Soil Nutrient Storage and Cycling in the Restored Kissimmee River Floodplain

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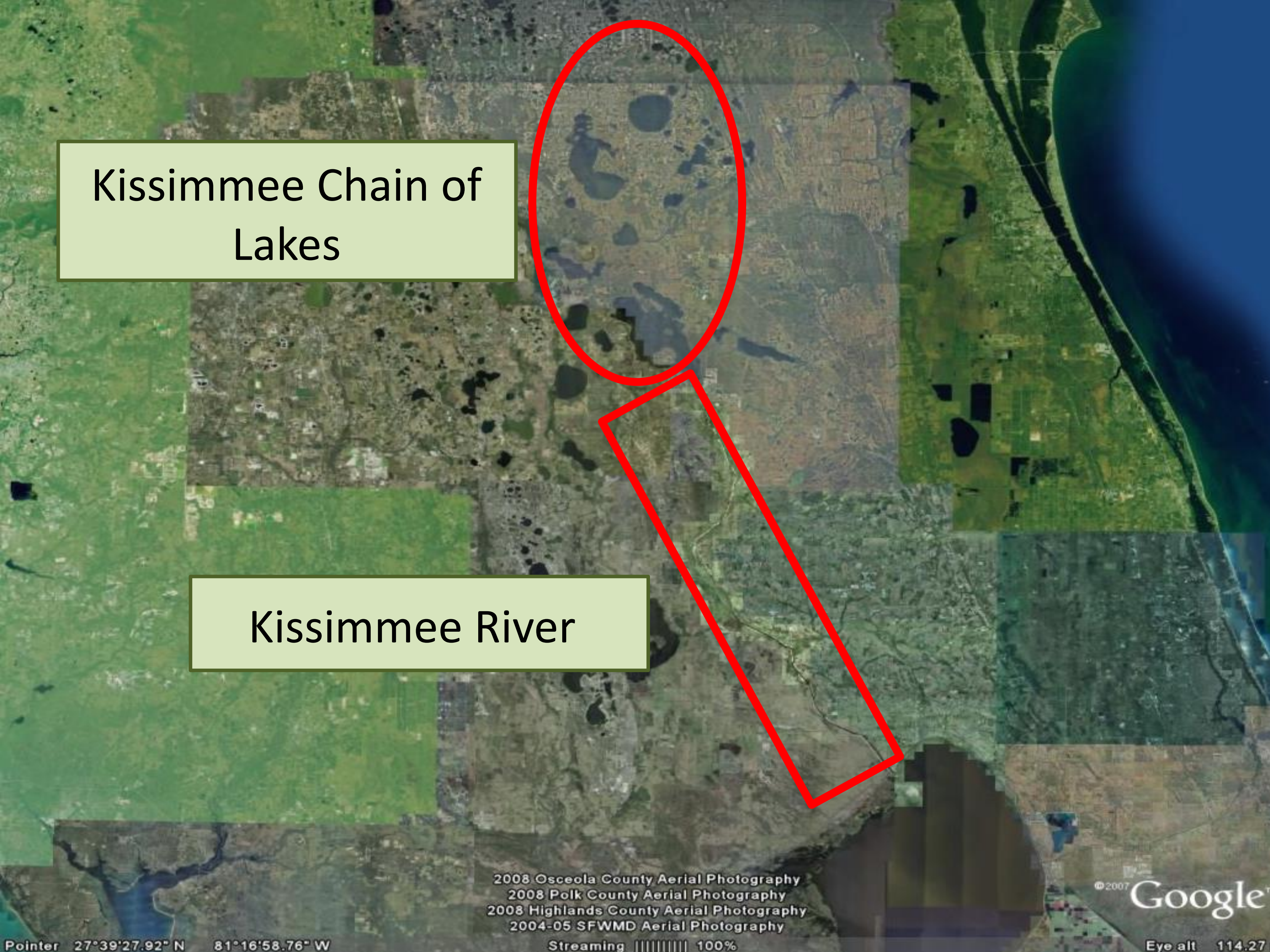
Photograph by Brent Anderson


Kissimmee Chain of Lakes
Kissimmee River
2008 Osceola County Aerial Photography
2008 Polk County Aerial Photography
2008 Highlands County Aerial Photography
2004-05 SFWMD Aerial Photography
©2007 Google
Pointer 27°39'27.92" N 81°16'58.76" W
Streaming |||||||||| 100%
Eye alt 114.27

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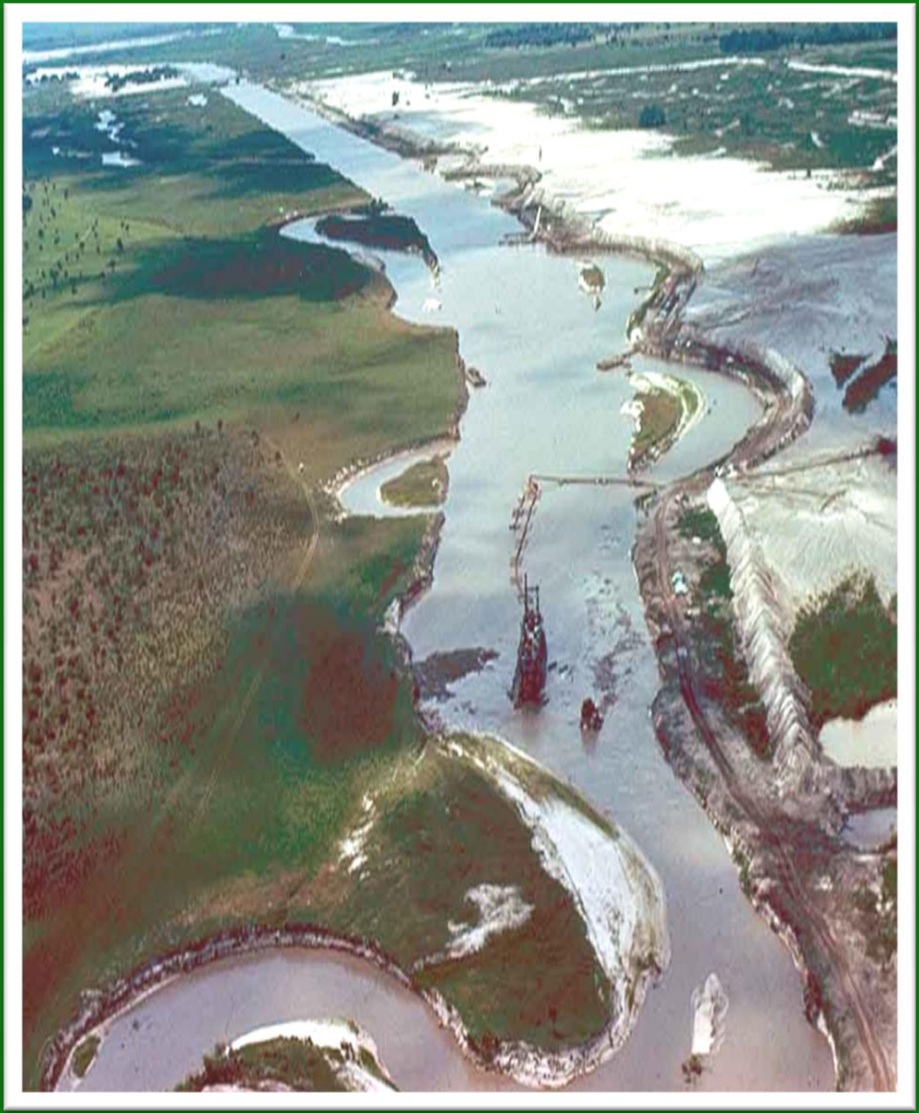
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

City of Kissimmee Flooding
circa 1948

Channelization 1962-1971



Environmental effects of Channelization

- **Loss of flood pulse**
  - Shift to terrestrial plants
  - Fewer wading birds, ducks
  - Loss of highly productive floodplain habitats
  - Interruption of nutrient cycling and food web dynamics
- **Loss of flow in river**
  - Increases in floating vegetation
  - Increases in organic matter deposition
  - Lower dissolved oxygen
  - Shift in fish, invertebrate communities
- **Loss of hydrologic connectivity between channel and floodplain**

Restoration Benefits
Expectations and Performance Measures

- Hydrology
- Geomorphology
- Dissolved Oxygen & Water Quality
- Plant Communities
- Invertebrate Communities
- Reptile and Amphibian Communities
- Fish Communities
- Avian Communities
- Threatened and Endangered Species

....Soils ??

