Wetland Sensitivity to Potential Reductions in Surface Water Flow in the St. Johns River

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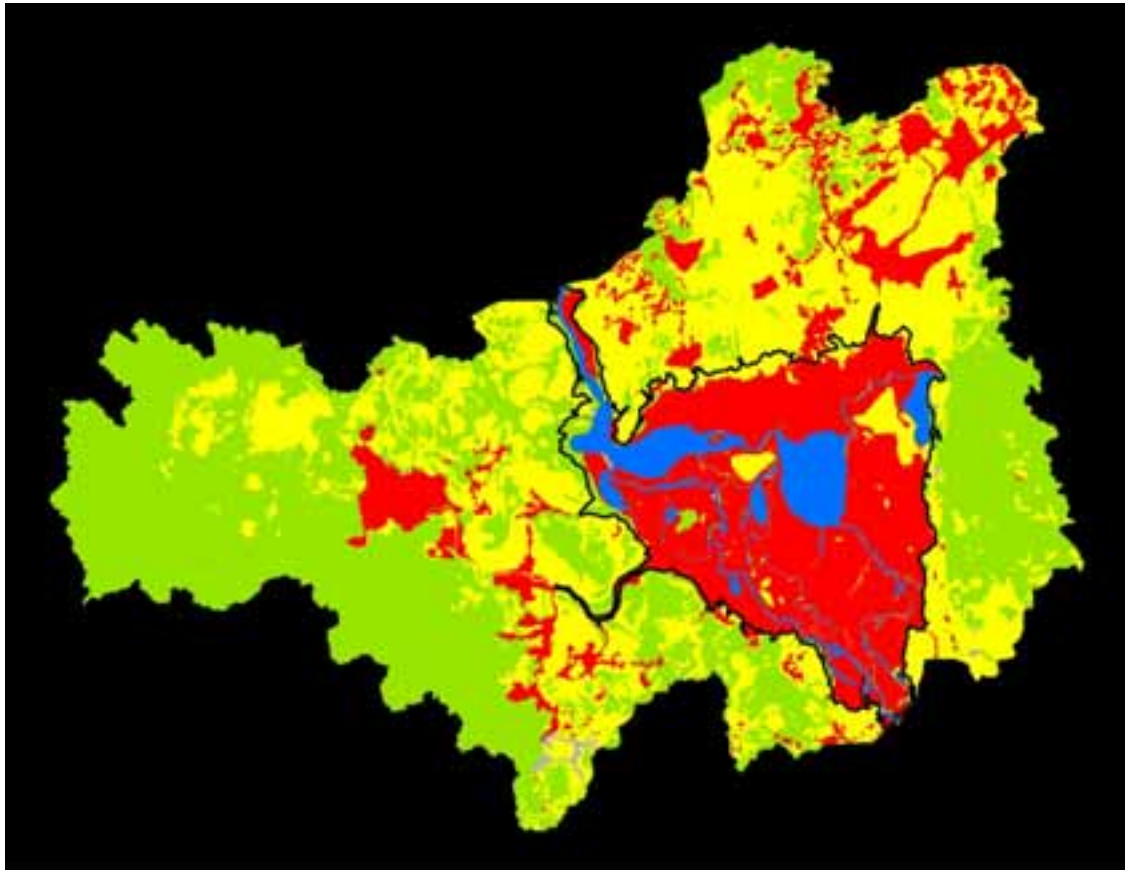
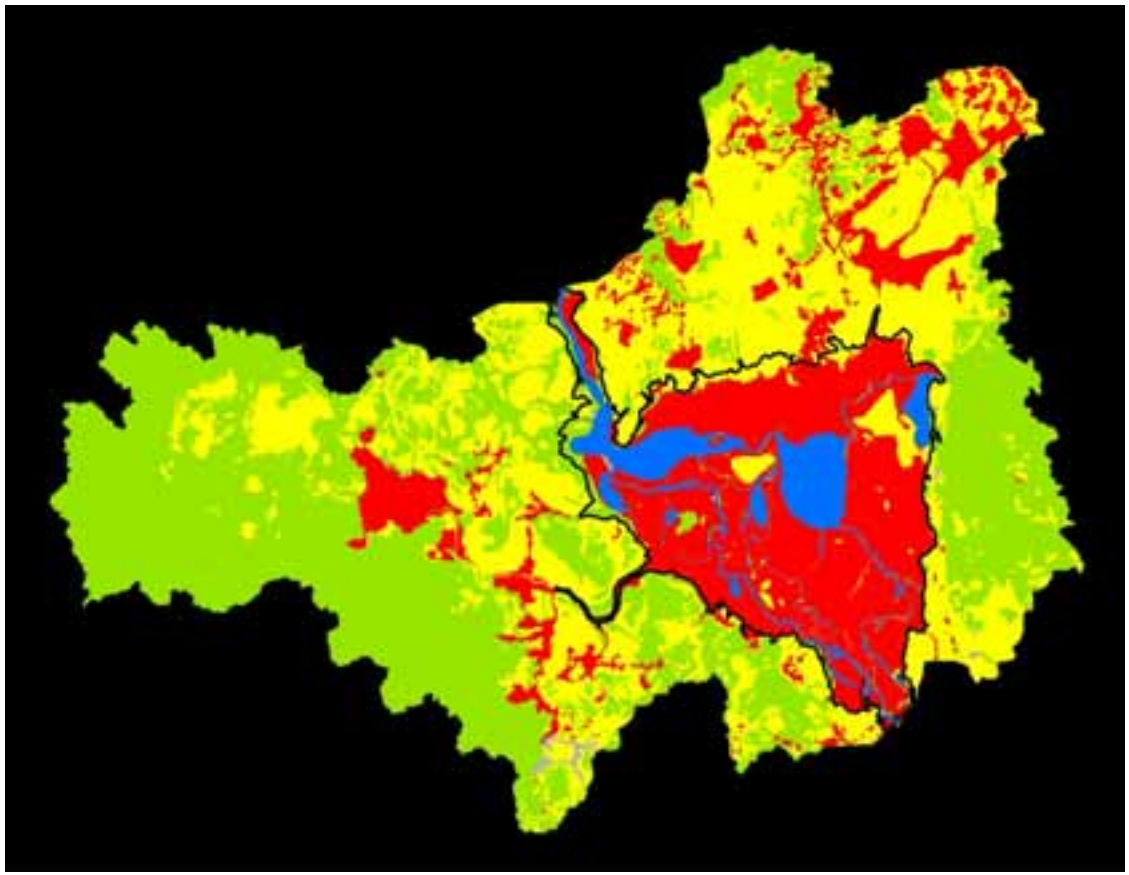


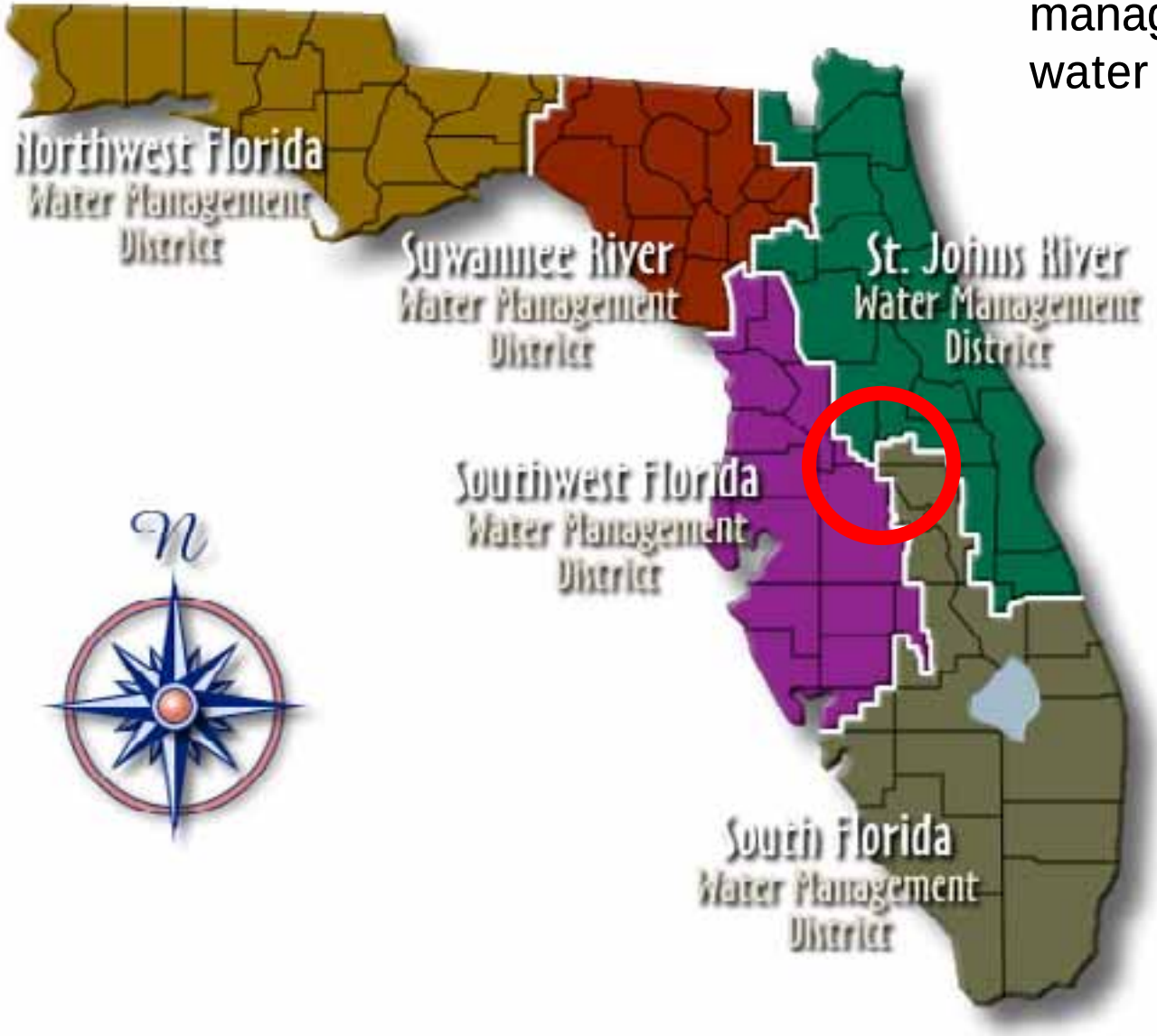
Outline:

- Background – Alternative Water Supply (AWS) project
- Approach to assess potential effect of drawdown on wetlands
  - Area of concern
  - River Segments
  - Inventory
  - River edge (wetlands)
  - GIS Model
- Methods
- Results to date



BACKGROUND:

Florida is divided into five water management districts to preserve and manage Florida's precious water resources.



Population growth in Central Florida will soon exceed GW capacity

Background
Florida Water Policy

- Maximize reasonable-beneficial use of water resources
- Maximize economic development of water resources
- Manage water resources for environmental protection, drainage, flood control, and water storage

http://www.sjrwmd.com/surfacewaterwithdrawals/index.html

There is a lot of information on the website – including the presentations from a symposium

Detailed report from Phase I available on line now

Project Structure

- Seven work groups consisting of District scientists and one or more non-District scientists with national standing
- External peer review panel convened by the NRC of the National Academies
- Public – website, working meetings

APPROACH: Alternative Water Supply

Wetland Components and Effects

Wetlands Plant Communities

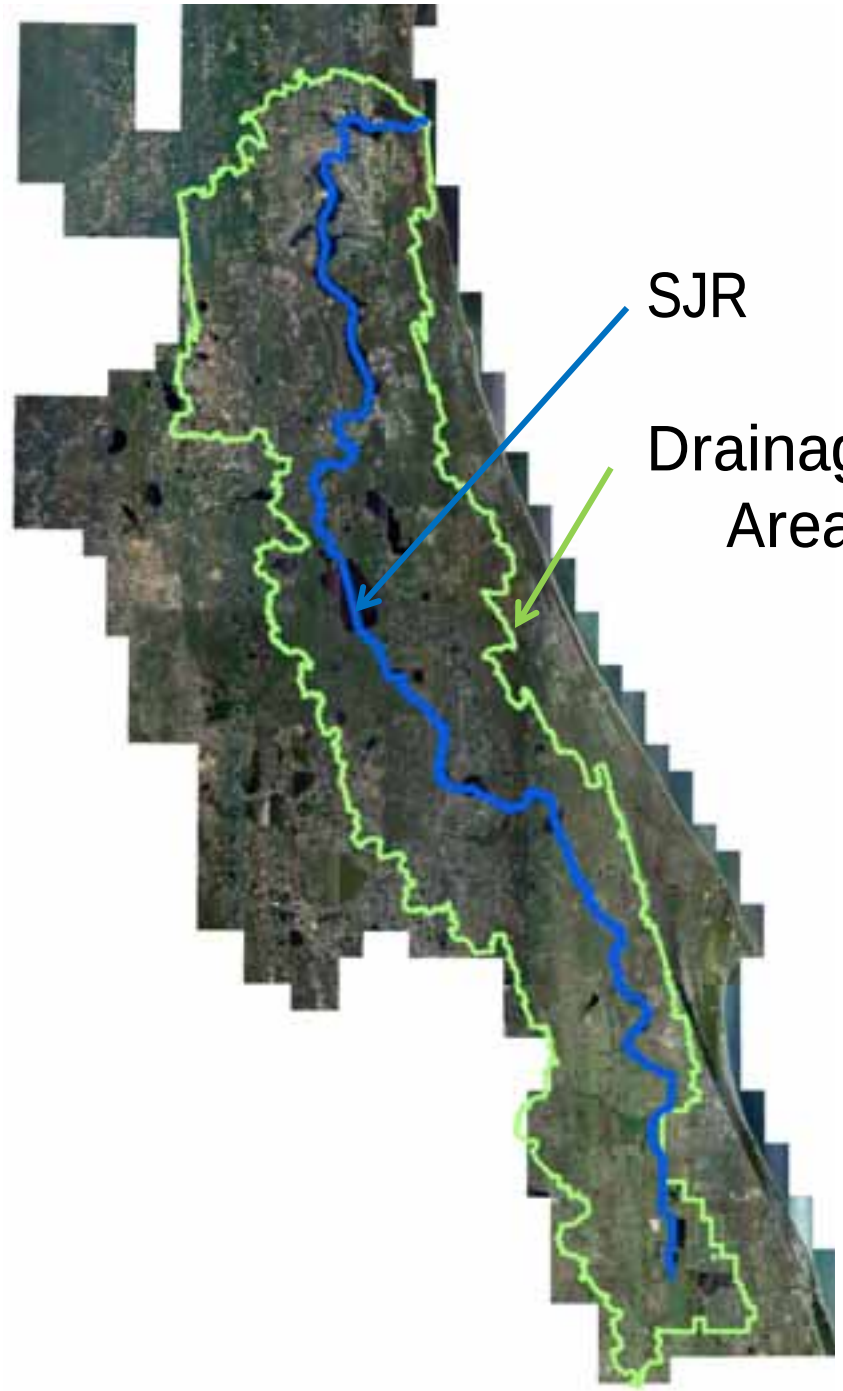
- Shift in type or structure
- Changes in biomass or productivity
- Shifts in community boundaries
- Shifts in community composition

Wetland Functions

- Alterations in habitats of wetland dependant species
- Others (generally covered by other groups)

Wetland Species

- Impacts to rare or listed species
- Impacts on life cycles and recruitment



First – What is the area of concern?

We need a boundary –

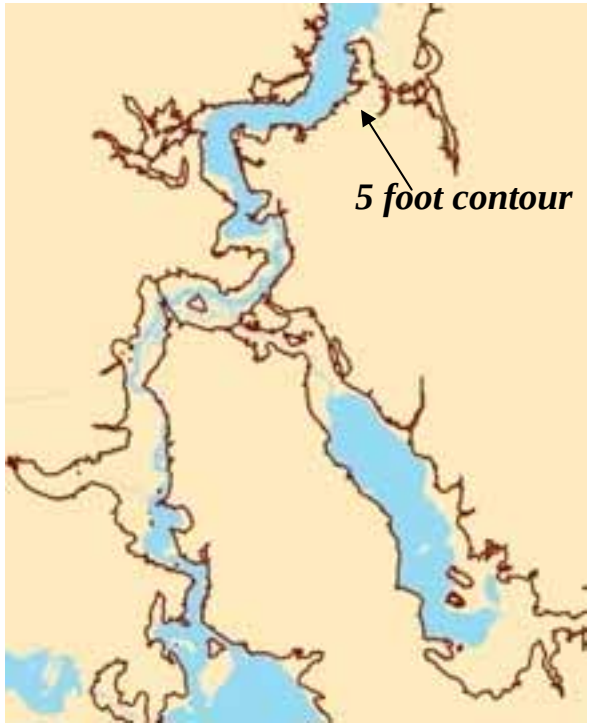
Outside = confident drawdown will not effect wetlands

Inside = wetlands possibly effected by drawdown

Serious limitation – DEM

“Floodplain” delineation:

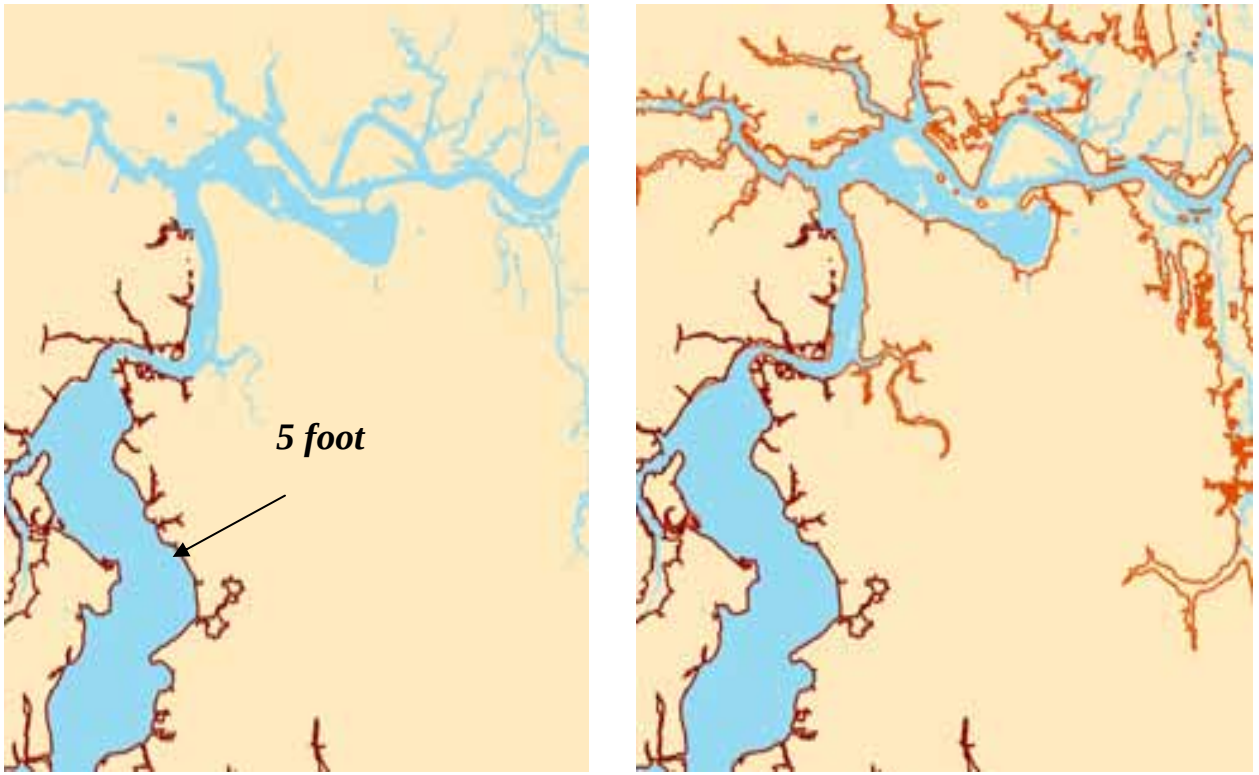
For most of the river – The District’s USGS 5 foot contour line was used



Corrected to 2004 aerial photography….

