CENTRAL
EVERGLADES
PLANNING
PROJECT

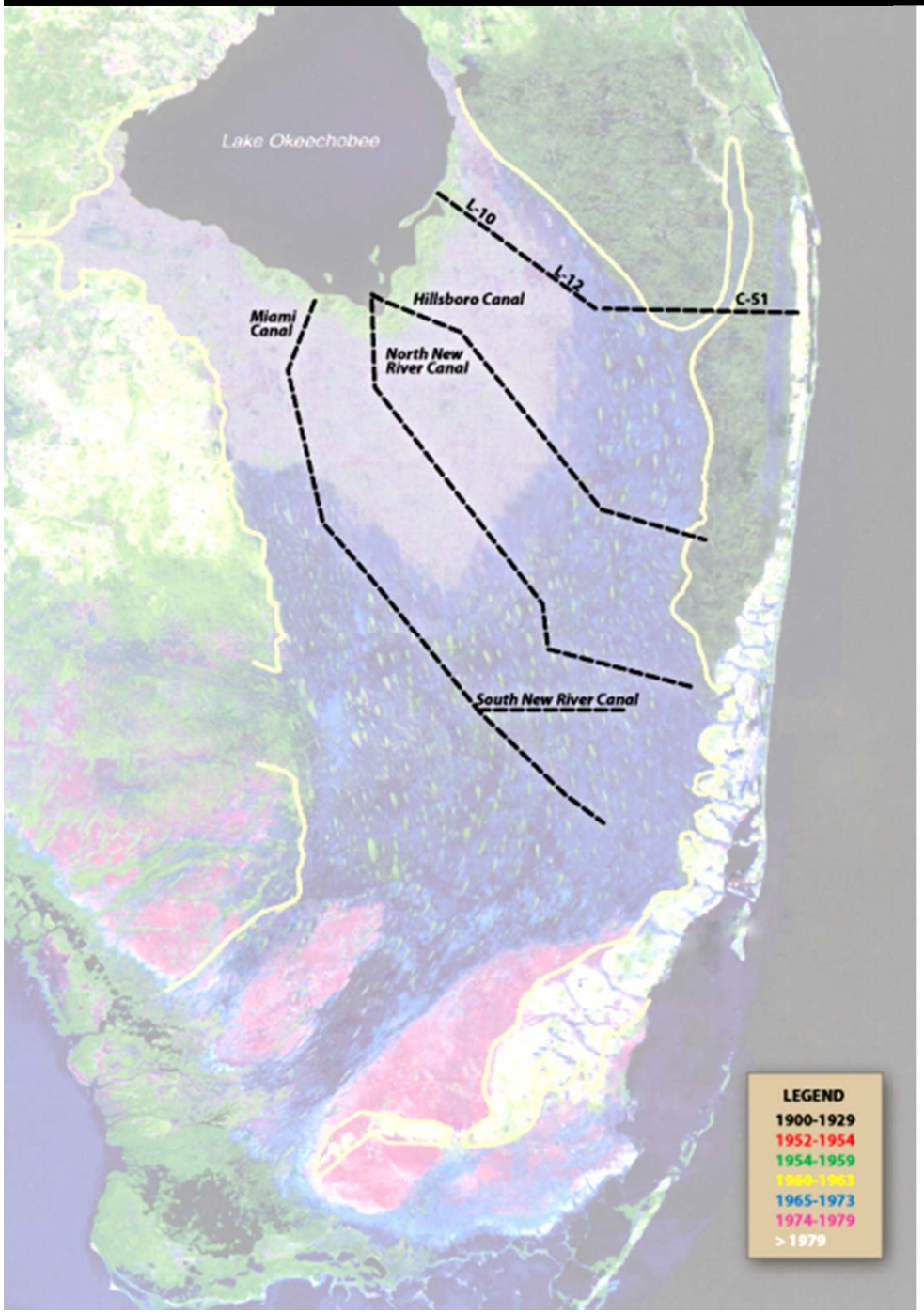
Hydrological Operational Targets and the Screening Process: A Review

Presentation for Restoration Task Force

CEPP Ecosystem Subteam

Fred Sklar, Everglades Systems Assessment, Applied Sci. Bureau, SFWMD

Nov. 19, 2012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L-12
C-51
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South New River Canal
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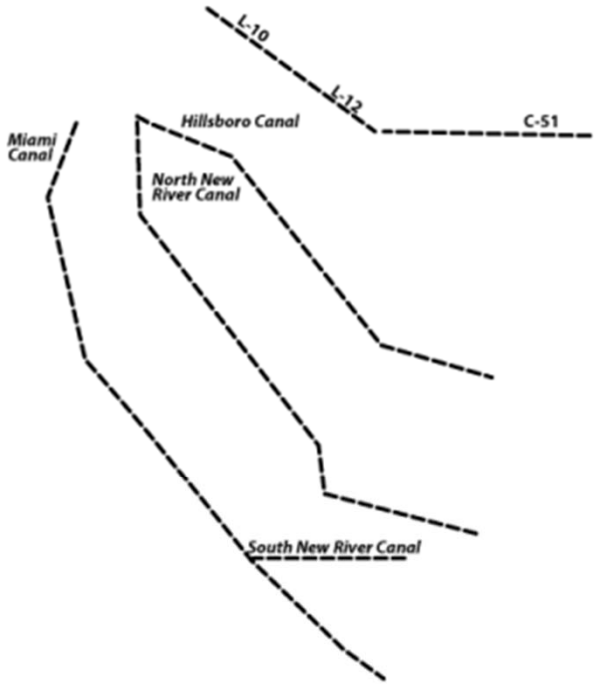
1900-1929
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1900-1929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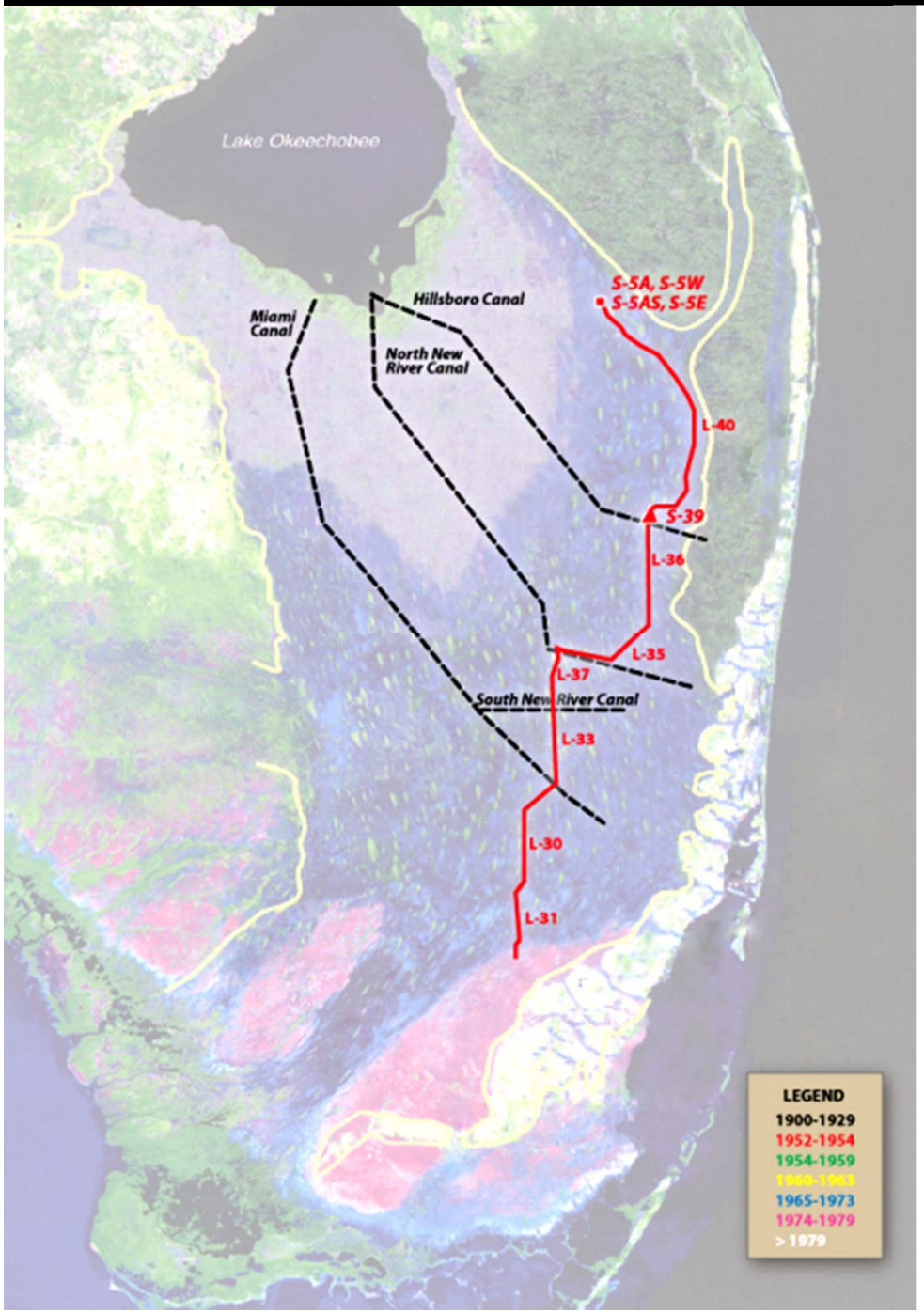
North New River Canal
South New River Canal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Hillsboro Canal
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S-5AS, S-5E
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L-36
L-35
L-37
South New River Canal
L-33
L-30
L-31
LEGEND
1900-1929
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1952-1954

