South Florida Ecological Services Office, Vero Beach, FL

Everglades

The Next Increment of Hydrologic Restoration

Lori Miller
Senior Hydrologist
April 12, 2017

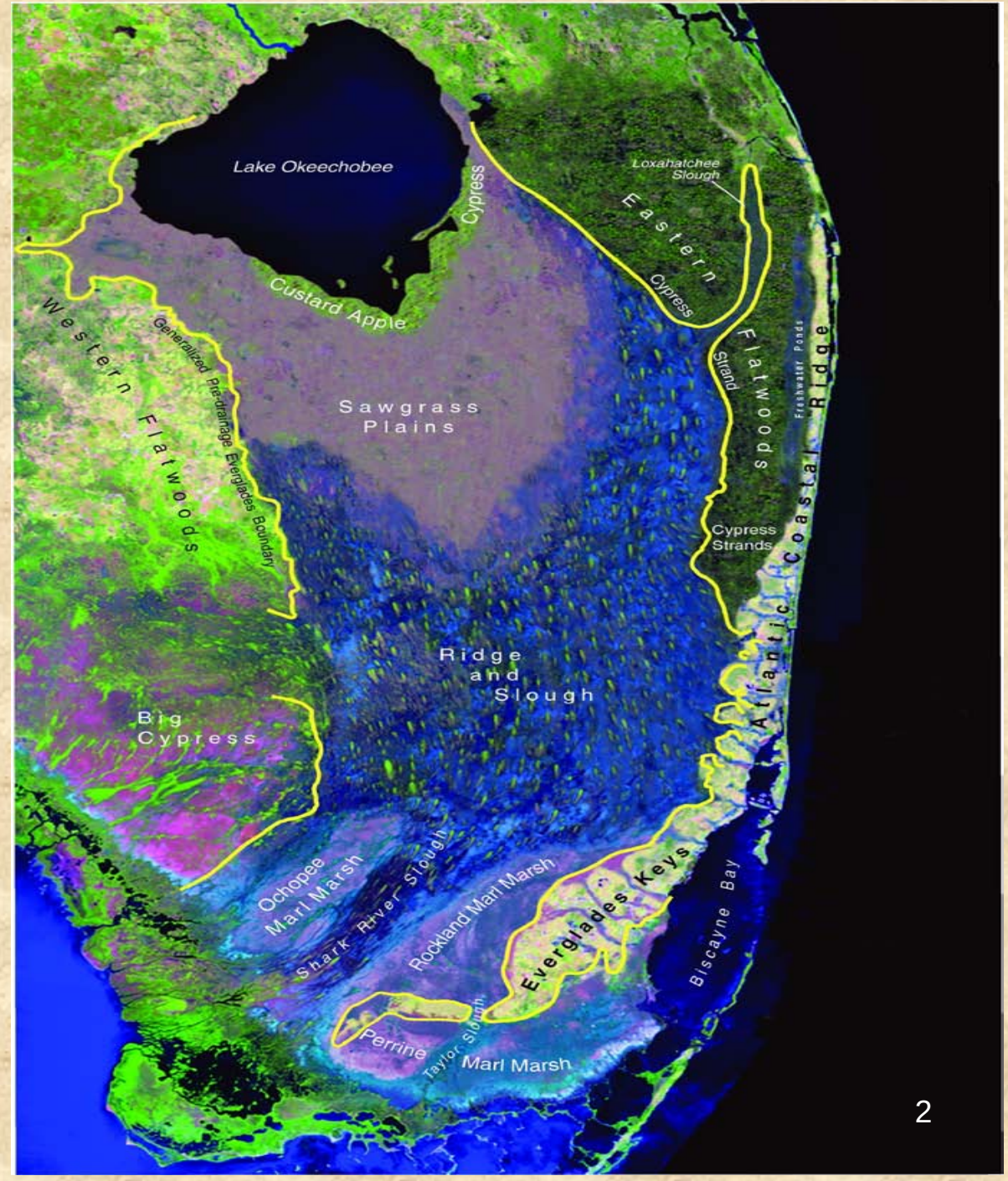
1800s – early 1900s

Lake Okeechobee

- 730 Square Miles
- Natural Reservoir for the Kissimmee Chain of Lakes

Everglades

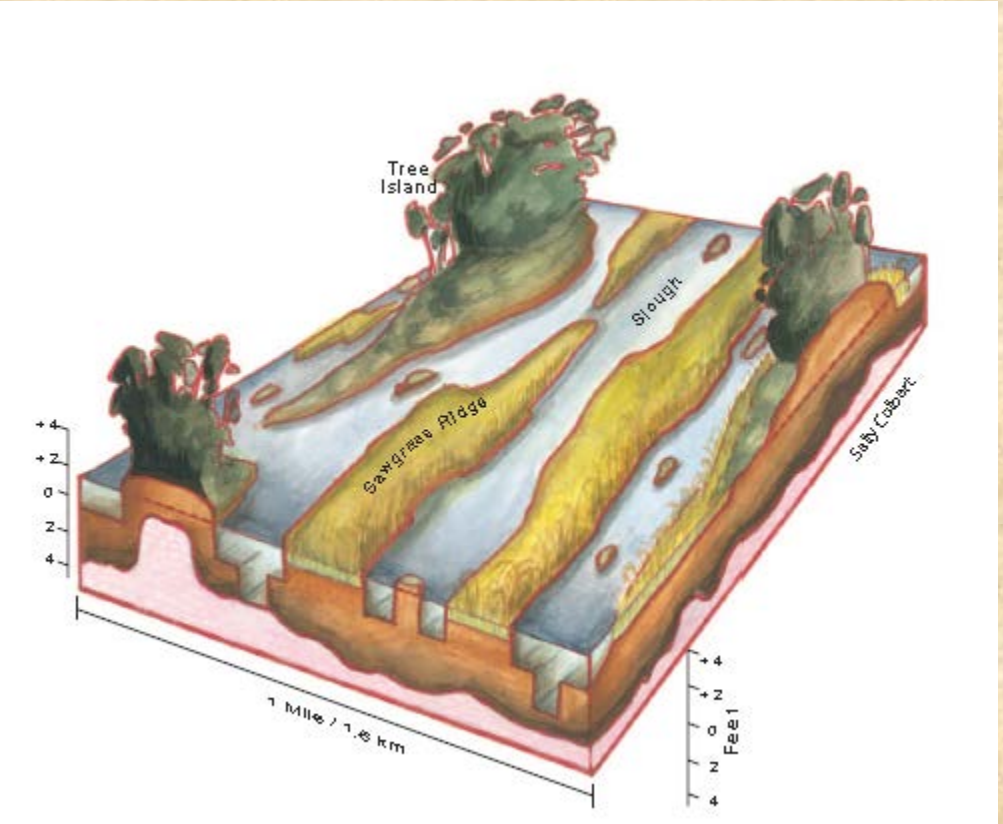
- 23 Million Acres
- Slope was 2 inches / mile
- Flows were 100 feet / day



Historic Everglades

Historic:
Tree Islands = 1-3 ft. high

Present Day:
Tree Islands = 8 inches high



Historic Everglades

1800s – 1930s: Settlers focused on drying the Everglades just south of Lake Okeechobee for agriculture using the rich muck.

Flood of 1947: 100 inches of rain from a Category 4 hurricane.

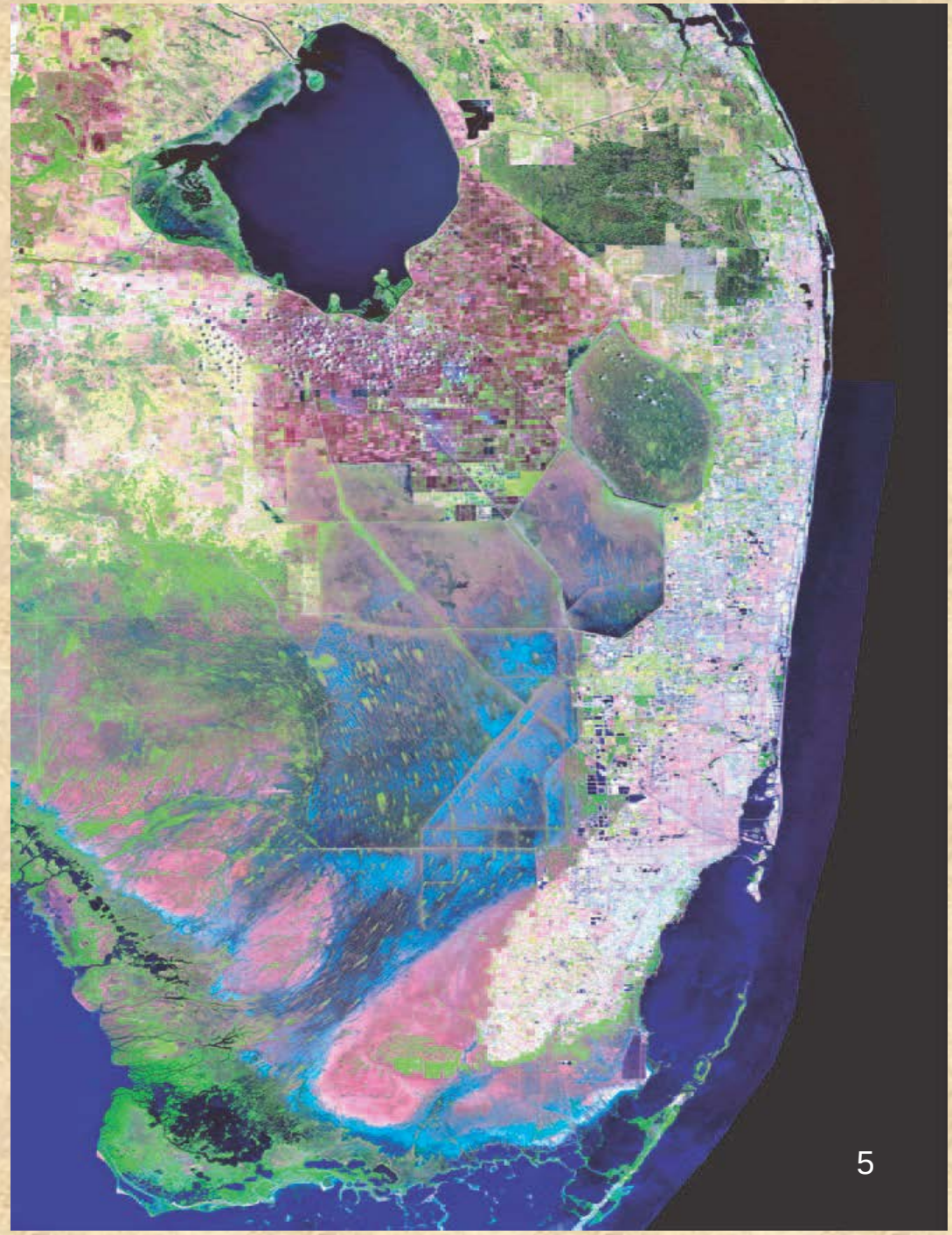
1948: The flood prompted Congress to authorize the C&SF Project for drainage and flood control.

C&SF Project (1950s-1960s)

- 720 miles of canals
- 1,000 miles of levees
- 250 water control structures

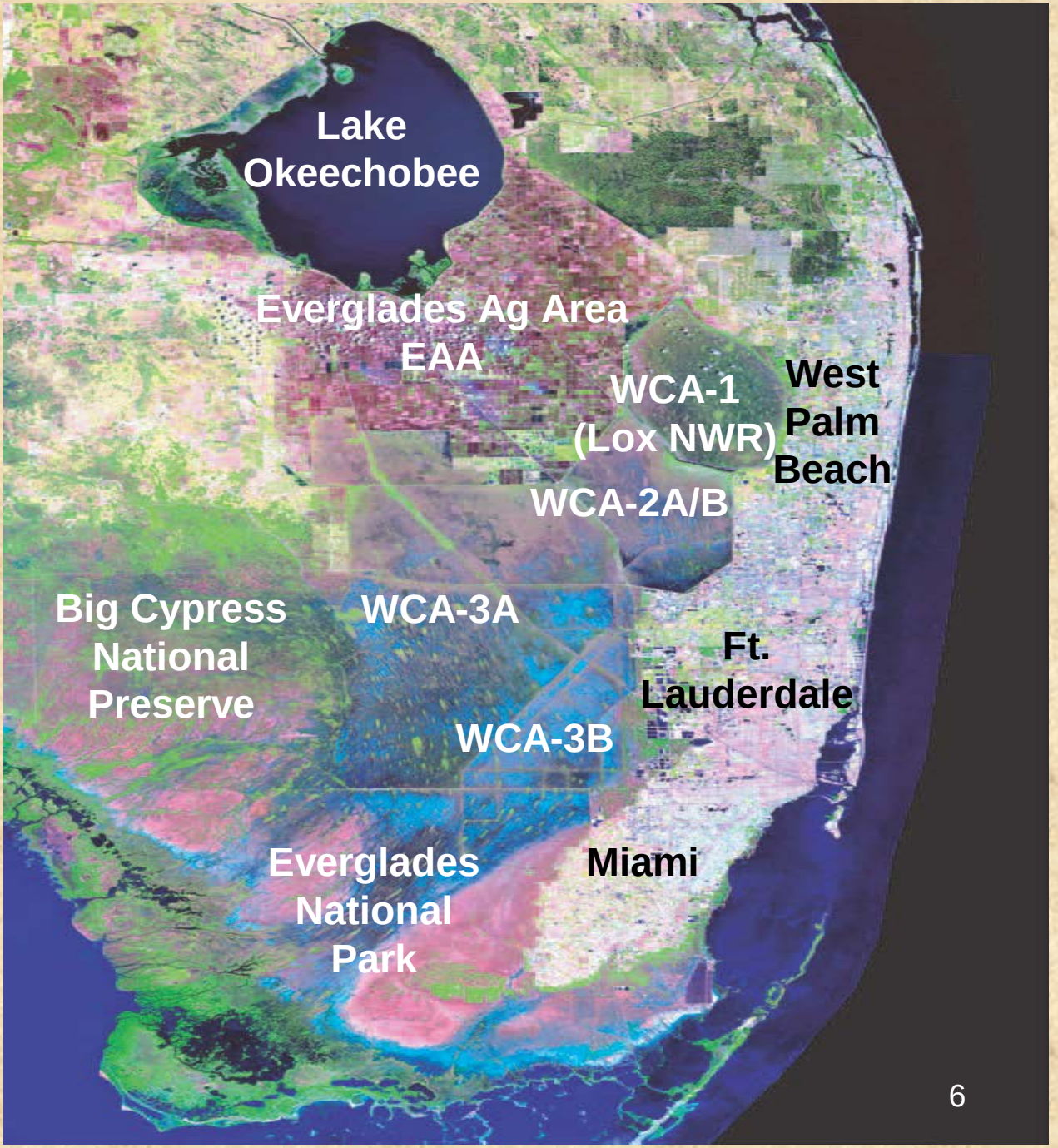
Marjorie Stoneman Douglas
Early Everglades Activist

"The Everglades: River of Grass"
Published 1947



50% of the Everglades were lost!

