Everglades Adaptive Management

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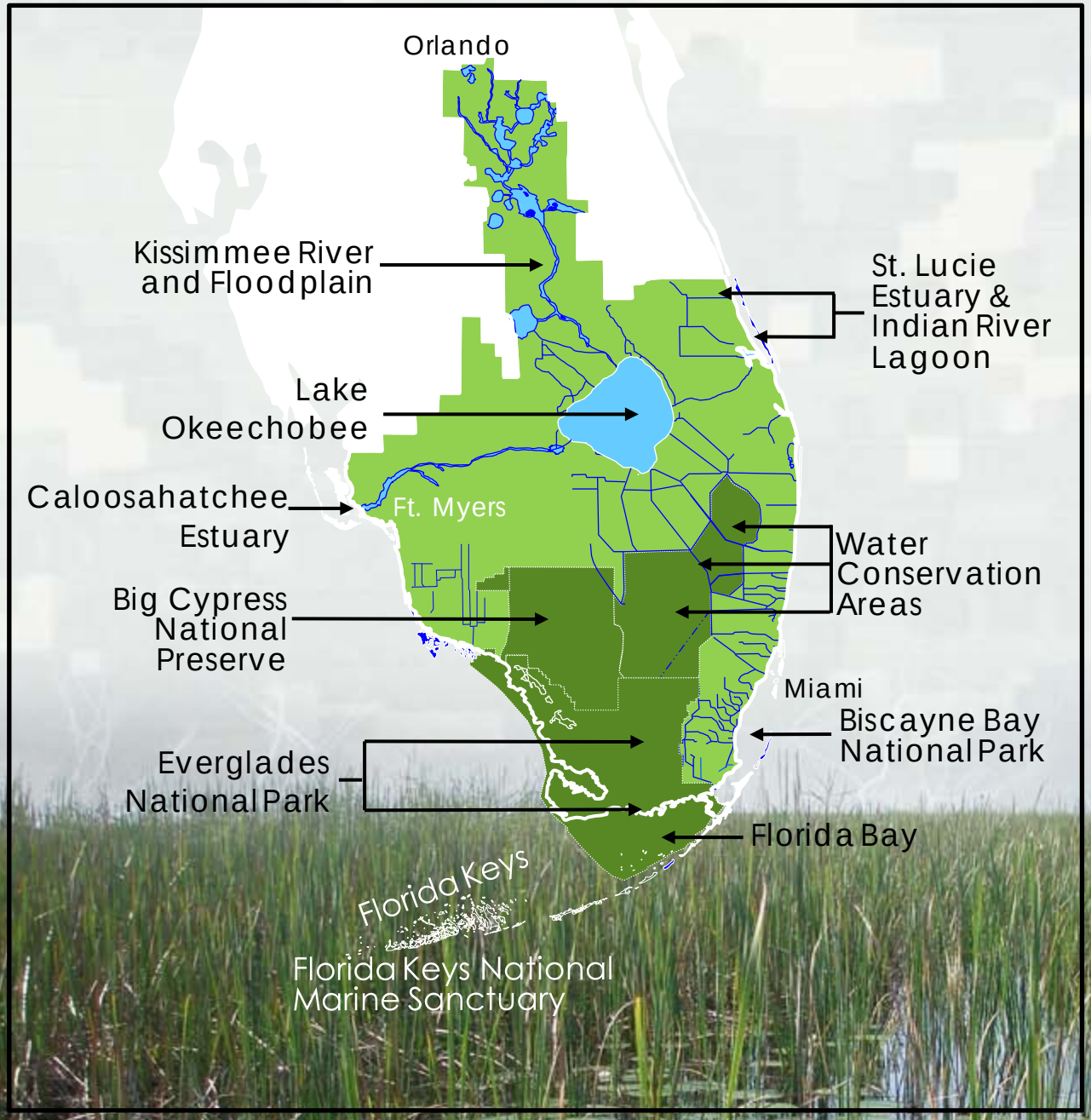
Overview

- Everglades Overview
- Everglades Adaptive Management Program
- Detailed Adaptive Management Example
  (Time and Interest Permitting)

South Florida Everglades Ecosystem

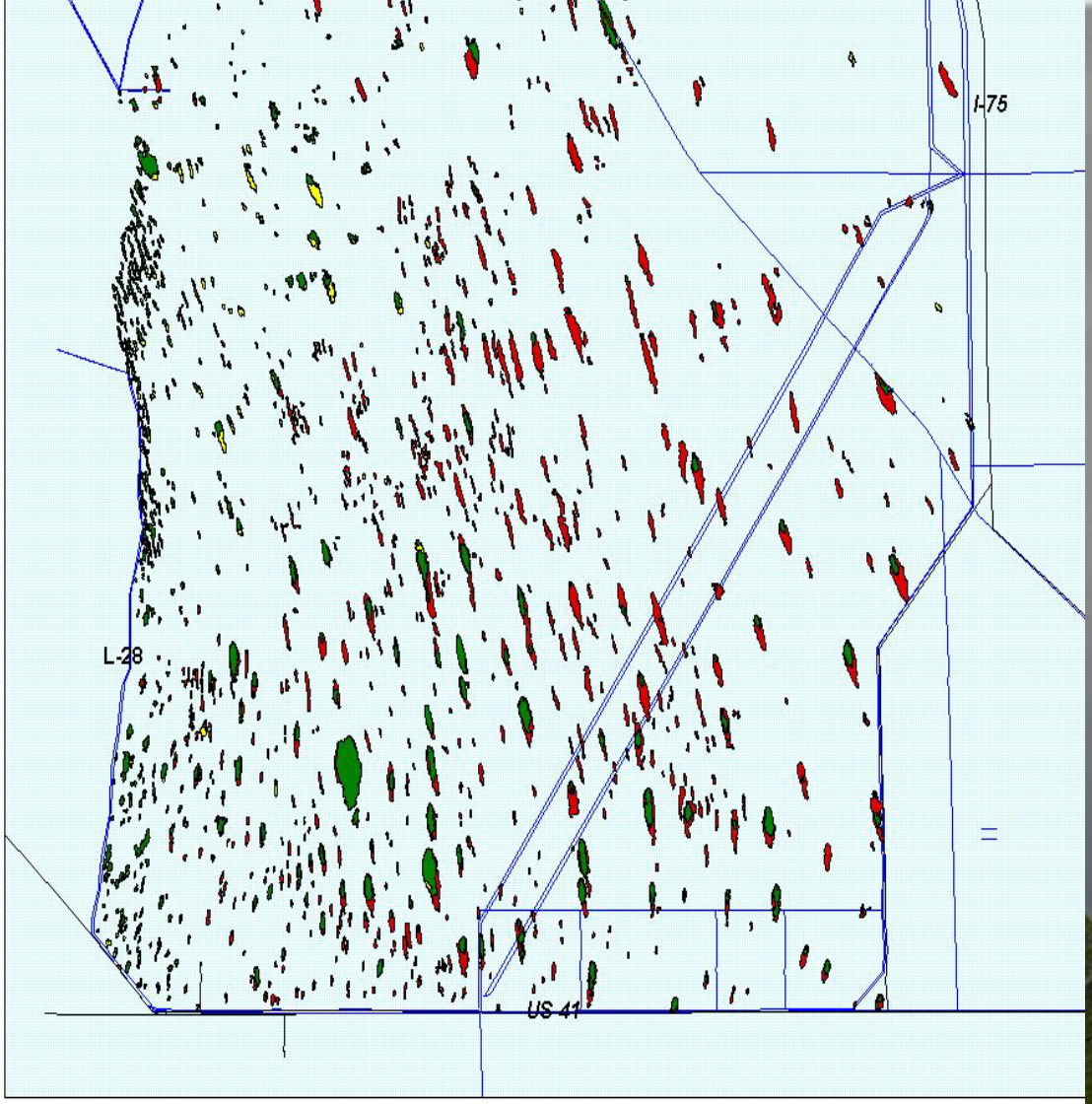


- ✓ Area - 18,000 square miles
- ✓ Population today - 6.5+ million

An Ecosystem in Trouble….

- Too much or too little water for the South Florida ecosystem
- 50 percent reduction in spatial extent of natural system
- Declining estuary health
- Massive reductions in wading bird populations
- Degradation of water quality
- Loss of native habitat to invasive exotic vegetation
- 68 federally-listed threatened and endangered species
- Repetitive water shortages and salt water intrusion

Tree Island Loss from 1940-2004

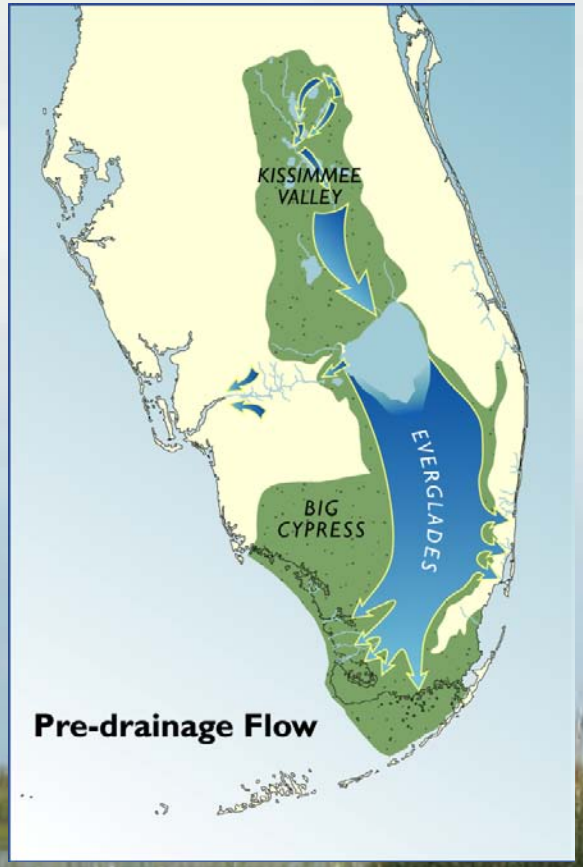


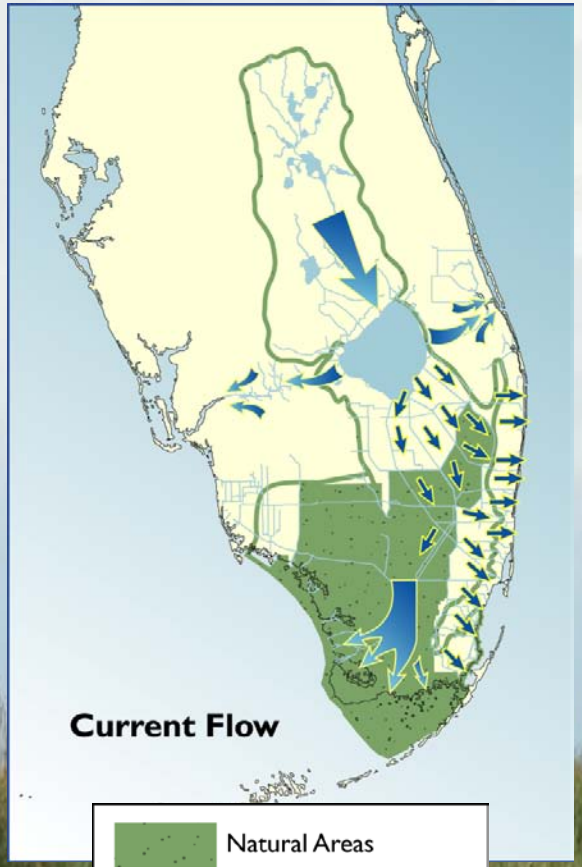
Tree Islands 1940's to 1995
- Tree Islands Gain
- Tree Islands Loss
- Tree Islands No Change
- Out
- Roads
- Canals

