Open Water Data Initiative Use Case Proposal:

Evaluating the Ecological Impacts of Water Resources Management Decisions on Wetlands (and Lakes)

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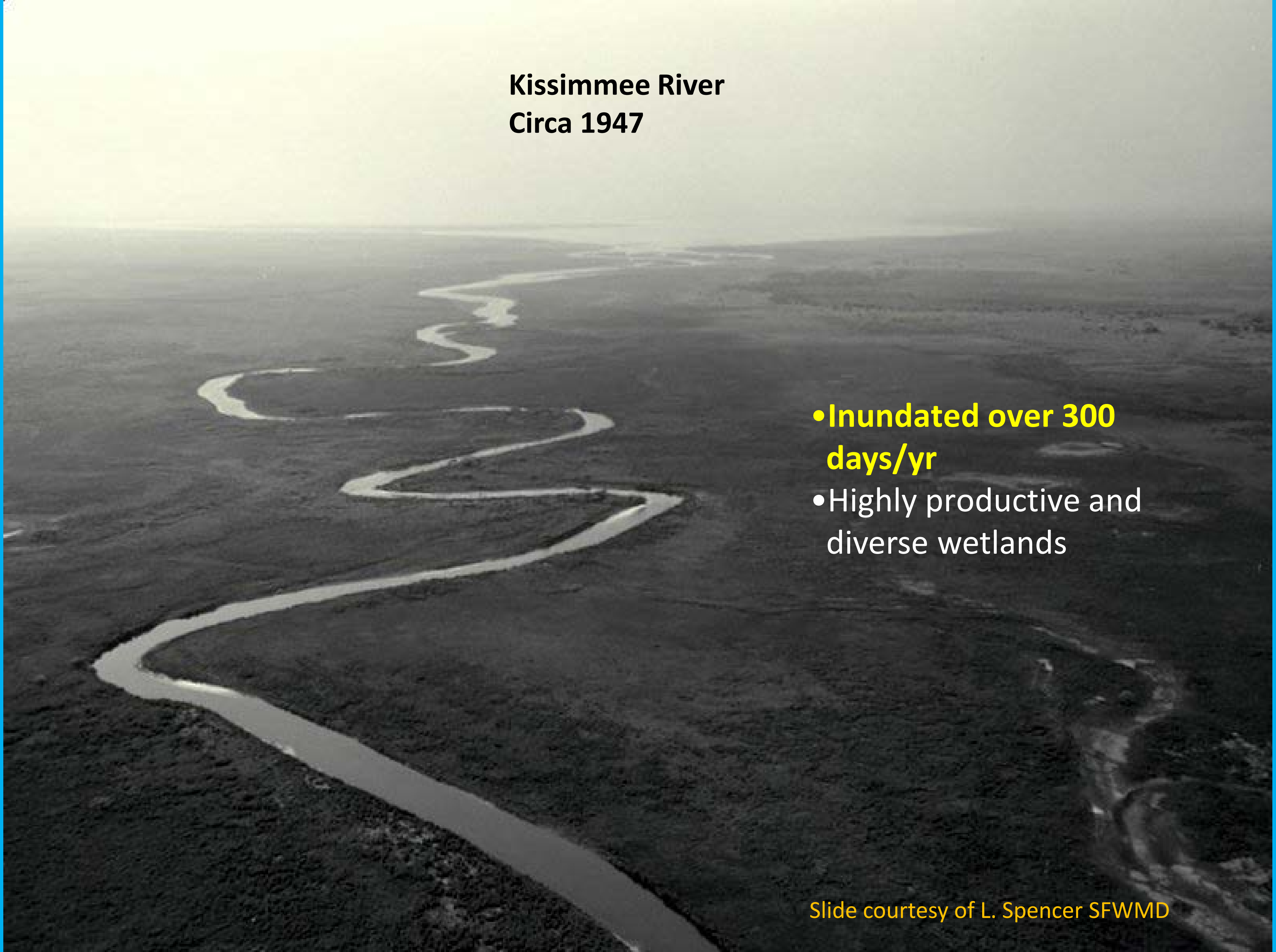
August 26, 2016

Outline

- The “Hydroperiod Tool”
  - History
  - “Mechanics”
  - Examples in detail
- OWDI Use case?


Kissimmee River
Circa 1947
•Inundated over 300 days/yr
•Highly productive and diverse wetlands
Slide courtesy of L. Spencer SFWMD

Hurricanes!
Floods!

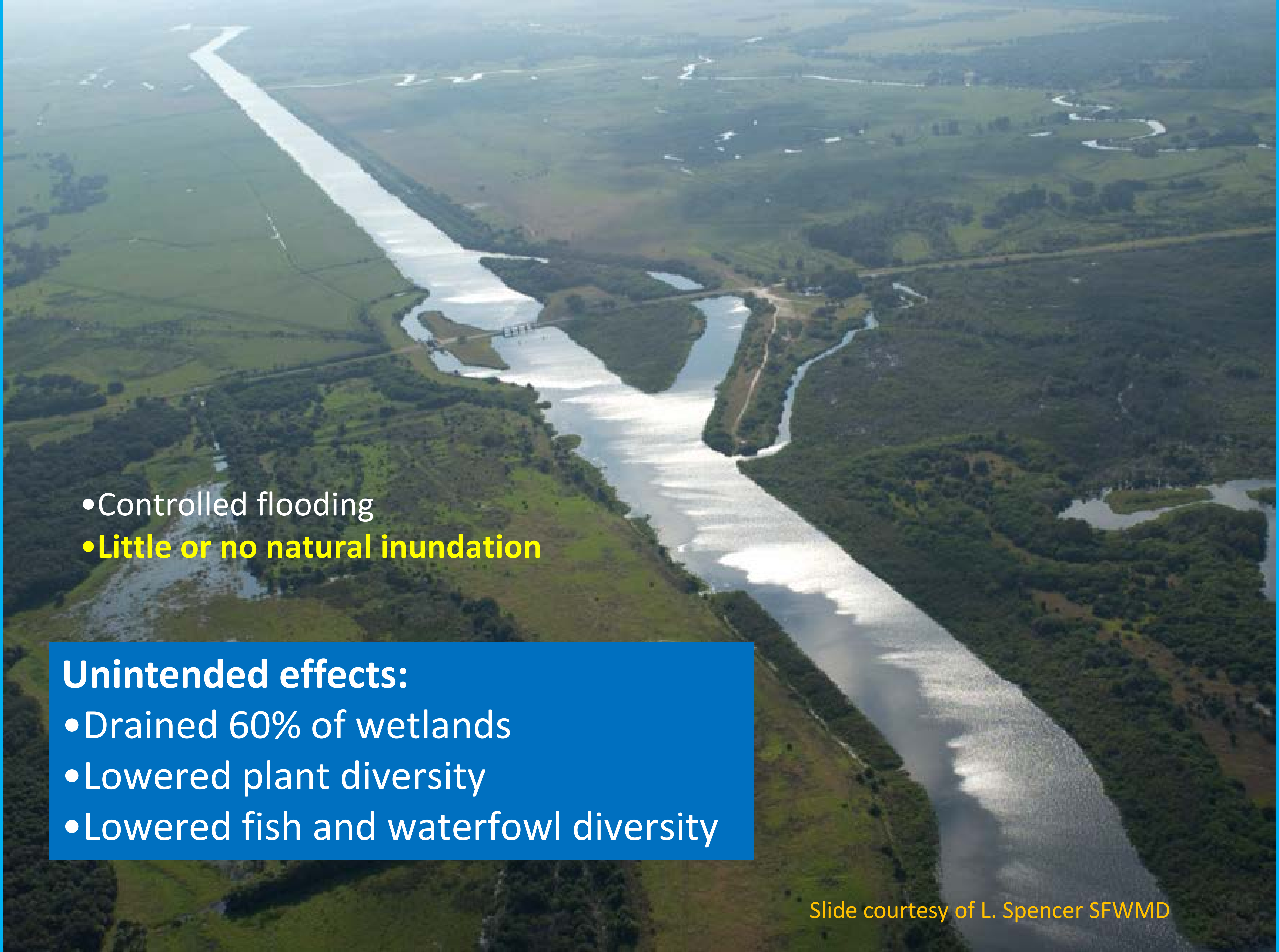
Water is our enemy!

Slide courtesy of L. Spencer SFWMD

Residents called for
Flood Control
So…

Federal and state cooperated
to create the
C & SF Project ca 1948

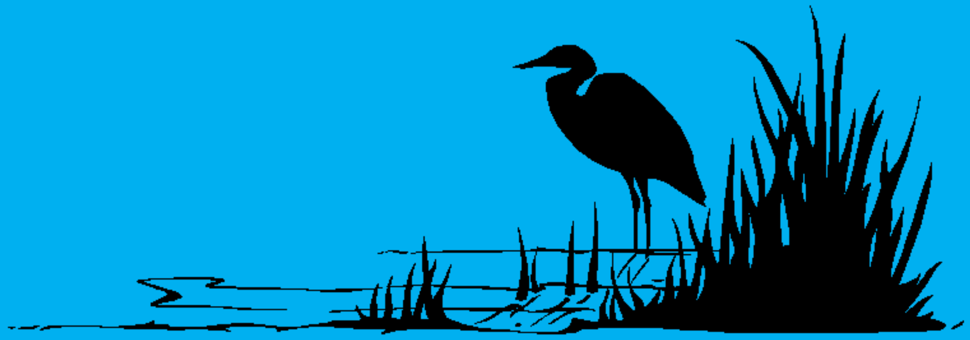
Slide courtesy of L. Spencer SFWMD


•Controlled flooding
•Little or no natural inundation
Unintended effects:
•Drained 60% of wetlands
•Lowered plant diversity
•Lowered fish and waterfowl diversity
Slide courtesy of L. Spencer SFWMD


•Controlled flooding
•Little or no natural inundation
How Important is Hydroperiod?
Slide courtesy of L. Spencer SFWMD

Hydroperiod

- Depth, duration and timing of inundation
- Critical to wetland plants and dependent species; ecosystem services
- Often impacted by water management
- *How do you measure / model it? (**Managers need metrics!**)*



- Water elevation is measured at **point** locations
- Measurement problem: characterize the **spatial extent which changes over time**
- The *Hydroperiod Tool* models depth, duration, timing and **areal coverage** of inundation

Kissimmee River:
Circa 2000's

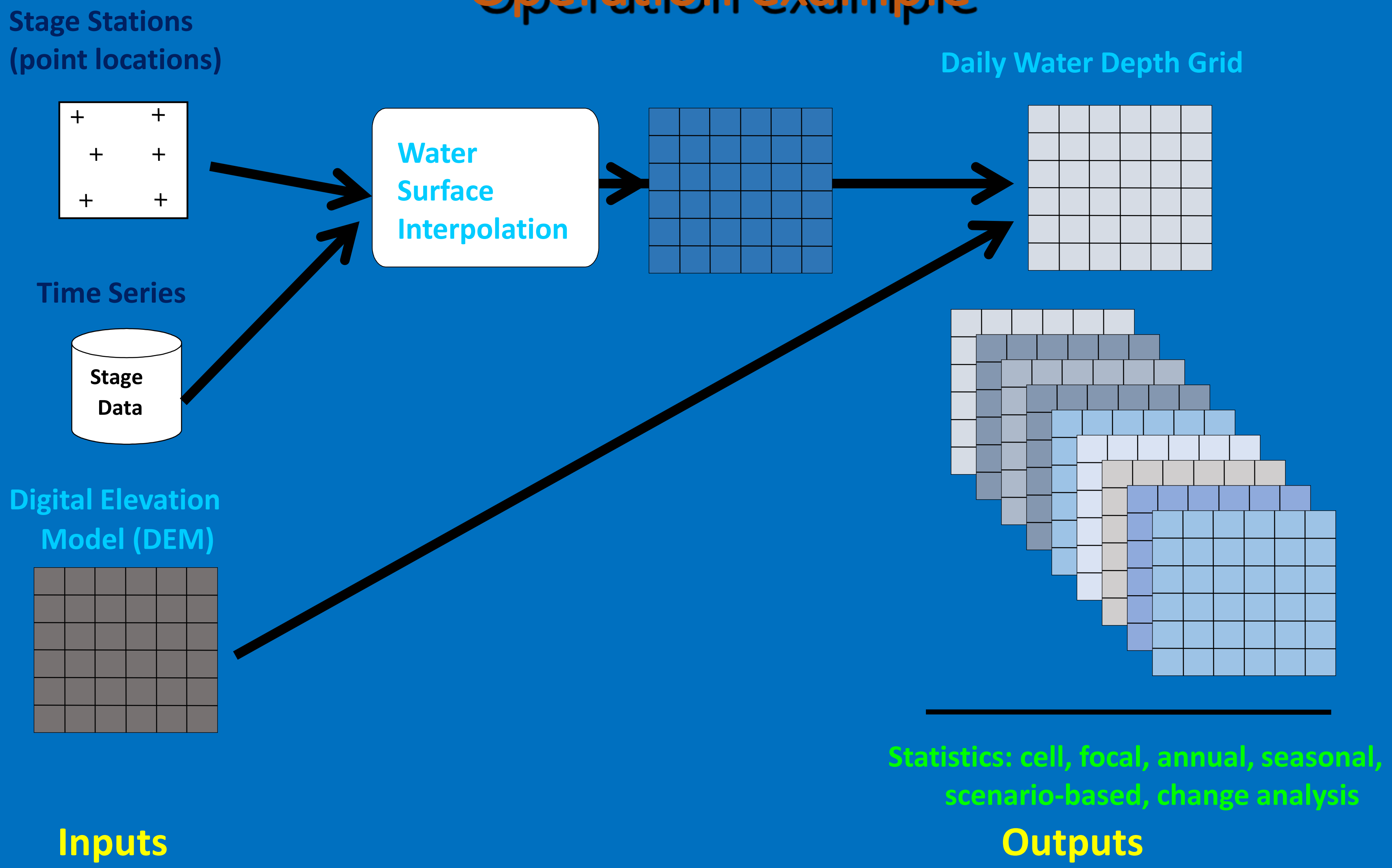
Kissimmee Restoration:

- Construction Phases have backfilled ~15 miles of C-38 canal and restored/ recarved channels
- Restoring hydrology

Slide courtesy of L. Spencer SFWMD

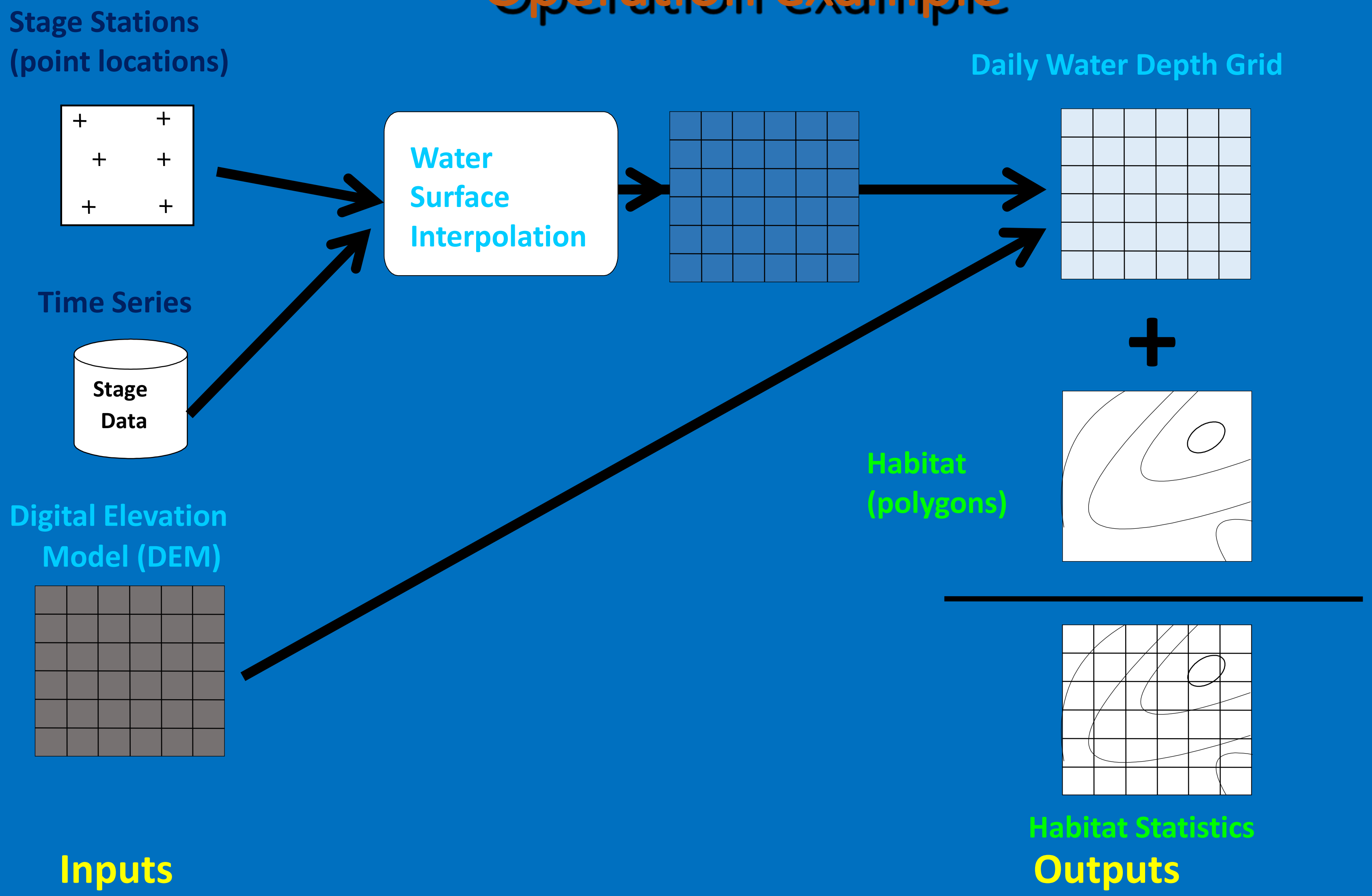

Management driver: Will the restored wetlands receive sufficient hydrology to support vegetation?
Goal: develop a relatively simple tool to model changes in inundation (hydroperiod) over time and under different hydrologic scenarios
- Christine Carlson, SFWMD
- David Maidment, UT – Austin
- PBS&J (now Atkins)
Slide courtesy of L. Spencer SFWMD

Tool Requirements / Operation example



Modified slide courtesy of L. Spencer SFWMD

Tool Requirements / Operation example

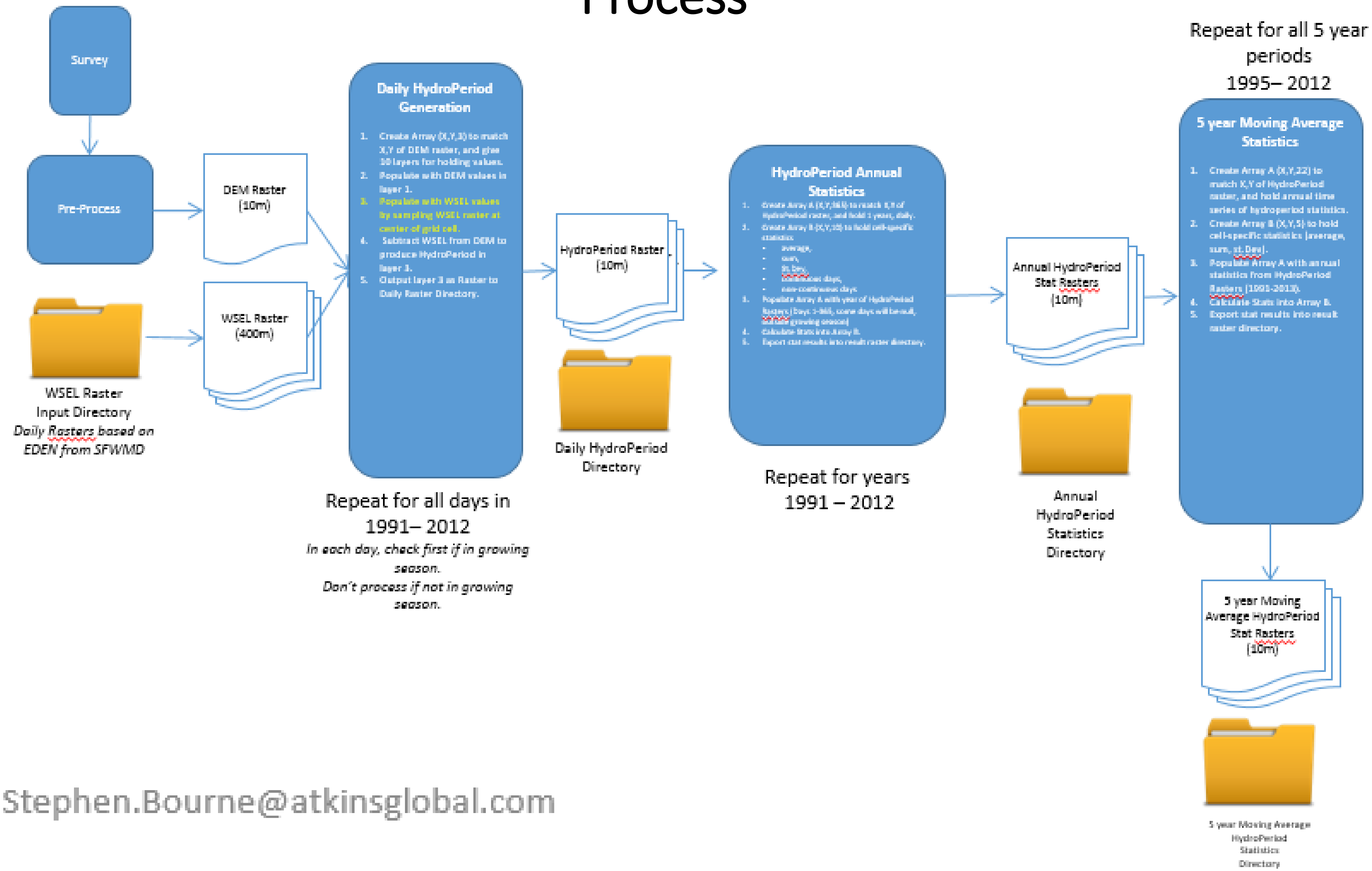


Modified slide courtesy of L. Spencer SFWMD

"HT" Details.....

- Tool is "calling" standard ESRI ArcMap functions – ***automated fashion based on time series data***
- Existing versions:
  - Model Builder (original)
  - VB.net
  - Python
- Current limitations
  - DEM issues in wetlands (*another topic*)
  - Stage data

Process



Stephen.Bourne@atkinsglobal.com

Assumptions / Limitations

- Input data is sufficient
  - *Stage data integrates inflows and outflows*
    - *This is not a hydrologic model, but it doesn't need to be one!*
  - *DEM is representative of terrain*

- Interpolation of water surface is representative of actual water surface
  - *Maintain method as constant to compare scenarios*

Examples

- *Hydrologic criteria for wetland species*
- *How much water, where, when and duration*

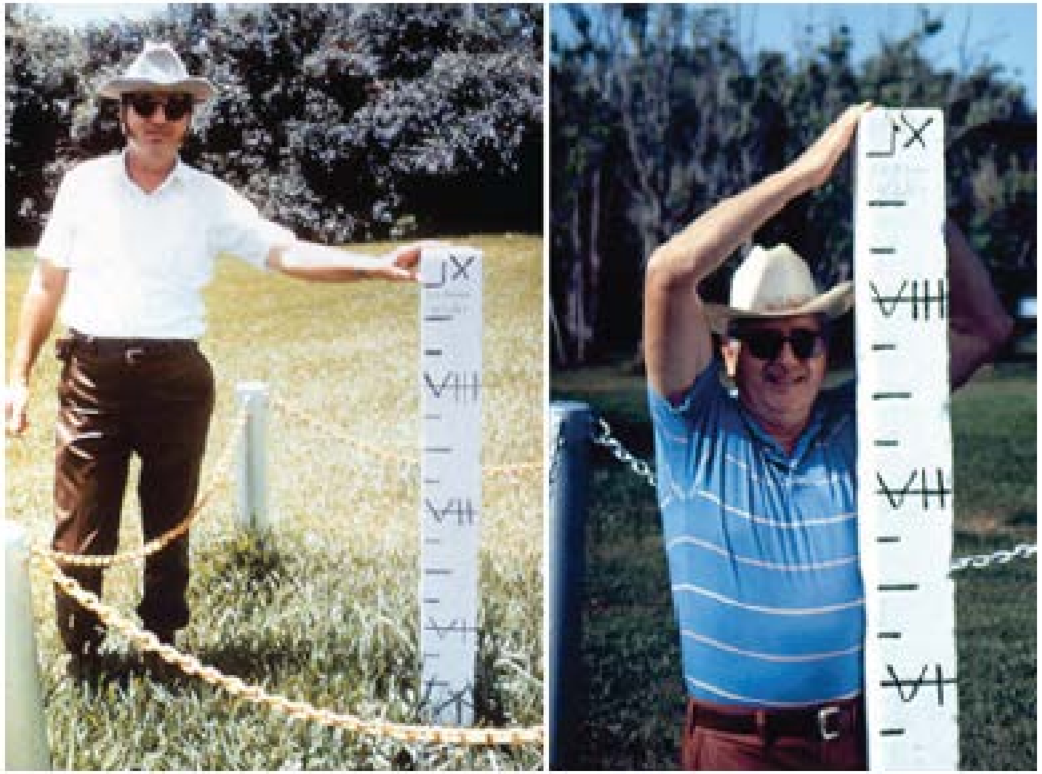
- St Johns Marsh Conservation Area
  - Soil oxidation (animation)
  - Invasive species encroachment
- Water Supply Impact Study
  - Impact of surface water withdrawals on wetland communities

First example

- Fundamental (often overlooked…) component of wetland science
- Wetland soils need to be wet!

Can we modify hydrology to reduce wetland soil oxidation and subsequent loss in elevation?