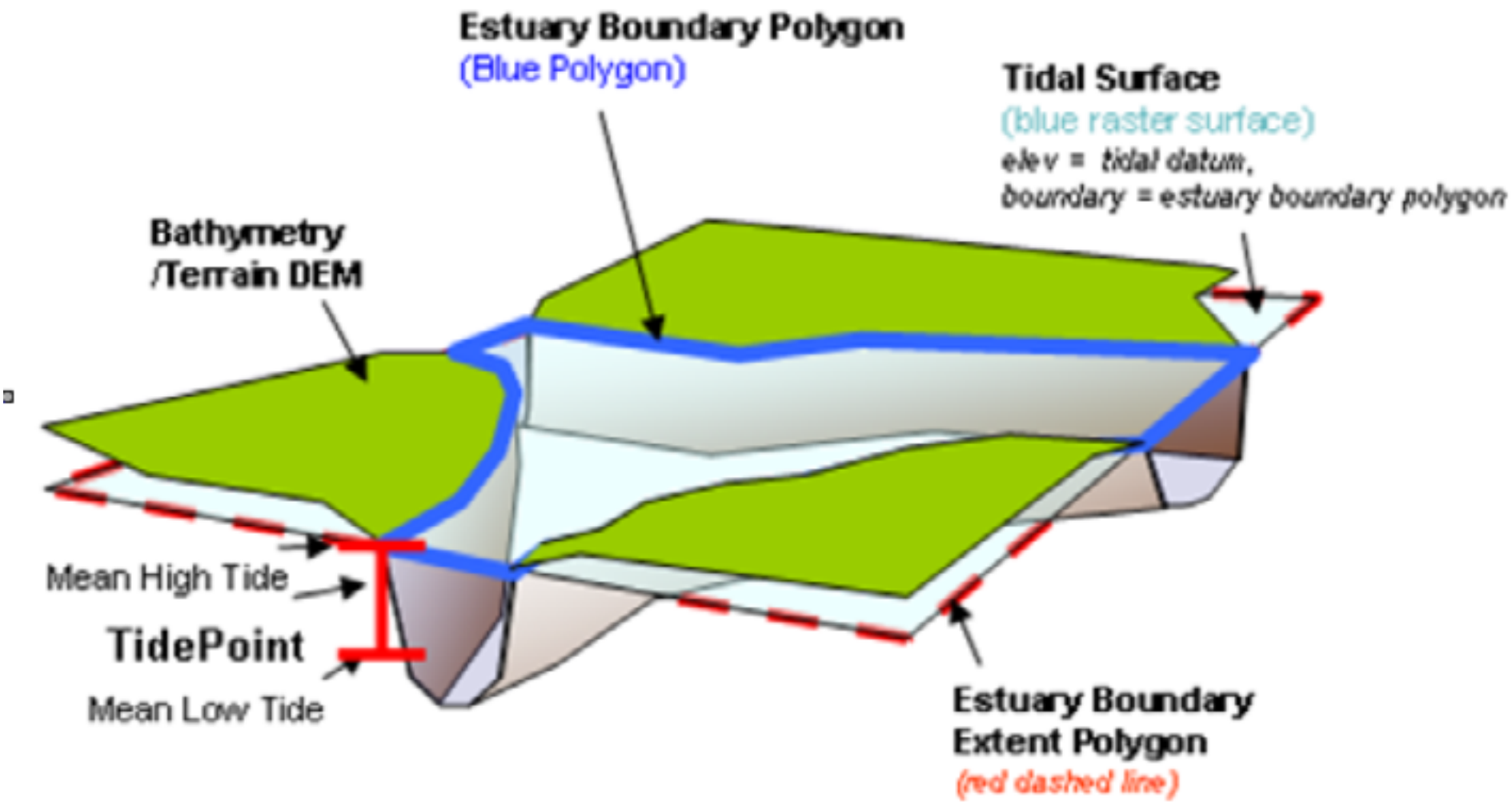
“Floodplain” delineation:

At the mouth of the river – we used a DEM-based methodology to estimate the 5 foot line – which was then QAQC’d using 2004 aerial photography



Also – “cleaned up” with reference to aerial photography
Method – QAQC’d to 5 foot contour lines in coastal areas

DEM method for coastal area

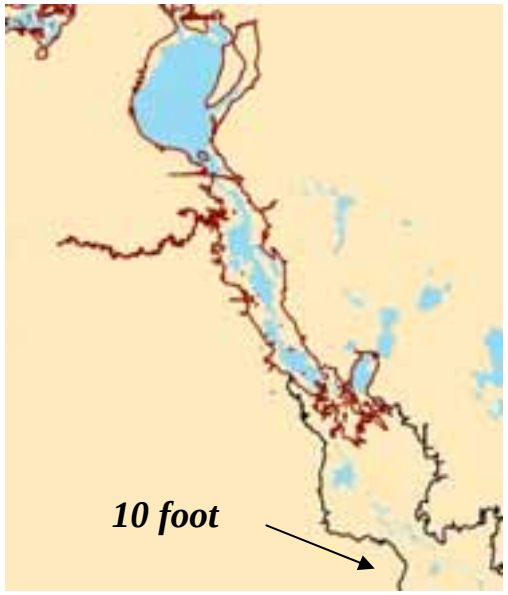


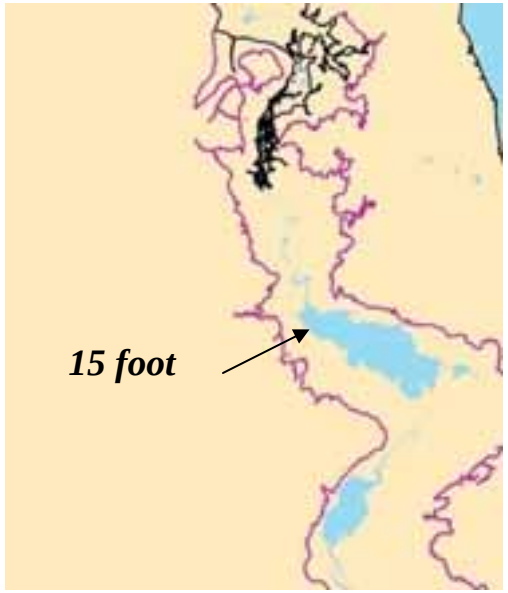
“Floodplain” delineation:

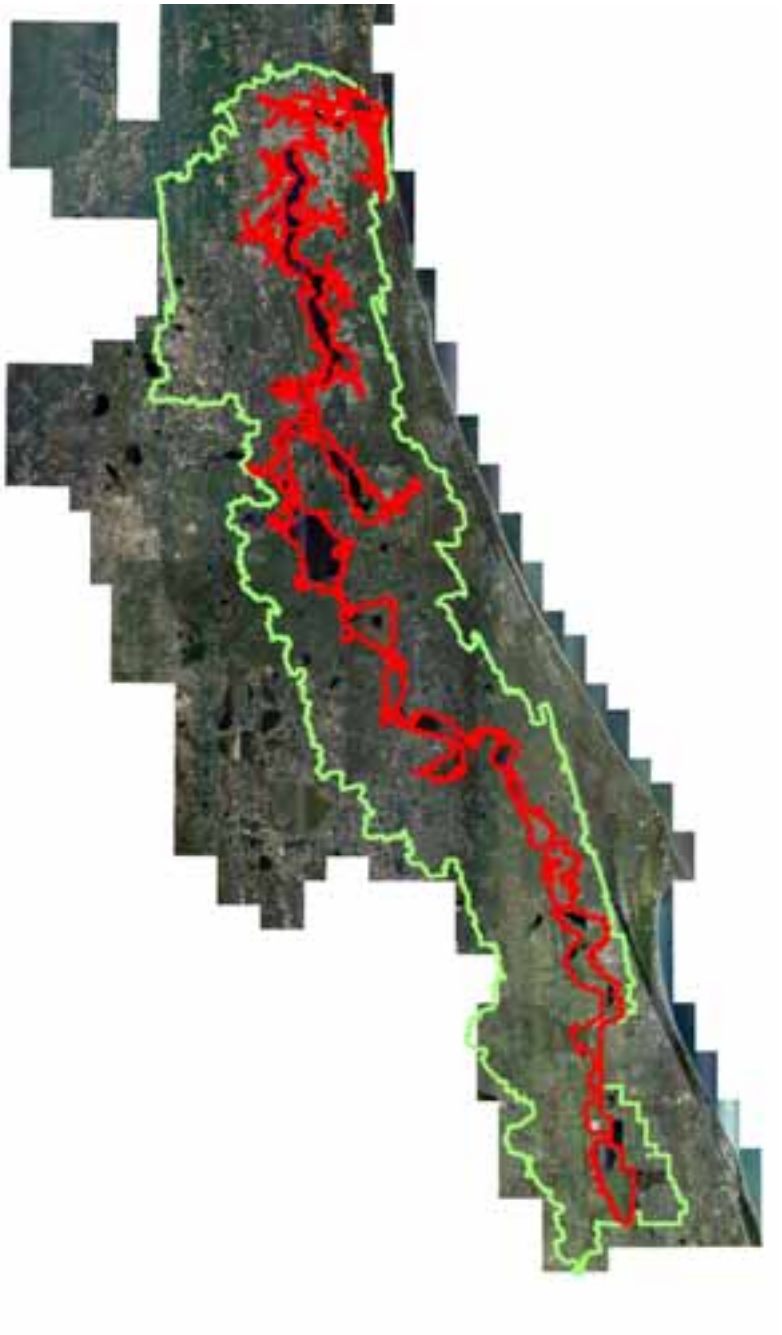
At the southern end –

We added the 10 through 25 foot contour lines which were adjusted to account for levees and canals in the far southern end;

“connections” between contour lines (so that boundary line would be continuous) were determined by wetlands in 2004 aerial photography.



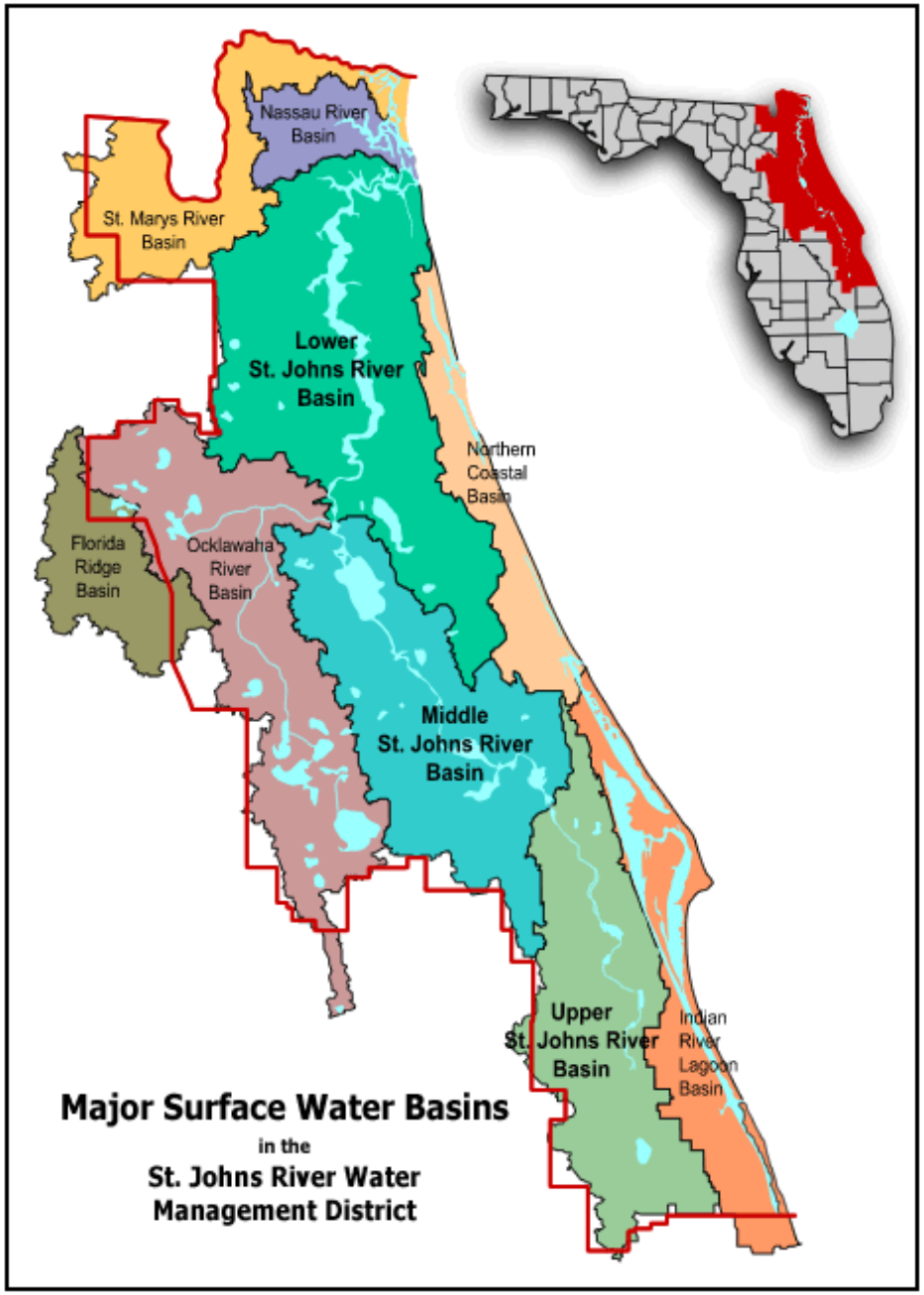




Now we have an area of concern.....

But....
.....we have one very long area of interest....

Dividing it up into logical subunits seemed like a very good idea!

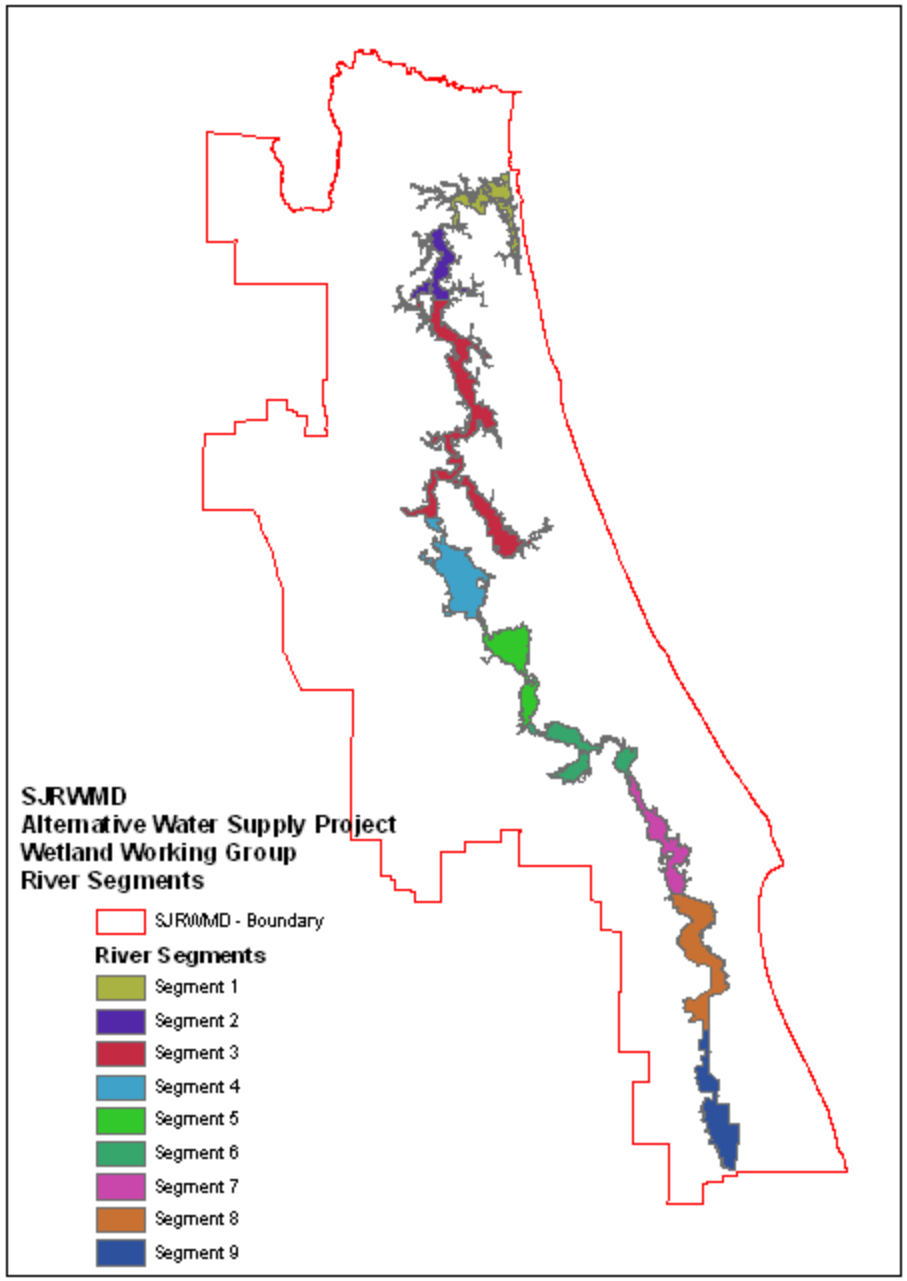


Start with standard “working divisions” of the river

Field excursions – to get to know the river and the wetlands better

Even within the upper, lower and middle basins – visually they were not homogeneous...

Divide the river AOI into approximately homogeneous areas – **GIS** (aerial photography) by water features and dominant wetland type

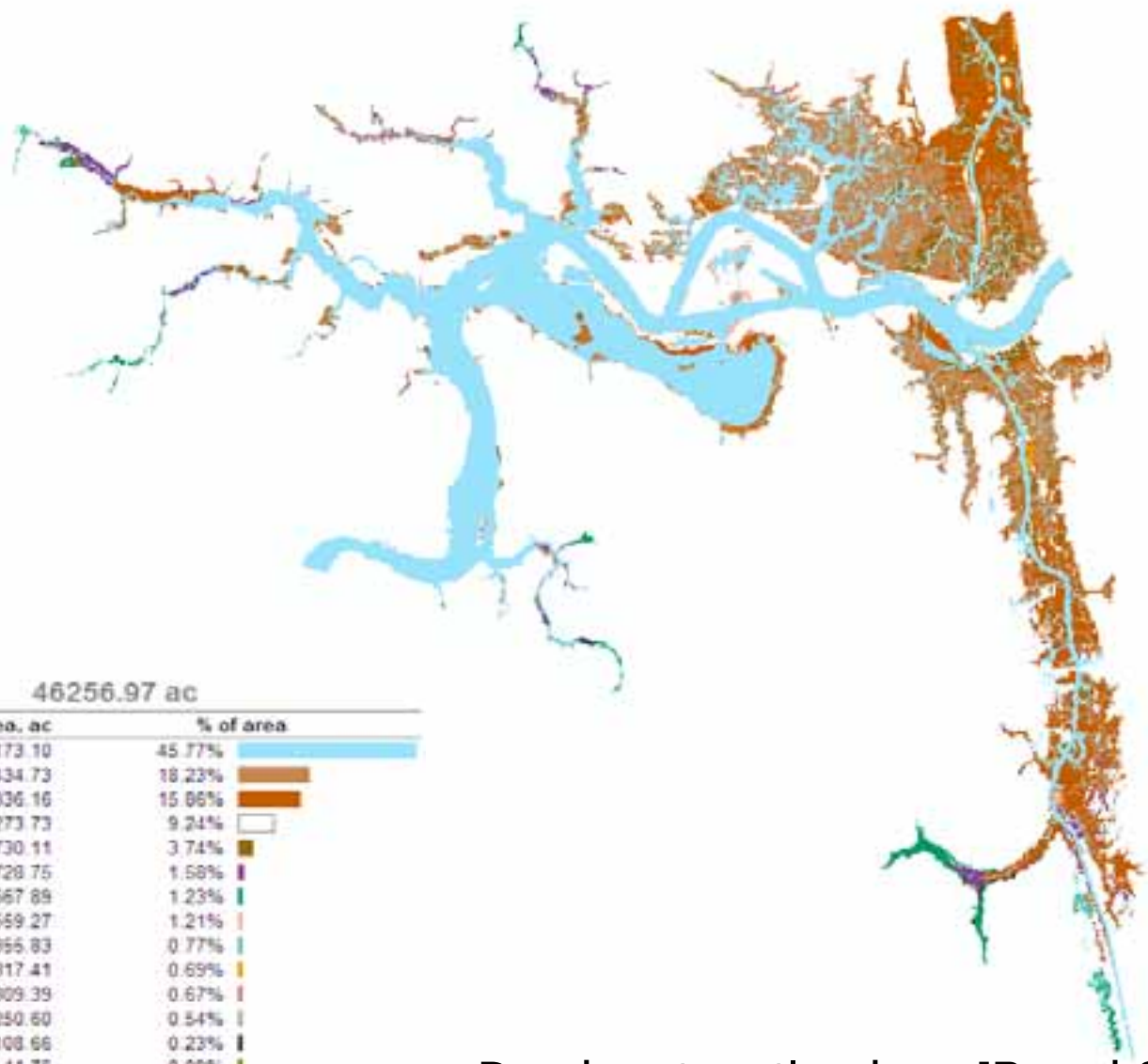


Ended up with 9 segments

Next: Inventories

- Wetlands
- Soils
- Combination – Wetlands and Soils
- "Local drainage" to each of the 9 river segments
- Land Use/Cover

River Segment 1



46256.97 ac

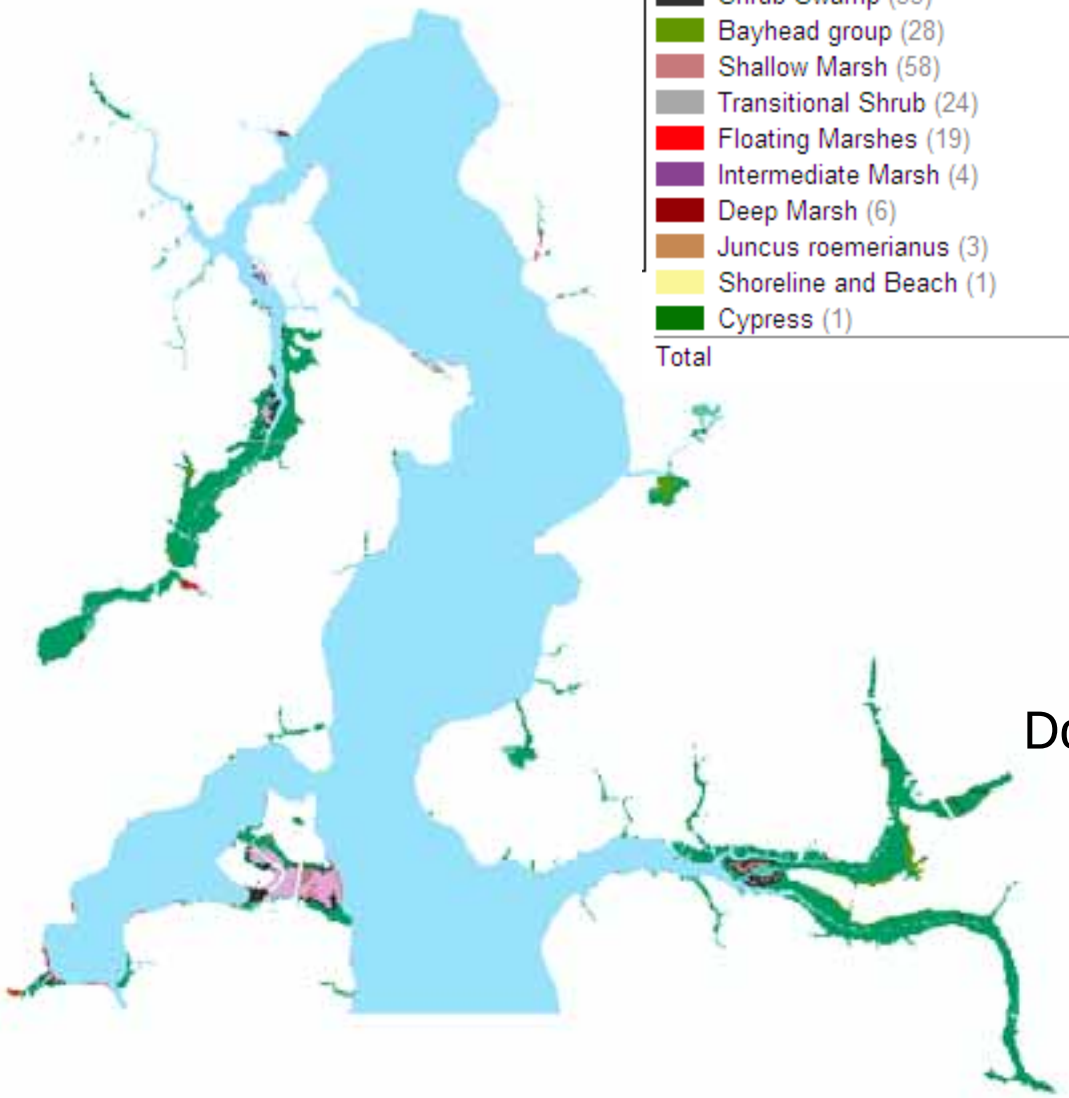
V3 (# of Features)	Area, ac	% of area
Water group (106)	21173.10	45.77%
Juncus roemerianus (722)	8434.73	18.23%
Spartina alterniflora (741)	7336.16	15.86%
Upland (350)	4273.73	9.24%
Tidal Flats (515)	1730.11	3.74%
Intermediate Marsh (196)	728.75	1.58%
Hardwood Swamp (75)	567.89	1.23%
High Meadow (311)	559.27	1.21%
Hydric Hammock group (134)	355.83	0.77%
Salt Flats (133)	317.41	0.69%
Shallow Marsh (85)	309.39	0.67%
Transitional Shrub (150)	250.60	0.54%
Shrub Swamp (53)	108.66	0.23%
Bayhead group (39)	41.75	0.09%
Shoreline and Beach (34)	39.42	0.09%
Wet Prairie (16)	17.48	0.04%
Cypress (3)	8.78	0.02%
Floating Marshes (2)	0.70	0.00%
Total	46256.97	

