Hydrology and the Distribution of Floodplain Plant Communities of the Upper St. Johns River, Florida:

Using transects to track the movement of plant communities along a changing hydrological gradient

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June 7, 2012

Background

Water withdrawals from the St. Johns River

may potentially affect

floodplain wetlands through

changes in

water quality and in the total **quantity** of water

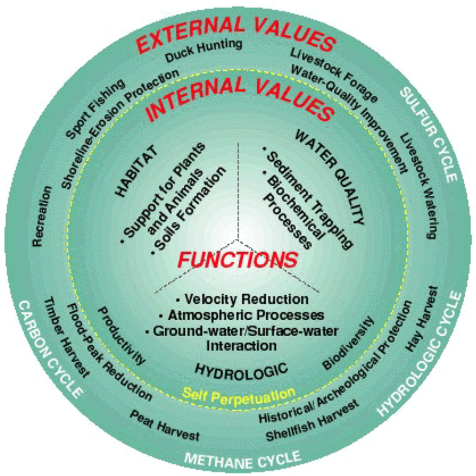
available to support

wetland functions.

Potential changes in wetlands were assessed as part of a comprehensive effort to assess potential changes to a wide array of water quality and biological resources of the St. Johns River from future water withdrawals. *

* E.F. Lowe, L.E. Battoe, H. Wilkening, M. Cullum, and T. Bartol (eds.). 2012.
St. Johns River Water Supply Impact Study.
St. Johns River Water Management District, Technical Publication SJ2012-1. Palatka, Florida.
http://floridaswater.com/watersupplyimpactstudy

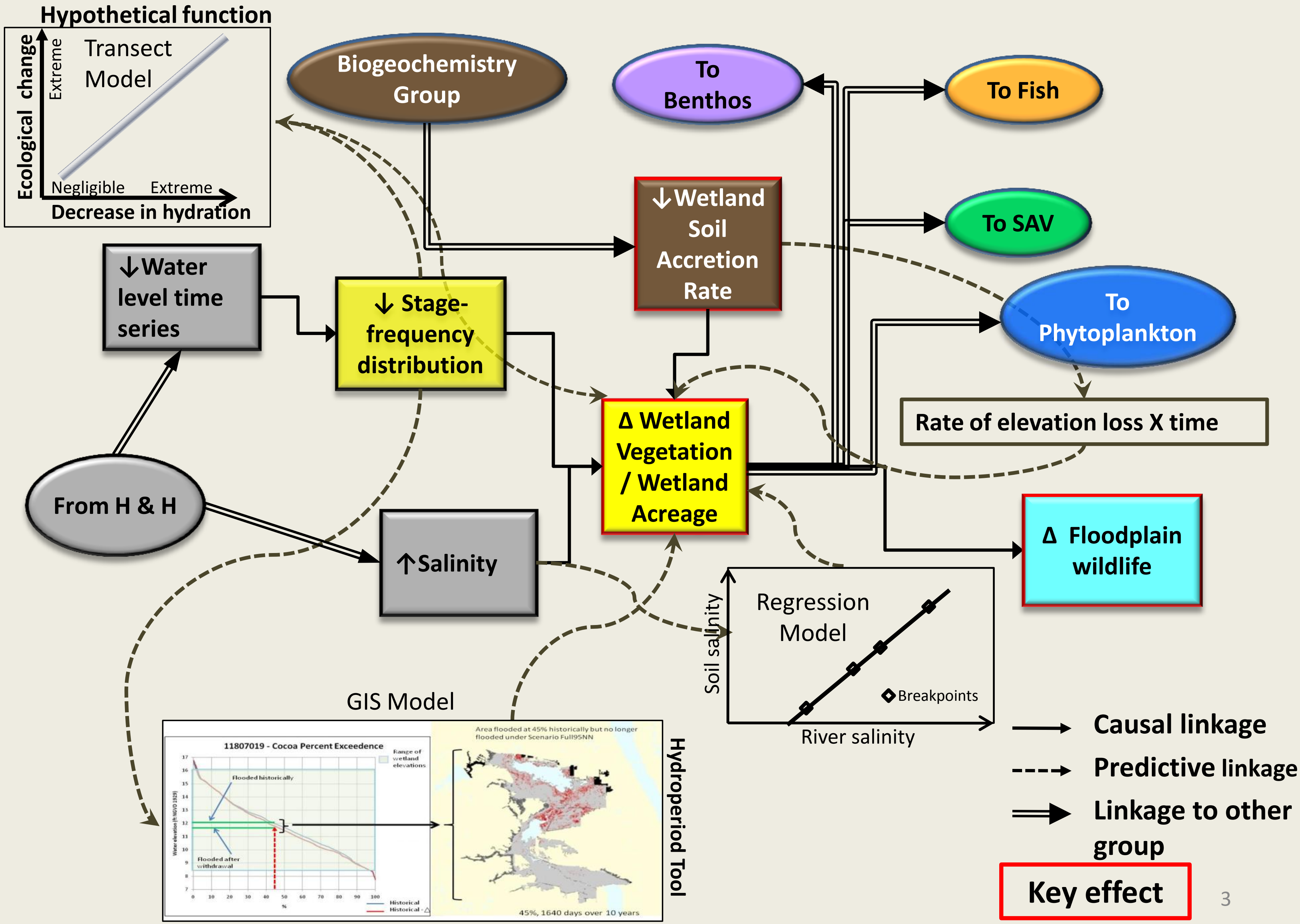
Wetland functions
(1) hydrologic functions
(2) water quality functions
(3) habitat functions
(4) biological functions
(5) aesthetic functions



*
Wetland functions and internal and external values.

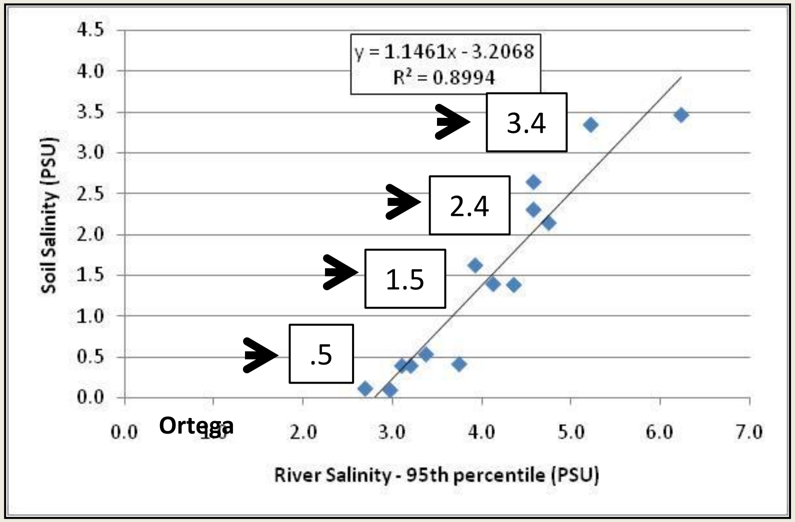
* Novitzki, R.P., R. D. Smith, and J.D. Fretwell. 1999. USGS