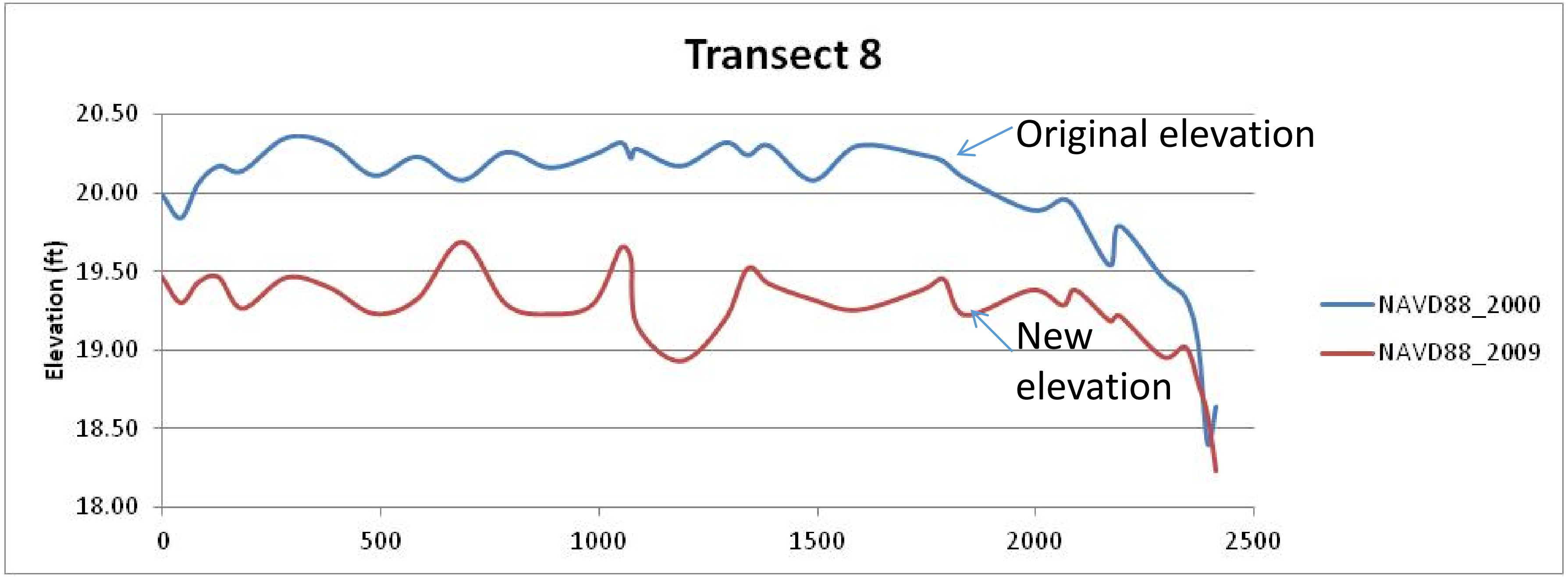
1971 & 1996

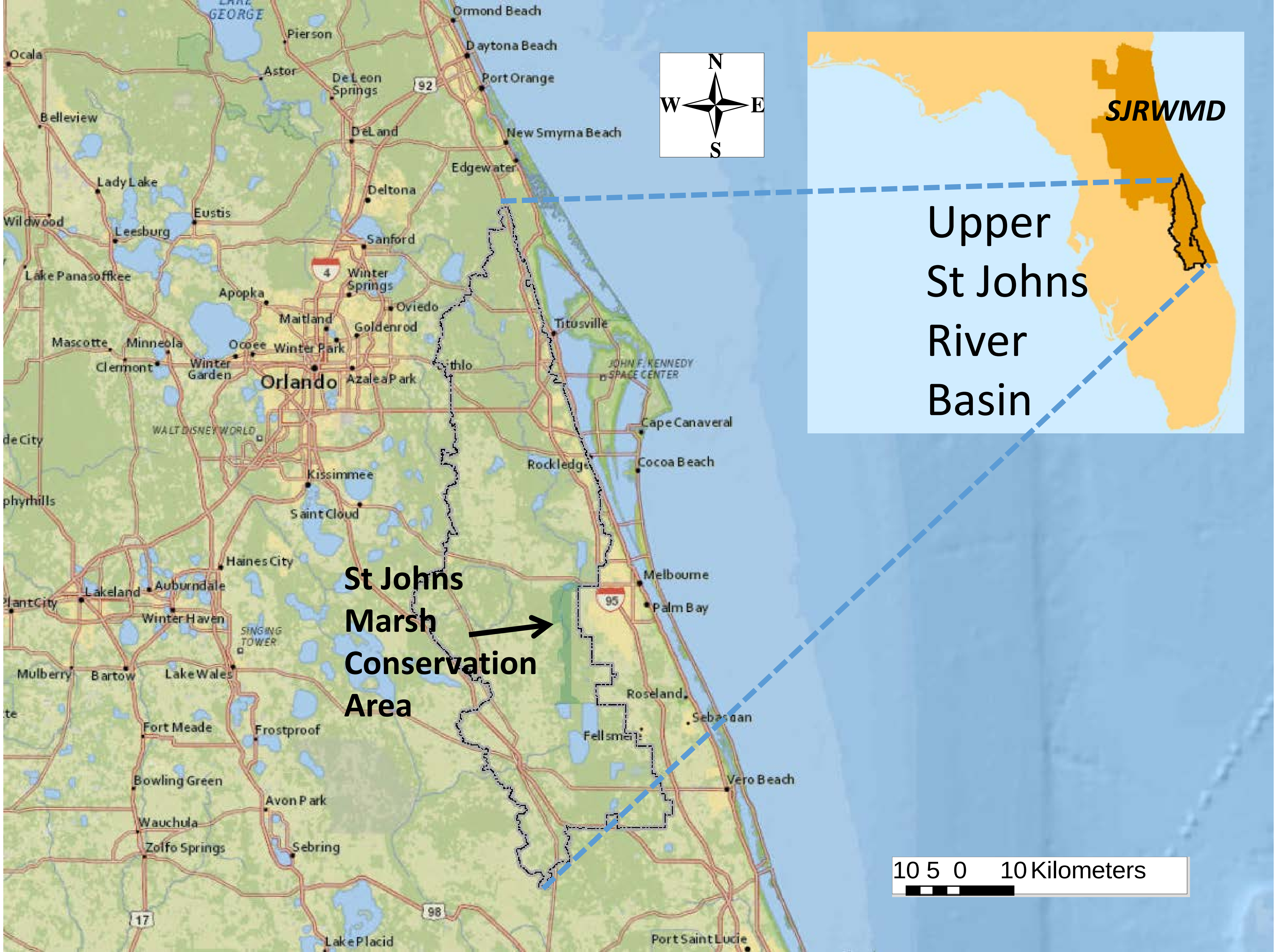


Dr. Victor Carlisle stands at the graduated concrete post near Belle Glade, FL, demonstrating soil subsidence between 1971 and 1996.

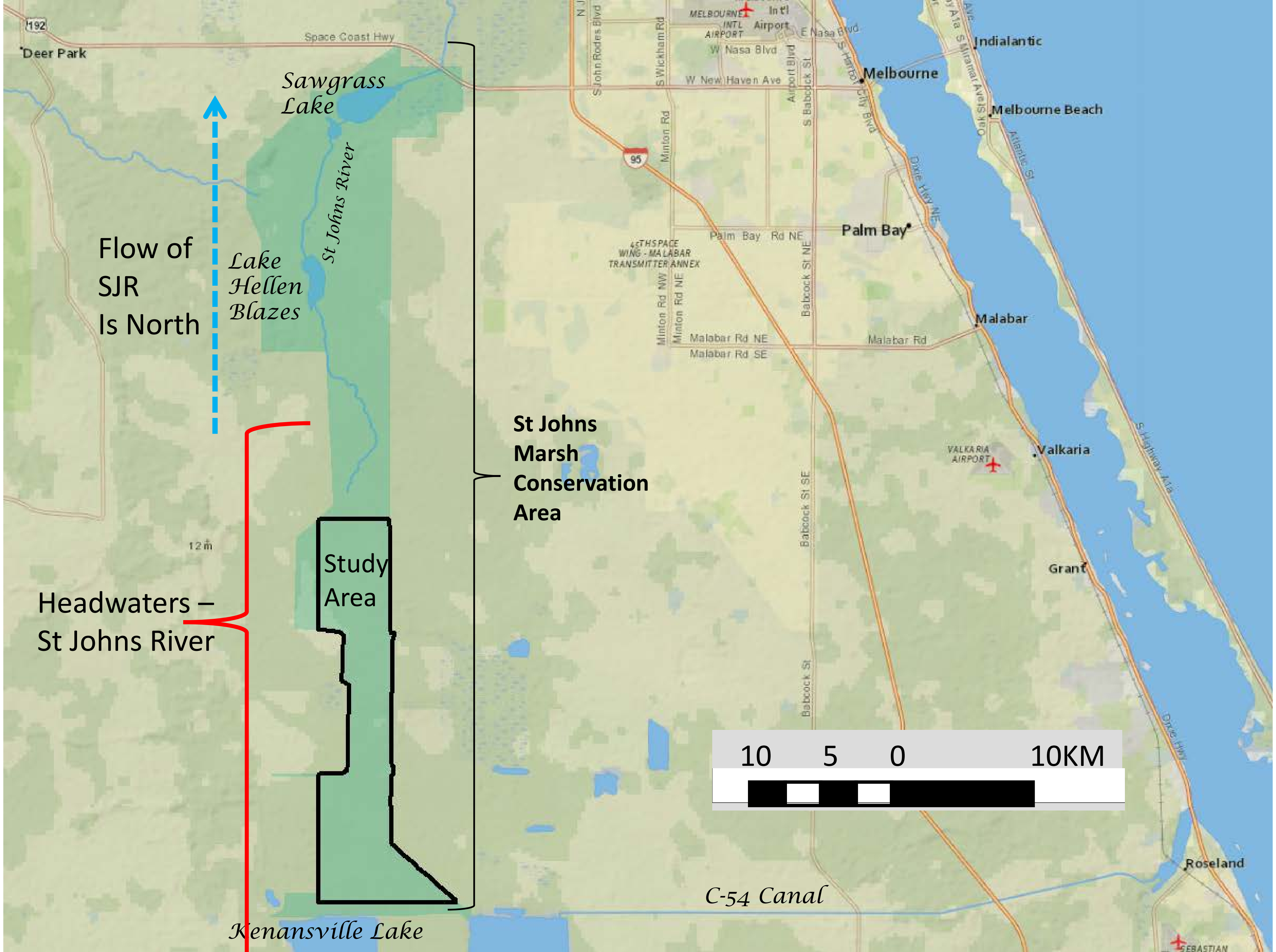
Wetland Subsidence

- Simplest definition intended here – reduced marsh surface elevation due to soil loss





Upper
St Johns
River
Basin
SJRWMD
St Johns
Marsh
Conservation
Area
N
S
E
W
10 5 0 10 Kilometers
Ormond Beach
Daytona Beach
Port Orange
Pierson
Astor
Ocala
De Leon Springs
DeLand
Belleview
New Smyrna Beach
Edgewater
Lady Lake
Deltona
Wildwood
Eustis
Leesburg
Sanford
Lake Panasoffkee
Winter Springs
Apopka
Oviedo
Maitland
Goldenrod
Titusville
Mascotte
Minneola
Ocoee
Winter Park
Clermont
Winter Garden
Orlando
Azalea Park
JOHN F. KENNEDY SPACE CENTER
Cape Canaveral
WALT DISNEY WORLD
Rockledge
Cocoa Beach
Kissimmee
Saint Cloud
Haines City
Melbourne
Lakeland
Auburndale
Palm Bay
Winter Haven
SINGING TOWER
Mulberry
Bartow
Lake Wales
Roseland
Fort Meade
Frostproof
Fellsmere
Bowling Green
Vero Beach
Avon Park
Wauchula
Zolfo Springs
Sebring
Lake Placid
Port Saint Lucie
92
4
95
98
17


Sawgrass Lake
St Johns River
Flow of SJR Is North
Lake Hellen Blazes
St Johns Marsh Conservation Area
Study Area
Headwaters – St Johns River
Kenansville Lake
C-54 Canal
10 5 0 10KM
Deer Park
Space Coast Hwy
Melbourne
Indialantic
Melbourne Beach
Palm Bay
Malabar
Valkaria
Grant
Roseland
W New Haven Ave
W Nasa Blvd
Palm Bay Rd NE
Malabar Rd NE
Malabar Rd SE
Malabar Rd
Babcock St NE
Babcock St SE
Babcock St
Minton Rd
S Wickham Rd
S John Rodes Blvd
Dixie Hwy NE
Atlantic St
S Highway A1a
Dixie Hwy
VALKARIA AIRPORT
MELBOURNE INTL AIRPORT
45th SPACE WING - MALABAR TRANSMITTER ANNEX

Hydroperiod Tool animation

- Daily time step
- October 1, 2007 - September 30, 2008

  Animation speed: 4 days per second
- Blue area is inundated
- White outline is model boundary

❖ Animation is a useful tool for communicating

- Must **summarize** in order to compare
  - Time

    - Monthly, Seasonal, Annual
  - By environmental hydrologic criteria
  - Model scenario