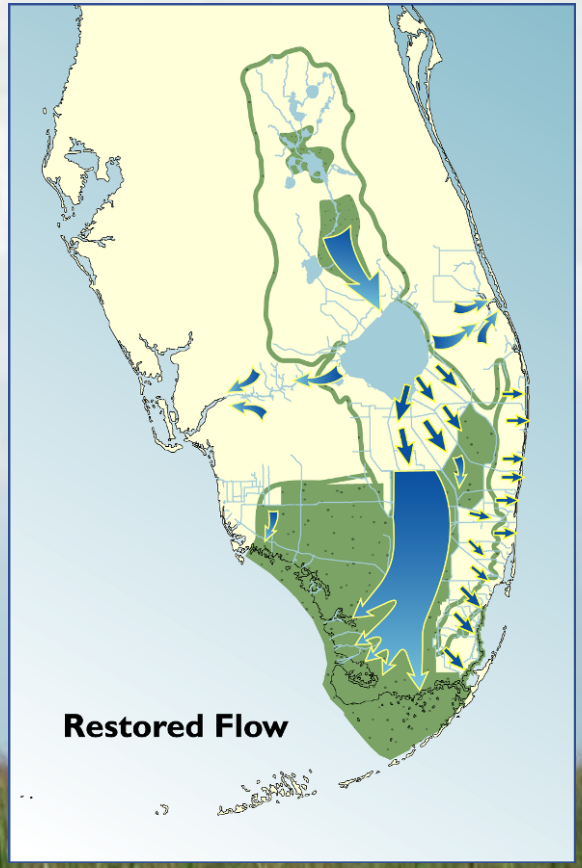
Stateplane Coordinate System
Datum: Nad83, Zone 3601 (Florida East)
Map Unit: Feet, Spheroid: GRS80

0 5 10 15 20 Miles

Comprehensive Everglades Restoration Plan (CERP) Goal







Natural Areas

Water Flows

Pre-drainage Boundary

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Comprehensive Everglades Restoration Plan

68 components to be implemented over 35 years including the following features:

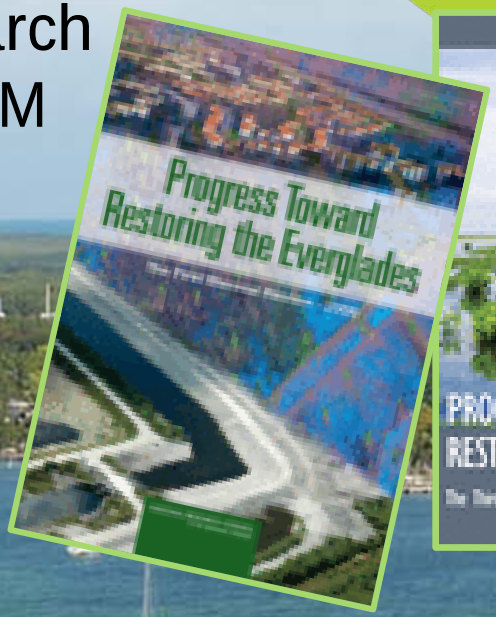
Surface Water Storage Reservoirs	Removing Barriers to Sheetflow
Aquifer Storage & Recovery	Wastewater Reuse
Stormwater Treatment Areas	Operational Changes
Seepage Management	

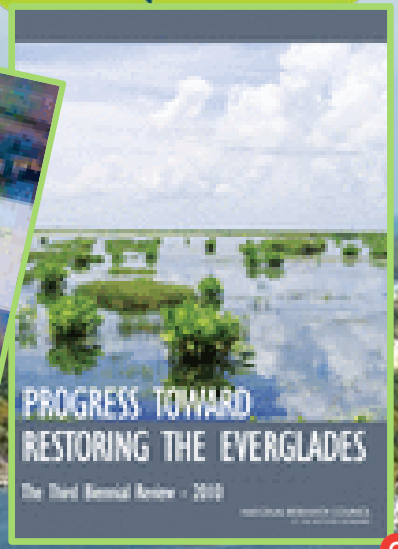
Foundations of Everglades Program

- 1992-1999 Science Foundation for CERP Adaptive Management (AM)
- 2000 WRDA Authorized CERP and Adaptive Assessment and Monitoring
- 2003 CERP Programmatic Regulations required development of AM Program

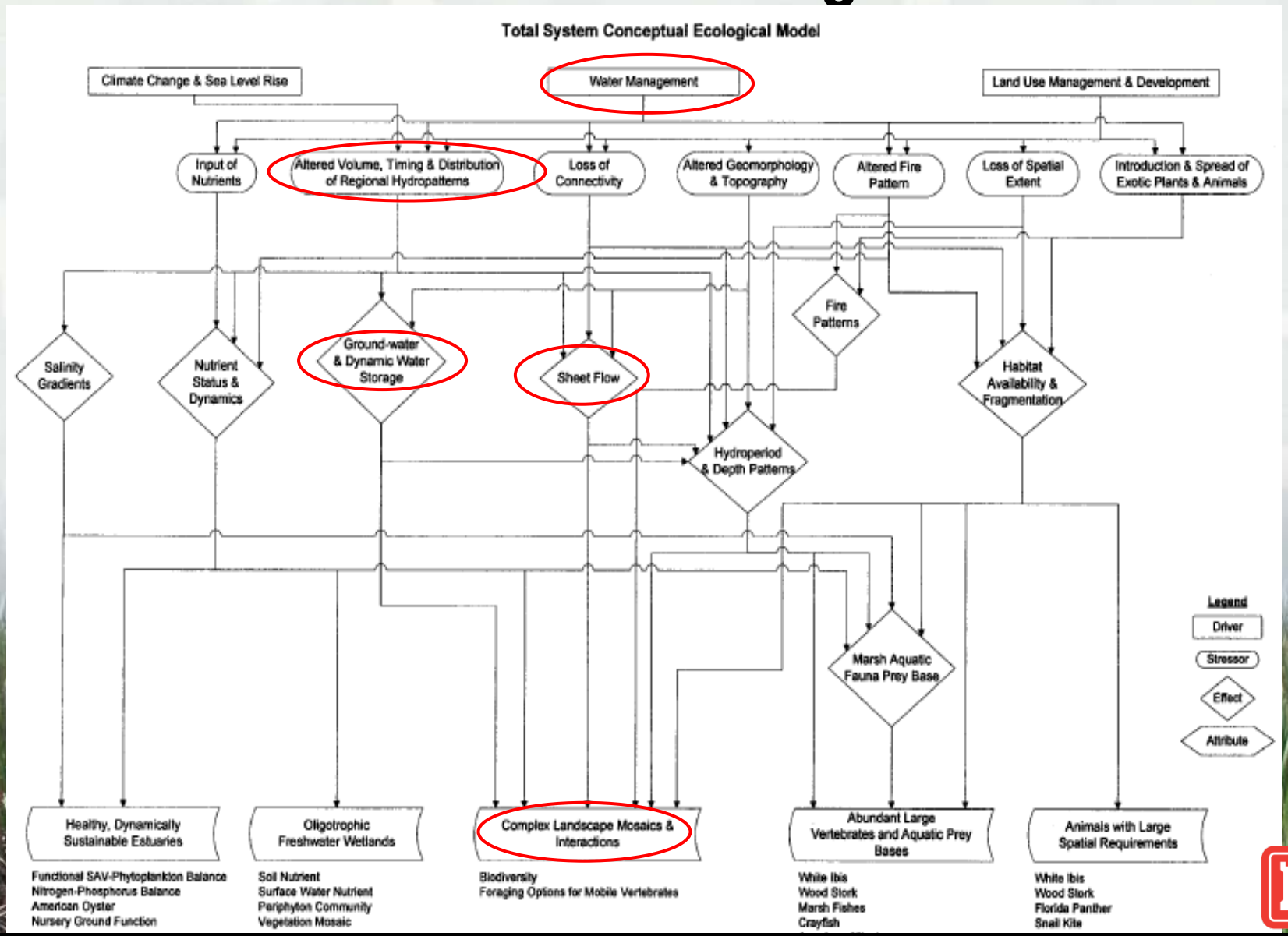
Everglades Adaptive Management Program

- Integration of Science – Program and project plans and implementation
- Evaluation – Models, performance measures, interim goals and targets
- Assessment – Monitoring and reporting and ecosystem status
- PEER Review – National Research Council Supports Everglades AM





