Water Quality Protection of the Grand Lake St. Marys in Ohio

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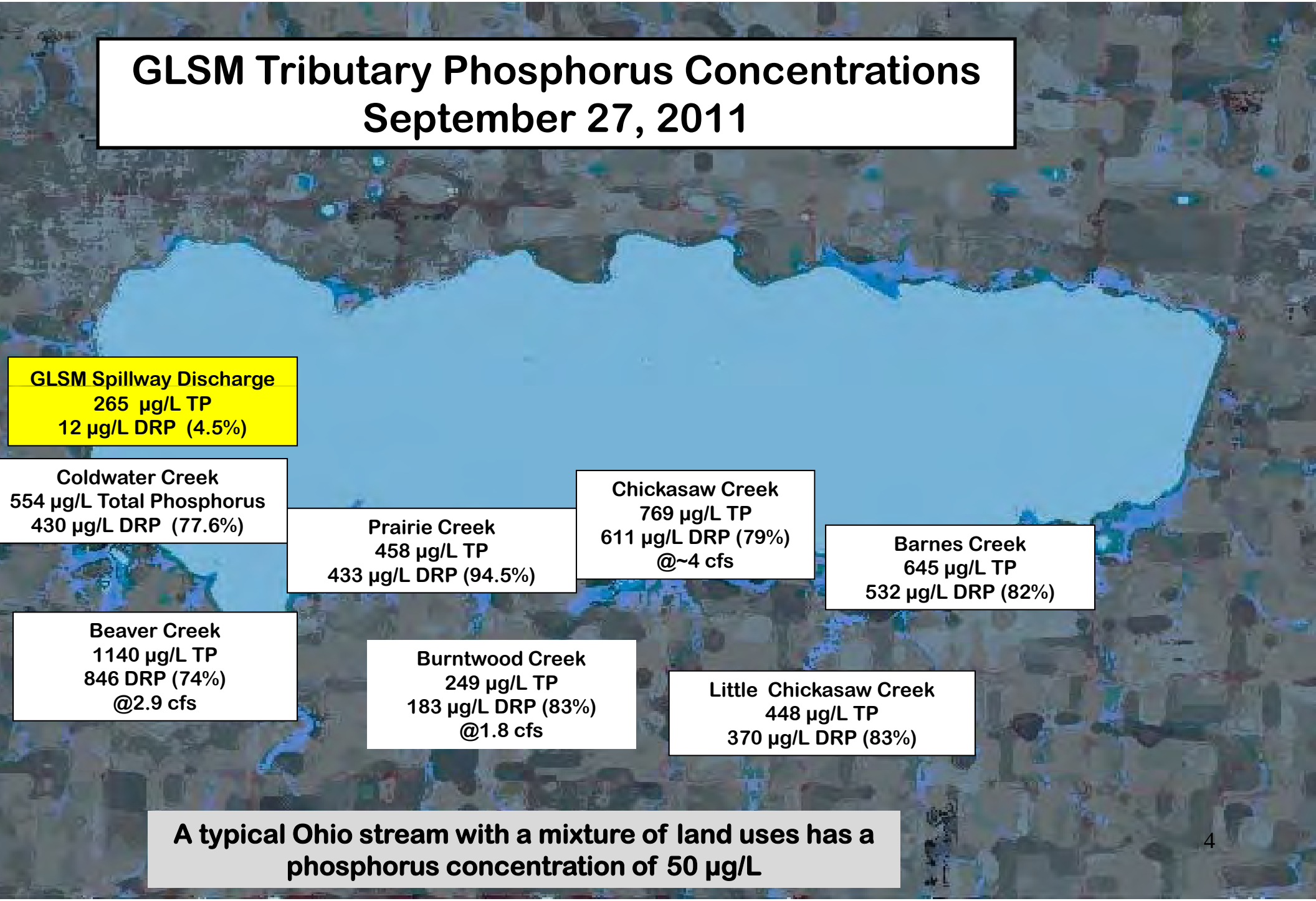
Background Information

- **Grand Lake St. Marys in northwestern Ohio is experiencing toxic levels of algal blooms resulting from nutrient input from agricultural runoff.**

Background Information

- **Since the outbreak of harmful algae bloom in the summer of 2010, the Ohio Environmental Protection Agency (OEPA) solicited potential short-term remedies from vendors and other interested parties.**
- **The conclusion from the review of received remedies is the application of alum, which is believed to improve the water quality over a short period.**
- **The more important message from this review is that improving the management of the GLSM watershed as a system is critical.**

GLSM Tributary Phosphorus Concentrations
September 27, 2011



A typical Ohio stream with a mixture of land uses has a phosphorus concentration of 50 µg/L

Objectives

- **To provide practical information to government officials and local land owners that helps to target the algae blooms in the lake.**
- **To achieve long term water quality protection of the GLSM.**