This is the same information summarized annually

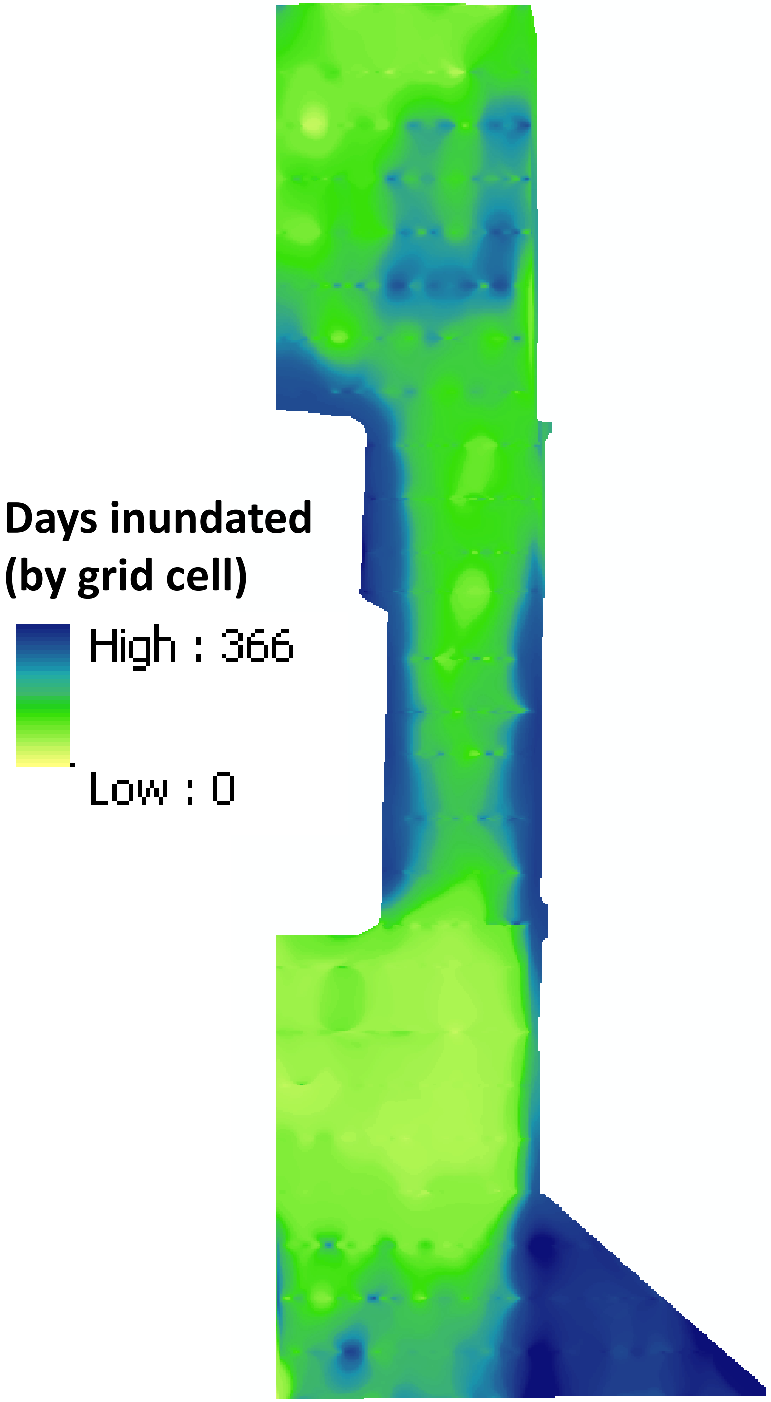
•**Daily results are generated by the Hydroperiod Tool**

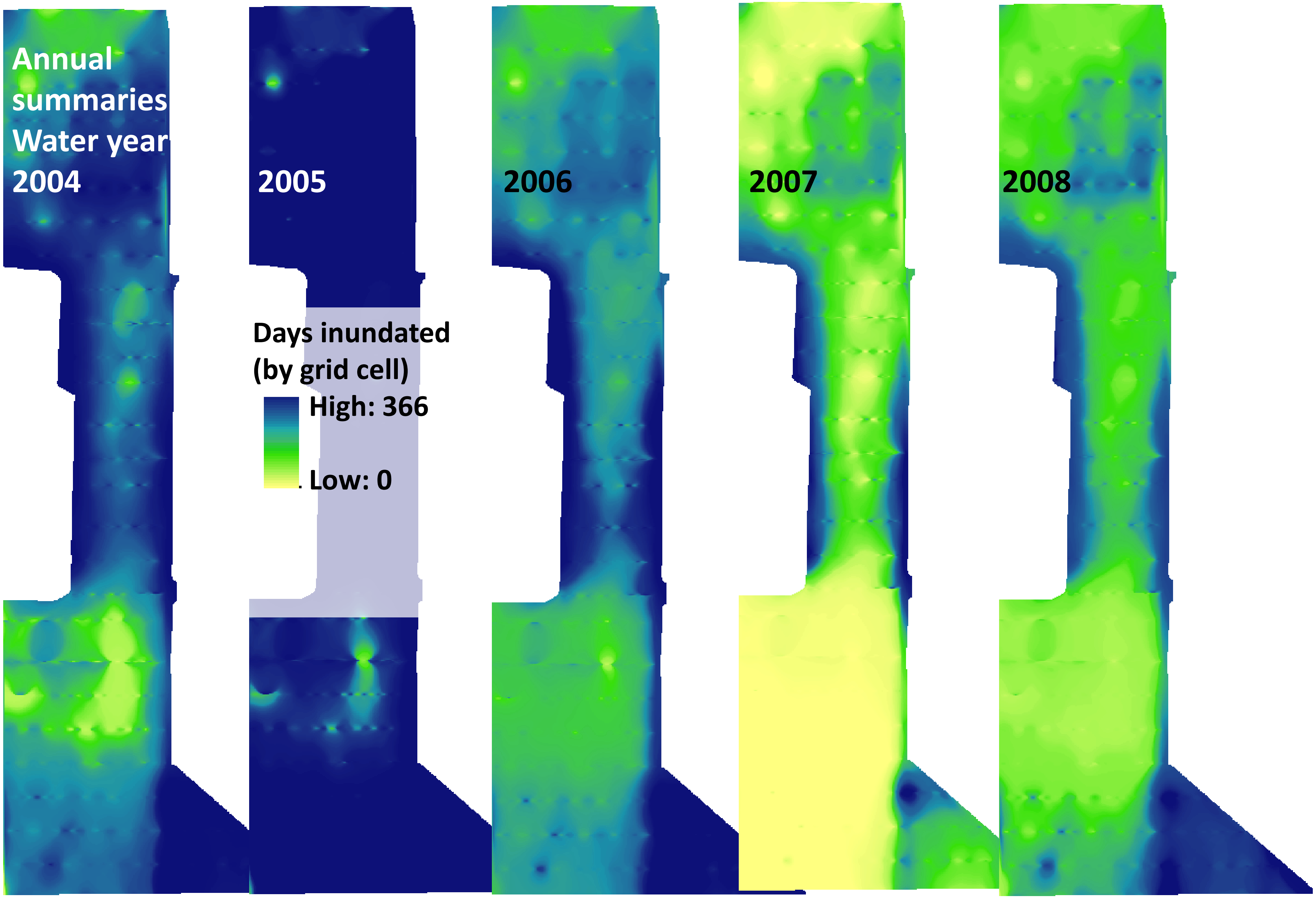
Raster (grid)
Polygon (vector)

•**Raster "stack"** – summarize individual grid cells

•Annual summary is good for **identification of <u>spatial pattern</u> of inundation**

•Downside…
All <u>time series</u> information is gone




Annual summaries Water year
2004
2005
2006
2007
2008
Days inundated (by grid cell)
High: 366
Low: 0

Some questions are asked at the <u>annual level</u>

Hydrologic Criteria:

Related to soil oxidation

Water Year	Percent of marsh area meeting inundation criteria Annual inundation criteria 60% (219 days)	75% (274 days)	100% 365 days
2004	78%	55%	10%
2005	99%	98%	72%
2006	62%	31%	0%
2007	12%	7%	1%
2008	27%	17%	1%

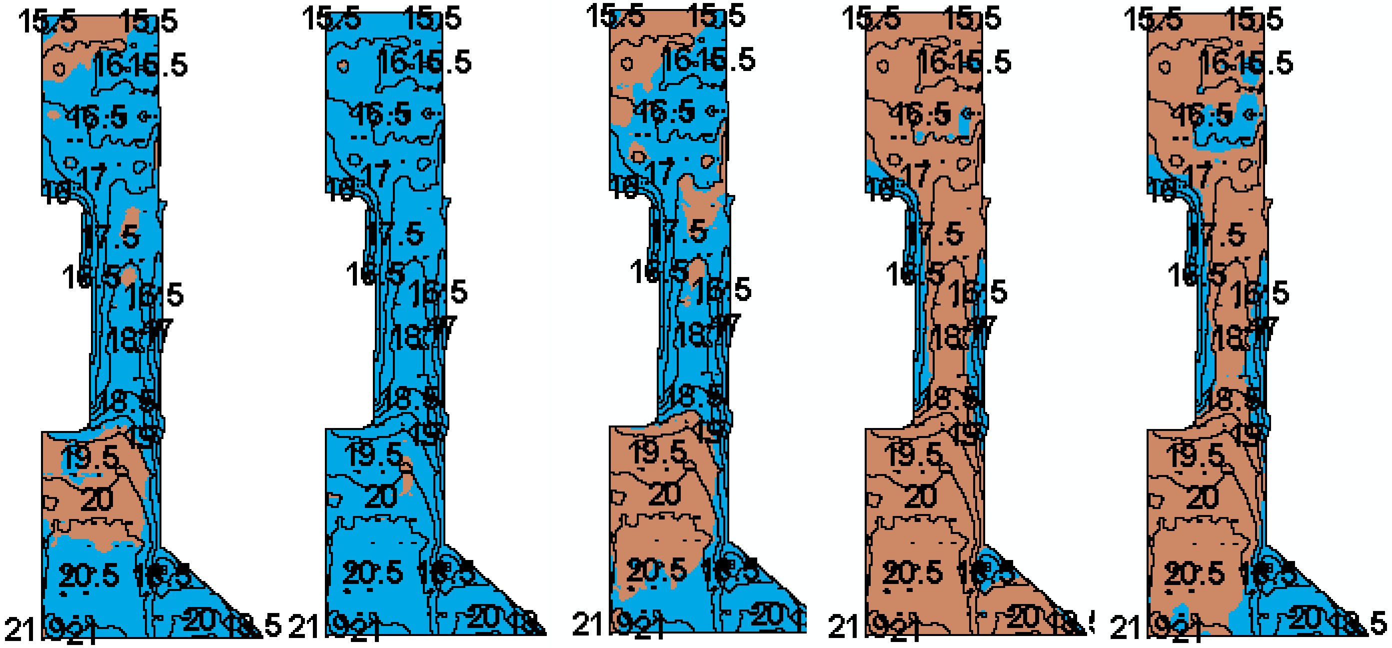
If wetland is inundated for less time annually, higher risk of soil loss

SJMCA Environmental Hydrologic Criteria Evaluation

Water year: **2004** **2005** **2006** **2007** **2008**

Hydrologic Criteria:
60% annual
(219 days)

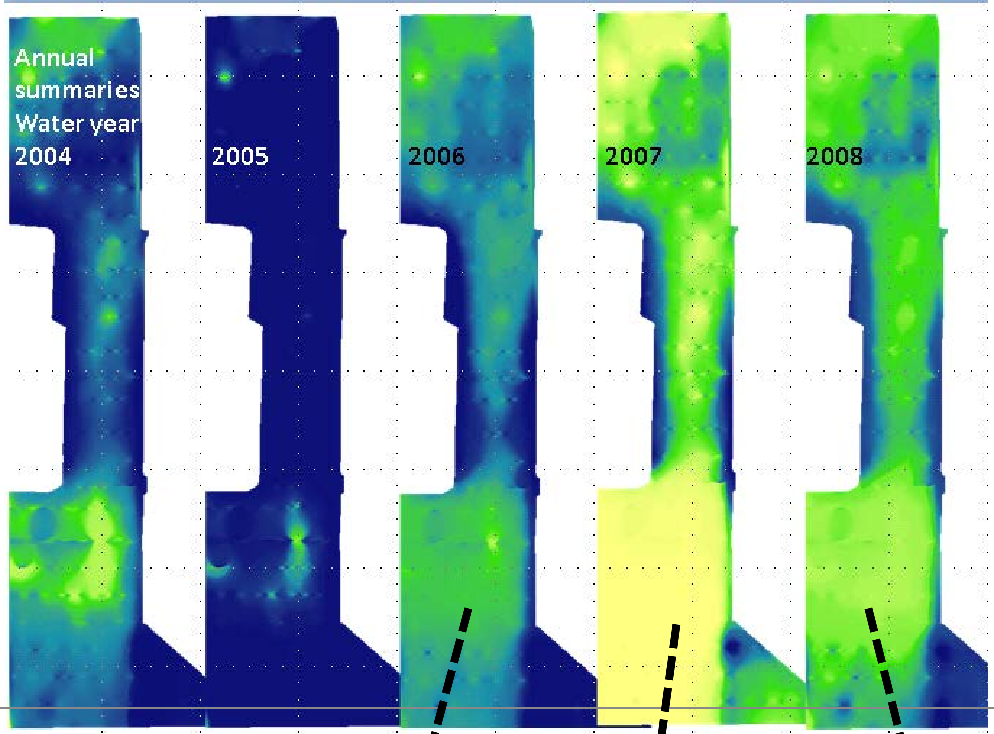
LEGEND
Does not meet criteria
Meets criteria
Elevation contours (0.5 ft intervals)