Why Soils?

- Soils are an integrator of long-term water chemistry conditions
- Nutrient inputs to wetlands primarily stored in soil organic matter
- Spatial distribution of soil nutrients can be used to assess long-term trends in nutrient dynamics
- Soils = ideal ecosystem component for assessing baseline status of Kissimmee River floodplain prior to restoration activities & after recovery

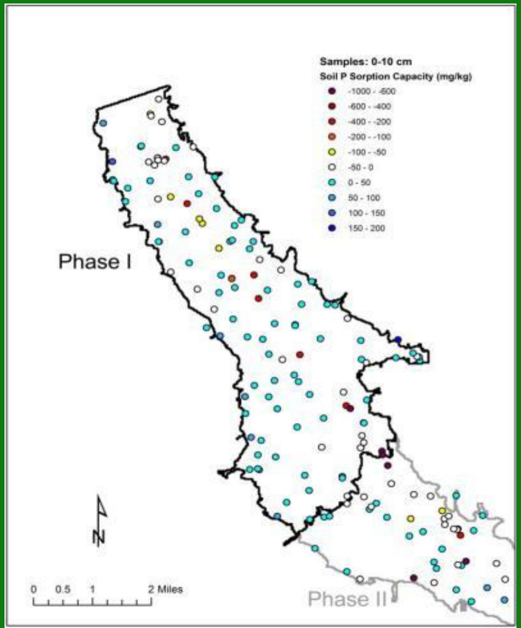

Rationale

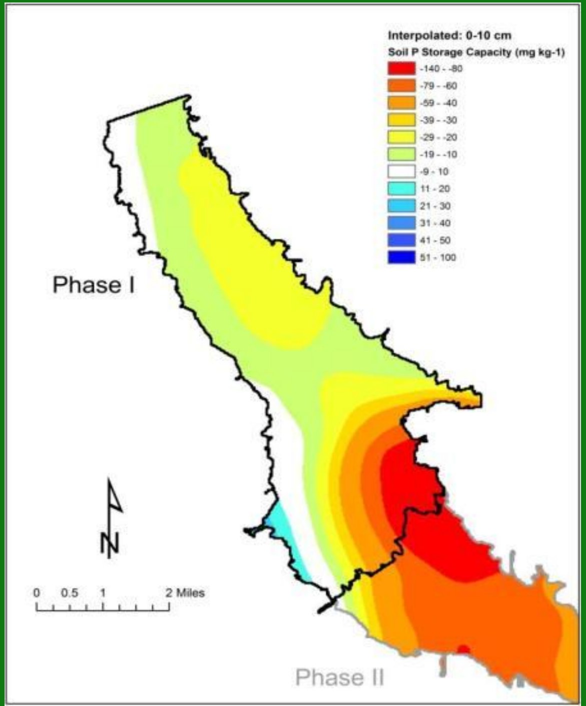
-Establish a baseline condition

-Assess pace of ecosystem response

-Identify trends at ecosystem scale

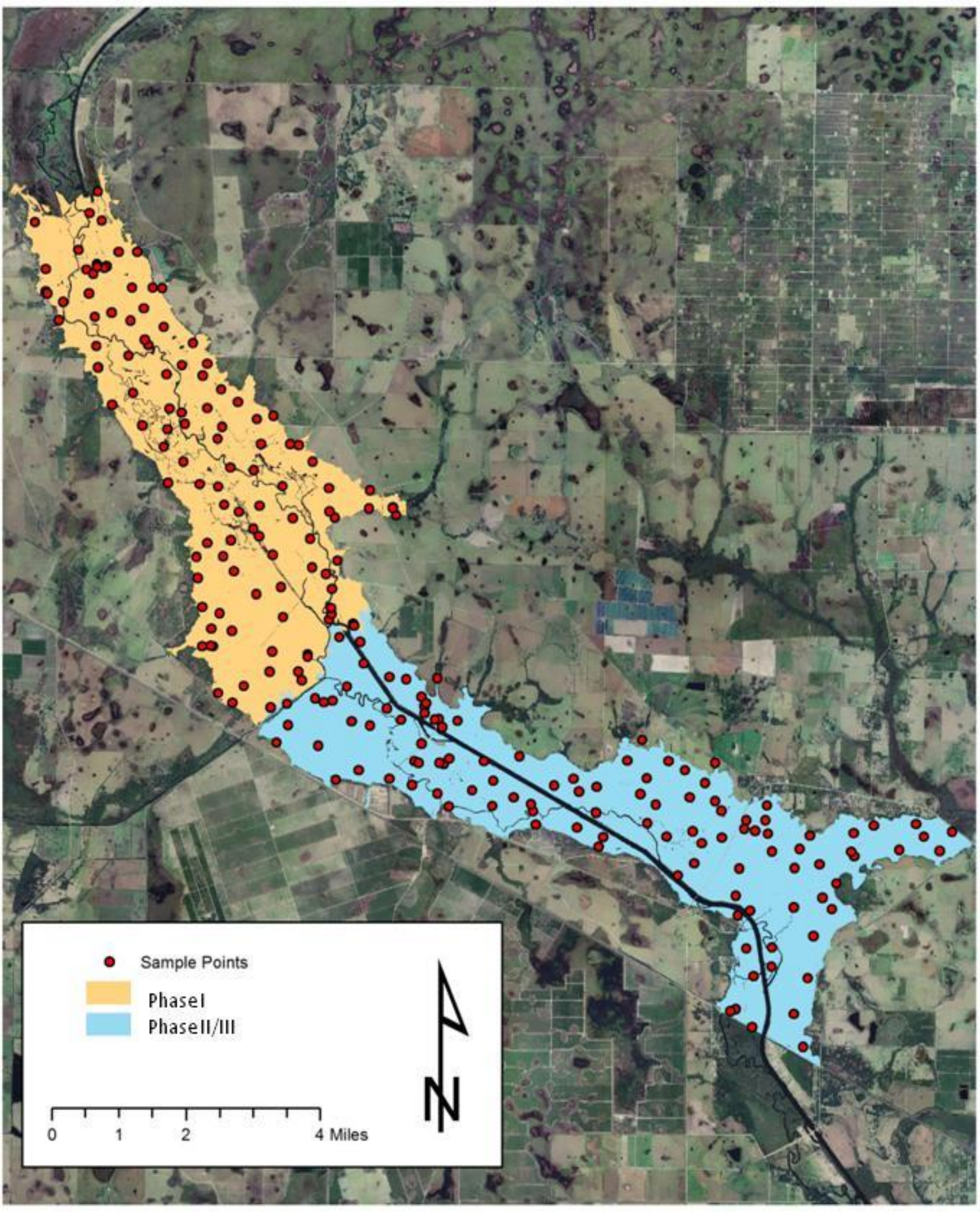
-Enable future assessment of ecosystem restoration success via comparison to baseline condition (= soil performance measure)





Project Objectives

- Survey current status of soil nutrients across Phase I and Phase II/III of the Kissimmee River
- Document baseline condition of soil characteristics for future assessment of restoration success (soil performance measure)
- Establish robust methods to assess soil performance measure which are capable of detecting ecosystem responses to restoration activities