Conceptual Model: Effects of Water Withdrawal on Wetland Plant Communities



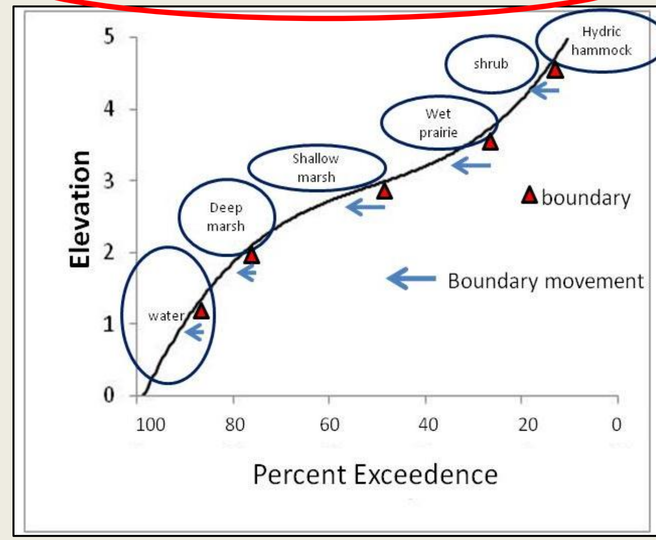
Hydroecological Models

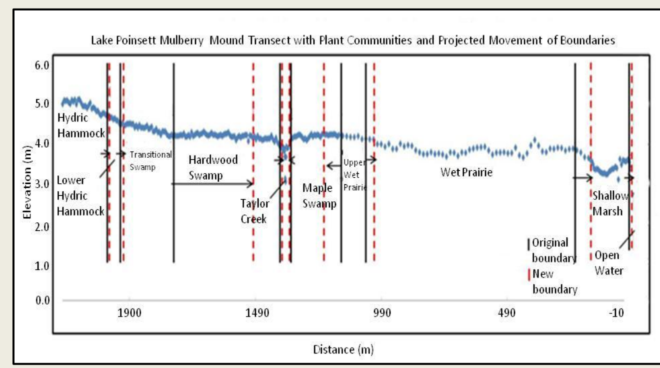
Ortega River Regression Model (see poster 289 – Kinser, et al.)



Change in river salinity drives change in soil salinity which drives vegetation change

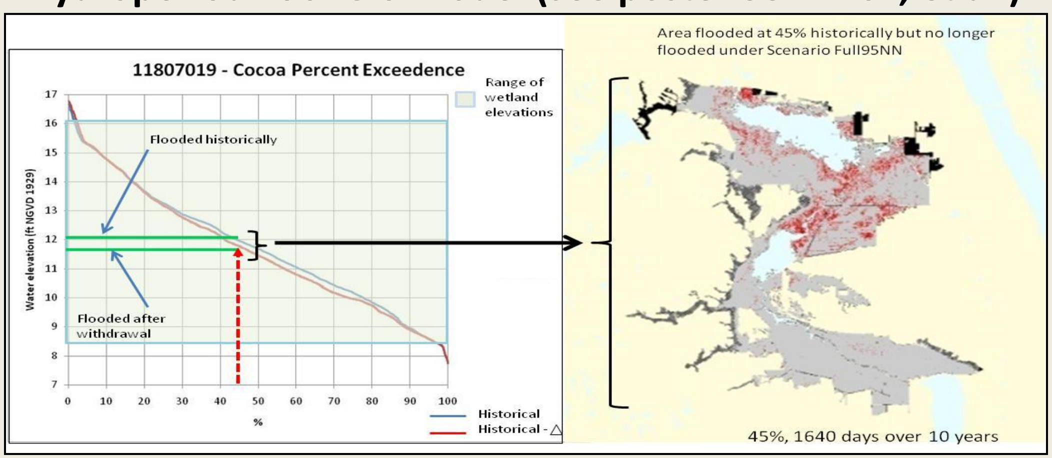
Upper St. Johns Transect Model





Change in exceedence drives movement of community boundaries

Hydroperiod Tool GIS Model (see poster 381 - Fox, et al.)



Change in exceedence drives change in duration of flooding.

Upper St. Johns Transect Model

Focus

• Movement in the boundaries of wetland plant communities along a hydrologic gradient in the Upper St. Johns River of Florida.
• Extreme water withdrawal scenario – 55mgd; 1995 land use; no restoration projects; no sea level rise.

