

Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Lower Mississippi River Basin

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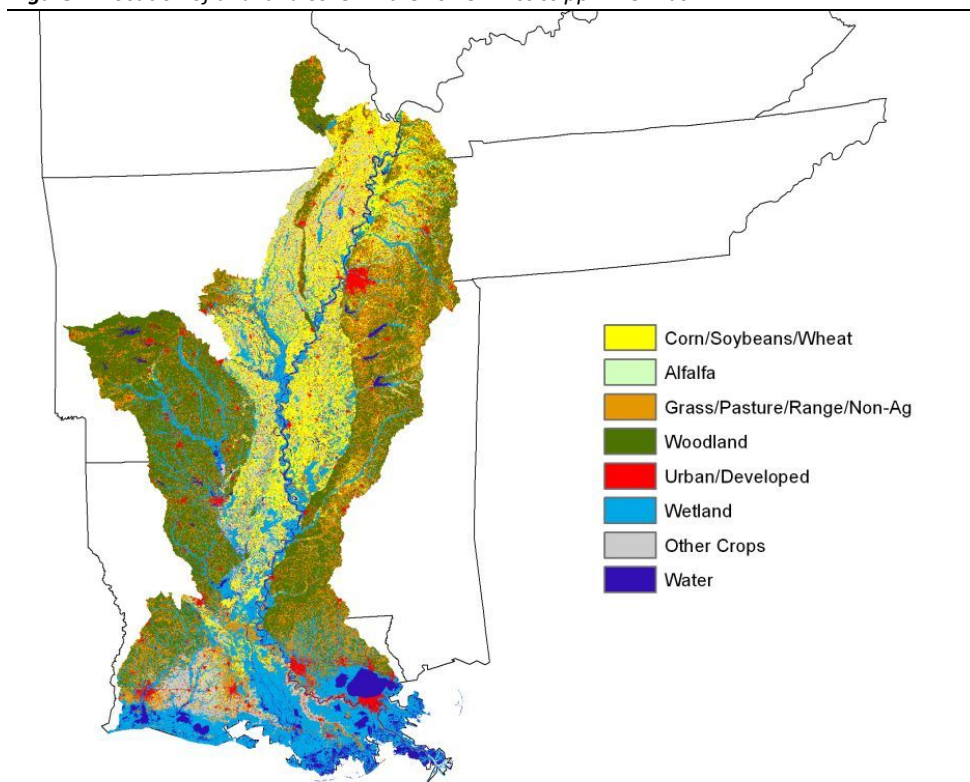
To view or download a PDF version of the full report, visit the NRCS Web site, <http://www.nrcs.usda.gov>, and follow links to Technical Resources / Natural Resources Assessment / CEAP

The U.S. Department of Agriculture's Conservation Effects Assessment Project (CEAP) has undertaken a series of studies designed to quantify the effects of conservation practices on cultivated cropland in the conterminous 48 States. The seventh study in this series is on the Lower Mississippi River Basin.

The Lower Mississippi River Basin is the smallest of the five major basins that make up the Mississippi River drainage. It covers about 105,000 square miles (67 million acres) in the lower reaches of the Mississippi River system, covering parts of Kentucky, Tennessee, Missouri, Arkansas, Mississippi, and Louisiana. It receives water from the Upper Mississippi, Ohio-Tennessee, Missouri, and Arkansas-White-Red River Basin (fig. 1).

About one-third of the region is cultivated cropland, including land enrolled in the General Signup of the Conservation Reserve Program. The main crops are corn, soybeans, cotton, and rice. In 2007, the region produced 65 percent of the U.S. rice crop and 26 percent of the national cotton crop