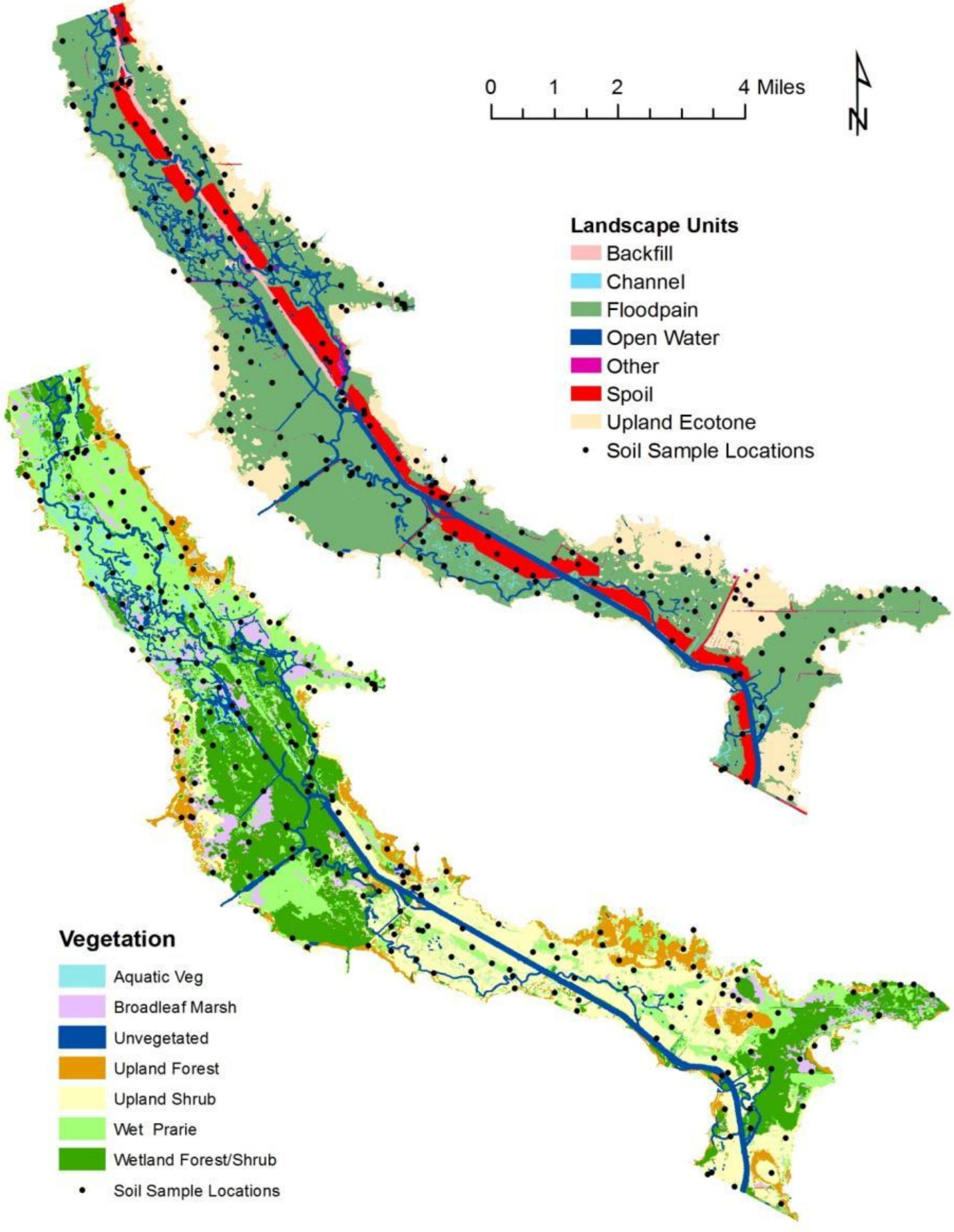
- 115 sites x 2 Phases = 230 sites
- 0-10 & 10-20 cm depths
- Stratified random design

Landscape Unit

- -Backfill
- -Channel
- -Floodplain
- -Spoil Material
- -Upland Ecotone
- -Other

Vegetation Community

- -Aquatic veg
- -Broadleaf Marsh
- -Upland Forest
- -Upland Shrub
- -Wet Prairie
- -Wetland Forest/Shrub