- Urbanization
- EAA = 1,100 sq. mi.
- WCAs = 1,350 sq. mi.



C&SF Consequences of Compartmentalization

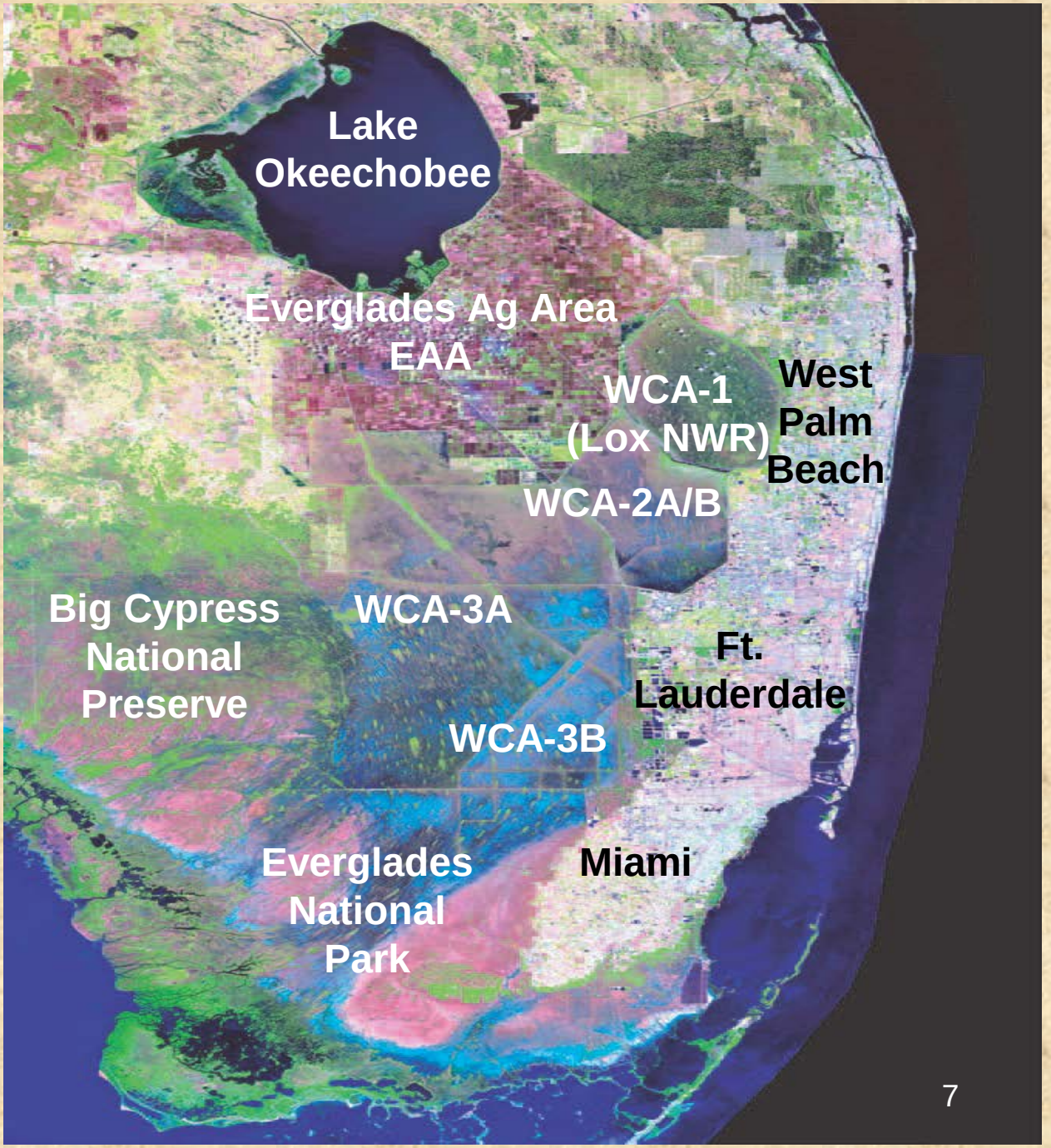
700,000 acres of wetlands were dried out

2.2 million ac-ft. of fresh water is drained off yearly

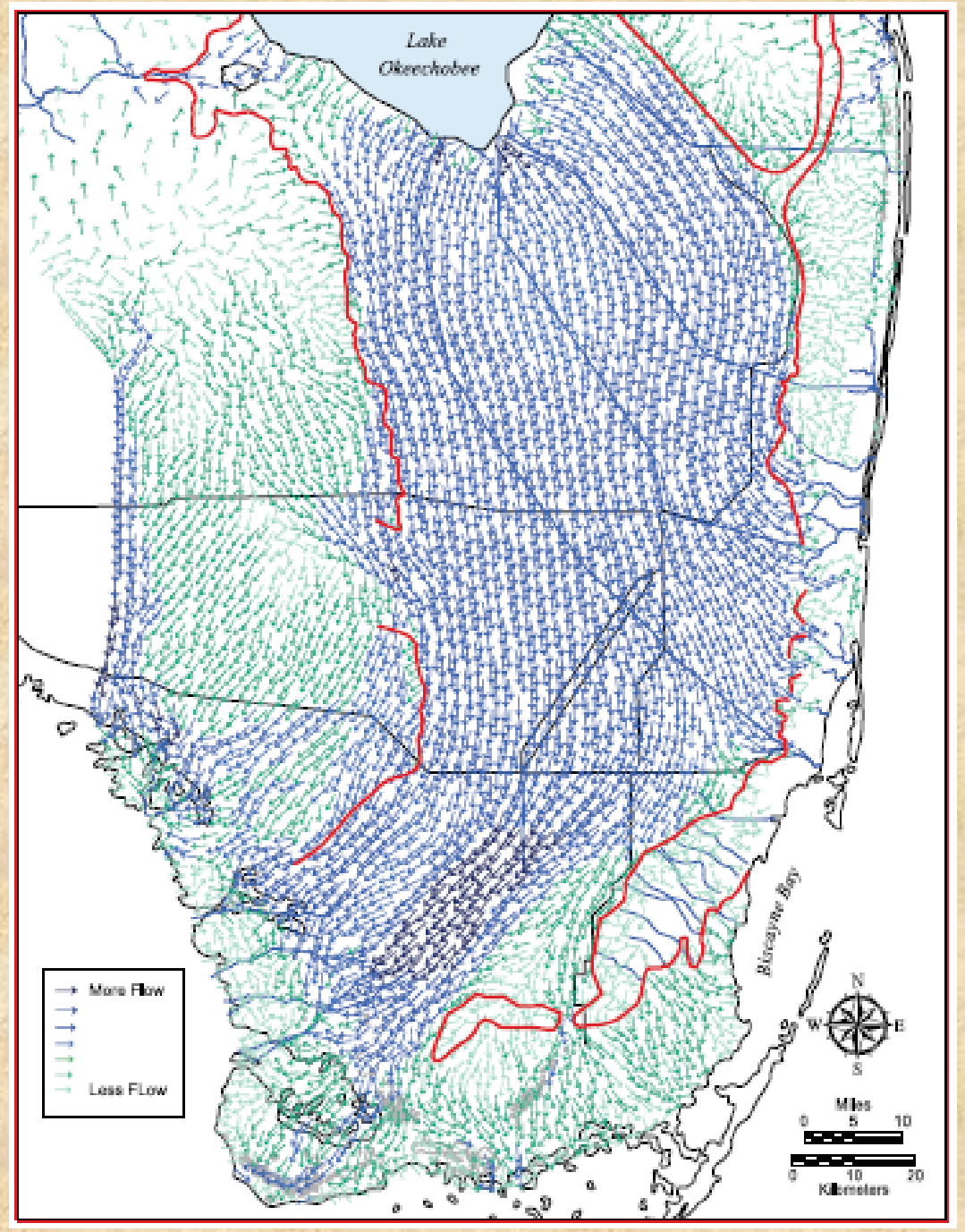
Water pollution of the estuaries

Lack of water in Everglades National Park

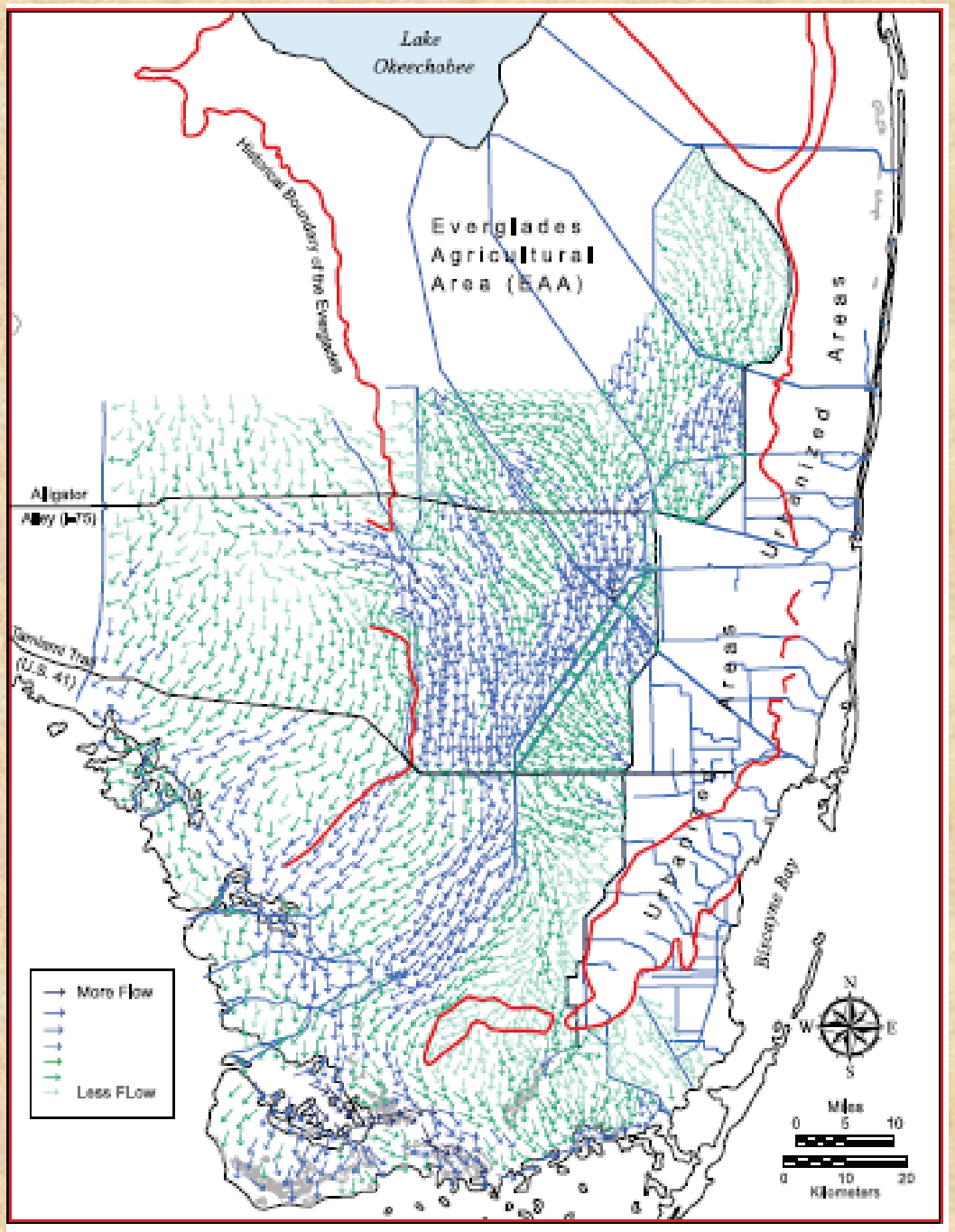
Hyper-salinity in Florida Bay



Before


Lake
Okeechobee
More Flow
Less Flow
Biscayne Bay
N
W
E
S
Miles
0 5 10
0 10 20
Kilometers