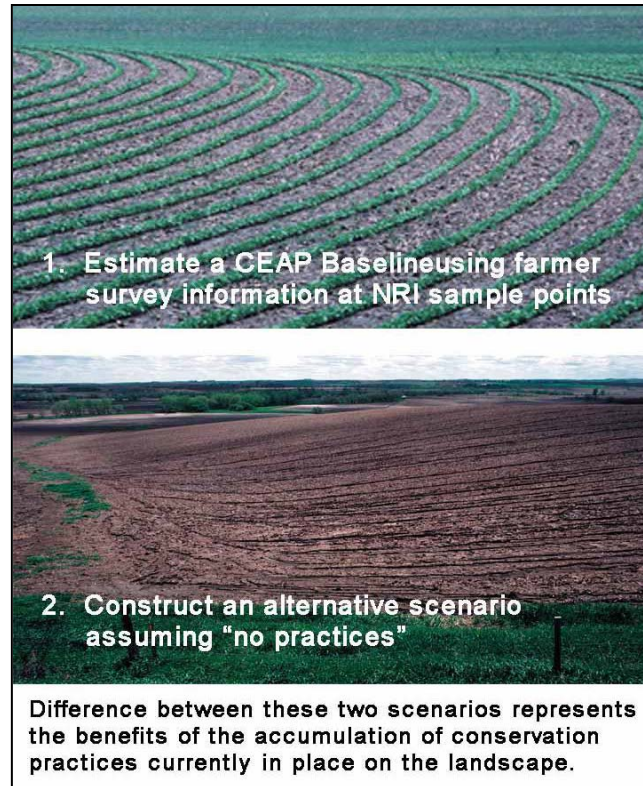
Figure 1. Location of and land cover in the Lower Mississippi River Basin



SOURCE: TEXAS AGRILIFE RESEARCH, TEXAS A&M UNIVERSITY (USDA-NASS DATA)

Study Methodology

The assessment uses a statistical sampling and modeling approach to estimate the effects of conservation practices. The National Resources Inventory (NRI), a statistical survey of conditions and trends in soil, water, and related resources on U.S. non-Federal land conducted by USDA's Natural Resources Conservation Service, provides the statistical framework for the study. Physical process simulation models were used to estimate the effects of conservation practices that were in use during the period 2003 to 2006. Information on farming activities and conservation practices was obtained primarily from a farmer survey conducted as part of the study. The assessment includes not only practices associated with Federal conservation programs but also the conservation efforts of States, independent organizations, and individual landowners and farm operators. The analysis assumes that structural practices (such as buffers, terraces, and grassed waterways) reported in the farmer survey or obtained from other data sources were appropriately designed, installed, and maintained.



The national sample for the farmer survey consists of 18,700 sample points with 1,735 of these sample points located in the Lower Mississippi River Basin. This sample size is sufficient for reliable and defensible reporting at the regional scale and for large watersheds within the region, but is generally insufficient for assessments of smaller areas.

The modeling strategy for estimating the effects of conservation practices consists of two model scenarios that are produced for each sample point.

1. A baseline scenario, the "baseline conservation condition" scenario, provides model simulations that account for cropping patterns, farming activities, and conservation practices as reported in the NRI-CEAP Cropland Survey (2003–06) and other sources.
2. An alternative scenario, the "no-practice" scenario, simulates model results as if no conservation practices were in use but holds all other model inputs and parameters the same as in the baseline conservation condition scenario.

The effects of conservation practices are obtained by taking the difference in model results between the two scenarios. The need for additional conservation treatment was evaluated using a common set of criteria and protocols applied to all regions in the country to provide a systematic, consistent, and comparable assessment at the national level.

Study Findings

The findings summarized below represent the baseline conservation condition, using conservation practices reported in the 2003–06 NRI-CEAP Cropland Survey.

Although Voluntary, Incentives-Based Conservation Approaches Are Achieving Results, Opportunities Exist to Further Reduce Soil Erosion and Nutrient Losses from Cultivated Cropland

Farmers have reduced sediment, nutrient, and pesticide losses from farm fields through conservation practice adoption throughout the Lower Mississippi River Basin, compared to losses that would be expected if no conservation practices were in use. Because 92 percent of cropped acres in this region have slopes of less than 2 percent, structural practices for controlling water erosion are in place on only 21 percent of all cropped acres in the region. On the 12 percent of cropped acres designated as highly erodible land, structural practices designed to control water erosion are in use on 42 percent. Fifty-three percent of cropped acres meet criteria for mulch till. Only 28 percent meet criteria for no-till, however, a much lower percentage than in the other regions in the Mississippi River Basin. Still, 90 percent of cropped acres have structural or tillage and residue management practices, or both. Farmers meet criteria for good nitrogen management on only about 14 percent of the cropped acres and good phosphorus management on 17 percent. Application of these practices has reduced sediment and nutrient losses from cultivated cropland (table 1).