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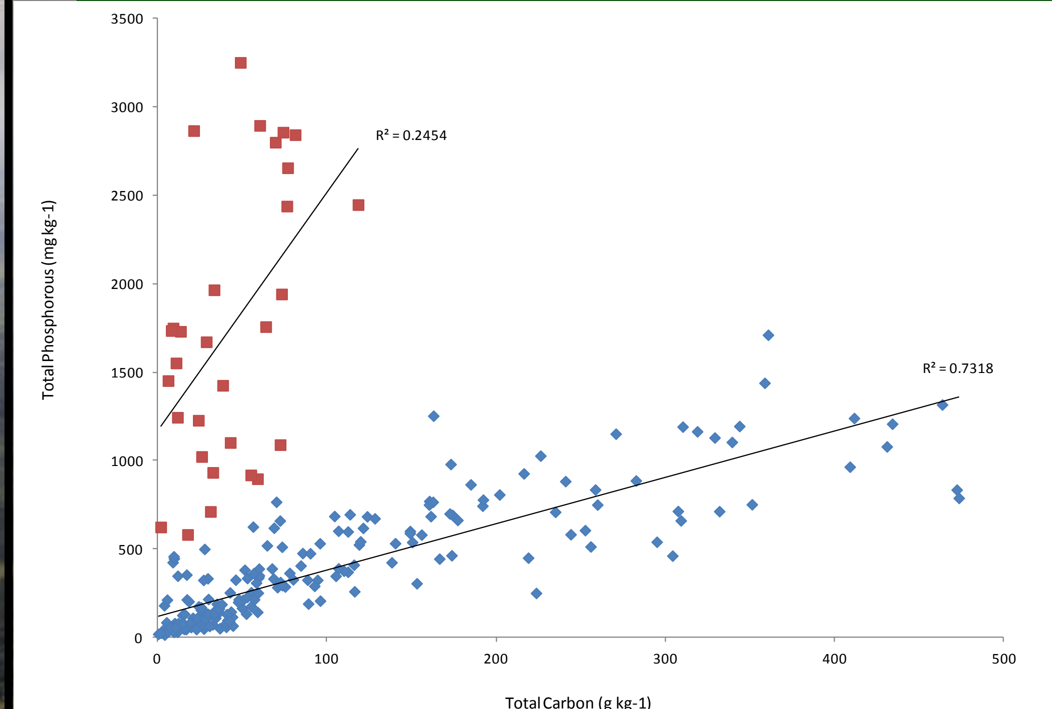
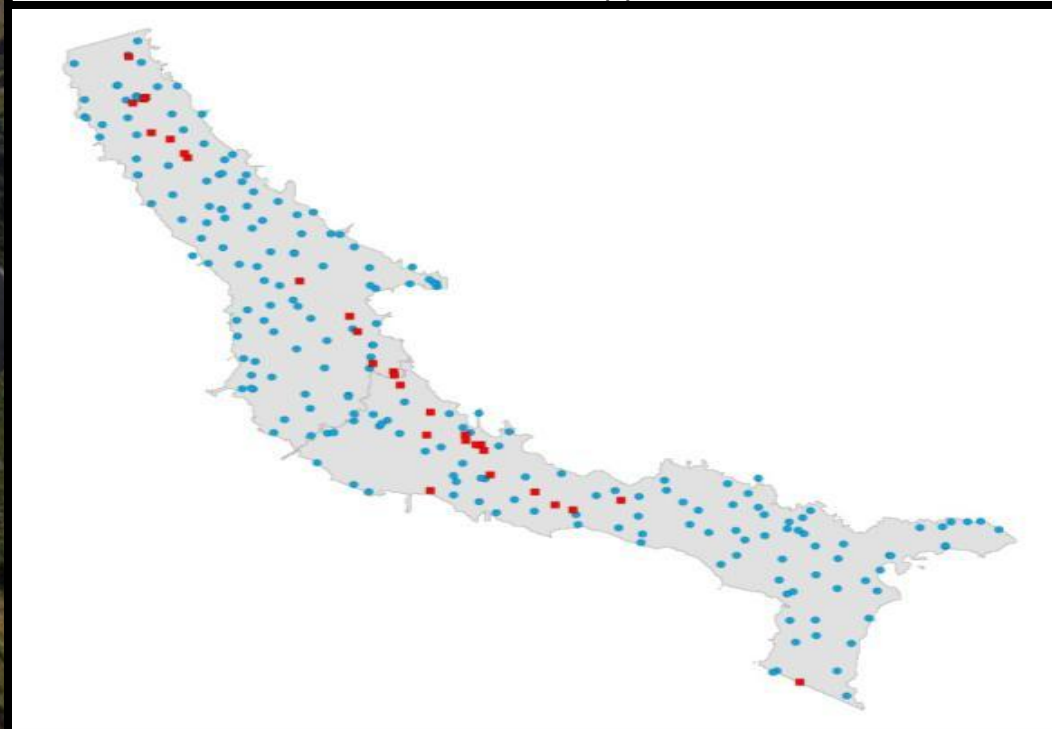
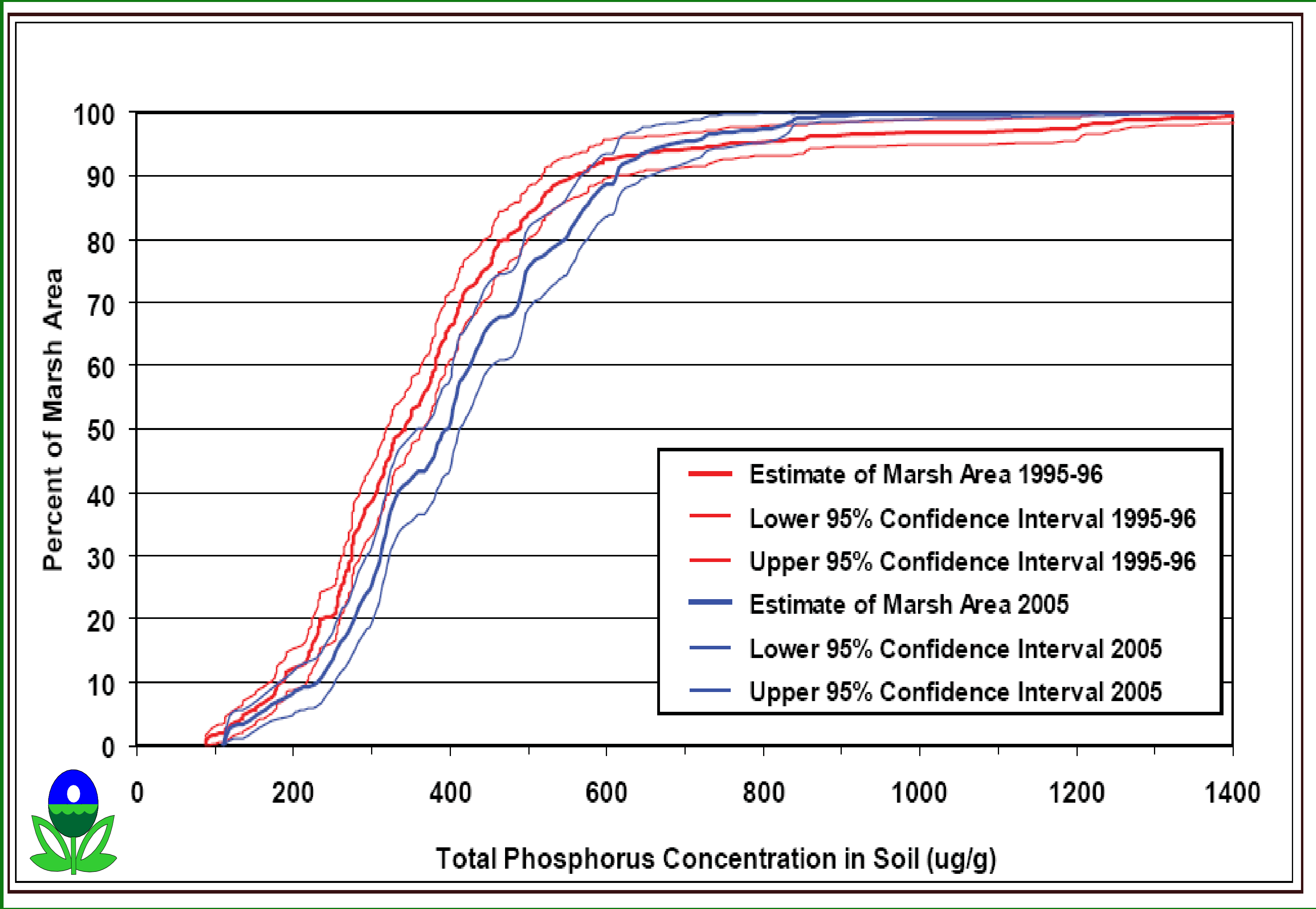
Landscape	N	Stat	pH	LOI (%)	TP (mg kg-1)	TN (g kg-1)	TC (g kg-1)	TCa (mg kg-1)	TMg (mg kg-1)	TFe (mg kg-1)	TAl (mg kg-1)
BF	12	mean	7.5 a	8.6	1001 a	2.46	35.7	16527 ab	781 ab	4029	7838
		SD	0.8	7.5	518	2.60	33.1	13699	397	2463	6174
CH	9	mean	5.5 c	26.5	436 b	9.34	130.4	5121 abc	576 ab	3751	6689
		SD	0.6	30.7	459	10.74	155.3	5174	498	3144	5421
FP	45	mean	5.4 c	26.2	472 b	9.61	126.5	4832 bc	644 ab	4111	8968
		SD	0.8	22.7	389	8.18	116.3	3604	504	3150	7428
OT	13	mean	5.6 c	20.1	385 b	6.94	96.0	4600 bc	703 ab	4491	8682
		SD	1.1	24.1	290	8.28	119.9	5088	676	4005	7926
SP	14	mean	6.6 d	11.3	809 ab	3.34	45.5	18485 a	1629 a	5159	10517
		SD	1.3	13.4	783	4.28	59.3	33857	2926	5034	11004
UE	27	mean	4.4 b	20.8	365 b	7.17	103.8	2445 c	370 b	2355	4219
		SD	0.6	21.0	383	7.88	109.3	2746	415	3002	5675

