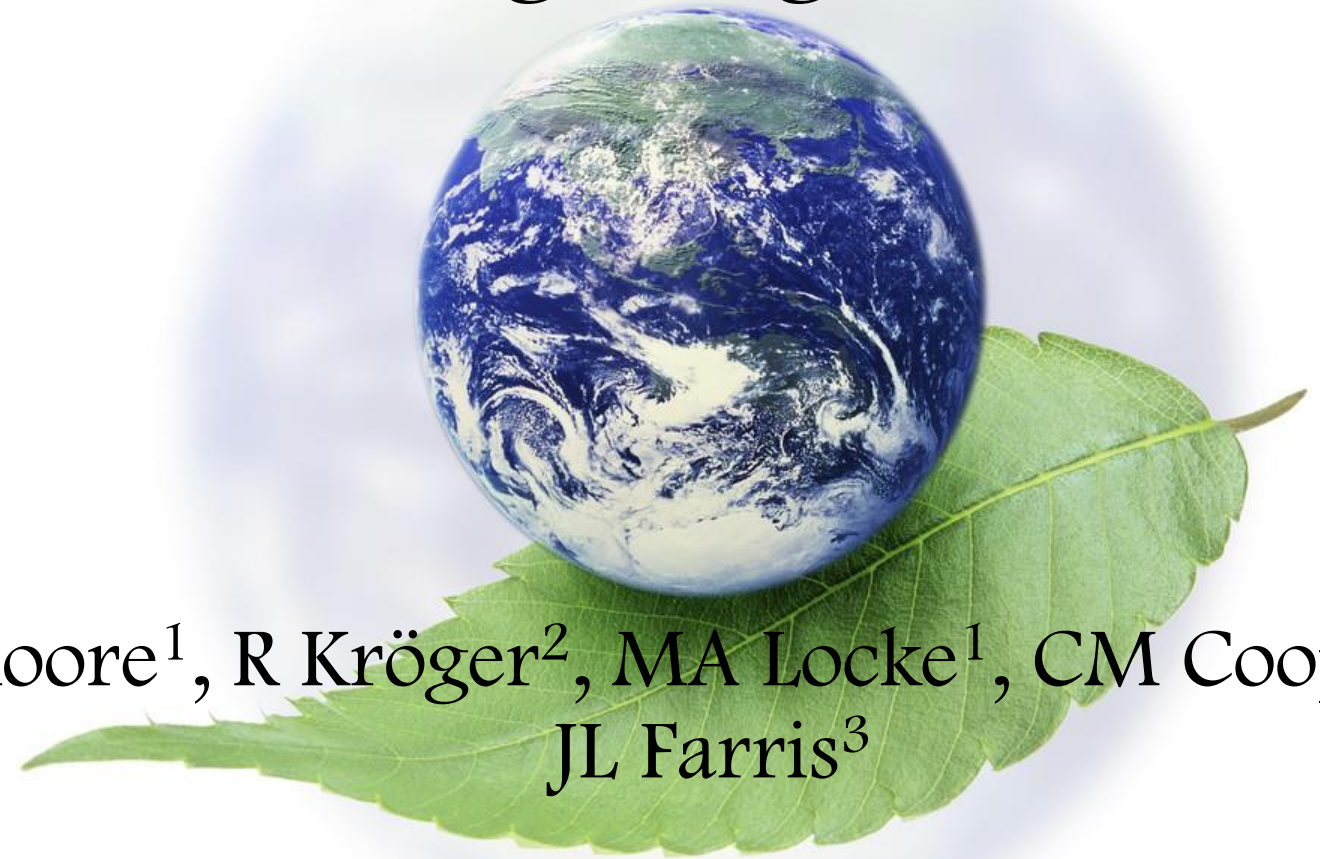
Going Green: Using Wetlands and Ditches to Mitigate Agricultural Runoff



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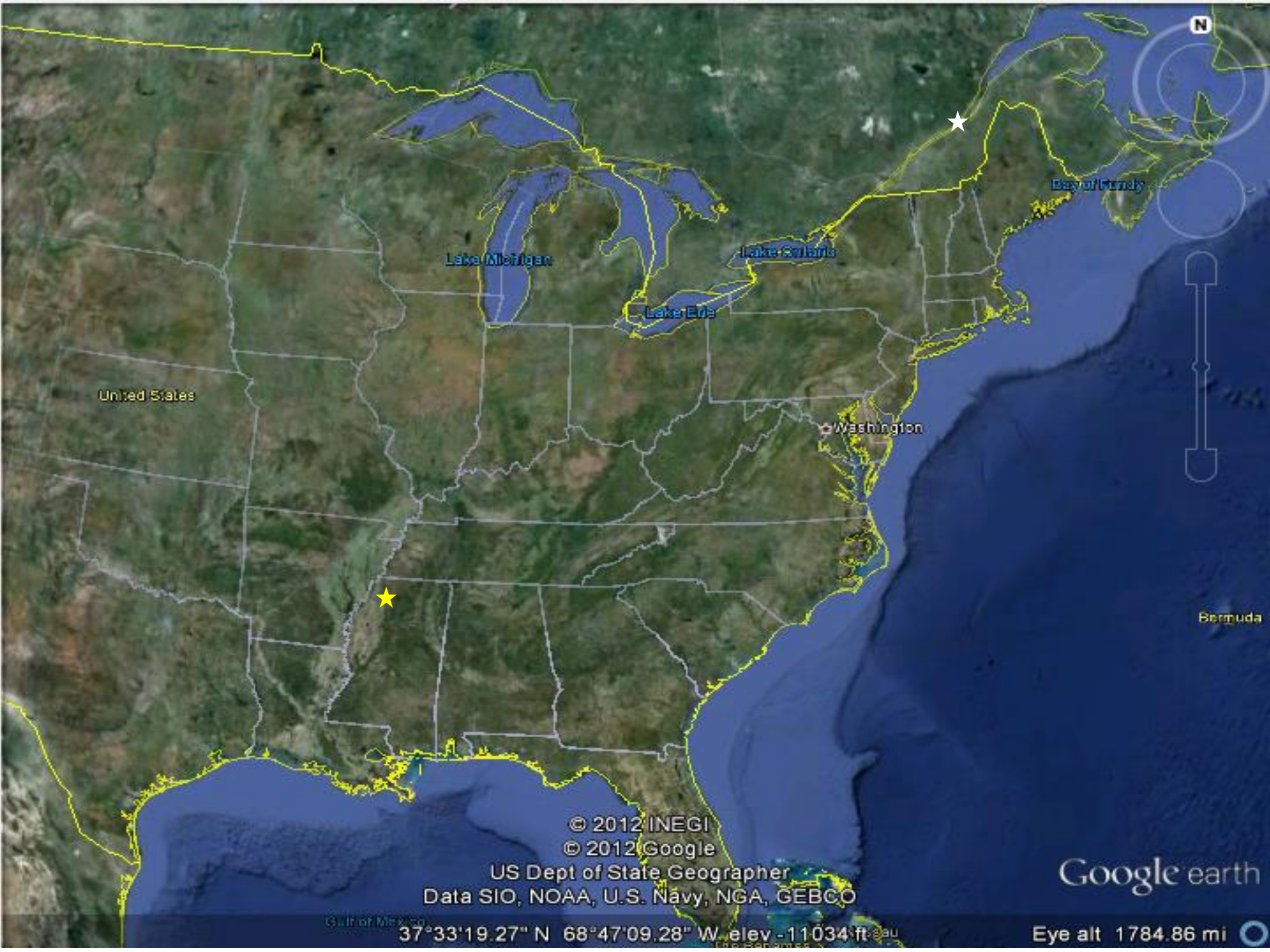
[3]Department of Biology, Arkansas State University, State University, AR USA


Lake Michigan
Lake Erie
Bay of Fundy
United States
Washington
Bermuda
© 2012 INEGI
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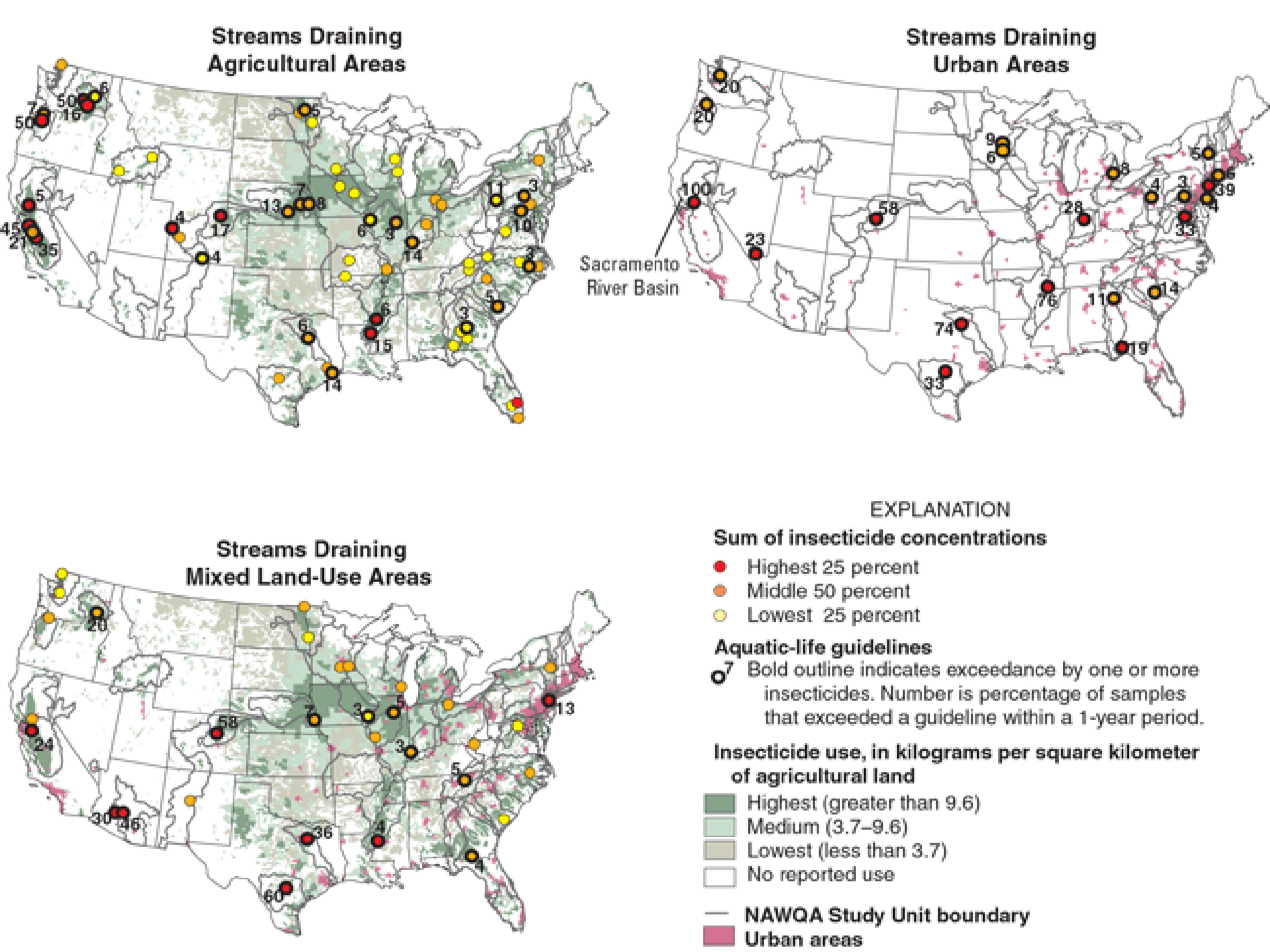
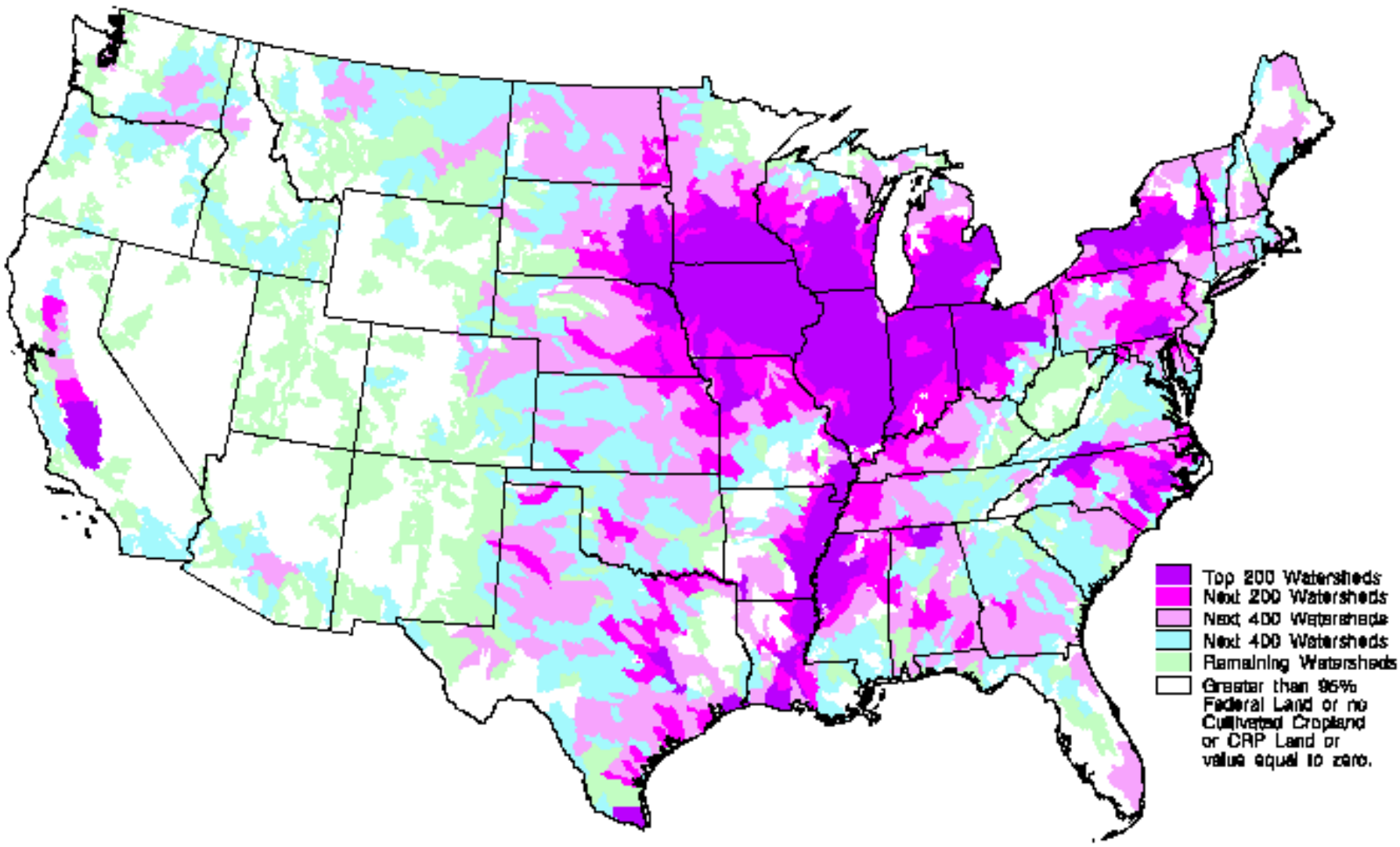
US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
37°33'19.27" N 68°47'09.28" W elev -11034 ft
Eye alt 1784.86 mi