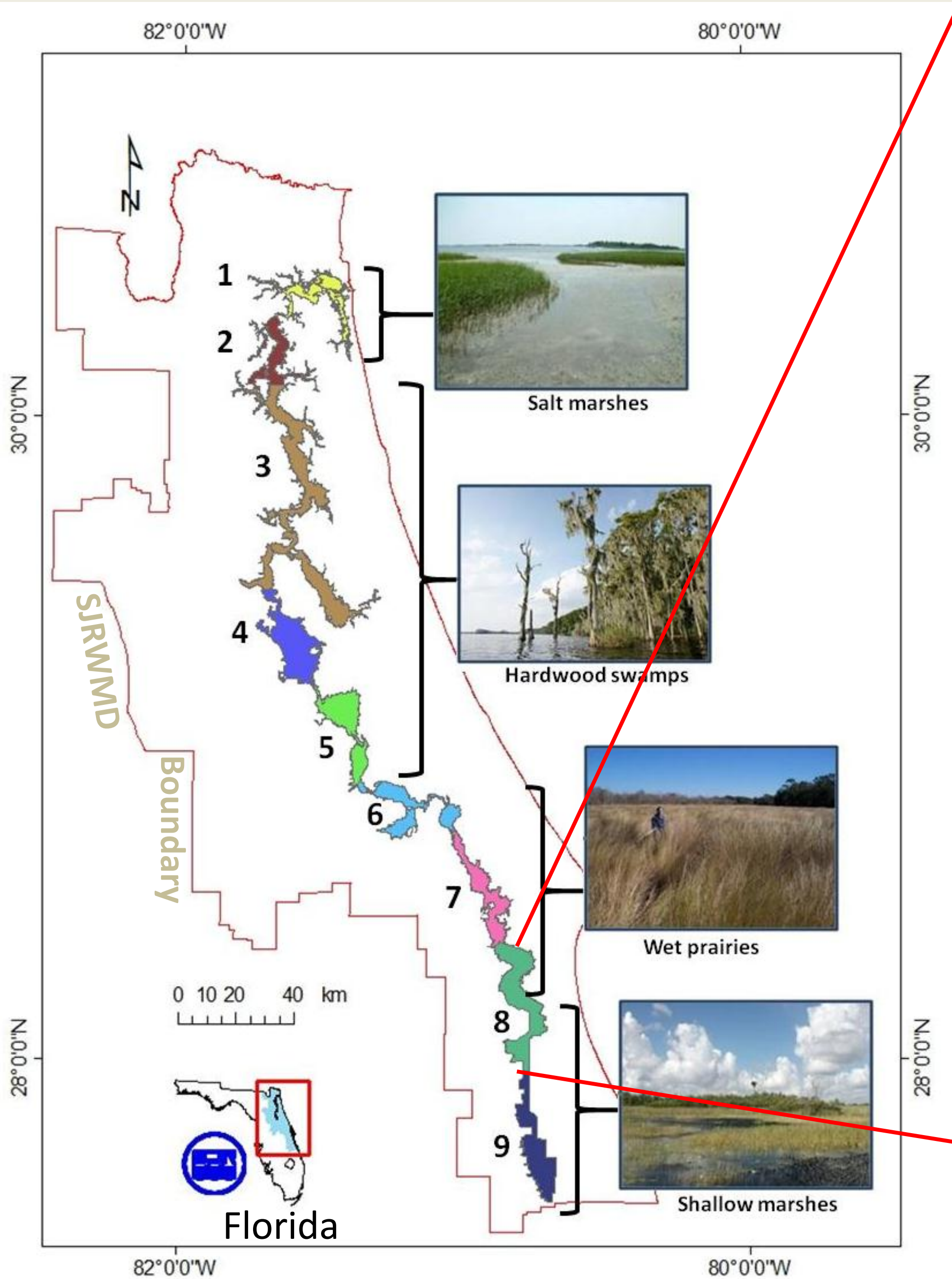
Premises:

• The placement and extent of freshwater wetlands are driven by hydrology.
• When hydrological conditions are altered, the placement and extent of wetlands change in predictable ways.

Objective

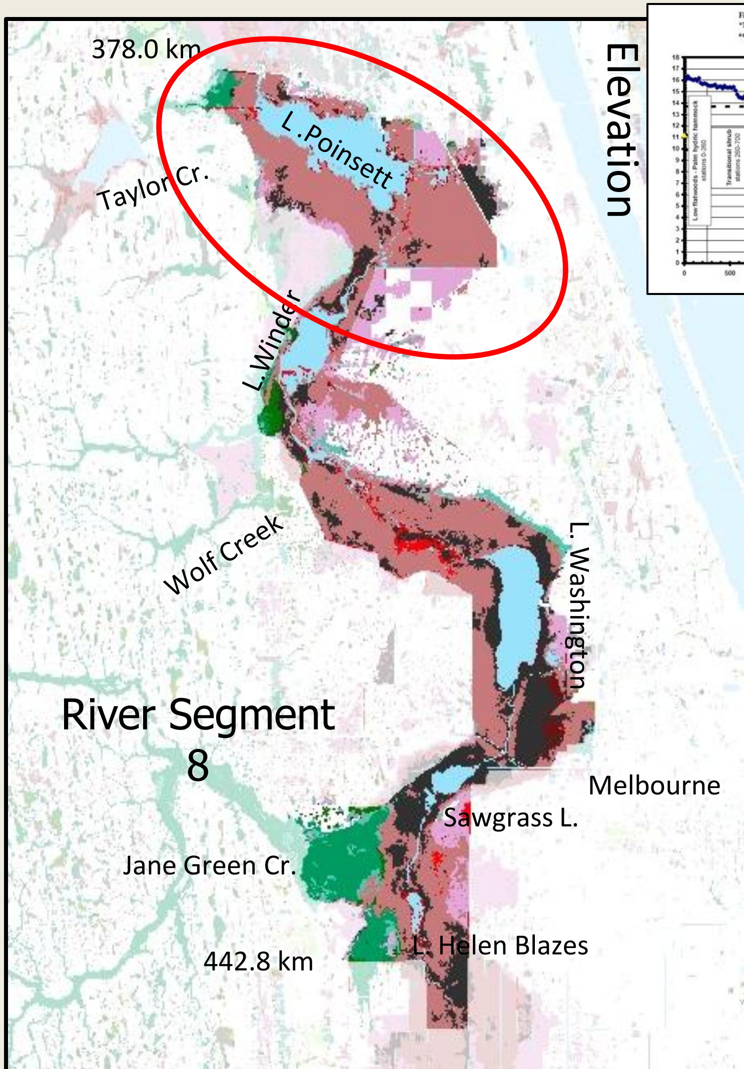
• To create a model simulating the movement of plant communities along a changing hydrological gradient.