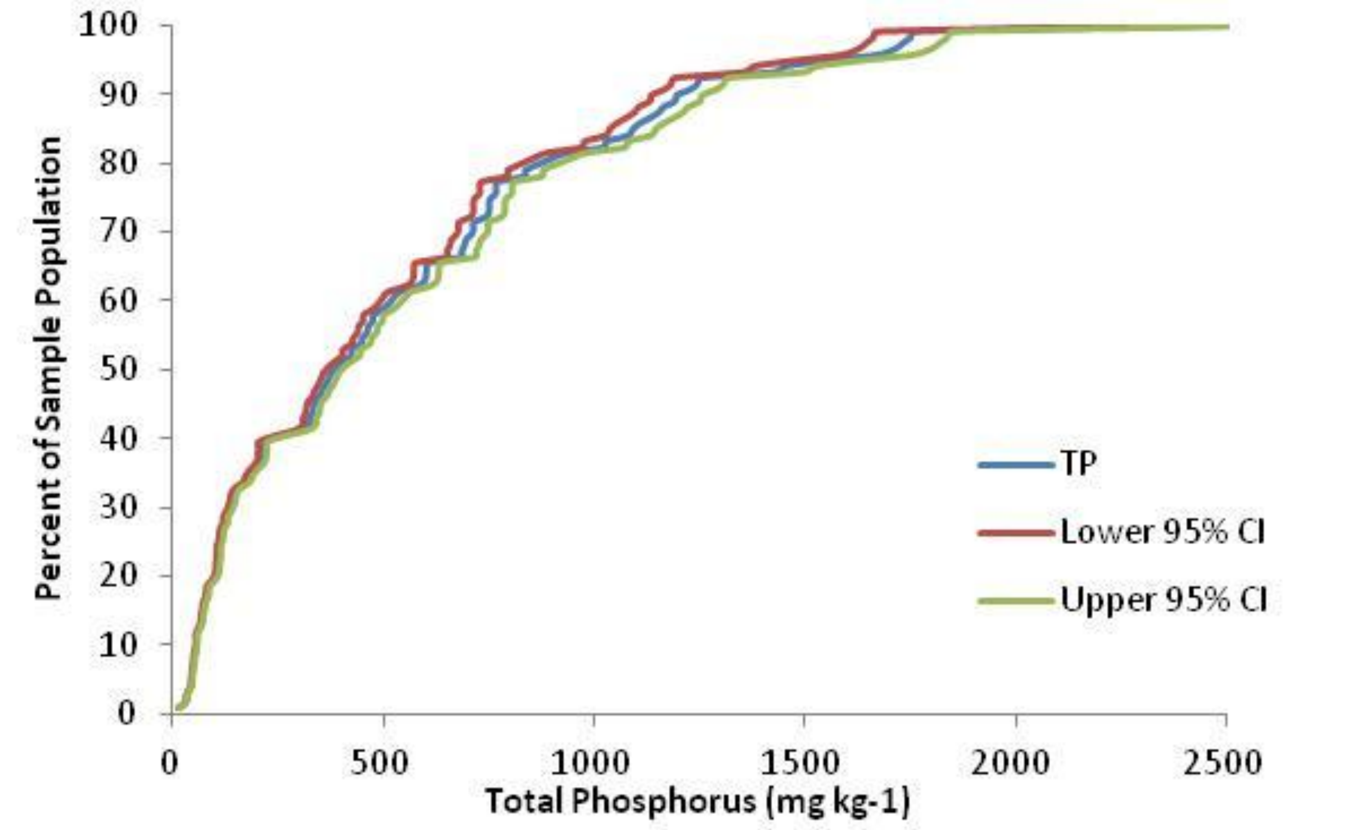

Total Phosphorous (mg kg-1)
Total Carbon (g kg-1)
R² = 0.2454
R² = 0.7318
0
500
1000
1500
2000
2500
3000
3500
0
100
200
300
400
500

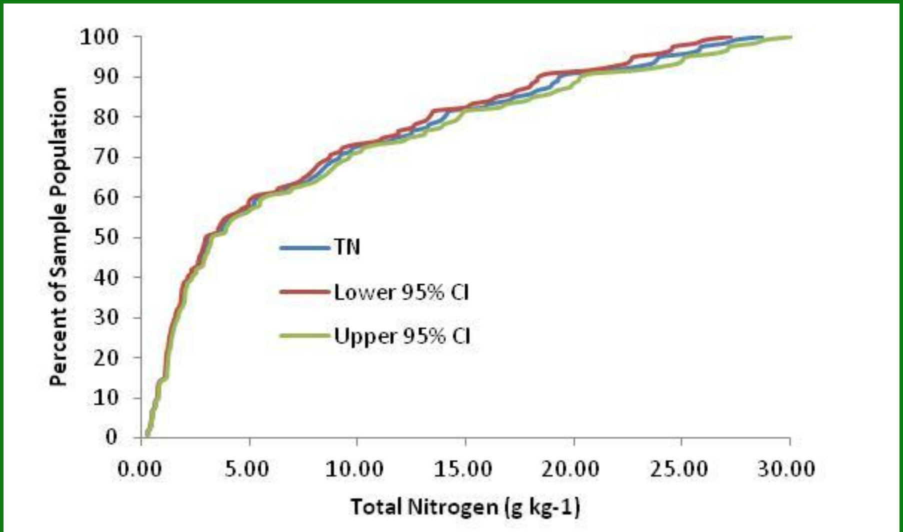


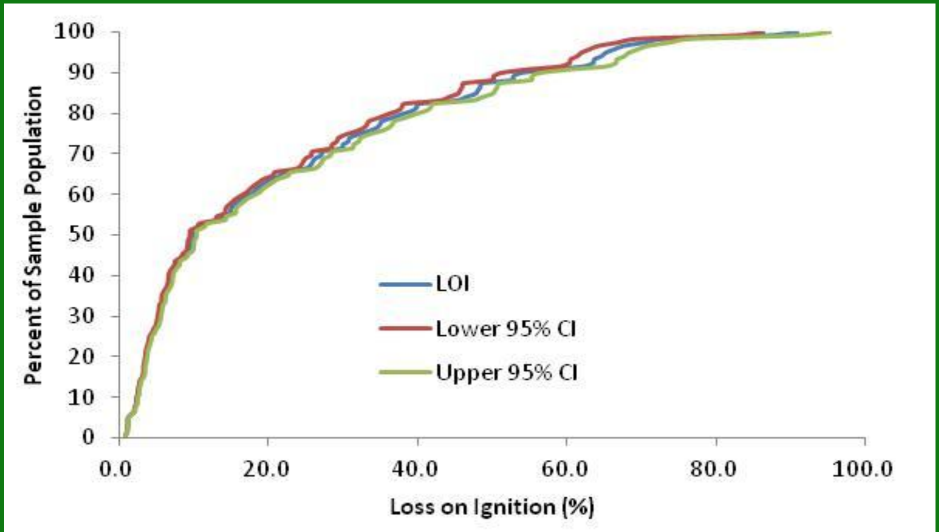
Vegetation Class	N	Stat	pH	BD (g cm-3)	LOI (%)	TP (mg kg-1)	TN (g kg-1)	TC (g kg-1)	TCa (mg kg-1)	TMg (mg kg-1)	TFe (mg kg-1)	TAl (mg kg-1)
AV	15	Mean	5.9	0.5 b	30.3 a	713	11.2 a	147	10390	838	4914 ab	9493 ab
		SD	1.1	0.4	24.6	459	9.6	126	11895	372	2205	4138
BM	16	Mean	5.9	0.6 b	25.6 abc	607	9.3 ab	120	5727	675	4748 ab	10061 a
		SD	1.1	0.3	20.0	425	7.6	99.4	3914	418	3265	5623
UF	18	Mean	5.1	0.9 a	9.9 c	346	3.0 b	47.8	2753	236	1547 c	2708 c
		SD	1.3	0.3	9.8	534	2.9	52.6	3905	246	2323	5387
US	16	Mean	5.3	0.1 a	10.6 bc	390	3.2 b	48.8	4336	348	1979 bc	3198 bc
		SD	1.7	1.0	16.2	474	4.7	77.8	6506	531	2486	4322
WF	25	Mean	5.8	0.5 b	30.1 ab	632	10.5 a	147	11964	1052	5250 a	9945 a
		SD	1.1	0.3	25.3	525	8.9	131	24504	1251	4102	8366
WP	29	Mean	5.7	0.7 ab	18.5 abc	505	6.6 ab	87.3	6222	894	4156 abc	9630 ab
		SD	1.0	0.4	21.2	484	7.8	110	10764	1826	3632	9293



