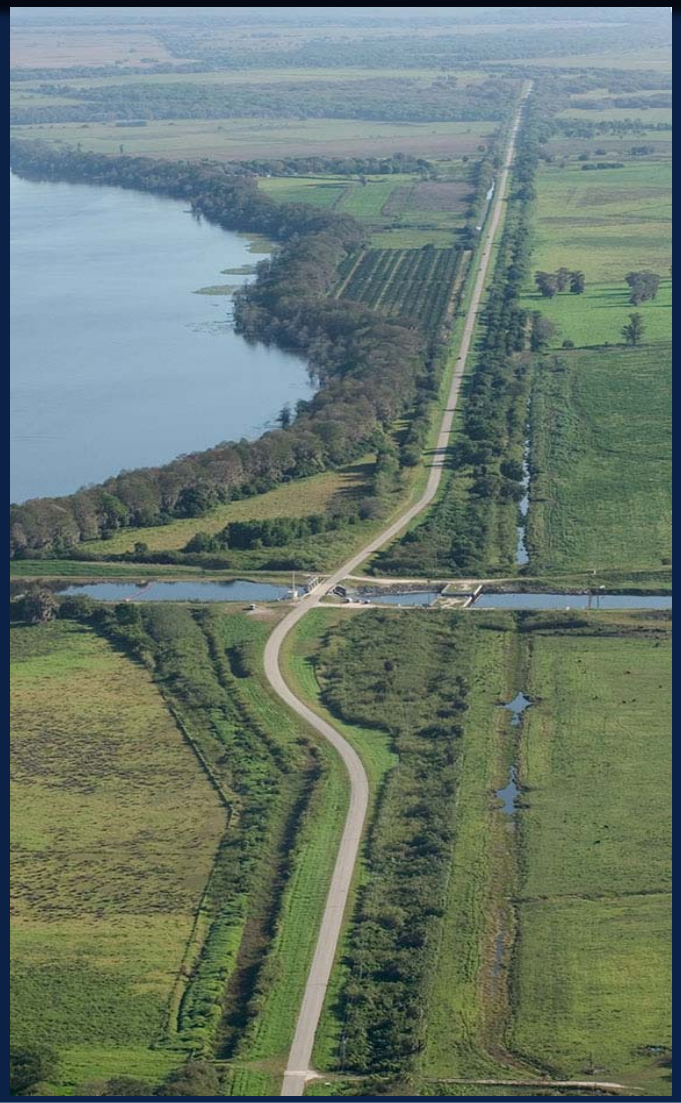
Future Strategies - Projects
Indian Prairie Feasibility Study (Cont.)



This sub-watershed contributes:

- About 10% of the total average annual flow volume to Lake Okeechobee
- About 17% of the average annual P loading to Lake Okeechobee (estimated at 89 mt/yr, with an average annual TP concentration of 289 ppb)