Dominant wetlands = JR and SA

River Segment 2

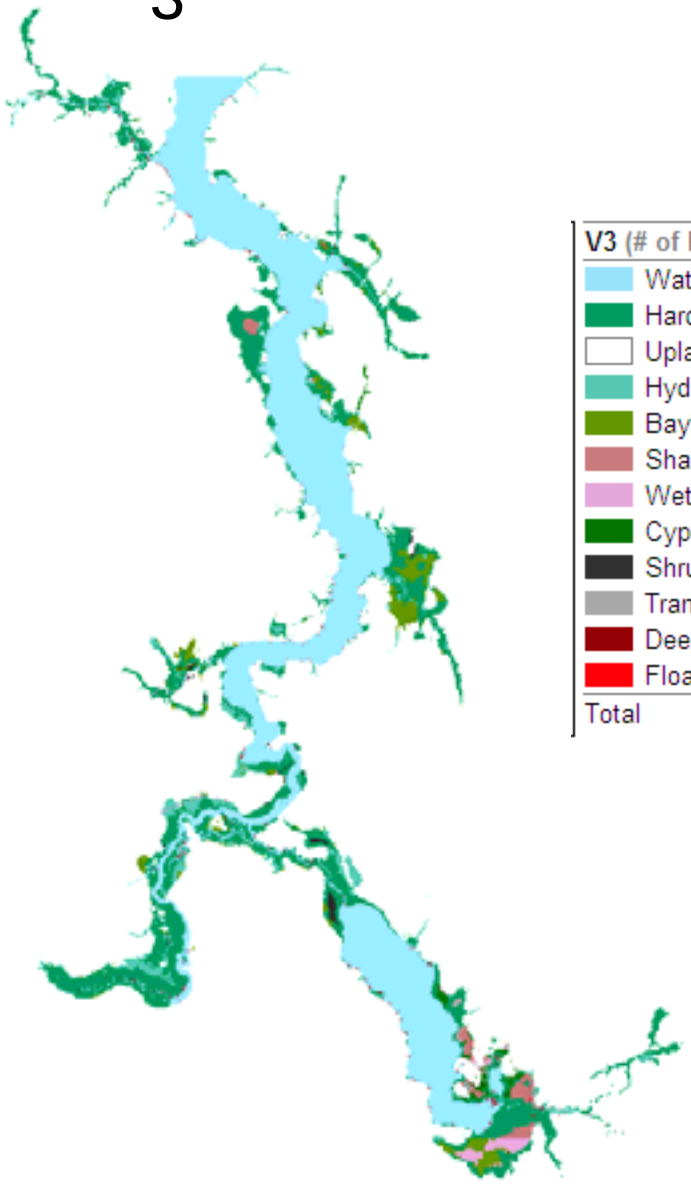
37215.00 ac

V3 (# of Features)	Area, ac	% of area
Water group (83)	29784.74	80.03%
Hardwood Swamp (146)	4005.61	10.76%
Upland (21)	2095.01	5.63%
Hydric Hammock group (77)	350.66	0.94%
Wet Prairie (17)	280.16	0.75%
Shrub Swamp (33)	230.58	0.62%
Bayhead group (28)	195.04	0.52%
Shallow Marsh (58)	122.85	0.33%
Transitional Shrub (24)	69.35	0.19%
Floating Marshes (19)	30.87	0.08%
Intermediate Marsh (4)	17.09	0.05%
Deep Marsh (6)	14.83	0.04%
Juncus roemerianus (3)	1.98	0.01%
Shoreline and Beach (1)	0.38	0.00%
Cypress (1)	0.35	0.00%
Total	37215.00	



Dominant wetlands = HS

River Segment 3



143694.31 ac

V3 (# of Features)	Area, ac	% of area
Water group (238)	72076.22	50.16%
Hardwood Swamp (433)	40555.41	28.22%
Upland (77)	12066.64	8.40%
Hydric Hammock group (380)	7240.38	5.04%
Bayhead group (146)	5069.10	3.53%
Shallow Marsh (235)	2345.79	1.63%
Wet Prairie (76)	1291.13	0.90%
Cypress (40)	1223.34	0.85%
Shrub Swamp (73)	756.51	0.53%
Transitional Shrub (41)	554.96	0.39%
Deep Marsh (182)	308.14	0.21%
Floating Marshes (96)	149.85	0.10%
Total	143694.31	

Dominant wetlands = HS & HH

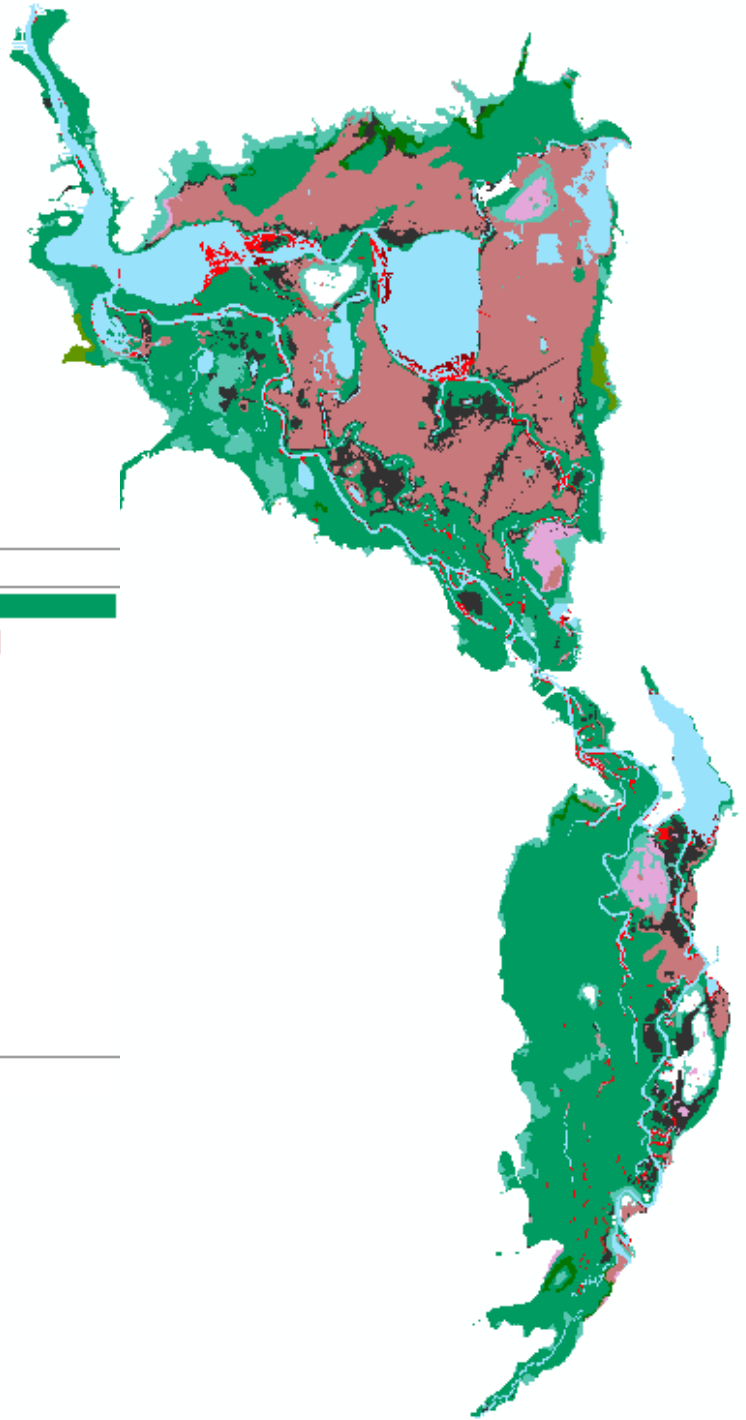
River Segment 4

72860.40 ac

V3 (# of Features)	Area, ac	% of area
Water group (77)	49319.51	67.69%
Hardwood Swamp (94)	9387.23	12.88%
Hydric Hammock group (192)	7286.46	10.00%
Upland (37)	3439.50	4.72%
Bayhead group (67)	975.52	1.34%
Deep Marsh (104)	778.72	1.07%
Shrub Swamp (40)	547.45	0.75%
Shallow Marsh (105)	330.14	0.45%
Wet Prairie (43)	266.45	0.37%
Transitional Shrub (8)	193.74	0.27%
Floating Marshes (69)	175.21	0.24%
Cypress (3)	67.13	0.09%
Salt Flats (10)	56.68	0.08%
High Meadow (1)	2.76	0.00%
Total	72860.40	

Dominant wetlands = HS & HH

River Segment 5

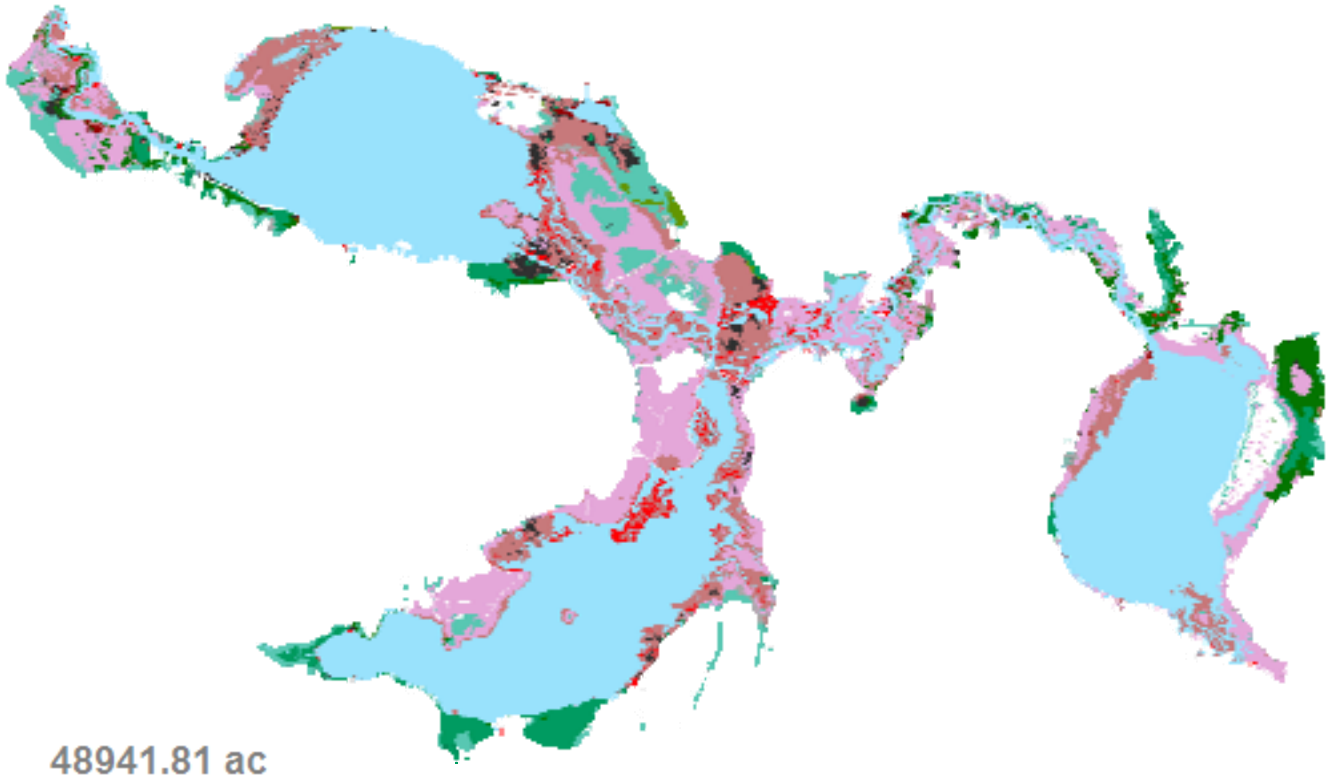


53628.19 ac

V3 (# of Features)	Area, ac	% of area
Hardwood Swamp (251)	23290.43	43.43%
Shallow Marsh (198)	11187.36	20.86%
Water group (69)	8259.78	15.40%
Hydric Hammock group (148)	3694.48	6.89%
Shrub Swamp (326)	3027.90	5.65%
Upland (47)	1532.41	2.86%
Floating Marshes (444)	929.69	1.73%
Wet Prairie (39)	849.91	1.58%
Cypress (16)	380.41	0.71%
Bayhead group (5)	229.75	0.43%
Deep Marsh (75)	182.21	0.34%
Transitional Shrub (11)	53.19	0.10%
Salt Flats (1)	0.77	0.00%
Total	53628.19	

Dominant wetlands = SM & HH

River Segment 6



48941.81 ac

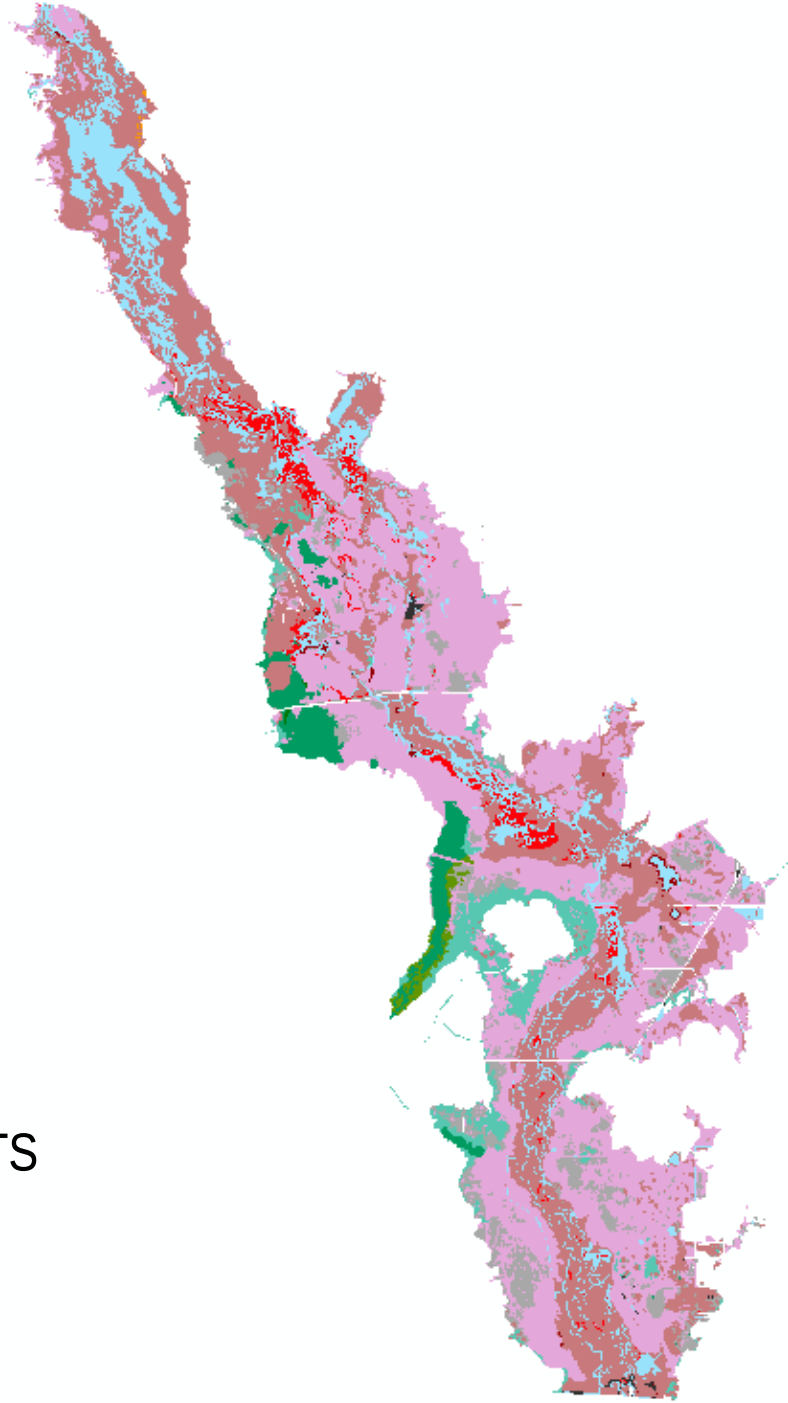
V3 (# of Features)	Area, ac	% of area
Water group (181)	26834.27	54.83%
Wet Prairie (260)	7517.96	15.36%
Shallow Marsh (463)	5214.50	10.65%
Hydric Hammock group (257)	2354.85	4.81%
Upland (57)	1940.26	3.96%
Hardwood Swamp (137)	1686.23	3.45%
Cypress (150)	1219.95	2.49%
Floating Marshes (358)	774.79	1.58%
Shrub Swamp (200)	772.67	1.58%
Transitional Shrub (118)	382.36	0.78%
Deep Marsh (62)	128.93	0.26%
Bayhead group (9)	108.22	0.22%
Total	48941.81	

Dominant wetlands = WP & SM

River Segment 7

45910.44 ac

V3 (# of Features)	Area, ac	% of area
Wet Prairie (275)	17614.89	38.37%
Shallow Marsh (684)	13764.36	29.98%
Water group (252)	5598.05	12.19%
Transitional Shrub (431)	3101.79	6.76%
Hydric Hammock group (192)	2101.04	4.58%
Hardwood Swamp (43)	1589.39	3.46%
Floating Marshes (294)	1144.13	2.49%
Upland (35)	503.18	1.10%
Bayhead group (10)	246.57	0.54%
Deep Marsh (36)	113.75	0.25%
Shrub Swamp (35)	99.17	0.22%
Salt Flats (15)	14.95	0.03%
Cypress (2)	14.68	0.03%
Total	45910.44	



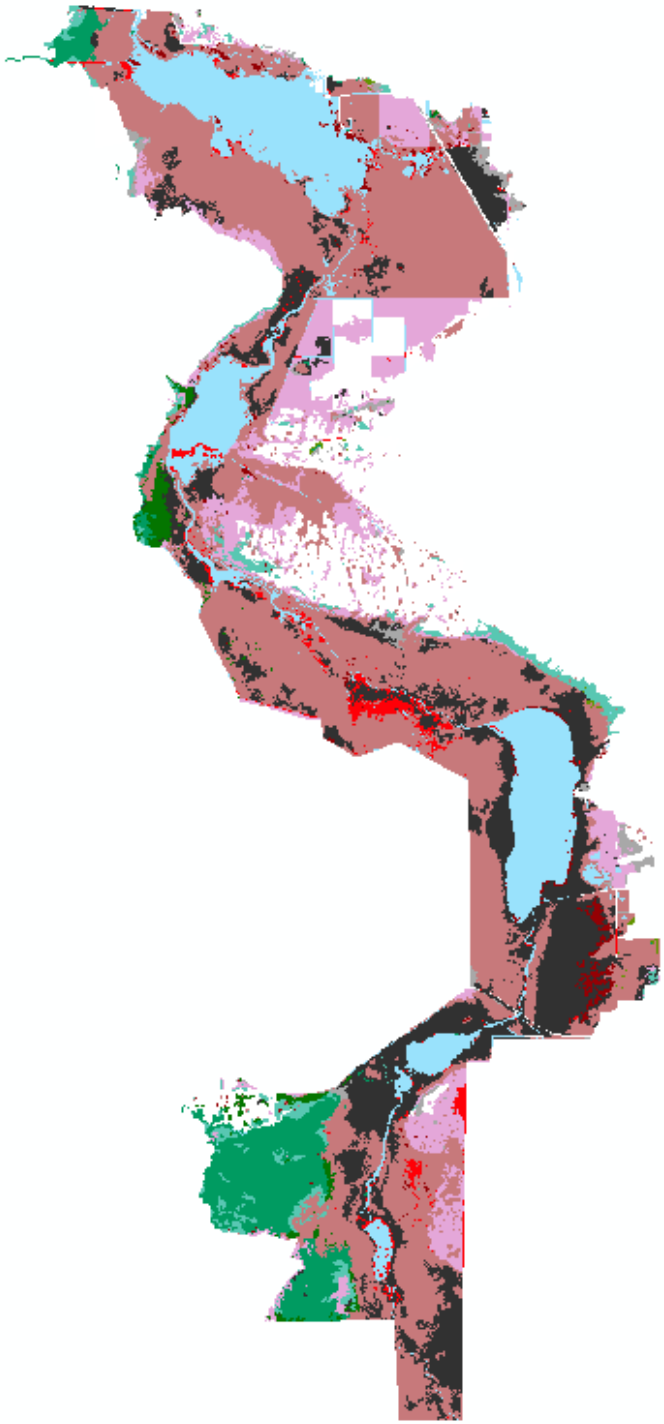
Dominant wetlands = SM & TS

River Segment 8

76823.57 ac

V3 (# of Features)	Area, ac	% of area
Shallow Marsh (643)	29456.43	38.34%
Shrub Swamp (386)	11577.37	15.07%
Water group (285)	10731.15	13.97%
Upland (29)	8255.75	10.75%
Wet Prairie (205)	7047.27	9.17%
Hardwood Swamp (57)	4096.57	5.33%
Hydric Hammock group (154)	1817.09	2.37%
Floating Marshes (346)	1275.13	1.66%
Transitional Shrub (117)	945.13	1.23%
Cypress (108)	809.84	1.05%
Deep Marsh (229)	737.01	0.96%
Bayhead group (16)	65.63	0.09%
Total	76823.57	