Watershed Characteristics

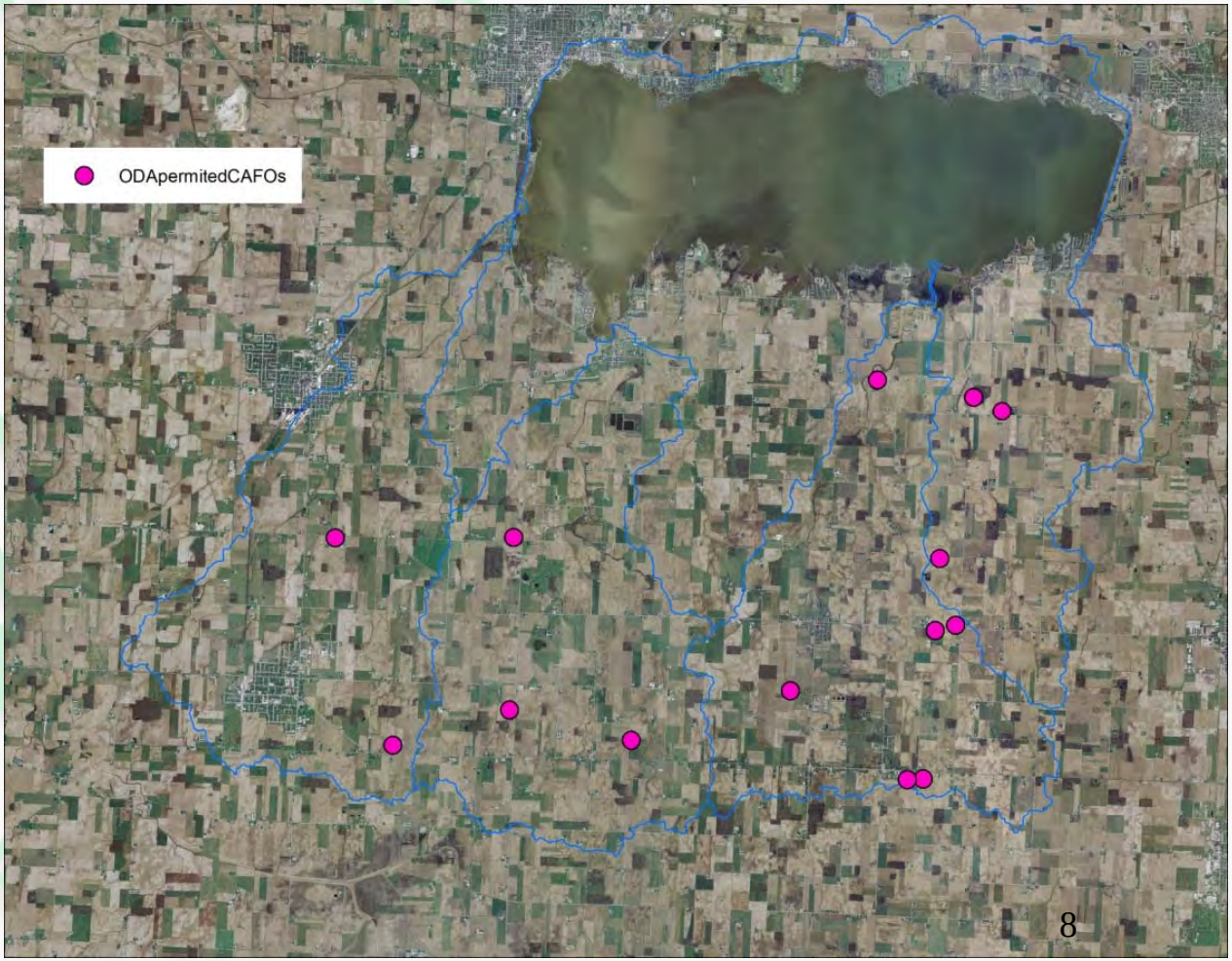
- **The watershed is predominantly under agricultural production with corn and soybeans as major crops.**
- **Other crops include alfalfa, winter wheat and hay.**
- **Many farmers own CAFOs/AFOs to sustain local economy due to the small acreage of farm land they own.**

Key Questions to be addressed

- **Whether CAFO/AFO production is sustainable in terms of the amount of animal manure produced?**
- **Whether point source discharges contribute to the algae bloom significantly?**
- **If conservation practices can be adopted to limit nutrient loadings, particularly dissolved N and P, to the lake?**