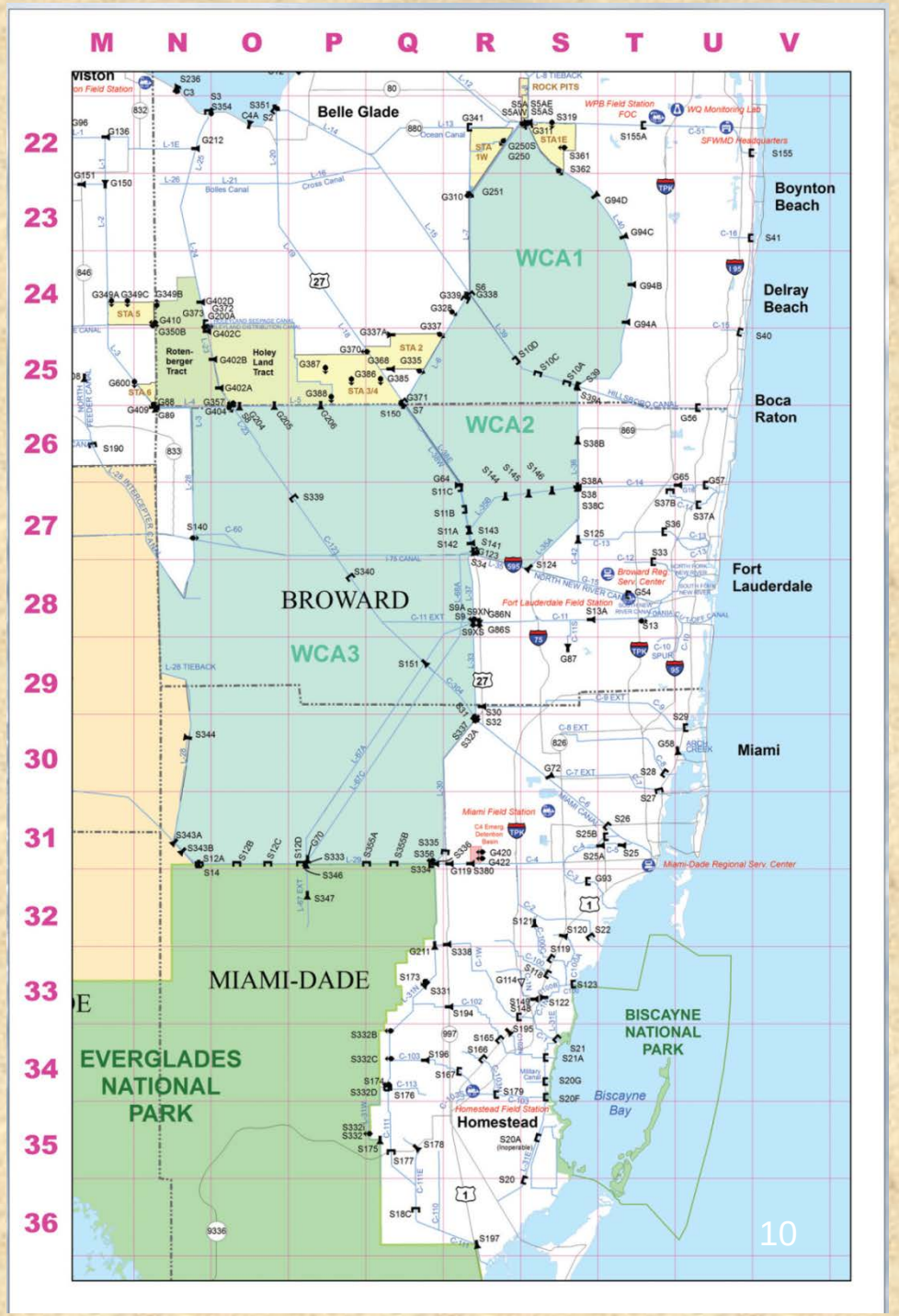
After


Lake
Okeechobee
Everglades
Agricultural
Area (EAA)
Urbanized
Areas
Alligator
Alley (I-75)
Tamiami Trail
(U.S. 41)
Biscayne Bay
More Flow
Less FLow
N
W
E
S
Miles
0 5 10
0 10 20
Kilometers

Water Control Structure Map

Just a sampling of culverts, gates and pumps!

The Myth of Command and Control!!!



C&SF System Status Update

Average Daily Conditions as of:
28 March 2016, 0000 hrs

Lake Okeechobee Stage
15.07 ft

Previous Day: 15.07 ft
One Week Ago: 15.25 ft
7-Day Trend: Falling

Structure Flows
Total Inflow: 3,120 cfs
Total Outflow: 3,090 cfs

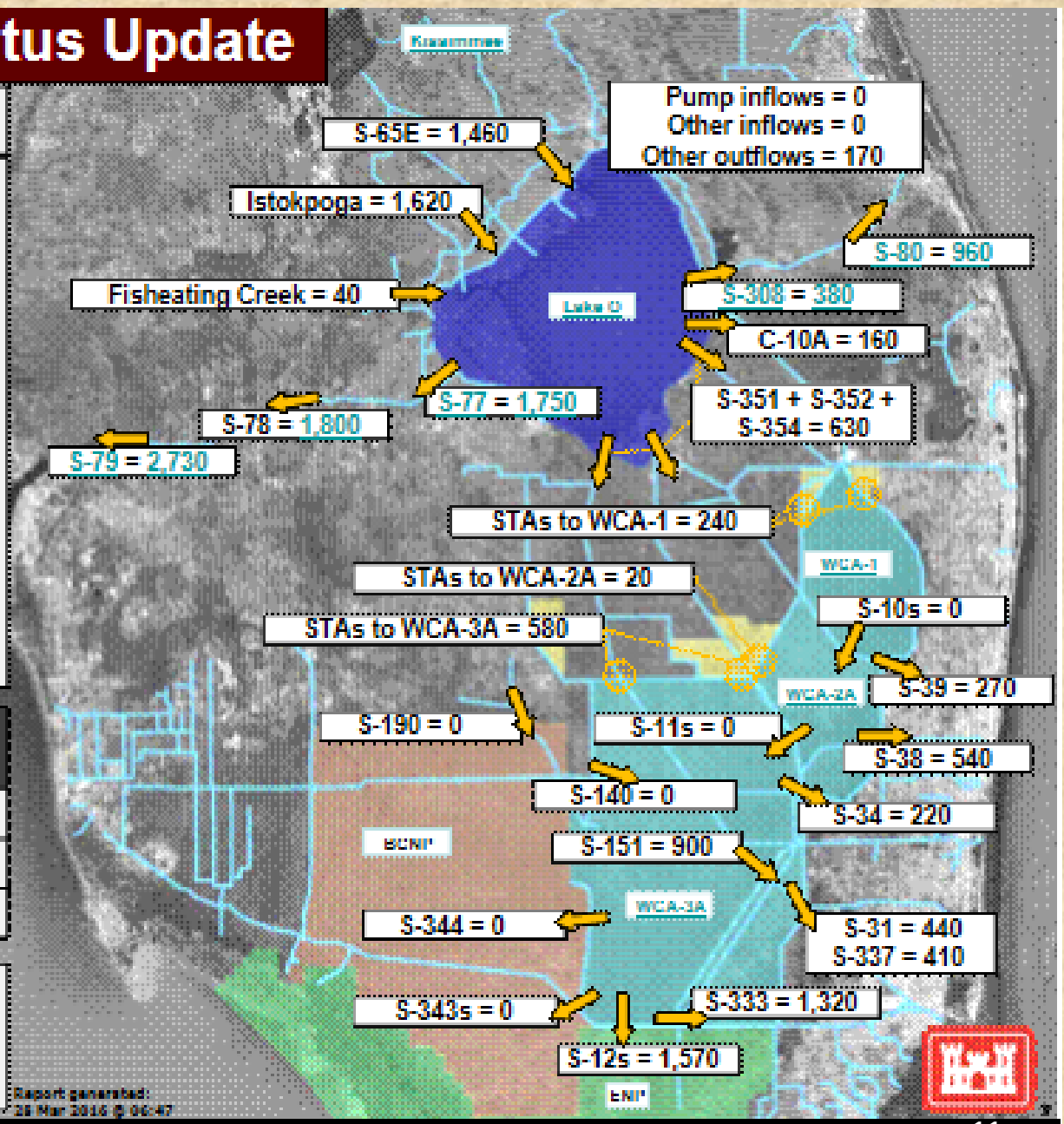
Estimated Net Gains (+)/Losses (-)
Direct Rain/ET/Others: -30 cfs

Current Average Target Outflows
S-79: 3,000 cfs
S-80: 1,170 cfs

Area	Stage	Departure from Reg.	7-Day Trend
WCA-1	16.40 ft	0.16'	Falling
WCA-2A	11.62 ft	0.62'	Rising
WCA-3A	10.79 ft	0.86'	Falling

For more detailed information please see our other reports:
http://w3.saj.usace.army.mil/h2o/reports.htm

Elevations are in feet, NGVD29. Flows are in average daily CFS. All data is provisional and subject to revision.



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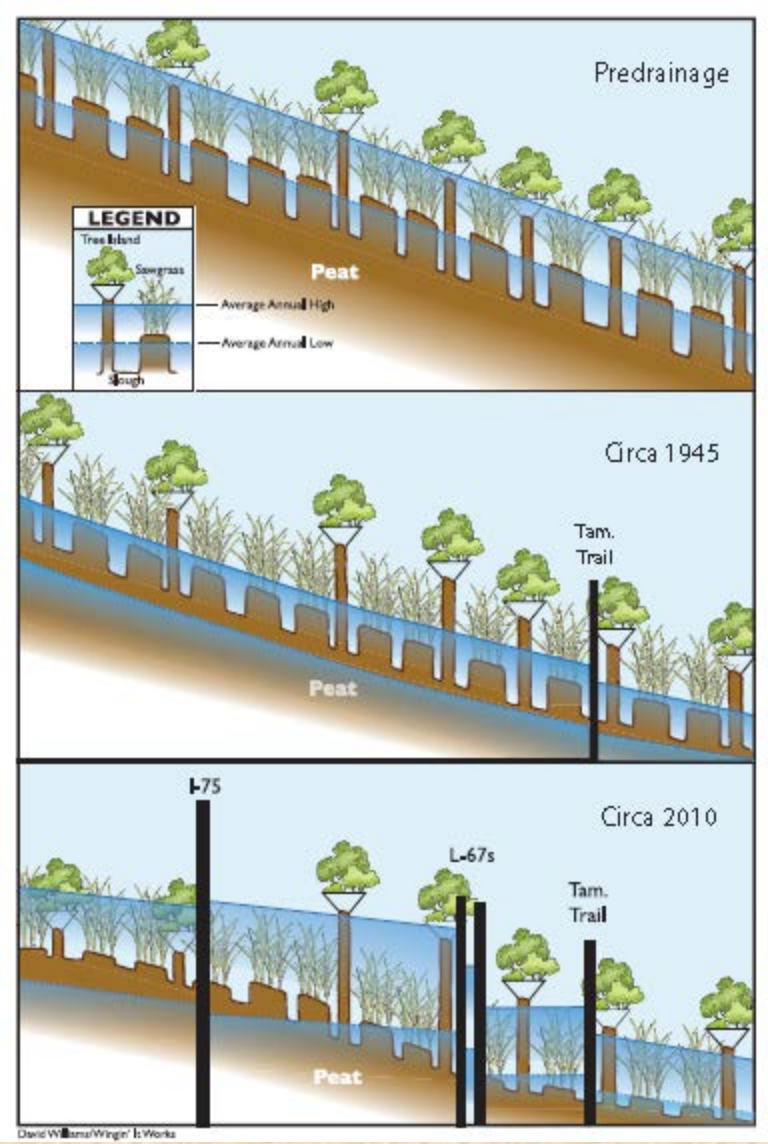
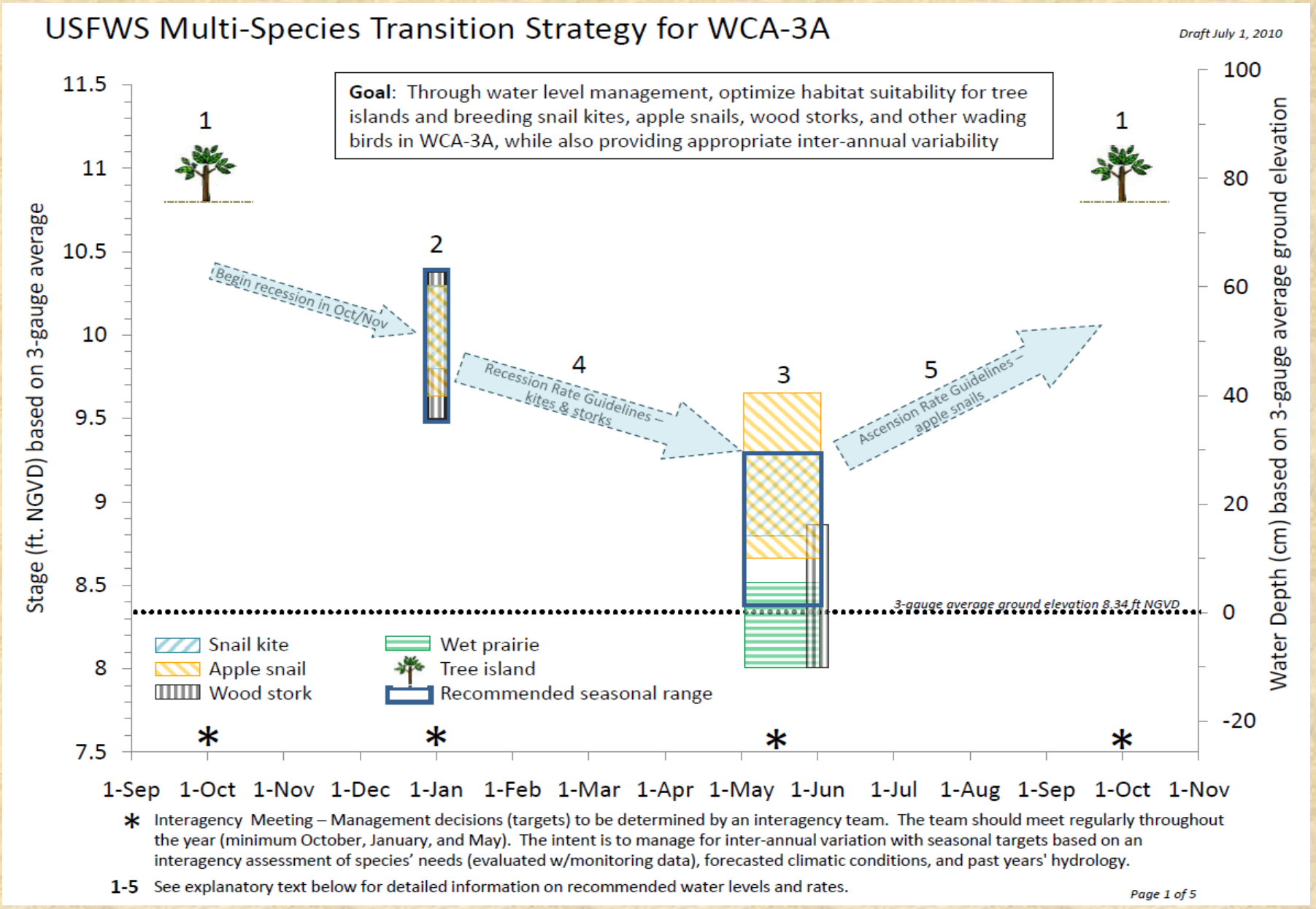
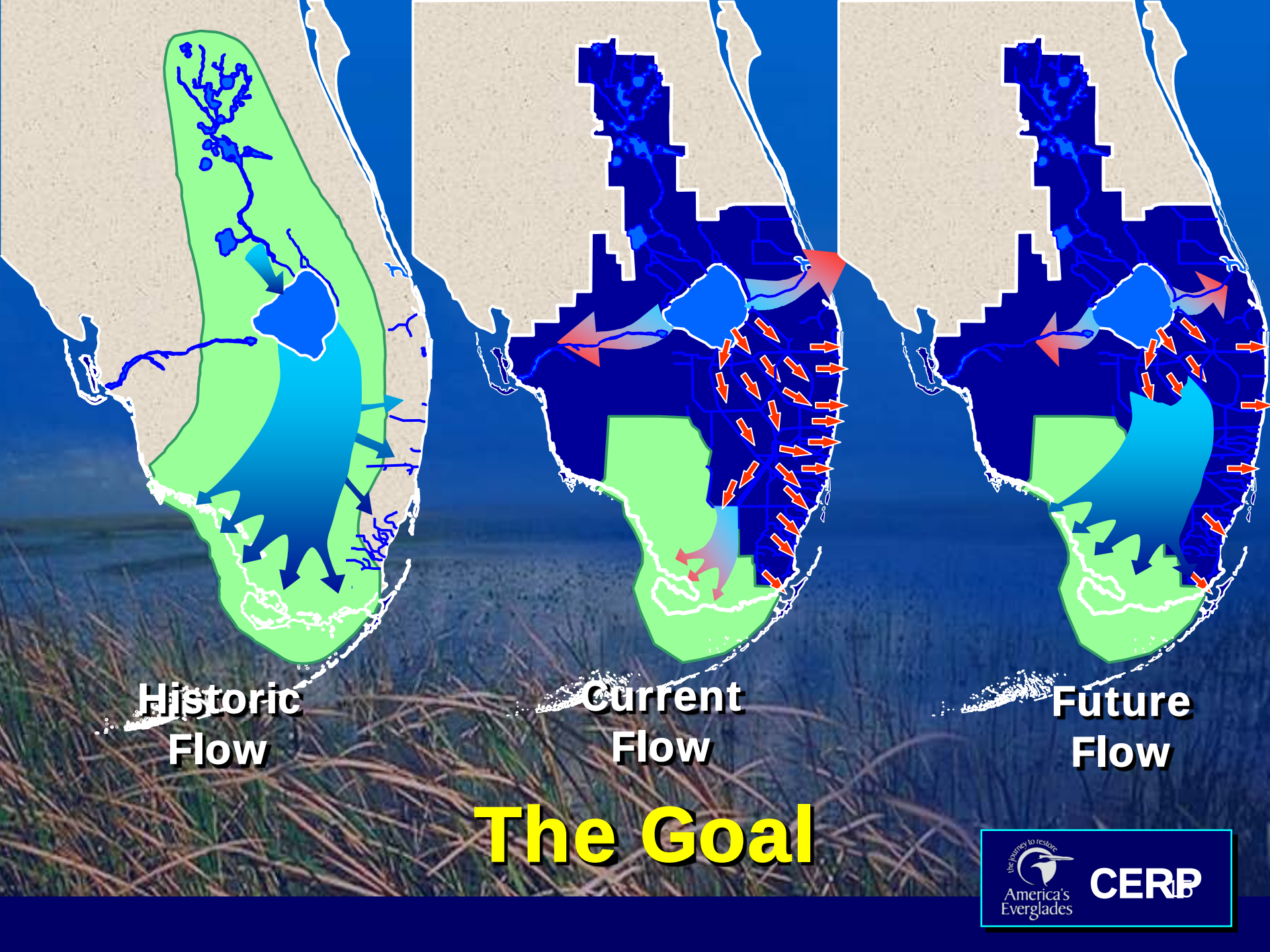