The Study Site

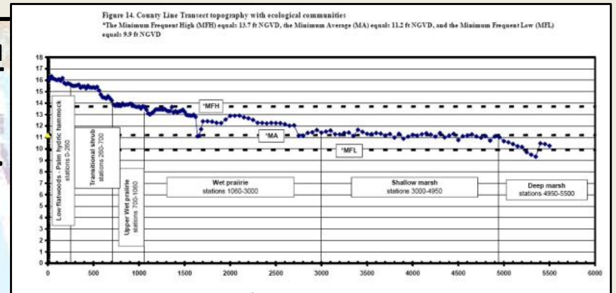


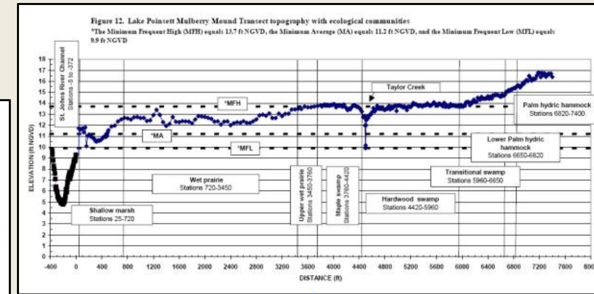
River Segment 8, Upper St. Johns River

Transects at Lake Poinsett

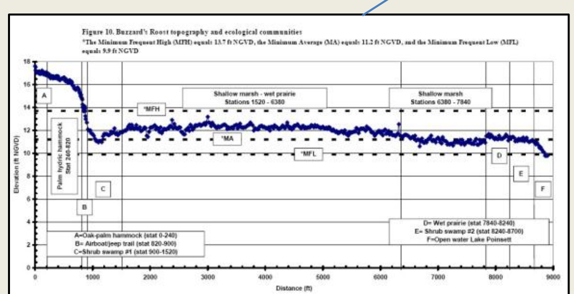


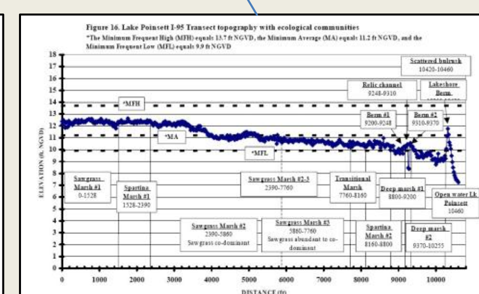
Elevation





Distance



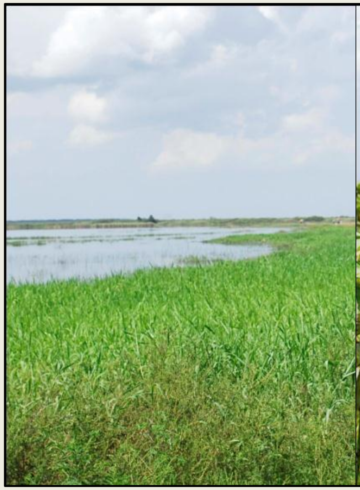


Mace, Jane W. 2007. Minimum levels determination: Lake Poinsett in Brevard, Orange, and Osceola Counties. Draft Report. St. Johns River Water Management District, Palatka, Florida. Unpublished manuscript.

Dominant Community Types

Open Water

Deep Marsh (yellow pondlily)



Shallow marsh
(grasses)

Shallow marsh
(Hibiscus / sawgrass)

Wet Prairie (sand cordgrass)

Dominant Community Types

Shrub swamp (willow)

Hardwood swamp

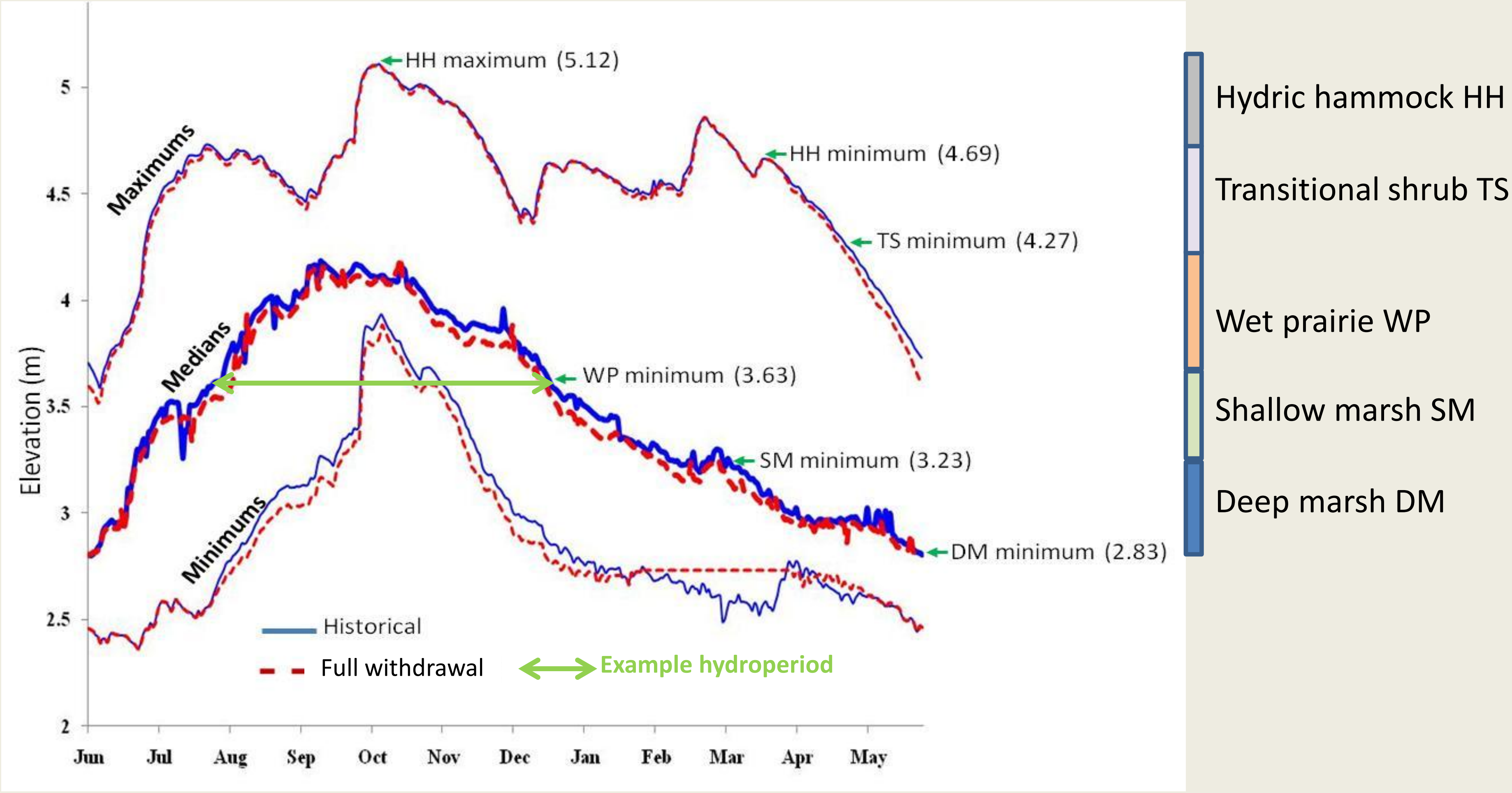
Transitional shrub

Hydric Hammock (cabbage palm)

The Hydrological Setting

Hydroperiod: the number of days per year that water is at or above the soil surface.