CAFO/AFO Mapping

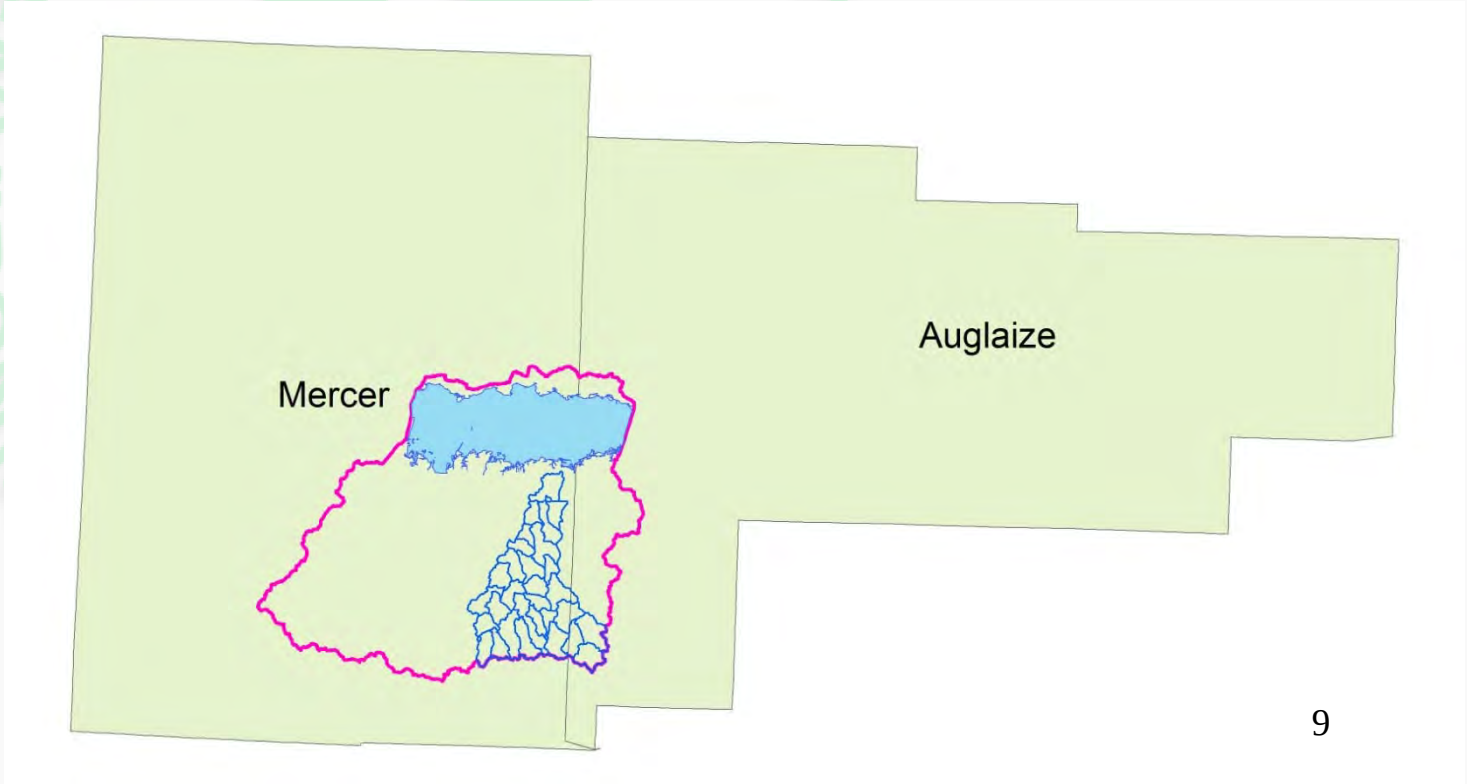
- **Spatial distribution of CAFO/AFO (number and type) is poorly known.**
- **Ohio Department of Agriculture has 14 large permitted facilities.**



County Level Data and Watershed Data

- **County level CAFO/AFO data show total number of animals and the type of animals, but do not show where they are located…**

Watershed models for GLSM need more detailed information



Animal Waste and Nutrient Content Estimation

- **Animal totals were summarized per county.**
- **Manure recovery and nutrient content were obtained from literature.**
- **Example of two counties, Auglaize and Mercer.**

Table 1. Estimated total animal waste produced in Auglaize County

Species	Total head	Head/Animal Unit*	Total Animal Unit	Manure Produced (Tons/AU/Year)	Total Waste produced (Tons/Year)
Cattle	19,700	1.0	19,700	11.5	226,550
Milk cows	5,300	0.74	7,162.2	15.24	109,151
Hogs & pigs	97,000	2.67	36,329.6	6.11	221,974
Chicken*	327,377	250	1,309.5	11.45	14,994
Sheep & lamb	800	10	80	N/A	

***One animal unit (AU) = 1000 lbs;**

Source: USDA – NRCS. Nutrients Available from Livestock Manure Relative to Crop Growth Requirements. 1998
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/nra/rca/?&cid=nrcs143_014150

Table 2. Estimated manure recovery and its nutrient contents

Species	Manure recovered (%)	Nitrogen (N)	Phosphorus (P)	Potassium (K)
		Lbs/Tons manure after losses		
Cattle	75	3.3	3.23	7.44
Milk cows	90	4.3	1.65	6.04
Hogs & pigs	75	3.3	3.62	7.04
Chicken	100	18.5	8.50	9.40

Source: USDA – NRCS. Nutrients Available from Livestock Manure Relative to Crop Growth Requirements. 1998
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/rca/?&cid=nrcs143_014175

Table 3. Potential nutrients available from animal waste in Auglaize County and Mercer County

Species	Auglaize County (lbs/year)			Mercer County (lbs/year)		
	N	P	K	N	P	K
Cattle	560,711	548,817	1,264,149	2,191,612	2,145,124	4,941,090
Milk cows	422,416	162,090	593,347	1,673,723	642,242	2,350,997
Hogs & pigs	552,715	602,659	1,172,022	1,652,446	1,801,763	3,503,982
Chicken	276,787	127,448	140,942	4,632,217	2,132,928	2,358,767
Total	1,812,628	1,441,014	3,170,460	10,149,998	6,722,057	13,154,836

Crop Nutrient Uptake Estimation

- **Plant nutrient content values were obtained from literature.**

Table 4. Nutrient information in harvested plants.