Ocean Spray®


Streams Draining
Agricultural Areas
Streams Draining
Urban Areas
Sacramento
River Basin
Streams Draining
Mixed Land-Use Areas
EXPLANATION
Sum of insecticide concentrations
Highest 25 percent
Middle 50 percent
Lowest 25 percent
Aquatic-life guidelines
Bold outline indicates exceedance by one or more insecticides. Number is percentage of samples that exceeded a guideline within a 1-year period.
Insecticide use, in kilograms per square kilometer of agricultural land
Highest (greater than 9.6)
Medium (3.7–9.6)
Lowest (less than 3.7)
No reported use
NAWQA Study Unit boundary
Urban areas

Potential Pesticide Dissolved Runoff Loss from Farm Fields



Corn, Wheat, Soybeans, Cotton, Barley, Sorghum, Rice, Oats, Peanuts, Potatoes, Beets, Sunflowers, and Tobacco

U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment and Strategic Planning Division
Map ID: SMW.2271 June 1998

Important Keys for Risk Mitigation

- **Frequency of pollutant**
  (How often)

- **Intensity of pollutant**
  (How much)

- **Duration of pollutant**
  (How long each time)

IN-FIELD & EDGE-OF-FIELD BMPs

Winter cover crops

Stiff-grass hedges

Constructed wetlands

Conservation tillage

Slotted-inlet pipes

Grassed waterway

UMFS Constructed Wetlands PESTICIDES

- Constructed wetland studies on pesticide mitigation since 1996

- Initial studies looked at wetland mitigation of chlorpyrifos, atrazine, and metolachlor based on 3 runoff scenarios (0.5%, 1%, and 5%)

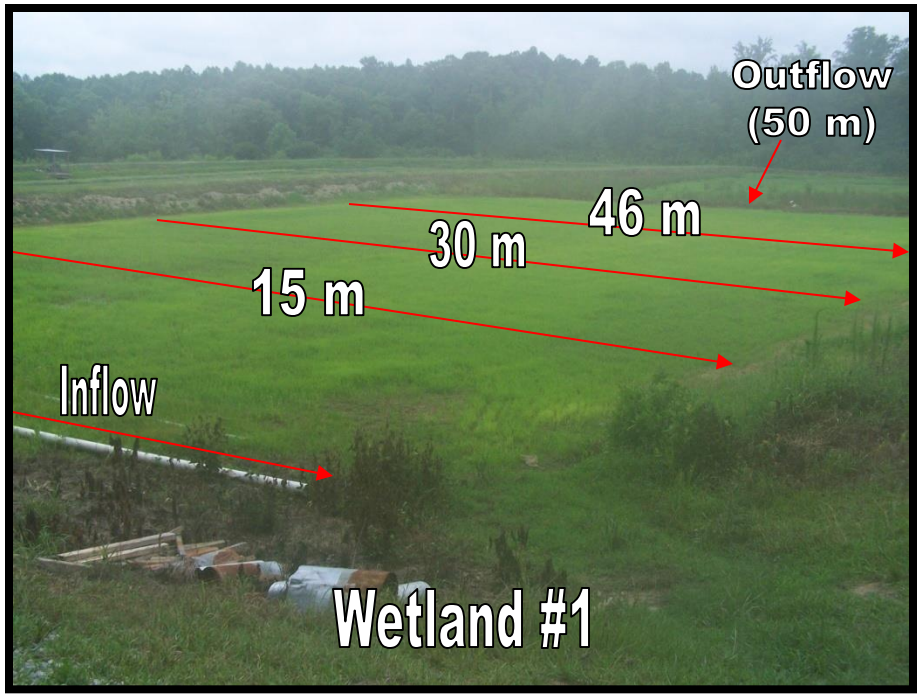
- Objective was to determine length of wetland buffer needed for mitigation of pesticides

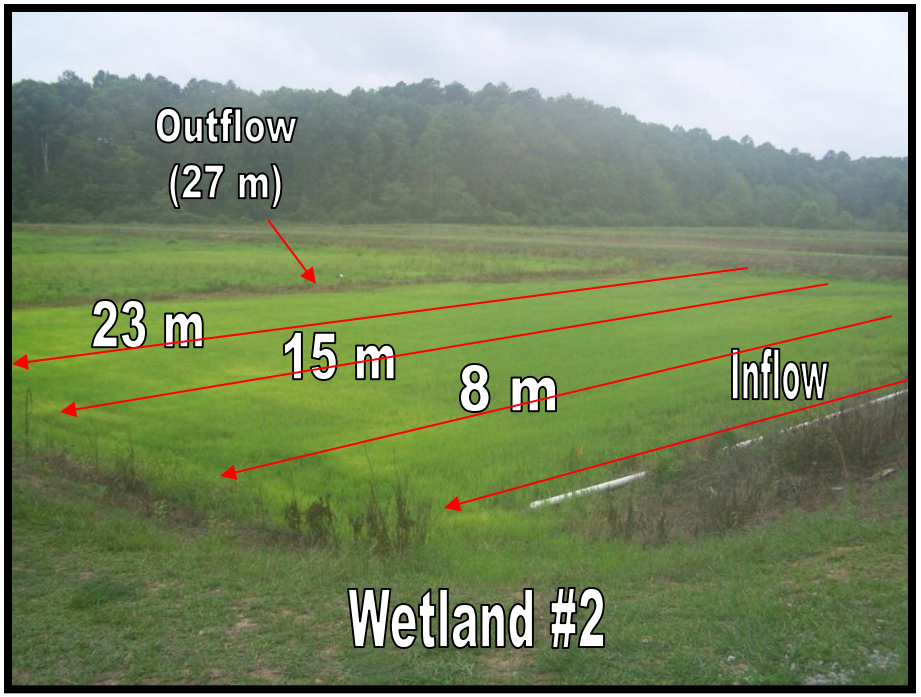
- Later studies looked at methyl parathion mitigation in ponds with and without vegetation

UMFS Constructed Wetlands
PESTICIDES

	Buffer length needed for mitigation
Chlorpyrifos	184-230 m
Atrazine	101-281 m
Metolachlor	100-400 m
Methyl Parathion (plants)	18.8 m
Methyl Parathion (no plants)	62.9 m