Conceptual Models Integrate Science with Planning



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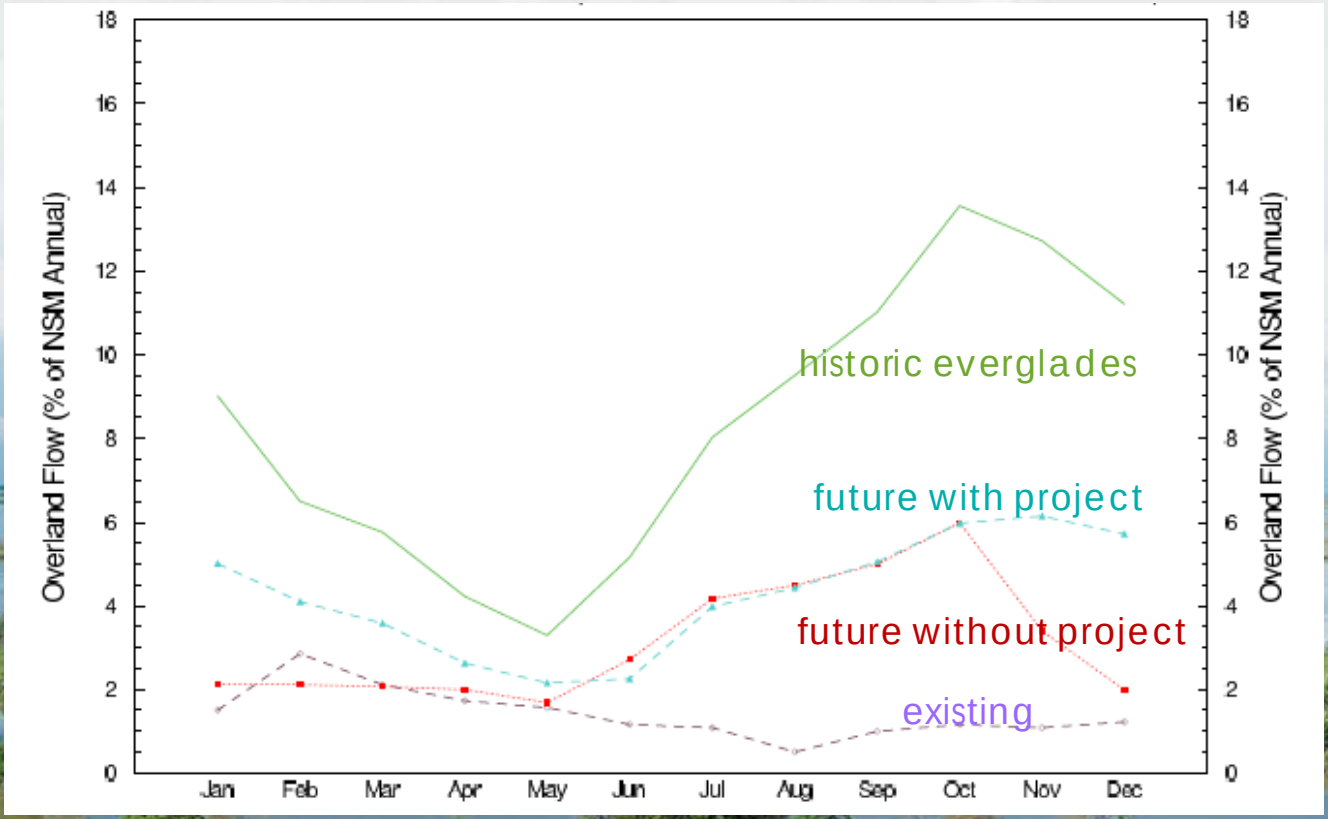
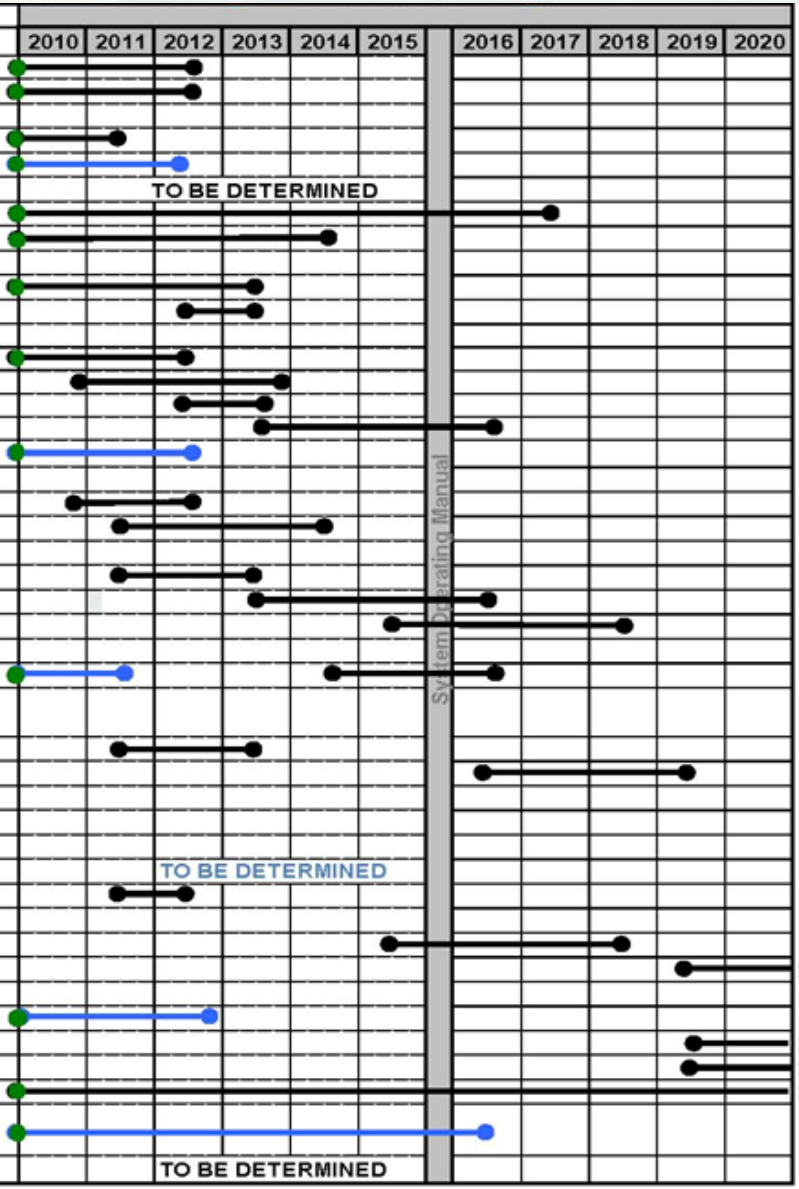
Evaluation

- Modeling Tools and Performance Measures
  - What Everglades **Was**: Data and modeling synthesis to understand historic Everglades
  - What It **Could-Should Be**: Restoration targets and interim goals
  - Evaluate project plans (Benefits)



Incremental Implementation of CERP

	Project	Total Project Cost ($M)
1	Seminole Big Cypress	$60
2	West Palm Beach Canal/STA-1E	$318
3	C-111 Spreader Canal	$154
	Design Test	$2
	Western Project	$150
4	L-31N Seepage Management Pilot Project	$16
5	C-111 South Dade	$391
6	Kissimmee River Restoration	$636
7	Modified Water Deliveries to Everglades National Park	$414
	Tamiami Trail Modifications	$113
	Conveyance and Seepage Control Features	$51
8	Picayune Strand Restoration	$448
	Merritt Pump Station	$65
	Faka Union Pump Station	$100
	Flood Protection Features	$30
	Miller Pump Station	$75
9	Lakeside Ranch STA Phase 1	$105
10	Site 1 Impoundment	$109
	Phase 1	
	Phase 2	
11	Indian River Lagoon-South	$1,882
	C-44 Intake Canal	$45
	C-44 Reservoir	$205
	C-44 STA	$115
12	Biscayne Bay Coastal Wetlands	$595
	Phase 1	$162
13	Water Conservation Area 3 Decompartmentalization and Sheetflow Enhancement (Decomp)	$390
	Decomp Physical Model	$10
	Decomp Part 1	$196
	Decomp Part 2	$133
	Decomp Part 3	$52
14	Caloosahatchee River (C-43)	$977
	West Basin Storage Reservoir	$595
15	Melaleuca Eradication and Other Exotic Plants	$17
16	Broward County Water Preserve Areas	$901
	C-11 Impoundment	
	WCA 3A&3B Levee/S-356	
	C-9 Impoundment	
17	North Palm Beach County Part 1	$287
18	ENP Seepage Management	$532
19	Lake Okeechobee Watershed	$1,561
20	Herbert Hoover Dike Rehabilitation	$991
21	Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area Projects (100% State)	$1,500
22	Central Everglades Storage Project	TBD



Projects are currently federal construction.

Projects are currently non-federal construction, subject to change based on further authorization and funding.

Construction has started on these projects.

October 2010

Monitoring and Assessment Program

- What Everglades **Is (Present):** Assess ecosystem status
- Hypothesis (What we expect from projects)
- What It Is **(Future)**: Verify restoration success and/or performance issues
- New knowledge to adjust and improve implementation

Performance Measure	'00	'01	'02	'03	'04	'05	'06	'07	Current Status
Total fish	G	G	R	R	R	R	R	R	Y
Wading Bird Indicat Summary						R	R	R	Y
Sea-grass	Abundance					R	R	Y	Y
	Target Species					Y	Y	G	G

Systems Status Report

Why Use Adaptive Management?

- Reduce risk of not meeting ecosystem restoration goals
- Builds shared understanding and stakeholder support
- Formalizes activities done in good planning and project management to address uncertainty
- New knowledge (learning) to improve current/future projects and program implementation, and operations

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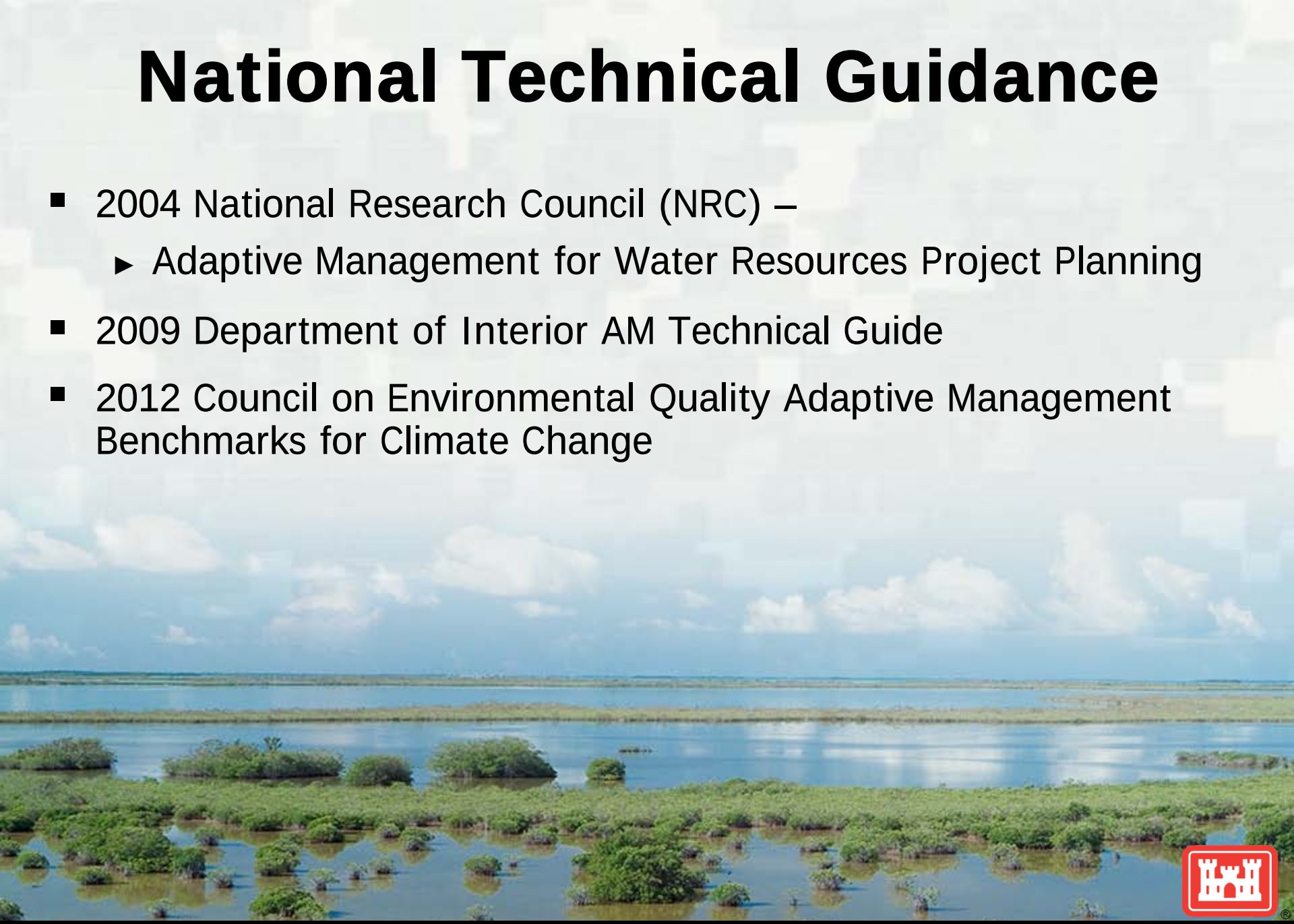
Law and Policies