S-5A, S-5W
S-5AS, S-5E
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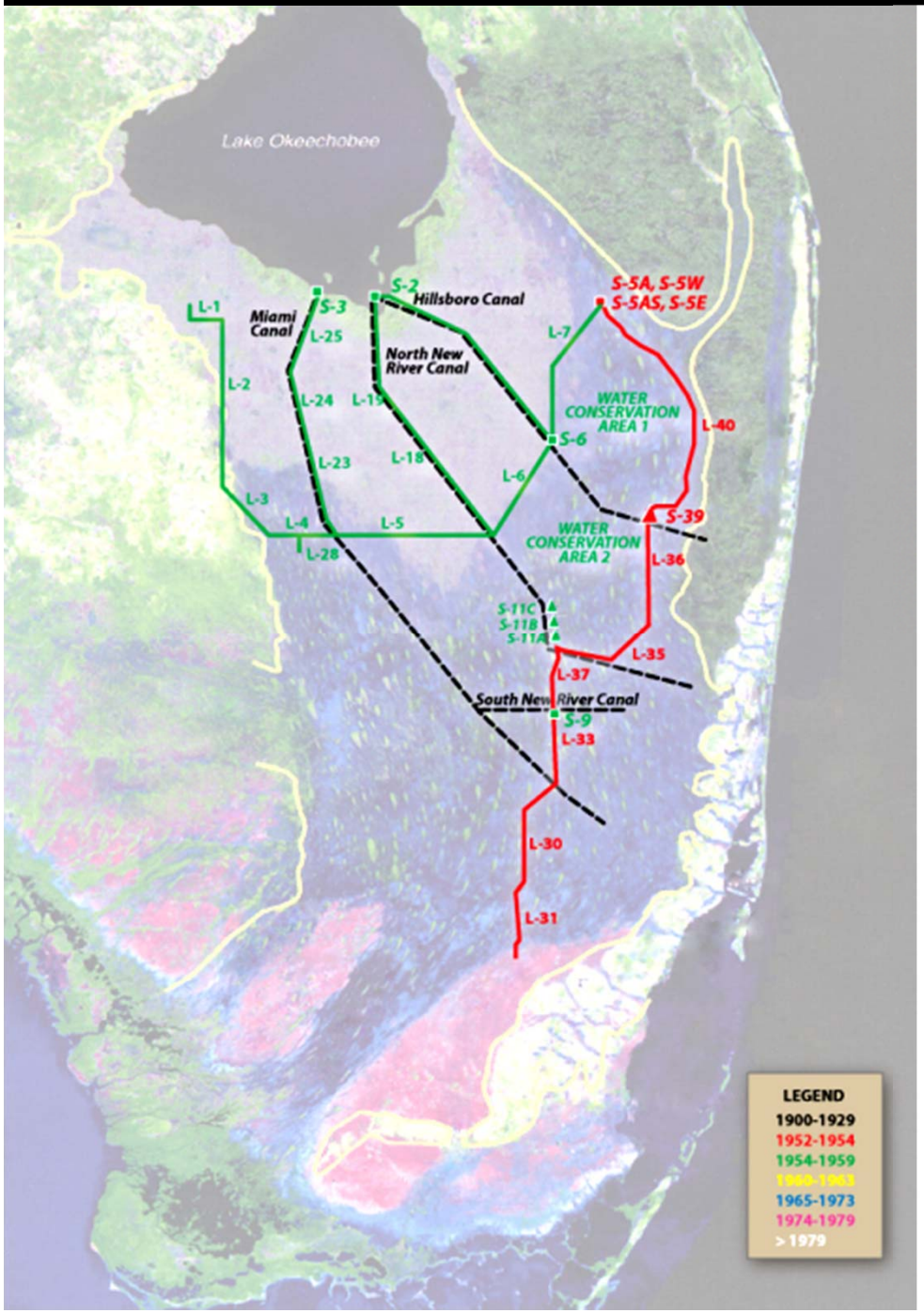
S-39
L-36
L-35
L-37
L-33
L-30
L-31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L-25
S-2
Hillsboro Canal
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L-7
North New River Canal
L-2
L-24
L-19
WATER CONSERVATION AREA 1
L-40
S-6
L-23
L-18
L-6
L-3
L-4
L-5
S-39
WATER CONSERVATION AREA 2
L-28
L-36
S-11C
S-11B
S-11A
L-35
L-37
South New River Canal
S-9
L-33
L-30
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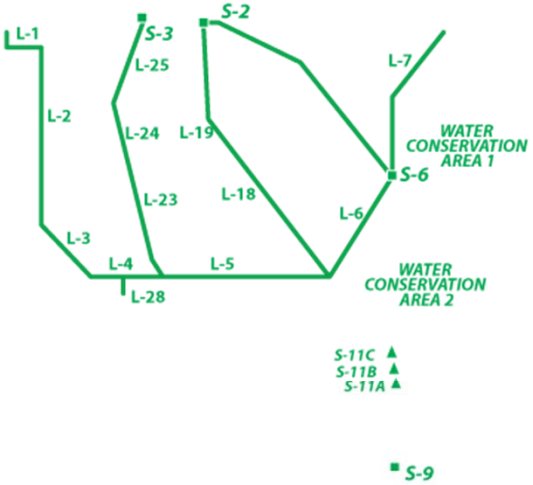
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1954-1959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L-4
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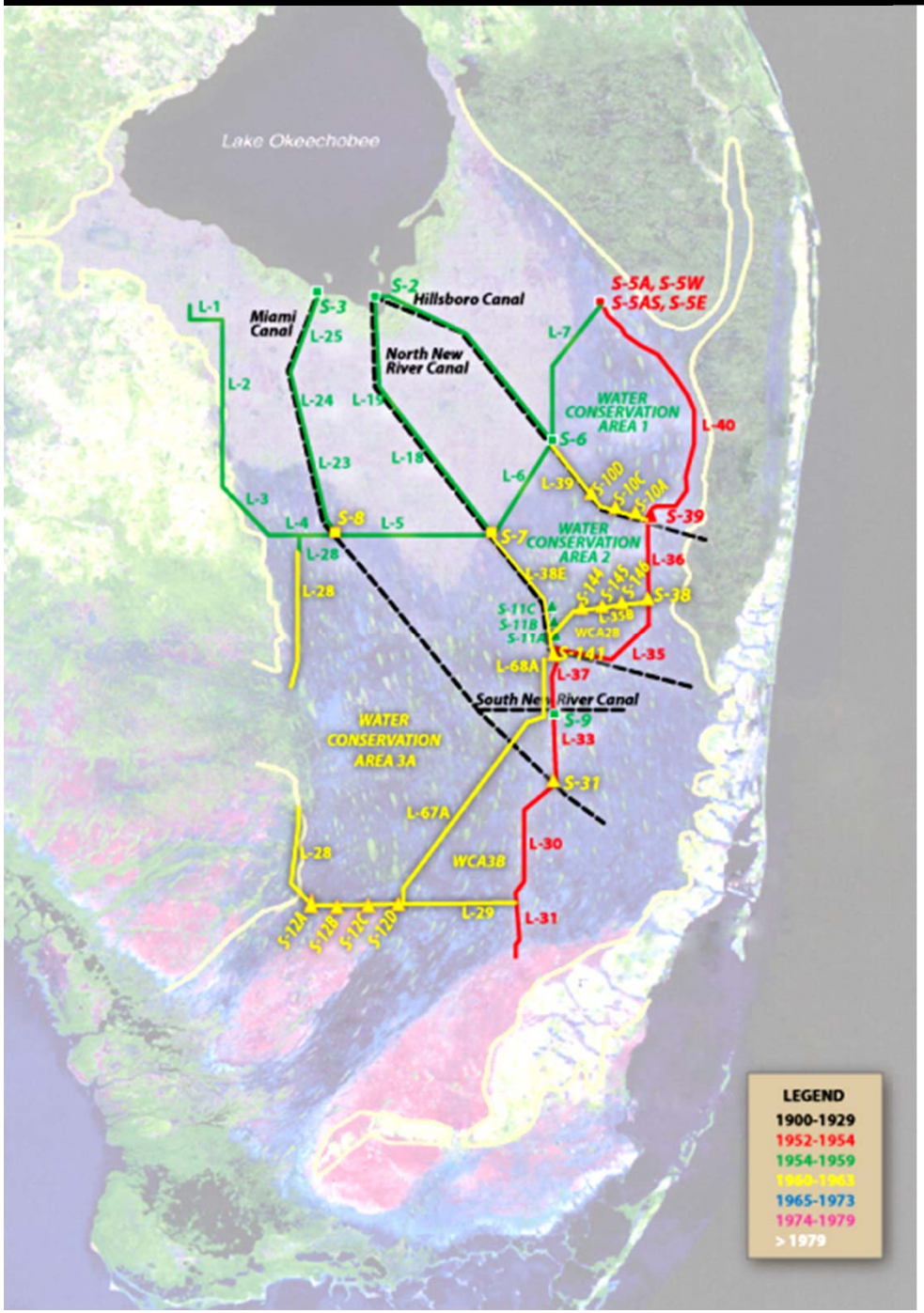
WATER CONSERVATION AREA 2
L-28
S-11C
S-11B
S-11A
S-9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Hillsboro Canal
North New River Canal
South New River Canal
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S-5AS, S-5E
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WATER CONVERSION AREA 2
WATER CONVERSION AREA 3A
WCA2B
WCA3B
L-1
L-2
L-3
L-4
L-5
L-6
L-7
L-18
L-19
L-23
L-24
L-25
L-28
L-29
L-30
L-31
L-33
L-35
L-35B
L-36
L-37
L-38E
L-39
L-40
L-67A
L-68A
S-2
S-3
S-6
S-7
S-8
S-9
S-10A
S-10C
S-10D
S-11A
S-11B
S-11C
S-12A
S-12B
S-12C
S-12D
S-31
S-38
S-39
S-141
S-144
S-145
S-146
LEGEND
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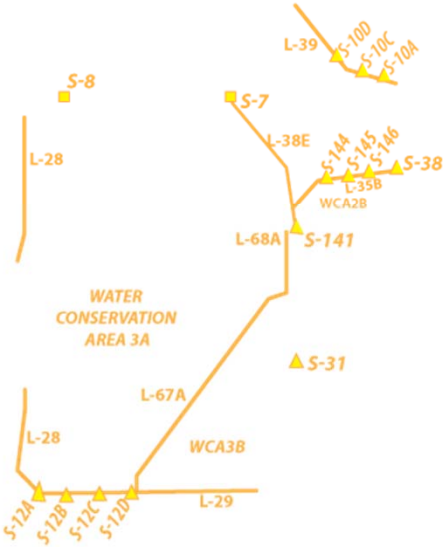
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1960-1963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L-35B
WCA2B
L-68A
S-141
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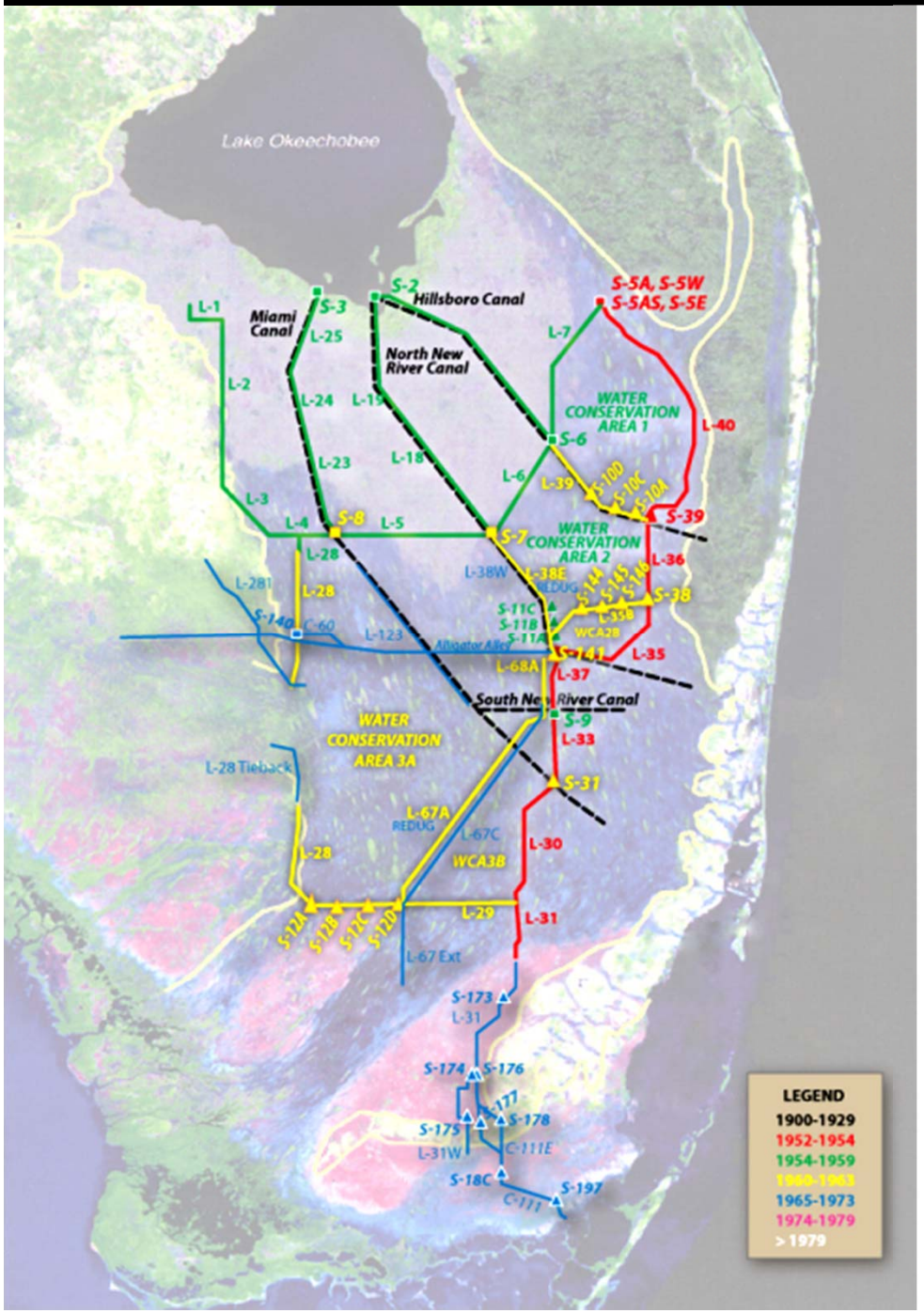
L-67A
L-28
WCA3B
S-12A
S-12B
S-12C
S-12D
L-29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Hillsboro Canal
North New River Canal
South New River Canal
S-5A, S-5W
S-5AS, S-5E
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WATER CONSERVATION AREA 2
WATER CONSERVATION AREA 3A
WCA3B
WCA2B
Alligator Alley
REDUG
L-1
L-2
L-3
L-4
L-5
L-6
L-7
L-18
L-23
L-24
L-25
L-28
L-281
L-38W
L-38E
L-39
L-40
L-36
L-35
L-37
L-33
L-30
L-31
L-29
L-67A
L-67C
L-67 Ext
L-28 Tieback
L-123
S-2
S-3
S-6
S-7
S-8
S-9
S-31
S-38
S-39
S-140
C-60
S-141
S-173
S-174
S-175
S-176
S-177
S-178
S-197
L-31
L-31W
C-111E
S-18C
C-111
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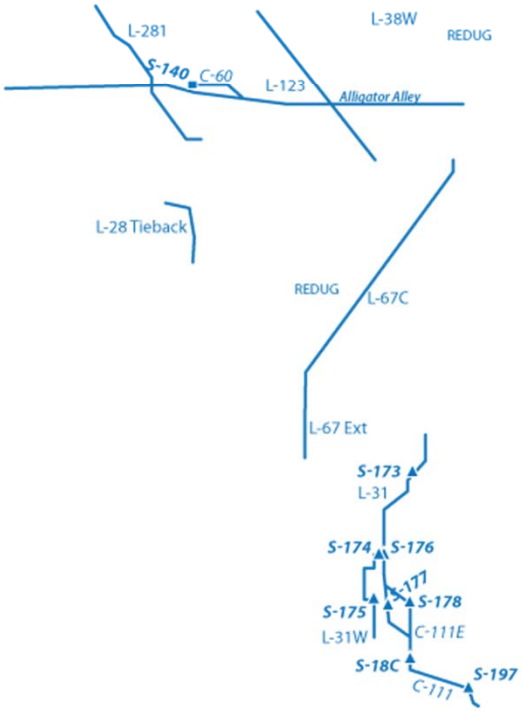
1900-1929
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1965-1973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L-38W
REDUG
S-140
C-60
L-123
Alligator Alley
L-28 Tieback
REDUG
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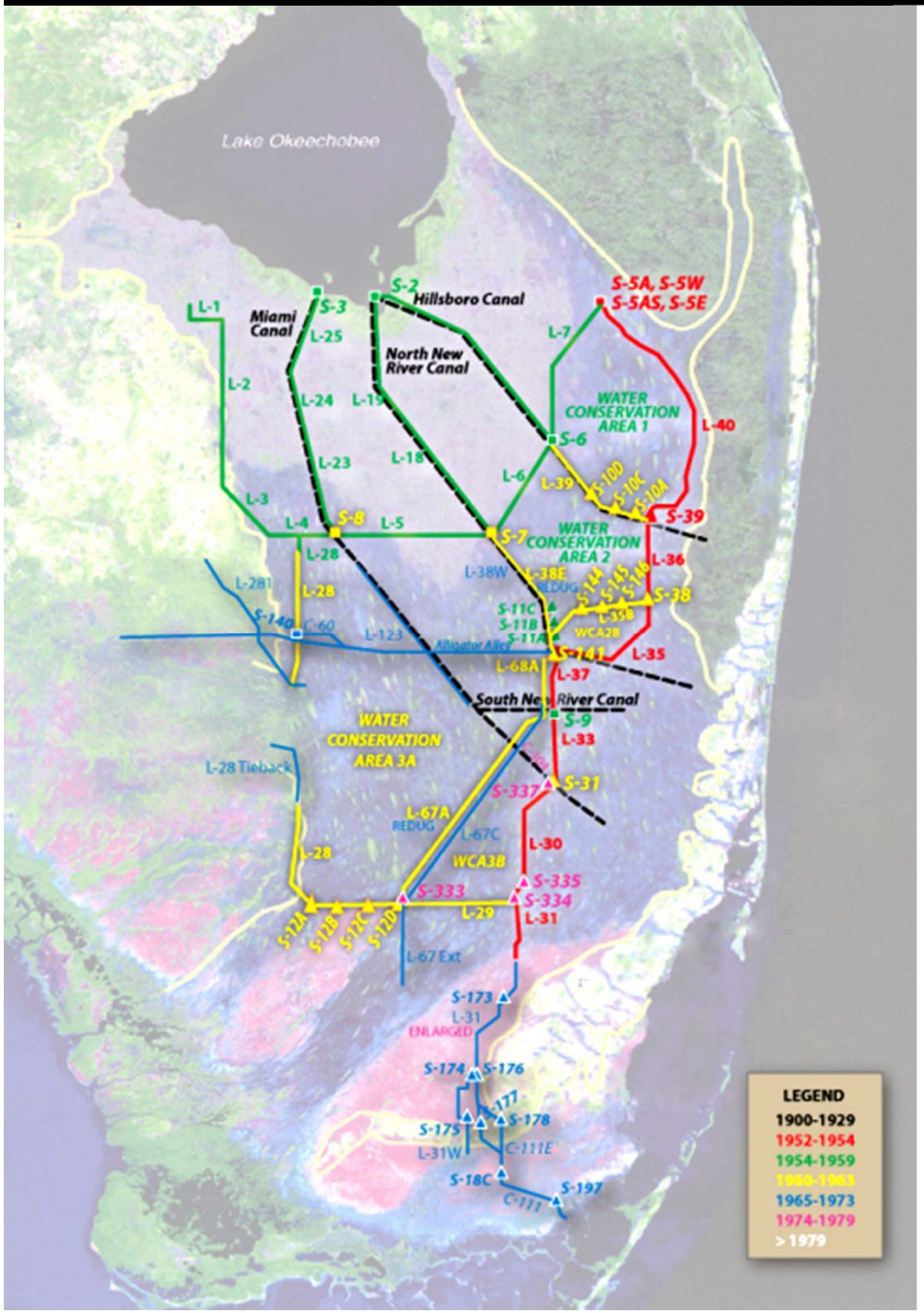
C-111


Lake Okeechobee
Miami Canal
Hillsboro Canal
North New River Canal
South New River Canal
WATER CONSERVATION AREA 1
WATER CONSERVATION AREA 2
WATER CONSERVATION AREA 3A
WCA3B
S-5A, S-5W
S-5AS, S-5E
S-2
S-3
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S-9
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S-37
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S-40
S-141
S-333
S-334
S-335
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S-174
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S-18C
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L-5
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L-18
L-19
L-23
L-24
L-25
L-28
L-28 Tieback
L-29
L-30
L-31
L-33
L-35
L-36
L-37
L-38E
L-38W
L-39
L-40
L-67A
L-67C
L-67 Ext
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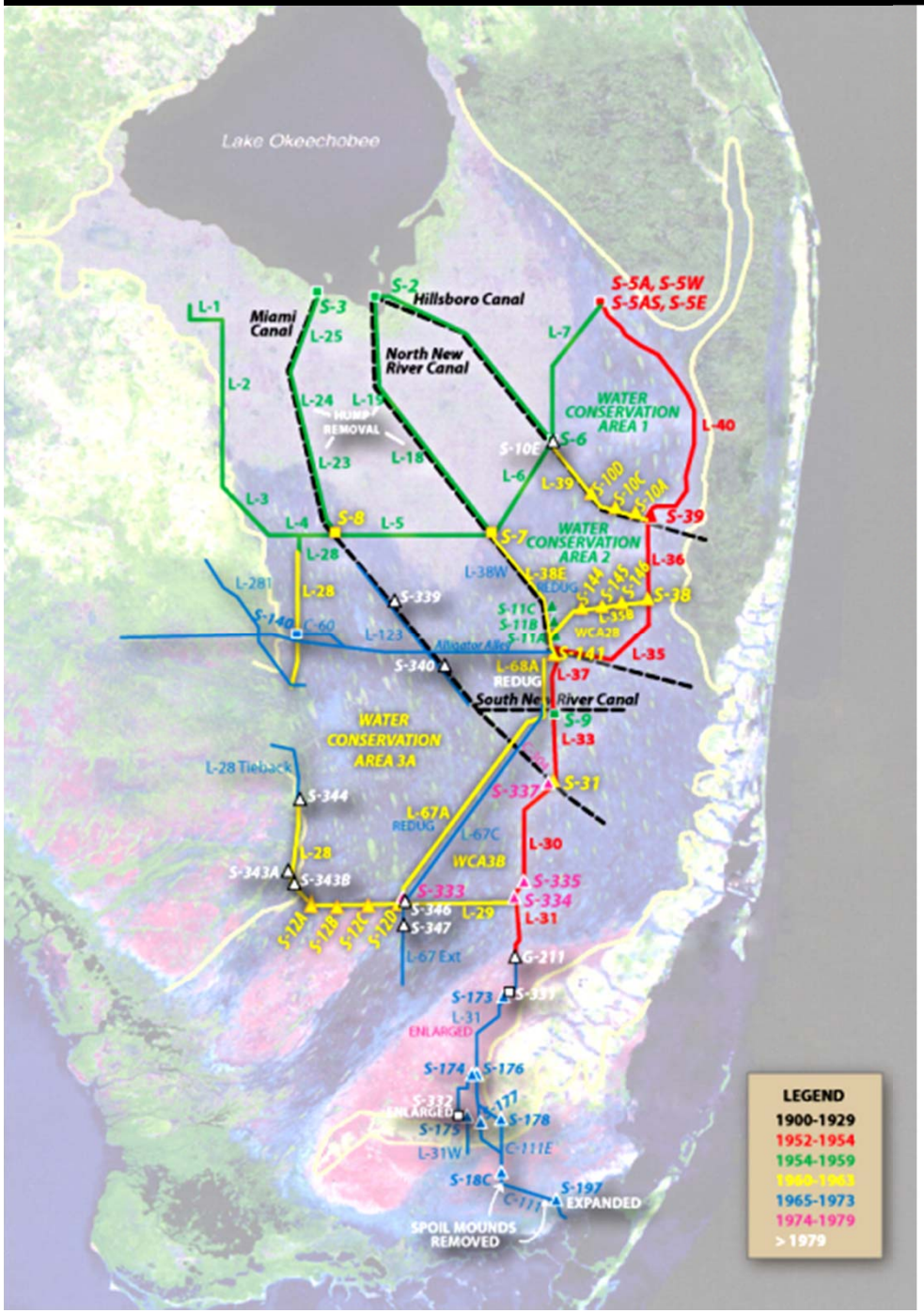
L-123
L-281
C-60
C-111
C-111E
L-31W
L-31 ENLARGED
REDUG
Alligator Alley
LEGEND
1900-1929
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

1974-1979

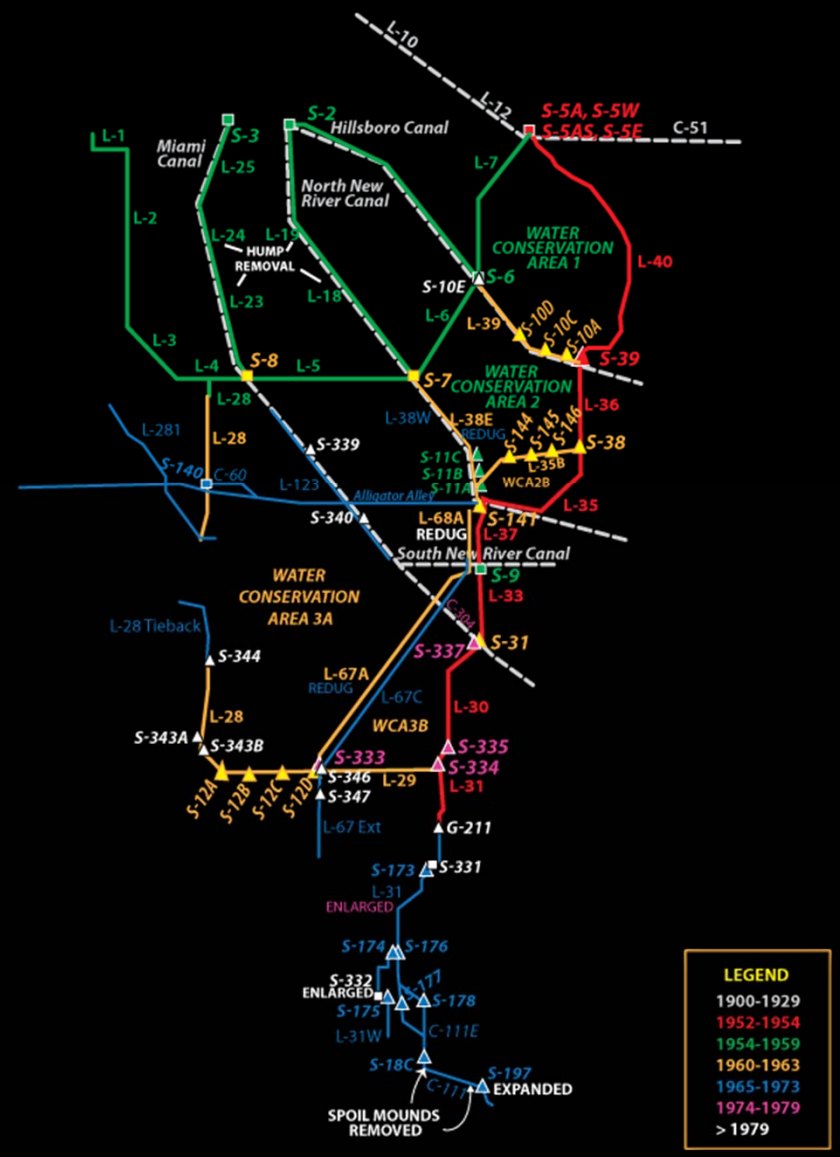
C-304
S-337
S-333
S-335
S-334
ENLARGED


Lake Okeechobee
Miami Canal
Hillsboro Canal
North New River Canal
S-5A, S-5W
S-5AS, S-5E
WATER CONSERVATION AREA 1
WATER CONSERVATION AREA 2
WATER CONSERVATION AREA 3A
HUMP REMOVAL
REDUG
WCA2B
WCA3B
South New River Canal
ENLARGED
EXPANDED
SPOIL MOUNDS REMOVED
LEGEND
1900-1929
1952-1954
1954-1959
1960-1963
1965-1973
1974-1979
> 1979