Crop	Nitrogen	Phosphorous	Potassium
Corn (lbs/bushels)	0.8	0.15	0.17
Soybeans (lbs/bushels)	3.55	0.36	0.84
Oats (lbs/bushels)	0.59	0.11	0.12
Wheat (lbs/bushels)	1.23	0.23	0.26
Hay (lbs/tons)	25.6	4.48	15.04

Source: USDA – NRCS. Nutrients Available from Livestock Manure Relative to Crop Growth Requirements. 1998
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/nra/rca/?&cid=nrcs143_014150

Table 5. Crop harvested in Auglaize and Mercer County.

Crop	Auglaize	Mercer
Corn (bushels)	774,2100	12,884,300
Soybeans (bushels)	3,063,650	3,655,600
Oats (bushels)	0	90,090
Wheat (bushels)	1,944,800	2,059,000
Hay (Tons)	24,400	51,090

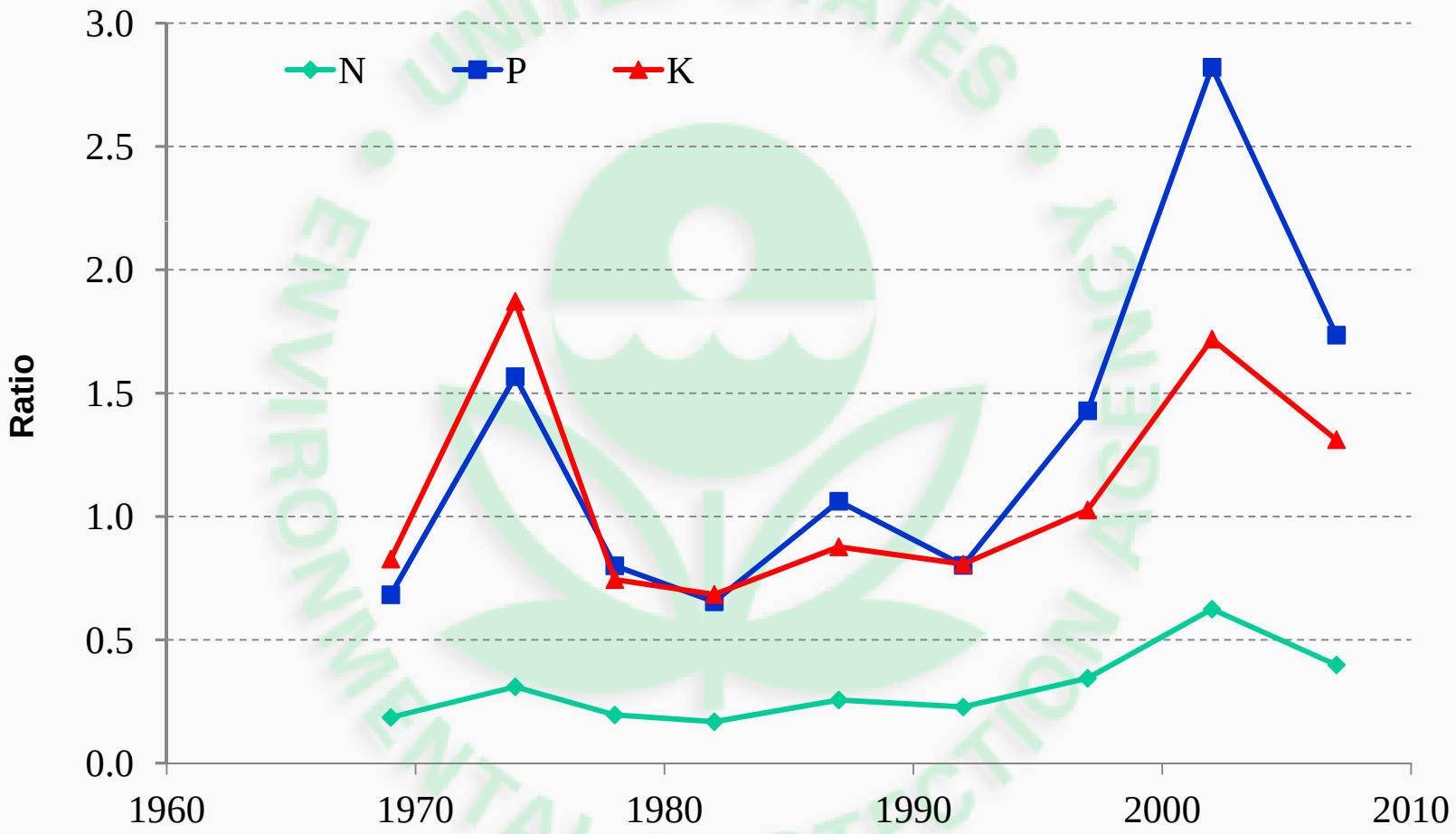
Crop yields were summarized per county.

Table 6. Estimated total nutrients available from animal manure and total by crop use (ratio >1 means available nutrient from animal manure is more than crop use).