68 Threatened and Endangered Species

Multi-Species Transition Strategy




Historic Flow
Current Flow
Future Flow
The Goal
the journey to restore America's Everglades
CERP

Can someone please tell me how to store all this water in a tiny bucket?

CEPP Planning Process

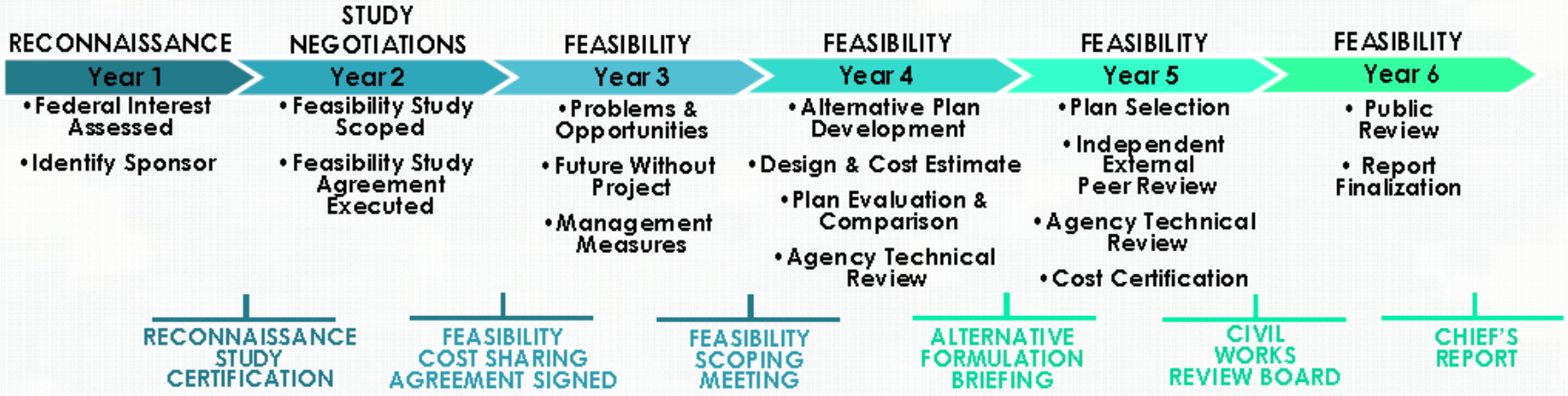
Central Everglades Planning Project 2011-2013 (CEPP)

USACE Pilot Planning Project

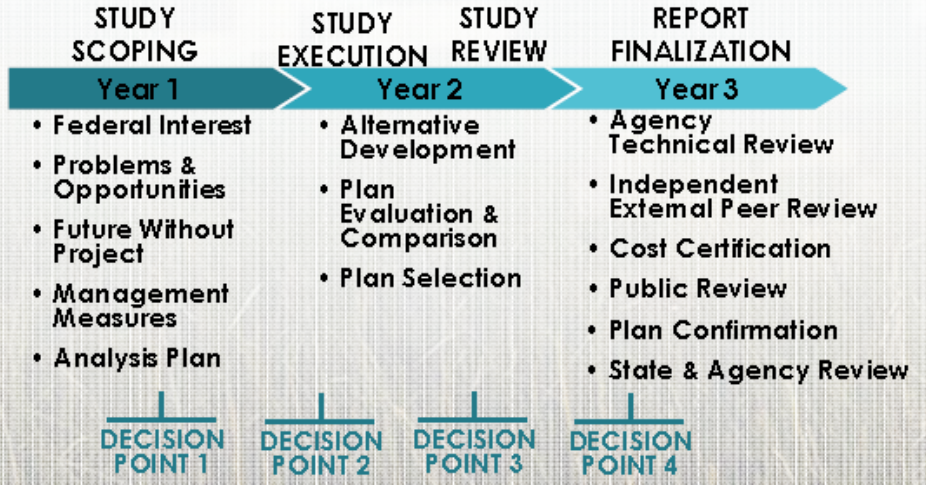
CEPP to the Rescue for a measly $3 billion!

Preauthorization Study Process

CURRENT PLANNING PROCESS: 6+ YEARS (approximate timeframes)

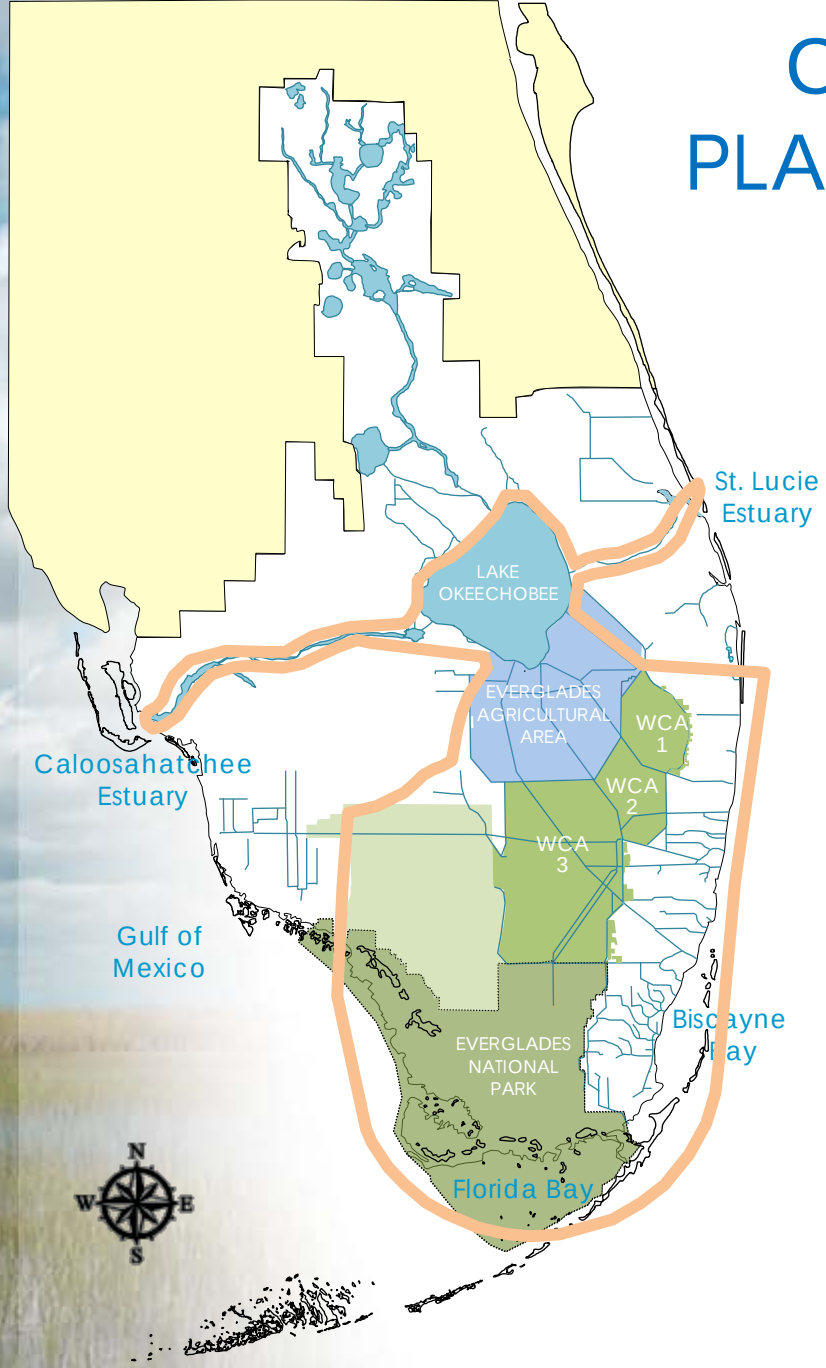


REVISED PLANNNING PROCESS: 2+ YEAR (approximate timeframes)



The revised process consolidates key decisions into the early part of the study process, allowing for more clear scoping and focused attention on relevant details. It integrates early decision making with more flexible analysis and emphasizes focused risk management strategies.