Median Annual Hydrograph

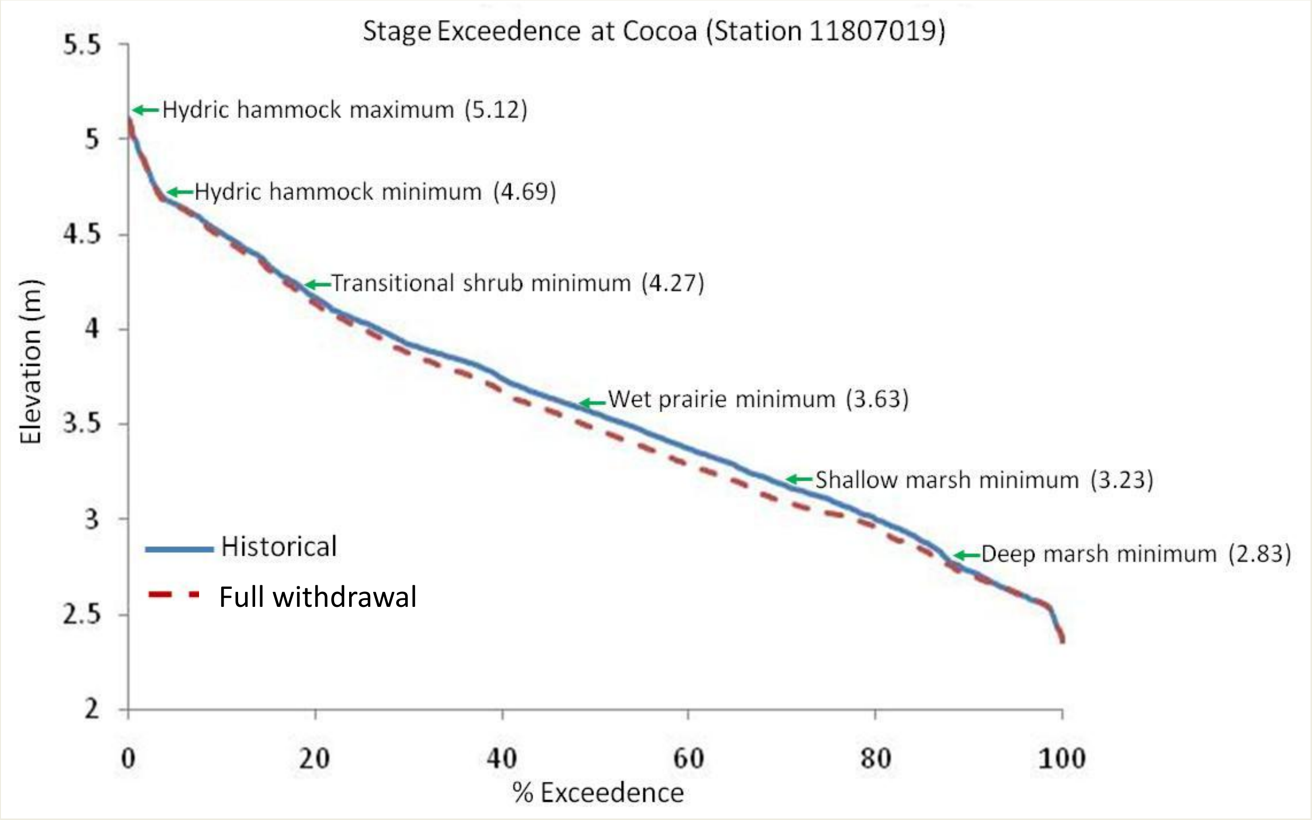


Plant Community Boundary Elevations relative to Historic and Modeled Future Conditions, St. Johns River at Cocoa (Lake Poinsett).

The Hydrological Setting

Exceedence: the probability that water levels will exceed a specified elevation.

Exceedence Curve

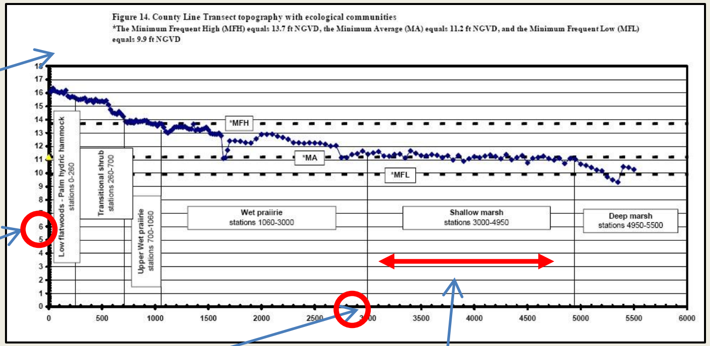


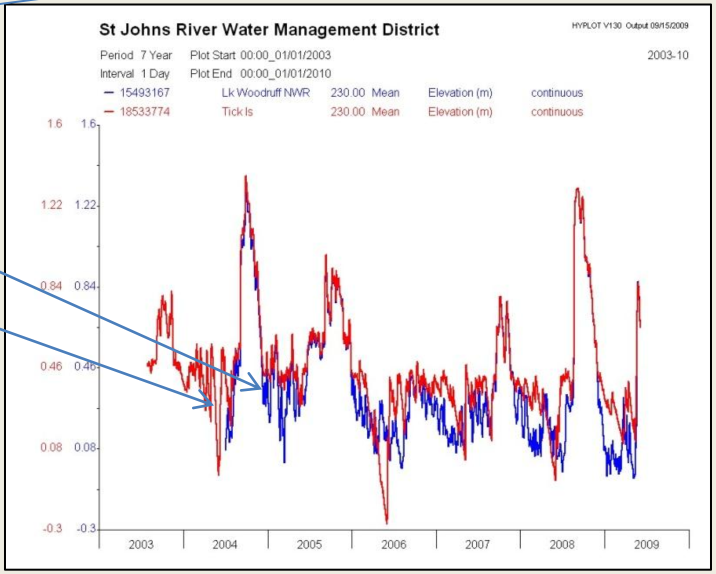
Plant Communities by Elevation and Exceedences for Historic and Modeled Future Conditions, St. Johns River at Cocoa (Lake Poinsett).

Methods

Ingredients

- Vegetation data from transects
- Elevations of plant community boundaries
- Spatial locations of plant community boundaries
- Width of communities
- Historical hydrological data (10 years or more)
- Modeled data reflecting a future hydrological condition
- Assumptions and rules





Assumptions

1.) Surface water levels (annual averages or medians) adequately describe the hydrology of adjacent wetlands,

2.) The system being modeled is in equilibrium with baseline hydrology

3.) The plant communities have definite, measurable boundaries.

4.) With changes in hydration, wetland communities shift and re-establish at elevations with hydrologic exceedences equal to those experienced in their previous landscape positions,

5.) When water levels drop, communities adapted to dryer conditions displace more hydrophilic communities through competition for moisture and light.

6.) When water levels rise, communities adapted to wetter conditions move into the space created by mortality of less flood tolerant species.

7.) Communities are discrete and move as intact units

Steps:

(1) Compile community metrics (elevation, position, and length of transect occupied.)