- Everglades:
  - WRDA 2000 and 2003 CERP Programmatic Regulations
- USACE Wide:
  - WRDA 2007 (Missouri River, Louisiana Coastal Area, Upper Mississippi)
  - 2009 HQ Guidance on WRDA 2007
    - Section 2039 (Ecosystem Restoration Projects)
    - Section 2036 (Wetland Mitigation Plans)

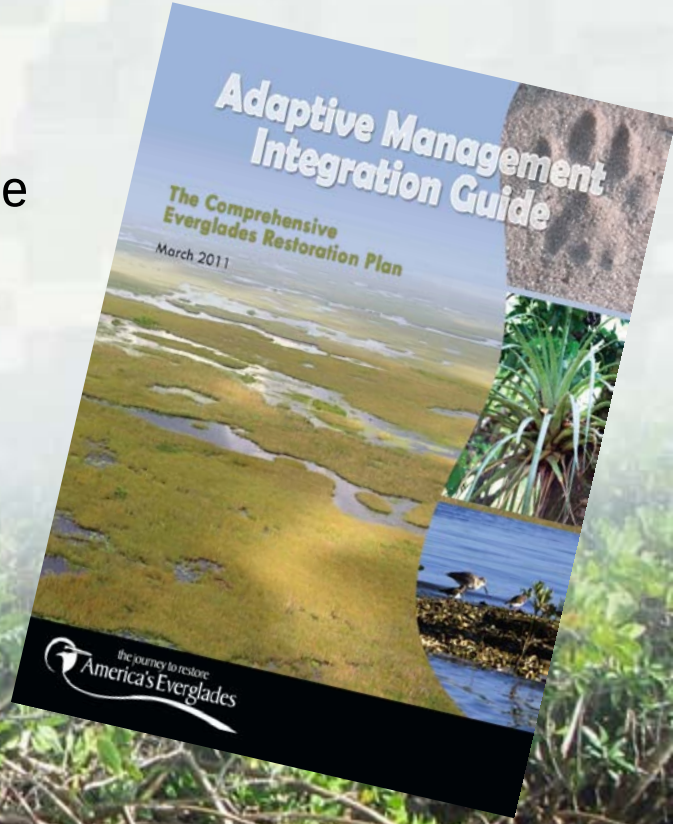
National Technical Guidance

- 2004 National Research Council (NRC) –
  - Adaptive Management for Water Resources Project Planning
- 2009 Department of Interior AM Technical Guide
- 2012 Council on Environmental Quality Adaptive Management Benchmarks for Climate Change

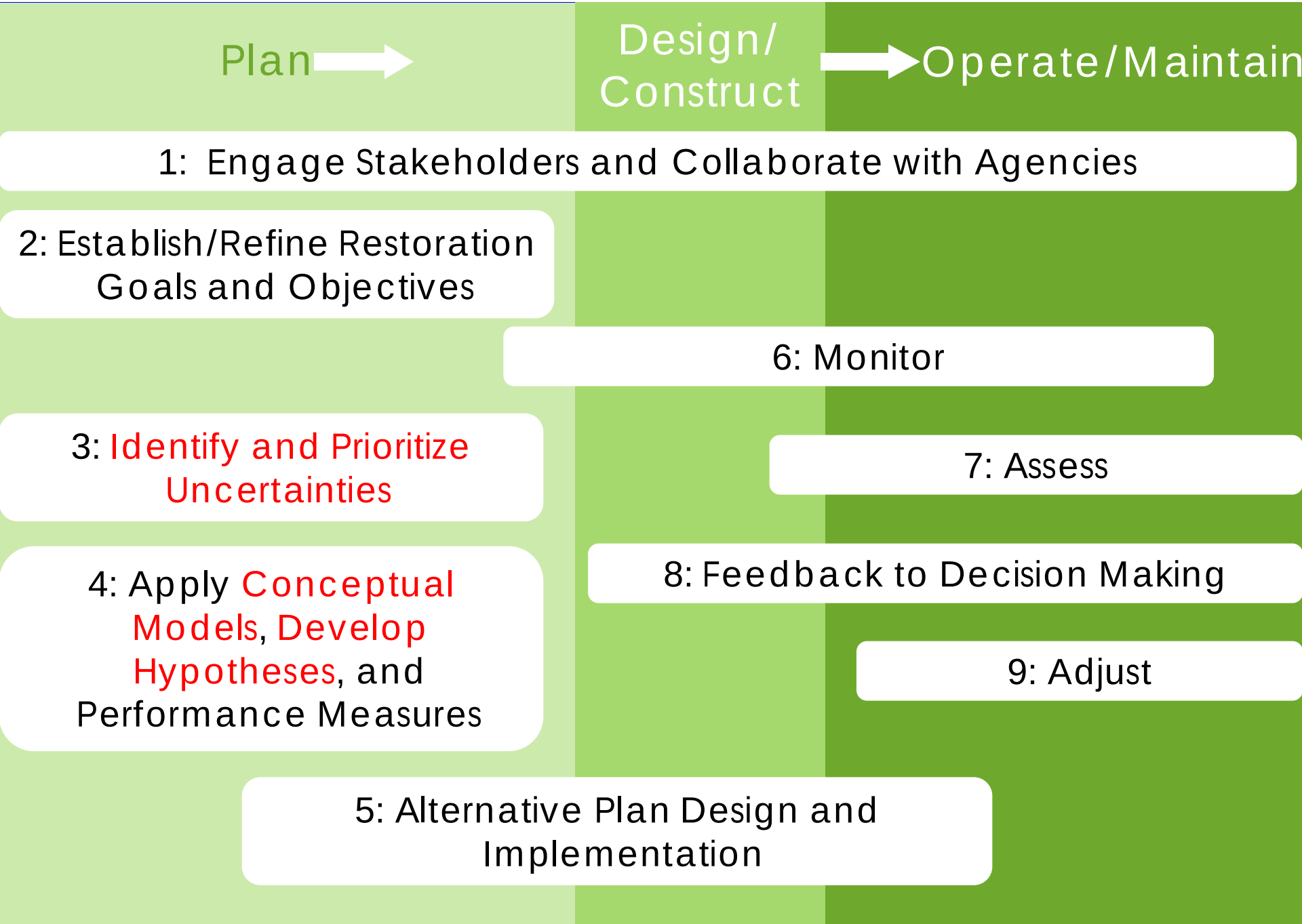


Everglades Adaptive Management Products

- 2004 Monitoring and Assessment Plan (MAP)
- 2006 CERP Adaptive Management Strategy
- 2010 CERP Adaptive Management Integration Guide (Developed 9 AM Activities)
- 2011 CERP Guidance Memorandum 56 on Integrating Adaptive Management Activities into Project and Program Management
- Several Project Level Adaptive Management Plans



Nine Activities to Integrate AM into USACE Project-Life Cycle



Project – Level Adaptive Management

Project	Life-Cycle Phase	Adaptive Management Plan	Adaptive Management Features
Aquifer Storage Recovery	Pilot Project and Planning	No	Testing Pilot Projects and Sensitivity Modeling
Decomp	Pilot Project and Planning	Yes	Decomp Physical Model and PIR 1 AM Plan
C-111 SC	Pilot Project and Chief's Report	No	Design Test and Operational Tests
Biscayne Bay Coastal Wetlands	Chief's Report	Yes	Post Construction Contingency Options
Indian River Lagoon – South	Construction	No	Project Sequencing Adjustments
Broward County Water Preserve Areas	Design	Yes	Operational Options and Design Improvements
Melaleuca	Implementation	No	AM Implementation Strategy
Picayune Strand	Construction	No	Construction Improvements and Vegetation Management

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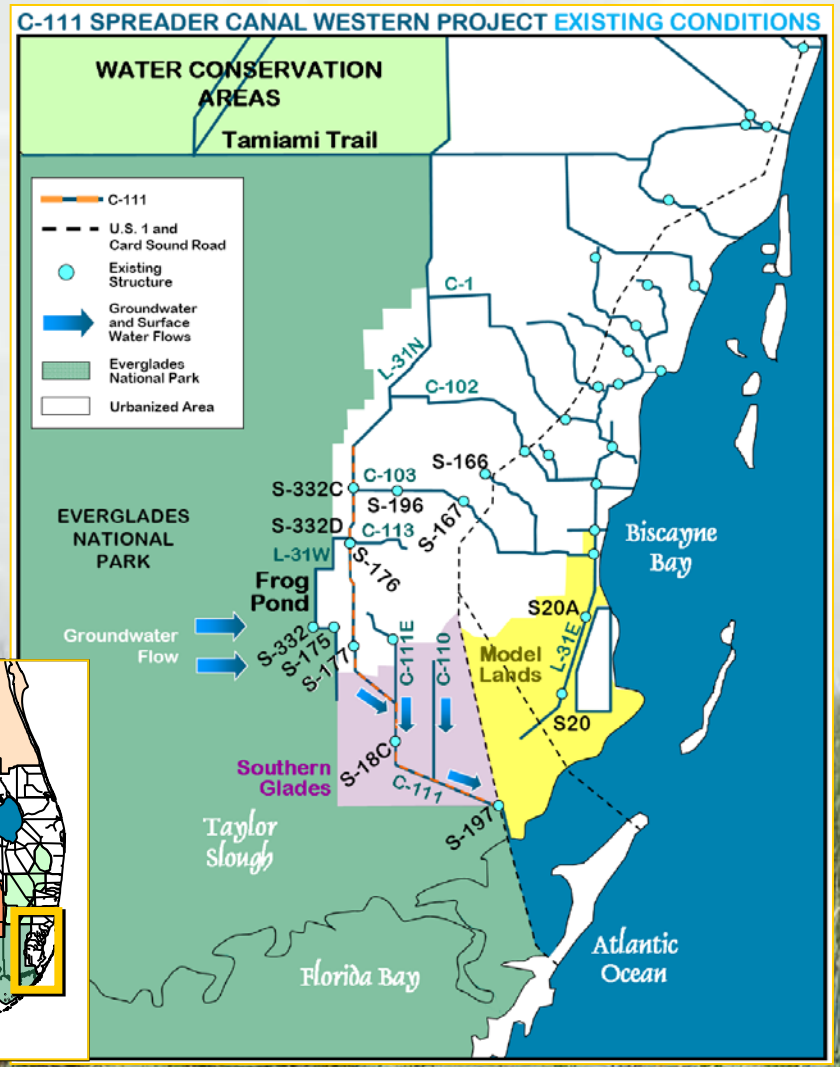
C-111 Spreader Canal