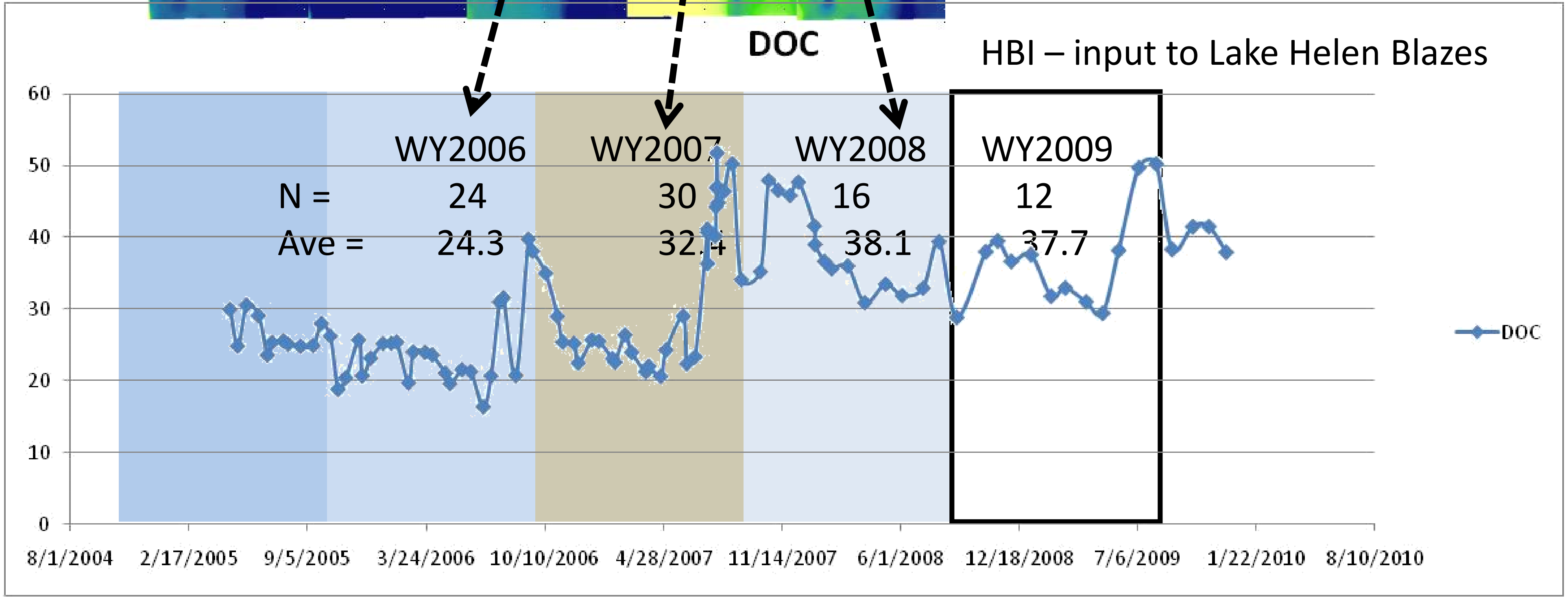


Water Year	60% (219 days)
2004	78%
2005	99%
2006	62%
2007	12%
2008	27%

Lake Helen Blazes
downstream

WATER QUALITY IMPACT





Next example: The Problem With Willow….

Methods of controlling willow -

- Burning

Photos courtesy of Steve R. Miller, SJRWMD

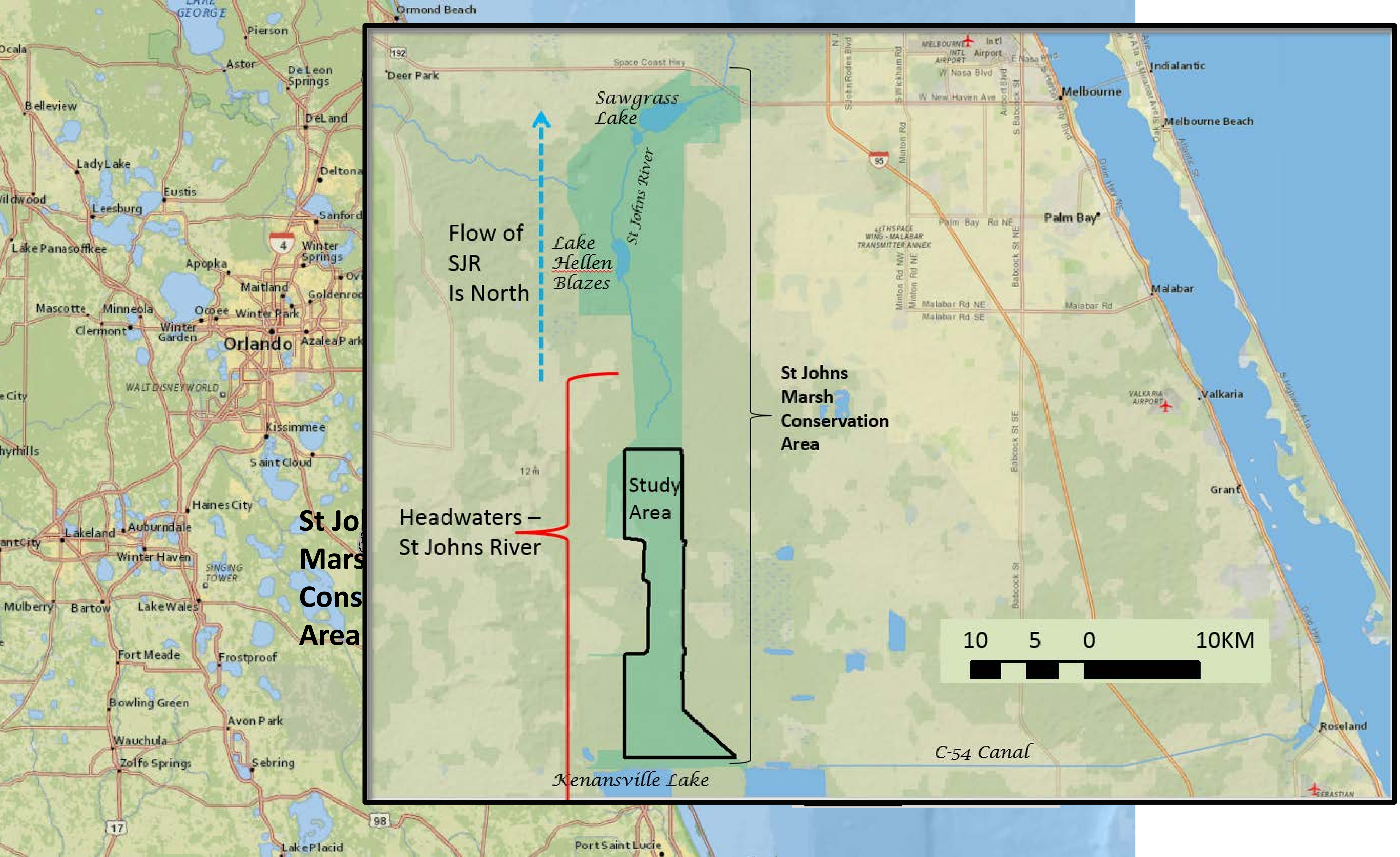
Methods of controlling willow -

- Herbicides

Photos courtesy of Tim Miller, SJRWMD

Is there an alternative? Current study - - - -

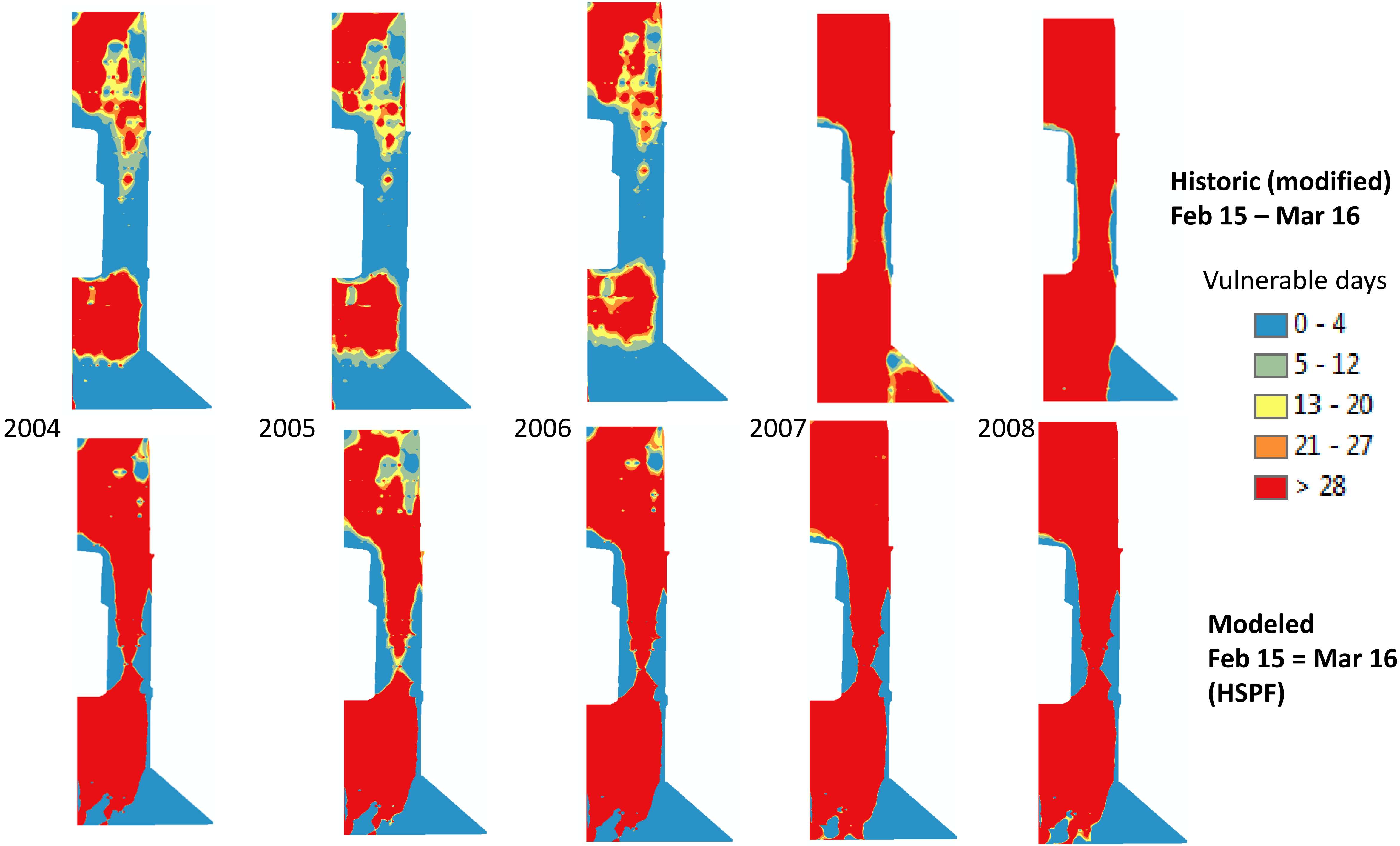
- Willow life history
  - Vulnerability based on hydrologic conditions during seedling establishment
    - When? Varies, but sometime in January to March in this part of Florida
  - Water depth determines willow success
    - ~ dry conditions favor willow establishment
    - ~depths >0.5 ft prevent seedling establishment
- Water control structure required



Flow of
SJR
Is North
Sawgrass
Lake
St Johns River
Lake
Hellen
Blazes
St Johns
Marsh
Conservation
Area
Study
Area
Headwaters –
St Johns River
Kenansville Lake
C-54 Canal
10 5 0 10KM
Deer Park
Melbourne
Indialantic
Melbourne Beach
Palm Bay
Malabar
Valkaria
Grant
Roseland
Orlando
Kissimmee
Saint Cloud
Lakeland
Sebring
Port Saint Lucie

“Third” key element required - to manage for willow (in addition to DEM and stage data):

CONTROL STRUCTURE(S)



Historic (modified)
Feb 15 – Mar 16
Vulnerable days
0 - 4
5 - 12
13 - 20
21 - 27
> 28
2004
2005
2006
2007
2008
Modeled
Feb 15 = Mar 16
(HSPF)

Last example: WSIS ca 2006

"Water Supply Impact Study" (WSIS)

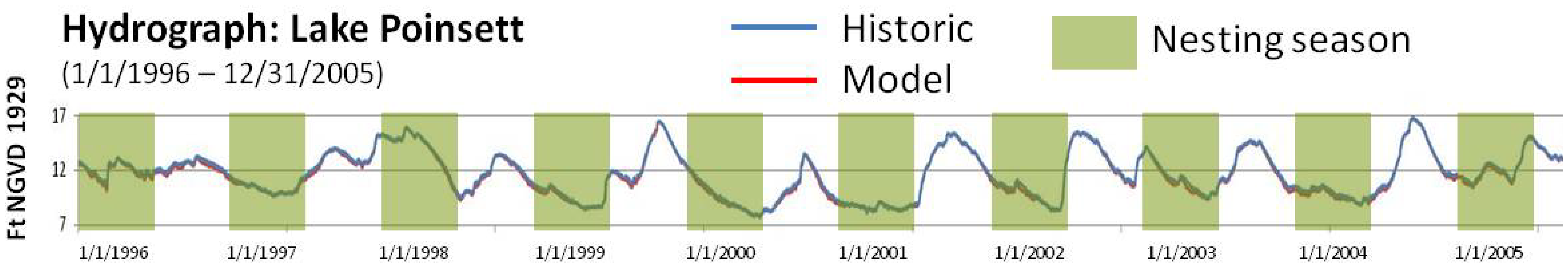
St Johns River as source of water supply