The need for additional conservation treatment in the region was determined by imbalances between the level of conservation practice use and the level of inherent vulnerability. Areas of sloping soils are more vulnerable to surface runoff and consequently to loss of sediment and nutrients with overland flow of water; areas of level, permeable soils are generally not vulnerable to sediment loss or nutrient loss through overland flow but are more prone to soluble nitrogen and soluble phosphorus losses through subsurface pathways. Three levels of treatment need were estimated:

- **A high level of need** for conservation treatment exists where the loss of sediment and/or nutrients is greatest and where additional conservation treatment can provide the greatest reduction in agricultural pollutant loadings. *Some 6.3 million acres—33 percent of the cultivated cropland in the region—have a high level of need for additional conservation treatment.*
- **A moderate level of need** for conservation treatment exists where the loss of sediment and/or nutrients is not as great and where additional conservation treatment has less potential for reducing agricultural pollutant loadings. *Approximately 10 million acres—53 percent of the cultivated cropland in the region—have a moderate level of need for additional conservation treatment.*
- **A low level of need** for conservation treatment exists where the existing level of conservation treatment is adequate compared to the level of inherent vulnerability. Additional conservation treatment on these acres would provide little additional reduction in sediment and/or nutrient loss. *Approximately 2.6 million acres—14 percent of the cultivated cropland in the region—have a low level of need for additional conservation treatment.*

Of the 16.3 million acres having a high or moderate level of need for additional treatment, significant further reductions in sediment and nutrient loss from baseline levels could be achieved through implementation of suites of conservation practices. Table 1 also shows potential for further reductions (beyond 2003–06 baseline levels) in *edge-of-field* sediment, nitrogen, and phosphorus losses.

Comparing the reductions already achieved (displayed in table 1) with potential reductions through application of comprehensive conservation treatment show that there are significant opportunities for additional gains. Although the Lower Mississippi River Basin has a higher proportion of level to nearly level soils than do the other basins in the Mississippi River drainage, the much higher and more intense precipitation in this region results in very high levels of sediment and nutrient loss from farm fields.

Table 1. Comparison of baseline (200306) reductions in edge-of-field sediment and nutrient loss from cultivated cropland, to potential for further reductions beyond baseline levels through comprehensive conservation treatment of high- and moderate-treatment-need cropland, Lower Mississippi River Basin

Reductions	Sediment	Nitrogen		Phosphorus *
		With runoff	Through leaching	
Baseline (200306)	27	26	5	39
Potential	83	48	44	62

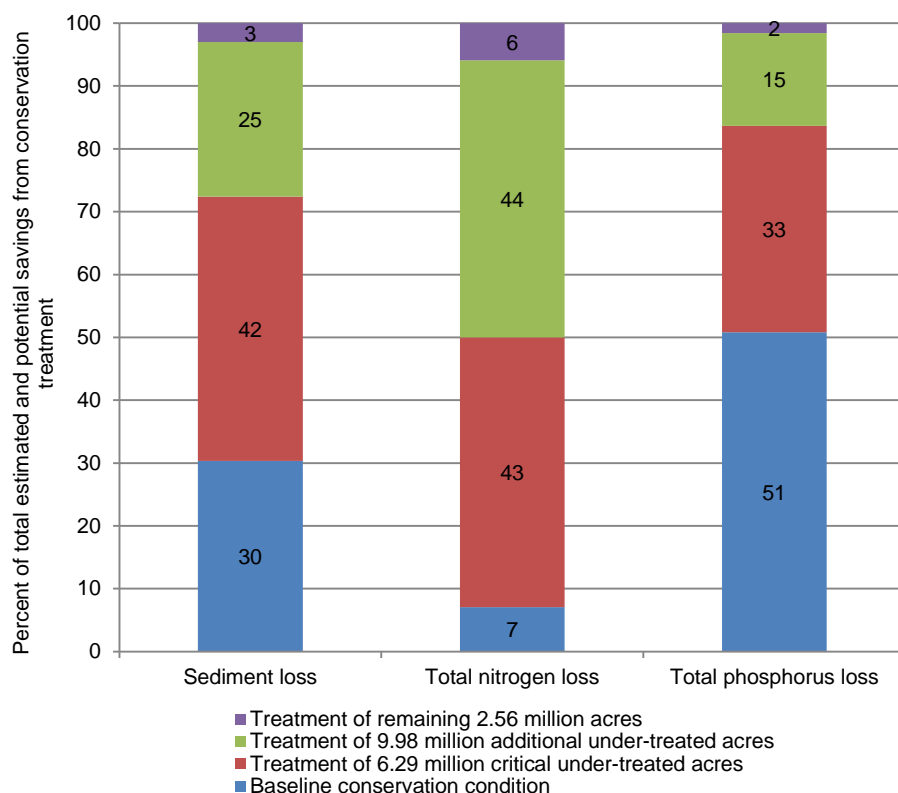
* Phosphorus lost to surface water includes sediment-attached and soluble phosphorus. Soluble phosphorus includes not only phosphorus in runoff but also leaching to loss pathways such as tile drains and natural seeps. Much of this lost phosphorus eventually returns to surface water.