Methods

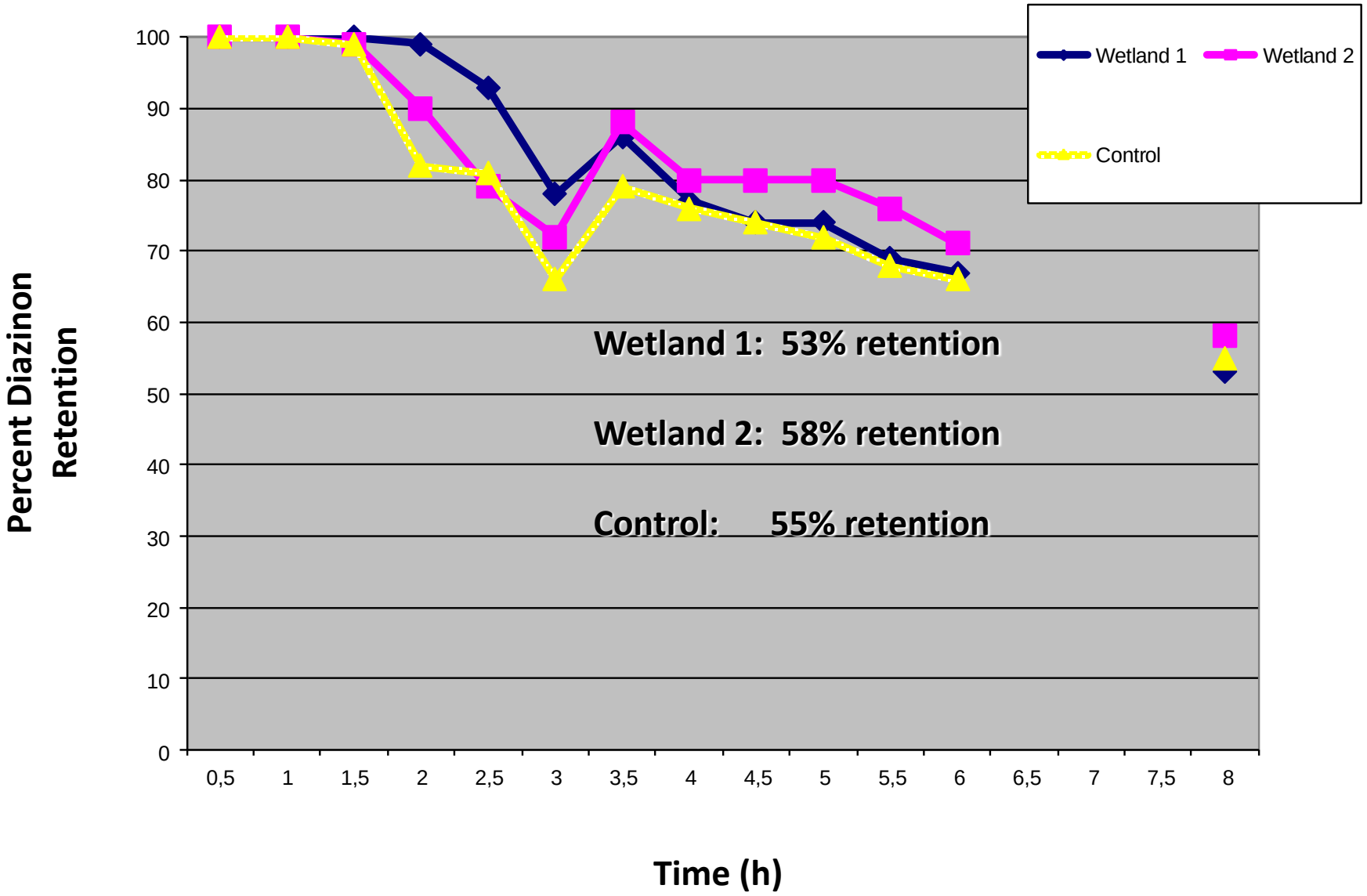

Outflow
(50 m)
46 m
30 m
15 m
Inflow
Wetland #1


Outflow
(27 m)
23 m
15 m
8 m
Inflow
Wetland #2

Results

- **Mass Partitioning**
  - **Wetland 1: 53 ± 4% WATER**
    44 ± 4% SEDIMENT
    2 ± 0% PLANT
  - **Wetland 2: 66 ± 5% WATER**
    31 ± 4% SEDIMENT
    3 ± 1% PLANT
  - **Control: 38 ± 7% WATER**
    62 ± 7% SEDIMENT

Results


Wetland 1
Wetland 2
Control
Wetland 1: 53% retention
Wetland 2: 58% retention
Control: 55% retention
Percent Diazinon Retention
Time (h)
100
90
80
70
60
50
40
30
20
10
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5
5,5
6
6,5
7
7,5
8

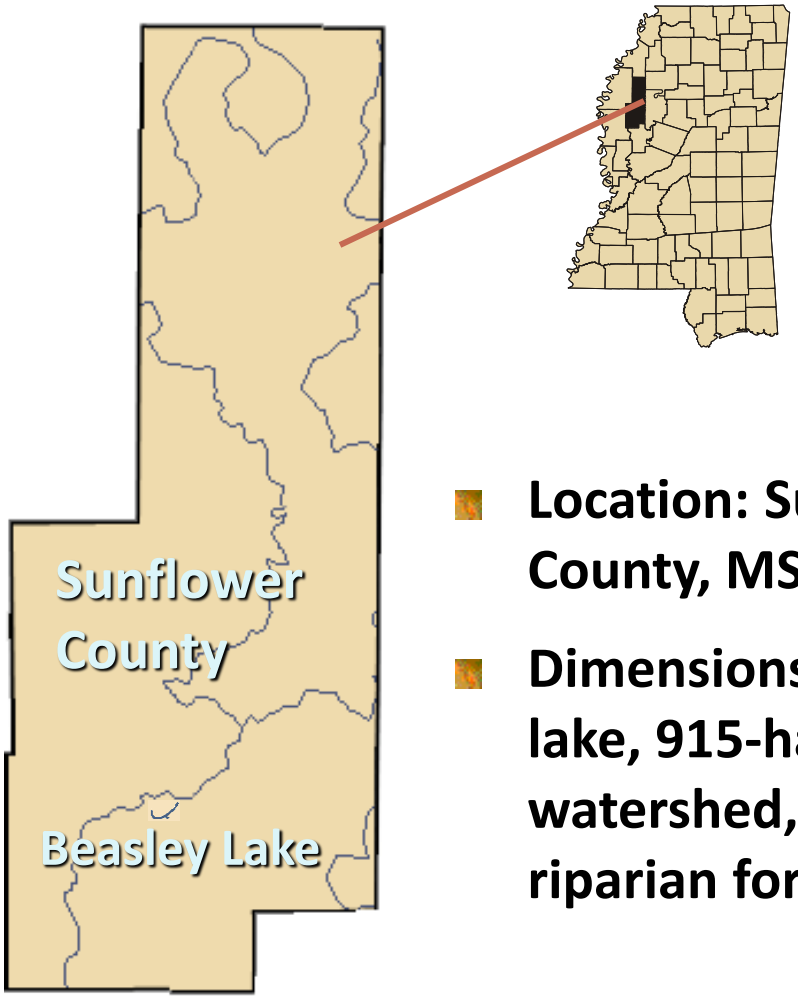
Discussion

- **Diazinon stability influenced by pH**
  - **Wetland system pH = 6**
  - **pH 7 = diazinon half-life is 138 d**
  - **pH 5 = diazinon half-life is 12 d**

- **Why not better uptake by rice?**
  - **Too late during life cycle?**
  - **Other studies have shown at least limited uptake by rice when applied to a field**

Future studies focus on exposure during active growing season, increasing wetland HRT, manipulating water depth, microbial activity

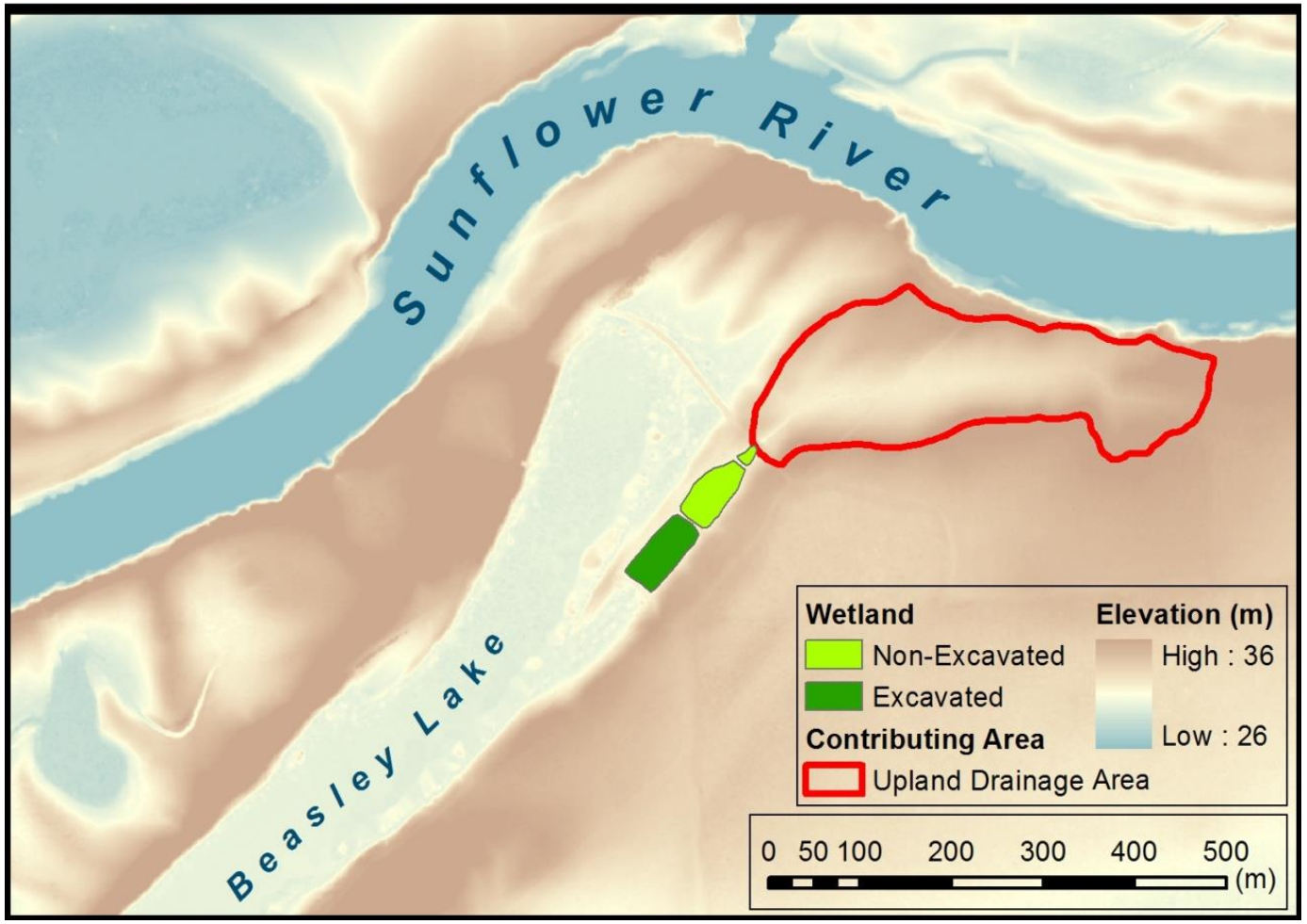
Beasley Lake Watershed



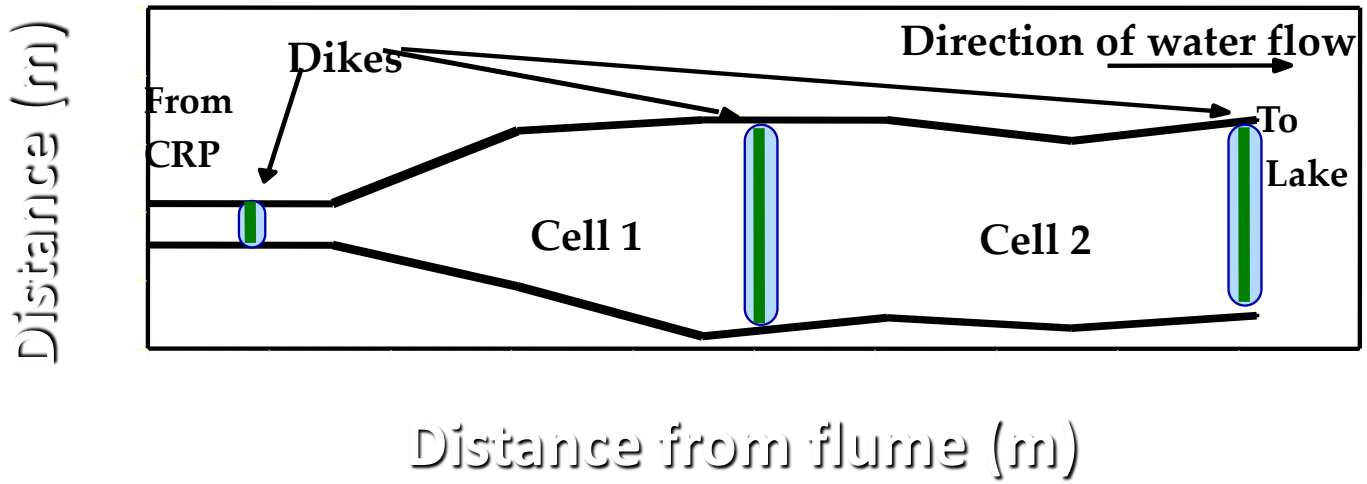
- **Location: Sunflower County, MS**
- **Dimensions: 25-ha lake, 915-ha watershed, 135-ha riparian forest**