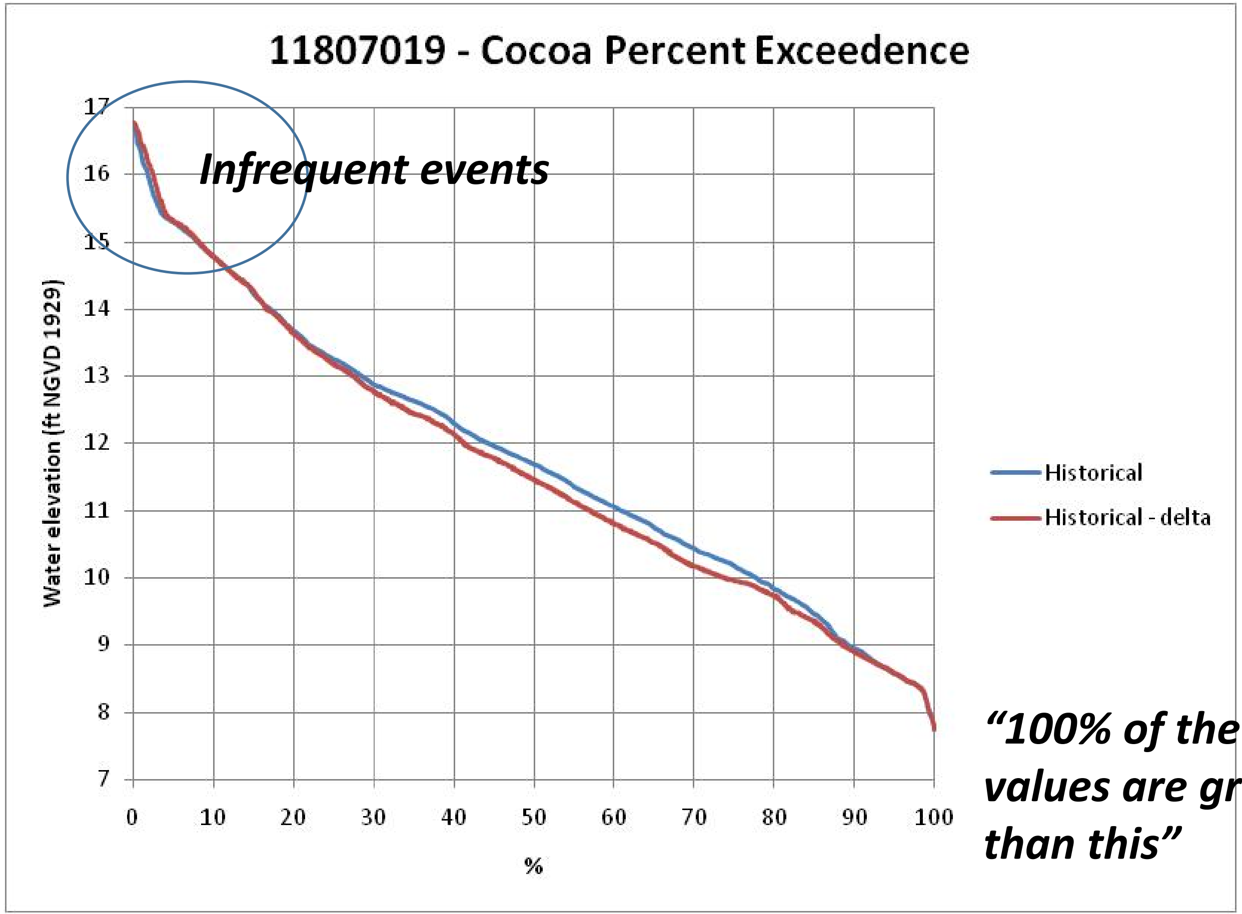
Evaluate impact of various withdrawal scenarios

on ecological systems of the River

Will changes in hydrology have a negative impact on existing wetlands?

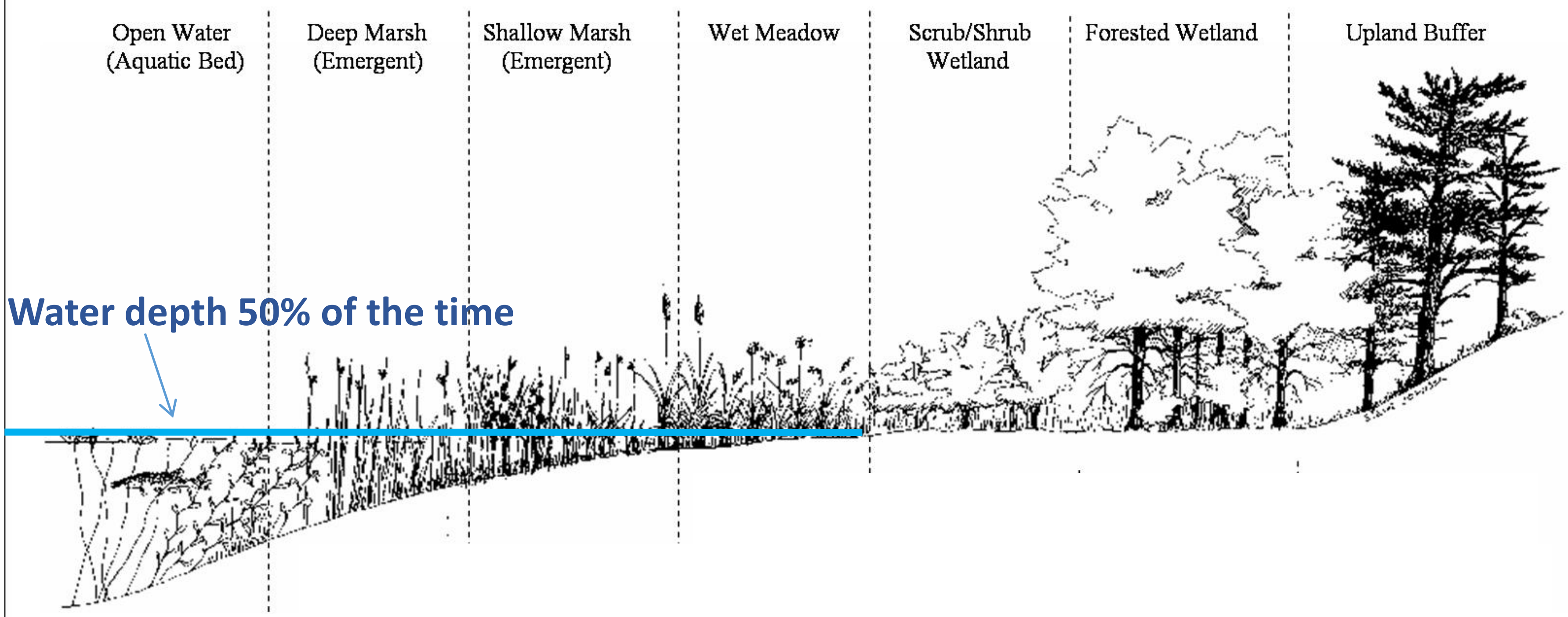
Hydrology / Exceedence Approach: *This is the same data…….*





"100% of the time, values are greater than this"

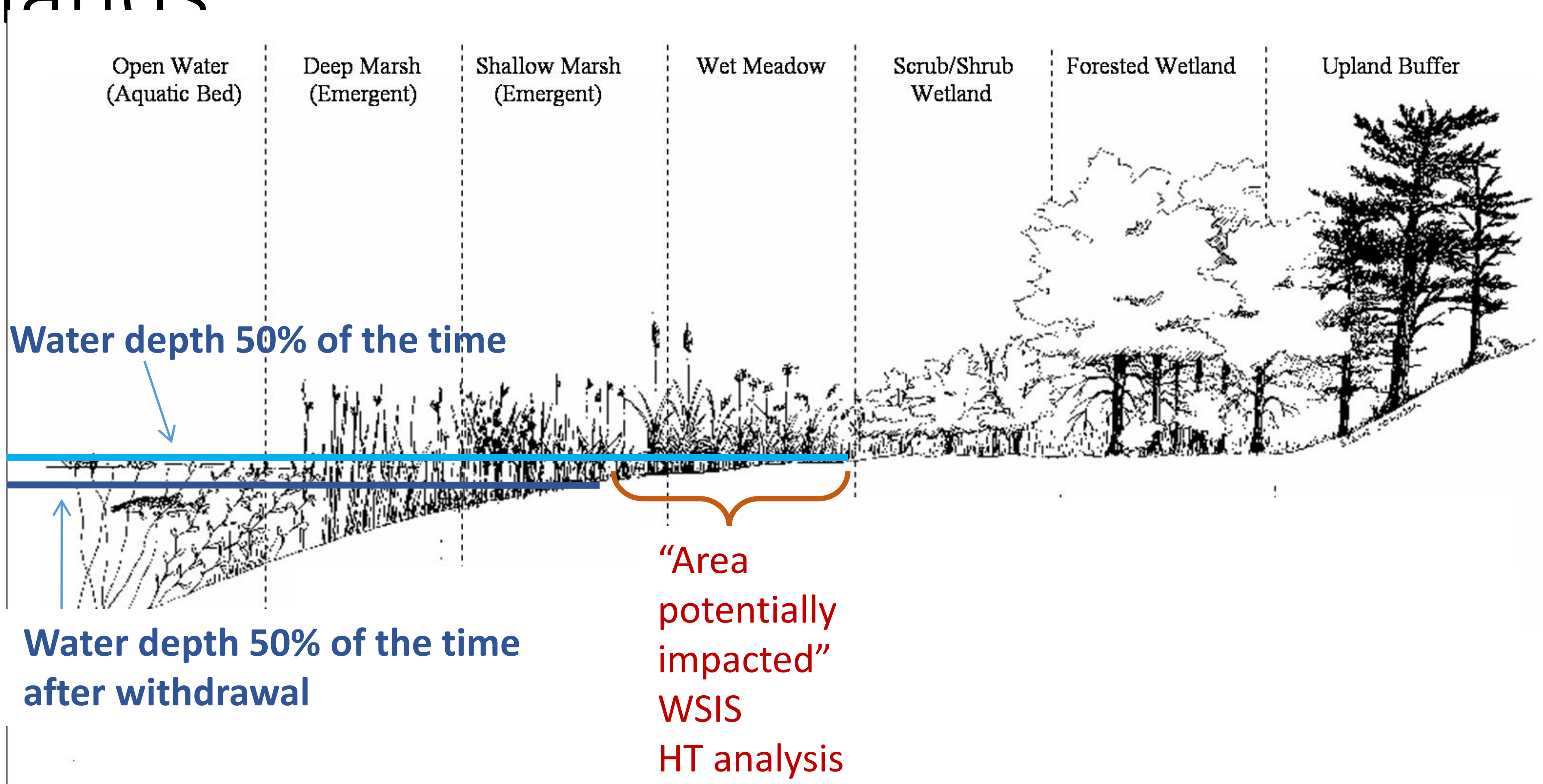
Potential effect of change in River stage on wetlands