CENTRAL EVERGLADES PLANNING PROJECT (CEPP) PROPOSES TO:



- Move water south from Lake Okeechobee through Everglades Agricultural Area (EAA)
- Improve benefits to the east and west coast estuaries
- Store and treat flows in facilities within the EAA
- Send treated water south to improve conditions within Water Conservation Area 3A and 3B (WCA 3) and Everglades National Park and Florida Bay

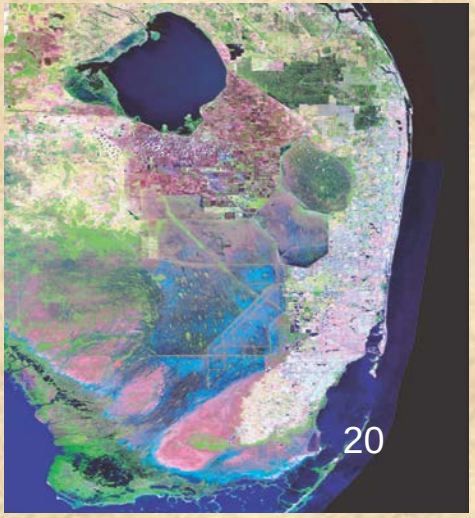
CEPP Models Used

Tier 1 – Screening

- ✓ Natural Systems Model (2011) - NSM-50 model is for historic conditions with 50% of historic flows.
- ✓ iModel (2011) – Inverse screening model where you input targets and let the model tell you how to operate the structures.
- ✓ Ecological Screening Models for landscape and species impacts.

Tier 2 – Alternative Plans

- ✓ Regional Simulation Model (2012) – The RSM produces the array of alternative plans for selecting the final plan.
- ✓ Savings Clause refinements for Water Supply (2013)



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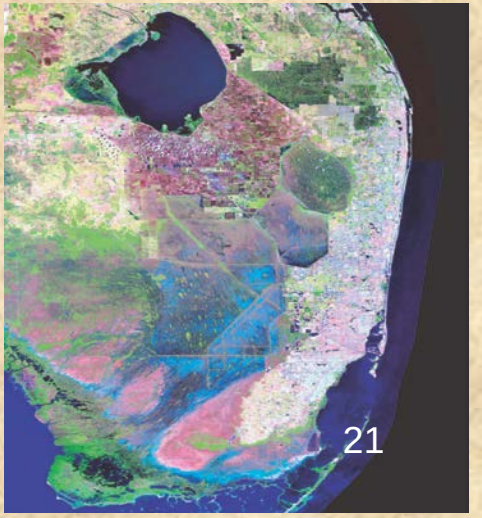
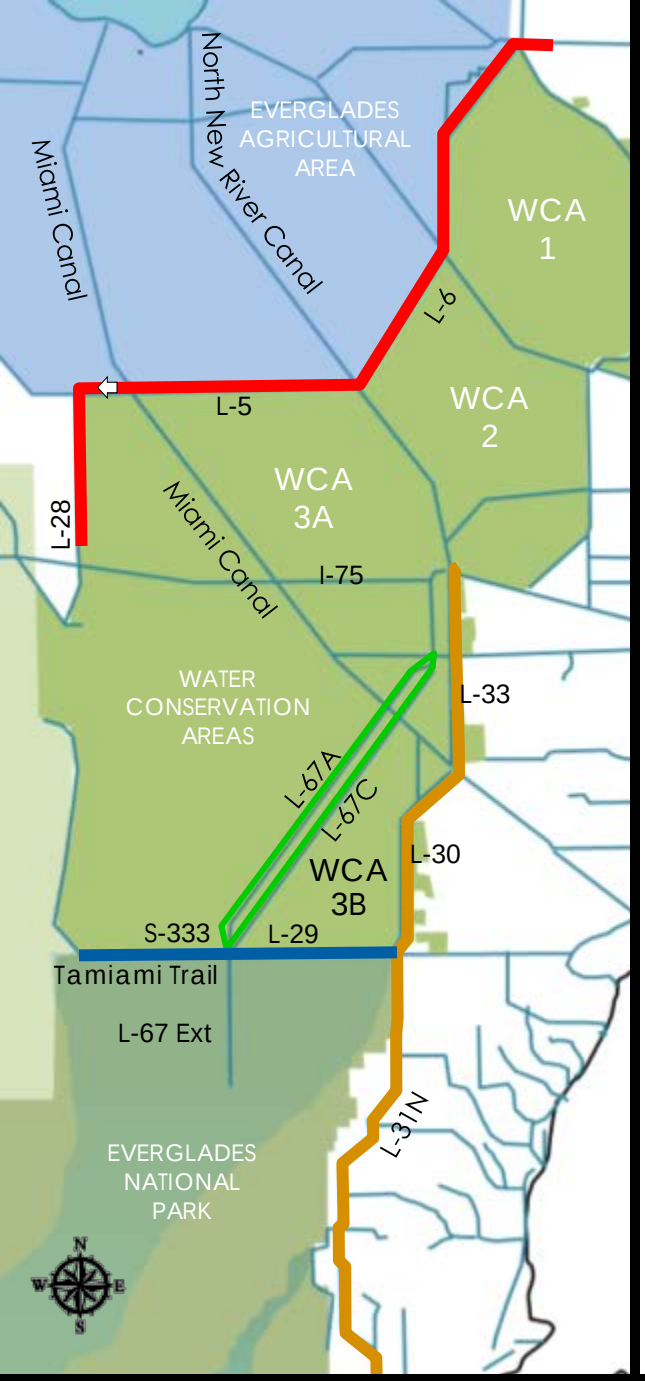




SCREENING COMPLETED

within considerations and constraints

North of the Redline

- Combination of features to **increase water deliveries** downstream and improve estuarine benefits

South of the Redline

- Features and their locations to best **restore sheetflow** in northern Water Conservation Area 3A

Greenline/Blueline

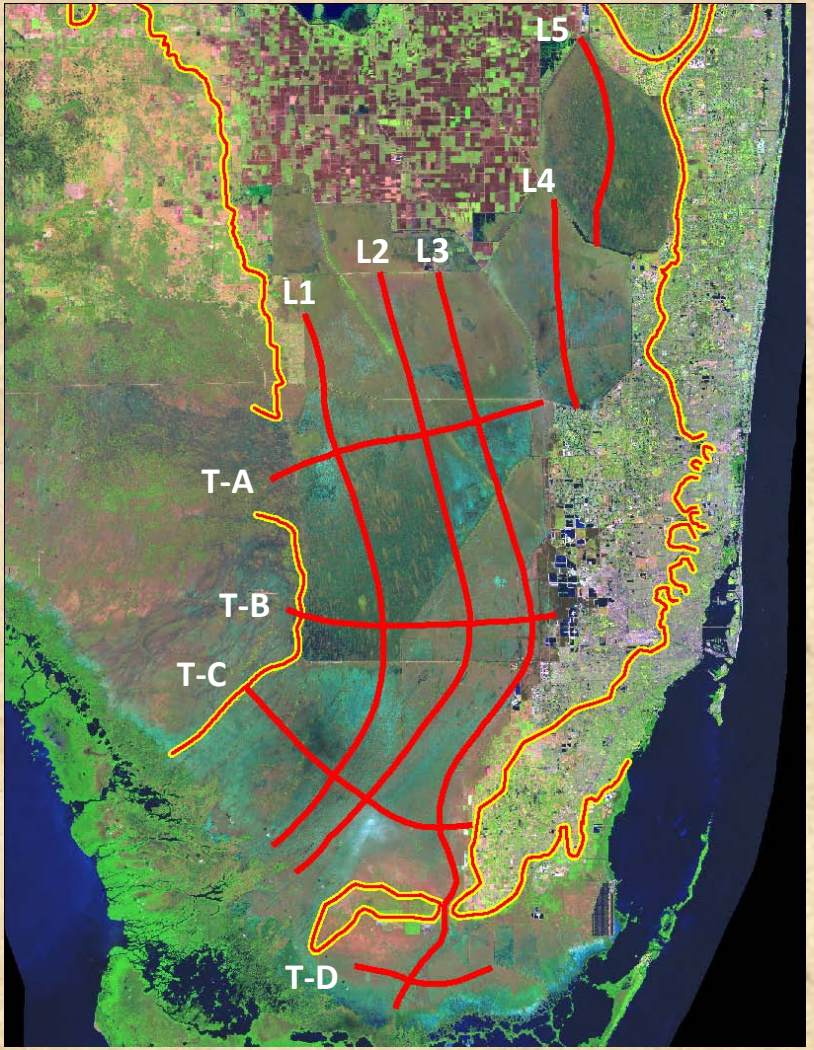
- Features to best **restore sheetflow** through southern WCA-3A and 3B
- Configuration of conveyance features to best **restore flows** to Everglades National Park

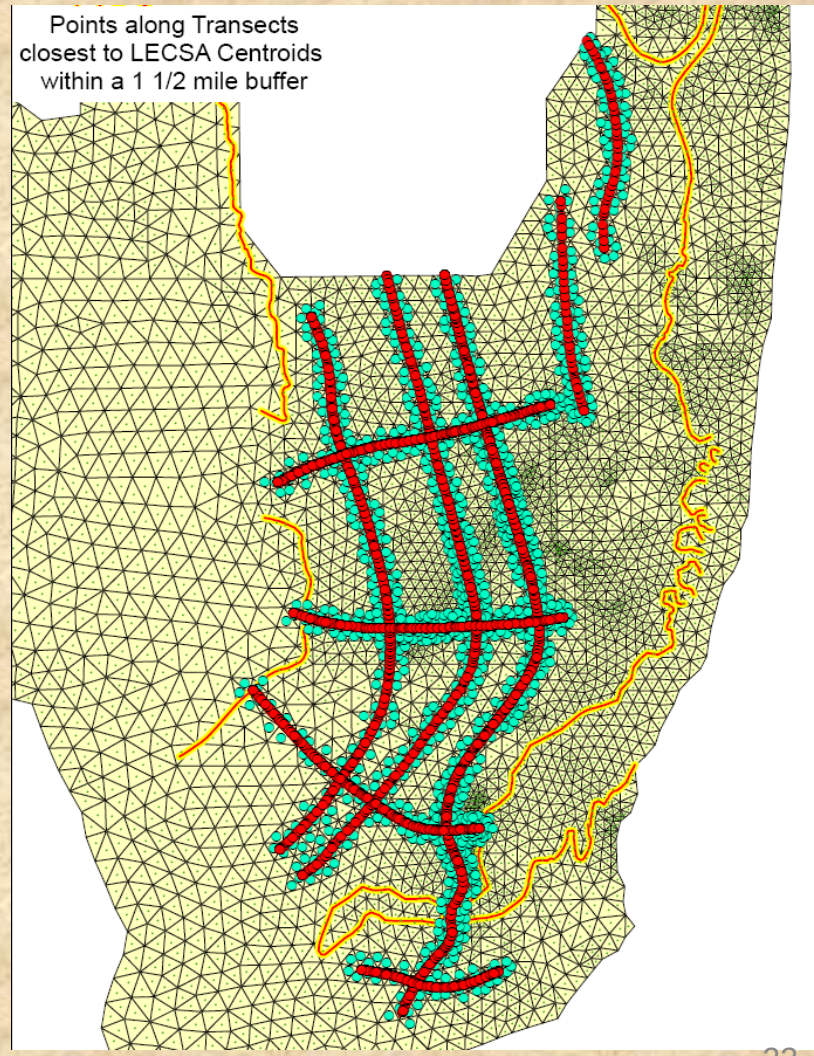
Yellowline

- Features to best compliment rest of project and **manage seepage** to the eastern urban area without impacting the water supply

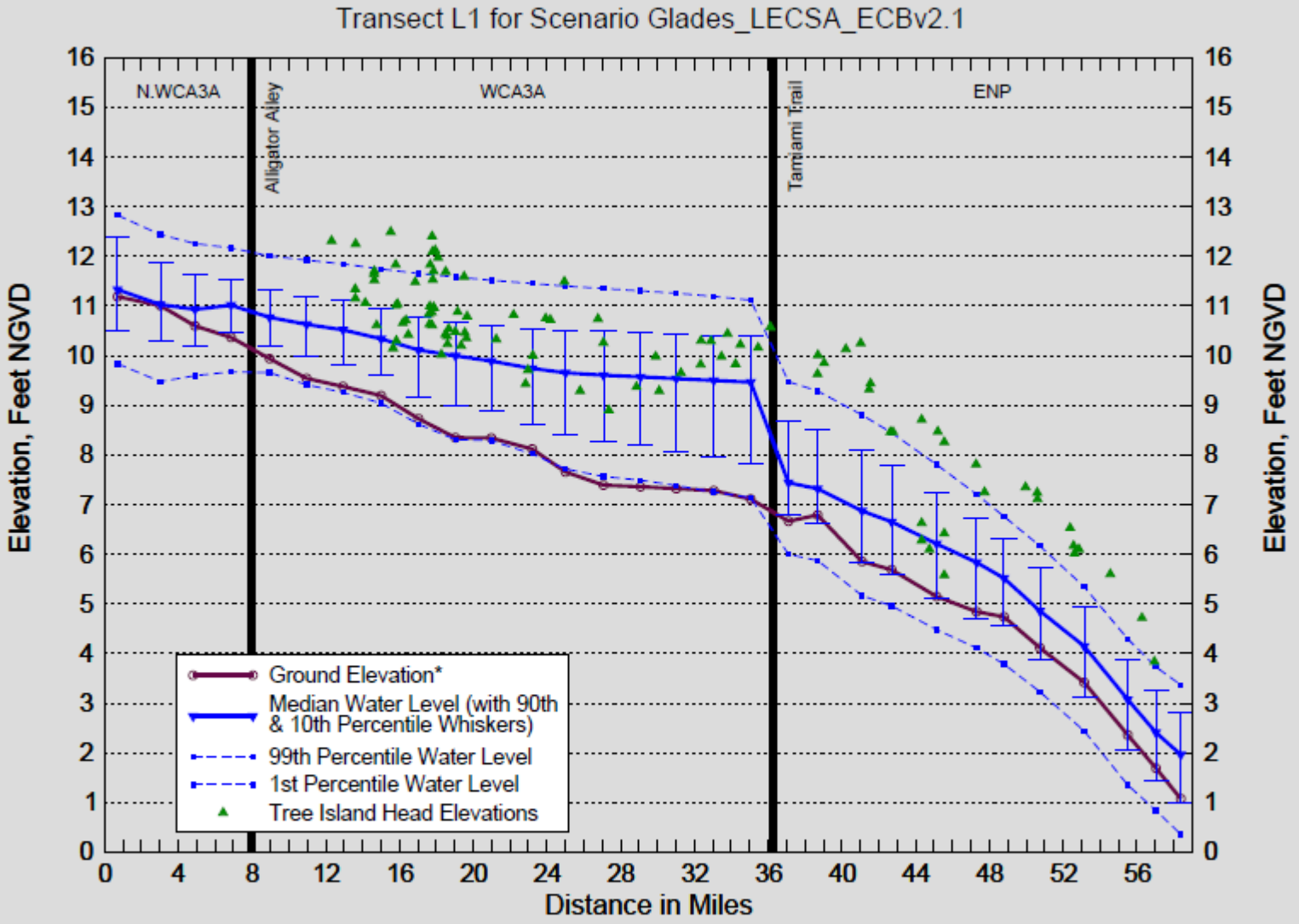
Everglades Viewing Window Transects

Aligned with Landscape Directionality





Water Depth Viewing Window



* Within the ridge & slough landscape, ground elevation = slough bottom.
For other landscapes, ground elevation = average model ground surface.