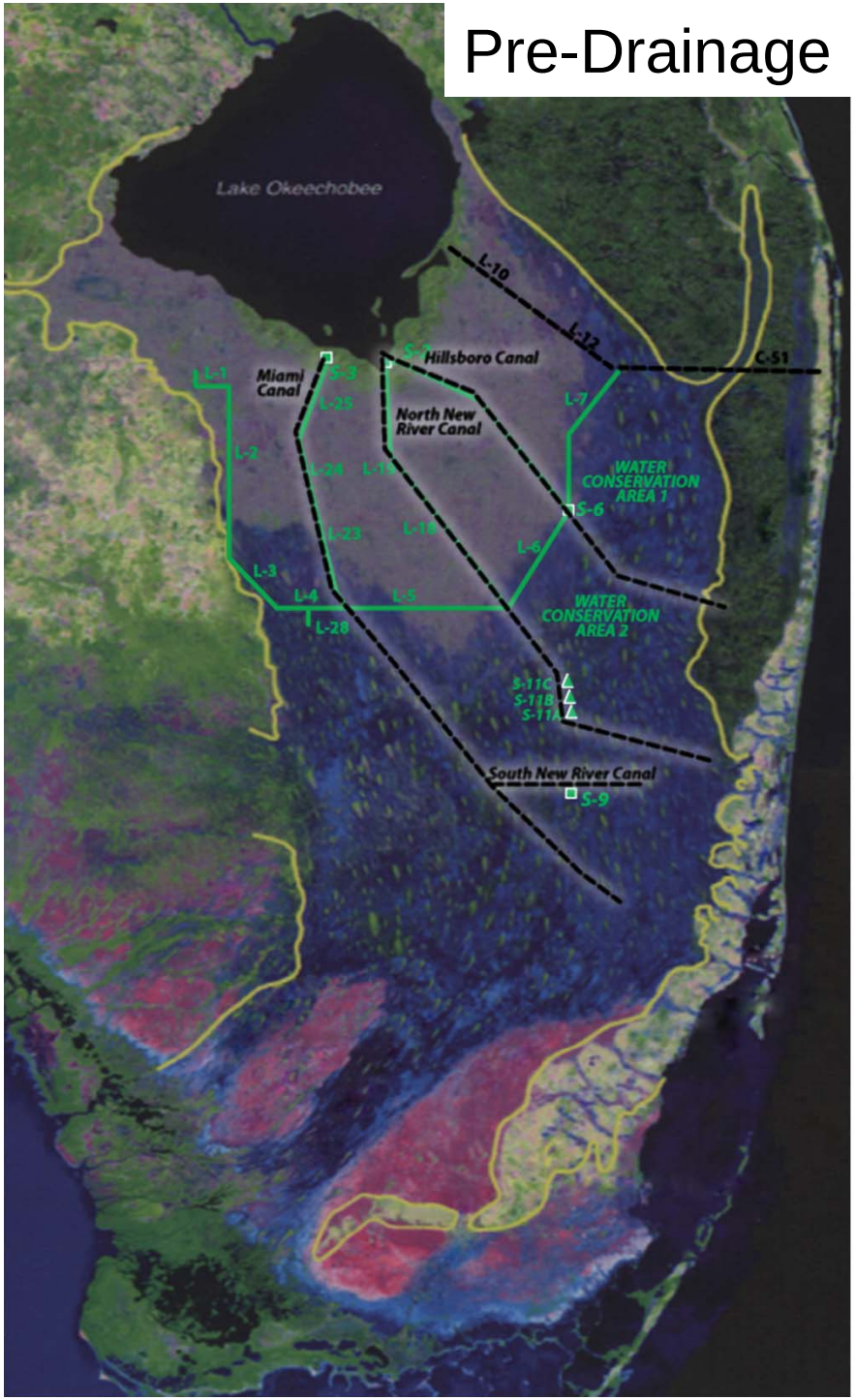
> 1979

HUMP REMOVAL
S-10E
S-339
S-340
REDUG
S-344
S-343A
S-343B
S-346
S-347
G-211
S-331
S-332
ENLARGED
EXPANDED
SPOIL MOUNDS REMOVED

SOUTH FLORIDA WATER MANAGEMENT DISTRICT



Pre-Drainage



Post-Drainage

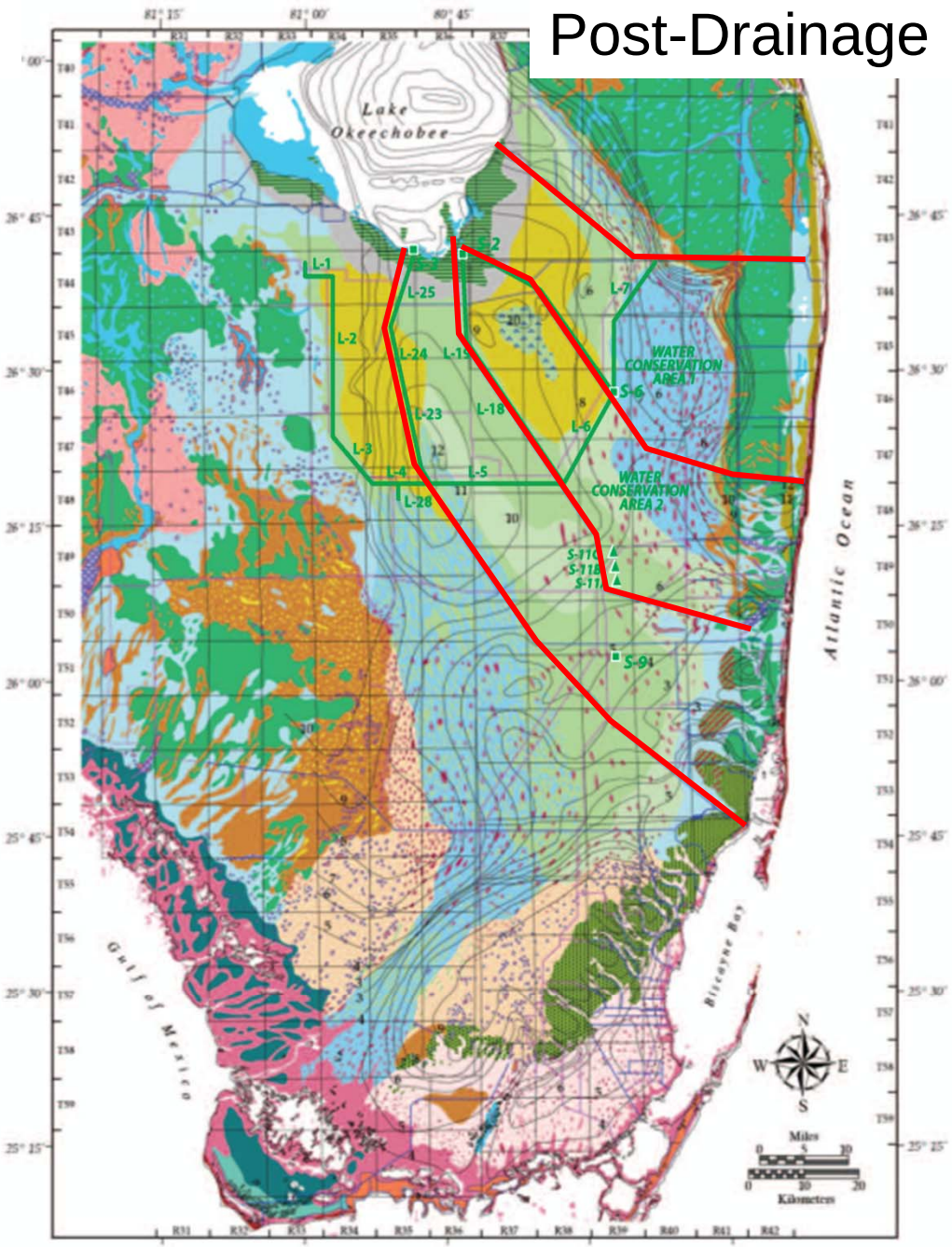
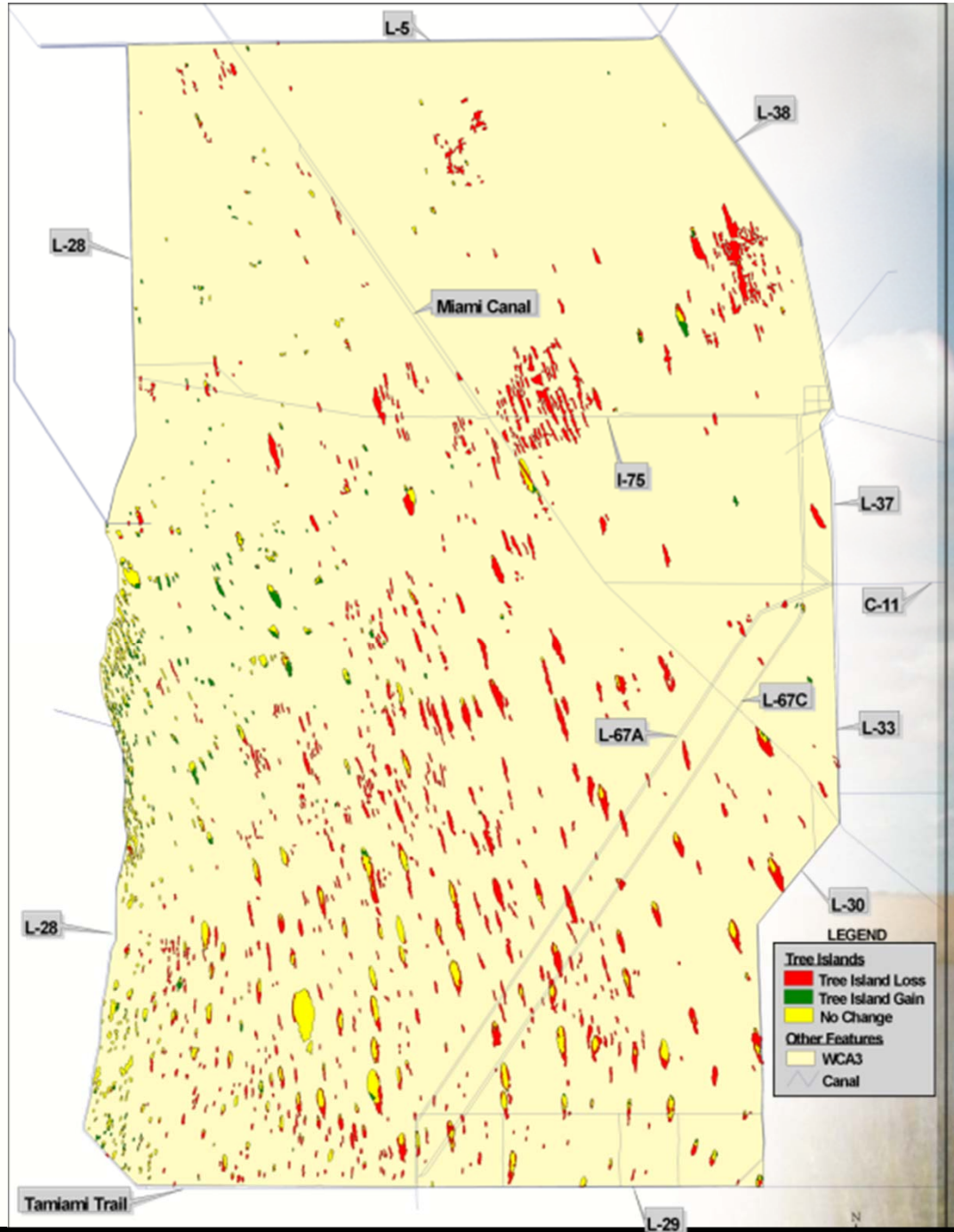
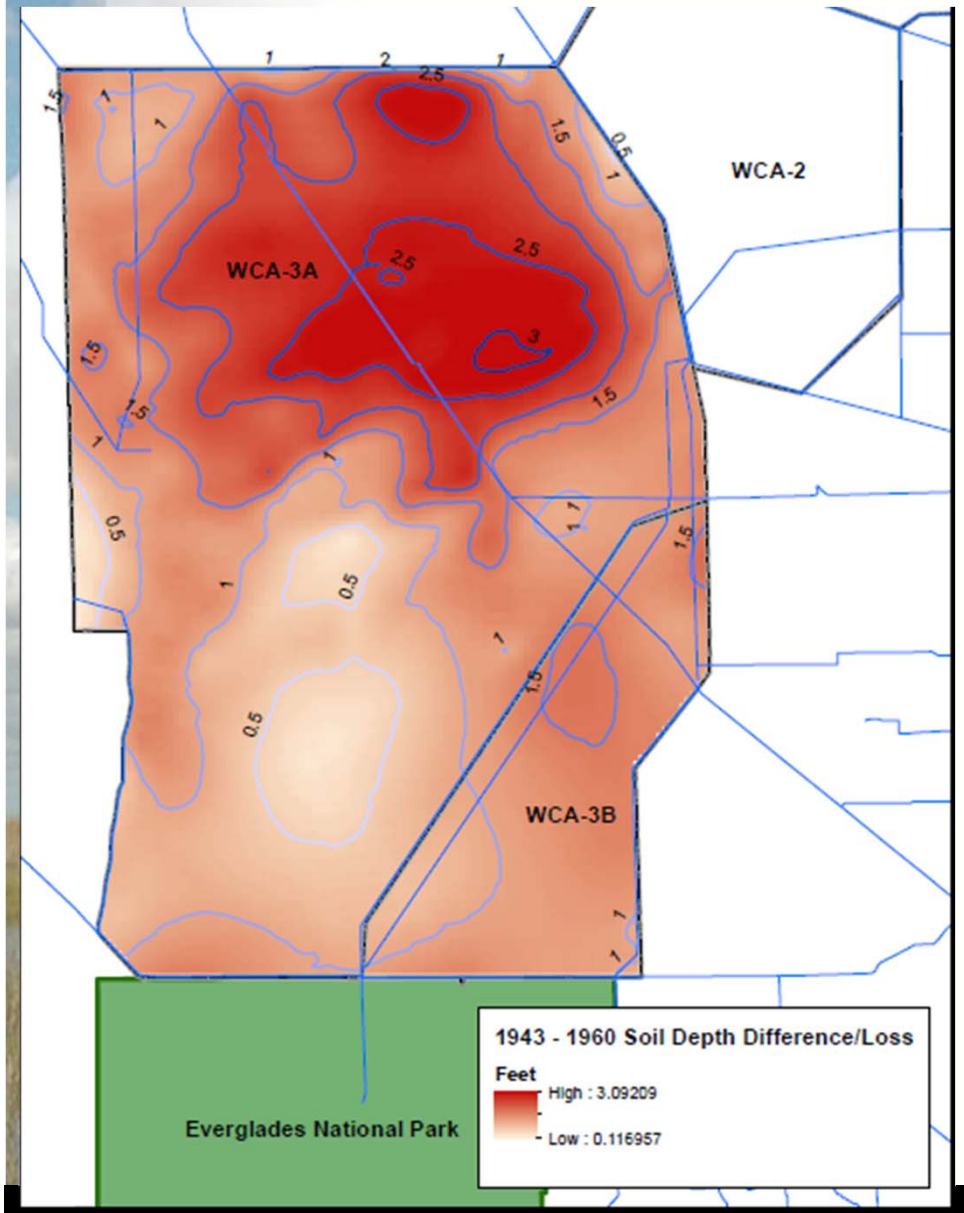


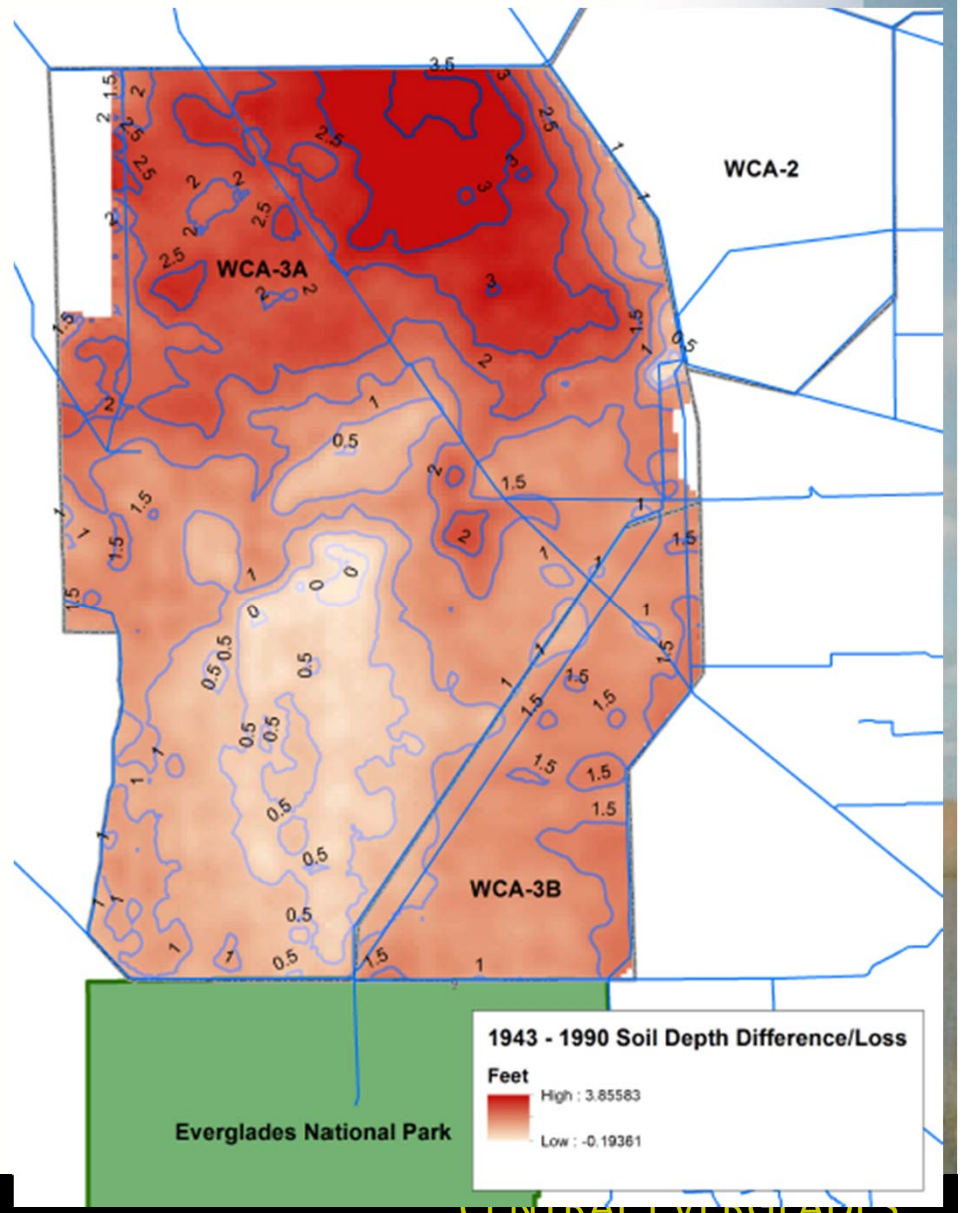
Plate 13. Postdrainage vegetation map of southern Florida, ca. 1940. See plate 12 for legend. Overlays: contours of rock floor of the Everglades, township range grid, and 1990 canals. Vegetation digitized from Davis (1943b); rock floor digitized from Parker et al. (1955).