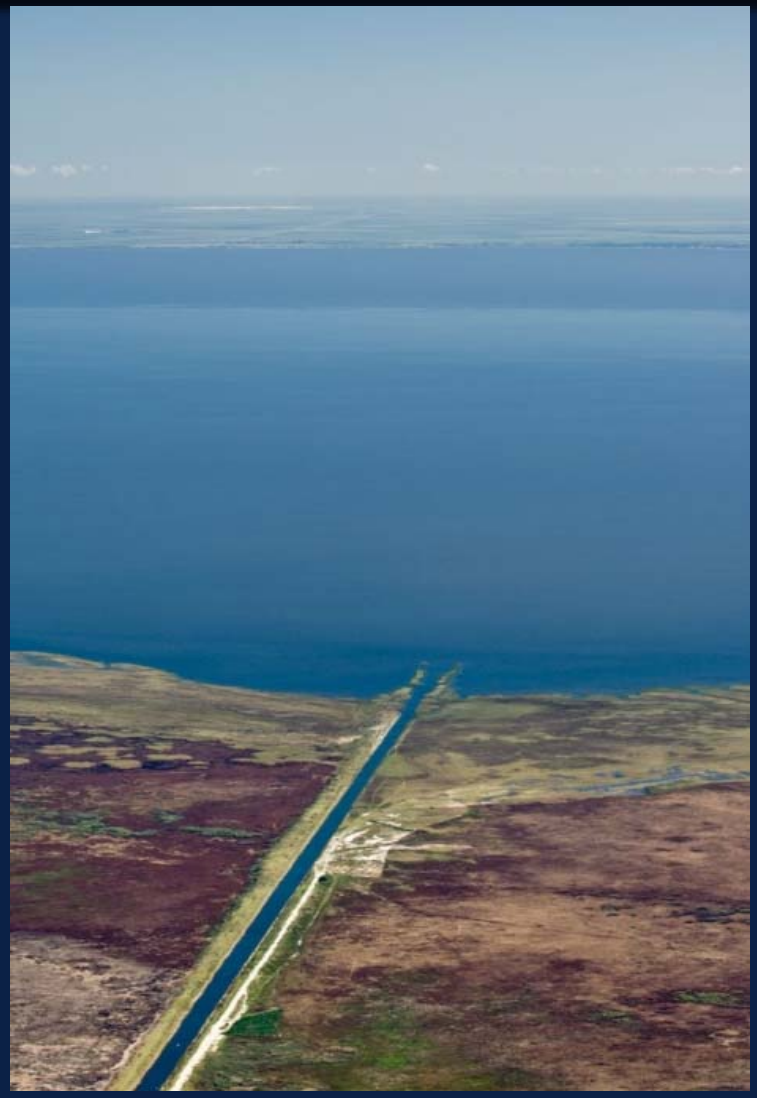
Future Strategies - Projects
Indian Prairie Feasibility Study (Cont.)



To be conducted in two phases with large stakeholder involvement:

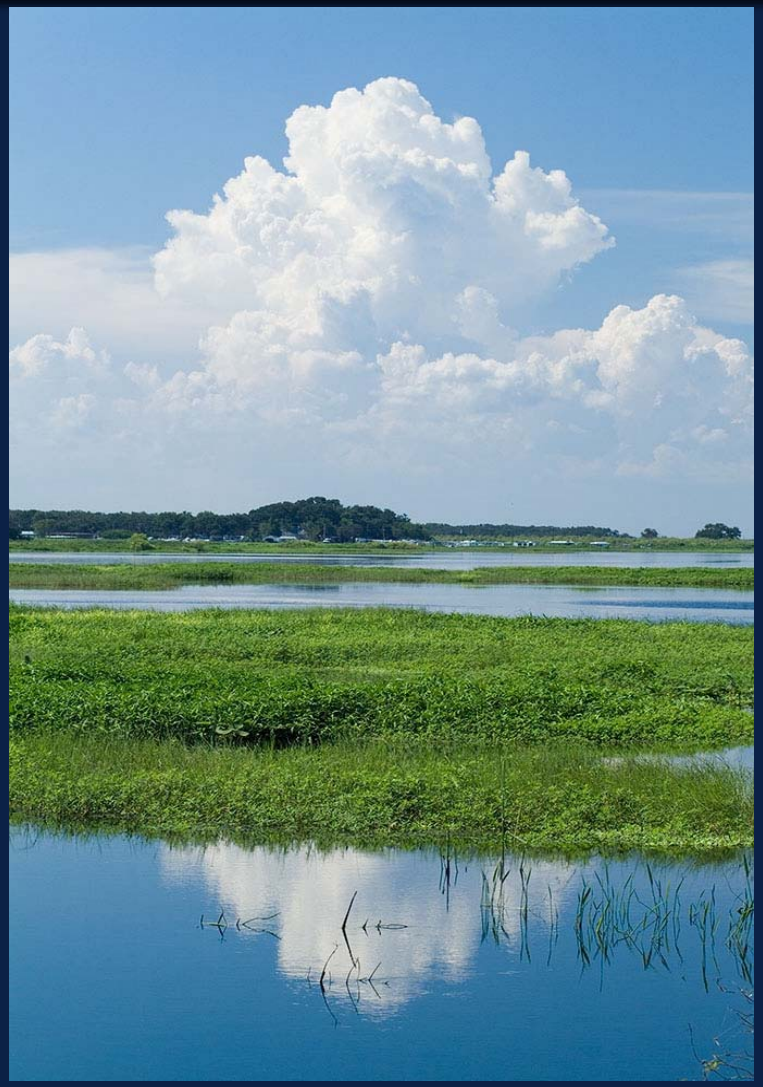
- Phase I
  - Collect and review background information
  - Identify data gaps and conduct additional data collection
- Phase II
  - Plan formulation, evaluation and selection