Detailed Project Example



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Activity 1: Engage Stakeholders and Collaborate with Agencies

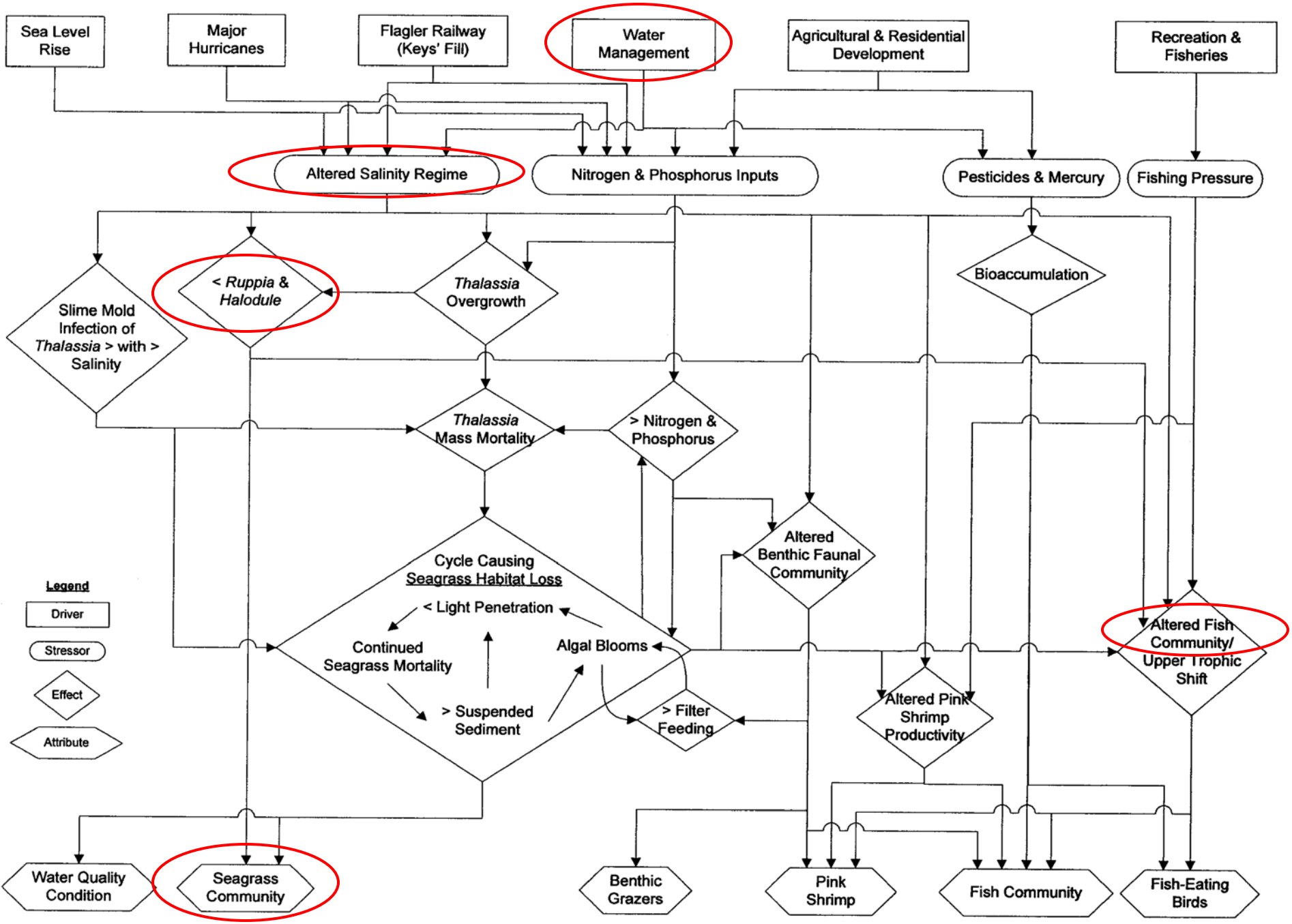
- Key stakeholders and values issues identified
- SFWMD stakeholder workshops to communicate and build support
- Interagency support (Project Delivery Teams)

Activity 2: Goals and Objectives

Planning Step 1: Specify Problems and Opportunities

- Confirm and refine project goals and objectives
- Ensure project planning consistency with system-wide goals
- Define restoration success and vision

Florida Bay Conceptual Ecological Model



Activity 3: Uncertainties Identification

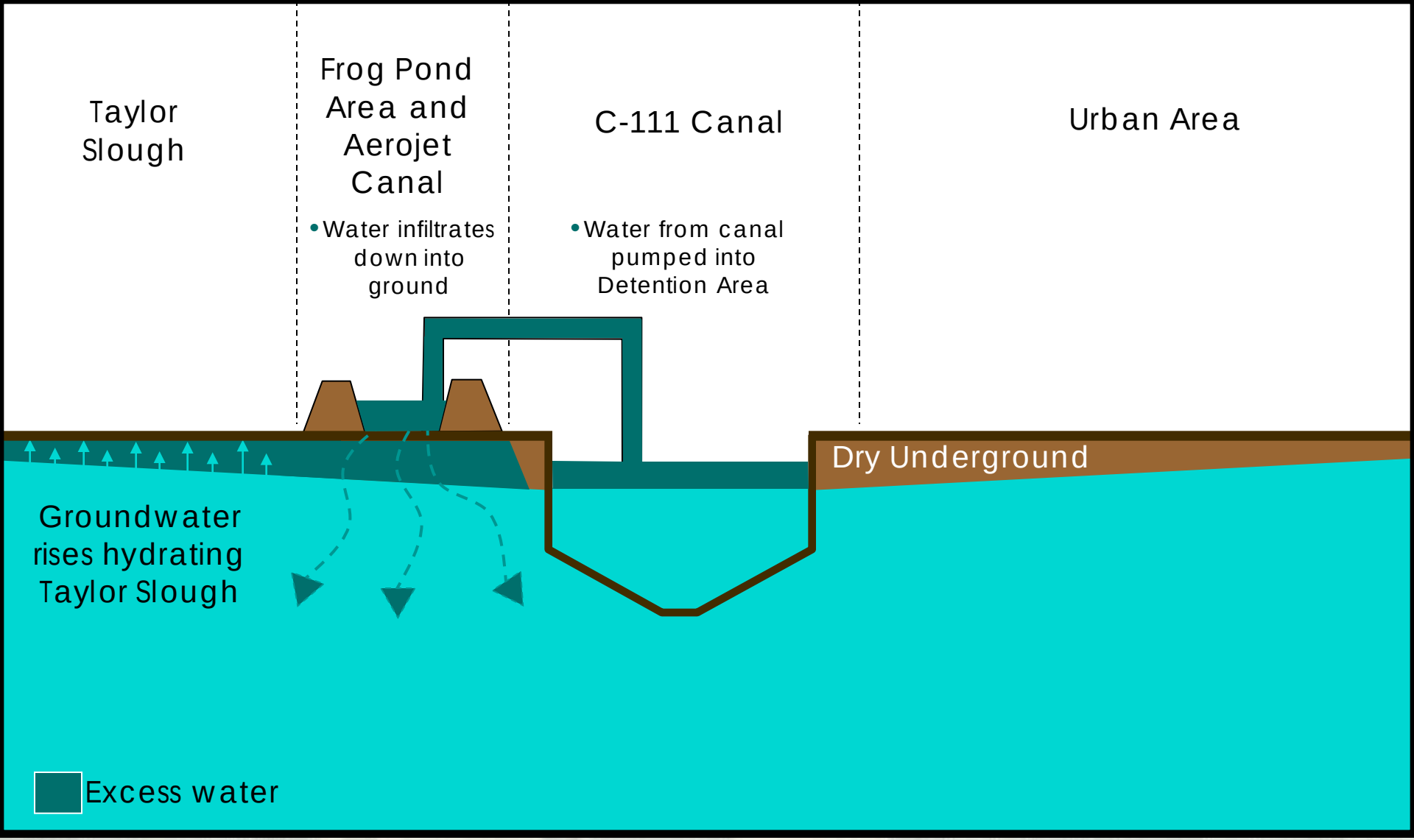
Planning Steps 1 and 2: Identify and Forecast Conditions

- Identify unanswered questions (uncertainties)
  - How effective will project (Frog Pond and Aerojet Canal) operations be to control seepage and increase hydroperiods in Taylor Slough?
  - Will flood control and endangered species constraints be violated?
  - What is the best spreader canal design in Southern Glades/Model Lands?
  - How much water (quantity and timing) is needed to restore longer hydroperiods in Taylor Slough?
  - Will hydroperiods result in anticipated salinity changes in freshwater and nearshore areas?
- Prioritize uncertainties
- Obtain management concurrence on strategies to address questions

Activity 4: Hypothesis

Planning Steps 2 and 3: Formulate Alternative Plans

- H1 (Project Operations):
  - Incremental Canal stage changes will not increase agricultural flooding risk
  - Will reduce C-111 canal influence on Taylor Slough water levels (increase hydroperiods)
- H2 (Freshwater – Upper Slough):
  - Longer hydroperiods will result in a vegetation community shift towards Everglades marsh species
- H3 (Nearshore – Down Stream):
  - Longer hydroperiods will result in desired salinity ranges and improve conditions for key ecological indicators (Seagrasses, Crocodiles, Fish)



Hydraulic Ridge Concept

Detention area used to infiltrate water into ground and artificially raise groundwater table

Activity 4: Performance Measures

Planning Steps 4: Evaluate Plans (compare to pre-project conditions)

- Performance Measures (PM): Predictive tools and target development
  - PM 1 (Project Operations): Taylor Slough Stages show limited change when canal operates
  - PM 2 (Freshwater): Hydroperiods in Taylor Slough are 30 percent longer
  - PM 3 (Freshwater): Graminoid vegetation species increase and woody/herbaceous vegetation will decrease
  - PM 4 (Nearshore): Salinity ranges gradually decrease to meet 10-20 ppt range
  - PM 5 (Nearshore): SAV increases in area, biomass, and species