P.O.S. = 01-01-1965 to 12-31-2000
Script used: depth_transects.scr
Filename: depth_transects_L1_Glades_LECSA_ECBv2.1.agr

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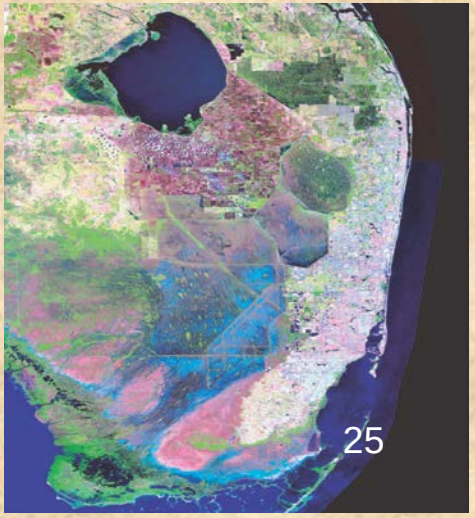
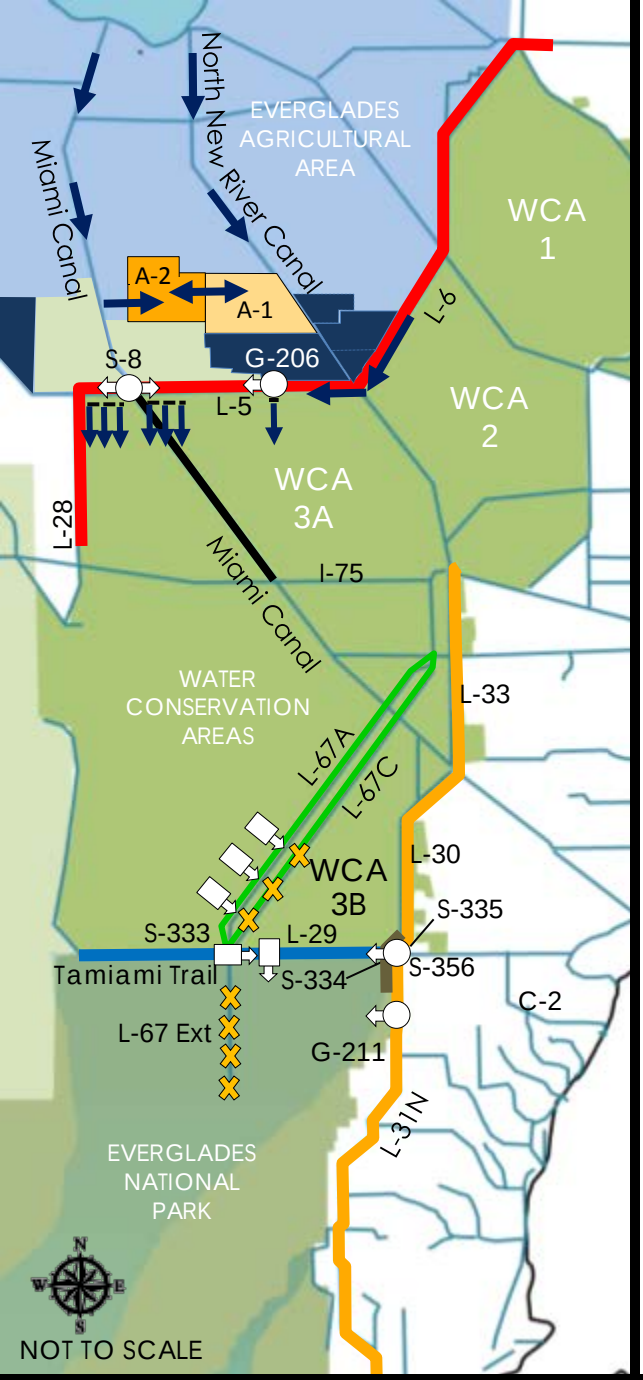




PROPOSED ALTERNATIVE 2

STORAGE AND TREATMENT

- Construct A-2 FEB and integrate with A-1 FEB operations
- Lake Okeechobee operation refinements within LORS

DISTRIBUTION/CONVEYANCE

- Diversion of L-6 flows and L-5 canal improvements
- Spreader canal: ~3 miles west of S-8 (3,000 cfs), ~3 miles east of S-8 (800 cfs) and ~1.5 miles east of G-206 (400 cfs)
- Backfill Miami Canal from S-8 to I-75

DISTRIBUTION/CONVEYANCE

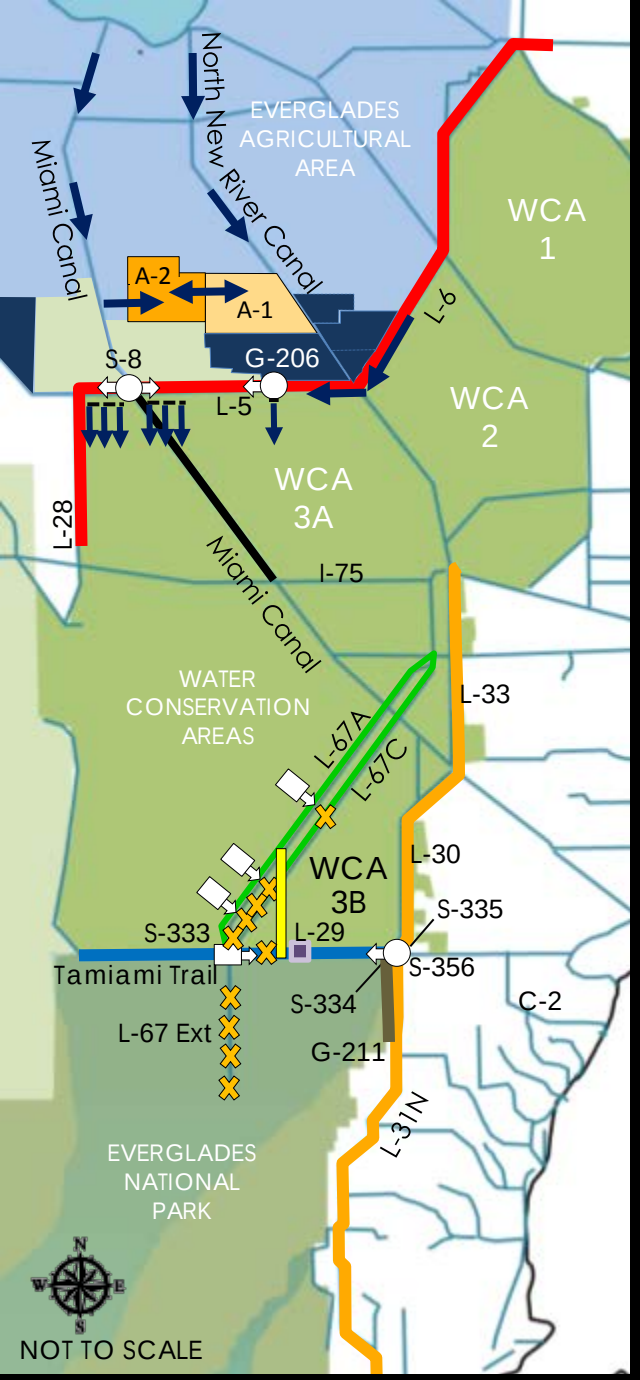
- Increase S-333 capacity to 3,000 cfs
- One 750 cfs and two 500 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A north and south of structures
- 6,000-ft gaps in L-67C levee at each structure
- One additional 500 cfs gravity structure out of WCA-3B
- Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft. (FUTURE WORK BY OTHERS)
- Degrade entire L-67 extension levee

SEEPAGE MANAGEMENT

- Increase S-356 to 1,000 cfs
- Full depth penetrating seepage barrier from S-335 to S-334
- Partial depth seepage barrier south of Tamiami Trail 2 miles along L-31N
- One 250 cfs pump on L-31N into ENP
- G-211 operational refinements; use coastal canals to convey seepage

FEB | STA | Pump | Spreader Canal | Backfill | Levee Removal | Gated Structure | Seepage Barrier

PROPOSED ALTERNATIVE 4



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- Backfill Miami Canal from S-8 to I-75

DISTRIBUTION/CONVEYANCE

- Increase S-333 capacity to 3,000 cfs
- Two 500 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A north and south of structures
- Include levee in WCA 3B
- Degrade L-67C levee in Blue Shanty flow-way
- One 500 cfs gated structure north of Blue Shanty levee and 6,000-ft gap in L-67C levee
- Degrade L-29 levee in Blue Shanty flow-way, divide structure east of Blue Shanty levee at terminus of western bridge
- Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft. (FUTURE WORK BY OTHERS)
- Degrade entire L-67 extension levee

SEEPAGE MANAGEMENT

- Increase S-356 to 1,000 cfs
- Partial depth seepage barrier south of Tamiami Trail 5 miles along L-31N
- G-211 operational refinements; use coastal canals to convey seepage

FEB | STA | Pump | Spreader Canal | Backfill | Levee Removal | Gated Structure | Seepage Barrier | Divide | Levee

Current Status of CEPP:

- March 31, 2016 – Report to Congress
- December 9, 2016 - Authorization from Congress under the Water Infrastructure Improvements for the Nation Act, signed December 16, 2016.
- Awaiting Appropriations – WRDA Revision 2016

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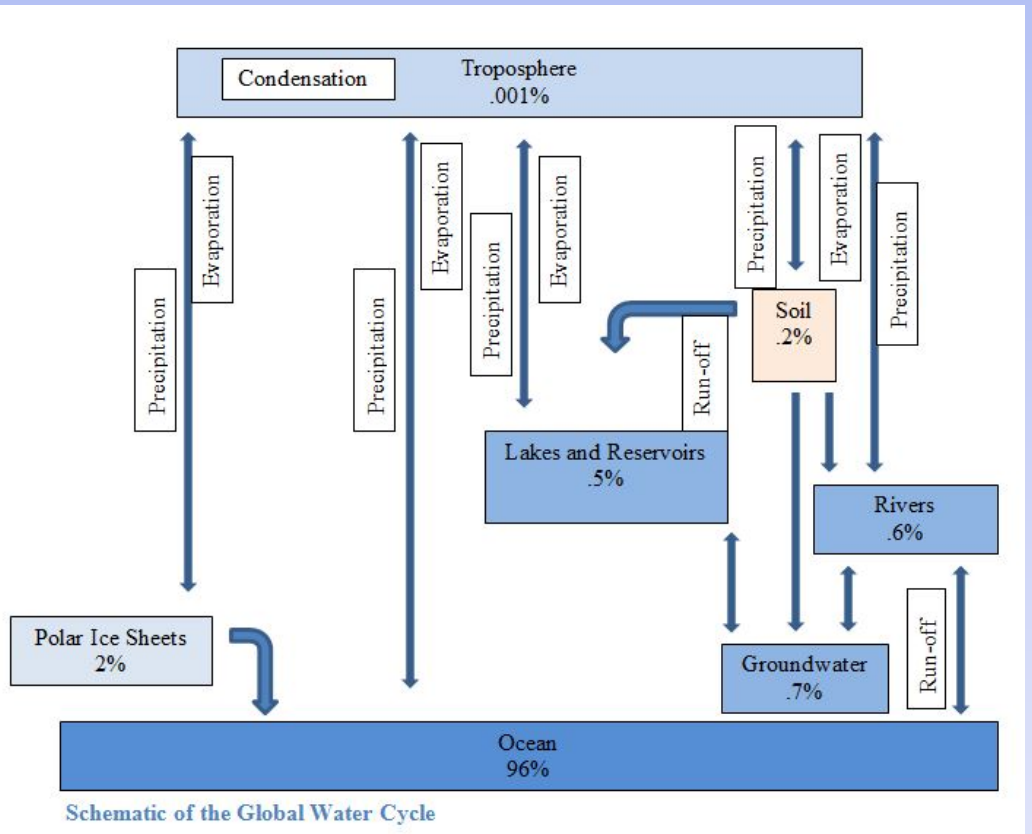
Earth System Box Model
For
Climate Change and the Everglades