Simplifying assumption: Only considering riverine stage to represent wetland hydrology

http://www.newp.com/wetland%20cross%20section.htm

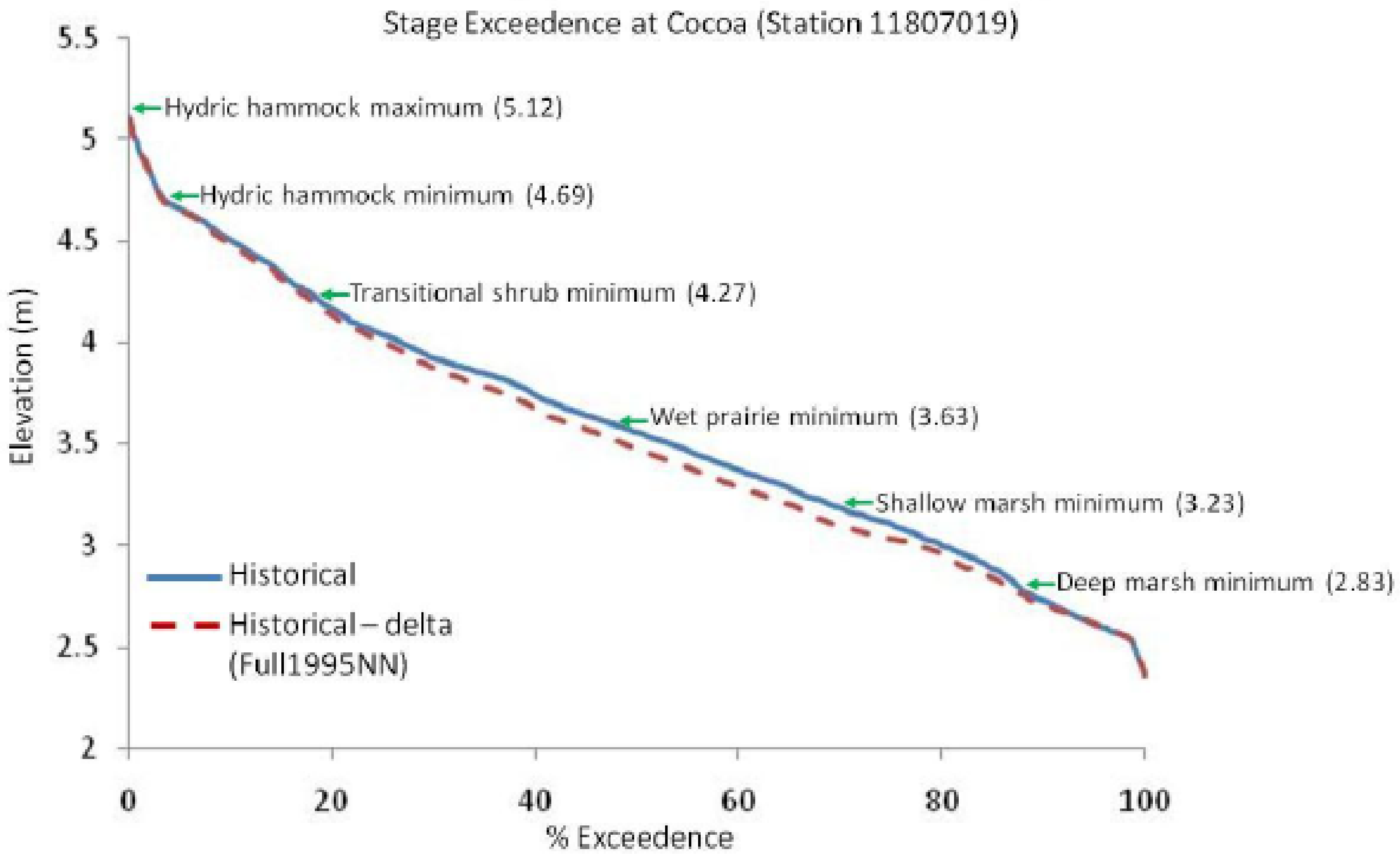
Potential effect of change in River stage on wetlands



BIG step: translating from "transect" to "floodplain"

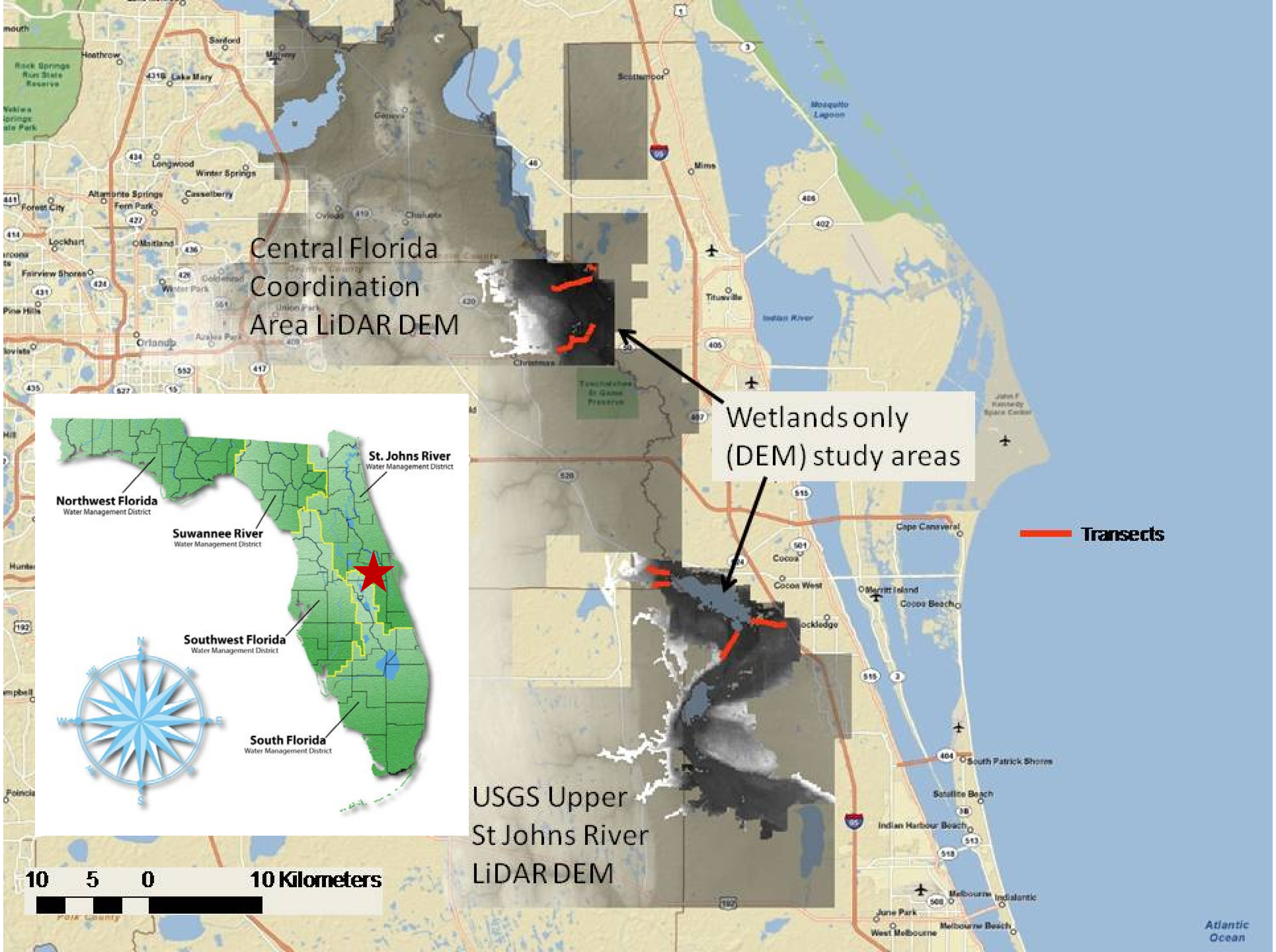
http://www.newp.com/wetland%20cross%20section.htm

Minimum Flows and Levels program
Compilation of community elevation statistics
Summarize characteristics and inherent variability
(Median of the minimums)



Hectare-Day

- Unit of measurement that encompasses both space and time (!)
- 100 hectare-days
  - 100 hectares inundated for 1 day
  - 10 hectares inundated for 10 days
  - 1 hectare inundated for 100 days
- ***Purpose of using this unit is to compare scenarios***


Central Florida
Coordination
Area LiDAR DEM
Wetlands only
(DEM) study areas
Transects
USGS Upper
St Johns River
LiDAR DEM
St. Johns River
Water Management District
Northwest Florida
Water Management District
Suwannee River
Water Management District
Southwest Florida
Water Management District
South Florida
Water Management District
10 5 0 10 Kilometers

Scenario Name	Description
Historical baseline	Empirical data on water surface elevation collected by USGS or SJRWMD, 1 January 1995 to 31 December 2005.
Base1995NN	Modeled data, no water withdrawals, 1995 land use, no USJRB projects, and no sea level rise.
Base1995PN	Modeled data, no water withdrawals, 1995 land use, USJRB projects operational, and no sea level rise.
Full1995NN	Modeled data, full water withdrawal, 1995 land use, no USJRB projects, and no sea level rise.
FwOR1995NN	Modeled data, full water withdrawal, Ocklawaha River withdrawal; no USJRB projects, and no sea level rise.
Half1995PN	Modeled data, half water withdrawal, 1995 land use, USJRB projects operational, and no sea level rise.
Full1995PN	Modeled data, full water withdrawal, 1995 land use, USJRB projects operational, and no sea level rise.
Full2030PS	Modeled data, full water withdrawal, USJRB projects operational, 2030 land use, and +14 cm of sea level rise.
Full2030PN	Modeled data, full water withdrawal, USJRB projects operational, 2030 land use, and no sea level rise.

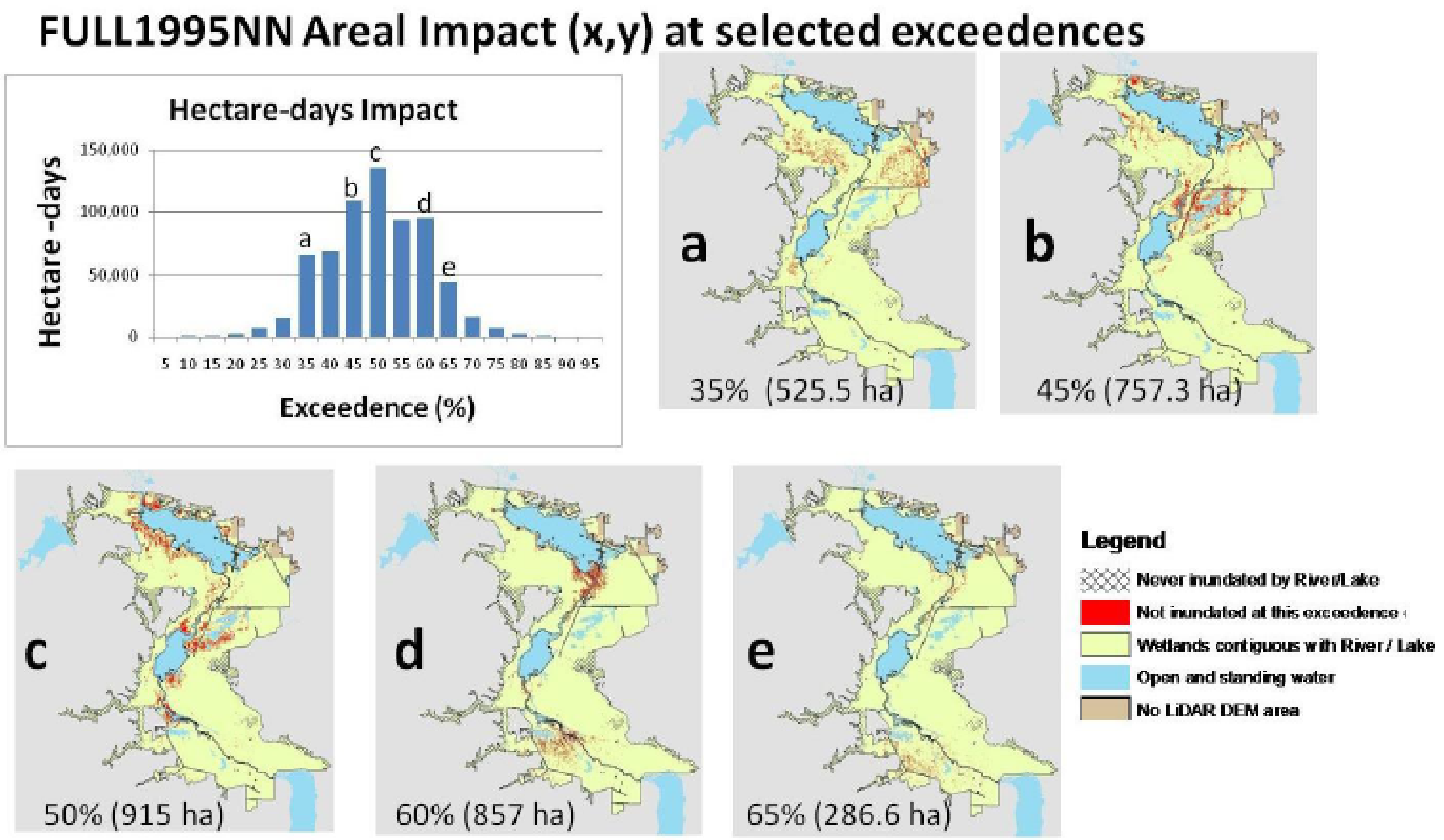


Figure 4–25. Areas dewatered and hectare-days of effect at selected exceedences for the Full1995NN scenario.