Constructed Wetlands

BEASLEY LAKE, MS



Beasley Lake Constructed Wetland



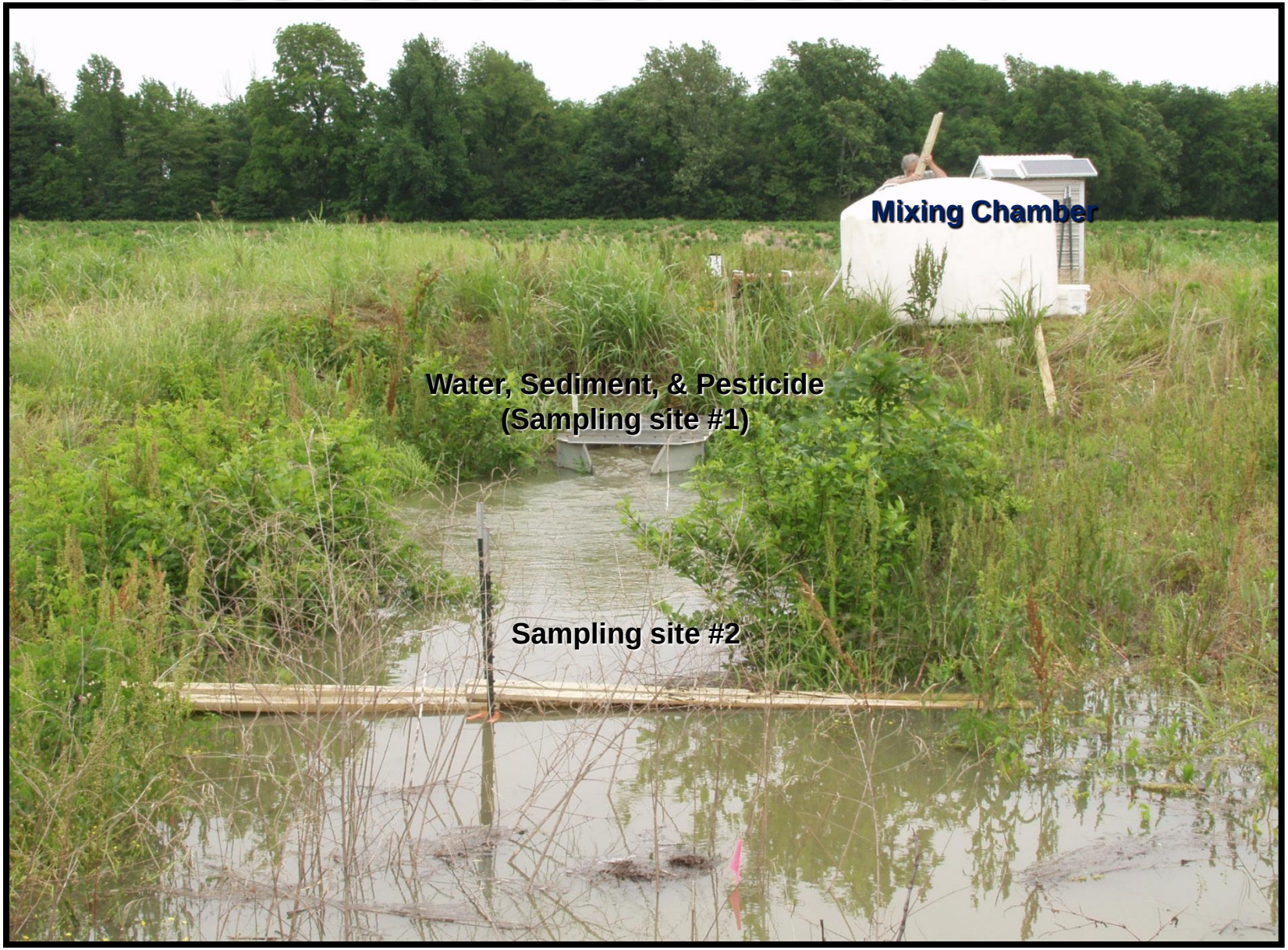
Materials & Methods

- **Mixture (diazinon, cyfluthrin, lambda-cyhalothrin & suspended sediment) amended for 4 hours**

- **Amount of pesticide used based on…**
  - **Recommended application rate**
  - **Wetland contributing area (35 acres)**
  - **Assumed 1% pesticide runoff**
    - **Rainfall based on 0.51” event with 50% runoff**