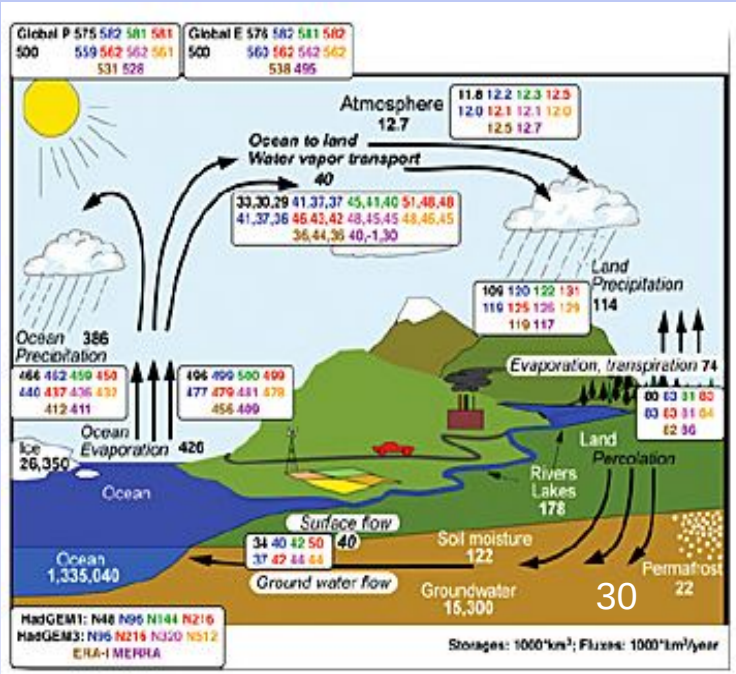
Developed December 13, 2016

Earth System Box Model

Primary Physical Processes



Schematic of the Global Water Cycle



Earth System Box Model
Incorporating Ocean Circulations

Parameters

Parameter	Description	Unit	Value
λ^1	Climate sensitivity	$W^{-1}\ m^2\ K^{-1}$	0.68
C_p^2	Heat capacity of ocean water	$J\ kg^{-1}\ K^{-1}$	3985
ρ^3	Density of sea water	$kg\ m^{-3}$	1082
V_{oc}^4	Volume of Ocean	m^3	$1.33 * 10^{18}$
v_d^5	Deepwater formation	$m^3\ s^{-1}$	6.5×10^7
A^4	Surface of the Earth	m^2	$5.1*10^{14}$

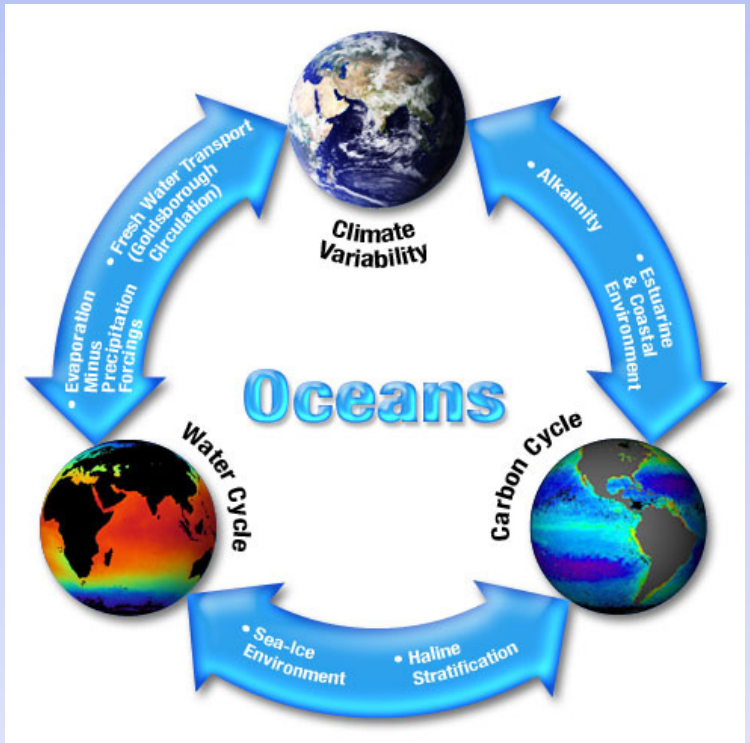
Earth System Box Model
Incorporating Land Carbon Cycle

Parameters

NPP0	55 PgC yr-1	(Gerber, 2014)
k0	0.033 yr-1	(Gerber, 2014)
Beta factor	0.6	(Norby et al., 2005)
Q10	2	
Climate sensitivity	2.5 K per doubling of CO2	(IPCC AR5)
CO2 (1850)	280 ppm	(Etheridge et al., 1998)
CO2 (2100)	700 ppm	(~Mid-range IPCC scenario, IPCC AR5)

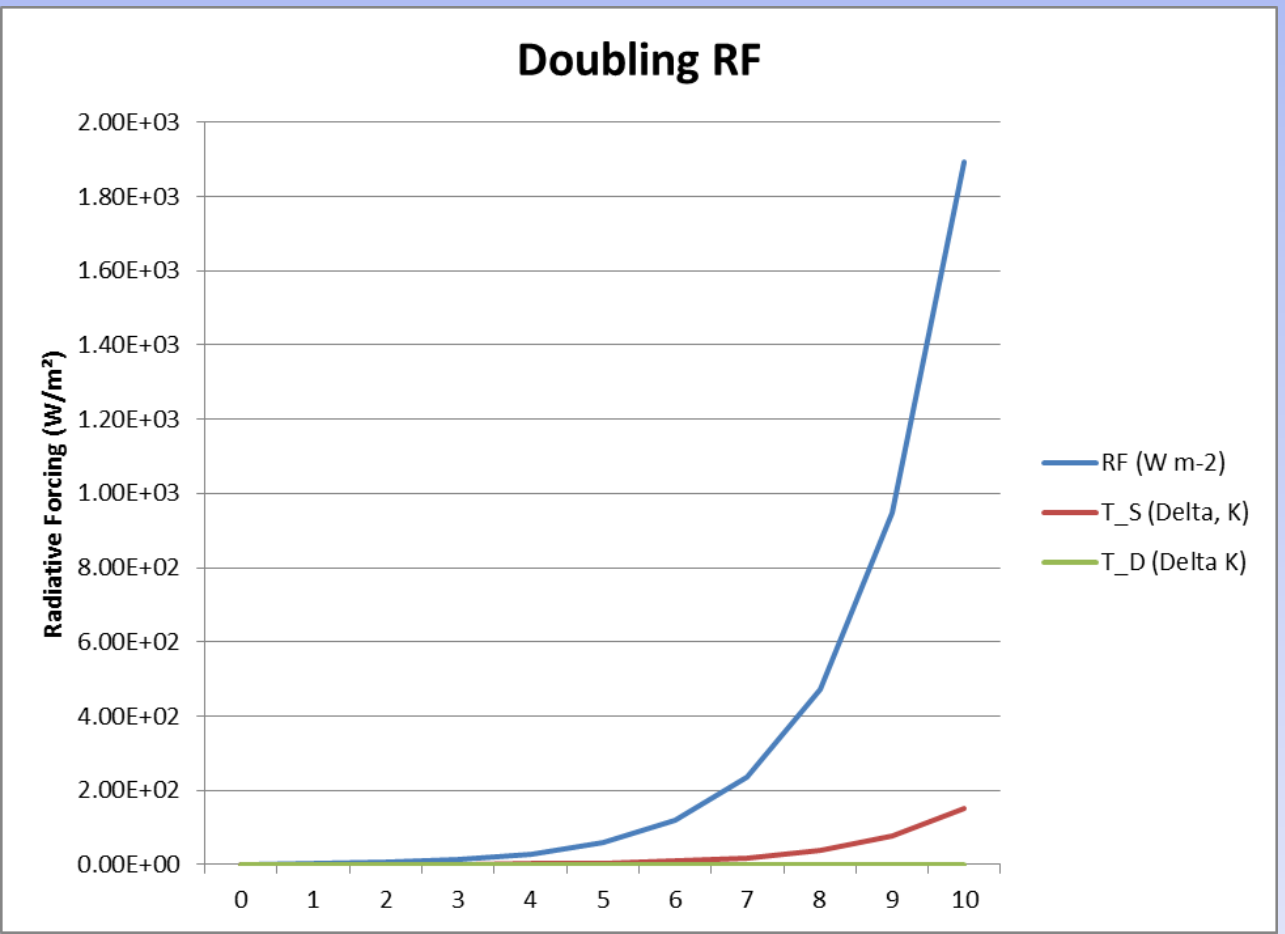
Earth System Box Model

Lag in Climate Warming in Response to Radiative Forcing



Earth System Box Model

Inducing a step change in radiative forcing:

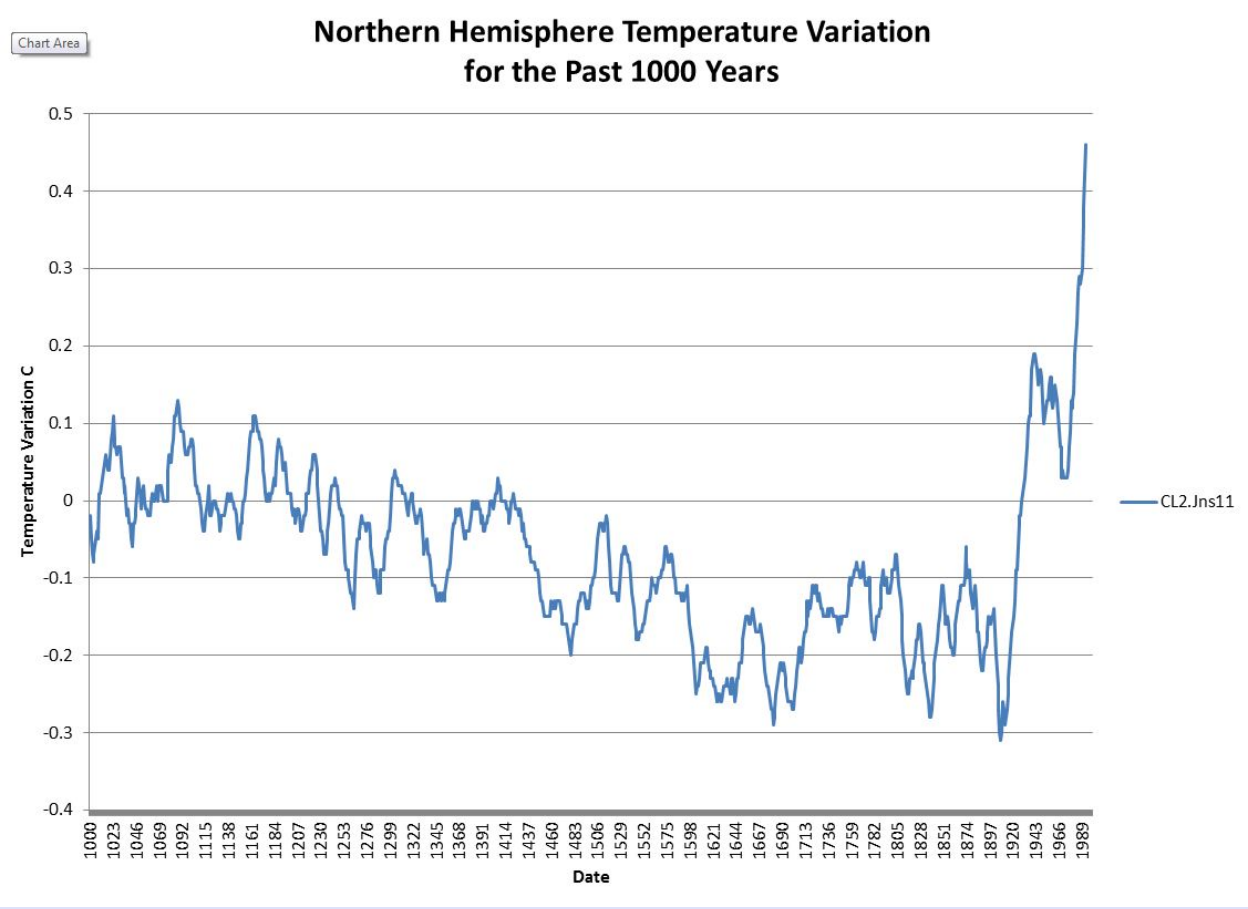


There is a warming trend in surface temperatures with the doubling of the radiative forcing.

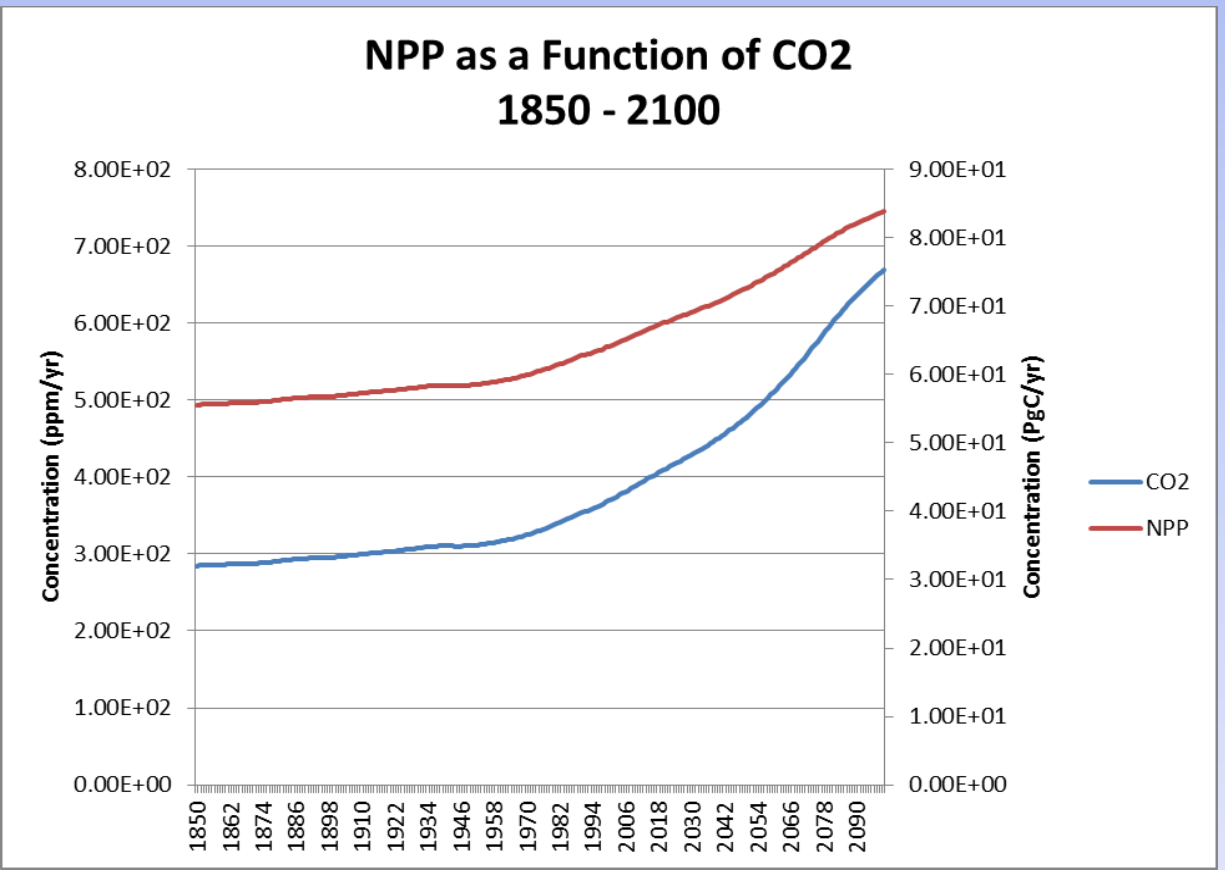
This temperature trend shows a lag in increases to the radiative forcing. The temperature of the deep ocean shows little effect.