Activity 5: Alternative Plan Design and Implementation

Planning Steps 3, 4 and 5: Comparing Plans

- Project operational tests (Frog Pond and Aerojet Canal)
- Design tests
- Project Implementation Report (PIR) 1 and Design Test Implementation will inform planning/design of PIR 2

Activity 6: Management Option Matrix Part of Adaptive Management Plan

Planning Steps 3-6: Evaluation, Comparison, Selection

Stressor Metric	Target	Management OPTION 1	Management OPTION 2	Program Management OPTION 3
Seepage Control	Maintain stages in Taylor Slough	Increase Frog Pond Stages	Increase Aerojet Canal Stages	System-wide/Regional issue (need additional water)
Salinity	Taylor River (0-9ppt); L. Madeira Bay (12-22 ppt) Terrapin Bay (12-26ppt)	Increase C-111 Stages	Adjust operations	System-wide/Regional issue (need additional water)
Seagrass Species and Area (SAV performance measure)	Seagrass Species and Area Increase Ruppia and Halodule species presence	Adjust operations to even salinity range transition and decrease salinities	Adjust Water Quality Source Control Measures	Targeted Seagrass Plantings
Wetland macro vegetation	Narrow mangrove fringe along shoreline; graminoid marsh inland from mangrove	Provide a more natural fire regime to promote and maintain graminoid marsh community	Physically remove forested wetland vegetation to promote growth and establishment of graminoids	

Activity 6: Monitoring

Planning Step 6: Part of PIR

- Monitoring plans designed to confirm or refute Hypotheses
- Verify project success (benefits-HUs)
- Monitoring plan coordination and cost constraints
  - Example: System-wide (MAP) monitoring for salinity can be used for project

Activity 7: Assessment

During Design - Construction - Operations

- Project-level monitoring and assessment
  - Contract management and data management
  - Synthesize data and report at system and management relevant timeframes

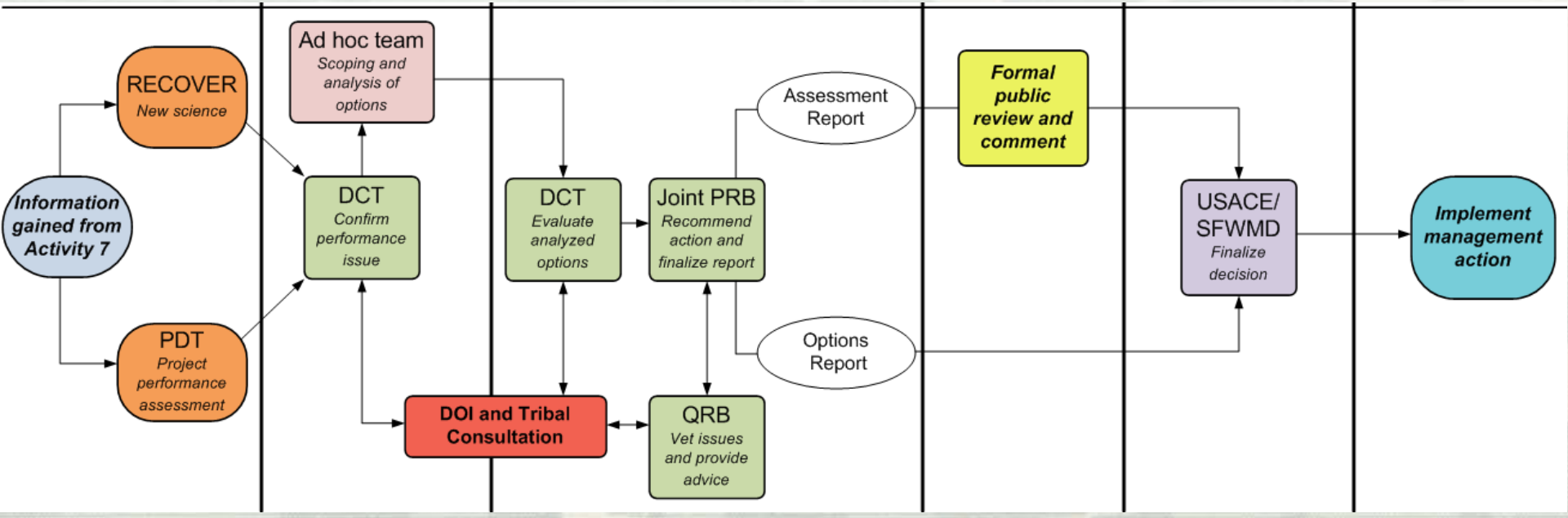
Eastern Florida Bay	Y	R	G	Y	R	Status was poor in 2009 versus the historical record.
North-Central Florida Bay	G	R	R	R	R	Poor performance exhibited in four of five MAP years.
South-Central Florida Bay	R	R	R	R	R	This is the worst performing of six areas in fall.

Activity 8: Decision-making

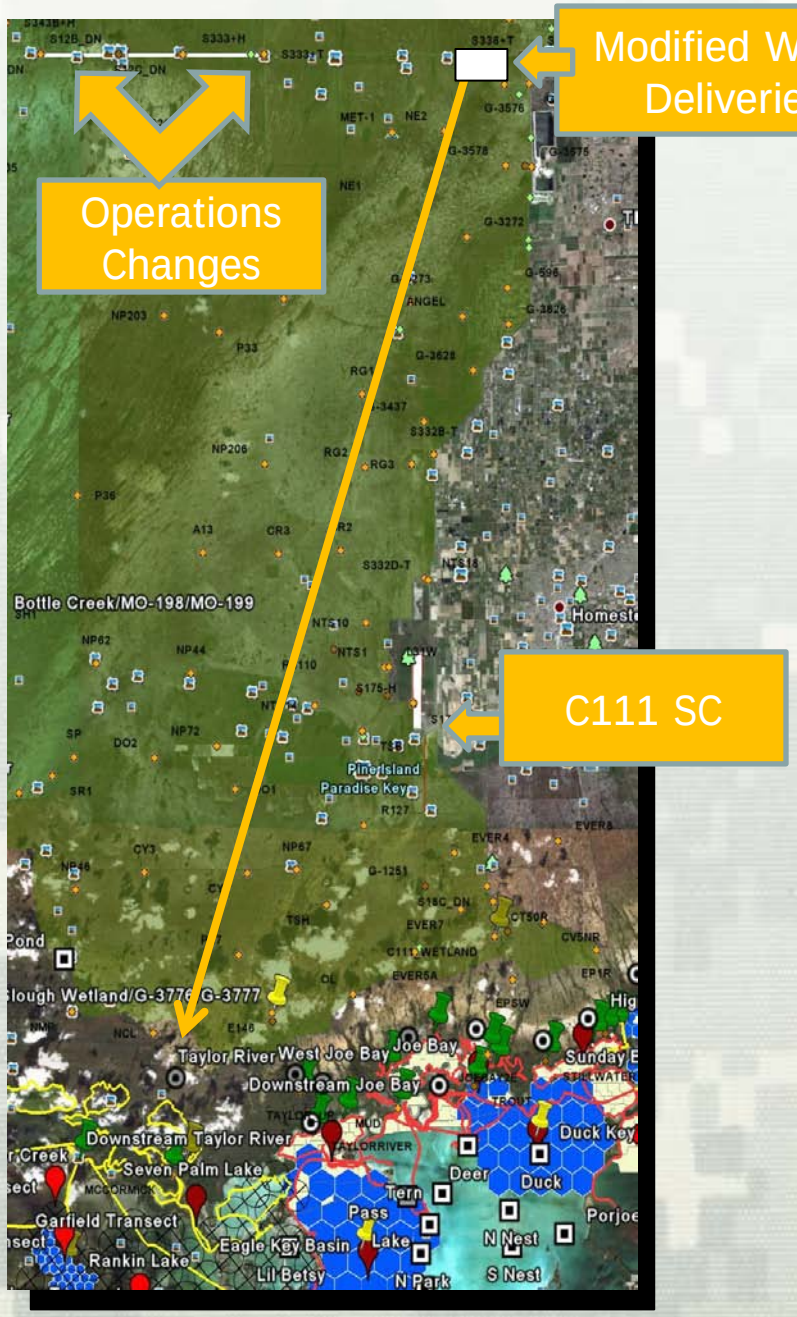
- Science-Management Interface (Forum) and timing of decisions will vary depending on several factors
  - Timing of restoration indicator response
  - Spatial scale of restoration performance issues
  - Urgency to correct performance issue
  - Type of management action

Activity 8: Decision-making continued

- Stakeholder Feedback Forums
- Management Forums
  - Discuss performance issues or success