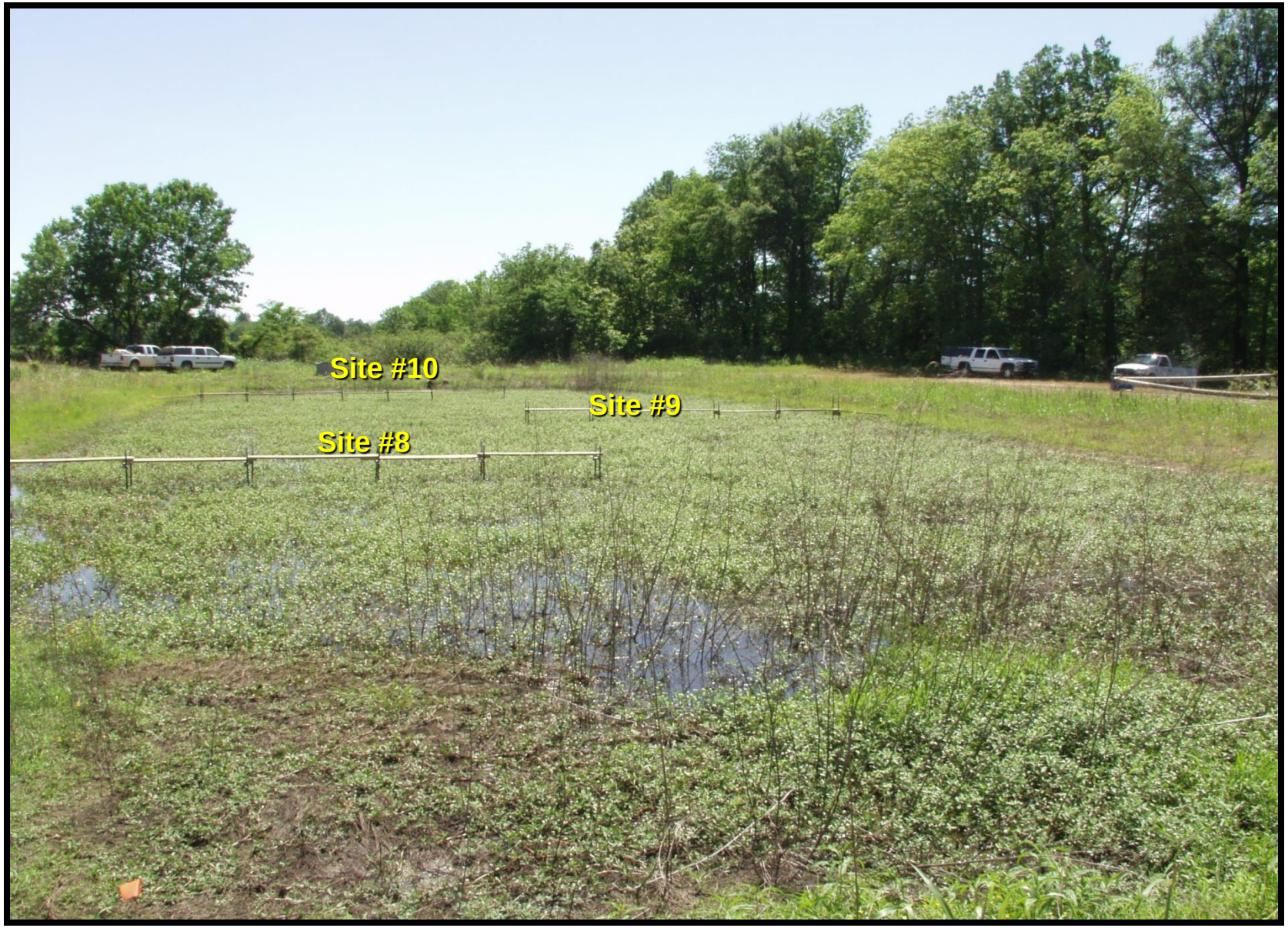
Simulated Runoff

Constructed Wetland



Constructed Wetland

Constructed Wetland



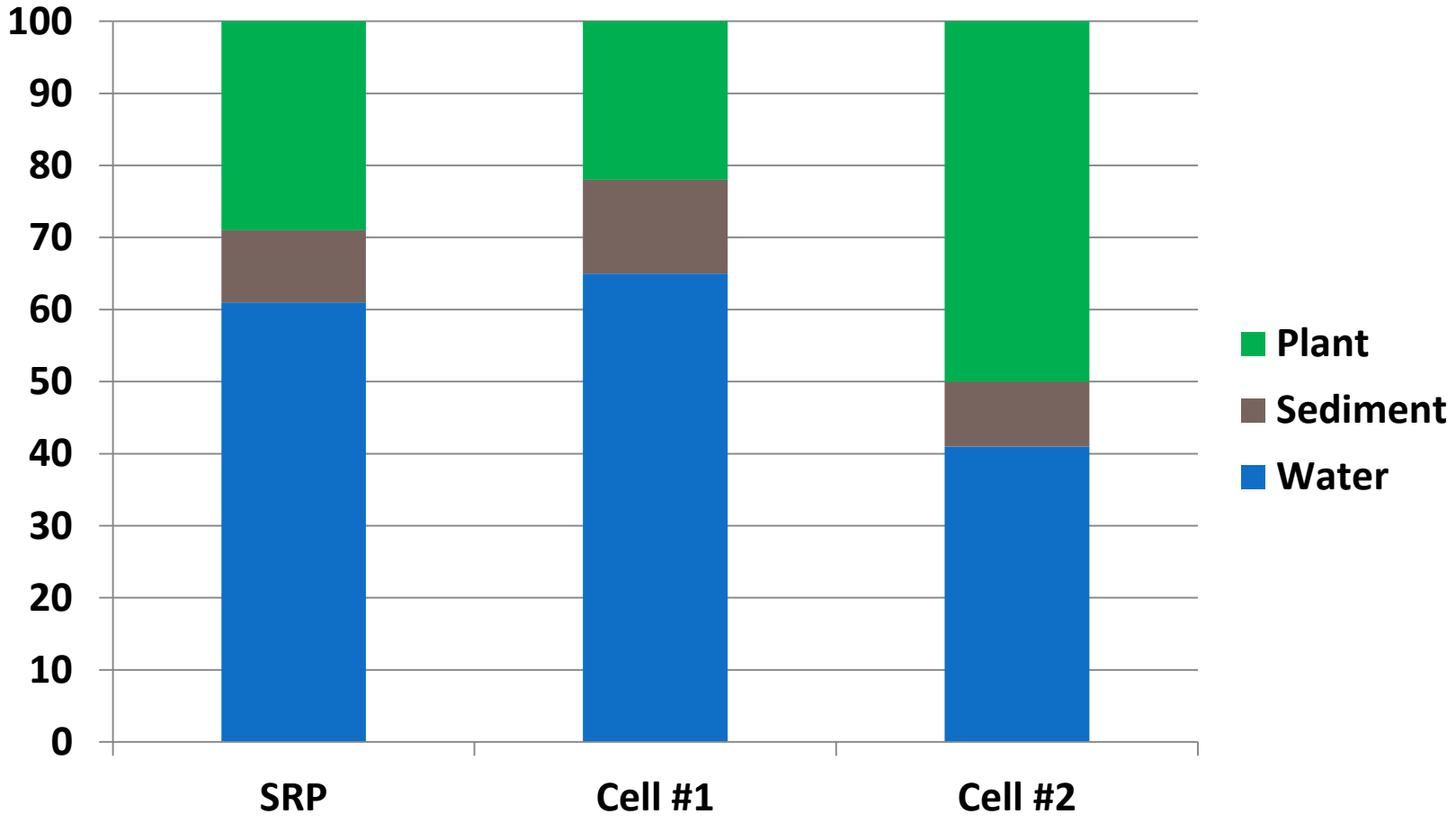
Constructed Wetlands

BEASLEY LAKE, MS

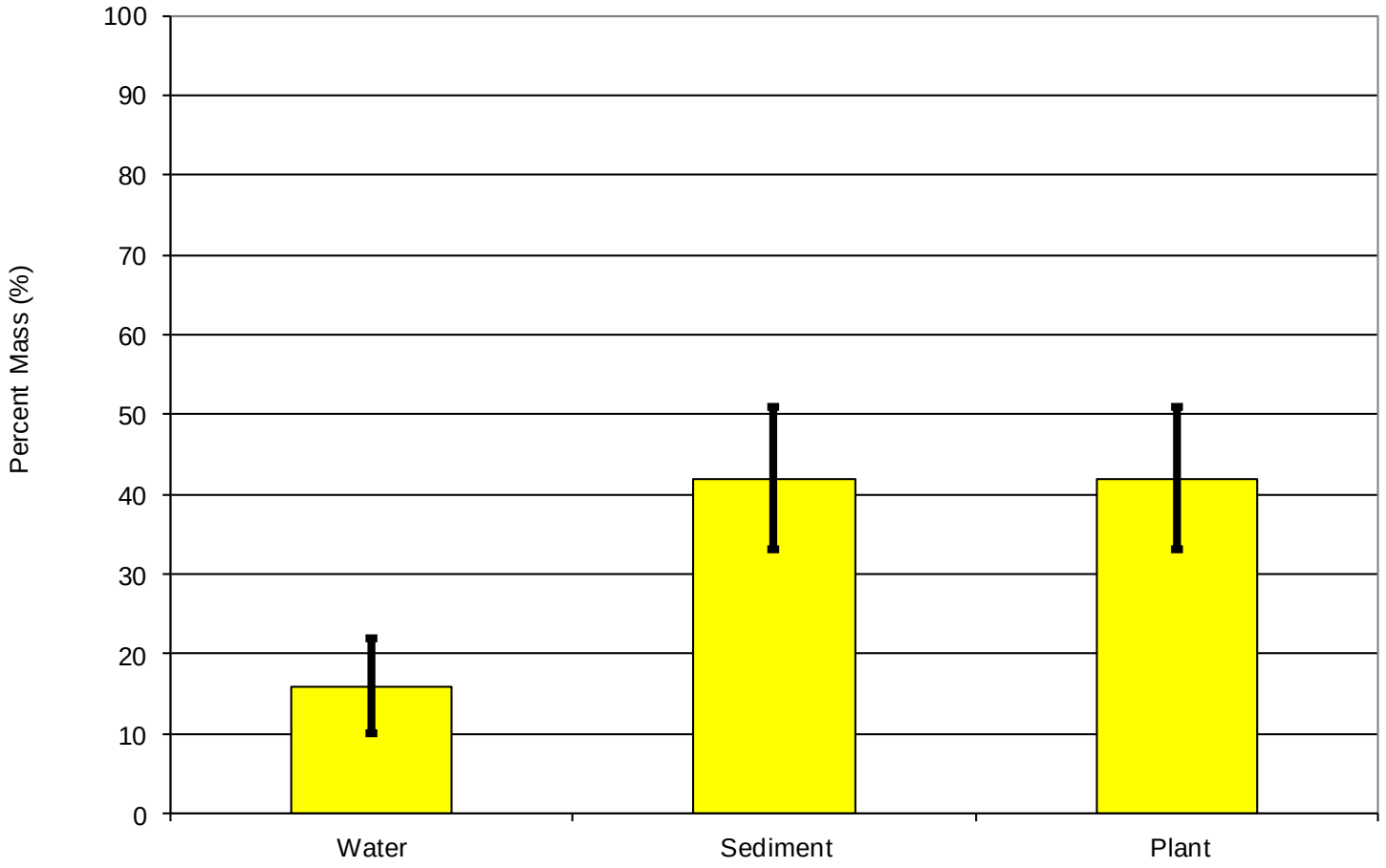
- **43% of measured diazinon mass in plant material**
- **49% of measured lambda-cyhalothrin mass in plant material**
- **76% of measured cyfluthrin mass in plant material**
- **Wetland dimensions of 215 m x 30 m required to mitigate 1% pesticide runoff from 14 ha contributing area**
- **32% decrease in atrazine and 22% decrease in flumeturon concentrations observed over 9 d**

(Moore et al. 2007; Moore et al. 2009; Locke et al. 2011)