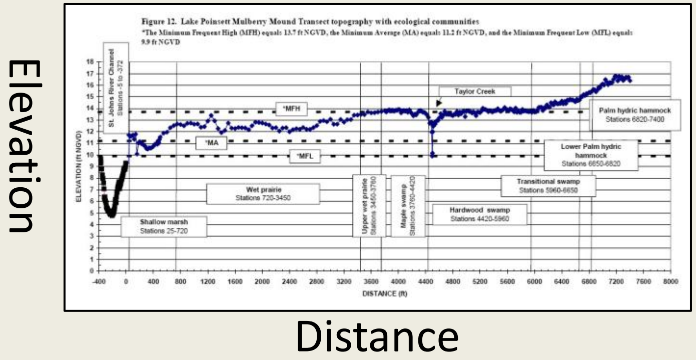
(2) Look up historical and modeled future exceedences at the minimum elevations for each wetland type.

(3) Look up historical exceedence in the modeled future exceedence table to find the new matching elevation.

(4) Starting with the community with highest elevation, move the community boundary to the next down-slope point having the correct exceedence.

(5) Plot results and record distance moved and new linear distance covered by each community.

(1) Compile community metrics (elevation, position, and length of transect occupied)



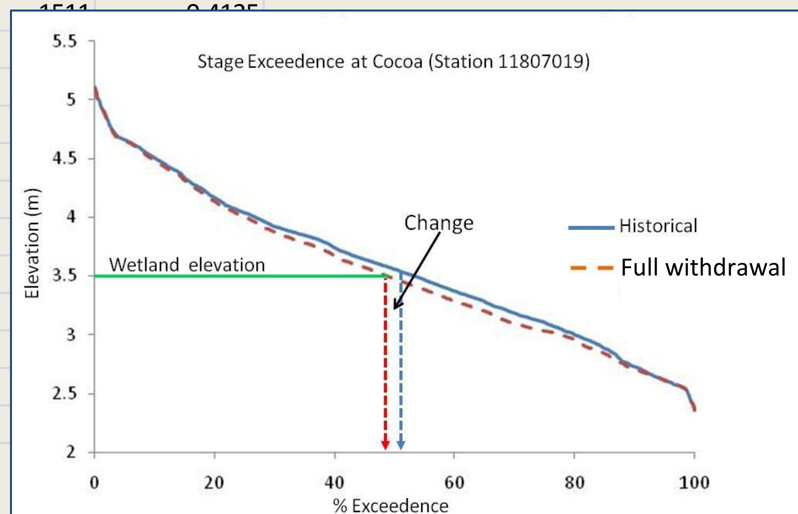
Example of community metrics (Mulberry Mound transect)

Community	Lower Boundary elevation (m)	Start (m)	End (m)	Length (m)
Shallow marsh	3.07	8	219	211
Wet Prairie	3.64	219	1052	833
Upper Wet Prairie	4.11	1052	1146	94
Maple Swamp	4.07	1146	1347	201
Hardwood Swamp	3.96	1393	1817	424
Transitional Swamp	4.17	1817	2027	210
Lower Palm Hydric Hammock	4.50	2027	2079	52
Palm Hydric Hammock	4.68	2079	2256	177

(2) Look up historical and modeled future exceedences at the minimum elevations for each wetland type on sorted tables

Historic Exceedence Table / Modeled Future Exceedence Table

Date	Elevation (m)	Rank	Exceedence		Elevation (m)	Rank	Exceedence
10/31/2002	3.6454	1640	0.4488		3.6424	1498	0.4100
5/11/2005	3.6454	1641	0.4491		3.6424	1499	0.4102
7/21/1996	3.6424	1642	0.4494		3.6393	1500	0.4105
7/7/1999	3.6424	1643	0.4496		3.6393	1501	0.4108
9/12/1999	3.6424	1644	0.4499		3.6393	1502	0.4111
1/28/1996	3.6393	1645	0.4502		3.6393	1503	0.4113
6/4/1998	3.6393	1646	0.4505		3.6363	1504	0.4116
7/3/1999	3.6393	1647	0.4507		3.6363	1505	0.4119
7/8/1999	3.6393	1648	0.4510		3.6363	1506	0.4122
9/28/2000	3.6393	1649	0.4513	Wet Prairie	3.6363	1507	0.4124
2/13/2003	3.6393	1650	0.4516		3.6363	1508	0.4127
7/28/2003	3.6393	1651	0.4518		3.6363	1509	0.4130
8/22/2004	3.6393	1652	0.4521		3.6363	1510	0.4132
12/18/2004	3.6393	1653	0.4524		3.6363		
3/19/2005	3.6393	1654	0.4527		3.6332		
6/7/2005	3.6393	1655	0.4529		3.6332		
3/12/1996	3.6363	1656	0.4532		3.6332		
5/18/1996	3.6363	1657	0.4535		3.6332		
8/3/1996	3.6363	1658	0.4537		3.6332		
1/12/2000	3.6363	1659	0.4540		3.6332		
12/19/2001	3.6363	1660	0.4543		3.6332		
10/23/2002	3.6363	1661	0.4546		3.6332		
11/14/2003	3.6363	1662	0.4548		3.6302		
5/12/2005	3.6363	1663	0.4551		3.6302		
1/29/1996	3.6332	1664	0.4554		3.6302		



(3) Look up historical exceedence in the modeled future exceedence table to find the new matching elevation