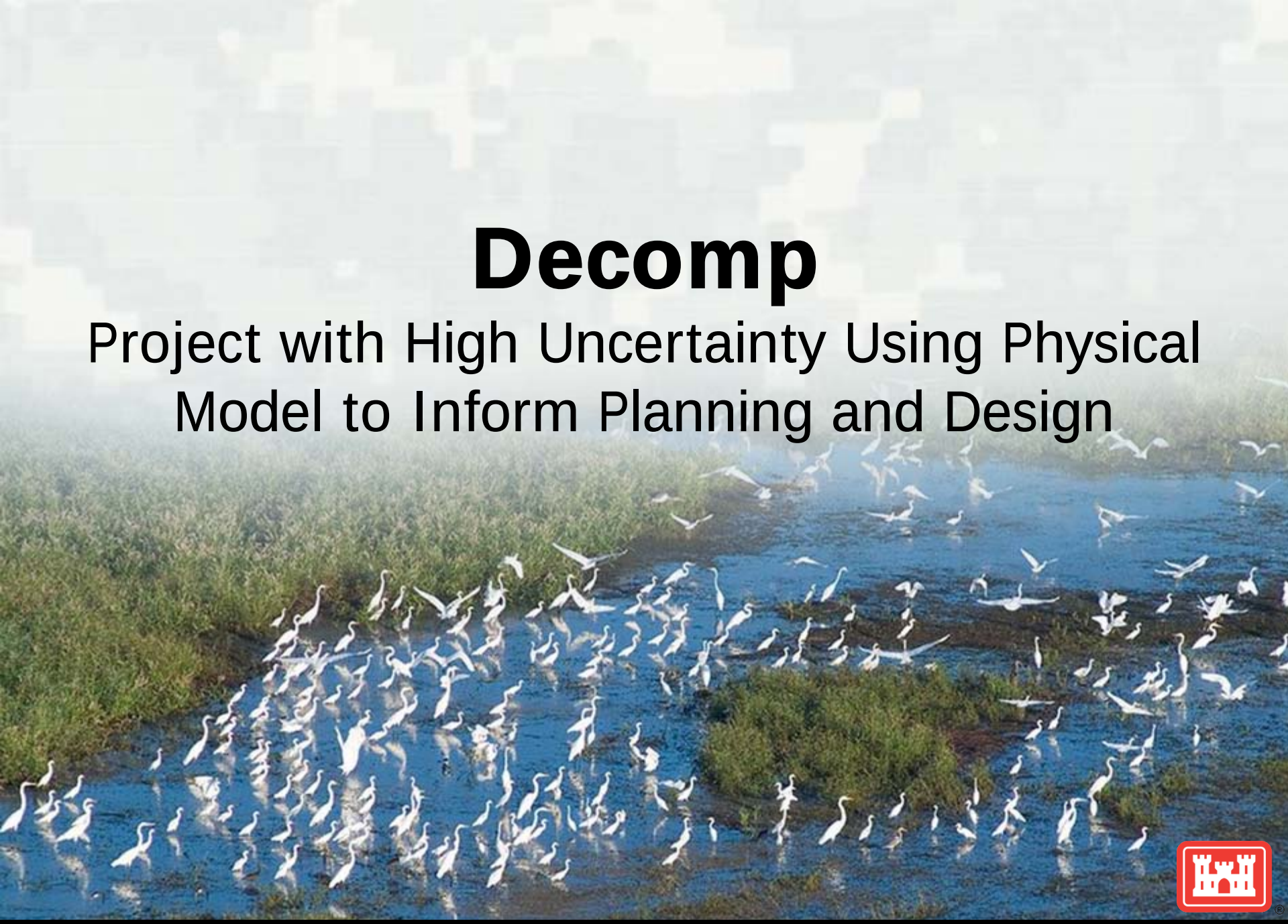
CERP Program and Project Interaction



- •Coastal Gradients RECOVER –USGS
- •Coastal Gradients Other – USGS
- •Crocodile Transect Surveys – UF
- •Everglades Depth and Elevation Network (EDEN) – USGS
- •Fish and Invertebrate – USGS/NOAA
- •FL Bay Seagrass – FWC
- •Coastal Bay Seagrass –DERM
- •Seatrout (sportfish) – NOAA
- •Spoonbill Trophic Sampling - Audubon

Decomp

Project with High Uncertainty Using Physical Model to Inform Planning and Design



Goals for Decomp

- Improve sheet flow, hydropatterns, and hydroperiods within WCA-3 and ENP
- Restore, maintain, and sustain ridge and slough topography
- Increase the spatial extent and restore vegetative composition, habitat function, and productivity of tree islands, and help compensate for past losses
- Restore peat soils, depth and micro-topography

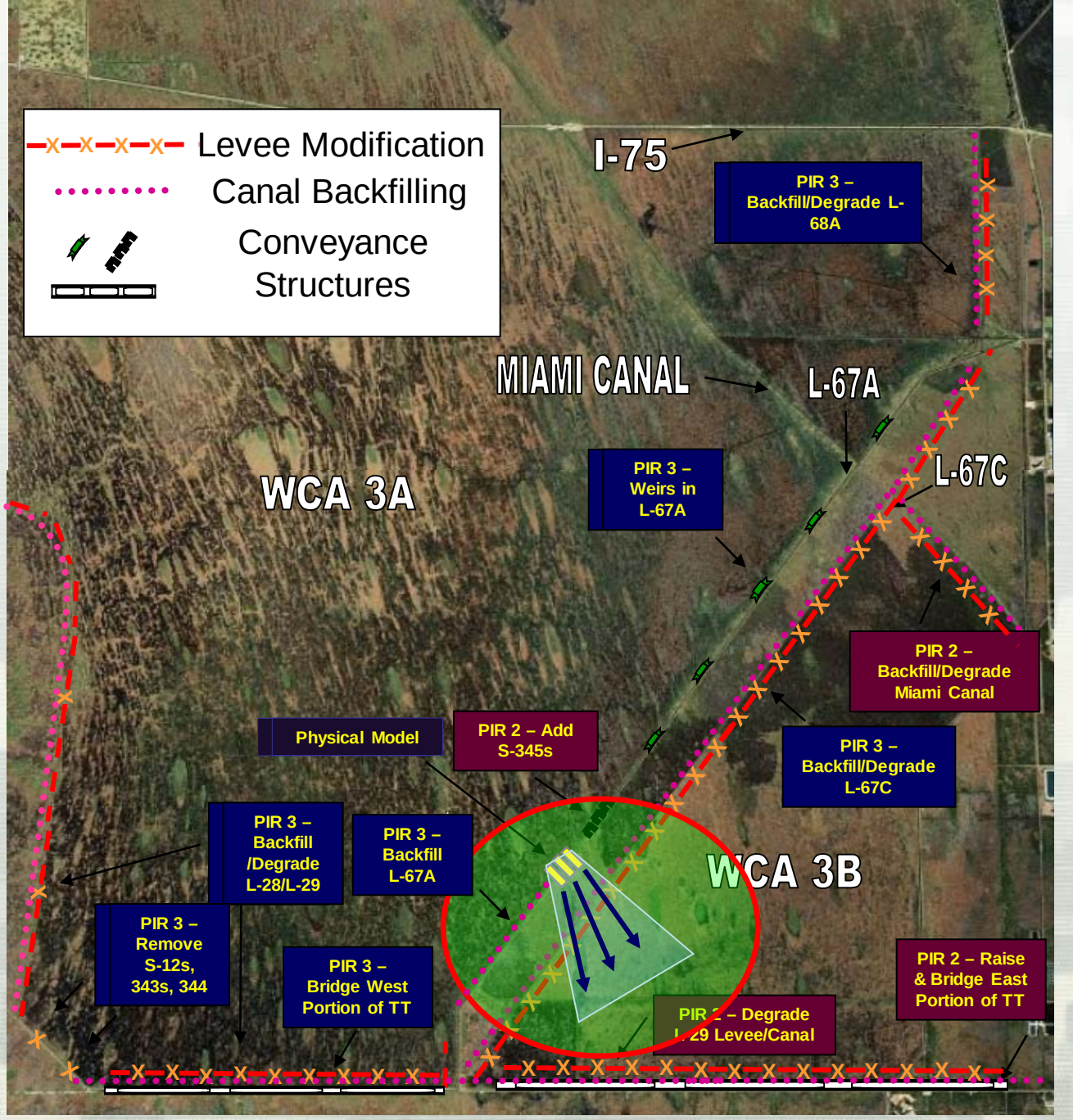
Key Restoration Uncertainties

- Is complete backfilling of canals an ecological and hydrologic necessity? Are partial backfilling and no backfilling of canals viable options?

- What are the quantifiable ecological benefits of sheet flow and ecosystem connectivity?

Risk

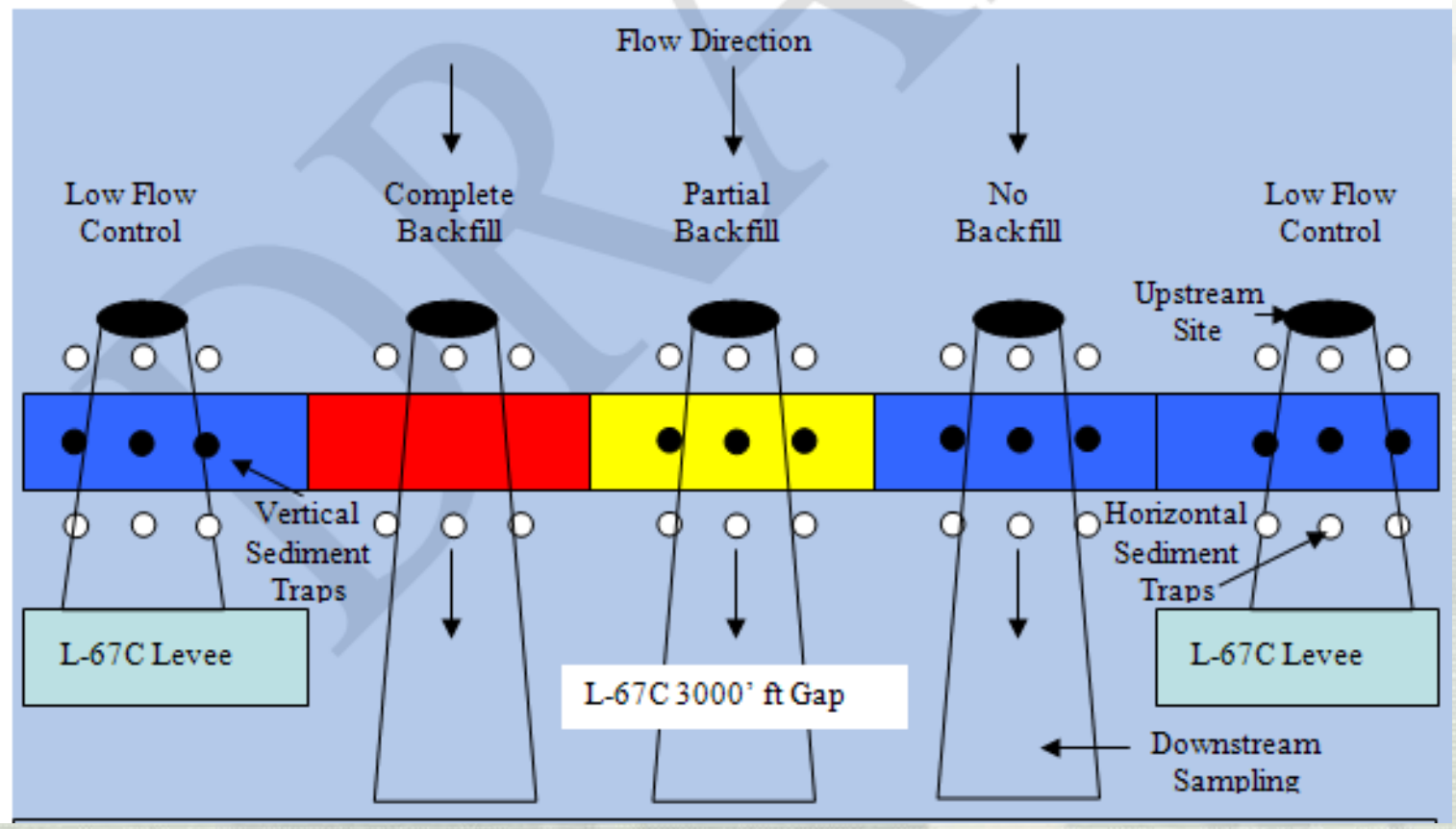
- Not Implementing Best Design to Achieve Restoration Goals
- Not Having Information to Defend Restoration Actions in Court



DECOMP Physical Model

Inform Planning and Design

- Uses Before and After Control Impact (BACI) Test
- Determine Best Design
- Update Models to Evaluate Benefits