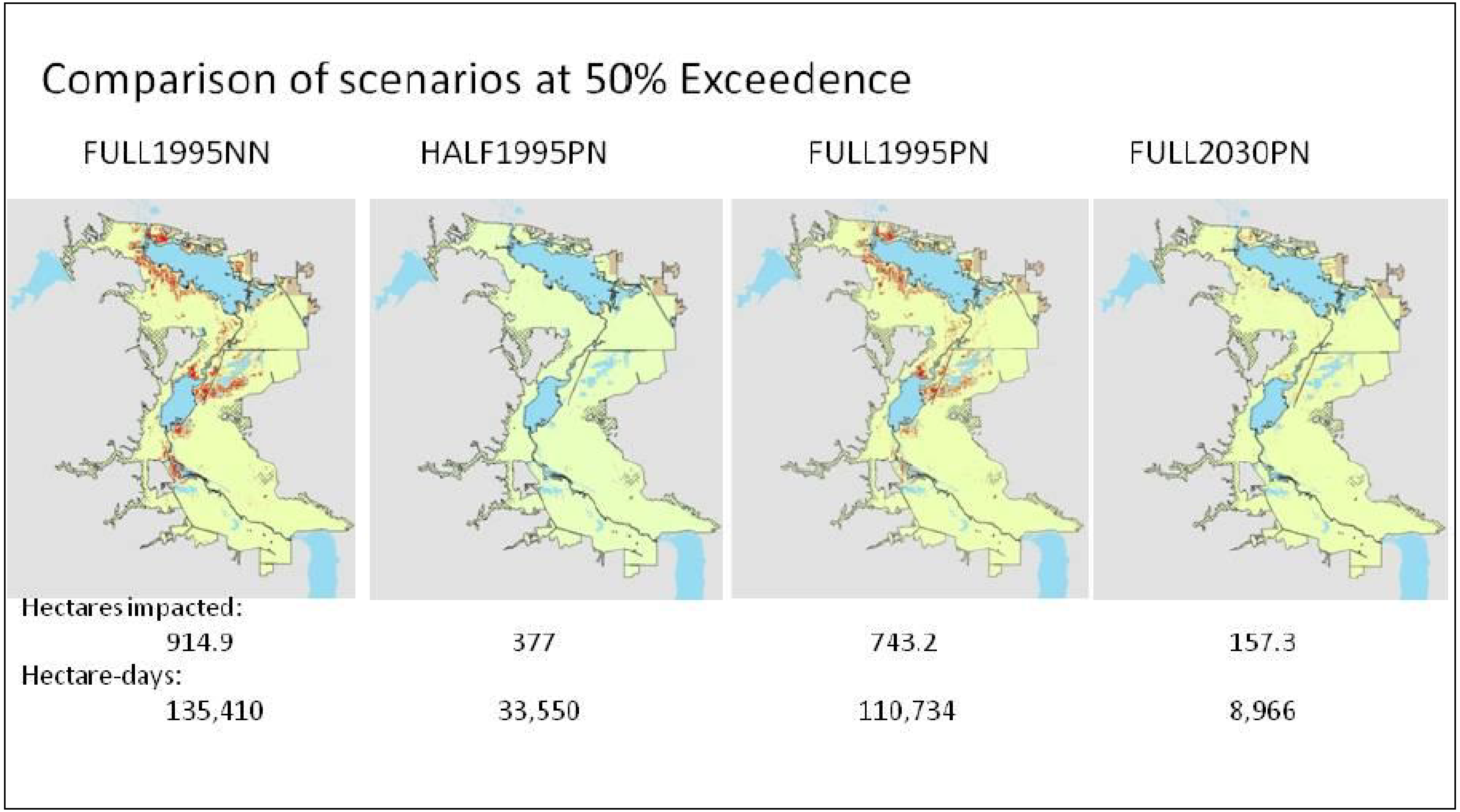


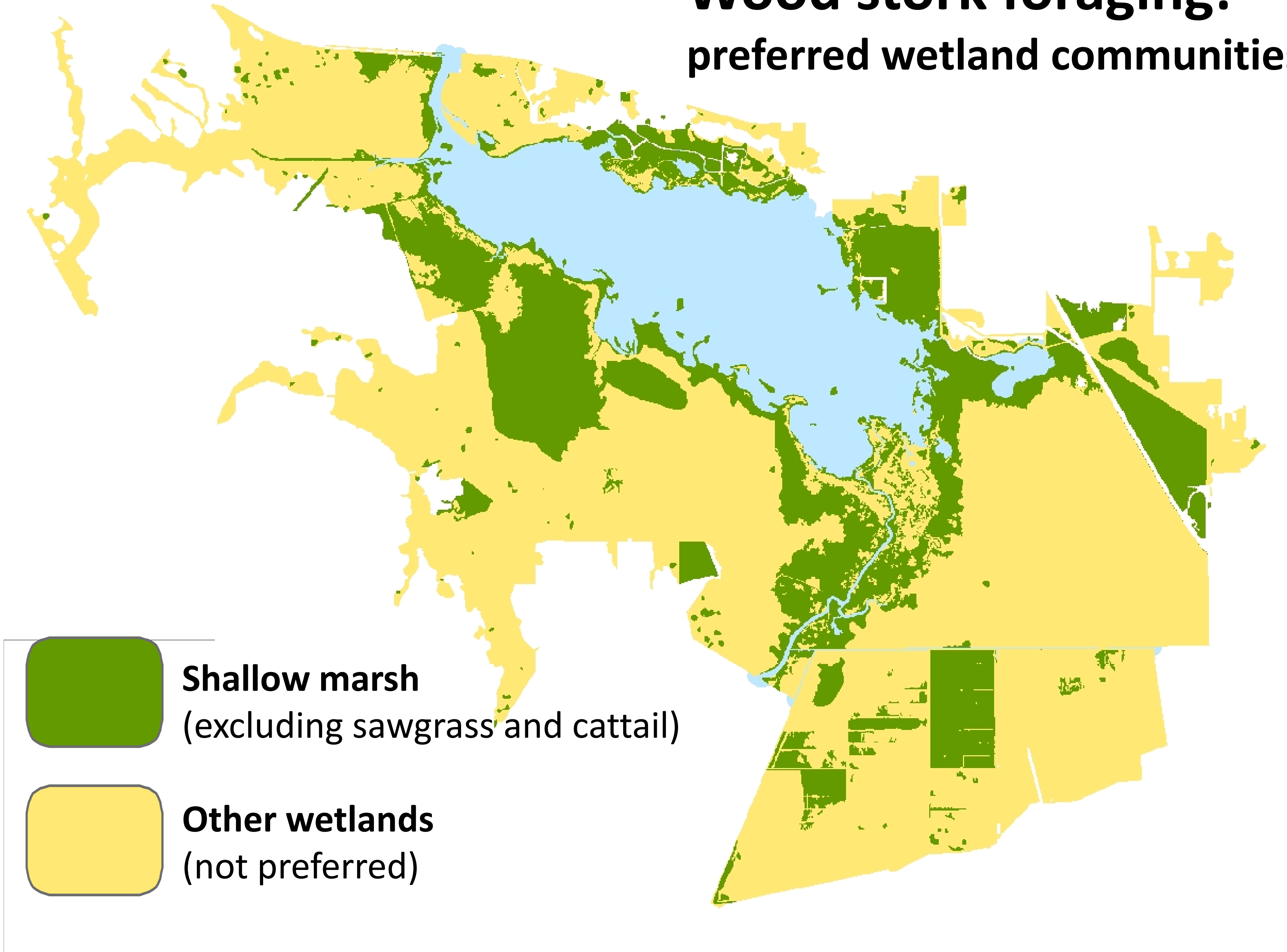
Figure 4–34. Comparison of scenarios at 50% exceedence, with reduction of areal flooding expressed as hectare-days.

Wildlife impacts

Springboard off WSIS – same study area, same data ---- return to time series as input

Is habitat supported by existing/changing hydrology?

Wood stork foraging:
preferred wetland communities



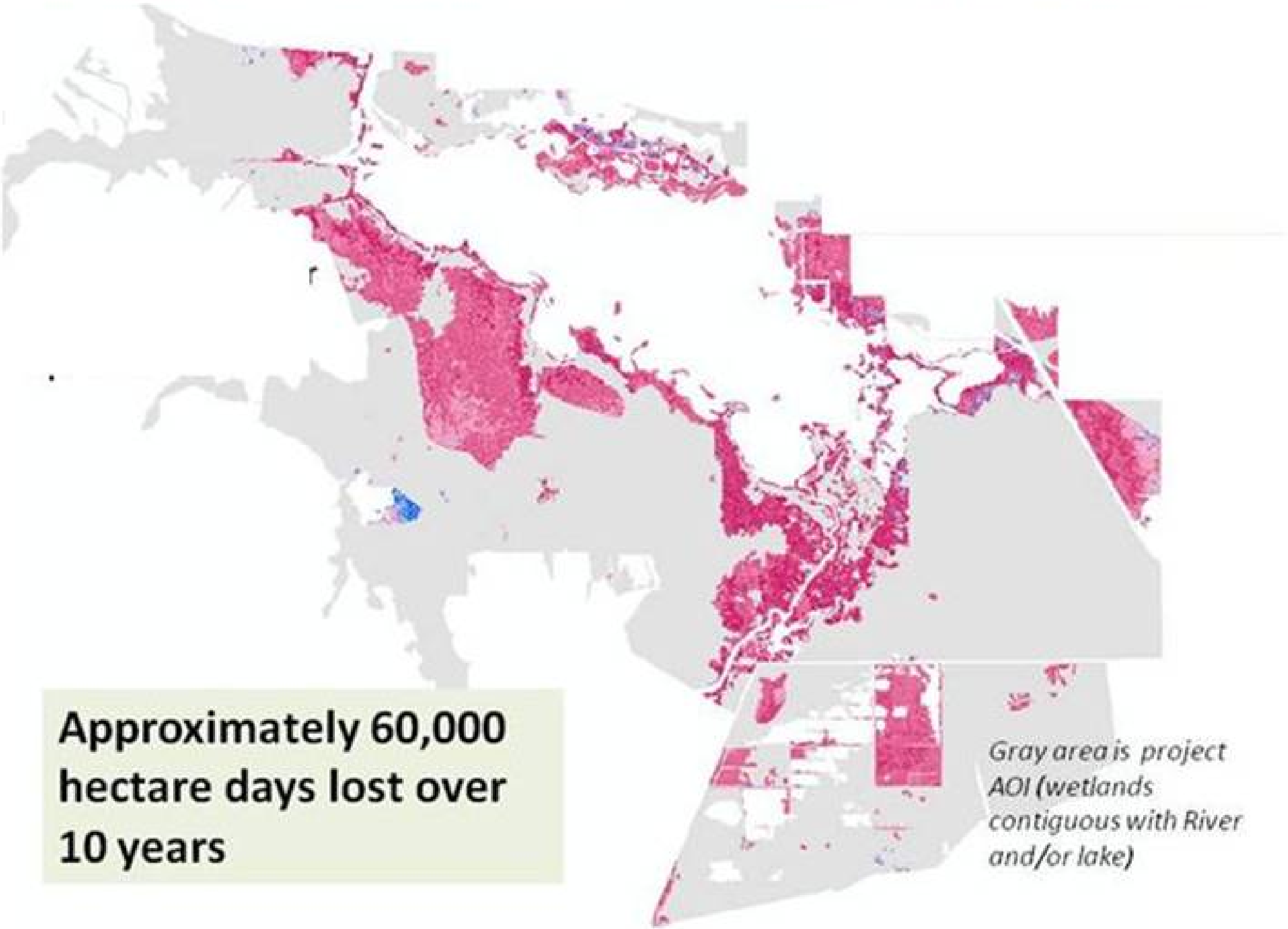
Loss (red tones) and gain (blue tones) of **wood stork foraging habitat during the 1996 - 2005 nesting seasons** due to the FULL1995NN withdrawal scenario

Days Lost or Gained

- 1 – 60
- 0
- -(0 – 1)
- -(1 – 5)
- -(5 – 10)
- -(10 – 15)
- -(15 – 20)
- -(20 – 25)
- -(25 – 30)
- -(30 – 35)
- -(35 – 40)
- -(40 – 45)
- -(45 – 50)
- -(50 – 55)
- -(55 – 64)

Wood stork foraging specs:

1. Jan 1 to June 30
2. Ponded depth = 5 – 30 cm
3. Duration = 90 days
4. Wetlands = Shallow marsh



Conclusions (WSIS)

- WSIS: Results indicated that effects of withdrawals largely disappeared with scenarios based on future land use
  - Wetlands work was not the only input in decision support
  - Review by National Research Council (NAS)

"…application of the Hydroperiod Tool was computationally challenging, but the result is a robust picture of the spatial extent of dewatering and shifting boundaries between wetland types"

Hydroperiod Tool: OWDI Use Case?

- Open Water Data Initiative:
  - will integrate currently fragmented water information into a connected, national water data framework and
  - leverage existing systems, infrastructure and tools to underpin innovation, modeling, data sharing, and solution development.

Use Case Concepts

- Define use cases that respond to societal needs and cover broad range of water resources issues
- Identify critical data inputs — focus on these first
- Our emphasis is on the data, not the full solution

OWDI Use Cases

Use Case 1:

National Flood Interoperability Experiment

- Identify flood data including stream-flow observations, forecasts and impacts
- Developing *geospatial framework* and exploring data conflation

Use Case 2:

Drought Decision Support System

- Identify water resources data including natural flow, reservoir storage and drought impacts
- Explore visualization of drought in Lower Colorado

Use Case 3:

Spill Response Tool

- Review existing modeling applications and data requirements
- Exploring requirements for new/additional data (e.g. velocity forecasts and reservoir residence times)

fgdc FederalGeographicDataCommittee

ACWI Advisory Committee on Water Information

Pros and cons of HT as OWDI use case

- Pro
  - Simple model
    - Not parameter driven
    - No special skills needed
    - Tool format is not important
  - Both input data types are prevalent
  - Can be used to address a wide array of ecological problems
  - Small group of committed practitioners
  - Quick answers (after initial set-up)
  - Strength is in comparing scenarios

- Con
  - Relatively unknown to many potential users
  - Data prep can be “daunting”
  - Can be a “processing hog” for “standard issue computers”
  - How “good” does the data have to be? (sensitivity analyses)

What is needed to become an OWDI use case?

- Collaborative partners
  - Exposure to the tool and “vision” for use
    - Wetland scientists (academic, government, private sector)
- Improved platform
  - Tweaks
  - Cloud-based?

Thanks!

QUESTIONS?

Contact: sfox@sjrwmd.com