Future Strategies - Projects
LOW Pre-Drainage Characterization



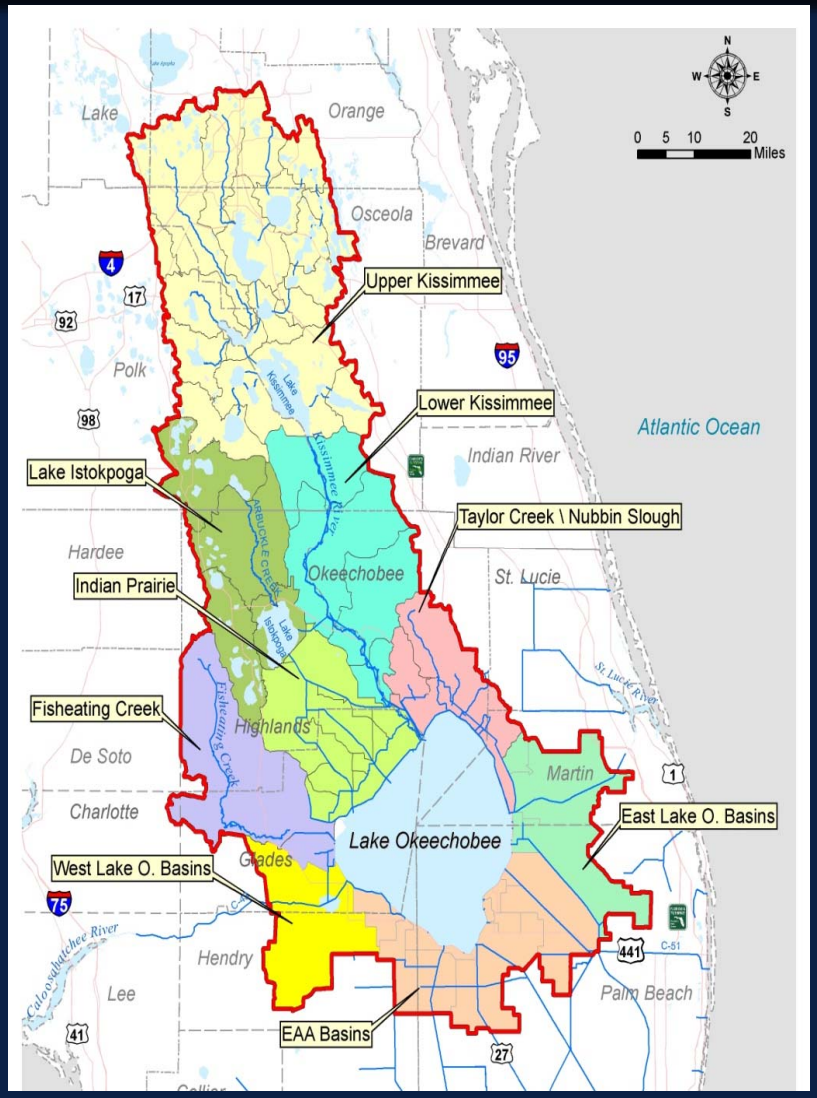
- **Objective: Characterize pre-drainage conditions to estimate planning level storage and P-Load reduction targets for individual sub-watersheds to ensure that the total P-load reduction required to meet the Lake Okeechobee TMDL is balanced throughout the entire LOW**

Future Strategies - Projects
LOW Pre-Drainage Characterization (Cont.)



- FEC the first sub-watershed level feasibility study to be initiated
- The FS had to conduct an independent analysis to estimate P-load reduction and storage planning targets
- These planning targets were based on a comparison of Watershed Assessment Model (WAM) simulated existing and pre-drainage flows and loads in the FEC sub-watershed

Future Strategies - Projects
LOW Pre-Drainage Characterization (Cont.)