Cumulative Tree Island Changes in WCA3 from 1940 until 2004

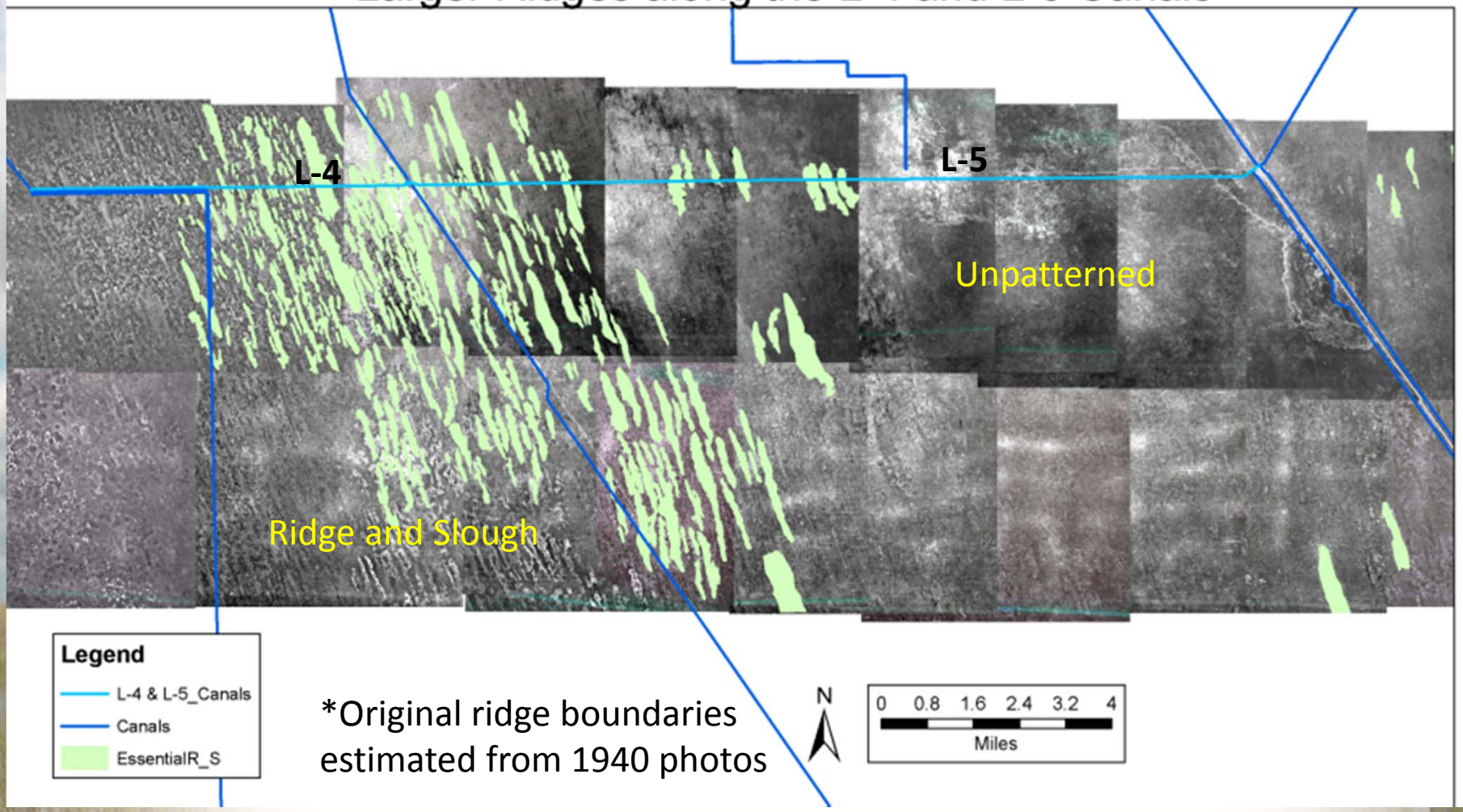


Soil Depth Changes in WA-3A/3B 1940's – 1990's





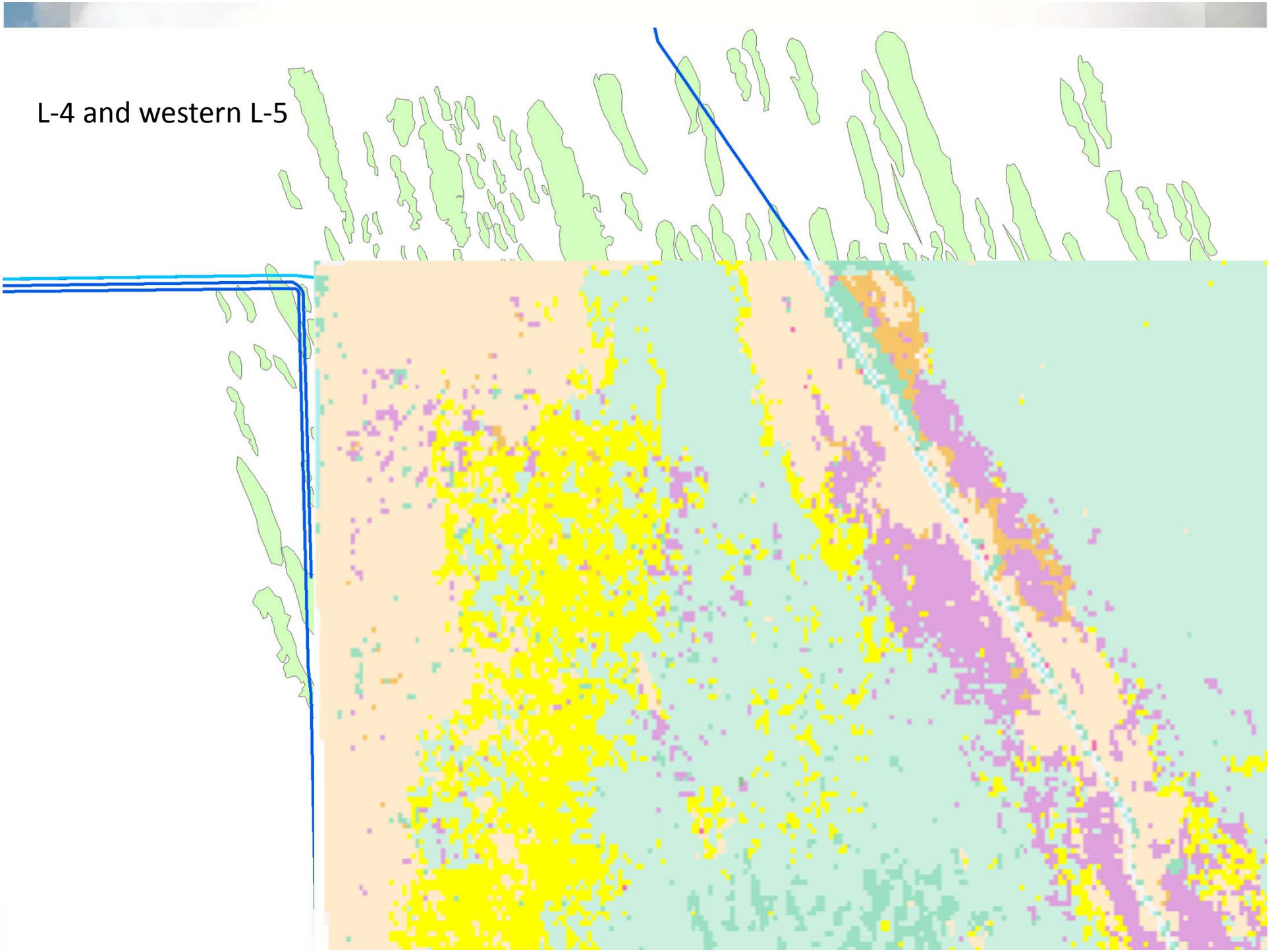
1940 USGS Aerial Photographs
Larger Ridges along the L-4 and L-5 Canals*



*Original ridge boundaries estimated from 1940 photos

DRAFT

L-4 and western L-5



WCA-3A (NW)

WCA-3A (NE)
Remnant Sawgrass Plain

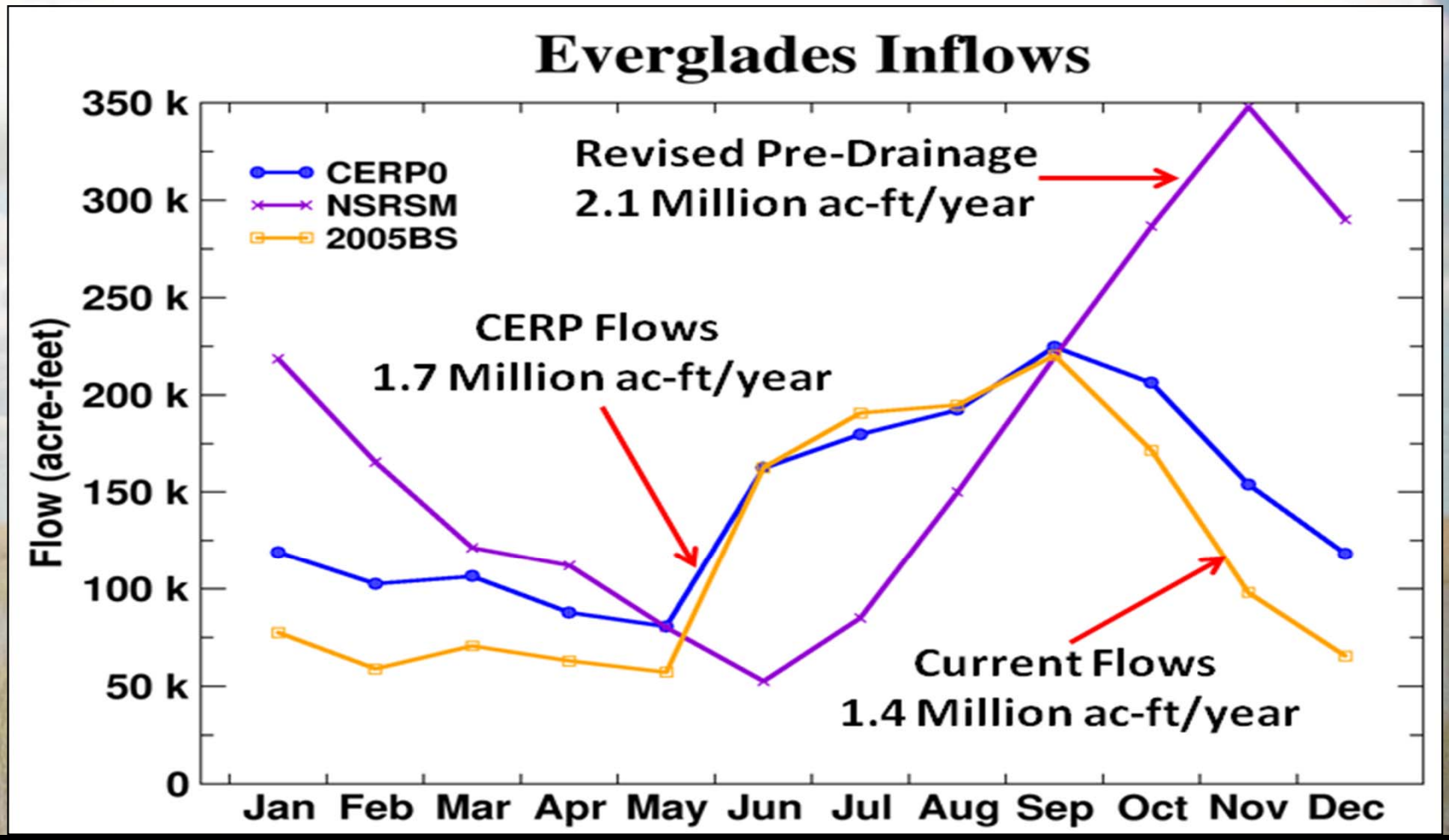
iModel for CEPP Screening

- iModel is a computer optimization program that provides flow scenarios (solutions) to meet numerous, operational targets simultaneously.
- Modeling team needs hydrologic targets in WCA3A, WCA3B and ENP for the iModel.
- iModel will show percent of target achieved and changes in infrastructure/operations, to achieve an increment of CEPP restoration.

Level 1 Screening Criteria

Everglades Dry Standard Score

Seasonality of Flows from STA's



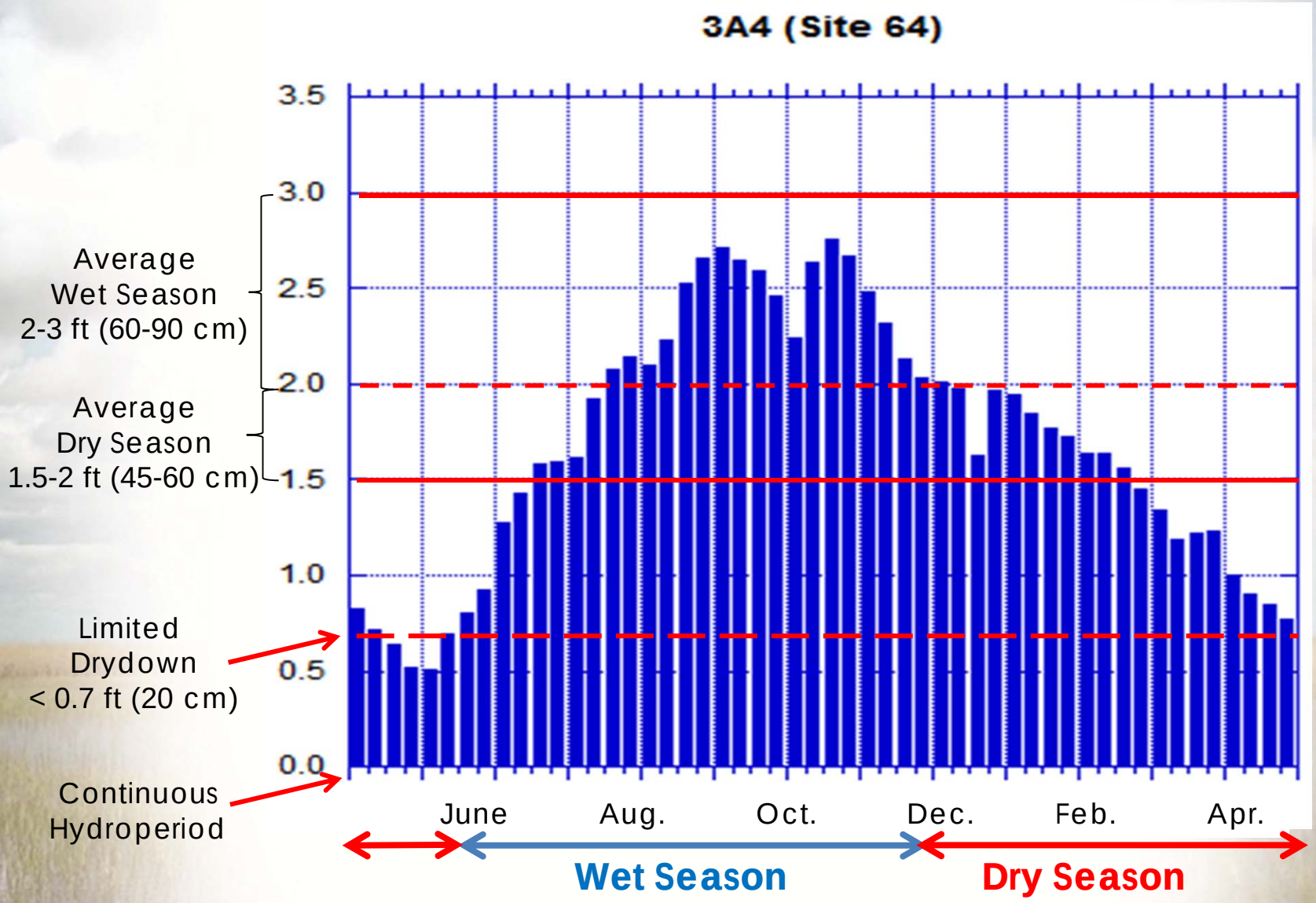
Hydrological and Ecological iModel Operational Targets

- Targets designed to achieve a natural system hydrology needed for ridge and slough landscape conservation and restoration (and used offsets where appropriate)
- Targets aim for an **increment of restoration** that will benefit the areas given the current ecology and elevations (e.g. sawgrass plain in northeastern WCA3).
- A major goal was to test possibility of gravity flow from WCA3A to WCA3B to ENP

Slough Vegetation Performance Measure (PM)

- This RECOVER PM provides a target that describes a full-restoration, pre-drainage pattern of hydroperiods within sloughs, with the expectation that suitable water depths for slough vegetation will provide the desired restoration condition for the entire ridge and slough landscape.
- Four hydrologic metrics are combined to determine suitability for slough vegetation: 1) continuous hydroperiod; 2) continuous dry-down duration below 0.7 ft (20 cm); 3) wet season average water depth; and 4) dry season average water depth.