NOTE: Not all edge-of-field losses of sediment and nutrients reach rivers and streams. Some are captured by buffers, wetlands, or other non-agricultural lands.

Comprehensive Conservation Planning is Needed, and Targeting Enhances Effectiveness and Efficiency

The practices in use during the period 2003 to 2006 achieved about 30 percent of potential reductions in sediment loss, 7 percent of potential reductions in nitrogen loss, and 51 percent of potential reductions in phosphorus loss (fig. 2). Significant per-acre reductions in sediment and nutrient losses could be achieved by focusing on the 16.3 million high- and moderate-treatment-need cropland acres. Targeting critical acres significantly improves the effectiveness of conservation practice implementation. Use of additional erosion- and nutrient-control practices on acres that have a high need for additional treatment—acres most prone to runoff or leaching and with low levels of conservation practice use—can reduce most edge-of-field losses by about twice as much or more compared to treatment of acres with a moderate level of need.

Figure 2. Comparison of estimated sediment, nitrogen, and phosphorus savings (field-level) due to practices in use in the baseline conservation condition and potential savings with additional water erosion control and nutrient management treatment of cropped acres in the Lower Mississippi River Basin



The Lower Mississippi River Basin is more subject to intensive tropical systems than are the upstream basins in the Mississippi River drainage system. Even though soil erodibility in the region is considered to be generally low, the high rainfall duration and intensity associated with tropical storms results periodically in high sediment and nutrient losses from farm fields. More than the other basins in the Mississippi system, the Lower Mississippi River Basin requires enhanced soil erosion control practices and high levels of nutrient management, even on soils that have low or moderate potential for sediment and nutrient losses.

Conservation Practice Effects on Water Quality

Reductions in field-level losses due to conservation practices, including land in long-term conserving cover, are expected to improve water quality in streams and rivers in the region. Figures 3, 4, and 5 summarize the extent to which conservation practices on cultivated cropland acres have reduced sediment, nitrogen, and phosphorus loads in the Lower Mississippi River Basin, on the basis of the model simulations. On all three figures—

- “no-practice scenario” refers to conditions that would be expected if no conservation practices were in use;
- “baseline conservation condition” refers to estimates of conditions based on farming and conservation practices in use during the period 2003–06;
- “critical under-treated acres” refers to land with a high level of conservation treatment need, as defined on page 3;
- “all under-treated acres” refers to land with high and moderate levels of conservation treatment need, as defined on page 3; and
- “background” refers to expected levels of sediment and nutrient loadings if no acres were cultivated in the region. Estimates of background loadings simulate a grass and tree mix cover without any tillage or addition of nutrients or pesticides for all cultivated cropland acres in the watershed. Background loads also include loads from all other land uses—hayland, pastureland, rangeland, horticultural land, forest land, and urban land—and point sources.