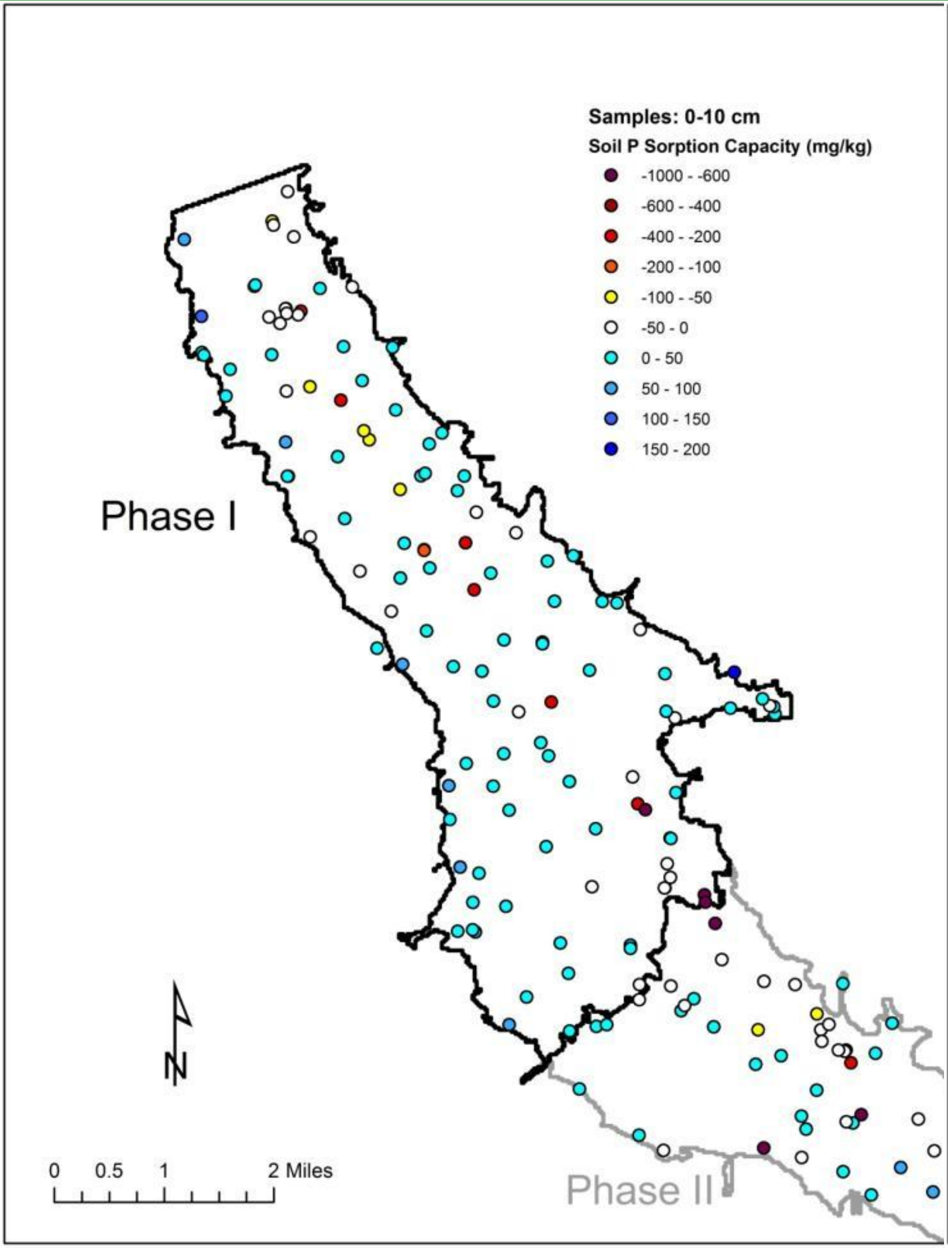
From Scheidt and Kalla (2007)

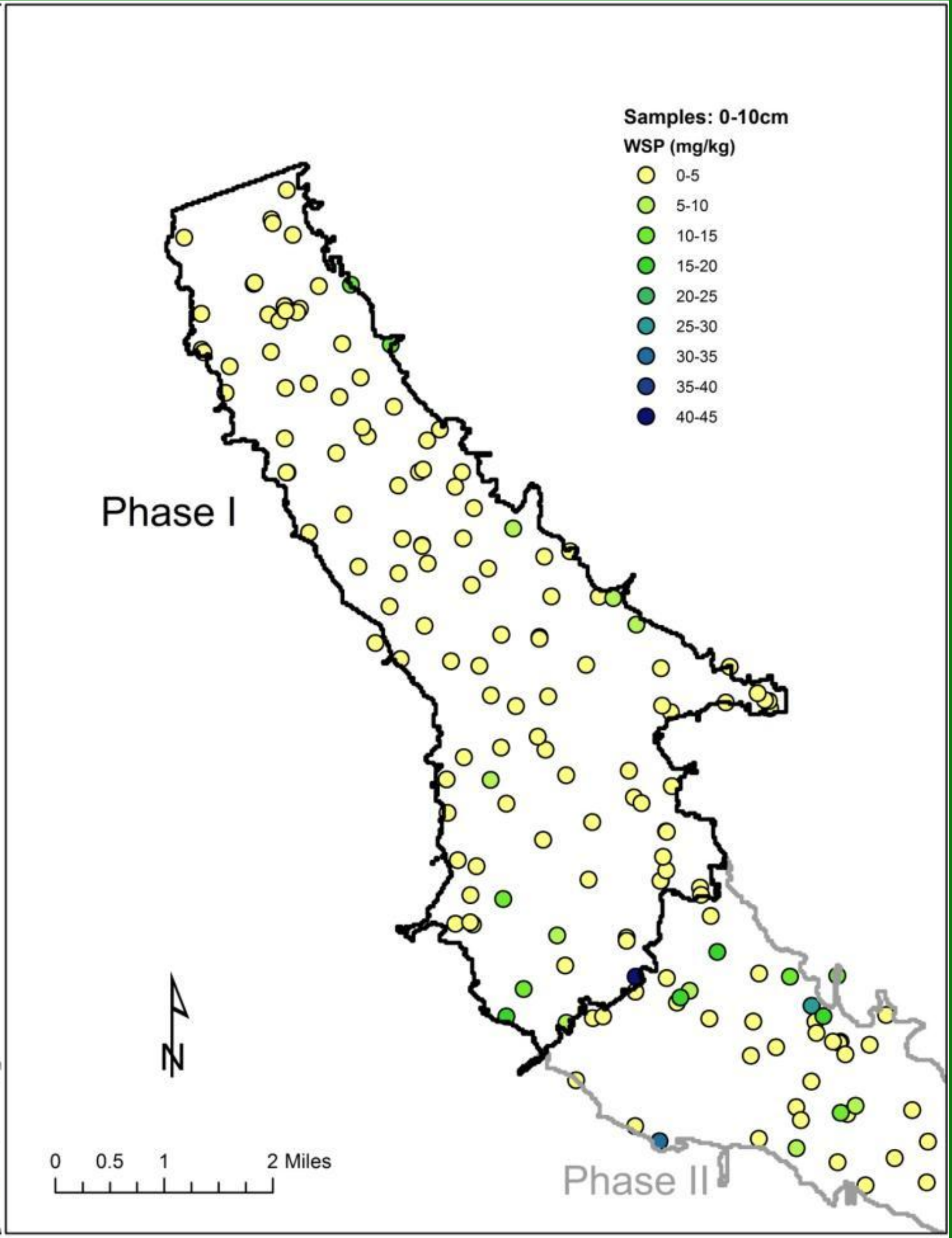

Percent of Sample Population
Total Phosphorus (mg kg-1)
TP
Lower 95% CI
Upper 95% CI
0
10
20
30
40
50
60
70
80
90
100
0
500
1000
1500
2000
2500