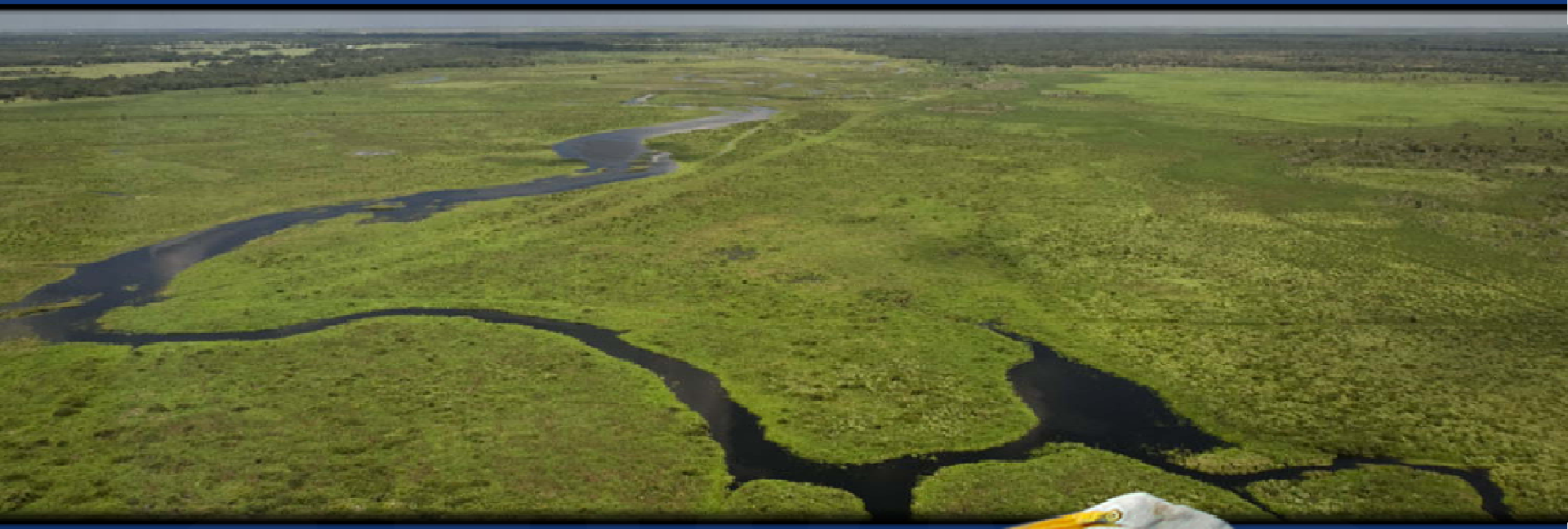


- Adopting planning targets for individual sub-watersheds, one sub-watershed at a time, may potentially lead to a shortfall in the total P-load reduction that is required to achieve the Lake Okeechobee phosphorus TMDL
- This analysis will address the remaining key sub-watersheds:
  - Upper Kissimmee
  - Lower Kissimmee
  - Lake Istokpoga
  - Indian Prairie
  - Taylor Creek/Nubbin Slough

Future Strategies - Projects
LOW Pre-Drainage Characterization (Cont.)

The main project deliverables will include:

- WAM Simulated Existing Conditions Characterization Report
  - WAM simulations using the updated model setup for each of the five sub-watersheds (WAM Enhancement Project)
  - Simulation data will be analyzed to determine flows and P-loads reaching Lake Okeechobee from each of the five sub-watersheds
- WAM Simulated Pre-drainage Conditions Characterization Report
  - Delineation of Pre-drainage Hydrography
  - Delineation of Pre-drainage Land Cover
  - Estimation of P-loading Associated with Unimpacted Wetlands
  - Pre-drainage WAM Setup and Simulations
- Lake Okeechobee Pre-Drainage Characterization Summary Report
  - Estimation of Planning Level Storage and P-Load Reduction Targets



Questions?