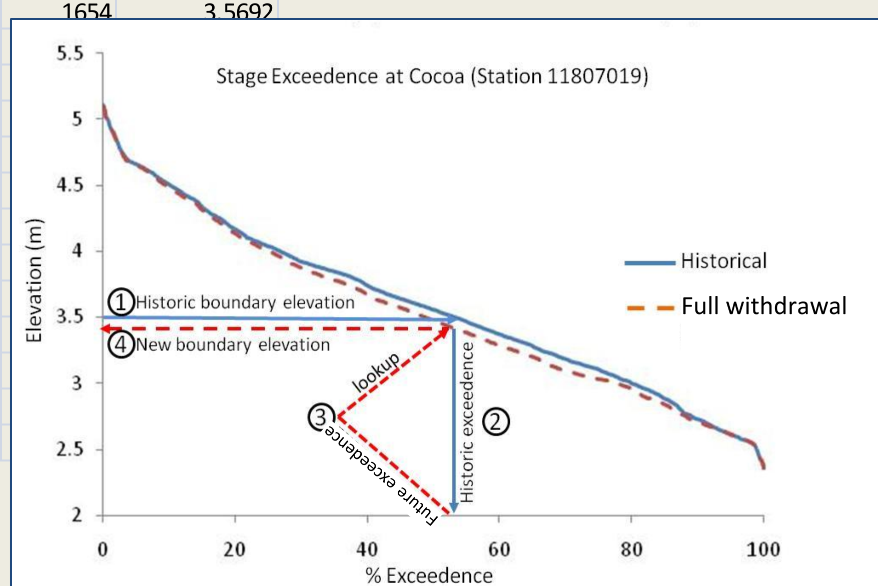
Historic Exceedence Table

Date	Elevation (m)	Rank	Exceedence
10/31/2002	3.6454	1640	0.4488
5/11/2005	3.6454	1641	0.4491
7/21/1996	3.6424	1642	0.4494
7/7/1999	3.6424	1643	0.4496
9/12/1999	3.6424	1644	0.4499
1/28/1996	3.6393	1645	0.4502
6/4/1998	3.6393	1646	0.4505
7/3/1999	3.6393	1647	0.4507
7/8/1999	3.6393	1648	0.4510
9/28/2000	3.6393	1649	0.4513
2/13/2003	3.6393	1650	0.4516
7/28/2003	3.6393	1651	0.4518
8/22/2004	3.6393	1652	0.4521
12/18/2004	3.6393	1653	0.4524
3/19/2005	3.6393	1654	0.4527
6/7/2005	3.6393	1655	0.4529
3/12/1996	3.6363	1656	0.4532
5/18/1996	3.6363	1657	0.4535
8/3/1996	3.6363	1658	0.4537
1/12/2000	3.6363	1659	0.4540
12/19/2001	3.6363	1660	0.4543
10/23/2002	3.6363	1661	0.4546
11/14/2003	3.6363	1662	0.4548
5/12/2005	3.6363	1663	0.4551
1/29/1996	3.6332	1664	0.4554

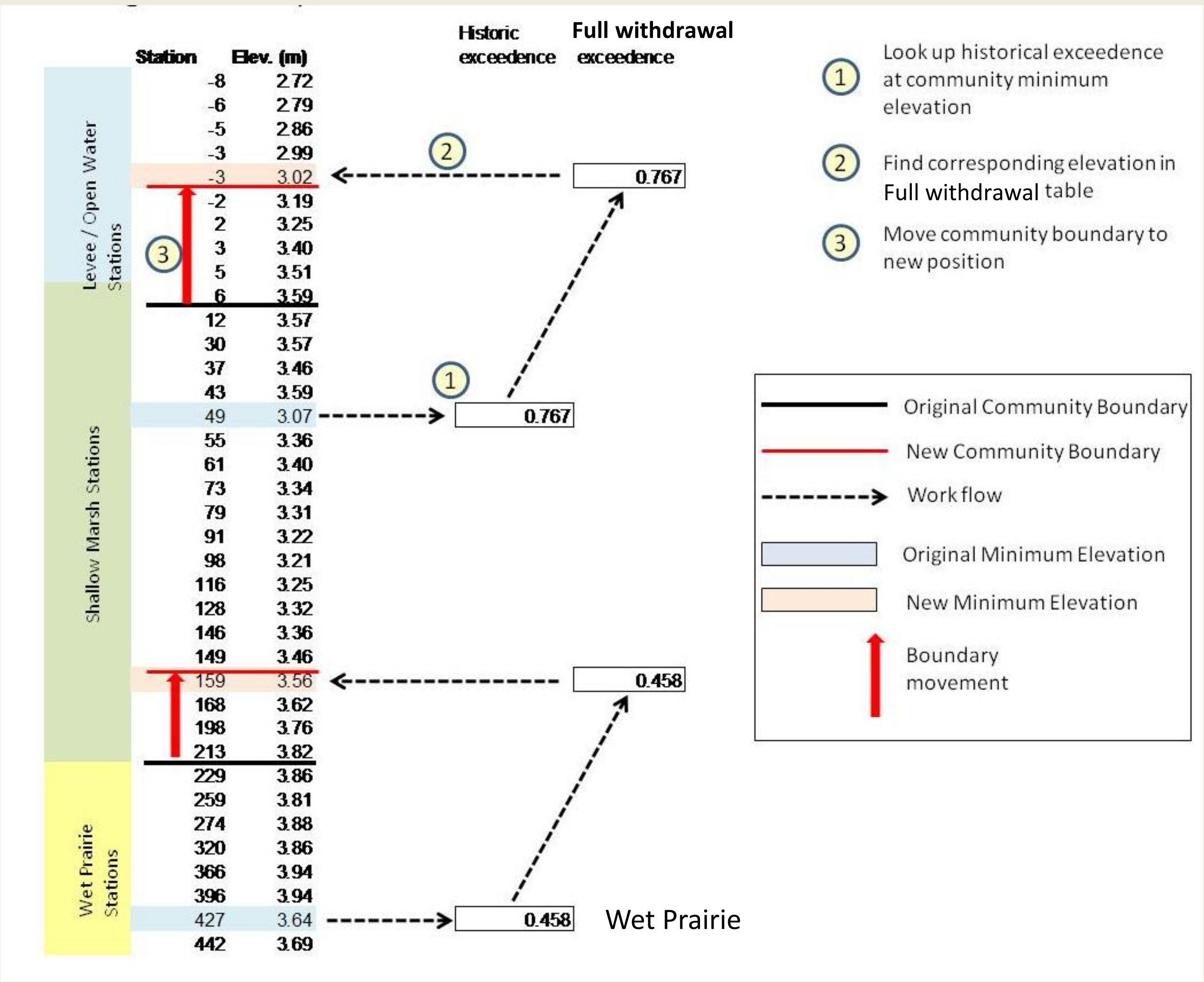
Wet Prairie

Modeled Future Exceedence Table

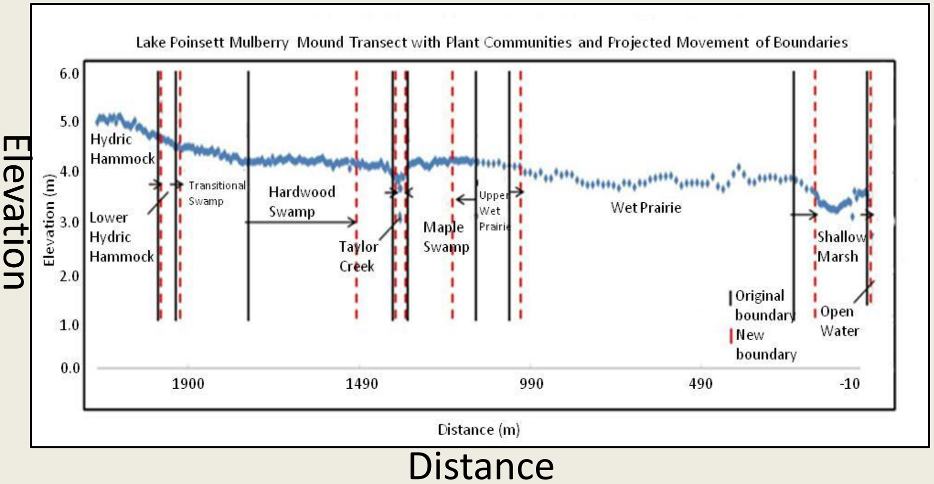
Exceedence	Rank	Elevation (m)
0.4494	1642	3.5753
0.4496	1643	3.5723
0.4499	1644	3.5723
0.4502	1645	3.5723
0.4505	1646	3.5723
0.4507	1647	3.5723
0.4510	1648	3.5723
0.4513	1649	3.5723
0.4516	1650	3.5723
0.4518	1651	3.5723
0.4521	1652	3.5723
0.4524	1653	3.5723
0.4527	1654	3.5692
0.4529		
0.4532		
0.4535		
0.4537		
0.4540		
0.4543		
0.4546		
0.4548		
0.4551		
0.4554		
0.4557		
0.4559		