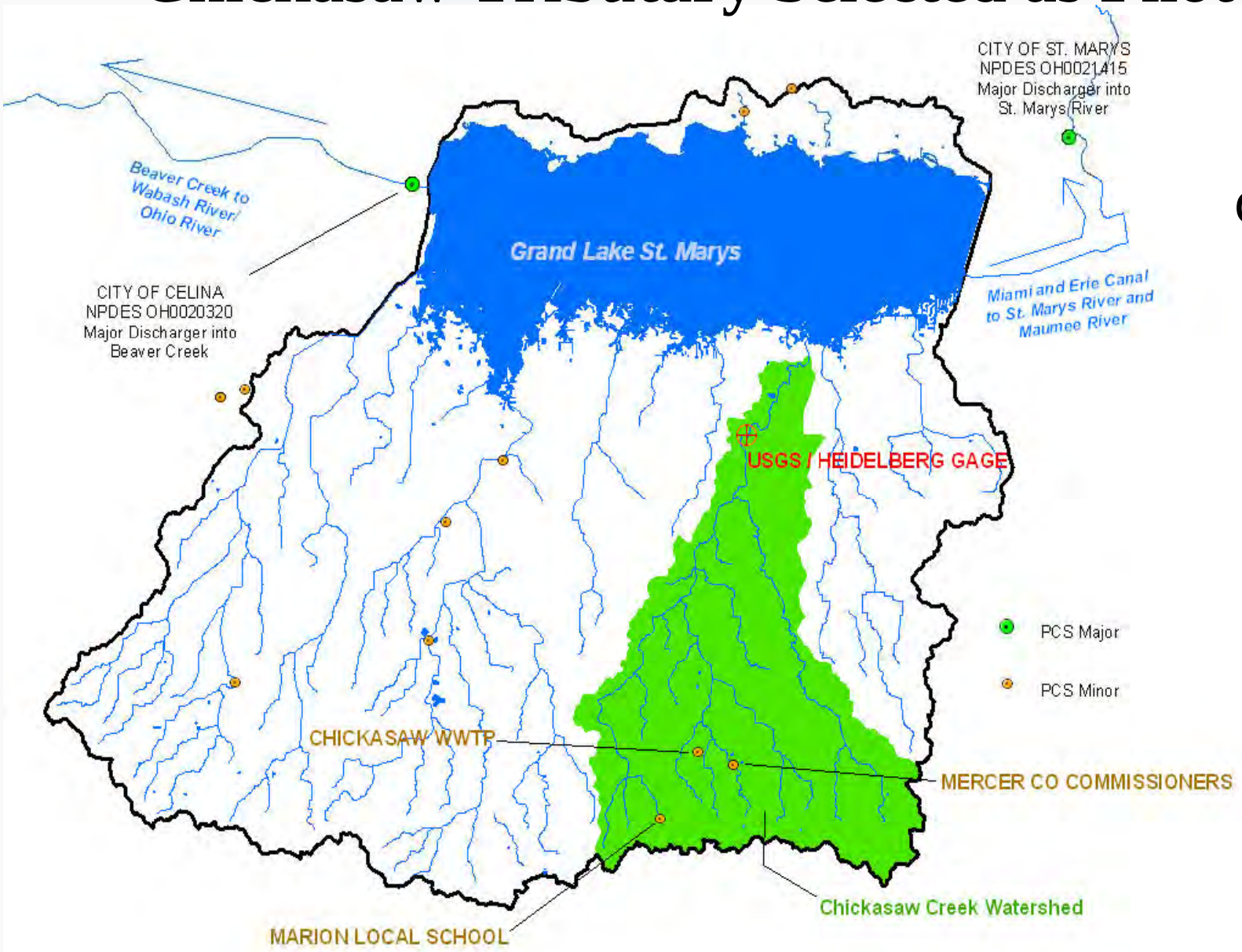
County	Auglaize County			Mercer County		
Nutrients	N (lbs)	P (lbs)	K (lbs)	N (lbs)	P (lbs)	K (lbs)
Total from manure	1,812,629	1,441,014	3,170,460	10,149,998	6,722,057	13,154,836
Total harvested by crop	20,086,382	2,820,845	4,762,247	27,178,447	3,961,024	6,575,579
Ratio	0.09	0.51	0.67	0.37	1.70	2.00

Commercial fertilizer application is not counted.

Ratios of nutrients from animal manure to crop production (N, P and K) in Mercer County