Dominant wetlands = SS & WP



River Segment 9

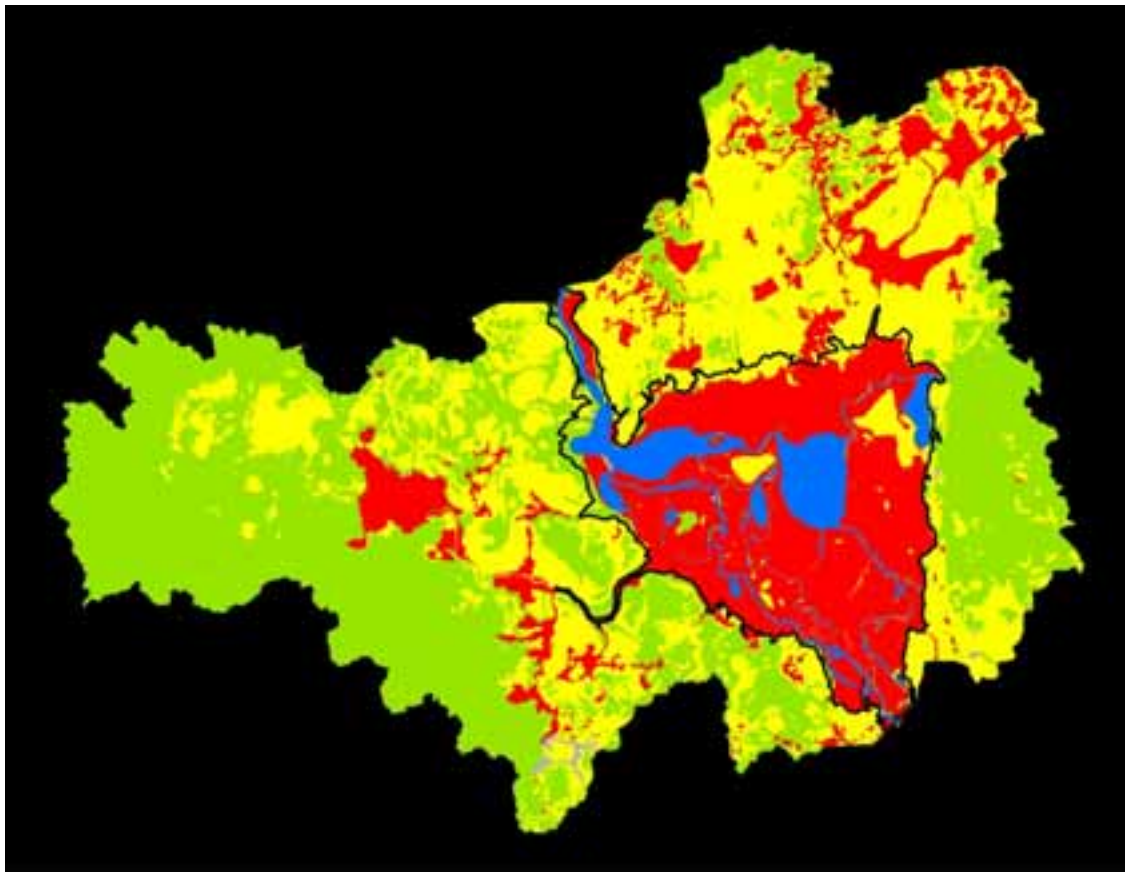
60834.53 ac

V3 (# of Features)	Area, ac	% of area
Shallow Marsh (128)	28507.66	46.86%
Upland (8)	7447.70	12.24%
Shrub Swamp (319)	6954.71	11.43%
Water group (35)	6785.12	11.15%
Hardwood Swamp (24)	5049.33	8.30%
Wet Prairie (68)	2202.96	3.62%
Transitional Shrub (95)	1468.75	2.41%
Deep Marsh (17)	1453.19	2.39%
Cypress (33)	550.55	0.90%
Floating Marshes (44)	291.06	0.48%
Hydric Hammock group (22)	113.75	0.19%
Total	60834.53	

Dominant wetlands = SS & HS

Outline:

- X • Background – Alternative Water Supply (AWS) project
- X • Approach to assess potential effect of drawdown on wetlands
  - X • Area of concern
  - X • River Segments
  - X • Inventory
    - • River edge (wetlands)
    - • GIS Model
  - • Methods
  - • Results to date



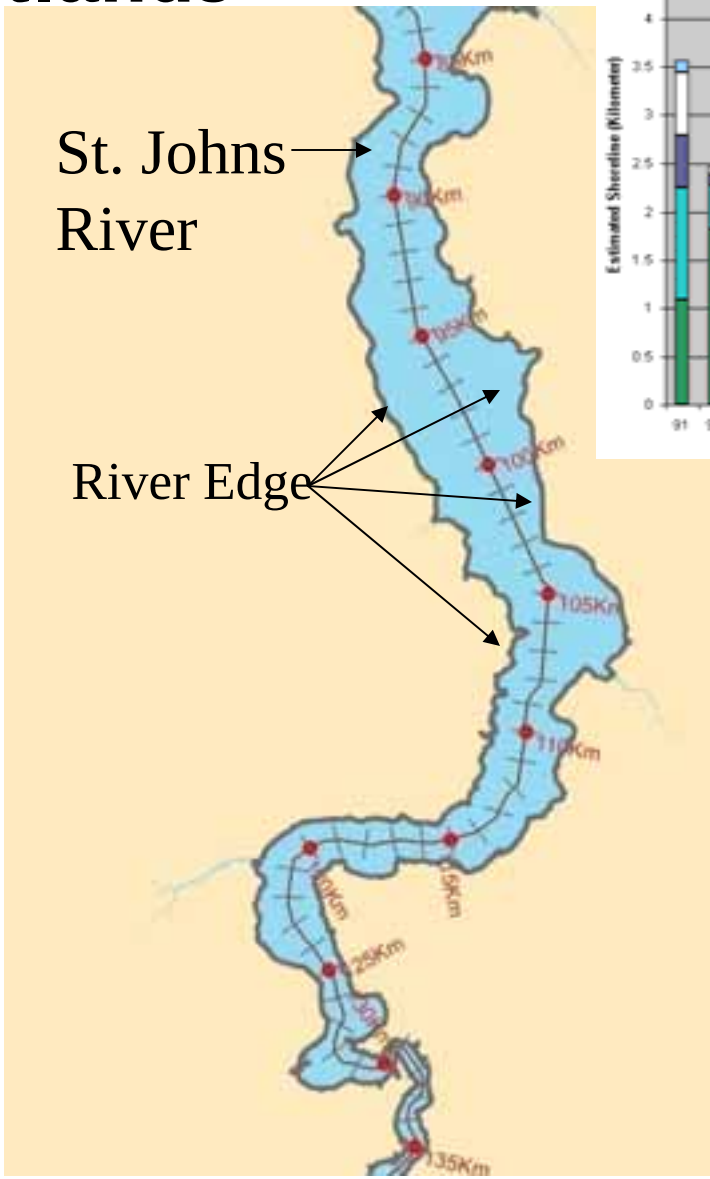
Edge significance:

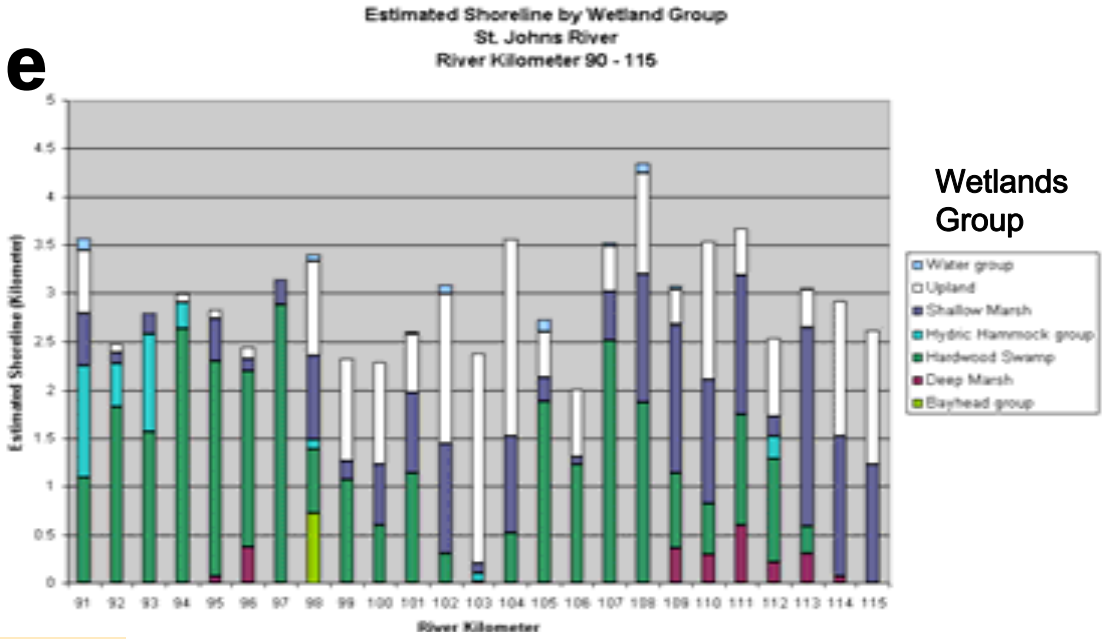
- Wading birds
- Change in salinity regime

Edge method:

- Worked with single layer (SJRWMD wetlands)
- Merged contiguous water features of the river – trimmed off tributaries (“River”)
- Buffered off – 1 meter
- Clipped same layer – captures edge
- Divided into 1 kilometer sections – based on a “river mile/kilometer” layer (~midline = Arc Hydro HydroEdge / National Hydrography Dataset)

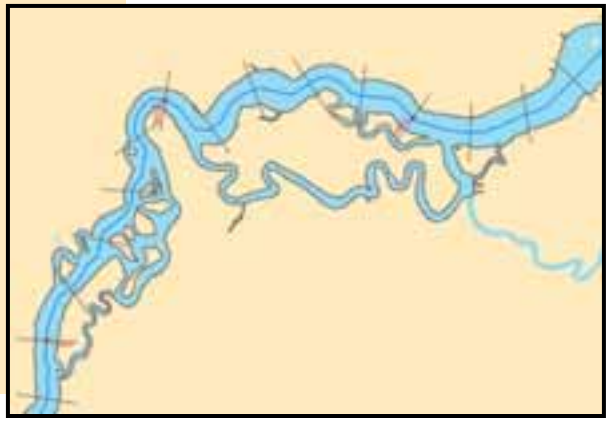
St. Johns River Edge Wetlands





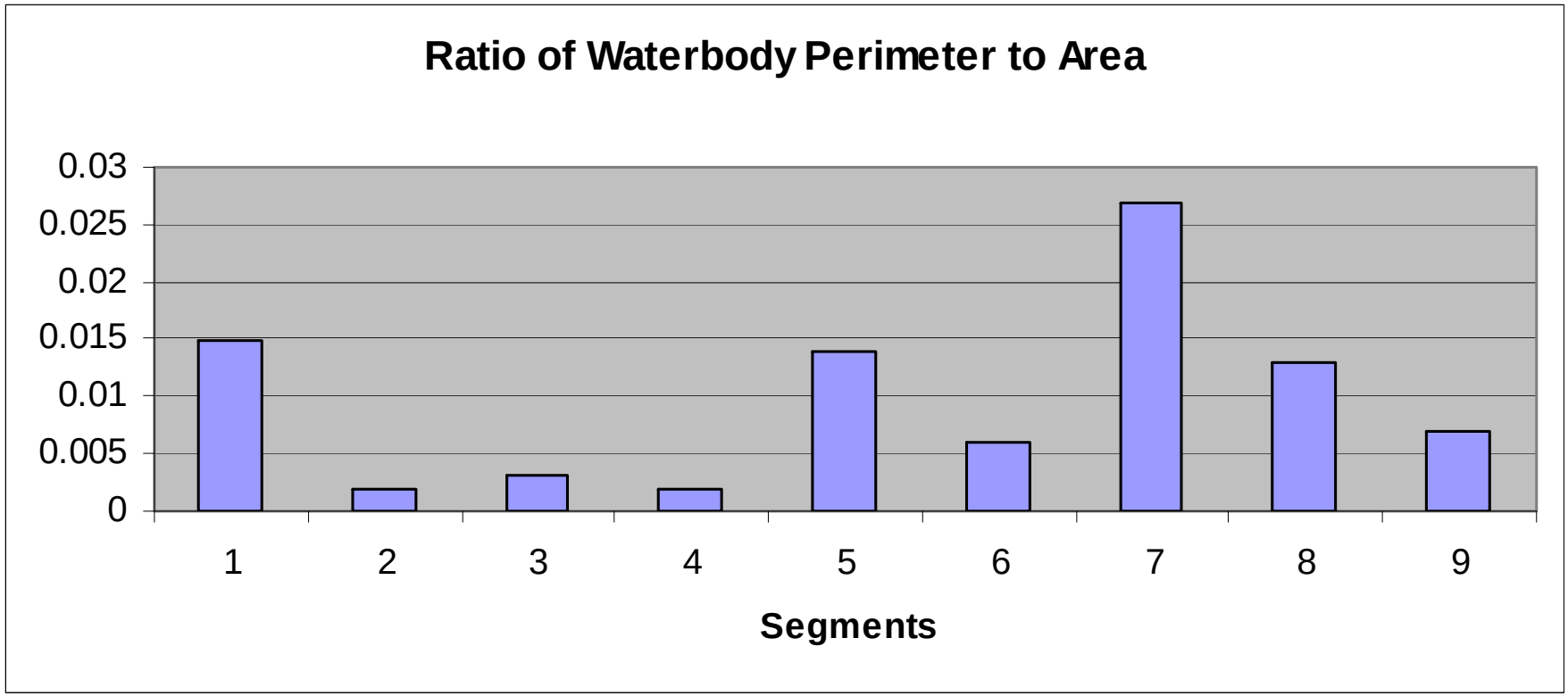
Wetlands at river edge derived from SJRWMD 24k Wetlands layer

Partitioned at 1 kilometer intervals (both sides and including “islands” and “braids”



Interesting GIS based metric….

- Merged riverine water features (from edge exercise)
- Divide into 9 segments
- Divide Polygon Perimeter by Area



Wetland Drawdown Sensitivity Model

- Background – 2 previous models – GW drawdown *(District pubs)*
  - "Harm to Lakes"
  - "Harm to Wetlands"

- AWS – wetland sensitivity to surface water withdrawal model still in development....

The Approach

1. GIS layers: Vegetation, Soils, topography; hydrological features
2. Populate resource and feature layers with attributes indicating sensitivity to stress
3. Intersect layers to determine potential for change
4. Create a stressor layer (e.g. drawdown or change in duration or return interval)
5. Intersect potential for change and stressor layers to predict harm or change geographically

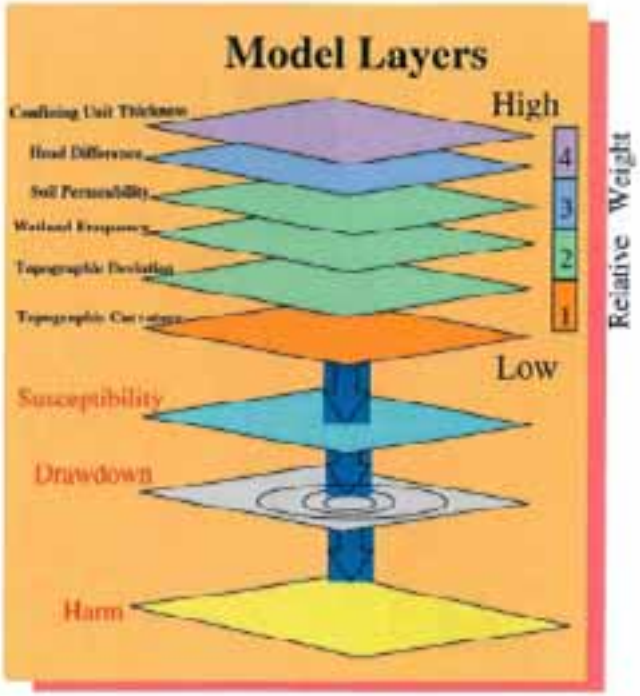


Figure 1. Graphical representation of the GIS model used to estimate the likelihood of harm to lakes from groundwater withdrawal in the St. Johns River Water Management District by the year 2005

MODEL – in development (proof of concept stage)

Hydrology

Riverine dominated versus tributary supported

Seepage – upland influence / slope

Rainfall / GW (springs)

Wetlands – sensitivity to drawdown

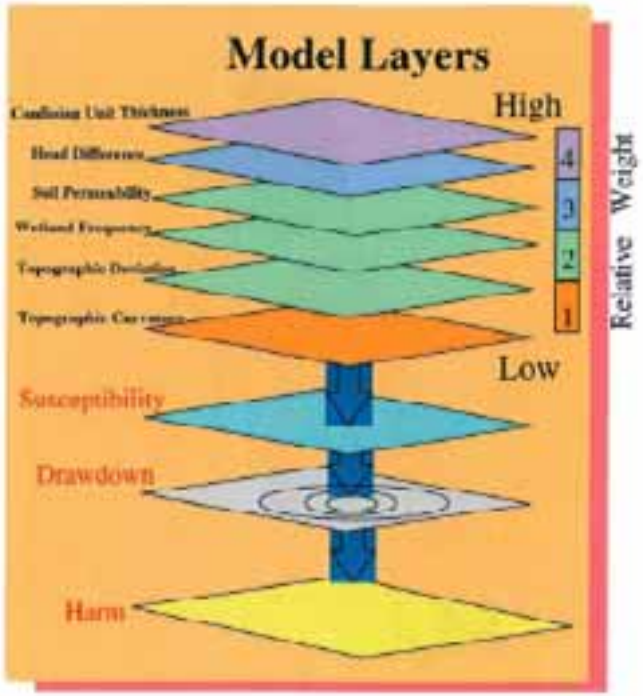
Soils

permeability

0 horizon thickness

Stressor layer – to be created

…..*Filter method versus weighting layers by importance*….



Model components

- Wetlands Hydrology (hydrogeomorphology)
- Soils susceptibility
  - Permeability
  - O horizon
- Wetland vegetation sensitivity

Wealth of data – Minimum Flows and Levels work (RM Dept)

Figure 15. Dexter Point East transect topography with ecological communities

Note: At Dexter Point, the minimum frequent high (MFH) equals 1.7 ft NGVD, the minimum average (MA) equals 0.7 ft NGVD, and the minimum frequent low (MFL) equals 0.2 ft NGVD.