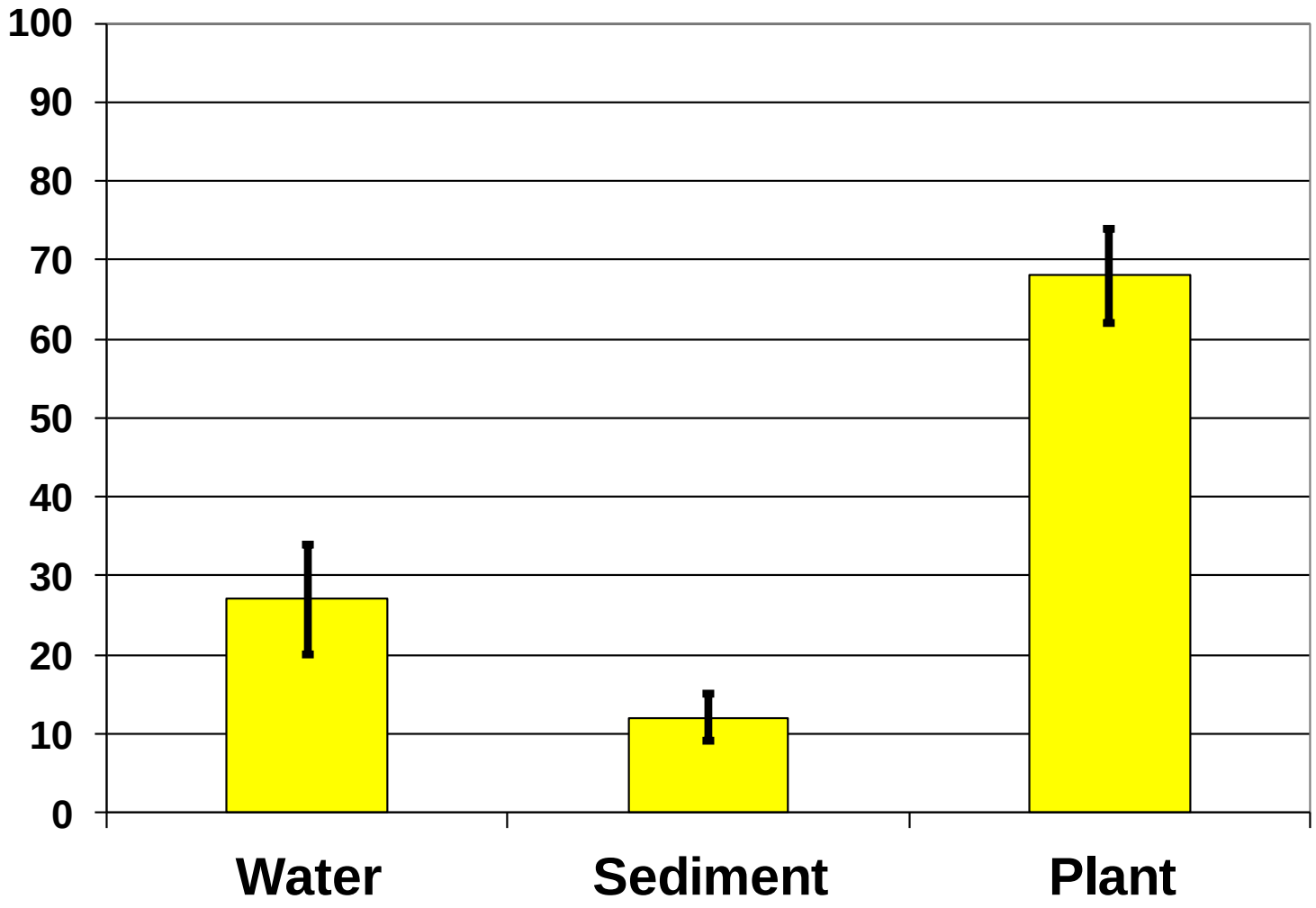
Results (1 h – 13 d)
DIAZINON



Results
Overall (SRP + cell 1 + cell 2) 55 d
LAMBDA-CYHALOTHRIN

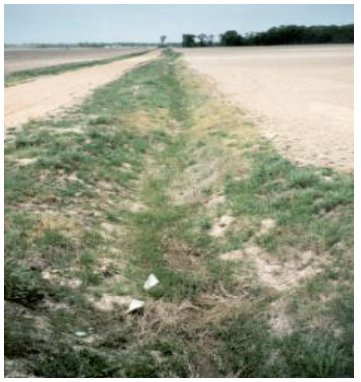


Results
Overall (SRP + cell 1 + cell 2) 55 d
CYFLUTHRIN



Ag Drainage Ditches: The New Wetlands

Drainage Ditches



--Already in place in the agricultural production landscape

--Historically served as means for water transport

--Actually served as sites for contaminant transfer and transformation

Drainage Ditches

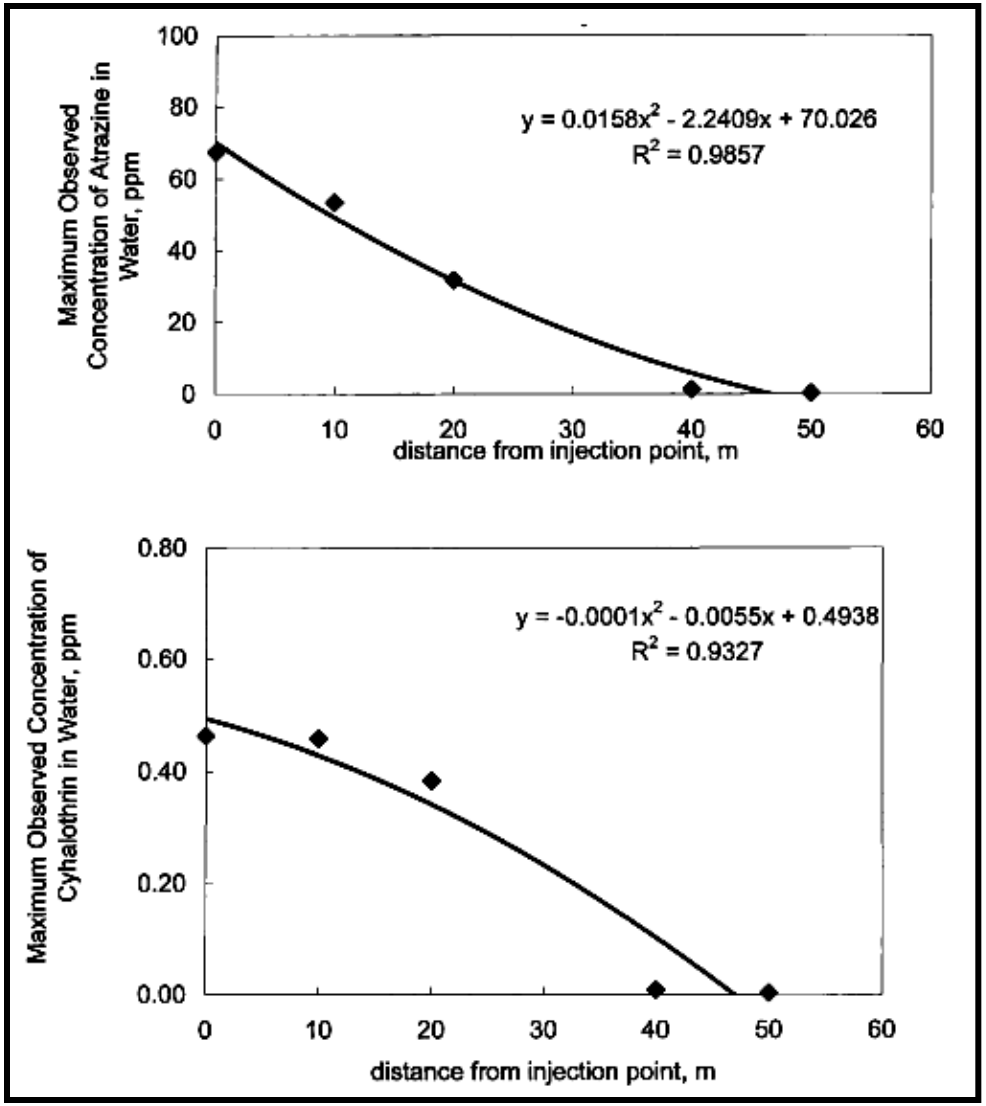
BEASLEY LAKE, MS

- 61% of measured atrazine concentrations in plant material
- 87% of measured lambda-cyhalothrin concentrations in plant material
- 50 m sufficient distance to mitigate pesticide concentrations

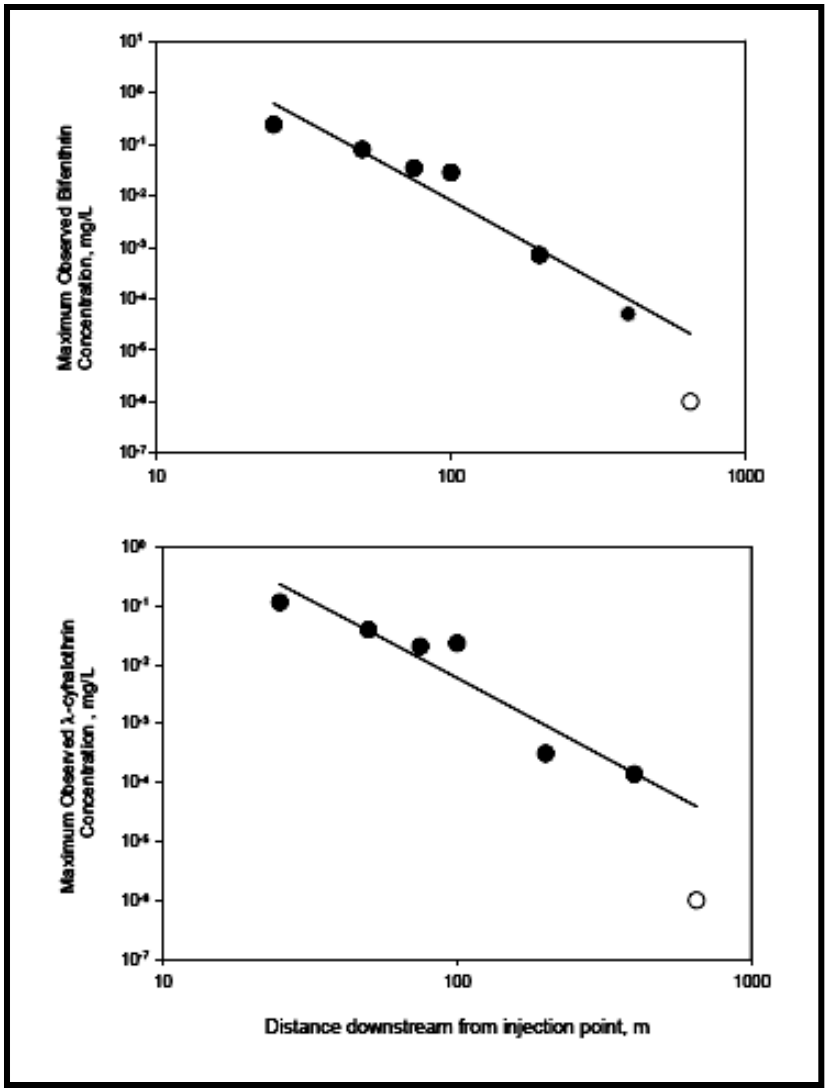
(Moore et al. 2001)