Weekly Average Water Depth (2000-2011)



Gage Locations for iModel Targets in WCA 1, WCA 2A, WCA 2B, WCA 3A, & WCA 3B (GREEN 1)

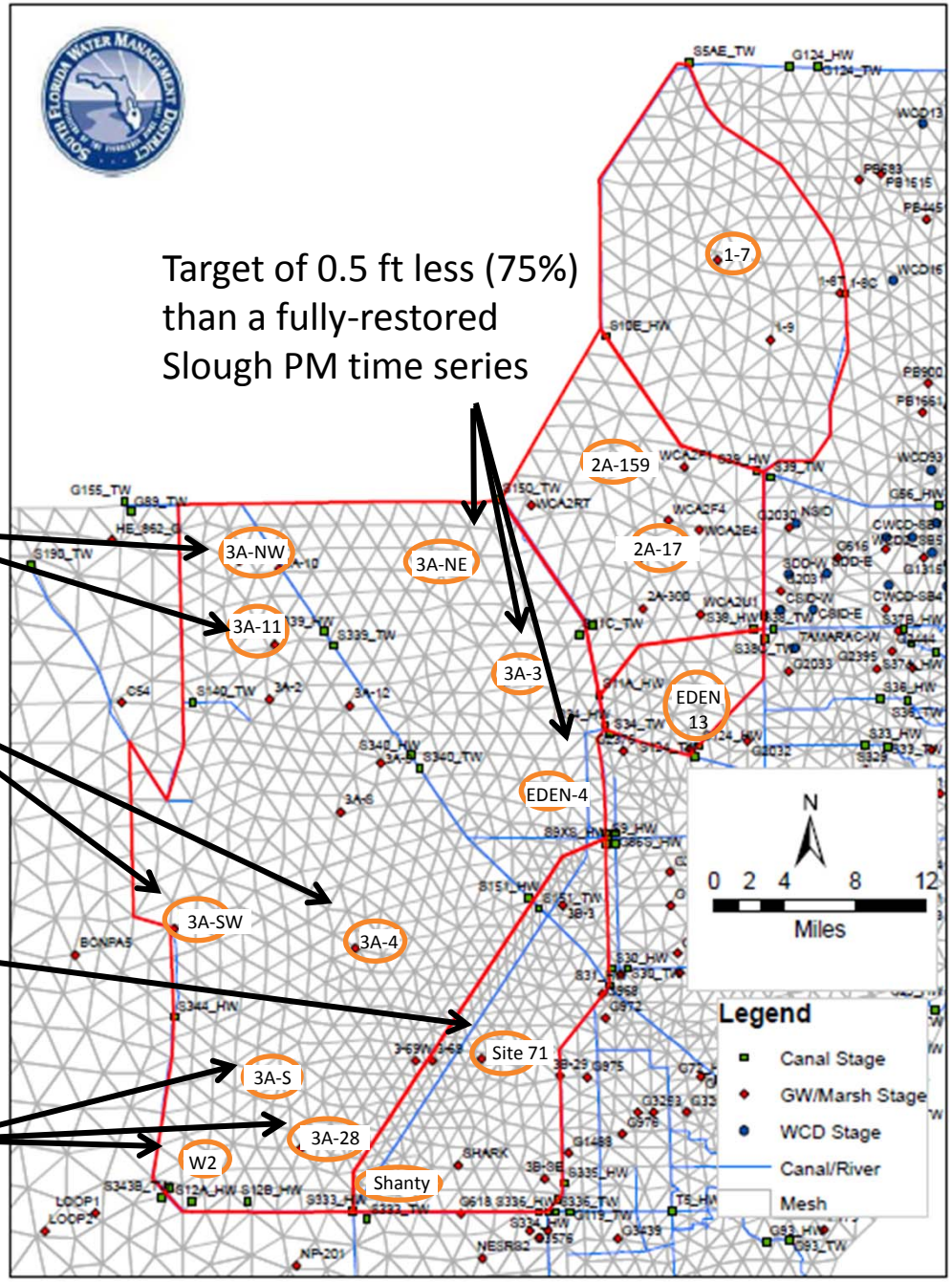
Target of 0.25 ft less (88%) than a fully-restored Slough PM time series

Target is a fully-restored (Site 64) Slough PM time series

Target is a "lower" Slough PM time series <u>and</u> 2.5-3.0 ft not to exceed 60 days duration for more than 3 consecutive years

Target is a fully-restored Slough PM time series

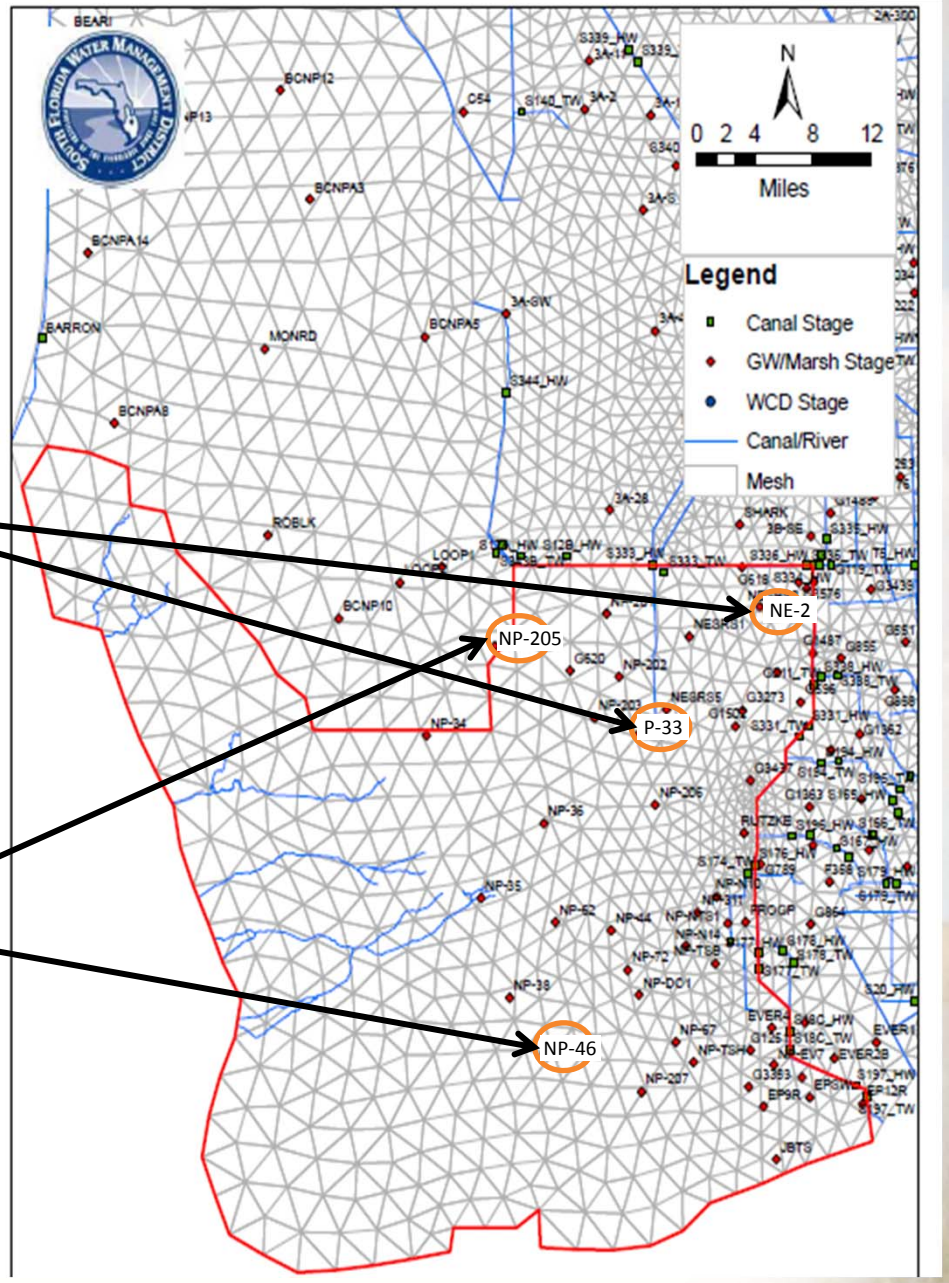
Target of 0.5 ft less (75%) than a fully-restored Slough PM time series



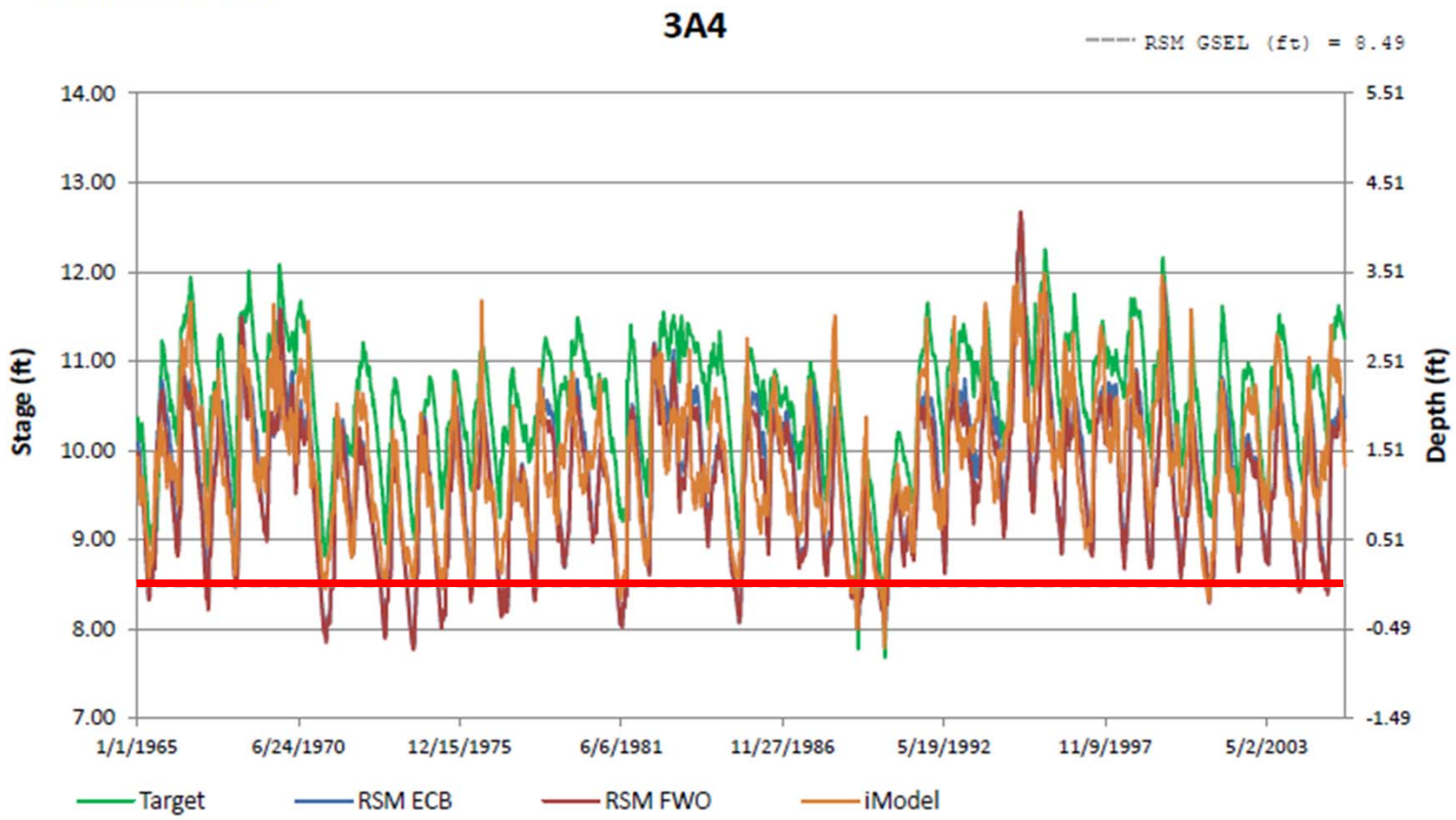
Gage Locations for iModel Targets in ENP

Target is a fully restored Slough PM time series at NE-2 and P-33

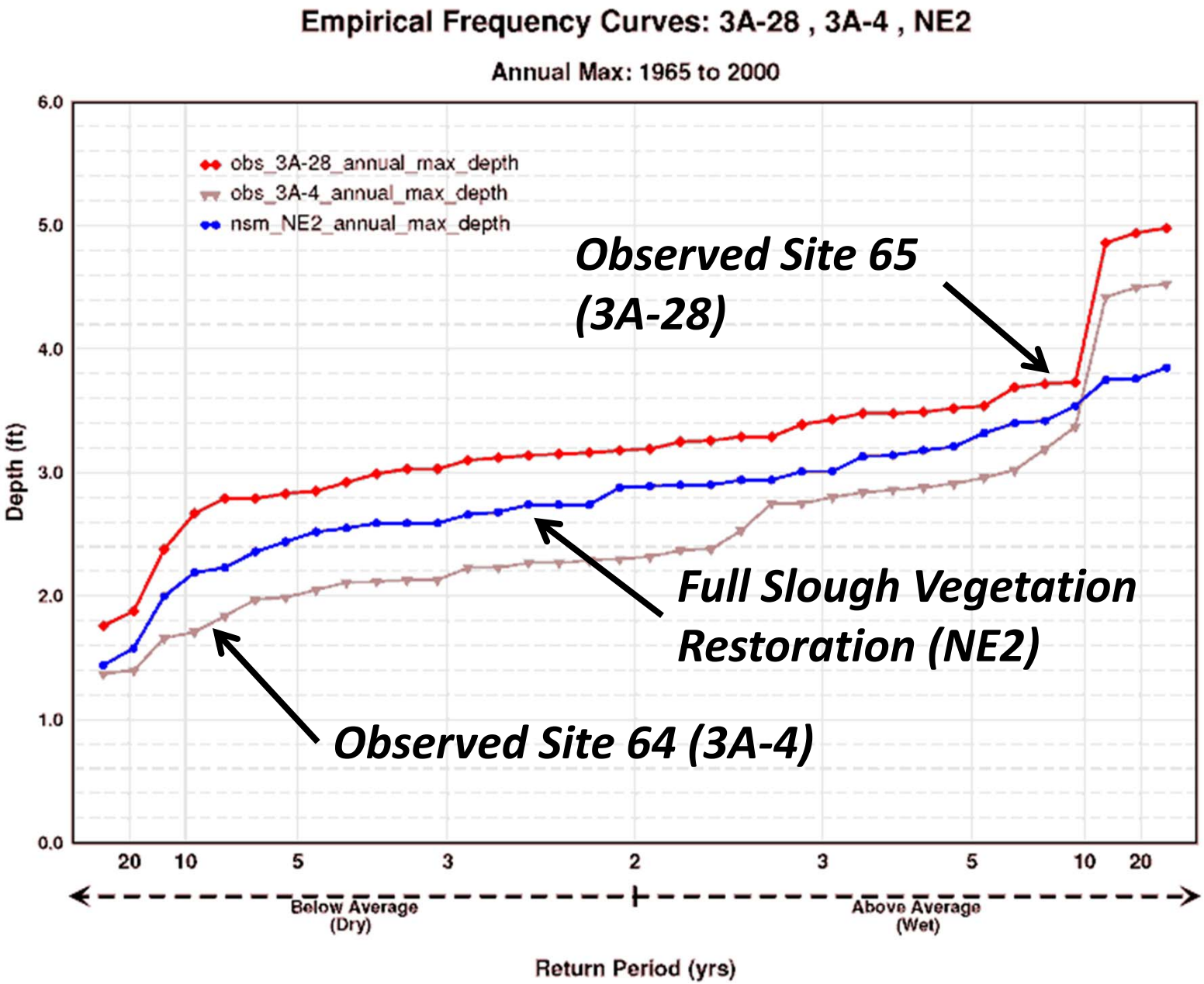
Target is a time series that mimics a preserved marl prairie water depths (approx. -0.5 to 1.25 ft) for NP-205 and NP-46