Percent of Sample Population
Total Nitrogen (g kg-1)
TN
Lower 95% CI
Upper 95% CI
0
10
20
30
40
50
60
70
80
90
100
0.00
5.00
10.00
15.00
20.00
25.00
30.00

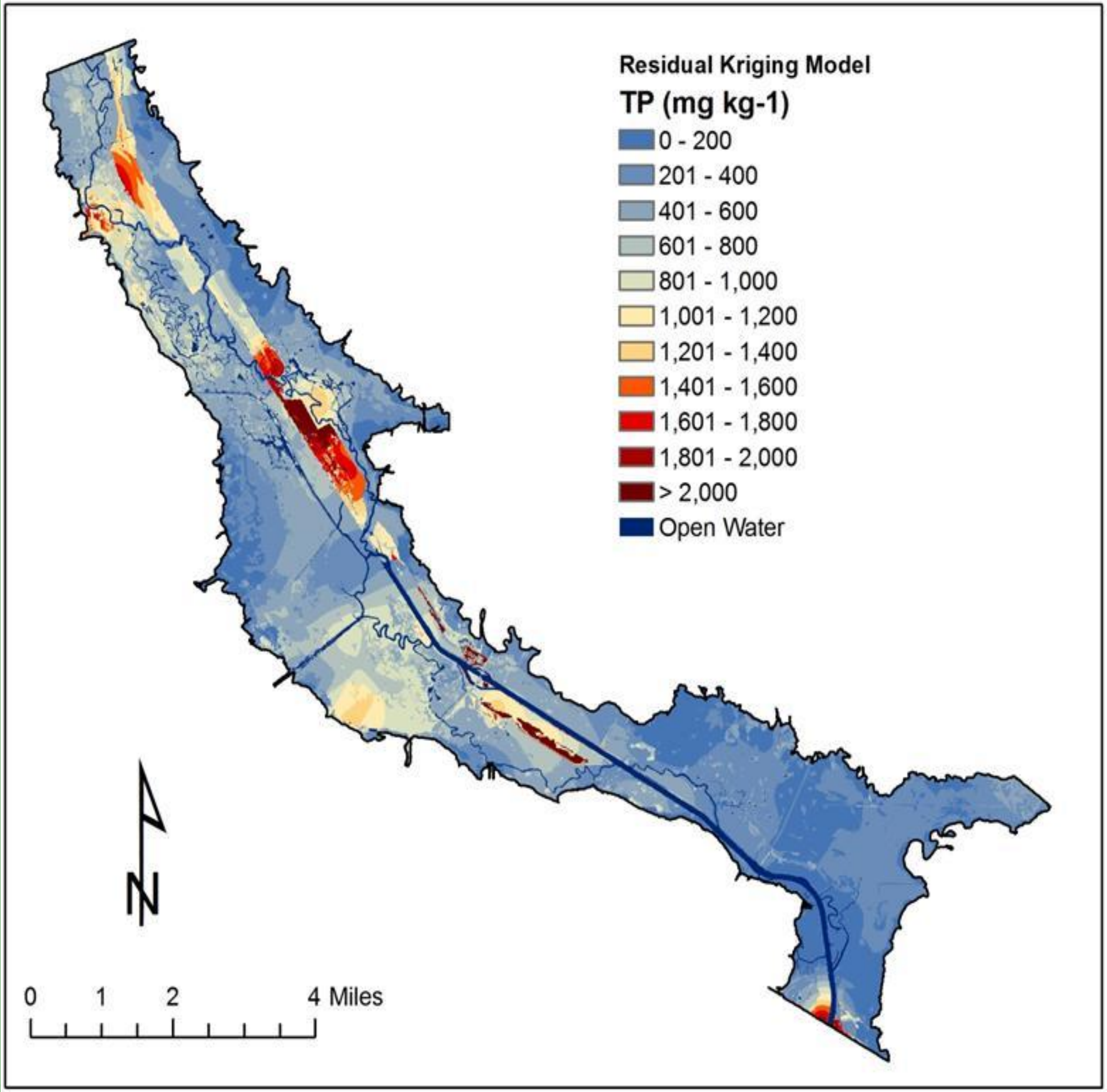

Percent of Sample Population
Loss on Ignition (%)
LOI
Lower 95% CI
Upper 95% CI
0
10
20
30
40
50
60
70
80
90
100
0.0
20.0
40.0
60.0
80.0
100.0