Chickasaw Tributary Selected as Pilot Watershed

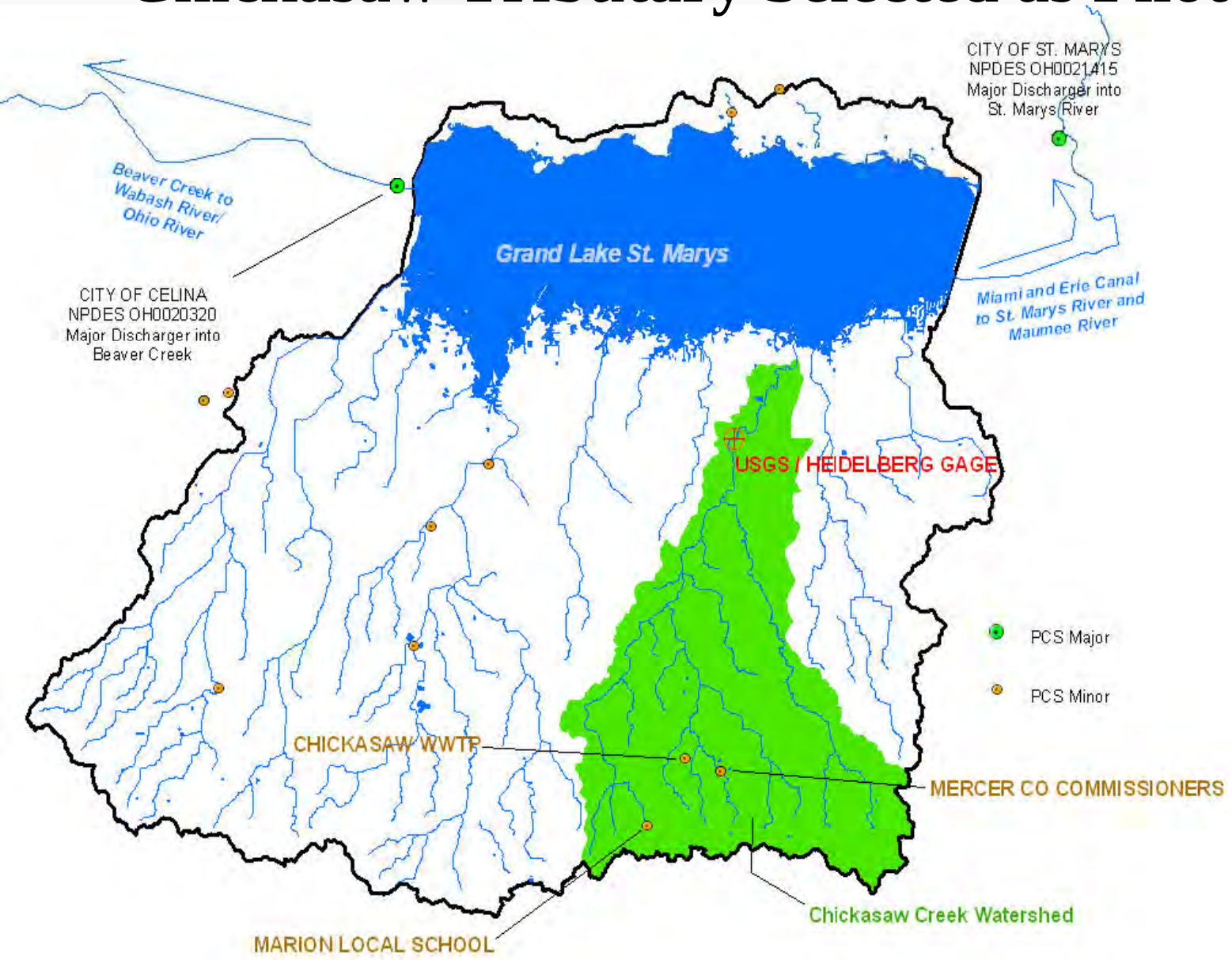


GLSM Watershed:
72,900 Acres

Grand Lake:
13,500 Acres

Chickasaw Creek
Watershed:
12,900 Acres

Chickasaw Tributary Selected as Pilot Watershed



Chickasaw Creek Watershed:
12,900 Acres

85.2% Agricultural
9.5% Urban
3.2% Wooded

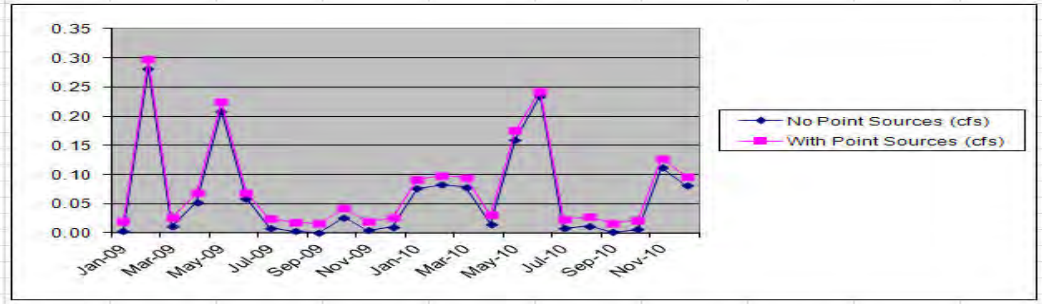
3 Permitted Discharges in Headwaters of Chickasaw Watershed

SWAT Results - Point Source Contributions

Point source contribution is not significant,
more noticeable at headwaters than downstream