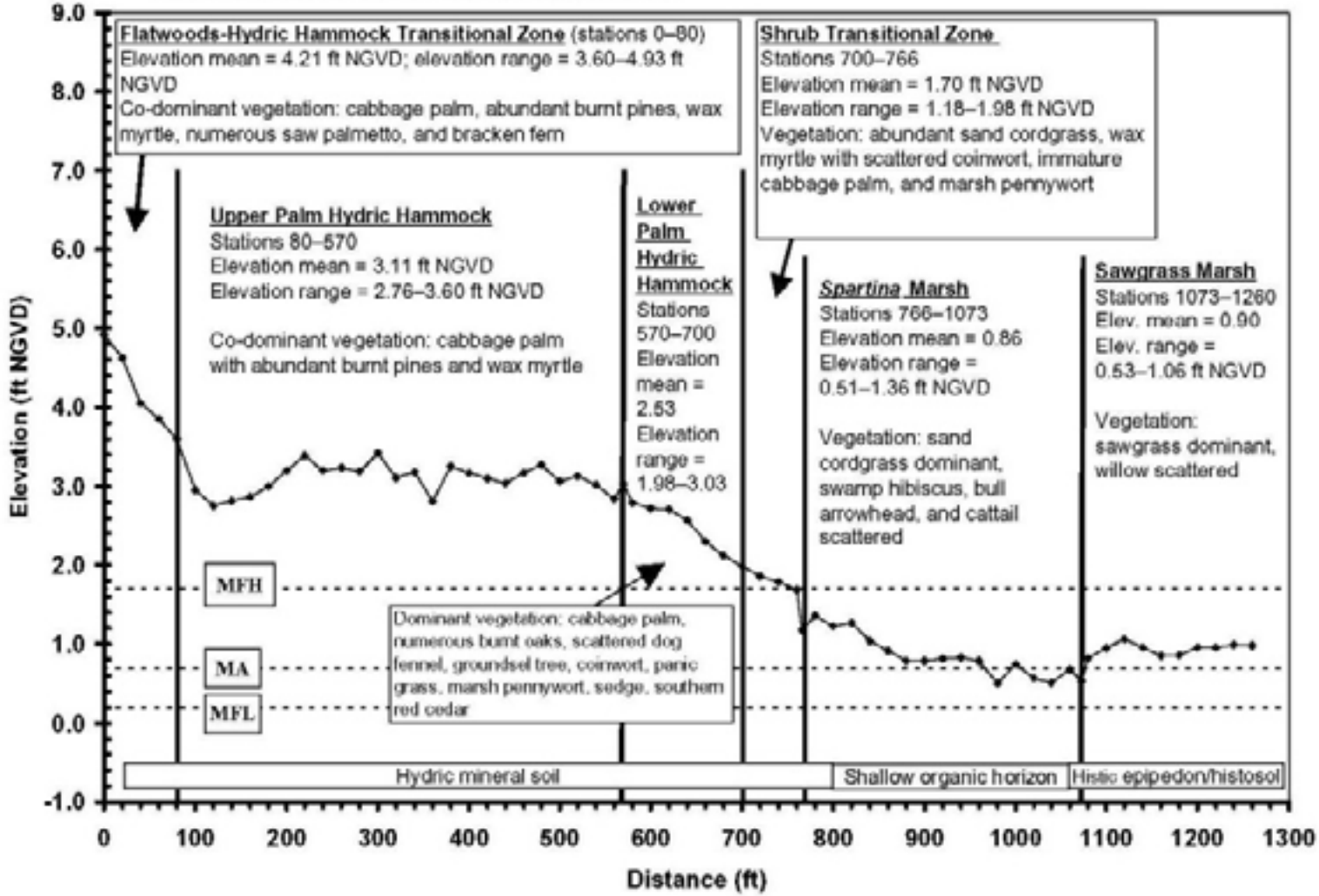
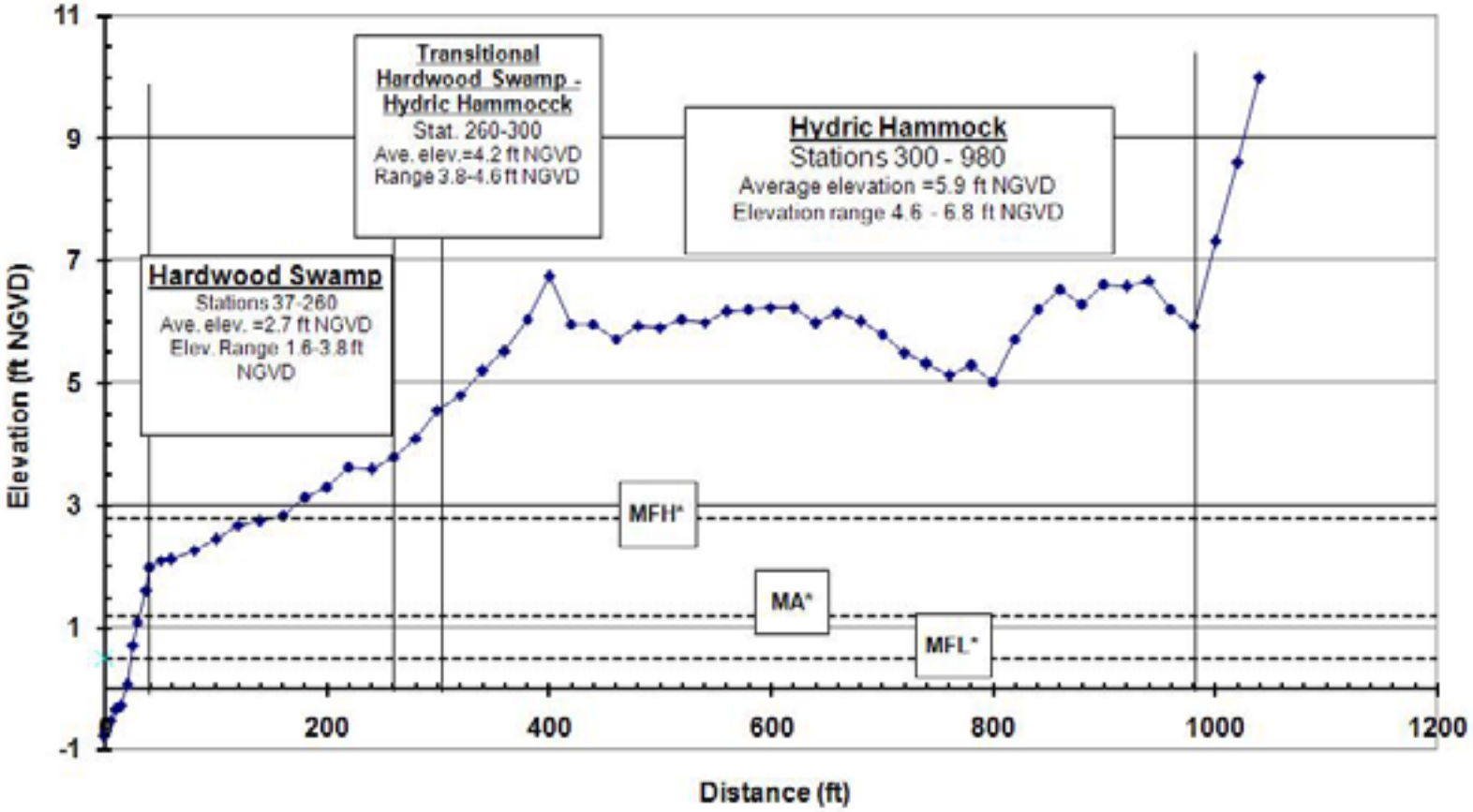
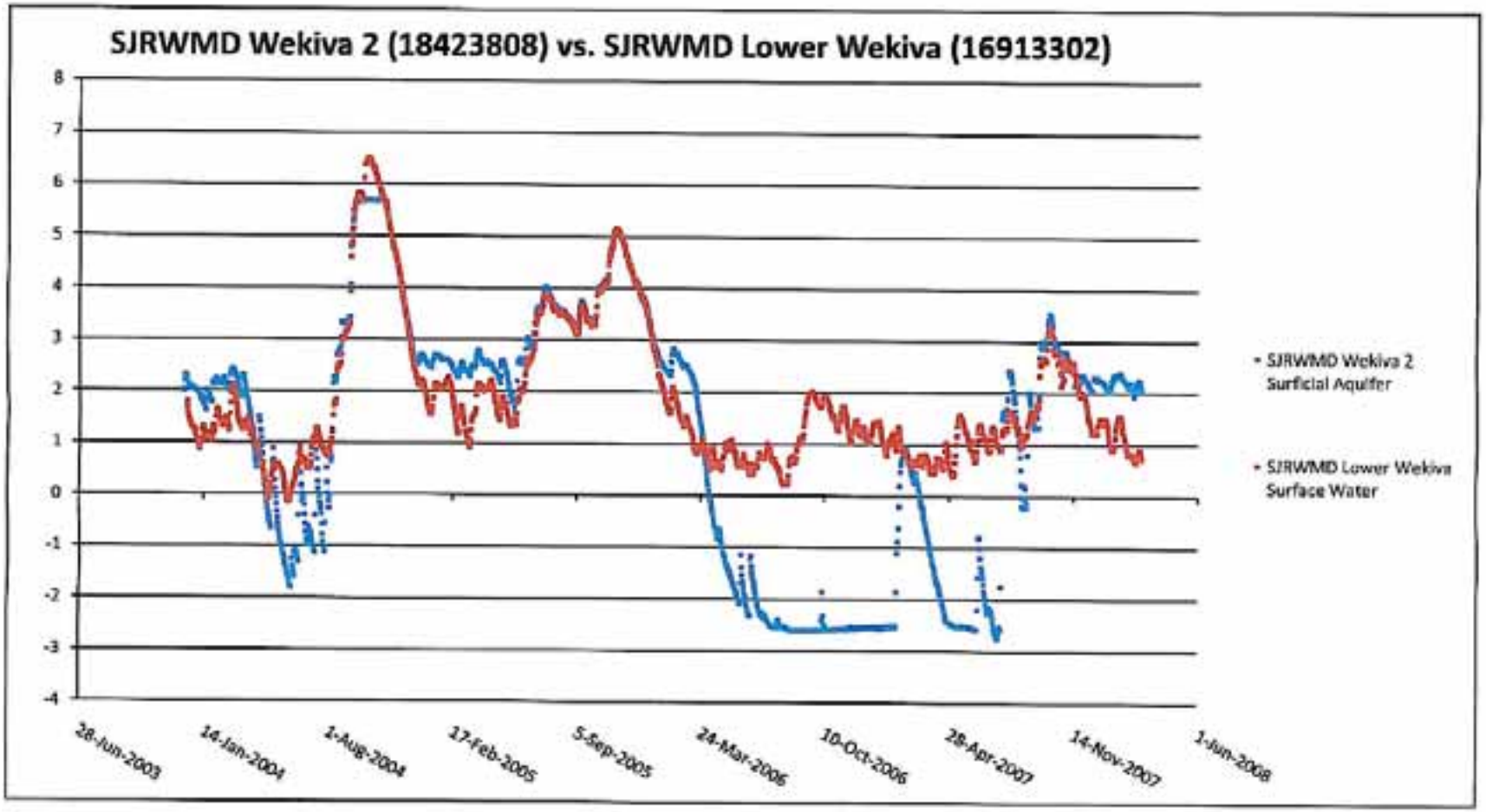


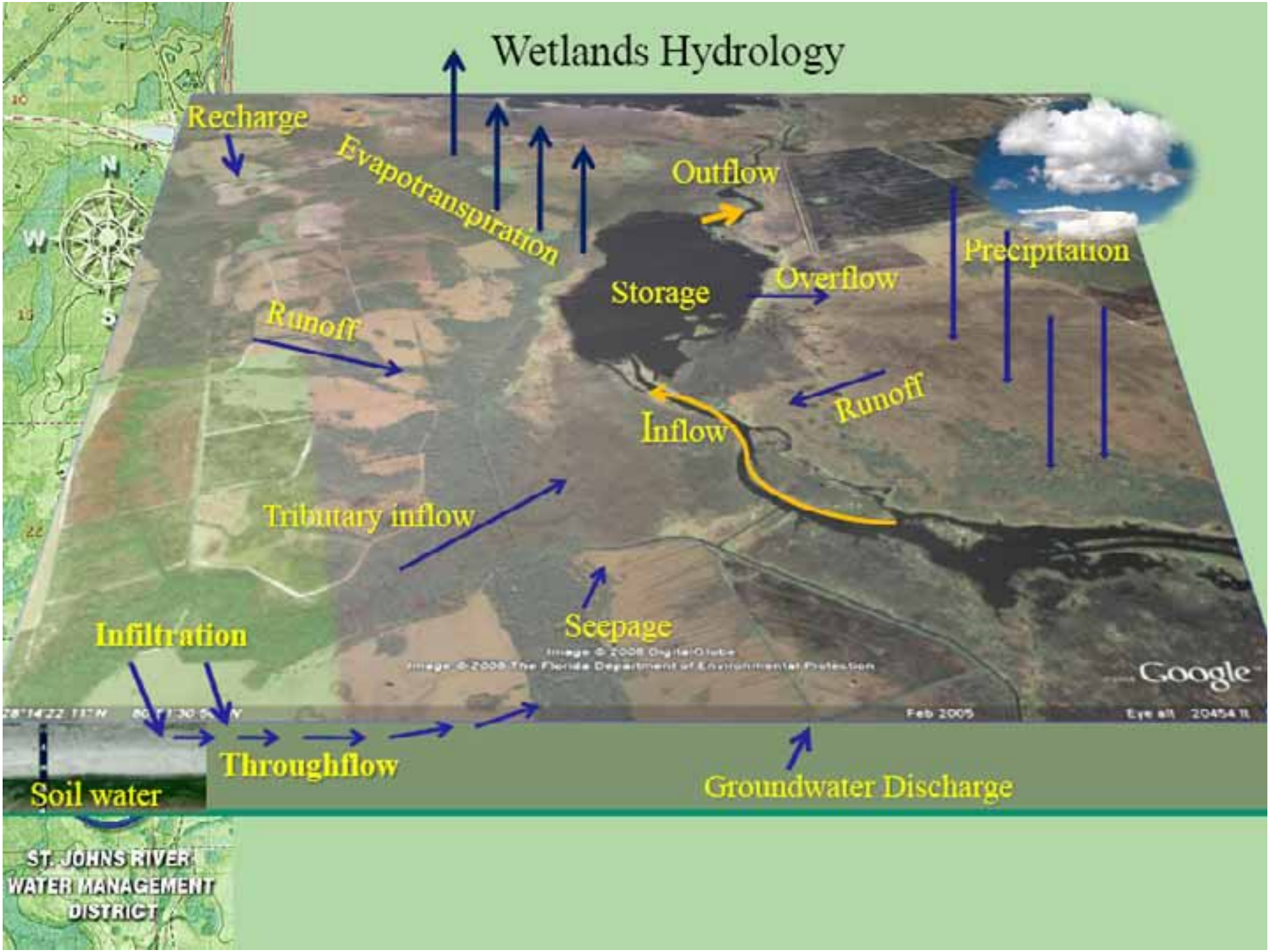
Figure 10. Lake Monroe Transect 1 topography with ecological communities

*The Minimum Frequent High (MFH) equals 2.8 ft NGVD, the Minimum Average (MA) equals 1.2 ft NGVD, and the Minimum Frequent Low (MFL) equals 0.5 ft NGVD



Wetland “decoupling”---- Critical issue

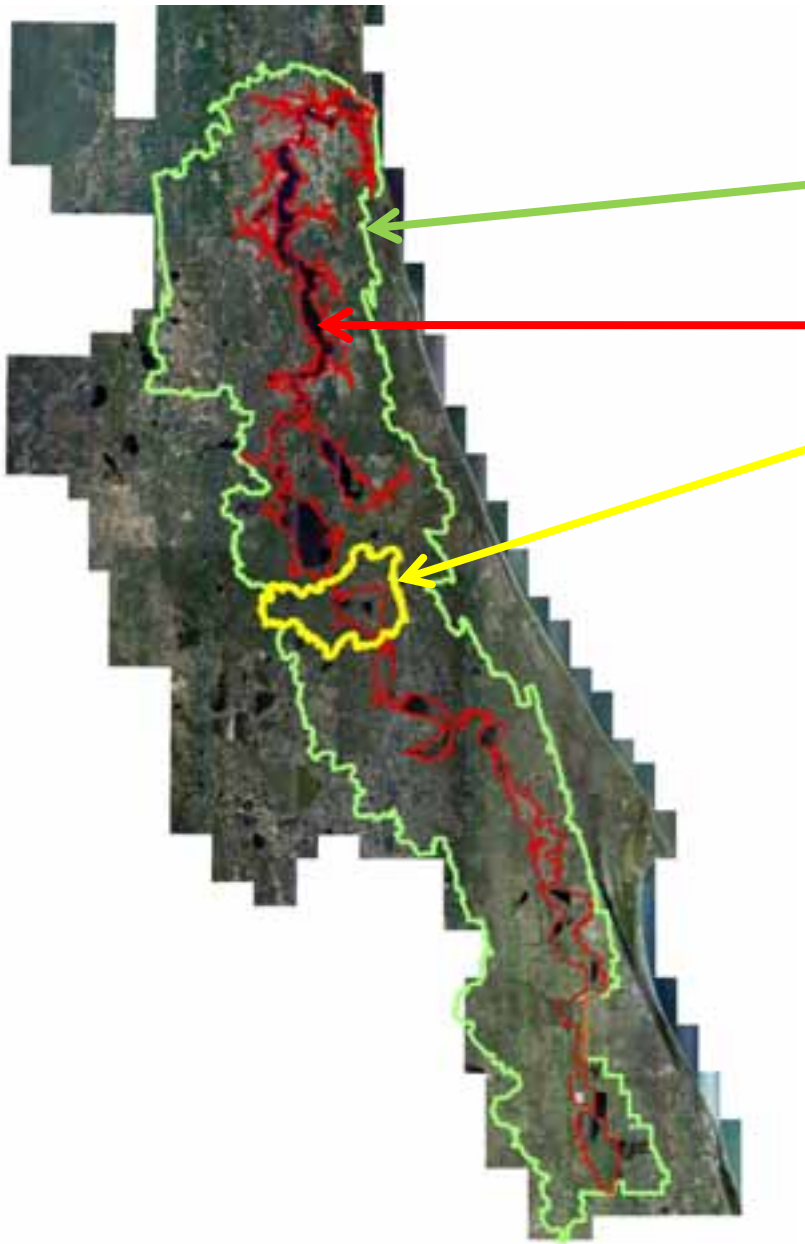



Wetlands Hydrology
Recharge
Evapotranspiration
Outflow
Precipitation
Storage
Overflow
Runoff
Runoff
Inflow
Tributary inflow
Seepage
Infiltration
Throughflow
Soil water
Groundwater Discharge
ST. JOHNS RIVER
WATER MANAGEMENT
DISTRICT
Google

Wetlands Hydrology

- Precipitation - *Depressional*
- Groundwater discharge , springs discharge
- Evapotranspiration
- River flow
- Tributary inflow
- Seepage
- Runoff from local drainage area (or “seepage 2”)
- Tidal

St. Johns River



entire drainage area

working “floodplain”

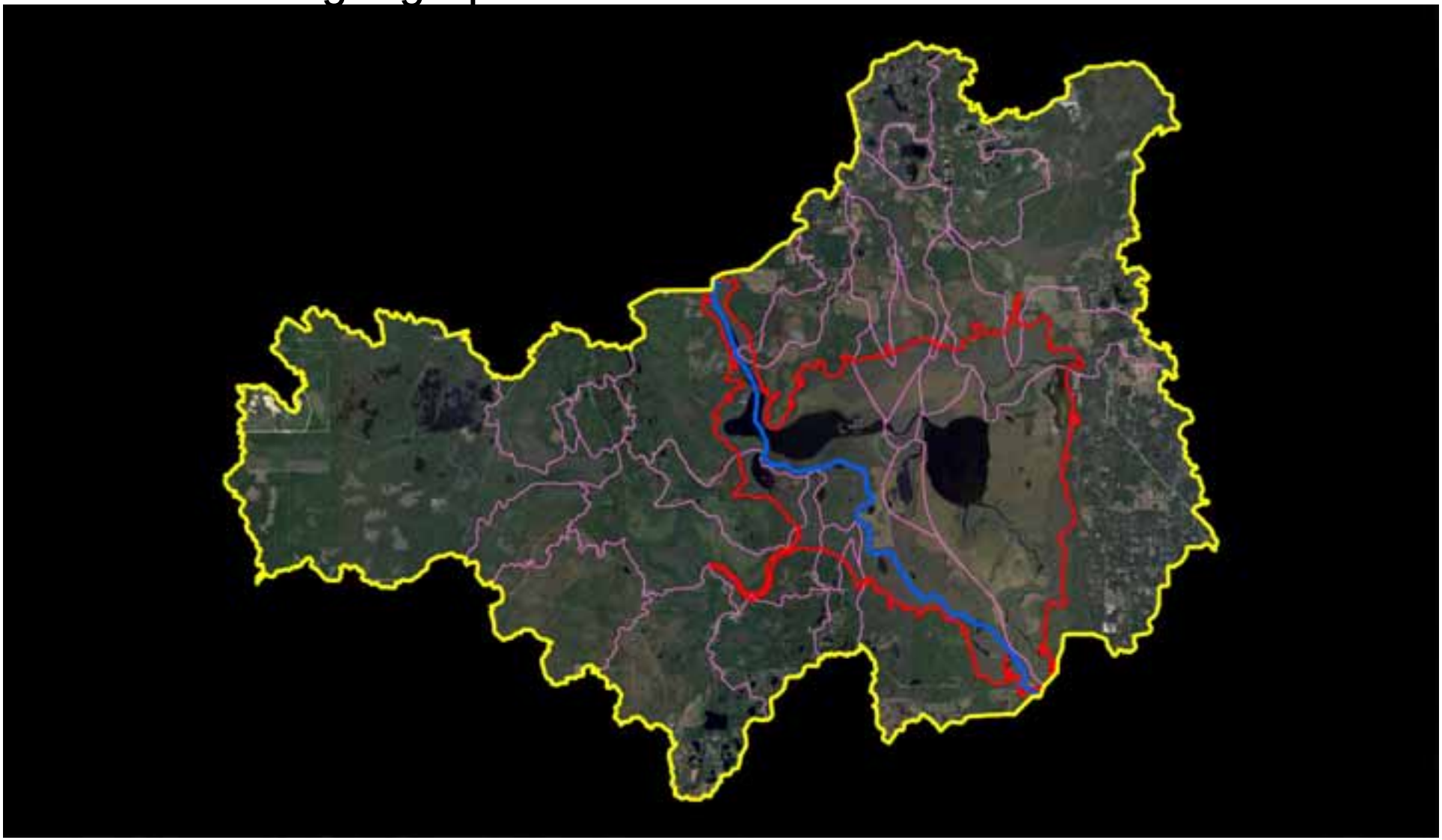
pilot “proof of concept” study area

Pilot: Segment 5

- Identified as potentially effected
- Interesting combinations of wetlands and soils

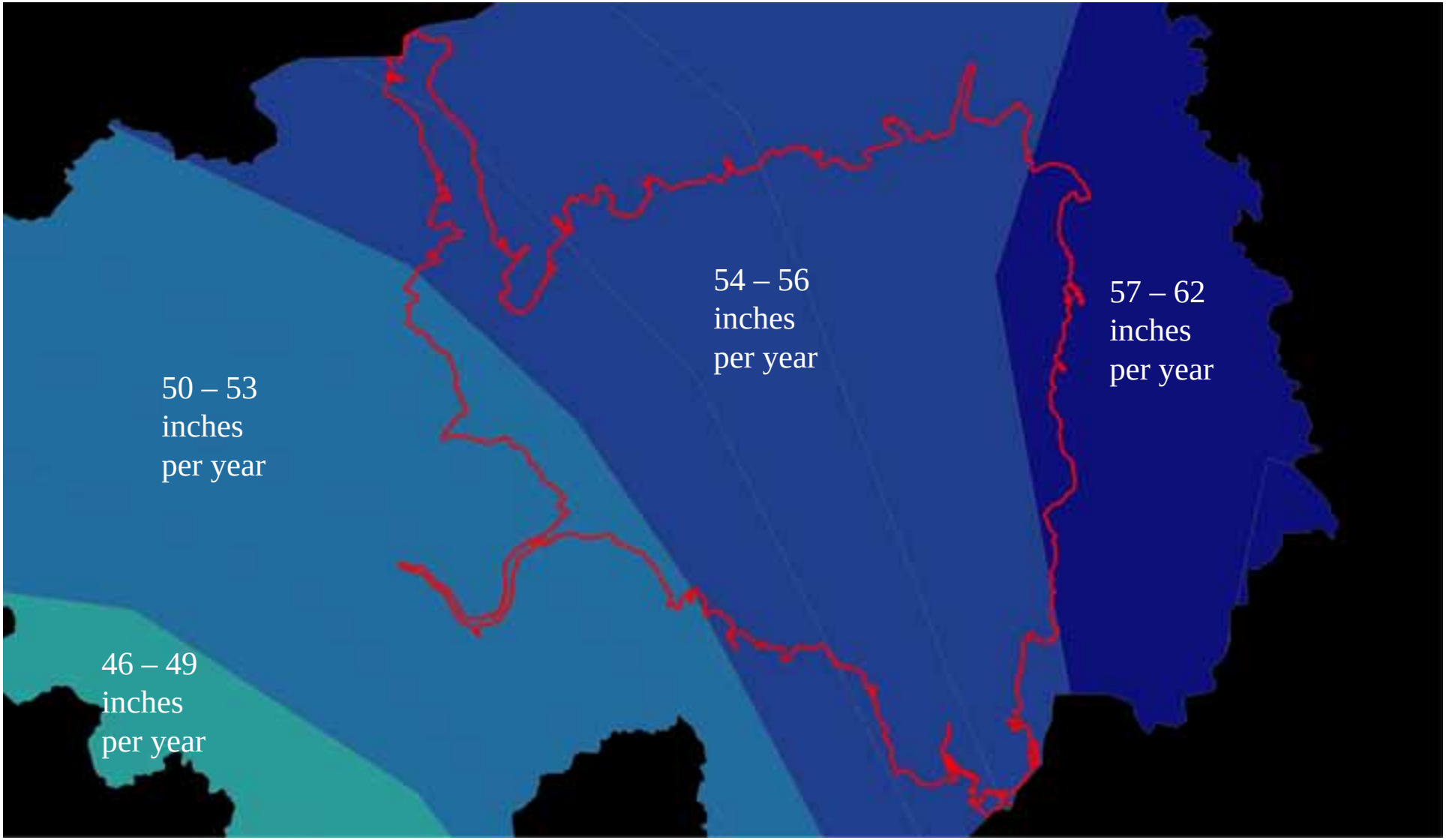
Close up of model “proof of concept” study area