Soil Phosphorus Storage Capacity

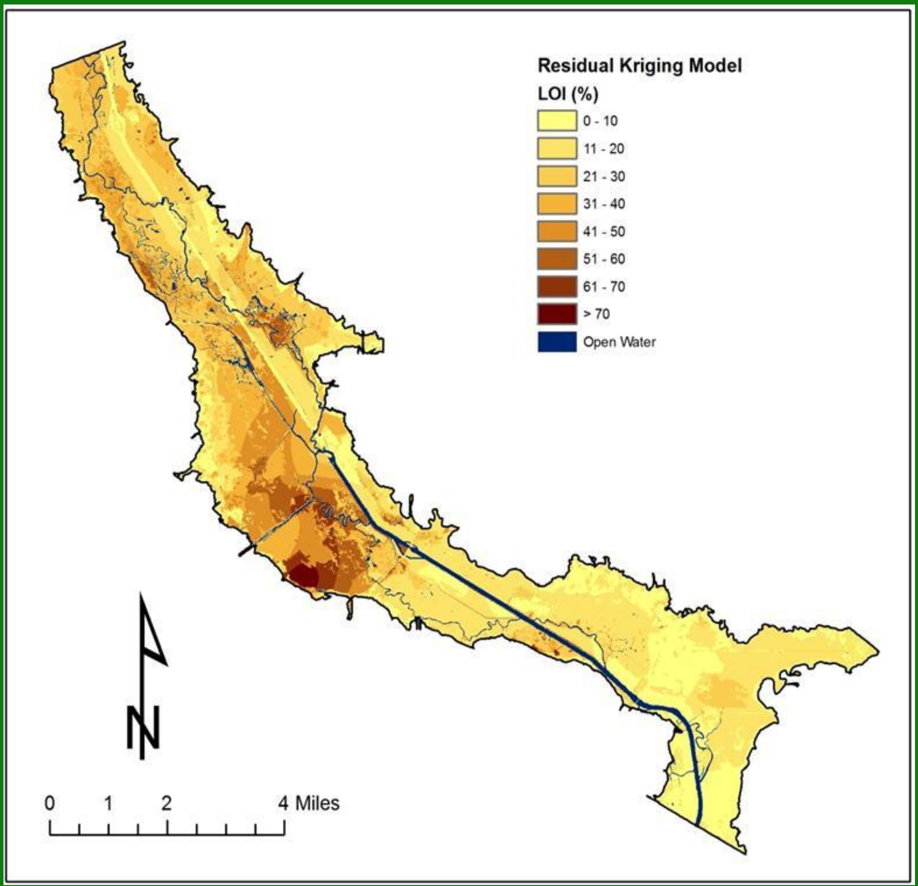




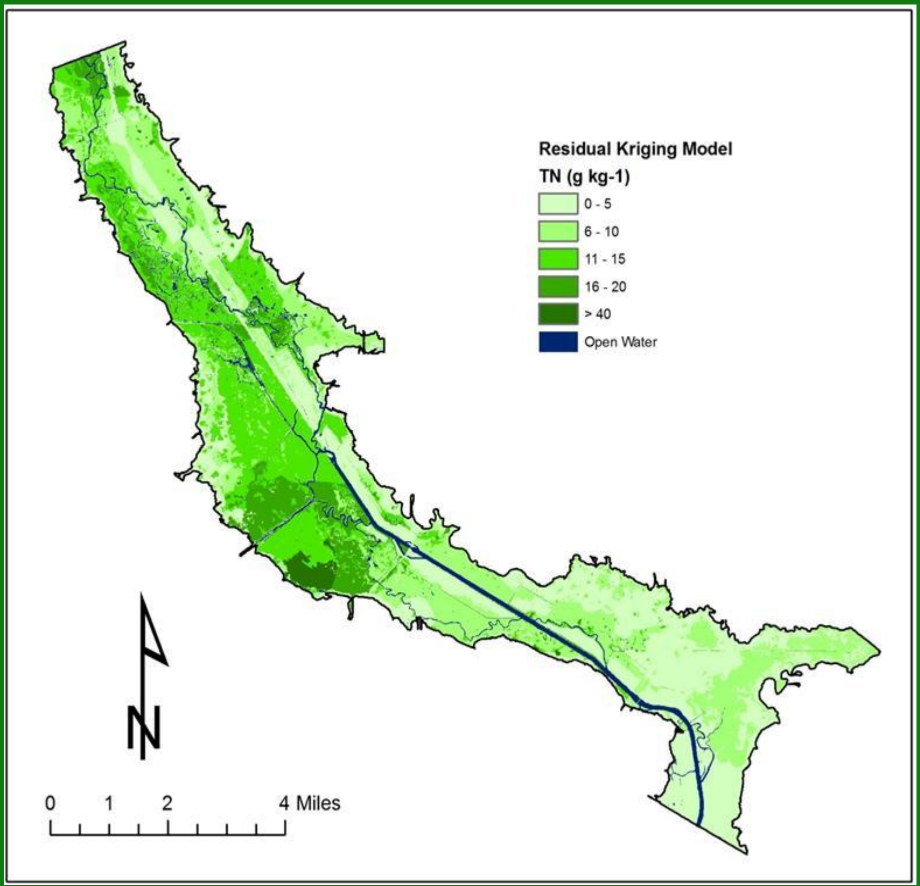
Total Phosphorus ($mg\ kg^{-1}$)



Loss on Ignition (%)



Total Nitrogen ($mg\ kg^{-1}$)



Conclusions

- Likely too soon to see differences between some landscape units and vegetation communities with respect to soil nutrients
- Expect soils to accumulate OM as floodplain wetlands mature
- Spoil material TP significantly higher than other soils
  - SPSC suggests higher flux potential
  - low WSP suggests P stability

Conclusions

- Observed marked changes in restored channel sediments (reduction in OM)
- Observed OM accretion in some portions of the restored floodplain
- CDF's are anticipated to:

  -provide a quantitative measure of change in soil properties over time

  -support interpretation of geostatistical analyses

Conclusions

- Residual Kriging models were more accurate than Ordinary or Universal Kriging interpolations
- Successful in documenting current baseline conditions
- Provide quantitative and qualitative methods to make comparisons to future surveys enabling assessment of restoration success

2011 “Kissimmee Torture Summit” Attendees

- Justin Vogel
- Chris Longman
- MJ Carnevale
- Matt Norton
- Bryce Van Dam

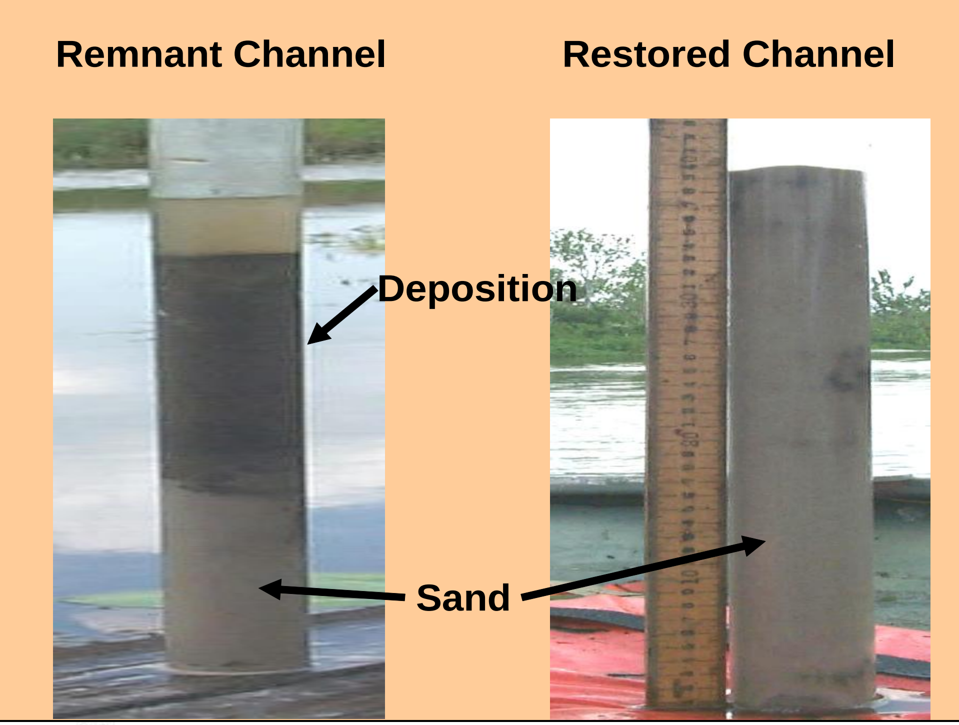

Thank You
For more info on Kissimmee River Restoration visit: www.sfwmd.gov

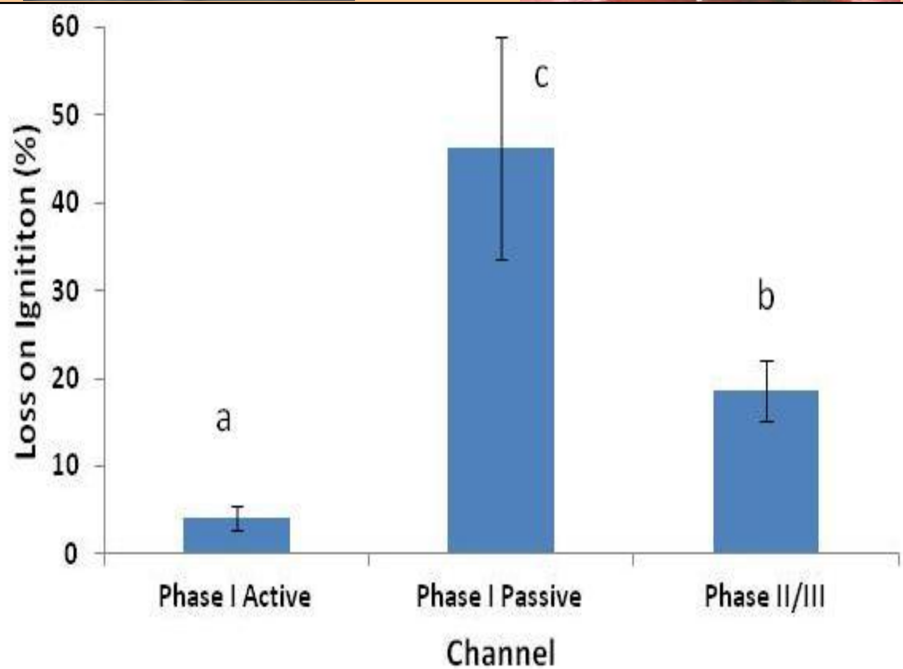
July 2011

Photograph by Brent Anderson

October 2011

Photograph by Brent Anderson





Expectation

-Significant reduction in channel sediments OM content when flow restored

Observation

-Restored active channel sediments very low OM

-Passive channels still high in OM content