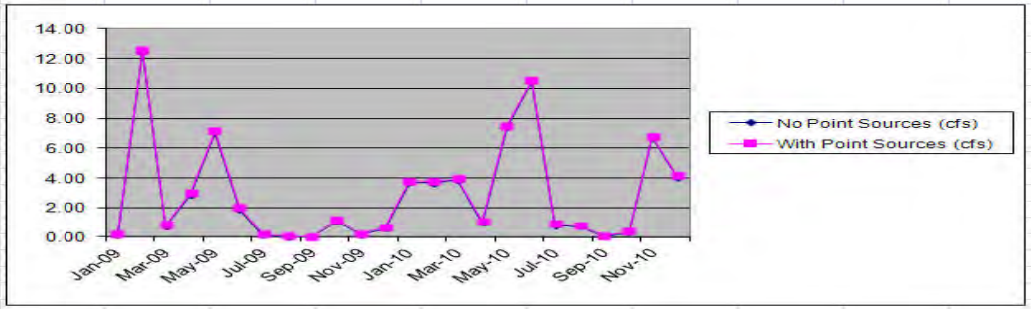
Intermittent Headwaters

Date	No Point Sources (cfs)	With Point Sources (cfs)	% Increase with PS
Jan-09	0.00	0.02	443%
Feb-09	0.28	0.30	5%
Mar-09	0.01	0.03	143%
Apr-09	0.05	0.07	29%
May-09	0.21	0.22	7%
Jun-09	0.06	0.07	17%
Jul-09	0.01	0.02	175%
Aug-09	0.00	0.02	607%
Sep-09	0.00	0.02	2232%
Oct-09	0.03	0.04	58%
Nov-09	0.00	0.02	339%
Dec-09	0.01	0.03	149%
Jan-10	0.08	0.09	20%
Feb-10	0.08	0.10	19%
Mar-10	0.08	0.09	20%
Apr-10	0.02	0.03	101%
May-10	0.16	0.18	10%
Jun-10	0.23	0.24	3%
Jul-10	0.01	0.02	192%
Aug-10	0.01	0.03	131%
Sep-10	0.00	0.02	1110%
Oct-10	0.01	0.02	249%
Nov-10	0.11	0.13	14%
Dec-10	0.08	0.10	20%
Average Flow % increase factoring in Point Sources:			254%
Median Flow % increase factoring in Point Sources:			79%