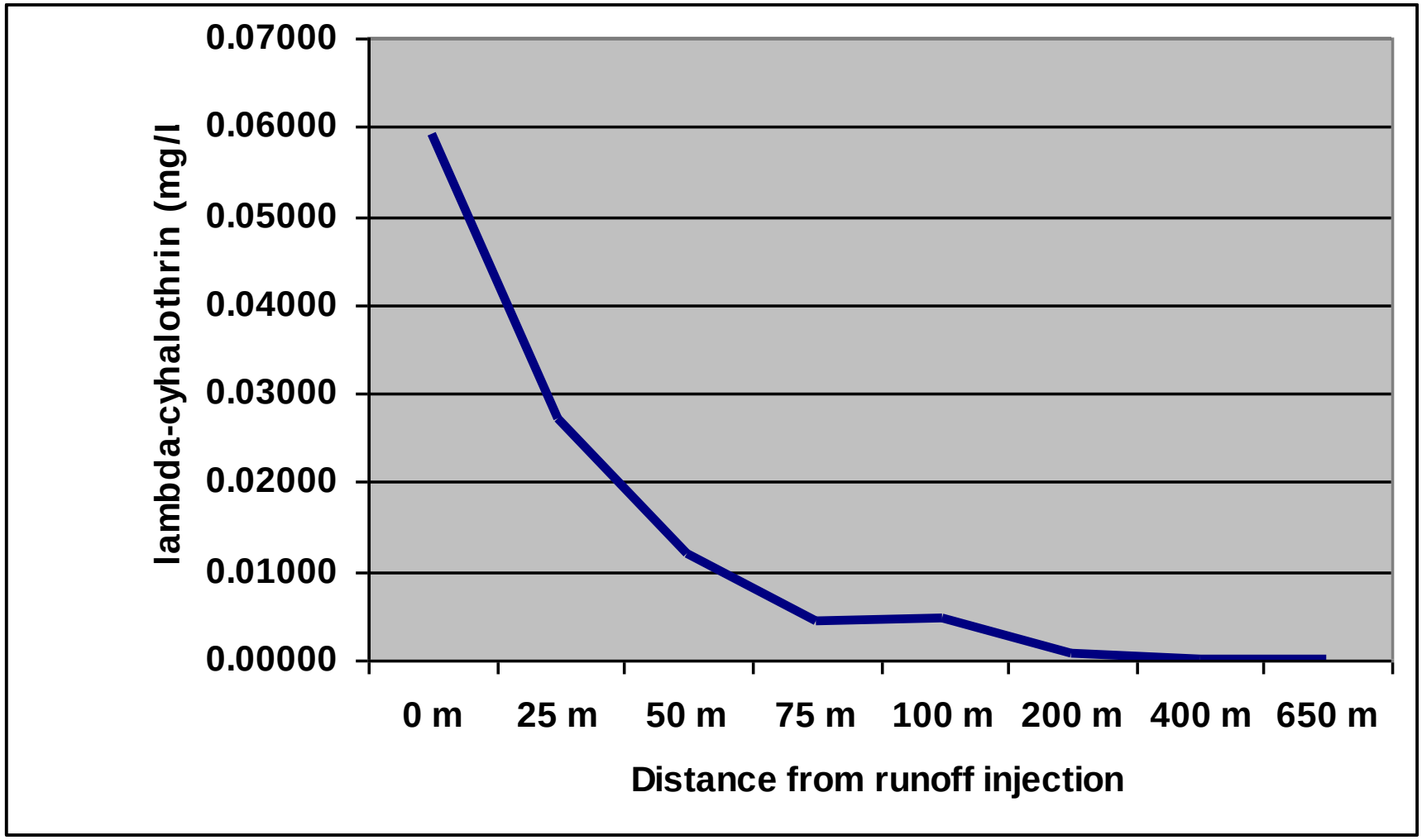
Vegetated Drainage Ditches

Beasley

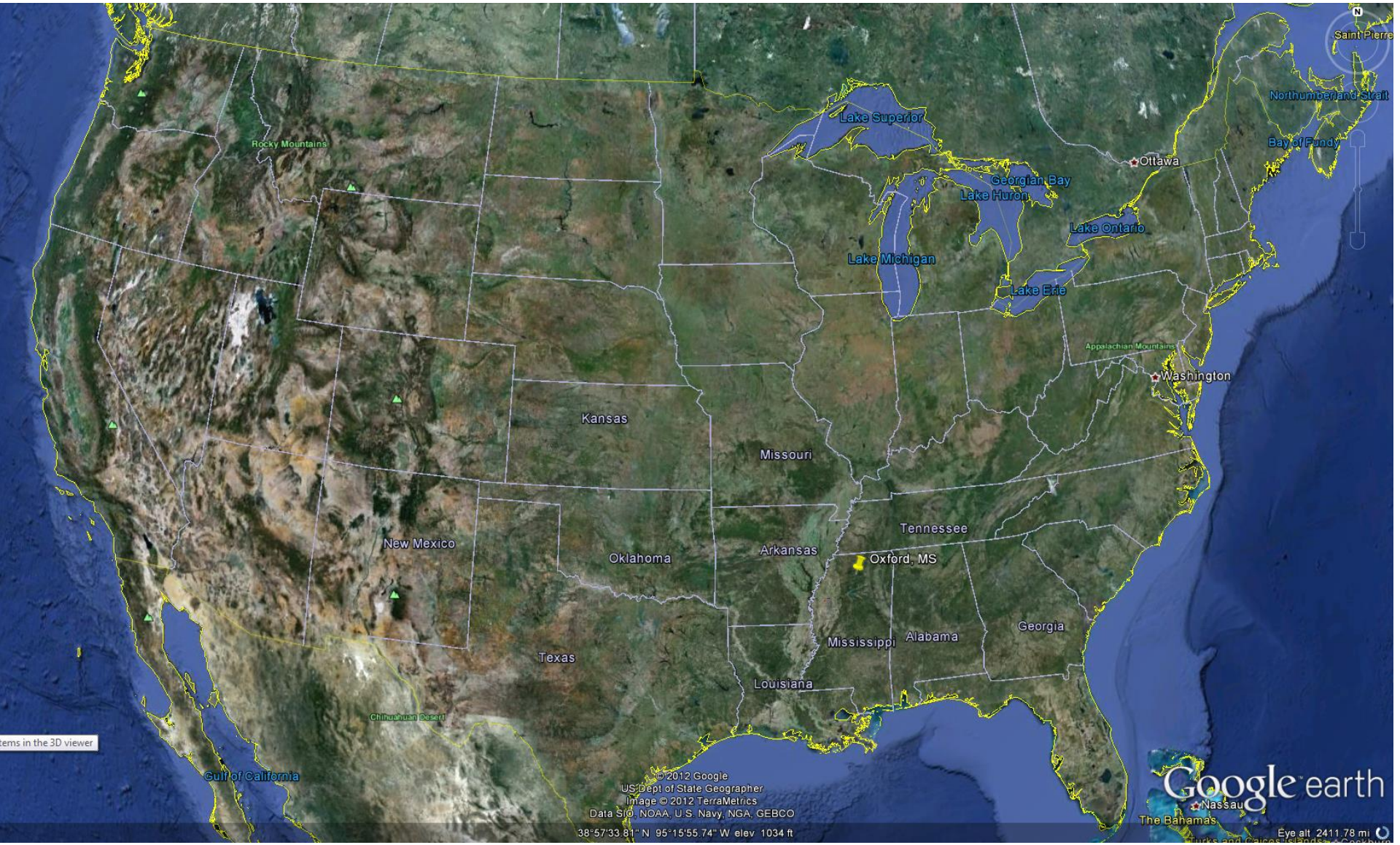


Thighman



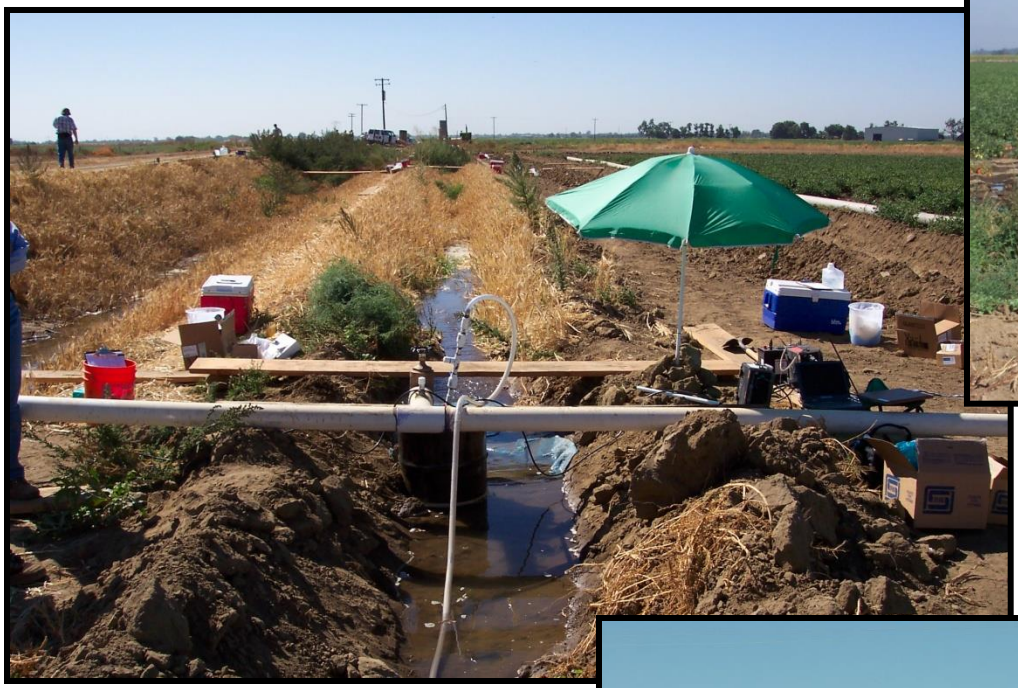


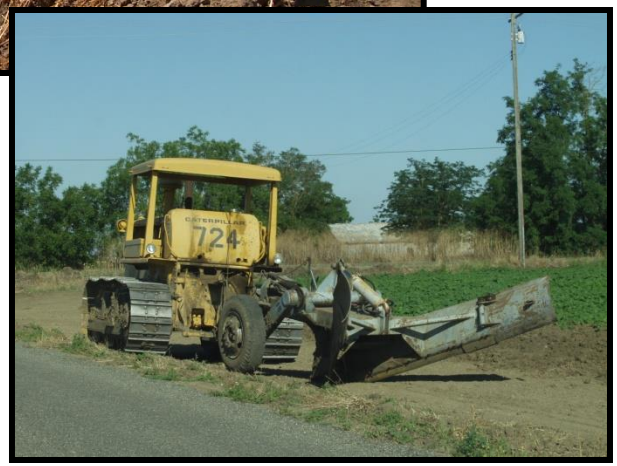
Degradation of lambda-cyhalothrin in Thighman Ditch water during the first 24 h following runoff simulation, 1999


Saint Pierre
Northumberland Strait
Lake Superior
Rocky Mountains
Bay of Fundy
Ottawa
Georgian Bay
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Appalachian Mountains
Washington
Kansas
Missouri
Tennessee
New Mexico
Oklahoma
Arkansas
Oxford, MS
Georgia
Mississippi
Alabama
Texas
Louisiana
Chihuahuan Desert
Gulf of California
© 2012 Google
US Dept of State Geographer
Image © 2012 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
38°57'33.81" N 95°15'55.74" W elev 1034 ft
Nassau
The Bahamas
Google earth
Eye alt 2411.78 mi

Sacramento Valley, California USA

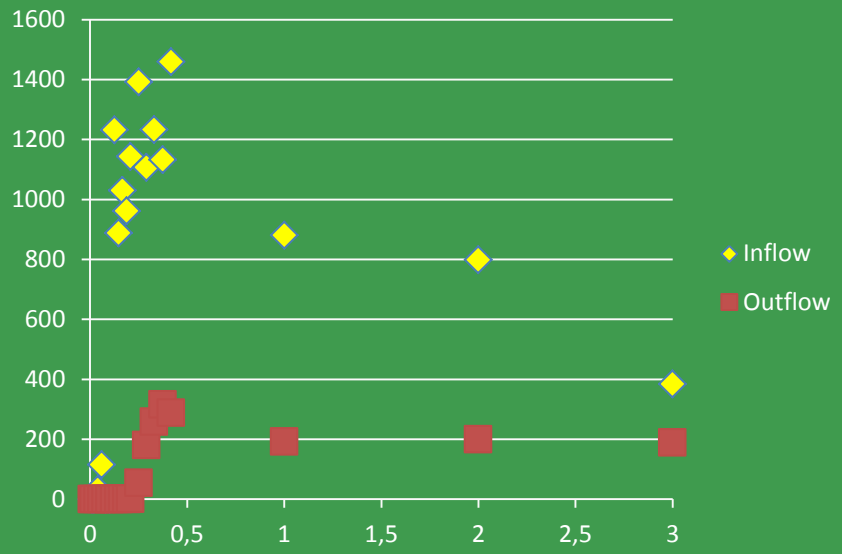
Vegetated Drainage Ditches

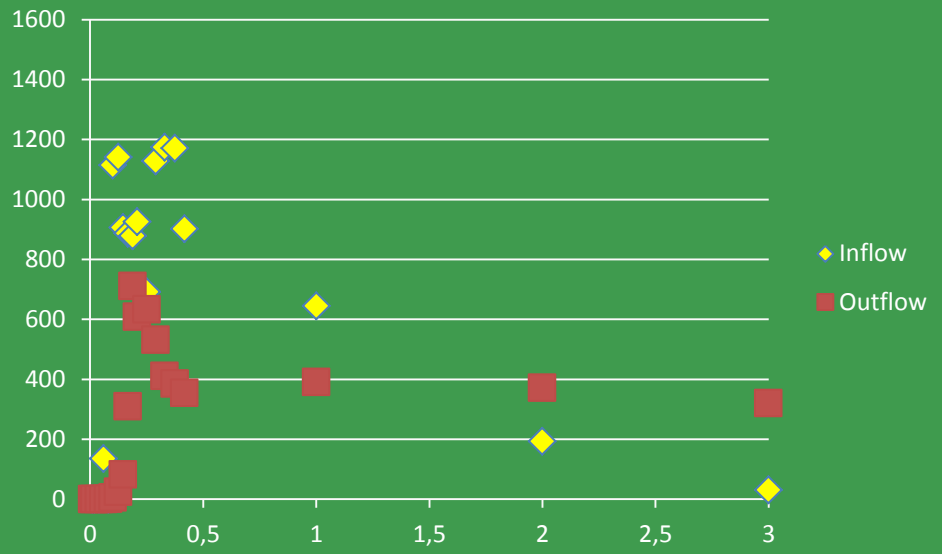




Pesticide Reduction Results

	V-vegetated	V-unvegetated
C-permethrin ½ life (h)	2.4	3.5
C-permethrin ½ distance (m)	22	50
T-permethrin ½ life (h)	3.4	3.7
T-permethrin ½ distance (m)	21	55
Diazinon ½ life (h)	4.5	4.5
Diazinon ½ distance (m)	56	158