Earth System Box Model

Temperature Variations for the last 1000 years:

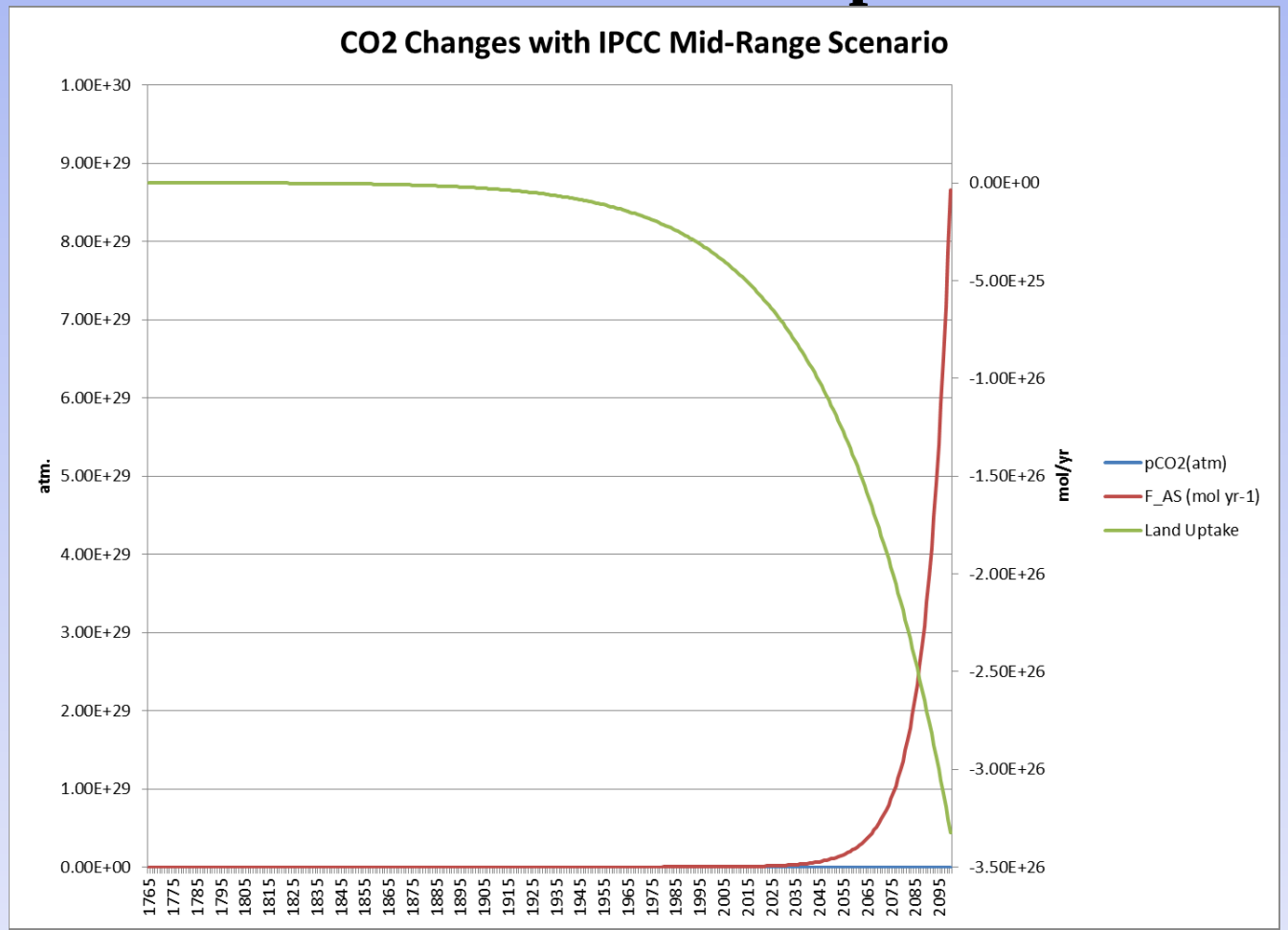


Earth System Box Model
NPP as a Function of CO_2



$$NPP = NPP_0 [1+ß\ln(CO_2/CO_{20})]$$

Earth System Box Model
Land and Ocean Uptake



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Earth System Box Model

The Greater Everglades

Earth System Box Model

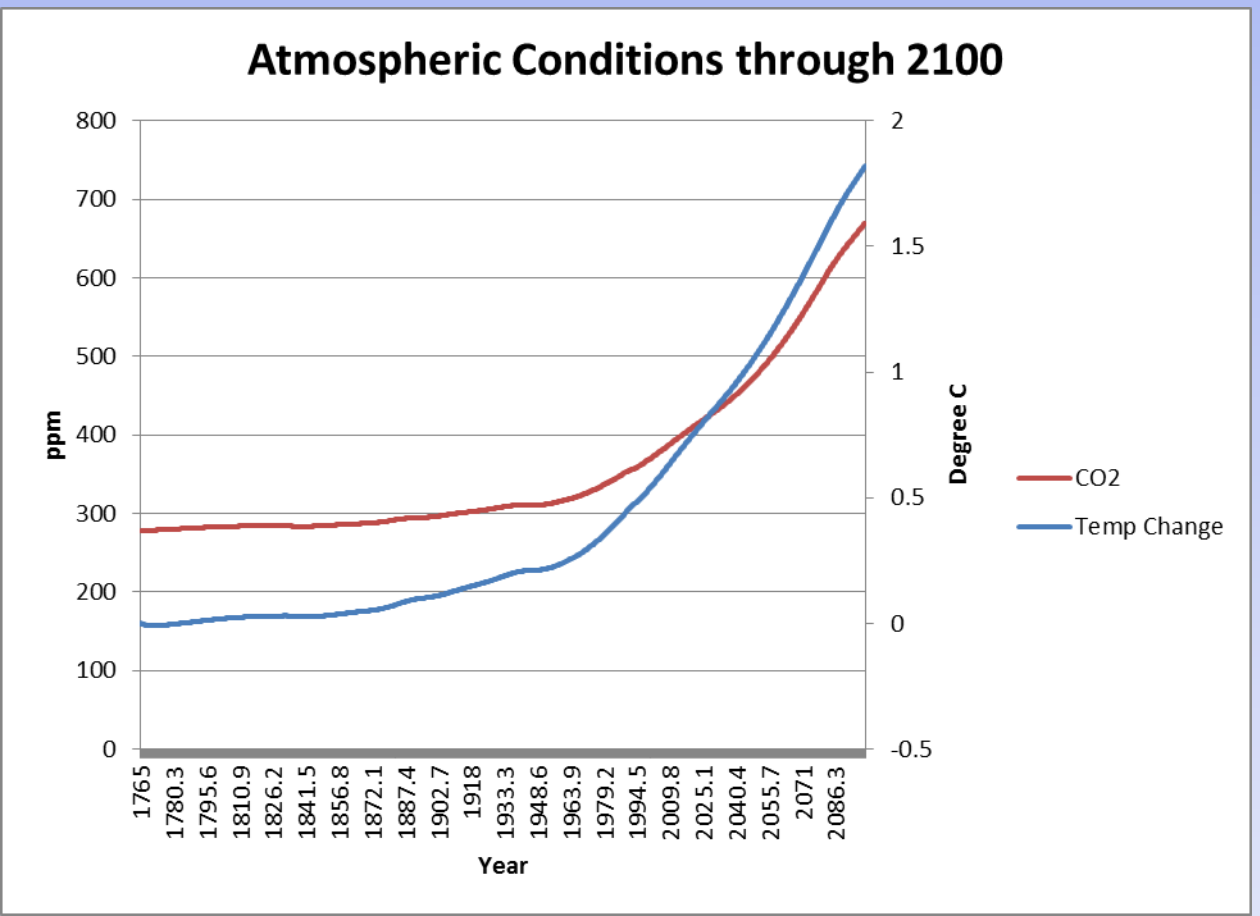
The Greater Everglades

NPP	Litterfall	Respiration
587 $gC/m^2/yr$	524 $gC/m^2/yr$	380 $gC/m^2/yr$

Recent values of NPP, litterfall, and decomposition for the Everglades (Qualls, 2007)

Earth System Box Model

The Greater Everglades

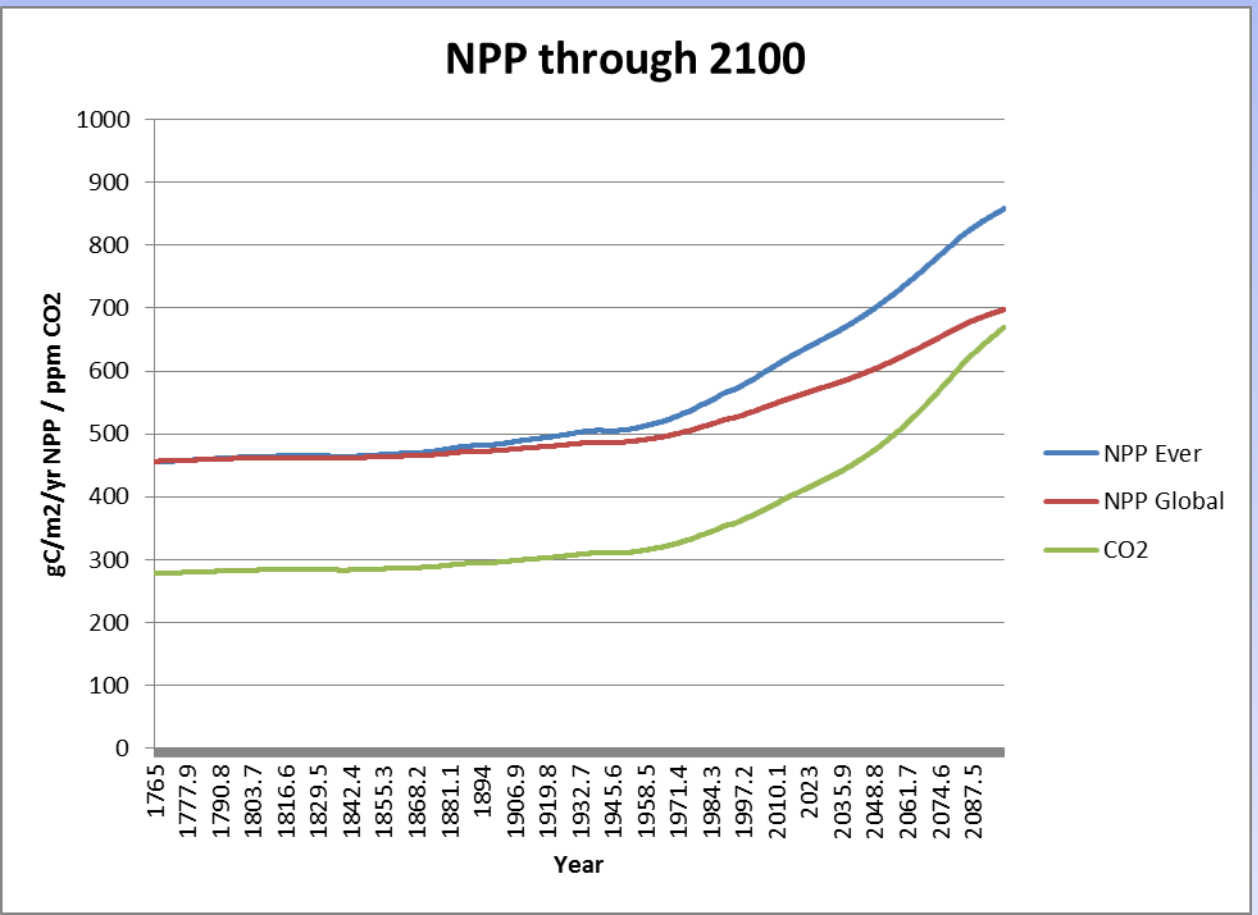


ESM modeling out to 2100 using the RCP6 scenario.

Increase in atmospheric CO_2 to 680 ppm and a temperature increase of 1.8°C

Earth System Box Model

The Greater Everglades



ESM modeling out to 2100 using the RCP6 scenario.

Increase in atmospheric CO_2 to 680 ppm and a temperature increase of 1.8°C

A typical day in the Everglades!!!