Some geographic details -

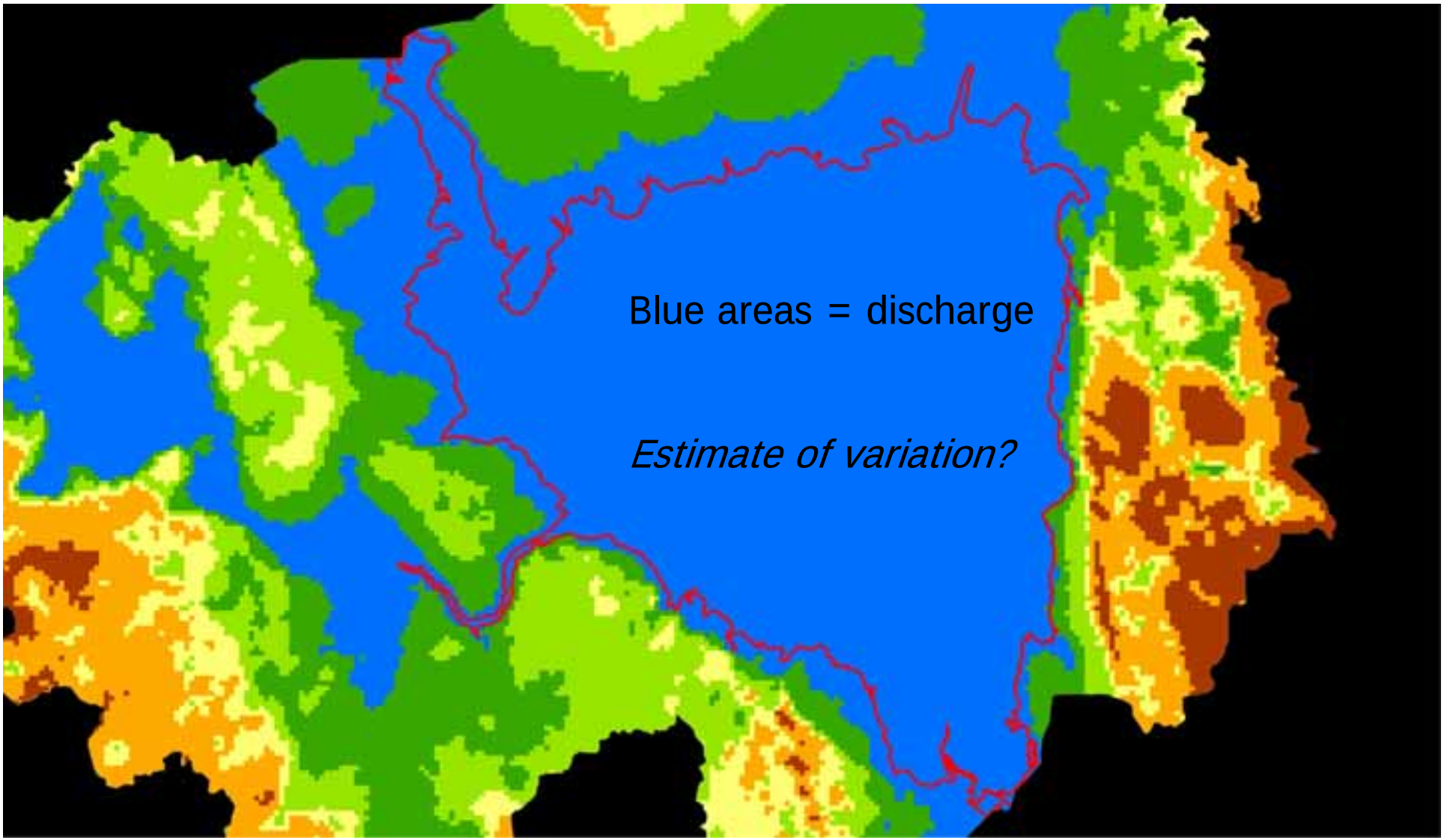


Red line = **proposed** boundary of concern (beyond which effects considered to be minimal)
Blue line = St Johns River Pink lines = SJRWMD catchment boundaries (local drainage)

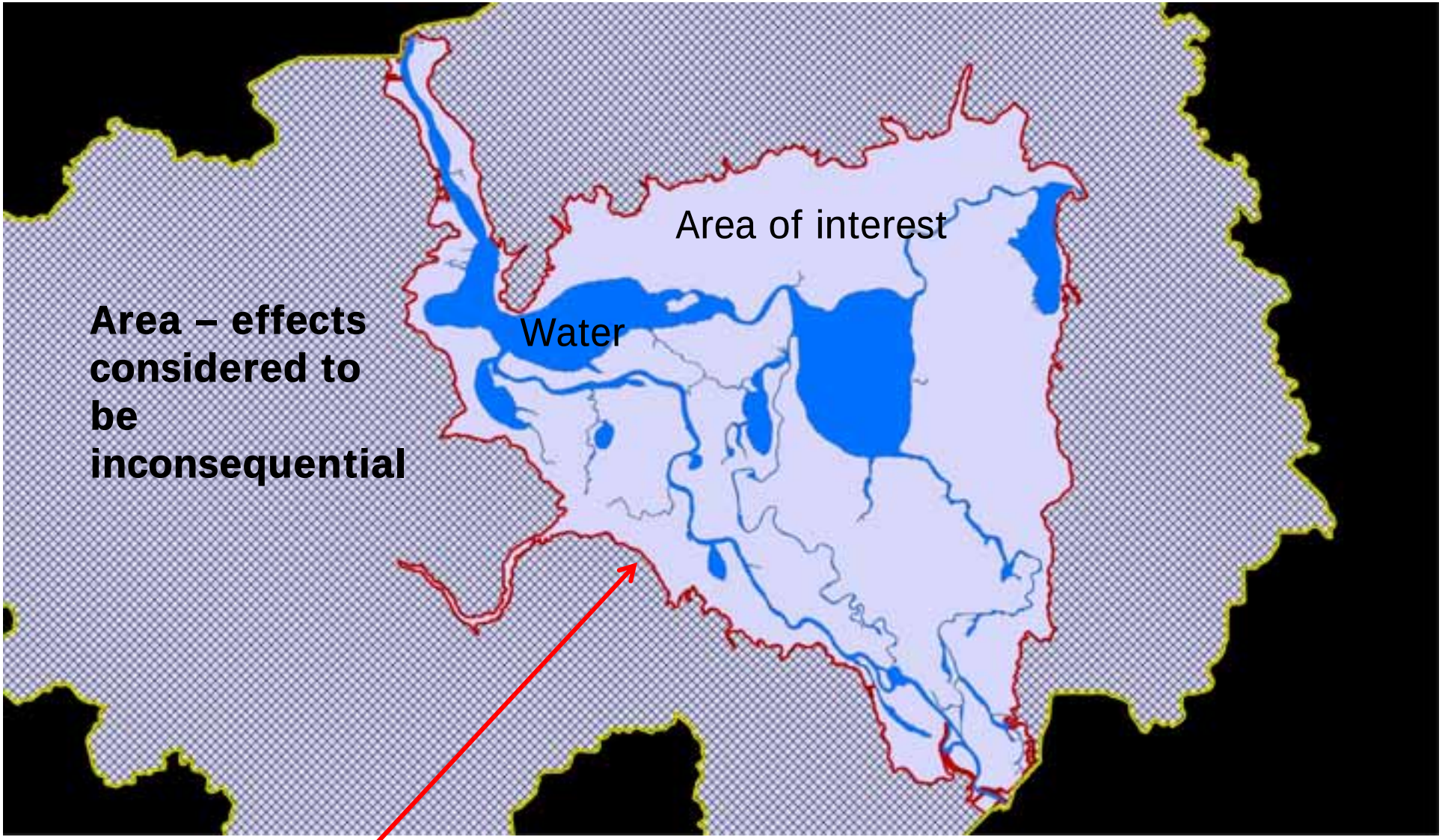
Rainfall: 30 year average annual



Groundwater recharge areas:

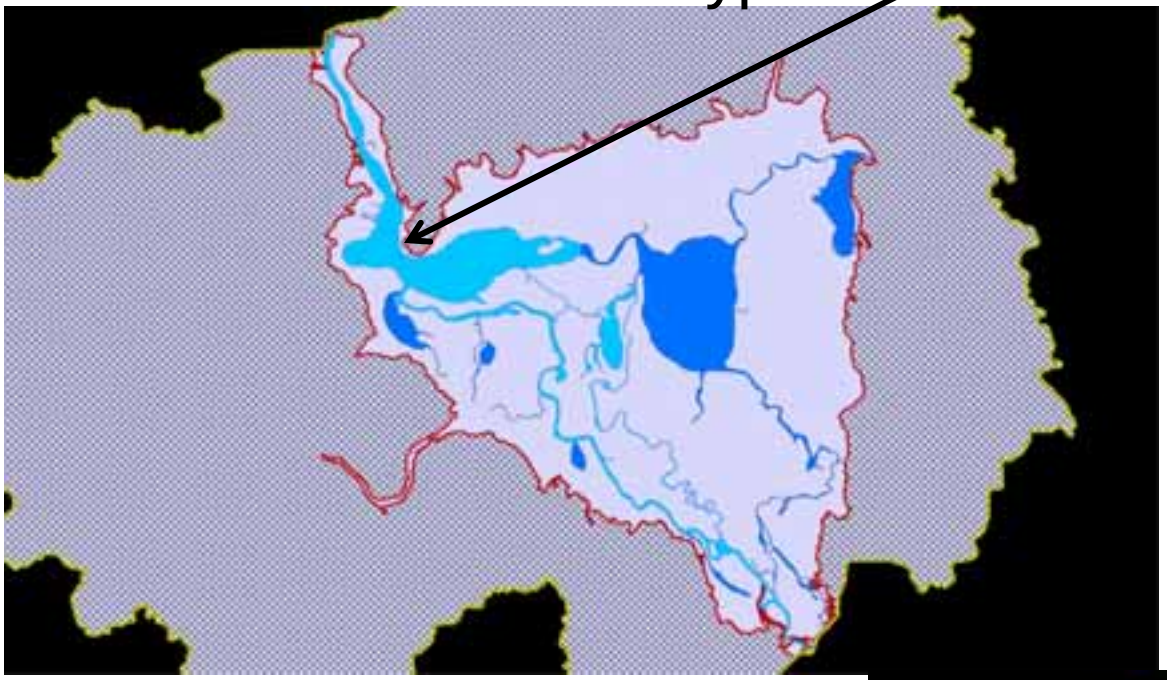


Model – “first cut”

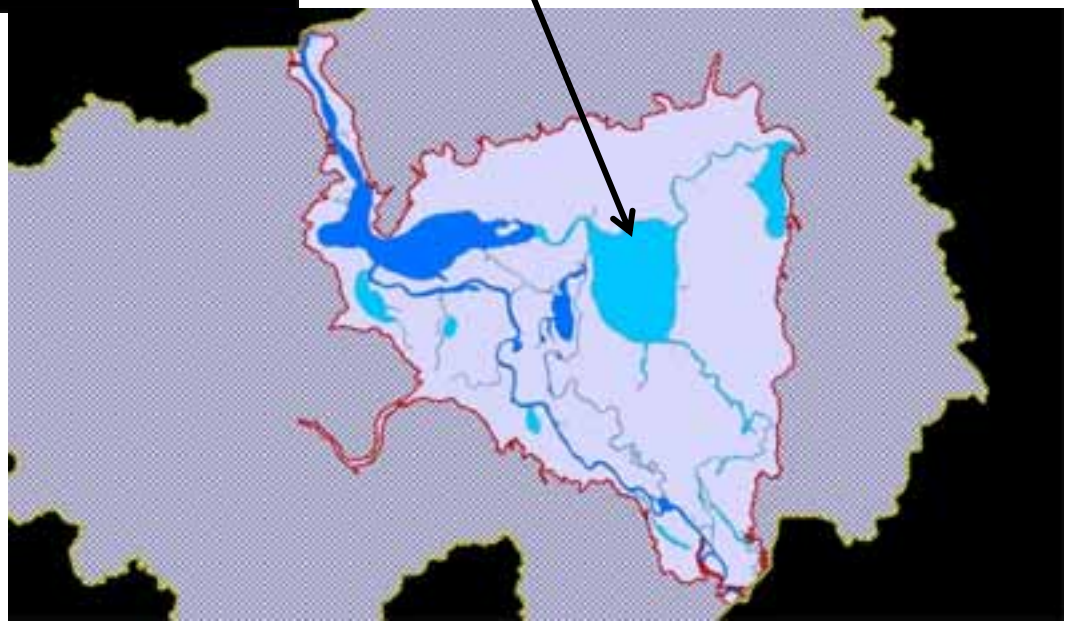


Note: this boundary may be modified

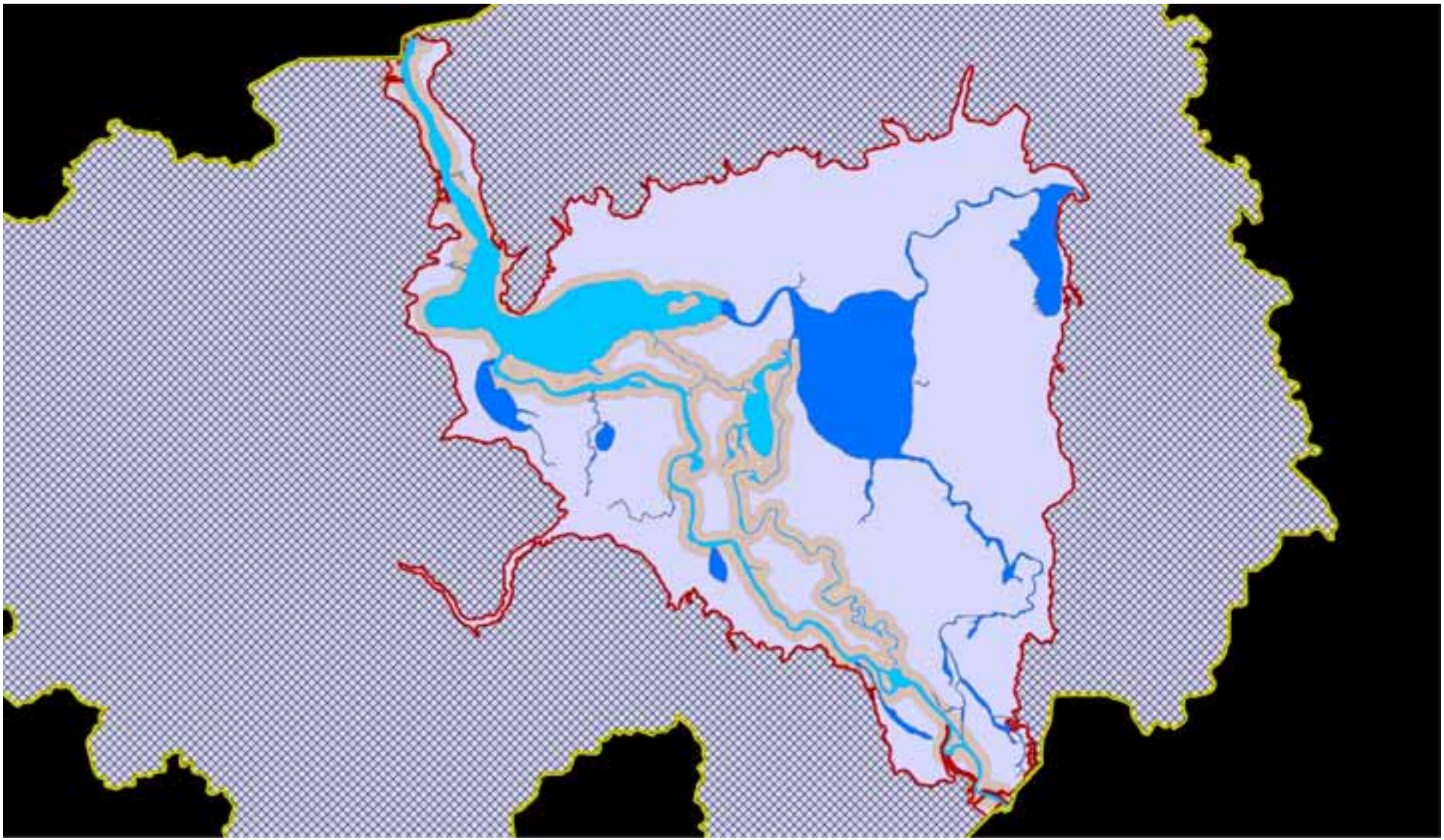
Water divided into two types: "River"



"Tributaries"
(separate drainage from SJR)

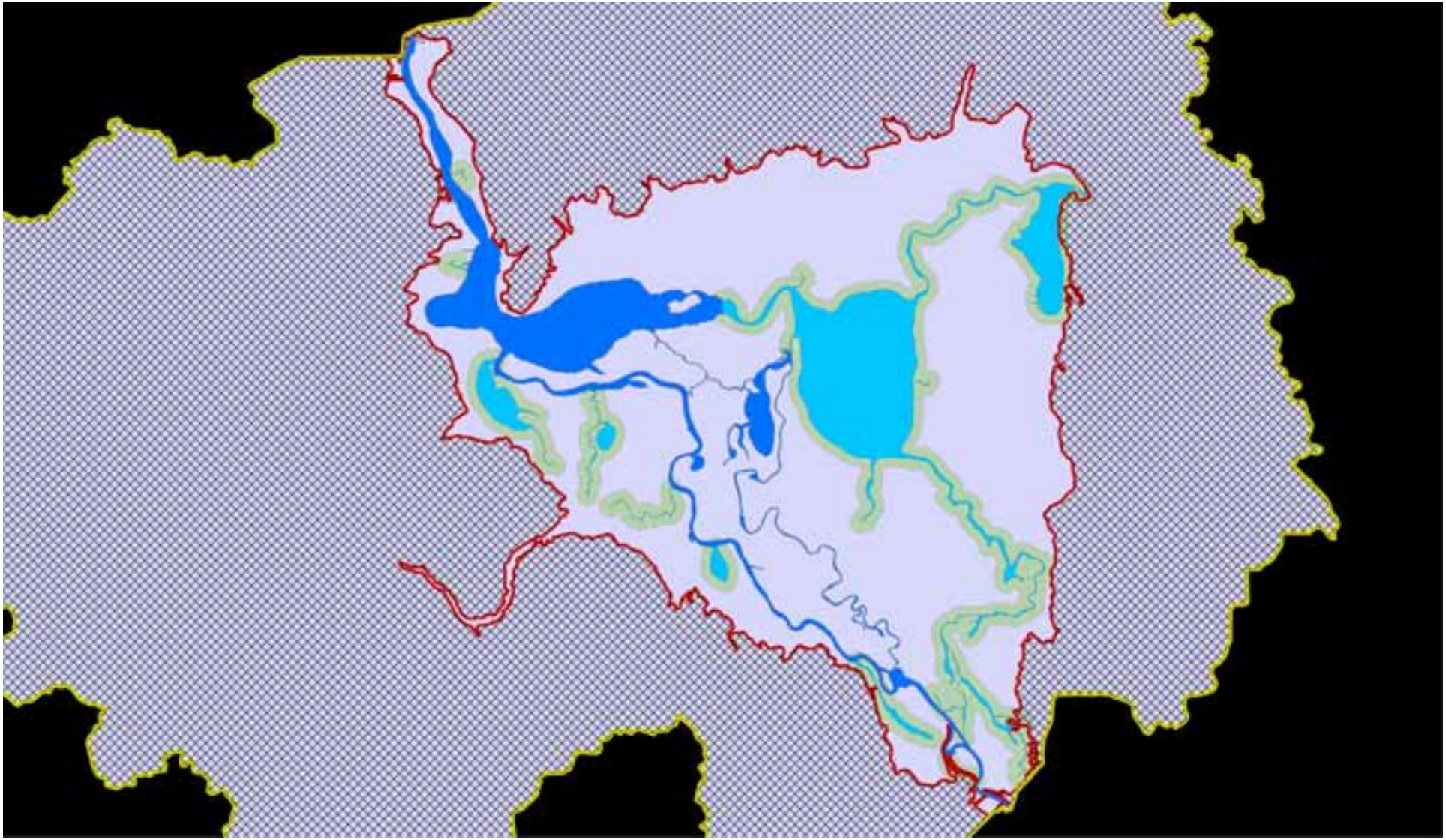


Next “cut” – area “buffered” off the river



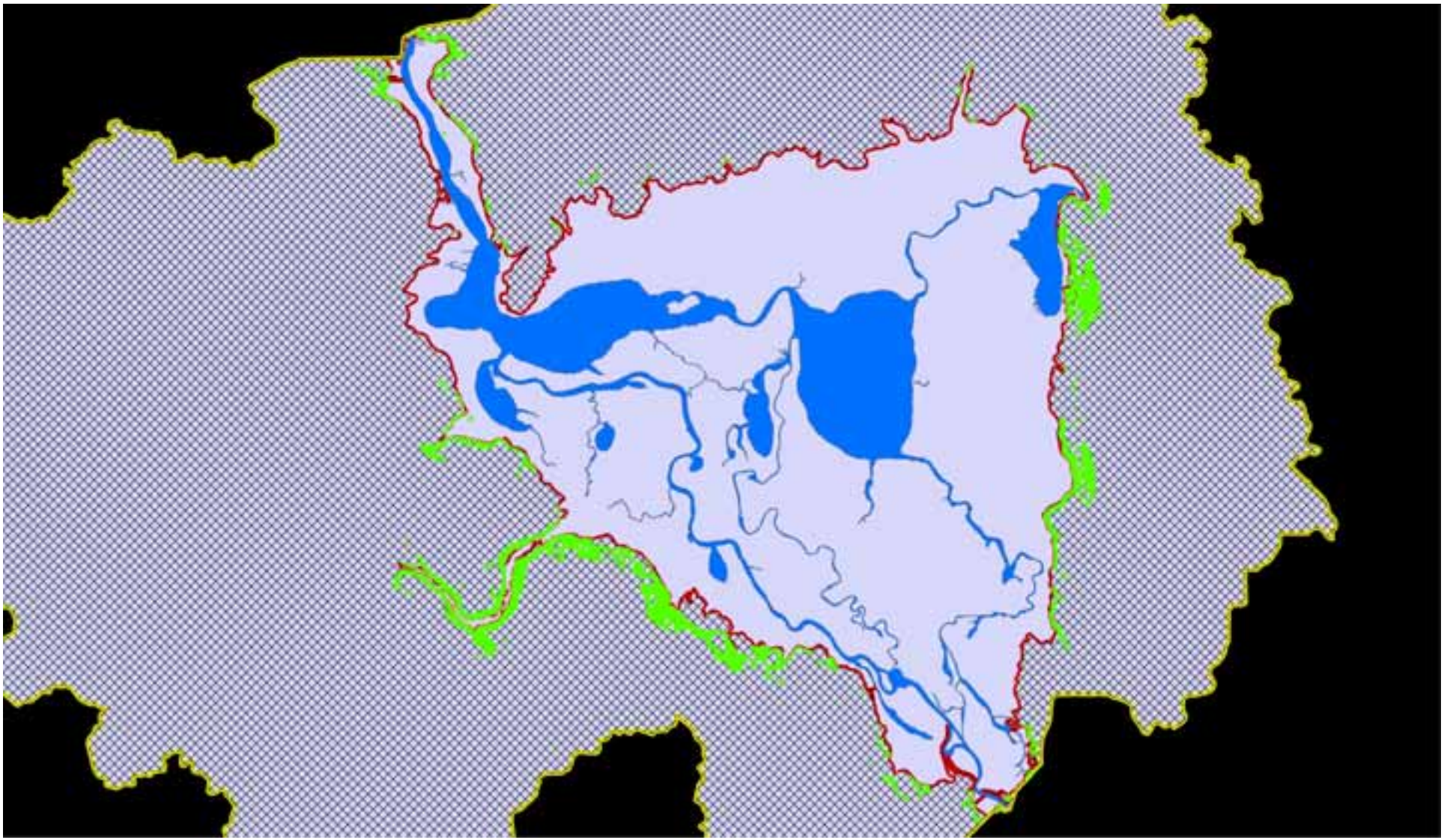
To start with --- buffered 50, 100, 150 and 200 meters....