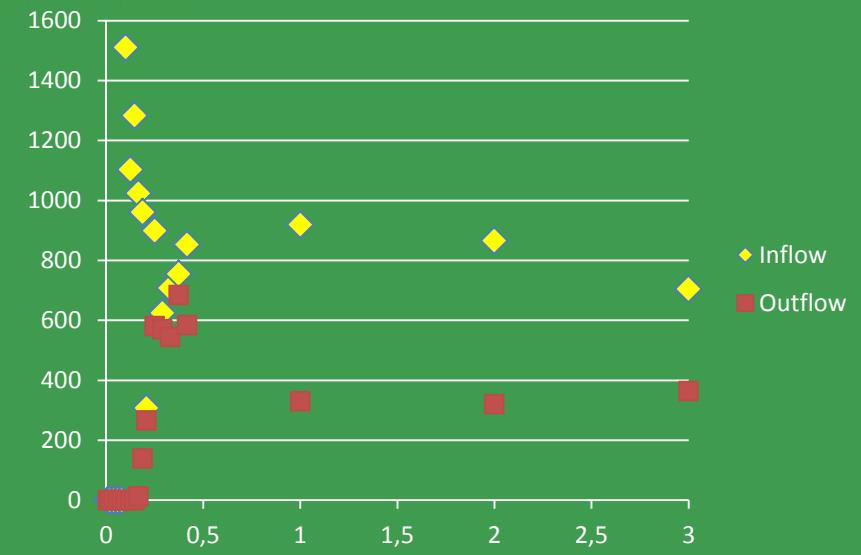


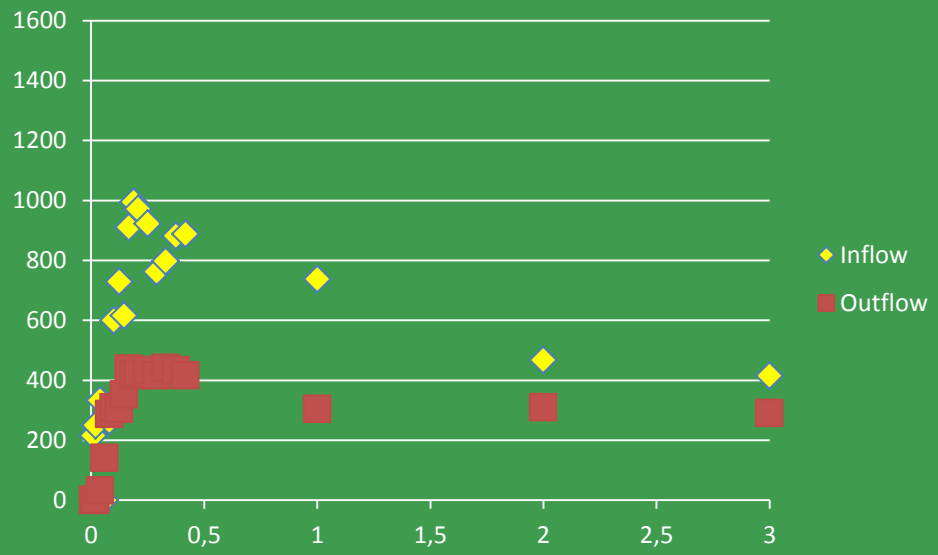


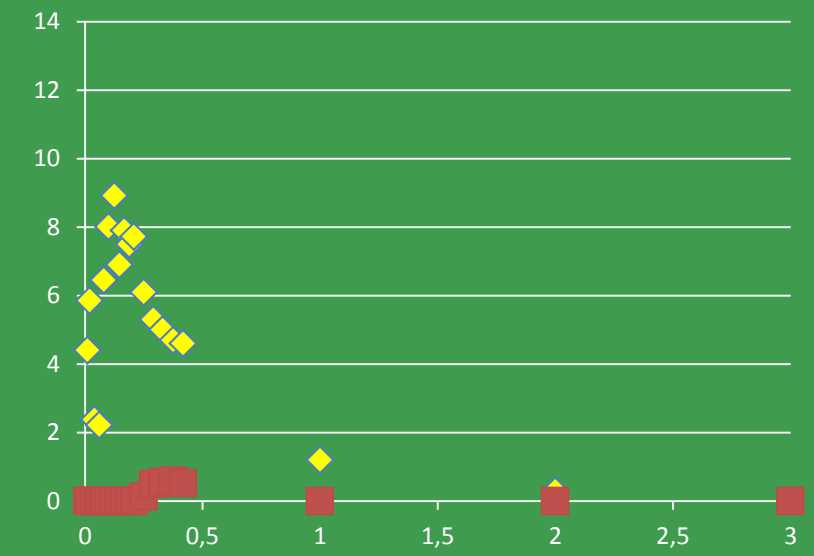
71% Rice

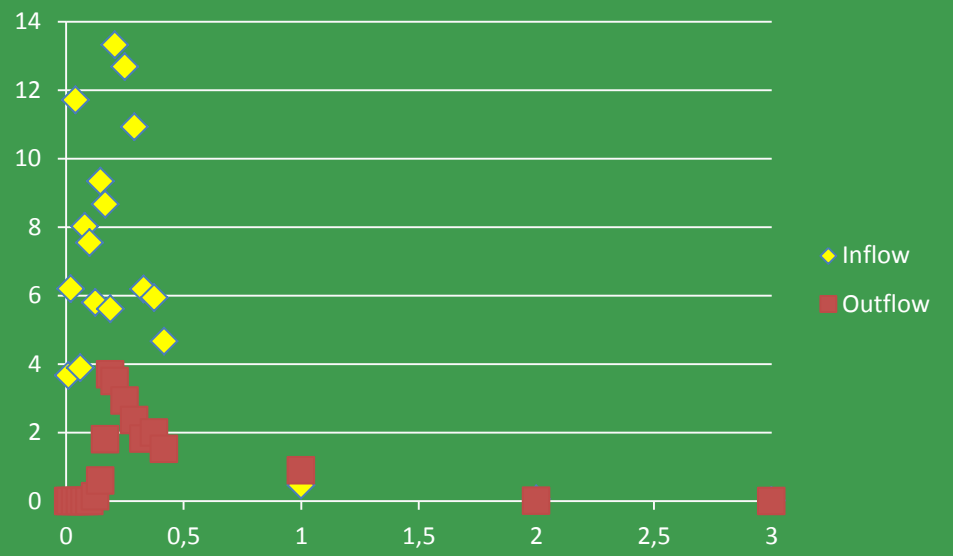
Diazinon

No Rice 43%





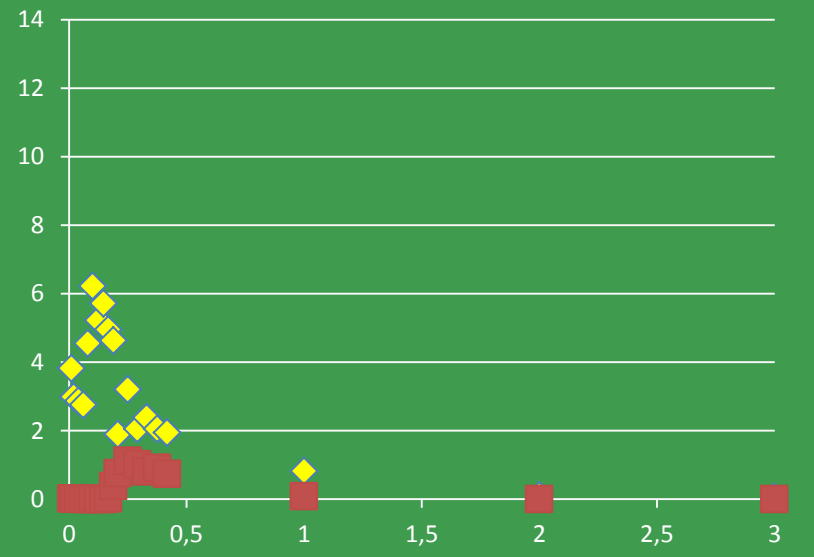


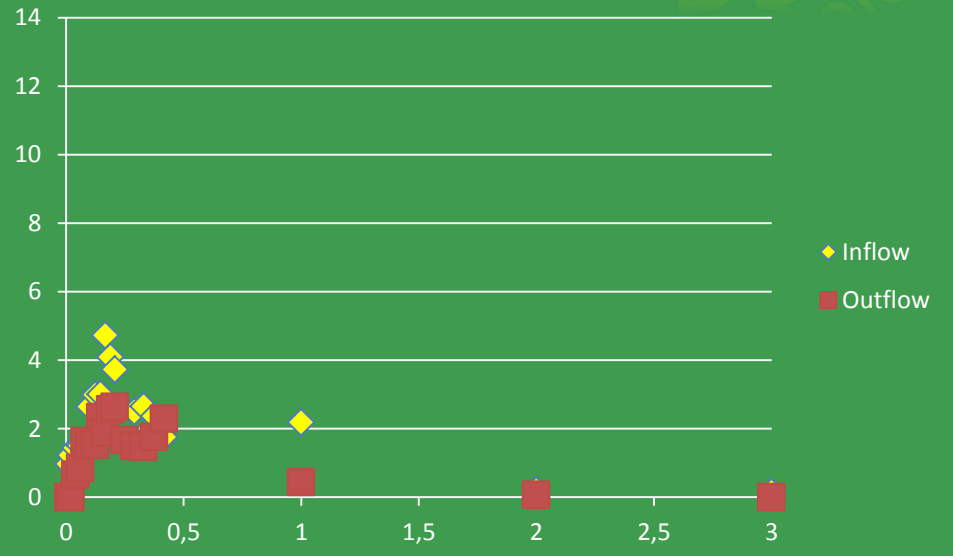


90% Rice

cis-Permethrin

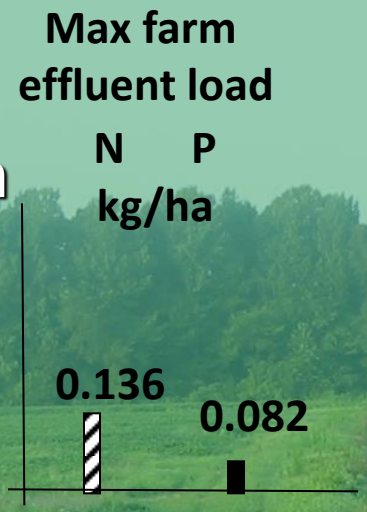
No Rice 53%

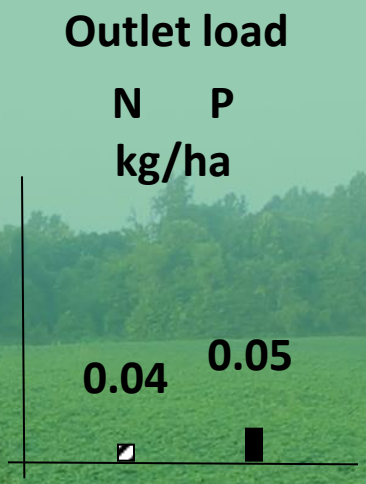




2004 – Ditch reduction capacity

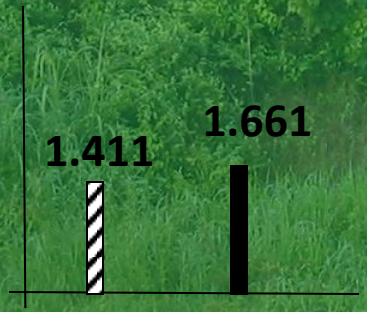
Growing season 2004

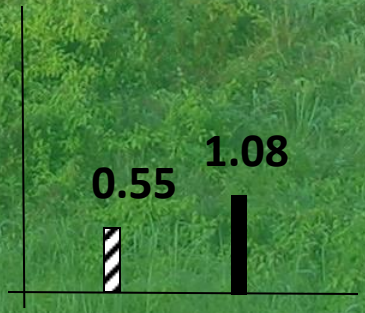




N: 71% decrease
P: 40% decrease

Dormant season 2004

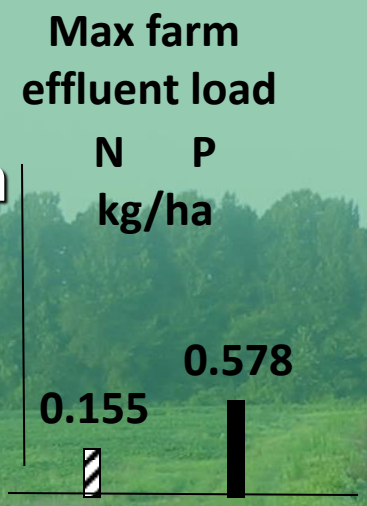


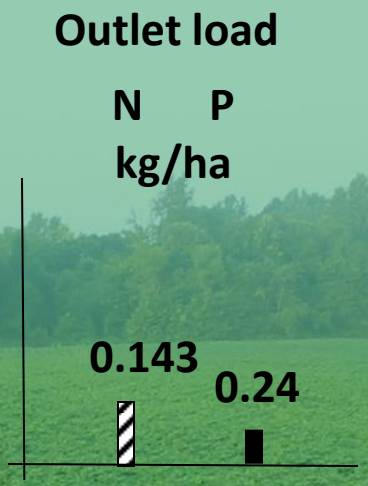


N: 61% decrease
P: 35% decrease

2005 – Ditch reduction capacity

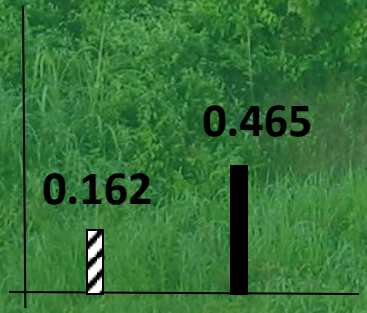
Growing season 2005

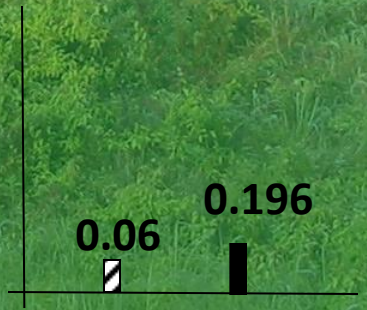




N: 9% decrease
P: 58% decrease

Dormant season 2005





N: 63% decrease
P: 58% decrease

Special Thanks

Lisa Brooks
Charlie Bryant
Ezekiel Cooper
Dr. Bobby Cullum
Dr. Ray Highsmith
James Hill
Landon Lee
Dr. Richard Lizotte
John Massey
Jimmy Oliver
Kevin Reece
Renee Russell
Duane Shaw
Sammie Smith
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