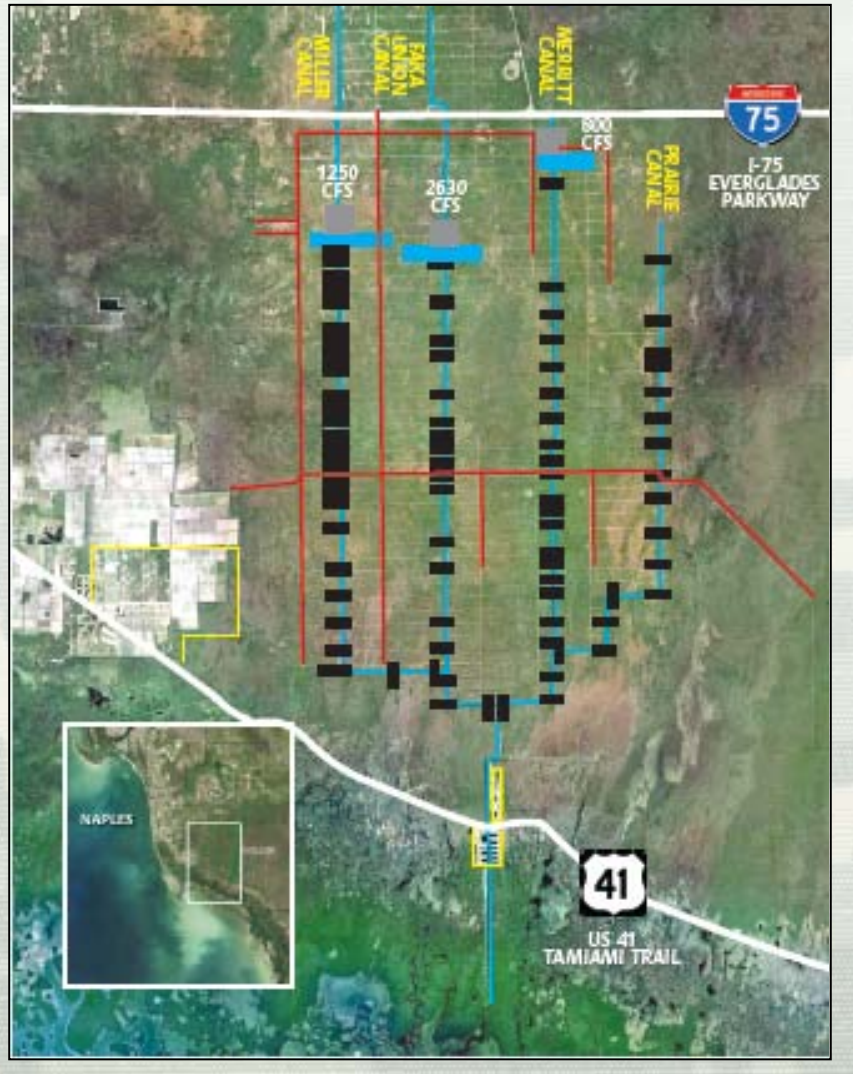
Performance Measures

- **Evaluate design that best achieves:**
  - Marsh Stages and Flow velocity (Increase flow– 3cm/s)
  - Sediment Transport (Increase)
  - Dissolved Oxygen (Water Quality)
  - Vegetation (Obstructions to Flow)
  - Total Phosphorus-Periphyton Changes (Water Quality)
  - Fish assemblage (Sport species, Invasives, Natural)
  - Aquatic Fauna (Increases of Benthic Prey Availability)

Picayune Strand

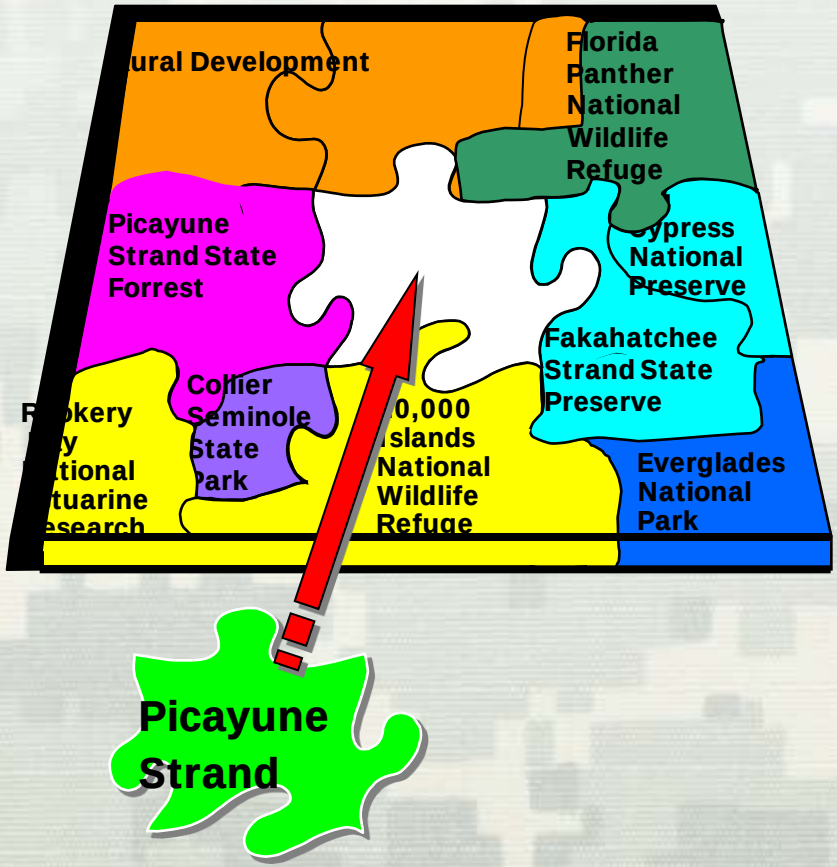
Example of restoration project
with low scientific uncertainty

Picayune Strand Restoration



SPREADER CANALS
CANALS
PUMP STATIONS
CANAL PLUGS
MAJOR ROADWAYS
LEVEES
ROADWAYS THAT WILL REMAIN

The “Missing Piece” of the Puzzle



Restores ecological connectivity between publicly owned lands

Project Goals

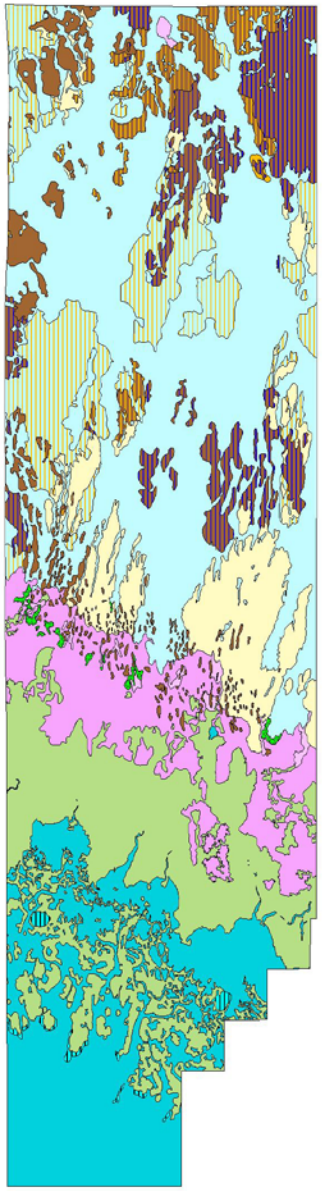
Picayune Strand ecosystem restoration requires the achievement of three goals:

1. Restore natural hydropatterns, including sheet flow
2. Control exotic and nuisance plants in Picayune Strand State Forest to reestablish natural plant communities
3. Manage Picayune Strand State Forest to reestablish a natural fire regime

Uncertainty and Risk

- **Uncertainty:**
  - Scientific uncertainty is low if project and state forest is managed according to project goals
- **Limited Flexibility:**
  - Range of operational and design change options is limited
- **Risk:**
  - Restore hydroperiods and not meet restoration goals and objectives because nuisance vegetation remains

Vegetation Management



Year 1940

CYPRESS
- Cypress (C)
- Cypress with palms (Cp)

PRAIRIE
- Wet Prairie (G)

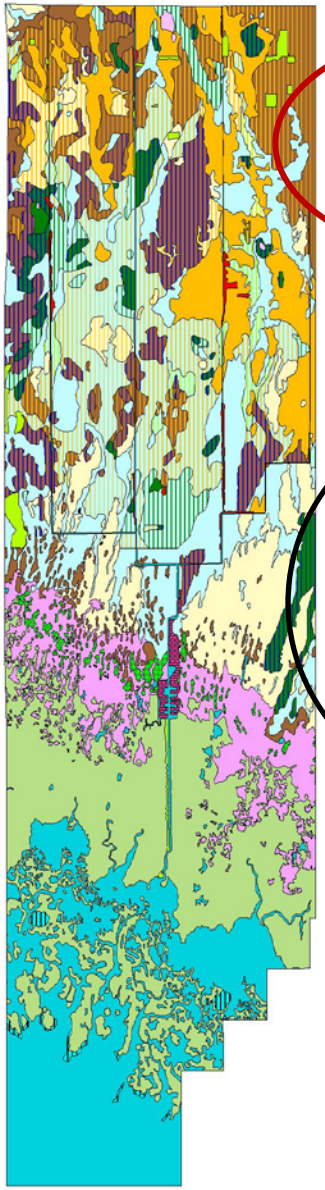
HAMMOCK
- Sabal Palm Hammock (Hp)
- Tropical Hammock (Ht)

FLATWOODS
- Mesic Pine Flatwoods (Pm)
- Hydric Pine Flatwoods (Ph)
- Pine Flatwoods with palms (Pp)

MARSH
- Freshwater Marsh (Mf)
- Salt Marsh (Ms)

OTHER
- Mangrove Swamp (Mg)
- Coastal Uplands (Cu)
- Water (WAT)

- Remove Upland Vegetation
- Fire Management
- Achieve Marsh Wetland Vegetation
- Achieve Cypress Forest



Year 1995

CYPRESS
- Cypress (C)
- Cypress with hardwoods (Ch)
- Cypress with palms (Cp)
- Cypress [disturbed] (Cx)

PRAIRIE
- Wet Prairie (G)
- Prairie with palms (Gp)
- Prairie [disturbed] (Gx)

HAMMOCK
- Mesic Hammock (Hm)
- Hydric Hammock (Hh)
- Sabal Palm Hammock (Hp)
- Tropical Hammock (Ht)

FLATWOODS
- Mesic Pine Flatwoods (Pm)
- Hydric Pine Flatwoods (Ph)
- Pine Flatwoods with palms (Pp)
- Pine Flatwoods [disturbed] (Px)

MARSH
- Freshwater Marsh (Mf)
- Marsh [Salt/Fresh] (Mfs)

OTHER
- Mangrove Swamp (Mg)
- Saw Palmetto (S)
- Brazilian Pepper (St)
- Urban Land (URB)
- Disturbed Land (x)
- Coastal Uplands (Cu)
- Water (WAT)