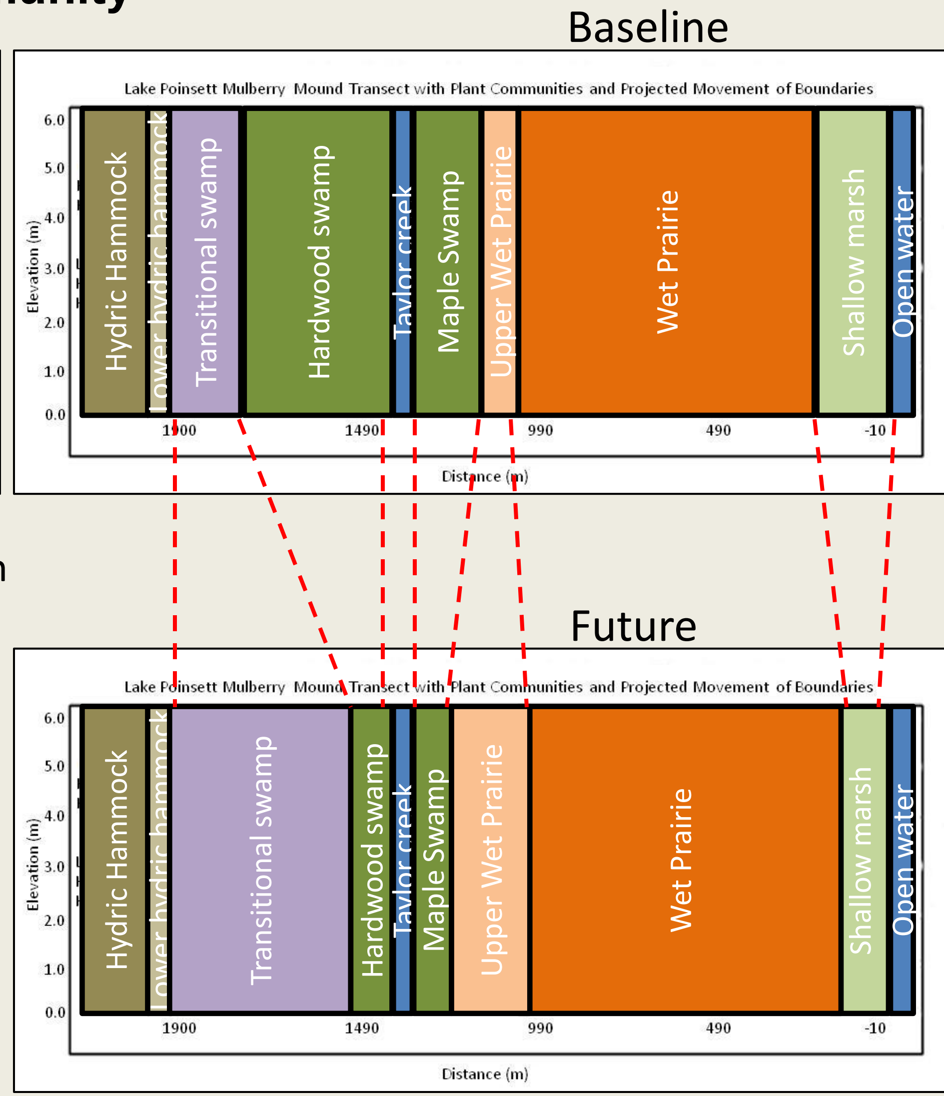


(4) Starting with the community with highest elevation, move the community boundary to the next down-slope point having the correct exceedence



(5) Plot results and record distance moved and new linear distance covered by each community





Potential movement of community boundaries from historical baseline scenario to Full1995NN scenario, Mulberry Mound transect (Lake Poinsett).

Results

Mulberry Mound Transect

Community	Minimum Elevation (m)	Historical Exceedence	Original Days Flooded	Historical minus Delta Exceedence	Change in Elevation	New Days Flooded	Reduction in Days Flooded	Reduction in Flooding (%)	Original Length	New Length	Change in Length	Change in length (%)
Shallow marsh	3.07	0.7671	280.2	0.7187	-0.05	262.5	17.7	6.3	212	162	-50	-23.6
Wet Prairie	3.64	0.4579	167.2	0.4157	-0.07	151.8	15.4	9.2	832	860	28	3.4
Upper wet prairie	4.11	0.2189	80.0	0.2096	-0.03	76.6	3.4	4.3	94	200	106	111.7
Maple swamp	4.07	0.2351	85.9	0.2217	-0.04	81.0	4.9	5.7	201	134	-67	-33.5
Hardwood swamp	3.96	0.2882	105.3	0.2701	-0.05	98.7	6.6	6.3	424	113	-311	-73.4
Transitional swamp	4.17	0.2017	73.7	0.1910	-0.04	69.8	3.9	5.3	210	515	305	144.8
Lower palm hydric hammock	4.50	0.1029	37.6	0.0969	-0.02	35.4	2.2	5.9	52	55	3	6.0
Palm hydric hammock	4.68	0.0402	14.7	0.0369	-0.01	13.5	1.2	8.2	177	186	9	5.3

All Transects

Community	Average % Change in length (all transects)
Deep marsh	-12.1
Shallow marsh / shrub swamp	-34.3
Wet prairie	63.7
Upper wet prairie	57.7
Hardwood swamp / maple swamp	-53.4
Transitional swamp	144.8
Transitional Shrub	-7.5
Hydric Hammock	7.0

Conclusions

- A simple transect model can be used to predict the movement of wetland community boundaries.

- Model assumptions lead to conservative results, i.e. the results will be no worse than those predicted (but may be less severe).

- On flat terrains, relatively small changes in average flooding depth can result in large changes in the positions of community boundaries.

- Changes from lowered water levels will occur slowly, especially if perennial species are dominant.

- Changes from increased water levels will occur more quickly.