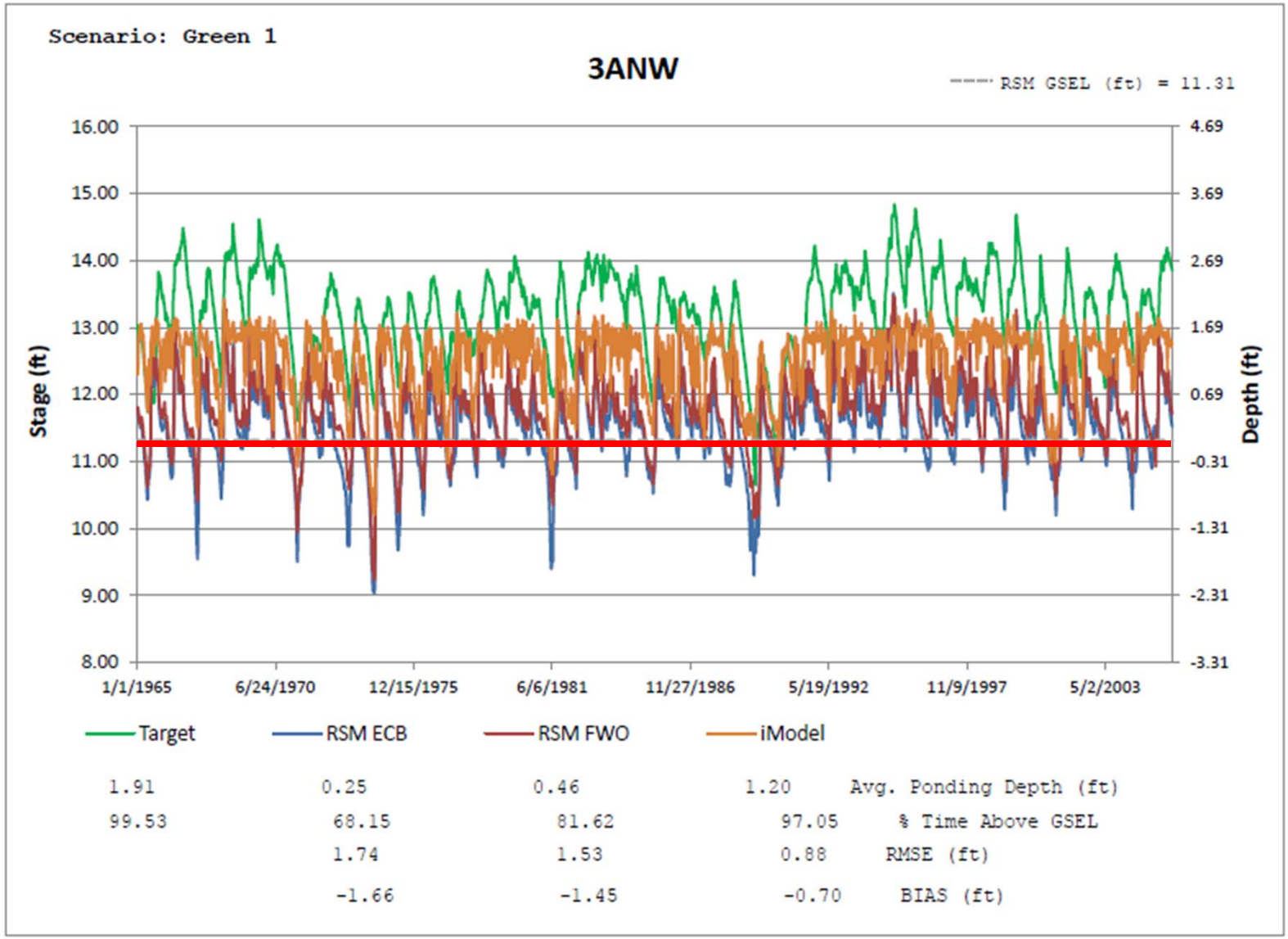


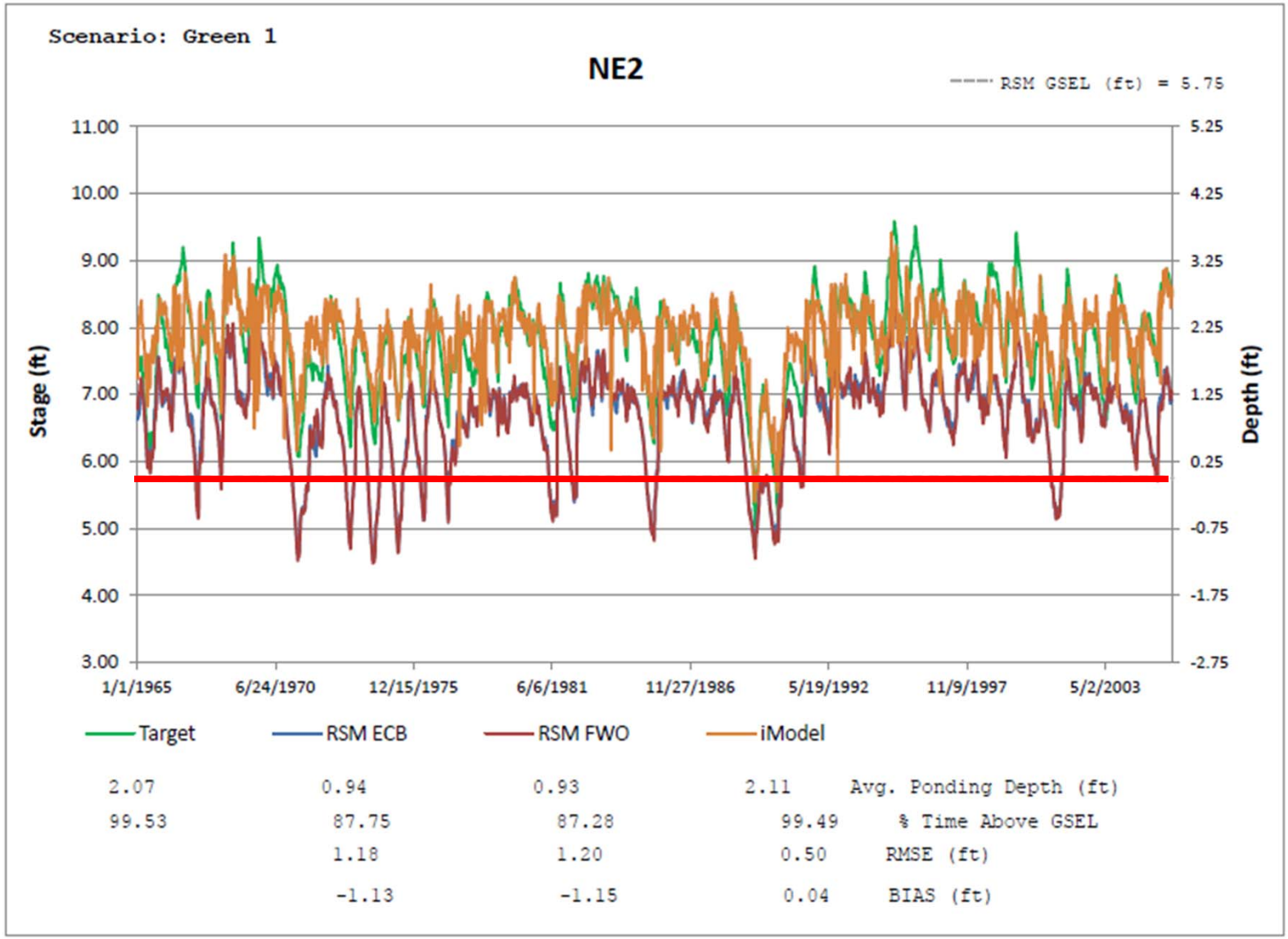
Scenario: Green 1



2.07	1.23	1.13	1.38	Avg. Ponding Depth (ft)
99.53	92.38	91.35	98.41	% Time Above GSEL
	0.93	1.02	0.83	RMSE (ft)
	-0.84	-0.94	-0.69	BIAS (ft)


Empirical Frequency Curves: 3A-28 , 3A-4 , NE2
Annual Max: 1965 to 2000
obs_3A-28_annual_max_depth
obs_3A-4_annual_max_depth
nsm_NE2_annual_max_depth
Depth (ft)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
20
10
5
3
2
3
5
10
20
Below Average (Dry)
Above Average (Wet)
Return Period (yrs)
Observed Site 65 (3A-28)
Full Slough Vegetation Restoration (NE2)
Observed Site 64 (3A-4)


Scenario: Green 1
3ANW
RSM GSEL (ft) = 11.31
Stage (ft)
Depth (ft)
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
4.69
3.69
2.69
1.69
0.69
-0.31
-1.31
-2.31
-3.31
1/1/1965
6/24/1970
12/15/1975
6/6/1981
11/27/1986
5/19/1992
11/9/1997
5/2/2003
Target
RSM ECB
RSM FWO
iModel
1.91 0.25 0.46 1.20 Avg. Ponding Depth (ft)
99.53 68.15 81.62 97.05 % Time Above GSEL
1.74 1.53 0.88 RMSE (ft)
-1.66 -1.45 -0.70 BIAS (ft)


Scenario: Green 1
NE2
RSM GSEL (ft) = 5.75
Stage (ft)
Depth (ft)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
5.25
4.25
3.25
2.25
1.25
0.25
-0.75
-1.75
-2.75
1/1/1965
6/24/1970
12/15/1975
6/6/1981
11/27/1986
5/19/1992
11/9/1997
5/2/2003
Target
RSM ECB
RSM FWO
iModel
2.07 0.94 0.93 2.11 Avg. Ponding Depth (ft)
99.53 87.75 87.28 99.49 % Time Above GSEL
1.18 1.20 0.50 RMSE (ft)
-1.13 -1.15 0.04 BIAS (ft)

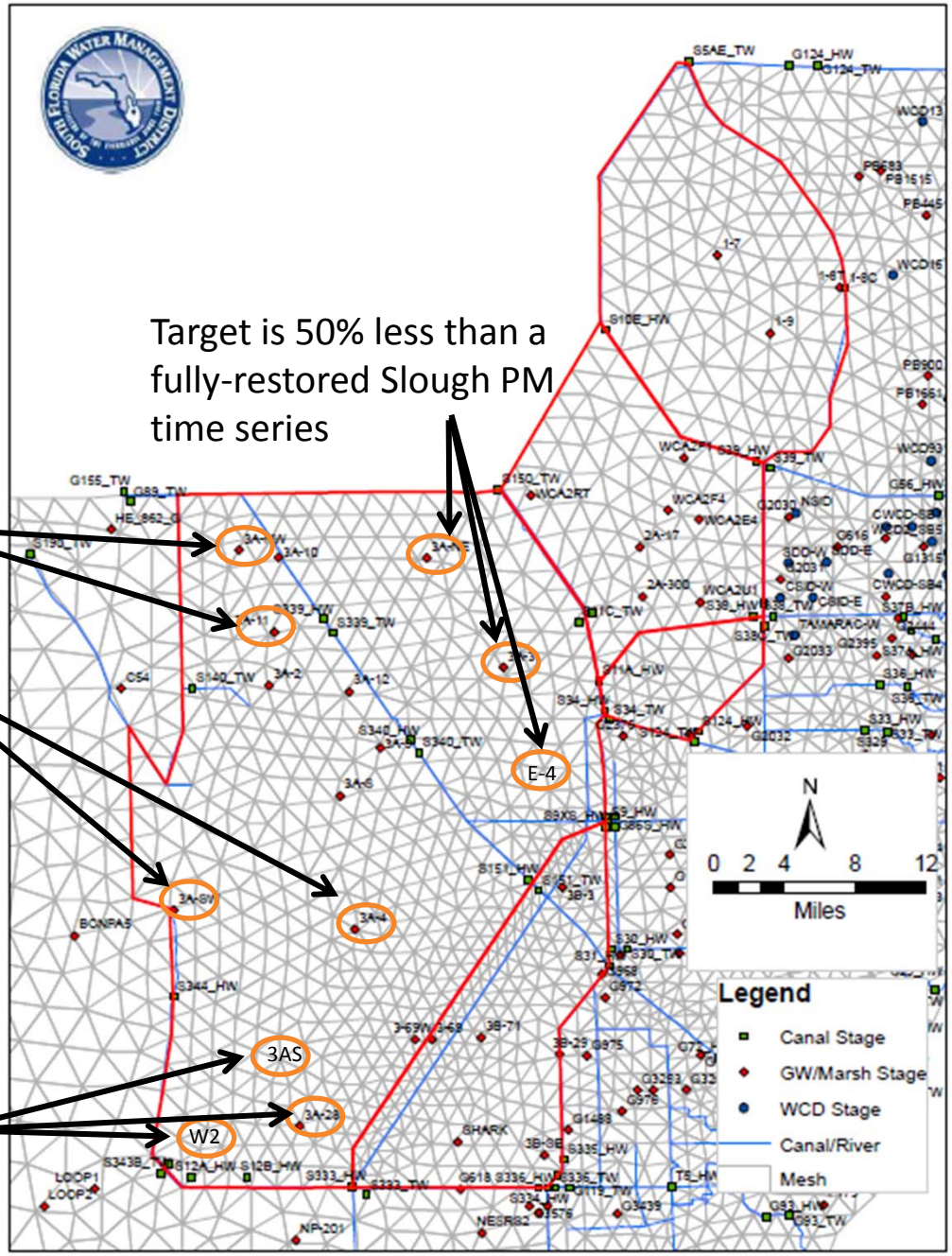
Location of Gages in WCA3 A&B and iModel Targets

Target is 50% less than a fully-restored Slough PM time series

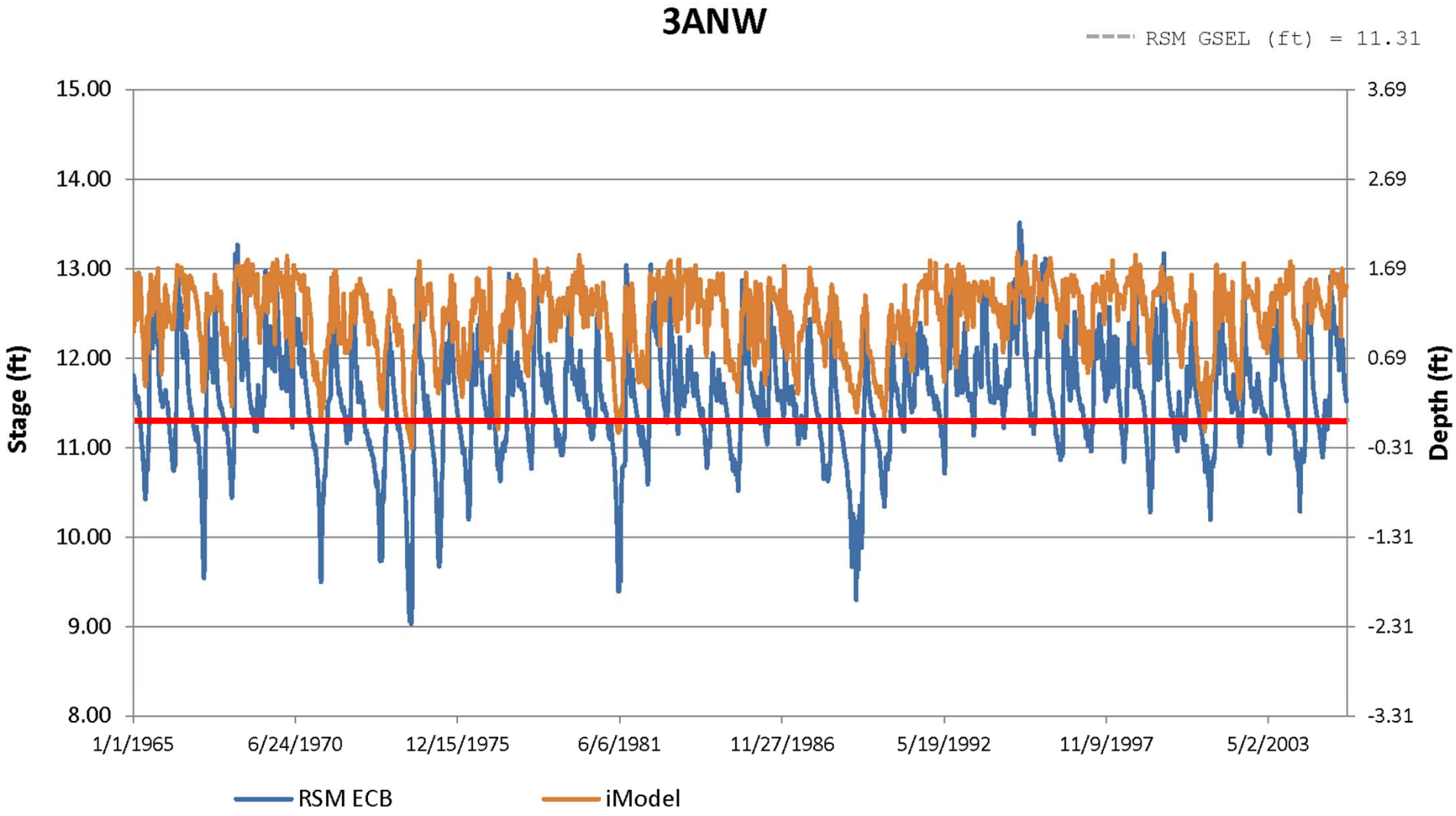
Target is a fully-restored Slough PM time series