Next “cut” – area “buffered” off the tributaries

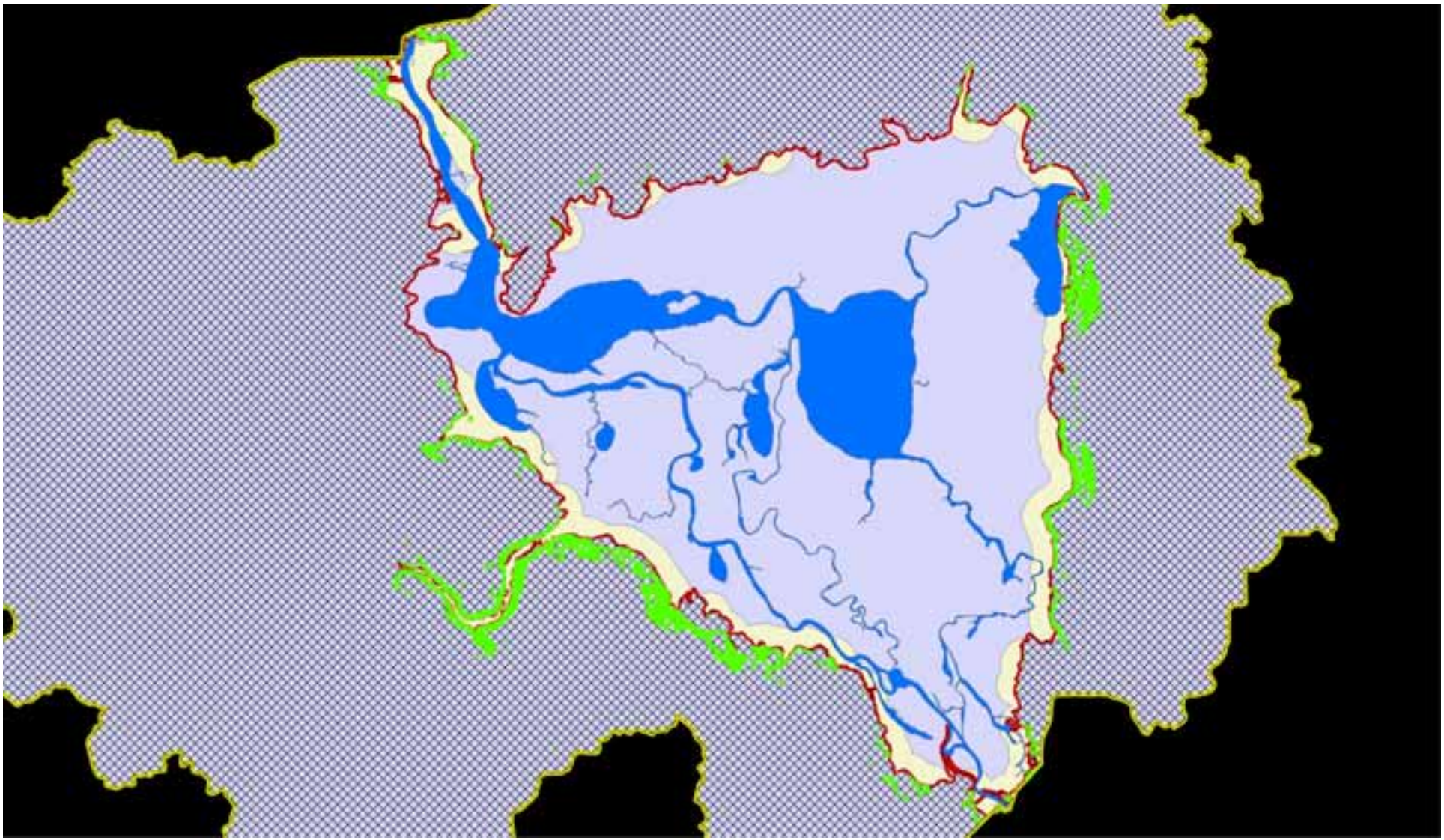


To start with --- buffered 50, 100, 150 and 200 meters....

Next area of attention: area adjacent to boundary – slope greater than 5 degrees



Buffer into area of concern – these areas will receive **<u>seepage</u>**



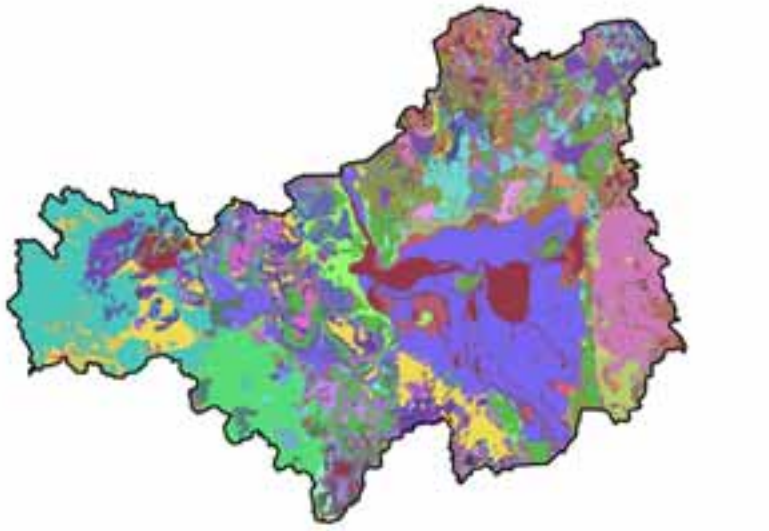
To start with --- 200 meters....

Also – seepage from upslope area

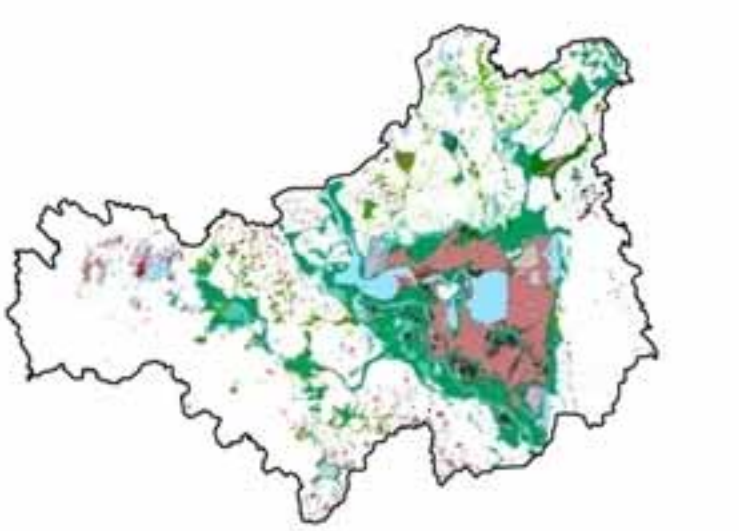
Model components

- Wetlands Hydrology (hydrogeomorphology)
- Soils susceptibility
  - Permeability
  - O horizon
- Wetland vegetation sensitivity

Soils and vegetation



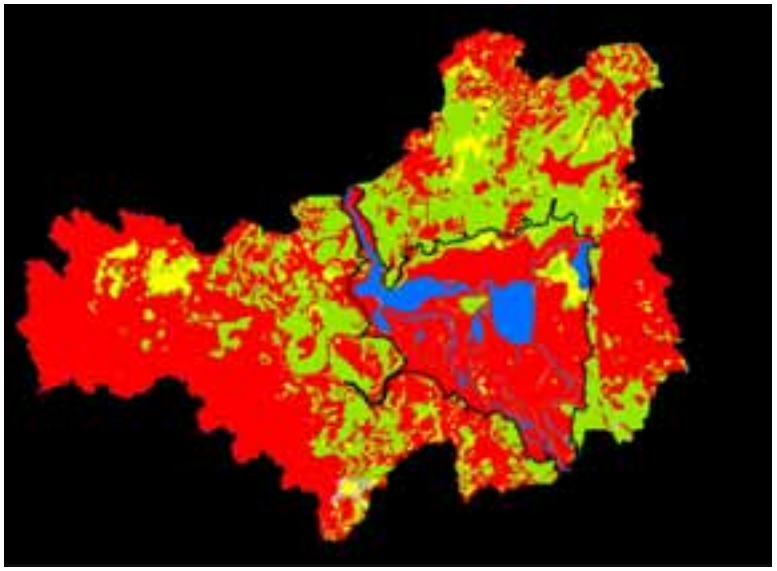
NCRS SSURGO
Multiple attribute fields including permeability and organic horizon
Concern with accuracy
Augmenting with field work



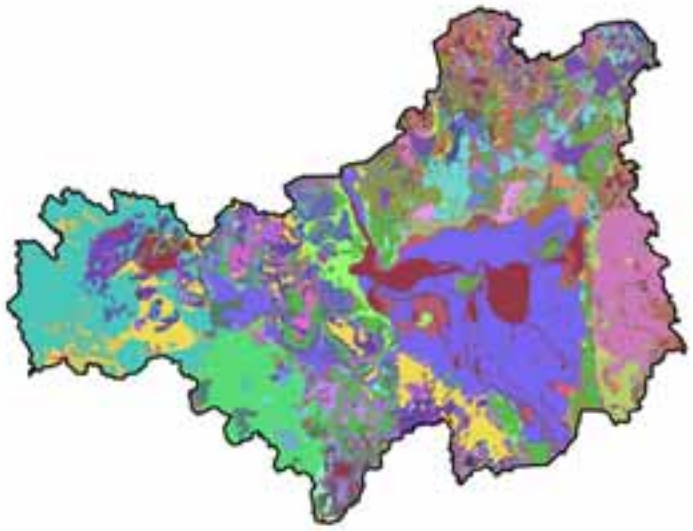
SJRWMD 24K wetlands layer
ca 1980's aerial photo interpreted

To be augmented with NWI conversion from 2004 LULC layer

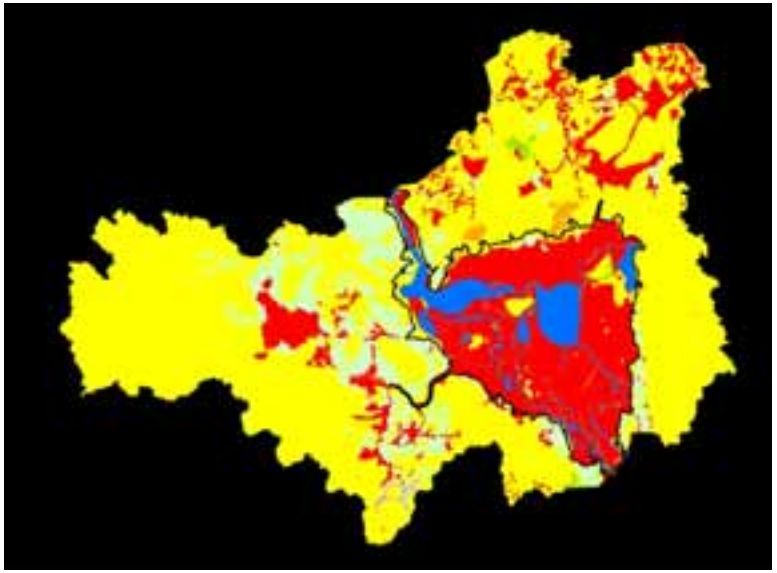
Soil permeability (4 classes)



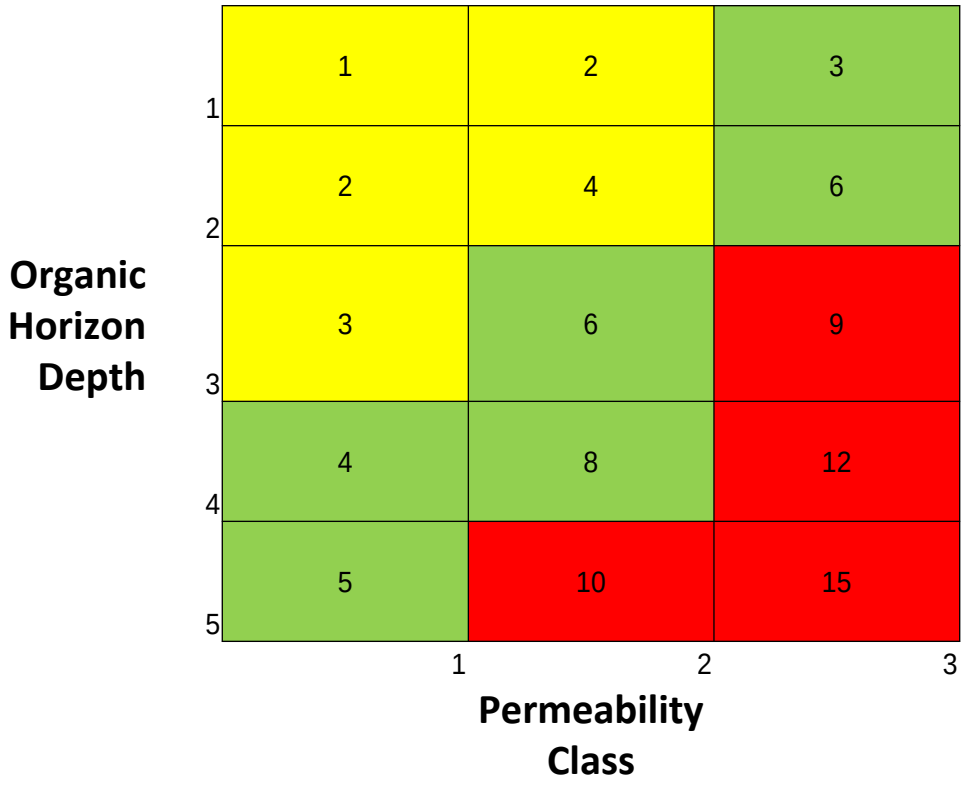
Soils (108 classes)



Soil – O horizon thickness
(4 classes)

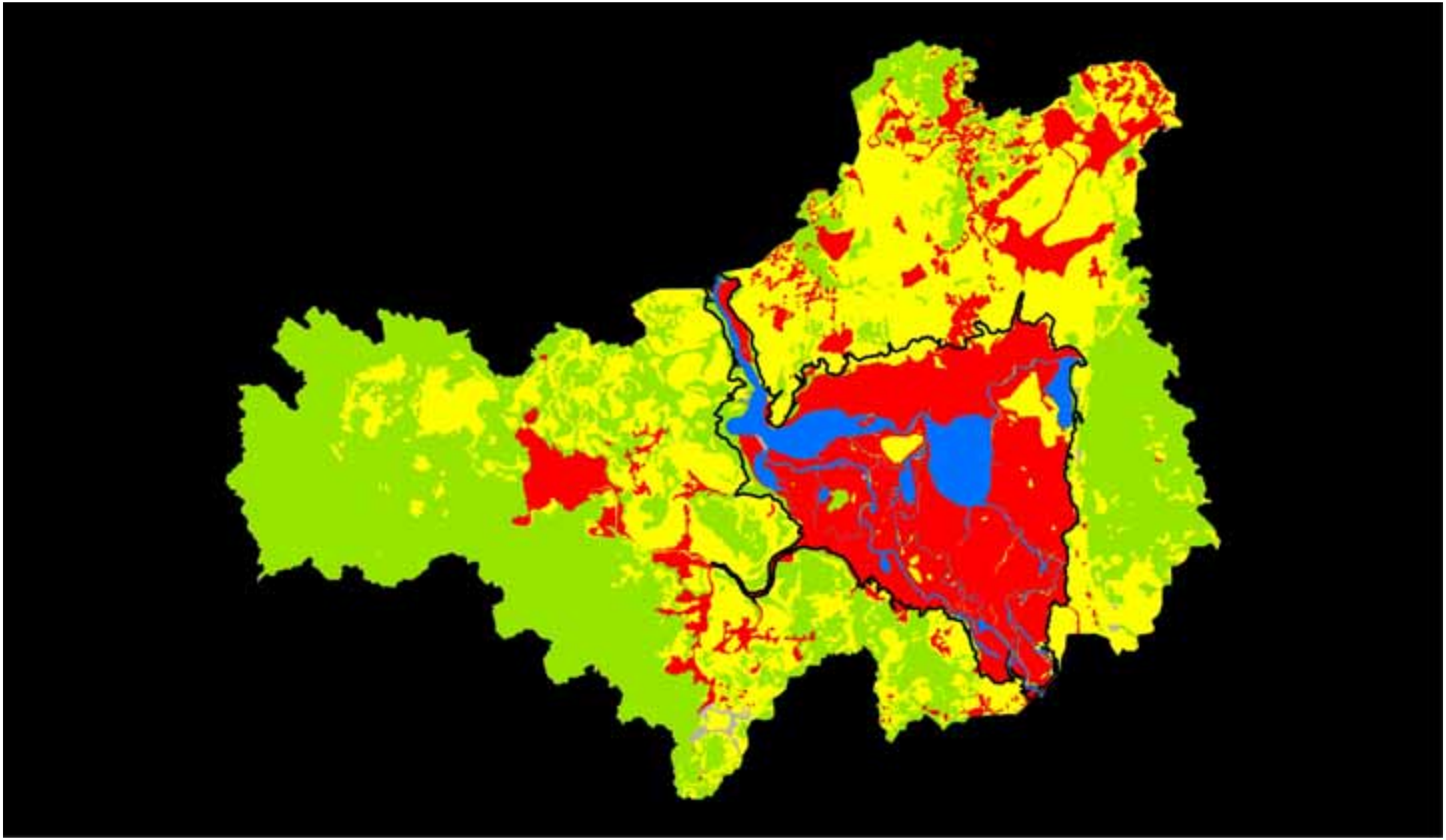


Decision Square - Soils susceptibility

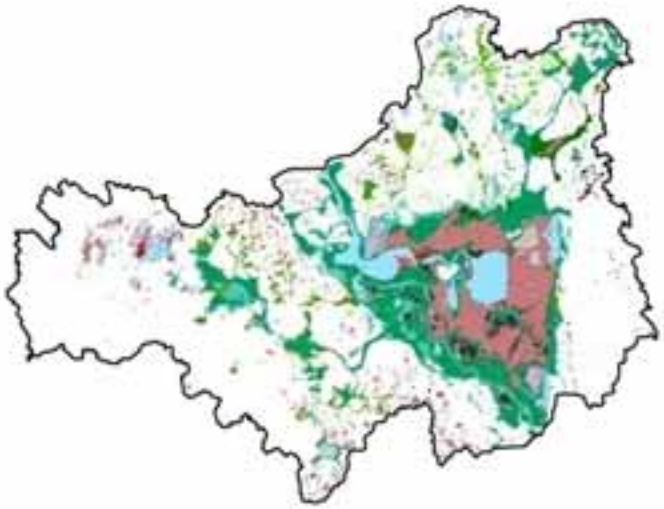


Rating Scale	
	low
	moderate
	high

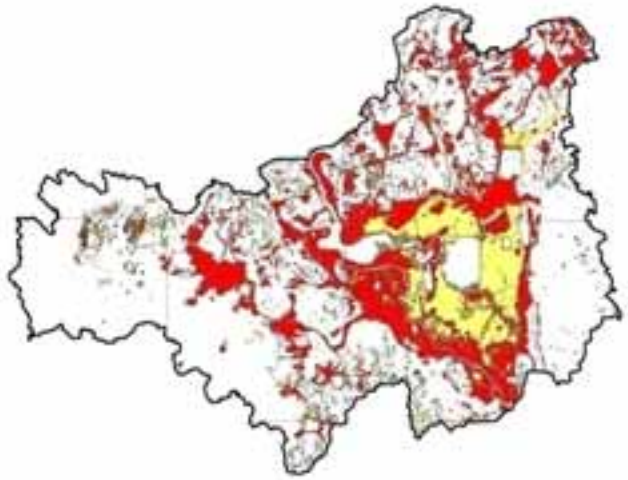
Decision square: Soil susceptibility (combined permeability and O horizon)



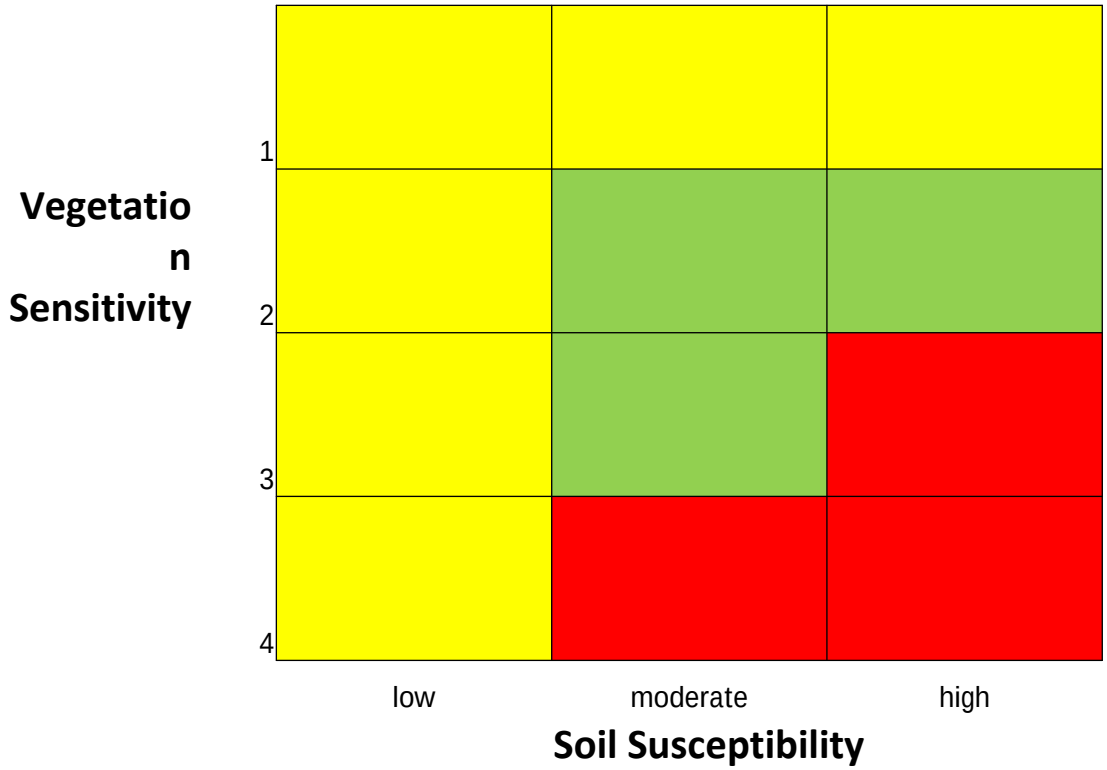
Wetlands (13 classes)



Wetland drawdown sensitivity (4 classes)