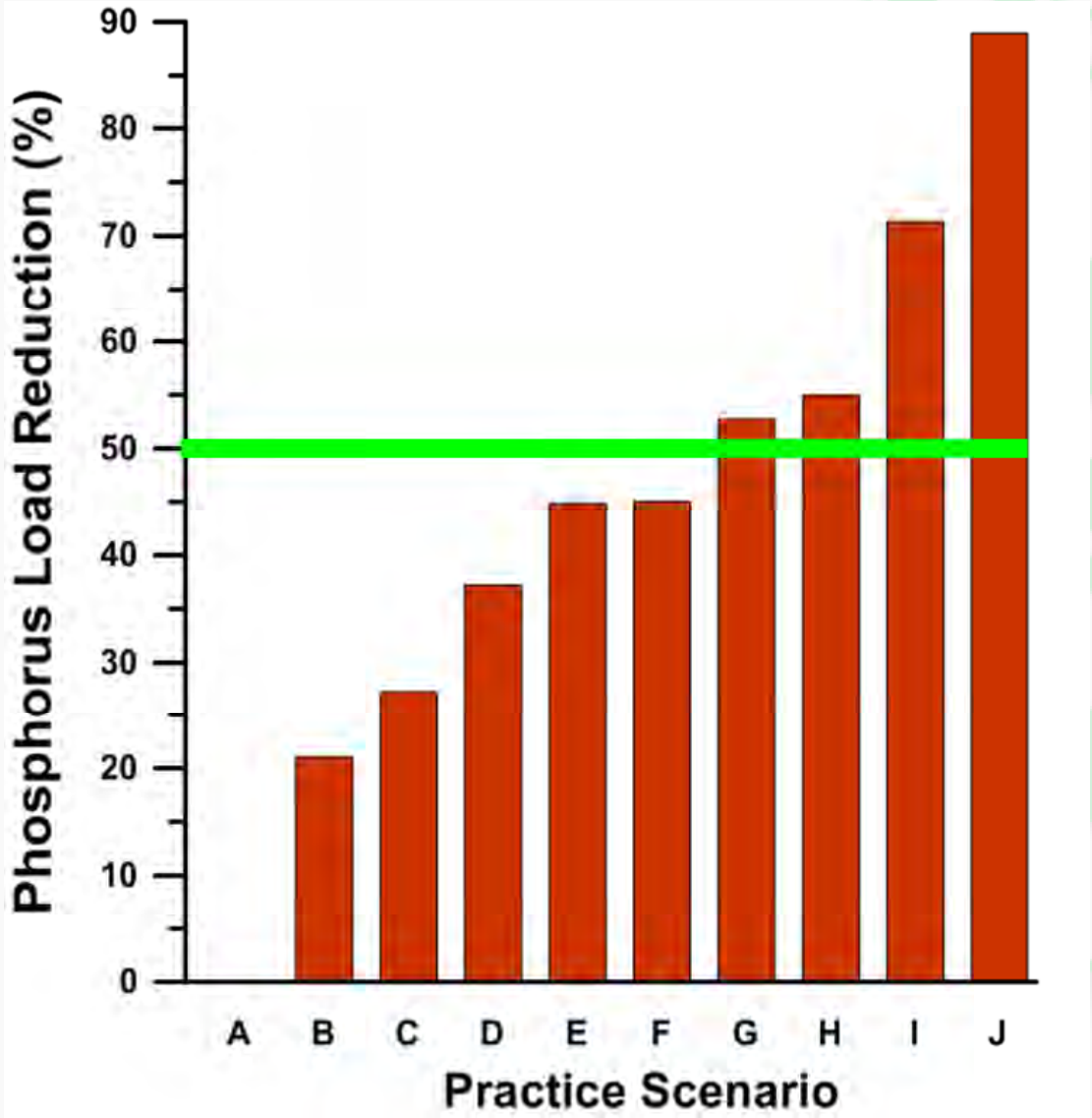


Perrenial Downstream

Date	No Point Sources (cfs)	With Point Sources (cfs)	% Increase with PS
Jan-09	0.10	0.20	100%
Feb-09	12.46	12.56	1%
Mar-09	0.73	0.84	16%
Apr-09	2.83	2.98	5%
May-09	7.03	7.15	2%
Jun-09	1.87	1.99	6%
Jul-09	0.10	0.22	112%
Aug-09	0.01	0.06	322%
Sep-09	0.00	0.03	567%
Oct-09	1.08	1.17	8%
Nov-09	0.15	0.22	48%
Dec-09	0.58	0.65	13%
Jan-10	3.70	3.80	2%
Feb-10	3.67	3.75	2%
Mar-10	3.87	3.96	2%
Apr-10	0.94	1.06	12%
May-10	7.42	7.50	1%
Jun-10	10.46	10.54	1%
Jul-10	0.80	0.88	11%
Aug-10	0.70	0.78	12%
Sep-10	0.04	0.08	116%
Oct-10	0.33	0.39	19%
Nov-10	6.71	6.78	1%
Dec-10	4.05	4.14	2%
Average Flow % increase factoring in Point Sources:			58%
Median Flow % increase factoring in Point Sources:			10%



AnnAGNPS Results –Impact of Conservation Practices on TP Losses



A. Conventional Tillage (Base Conditions)

B. Minimum Tillage

C. No-Tillage

D. Buffers w/ Conv. Till.

E. Rye Cover w/ Conv. Till.

F. Clover Cover w/ Conv. Till.

G. Wheat Cover w/ Conv. Till.

H. Vetch Cover w/ Conv. Till.

I. Radish Cover w/ Conv. Till.

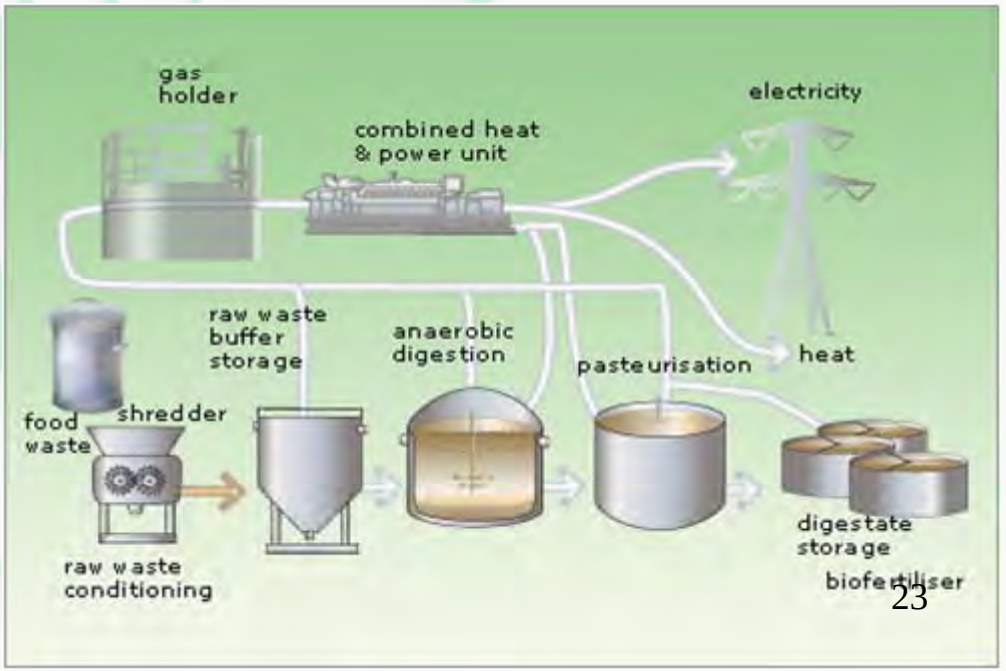
J. No-Till w/ Radish Cover w/ Buffers

Discussion and Conclusions

- **Animal wastes from CAFO production is the major sources of phosphorous input to the lake.**
- **Point source contribution is not significant.**
- **Agricultural conservation practices such as cover crops and buffers can be used for dissolved P removal.**
- **More important solution is using new manure treatment technologies for manure removal and recycle**

Manure Treatment Technologies

- **Anaerobic digestion.**
- **Composting.**
- **Converting animal manure to biofuel .**



Thank you!

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