Target is 50% less than a fully-restored Slough PM time series

Target is a fully-restored Slough PM time series

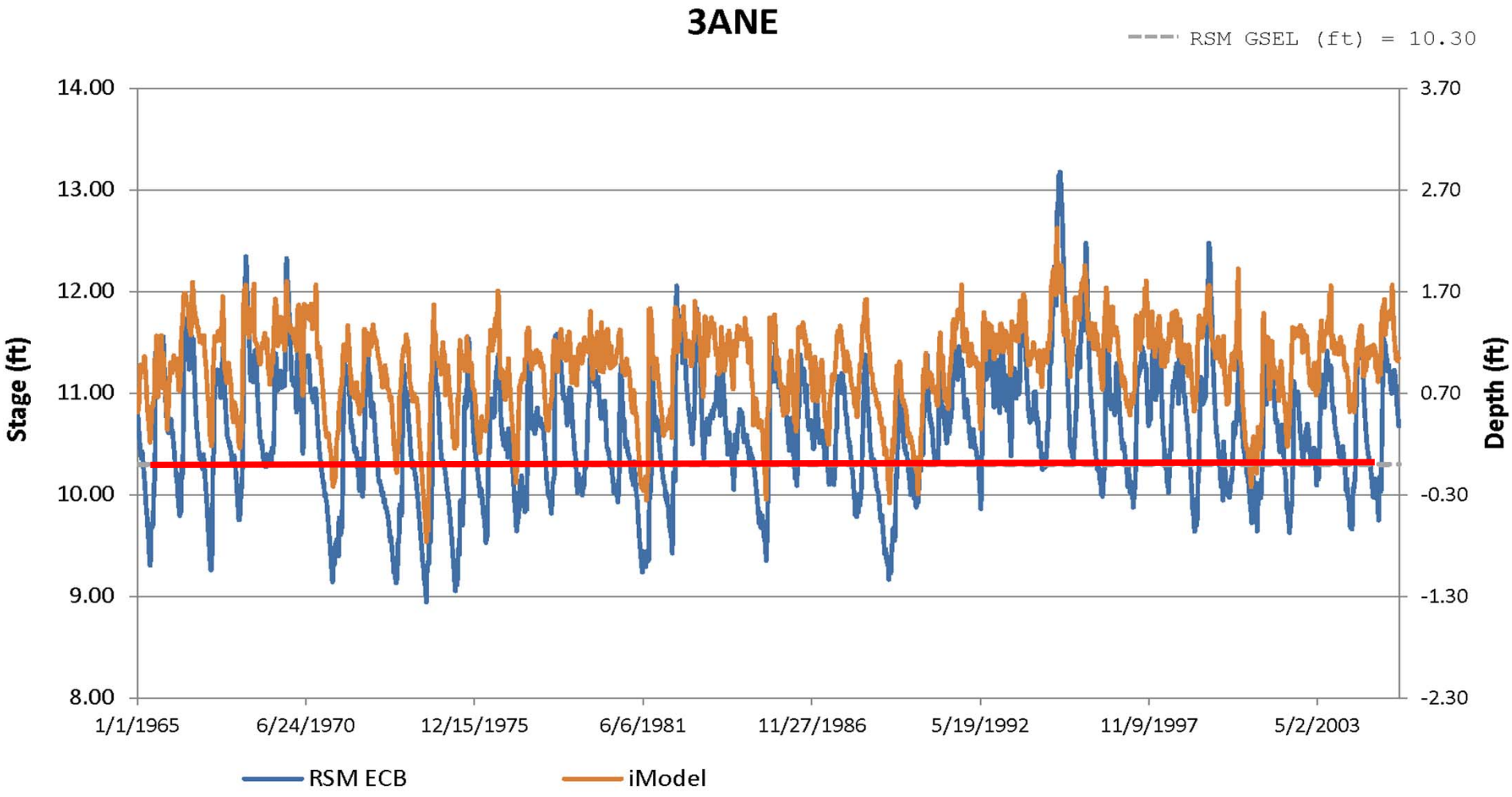


Scenario: Green1 North3A



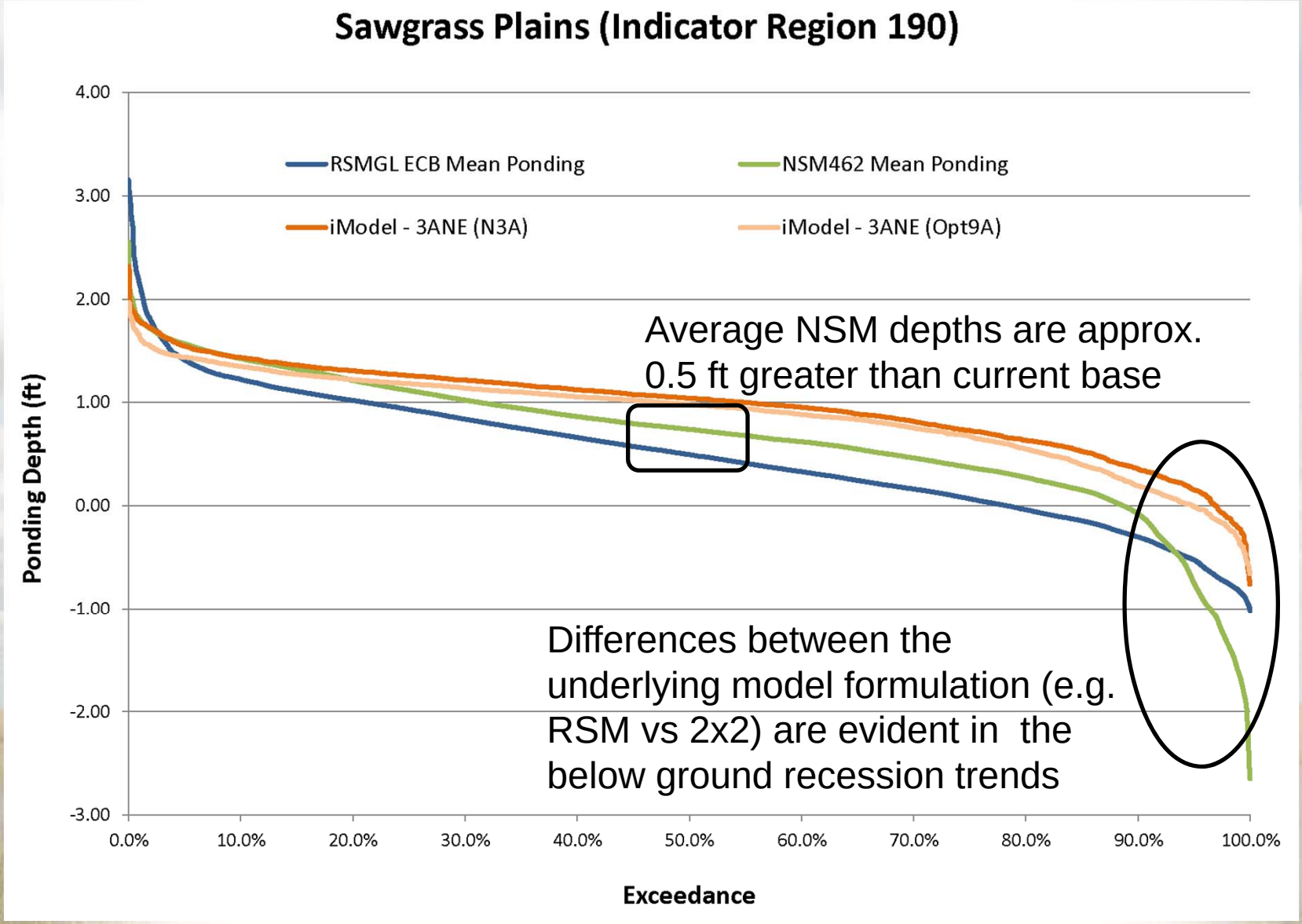
0.25	1.16	Avg. Ponding Depth (ft)
249	362	Average Hydroperiod (Days)

Scenario: Green1 North3A



0.32	0.97	Avg. Ponding Depth (ft)
253	354	Average Hydroperiod (Days)

	3A-NW Depth (ft)		3A-NE Depth (ft)	
	ECB	iModel$^{50\%}$	ECB	iModel$^{50\%}$
Wet Season	0.93	1.54	1.00	1.39
Avg Condition	0.25	1.25	0.31	1.04
Dry Season	-0.42	0.67	-0.37	0.48


Sawgrass Plains (Indicator Region 190)
RSMGL ECB Mean Ponding
NSM462 Mean Ponding
iModel - 3ANE (N3A)
iModel - 3ANE (Opt9A)
Ponding Depth (ft)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
80.0%
90.0%
100.0%
Exceedance
Average NSM depths are approx. 0.5 ft greater than current base
Differences between the underlying model formulation (e.g. RSM vs 2x2) are evident in the below ground recession trends

3A-NE Depth (ft)

	ECB	iModel$^{50\%}$	IR190^{NSM}	iModel^{9A}
Wet Season	1.00	1.39	1.31	1.29
Avg Condition	0.31	1.04	0.74	0.97
Dry Season	-0.37	0.48	-0.05	0.38

The iModel Screening Process Identified Three Major Eco-hydro Challenges for the RSM and CEPP

1) Restoration of Ridge-Slough headwaters while preserving extant sawgrass plain in northern WCA-3A.
2) Reconnection of historic slough flow patterns while preserving extant tree islands in WCA-3B.
3) Restoration of SRS hydrology and Fl Bay salinity while preserving extant CSSS habitats.

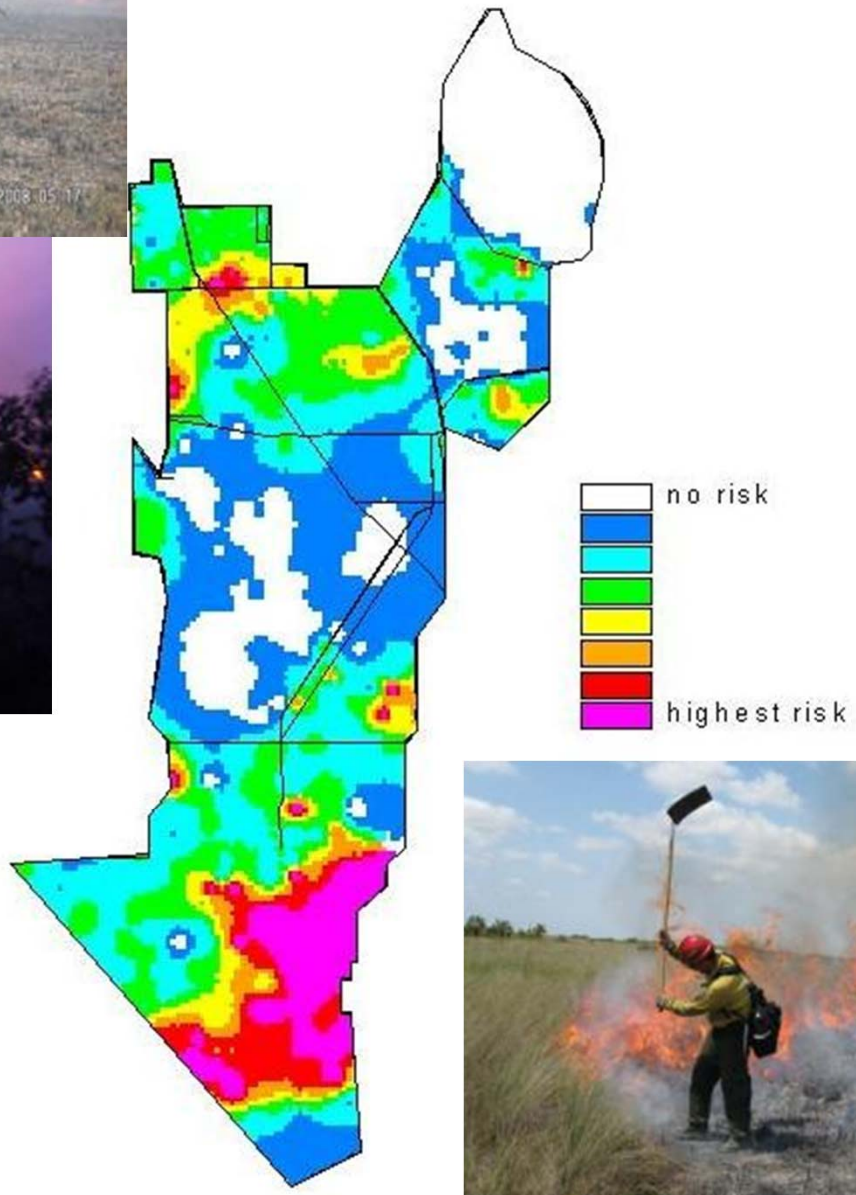
Available Performance Measures – Benefits Quantification (Habitat Units)

- Inundation Duration
  - PM 1.1 PPOR of Inundation
- Sheetflow
  - PM 2.1 Timing
  - PM 2.2 Continuity
  - PM 2.3 Distribution
- Soil Oxidation
  - PM 3.1 Cumulative Drought Intensity
- Dry Events in Shark River Slough
  - PM 4.1 Number of Dry Events
  - PM 4.2 Duration of Dry Events
  - PM 4.3 PPOR of Dry Events
- Slough Vegetation Suitability
  - 5.1 Hydroperiod
  - 5.2 Drydown
  - 5.3 Dry Season Depths
  - 5.4 Wet Season Depths
- Northern Estuaries – Caloosahatchee*
  - PM 6.1 Low Flow
  - PM 6.2 High Flow
- Northern Estuaries – St. Lucie*
  - PM 7.1 Low Flow
  - PM 7.2 High Flow

* PMs produced by RSMBN, all others RSMGL

Additional metrics to evaluate potential impacts to Lake Okeechobee and Florida Bay.

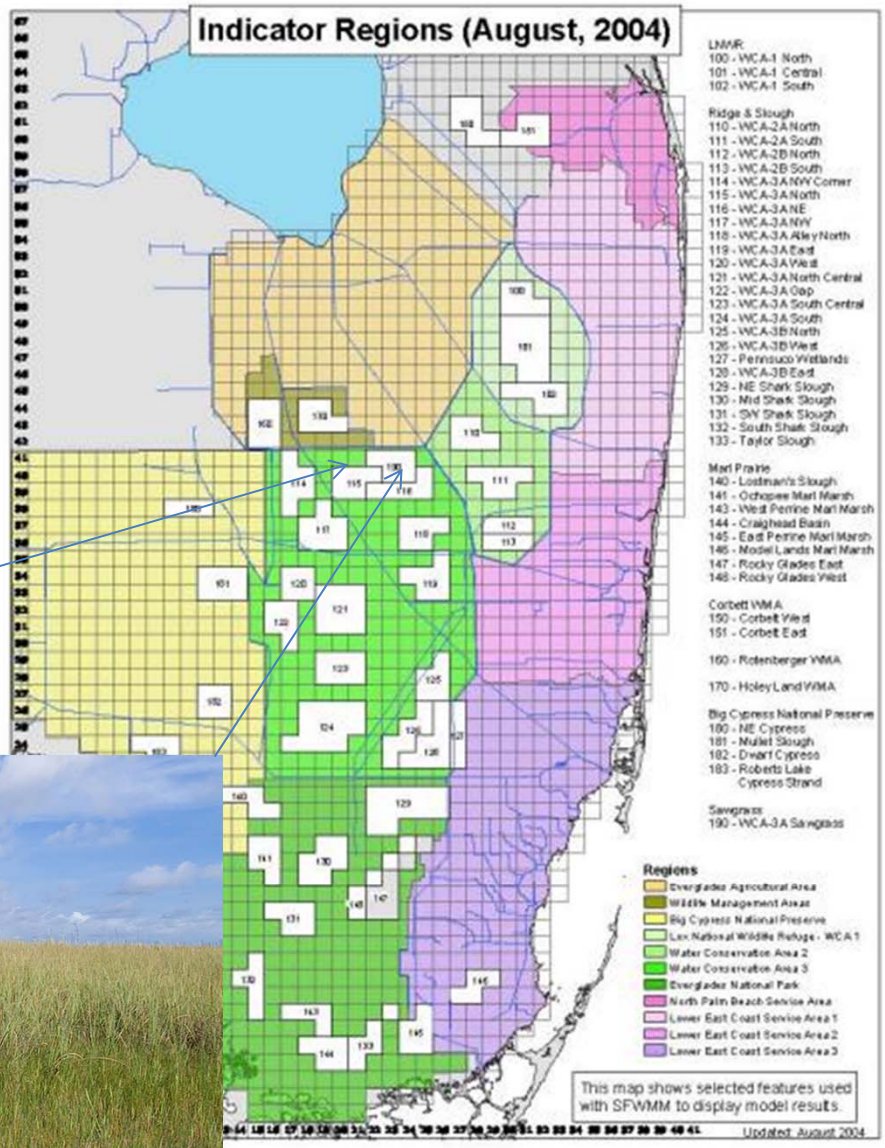
Muck Fire Risk



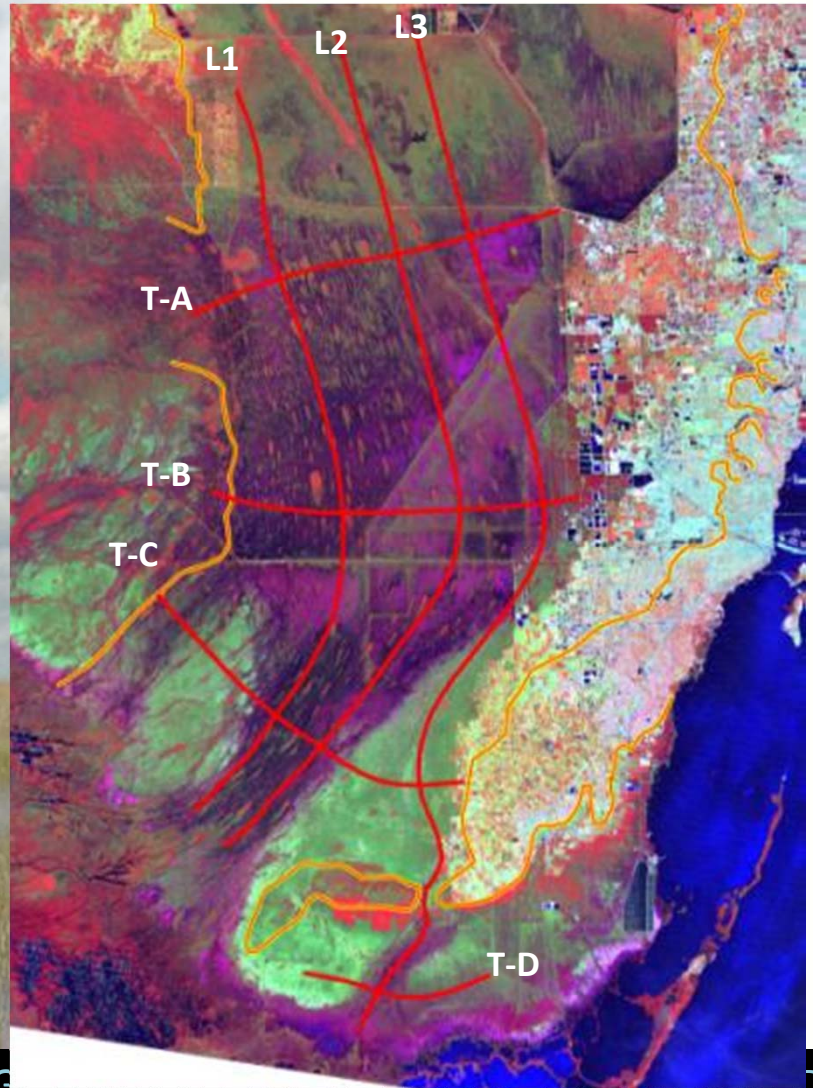
Greater Everglades Indicator Regions:

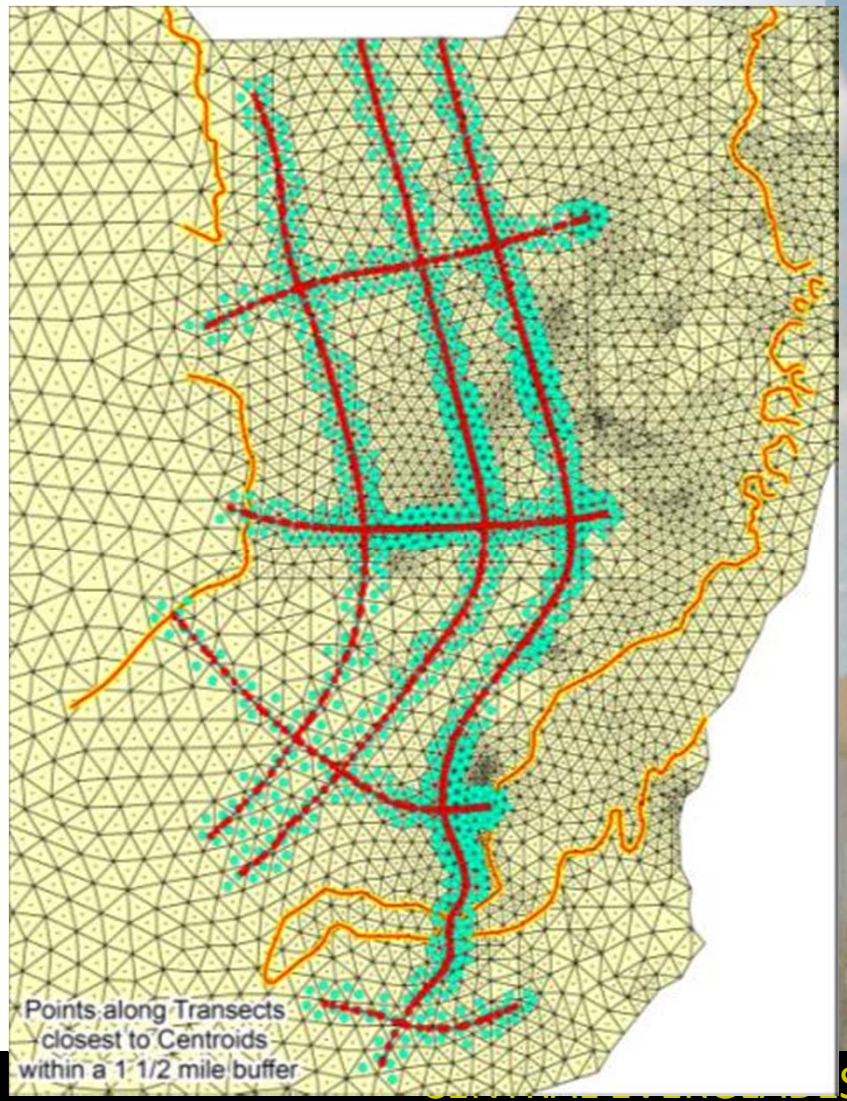
Sawgrass Plains:

- Inundation Duration
  - PM 1.1 PPOR of Inundation
- Sheetflow
  - PM 2.1 Timing
  - PM 2.2 Continuity
  - PM 2.3 Distribution
- Soil Oxidation
  - PM 3.1 Cumulative Drought Intensity

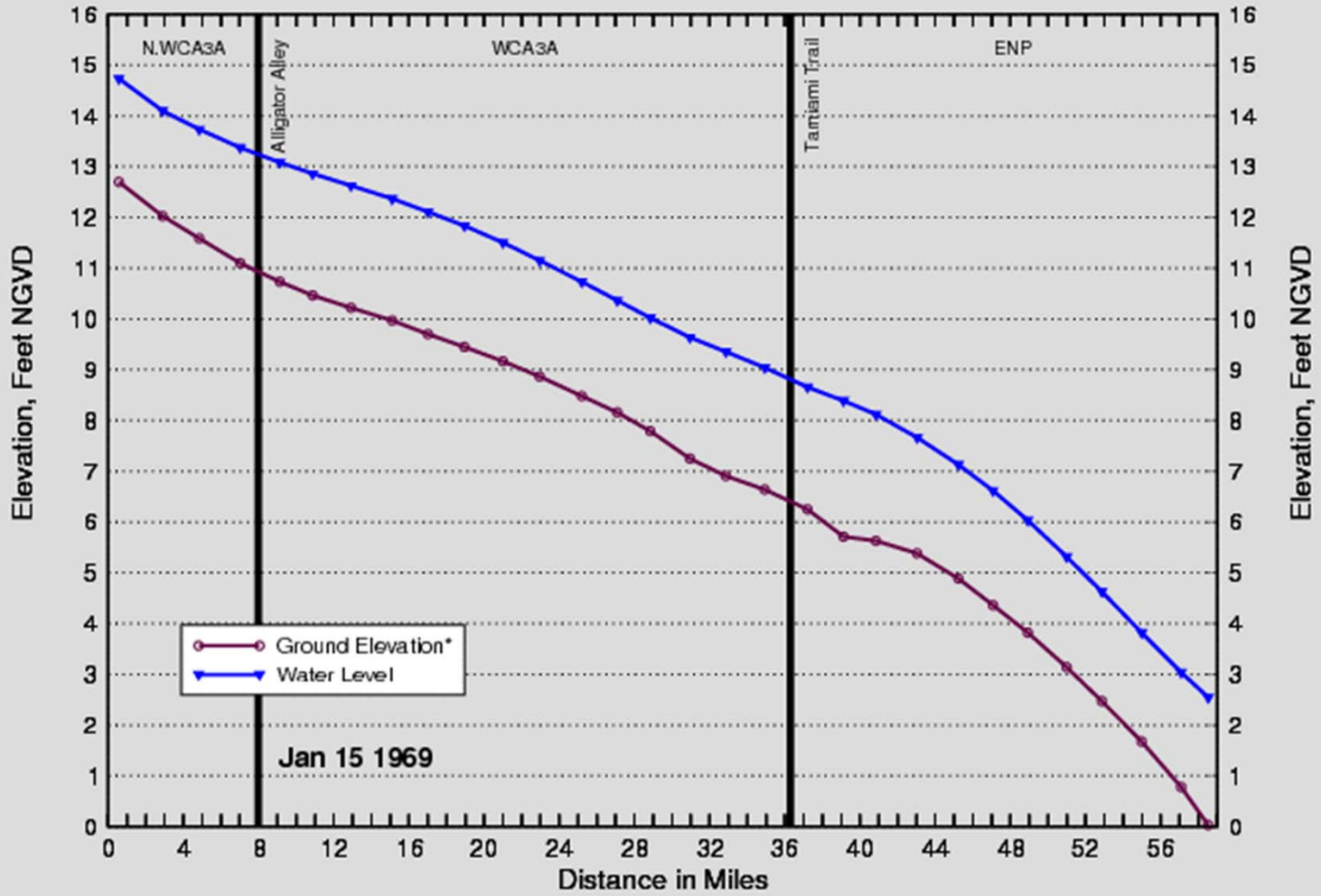


EverView Transects





NSRSM L1 Transect



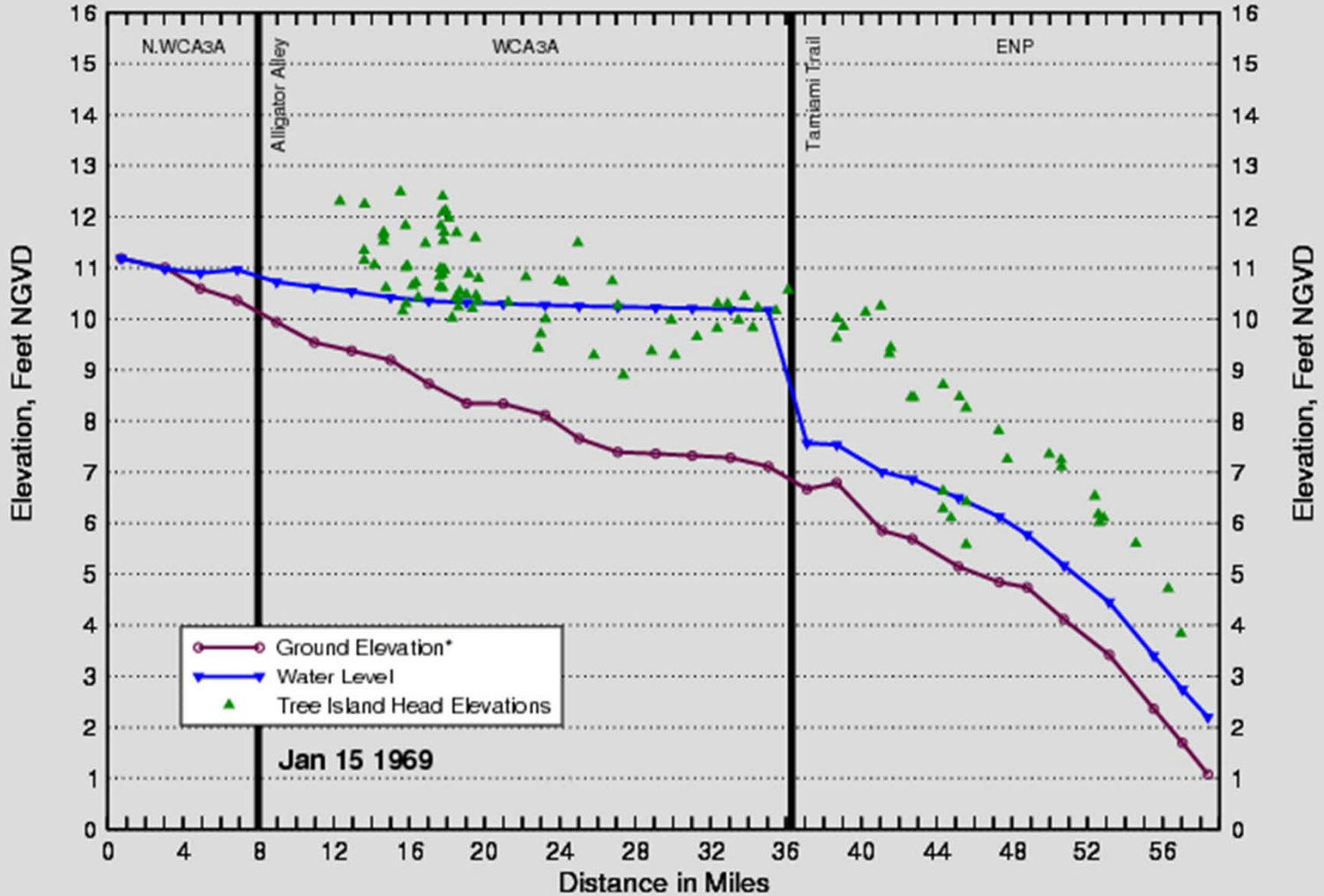
* Within the ridge & slough landscape, ground elevation = slough bottom.
For other landscapes, ground elevation = average model ground surface.

Script used: depth_transects.scr
Filename: depth_transects_L1_NSRSMv3.3_ANIM.agr

CURRENT
L1 Transect

Water Depth Viewing Window

Transect L1 for Scenario RSM_PCB1_GLD_rev_4848



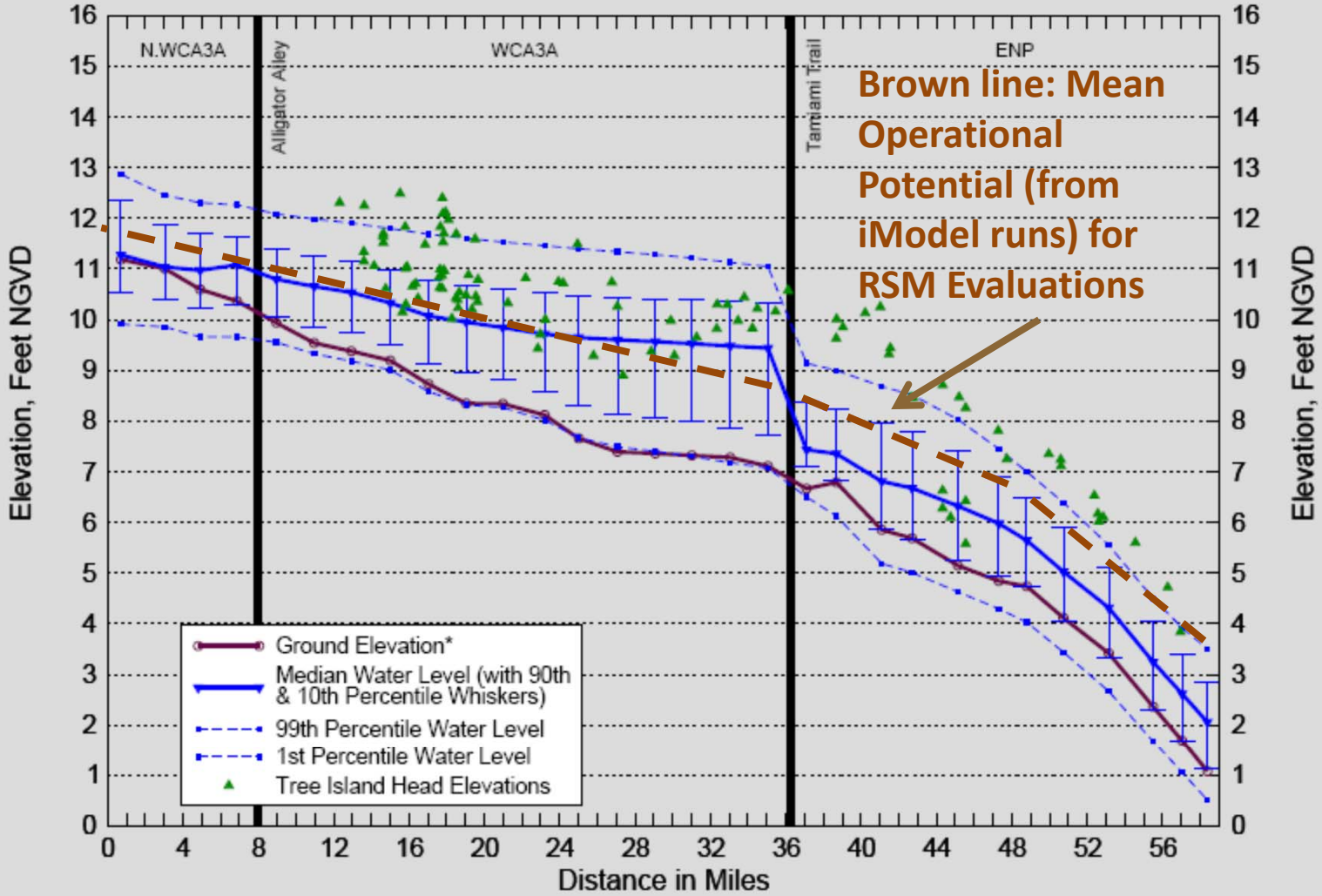
* Within the ridge & slough landscape, ground elevation = slough bottom.
For other landscapes, ground elevation = average model ground surface.

Script used: depth_transects.scr
Filename: depth_transects_L1_RSM_PCB1_GLD_rev_4848.agr

CURRENT
L1 Transect

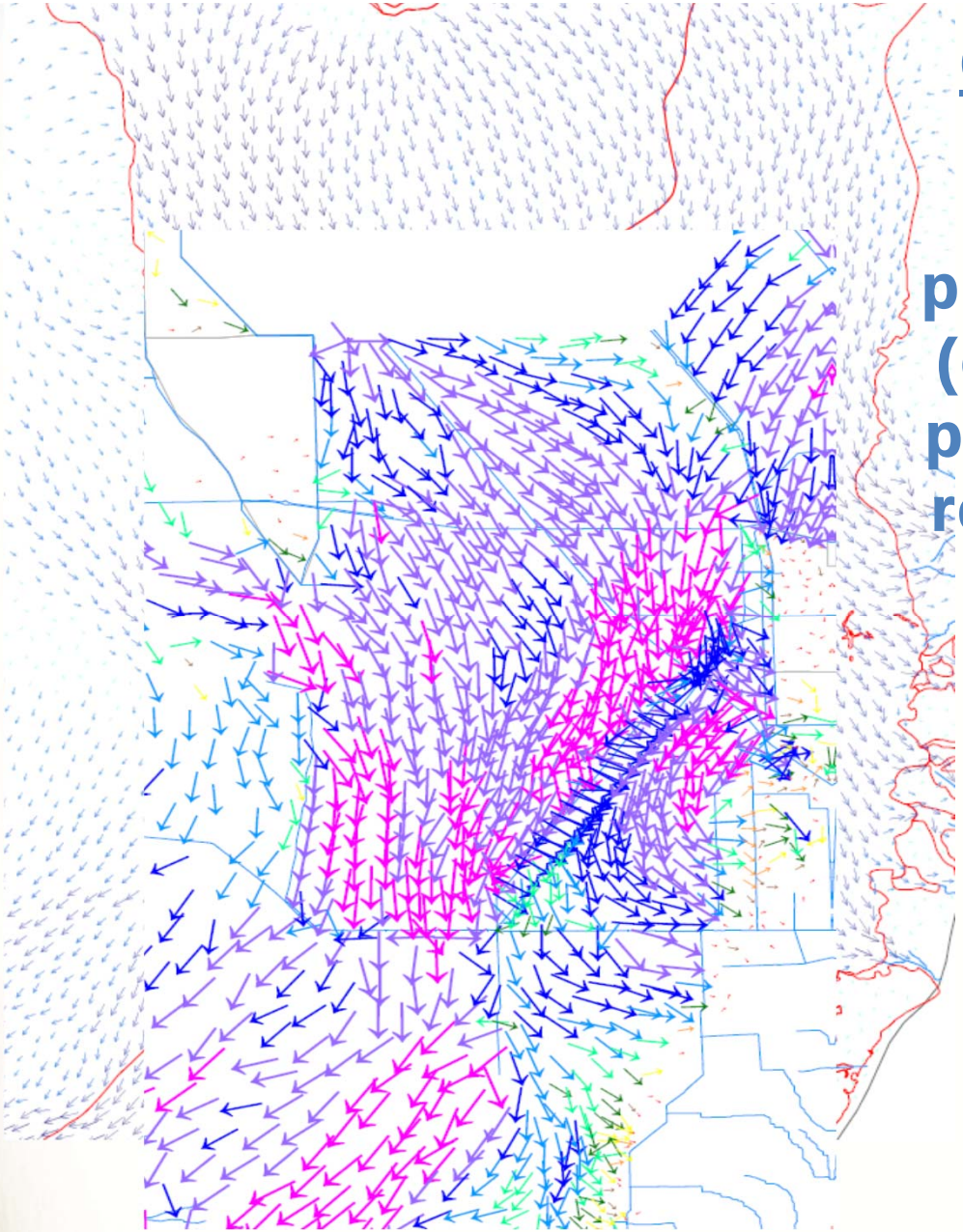
Water Depth Viewing Window

Transect L1 for Scenario RSM_PCB1_GLD_rev_4848



* 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_RSM_PCB1_GLD_rev_4848.agr



CONCLUSION

Screening identified the physical options (canals, levees, pumps, etc.) for rehydrating the Everglades

Eco-subteam Recommendation: Continue to think large-scale and holistically