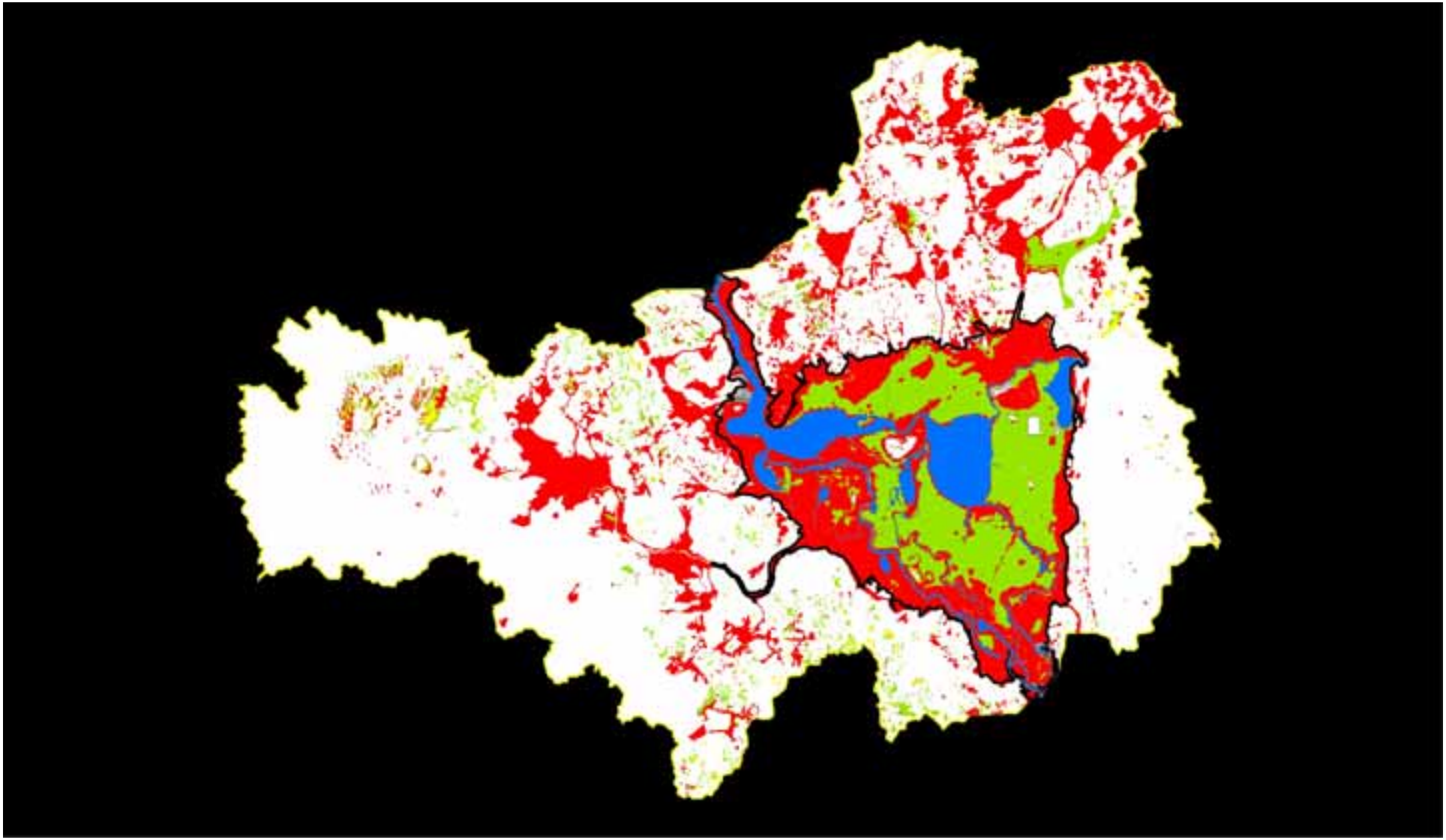


Potential for Harm

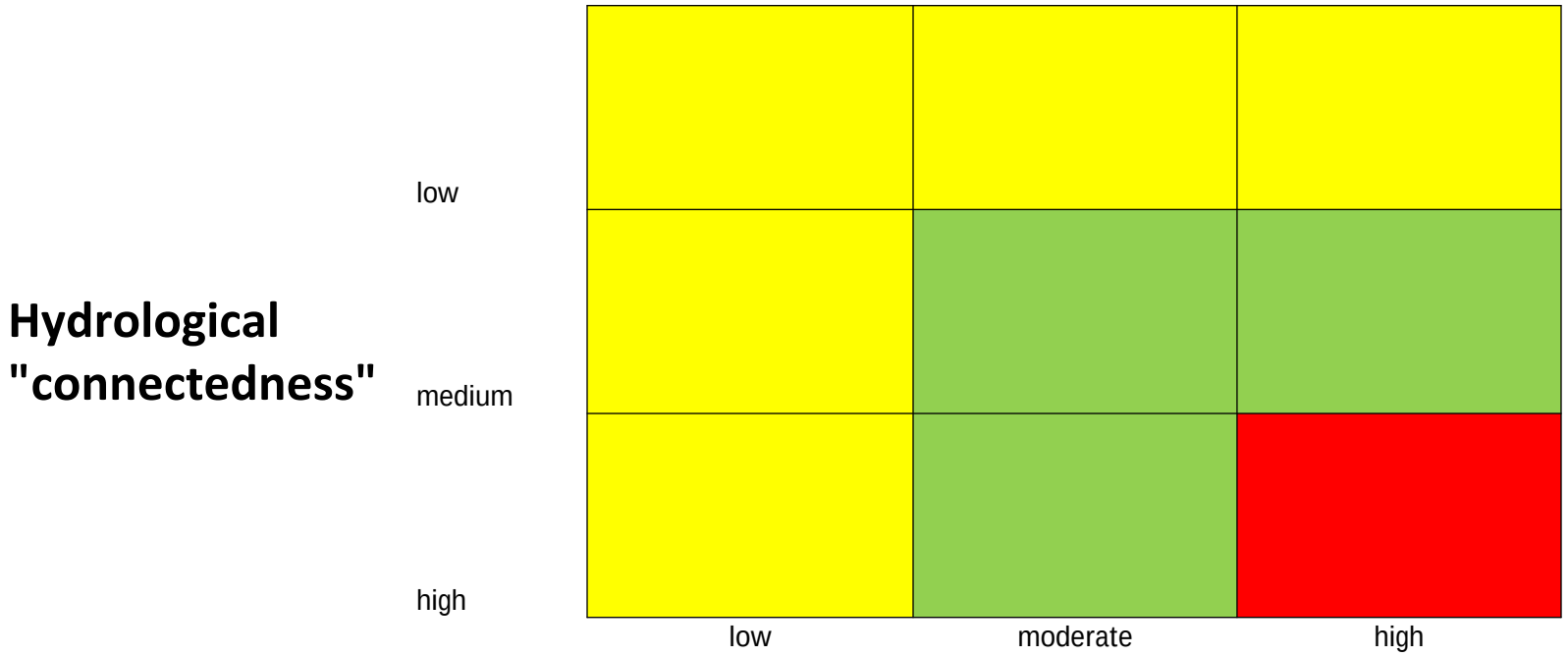


Rating Scale	
	low
	moderate
	high

Decision square: Wetland vegetation sensitivity



Potential for Harm --- Mock Up – so far…



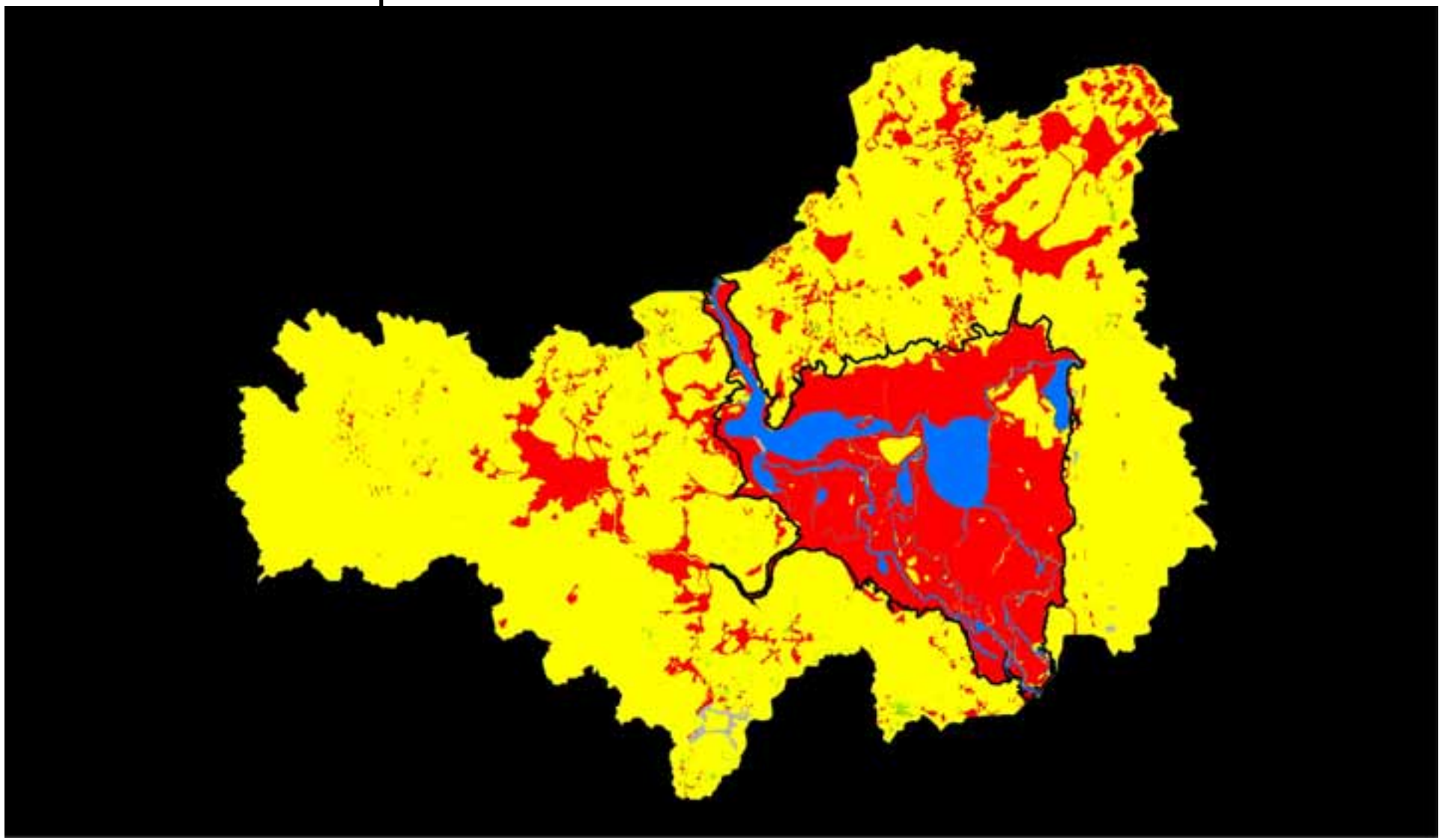
Examples – wetland types

Low: Seepage, tributary
Moderate: GW, rainfall
High: Riverine

Potential for Harm / Soils and Veg

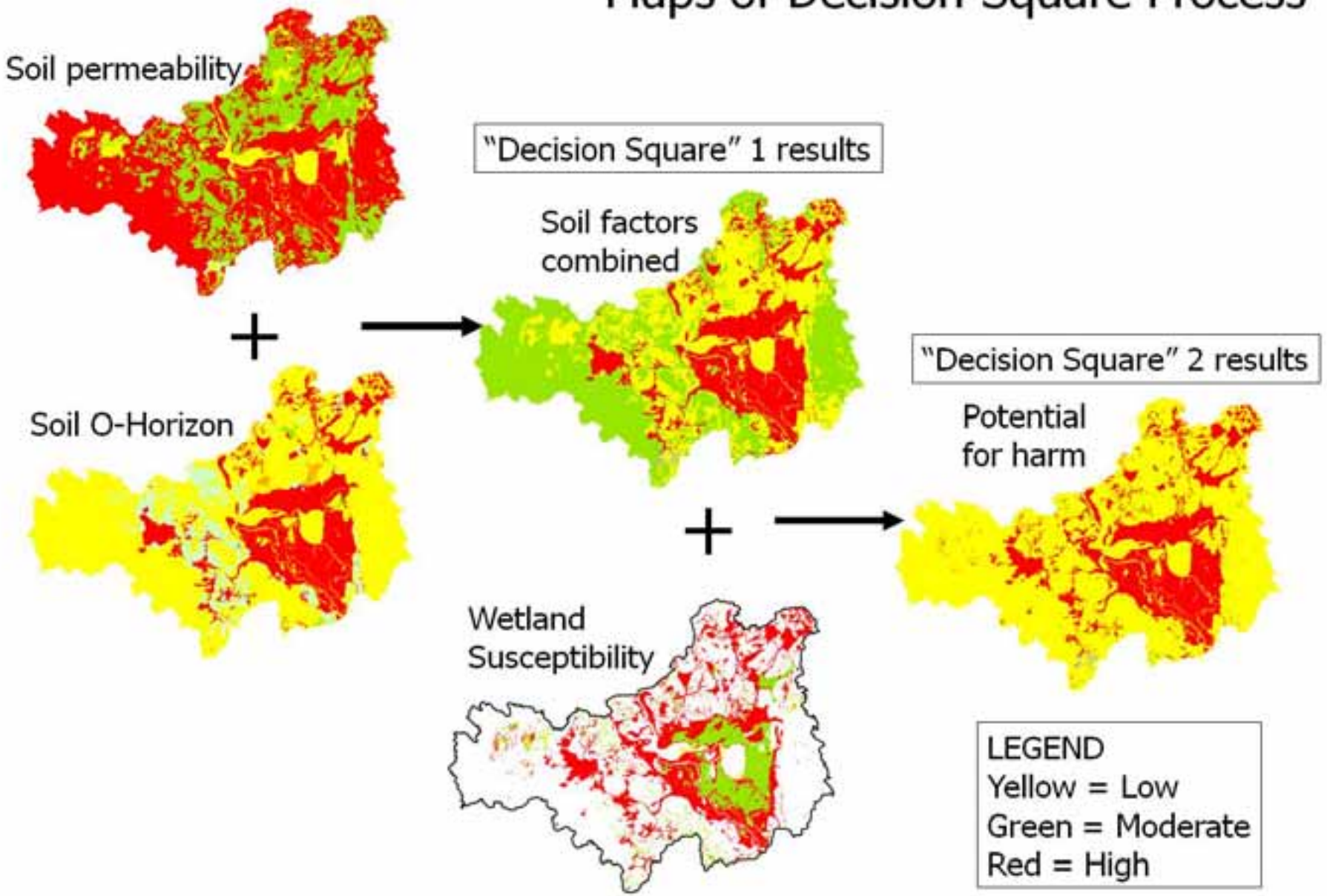
Rating Scale
low
moderate
high

Decision square: All factors

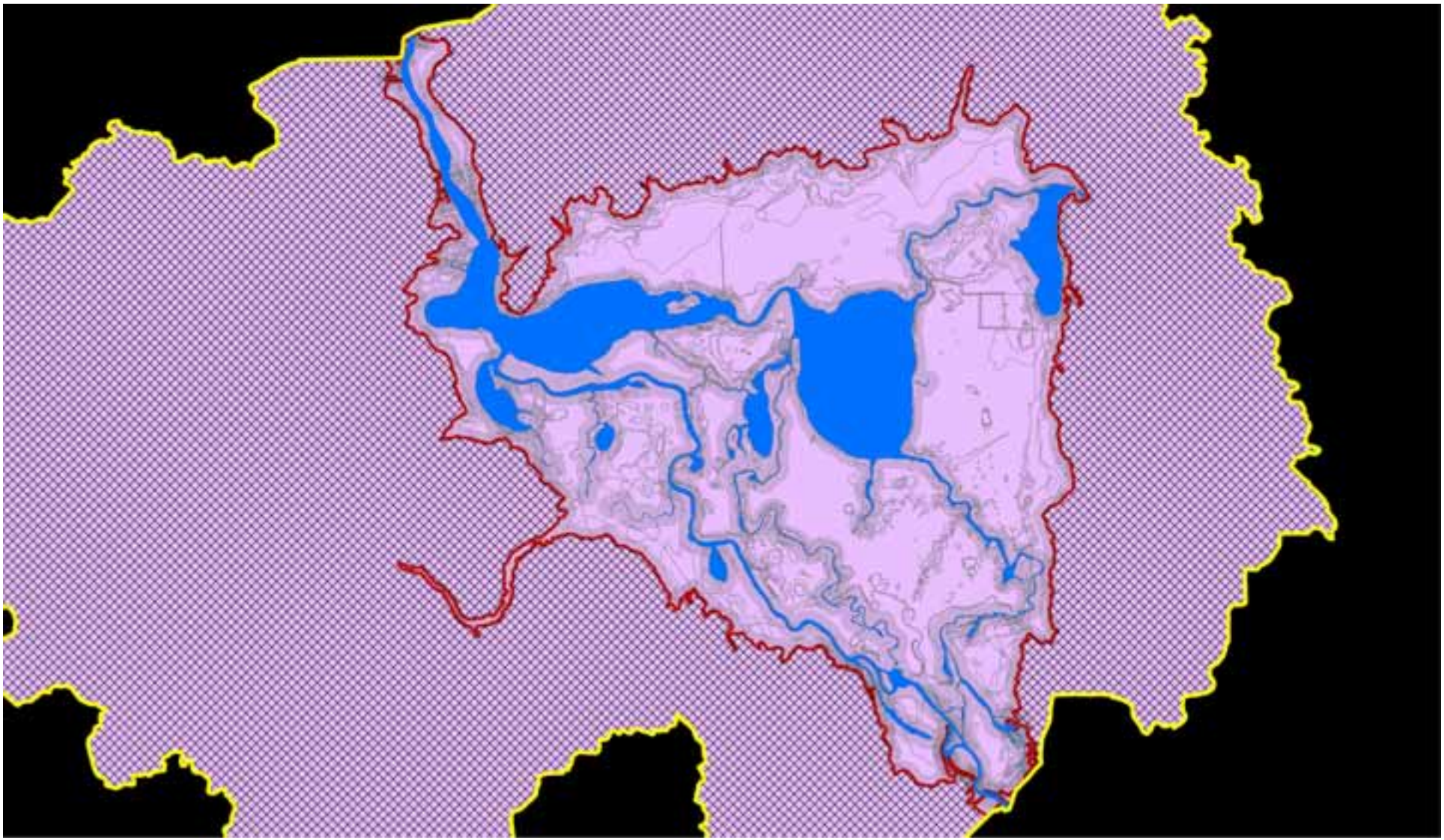


MODEL DEVELOPMENT: Soil permeability, O-horizon and wetland sensitivity to drawdown

Maps of Decision Square Process



All factors combined in single layer.....



Attribution for each polygon contains all model inputs

HYDROGEOMORPHOLOGY:

Within 200 meters from the River

Greater than 200 meters from a tributary

Seepage

Relatively small upslope drainage (“Runoff or seepage 2”)

SOIL: Astor sand soil

If soil type X and veg type Y, then buffer distance Z…

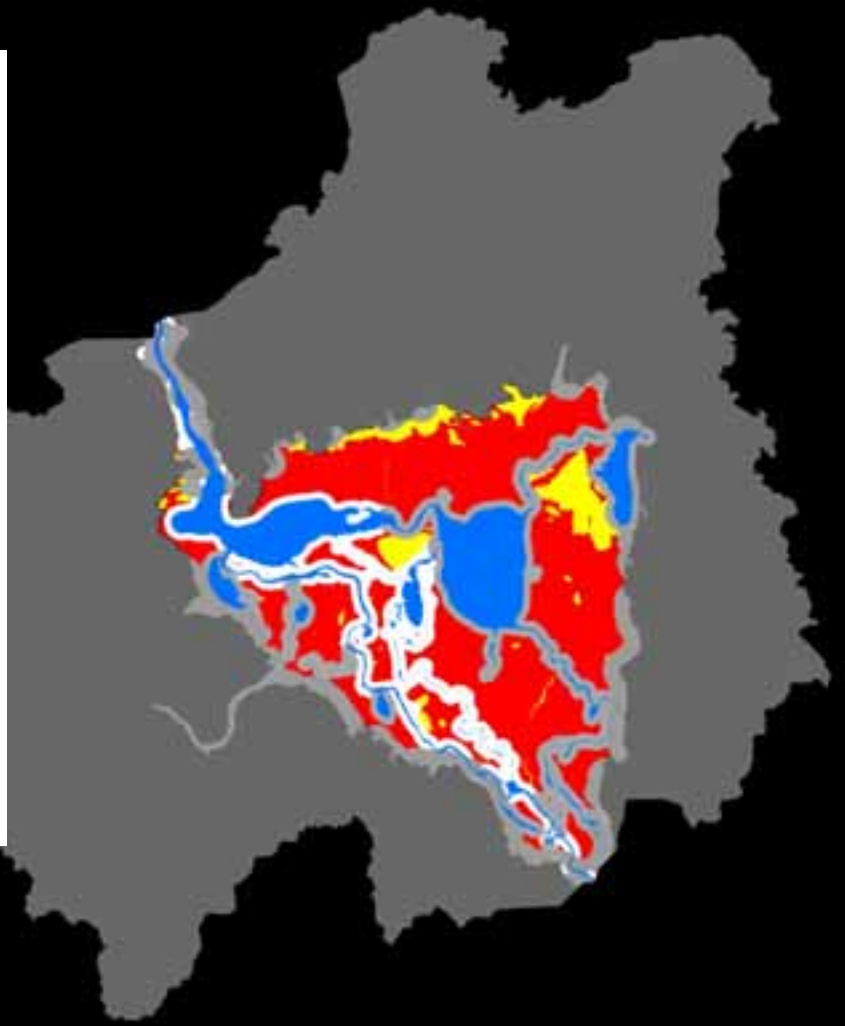
VEGETATION: Hardwood Swamp

Decision square: Add hydrogeomorphology

White = riverine wetlands

Red and yellow = rain & GW dominated wetlands

All shades of light gray = other hydrology (seepage, tributaries)



What's next

- Contract with wetlands hydrologist
- Refine model further
  - Different buffer distances based on soil characteristics and vegetation
  - Apply method of variable weighting
  - Create stressor layer
  - Determine appropriate scale for model run
  - Consider automation
- Field work in progress (Phase II)
  - Soil and vegetation
  - Analysis – help to identify dominant hydrology

Summary:

- Exploration of wetlands and the St. Johns River in a way that has not been previously performed

- Interesting questions
  - Water / wetland edge
  - Soil / wetland relationships
  - Primary hydrological source for wetlands

- Model in development
  - Adaptation of earlier successful modeling efforts
  - Multi-criteria GIS
  - Qualitative GIS (weightings, expert opinion)

- Contribution to larger question about water supply issue