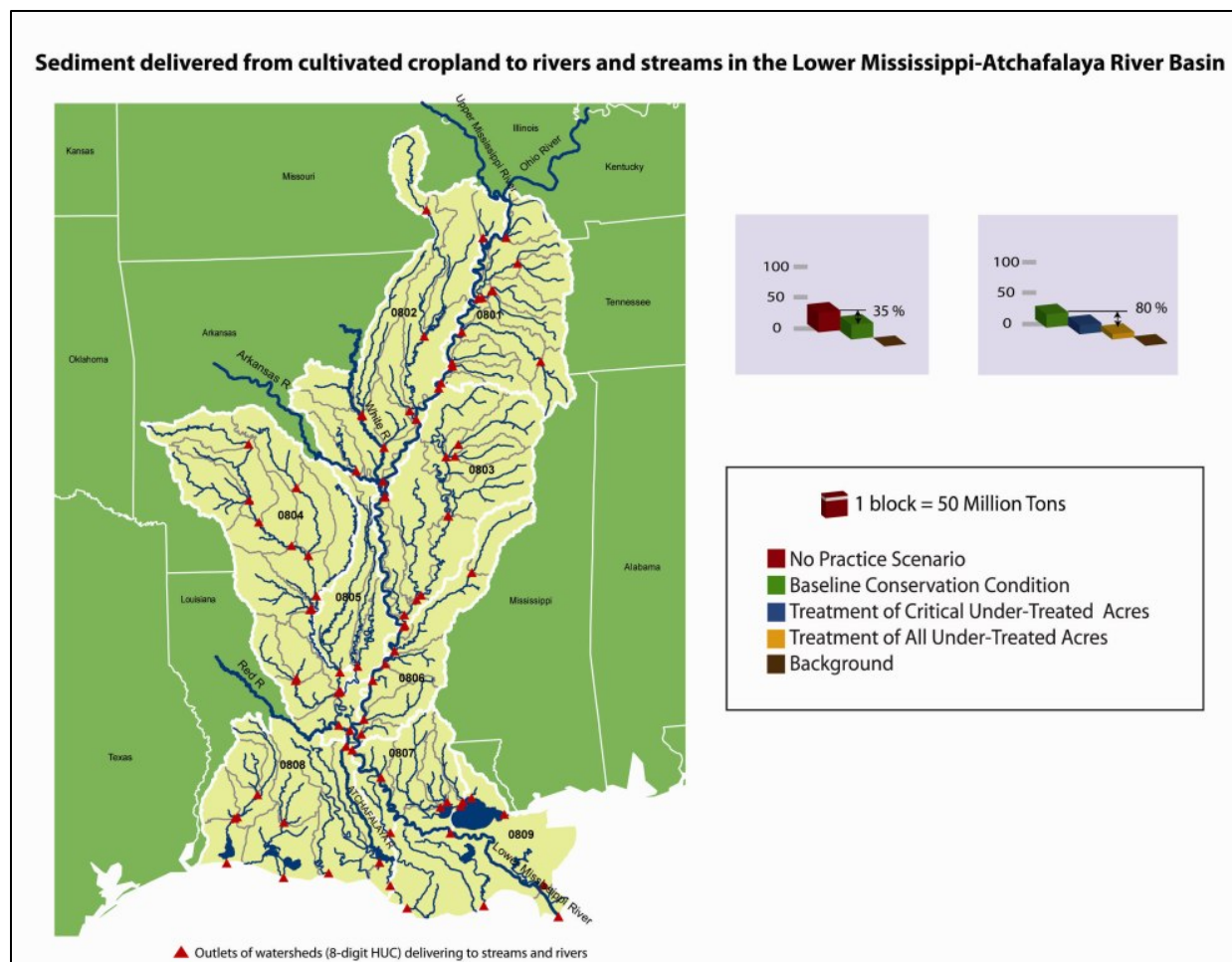
The effects of practices in use during the period 2003 to 2006 are determined by contrasting loads for the baseline conservation condition to loads for the no-practice scenario. The effects of additional conservation treatment on loads are determined by contrasting the loads for the baseline condition to either loads for treatment of cropped acres with a *high* level of treatment need (6.3 million acres), or loads for treatment of cropped acres with a *high or moderate* level of treatment need (10 million acres).

Sediment Loss

Figure 3 shows that the use of conservation practices has reduced **sediment loads delivered from cropland to rivers and streams** in the region by 35 percent from conditions that would be expected without conservation practices. Application of additional conservation practices on the high- and moderate-treatment-need acres would further reduce sediment loads to rivers and streams by 80 percent.

We estimate that the four major upstream river basins deliver a total of some 136 million tons of sediment to the Lower Mississippi River Basin annually, on average. These sediments originate not only on cultivated cropland but also other agricultural lands, forest land, urban point sources, and other rural and urban nonpoint sources. The Lower Mississippi River Basin contributes an additional 54 million tons of sediment to deliver a total of 190 million tons of sediment annually to the Gulf of Mexico. Model simulations estimate that the use of comprehensive conservation treatment on all high- and moderate-treatment-need cropland in the Mississippi River drainage system could reduce sediment loads to the Gulf by about 4 percent from baseline levels.

Figure 3. Summary of the effects of conservation practices on sediment loads delivered to rivers and streams in the Lower Mississippi River Basin)

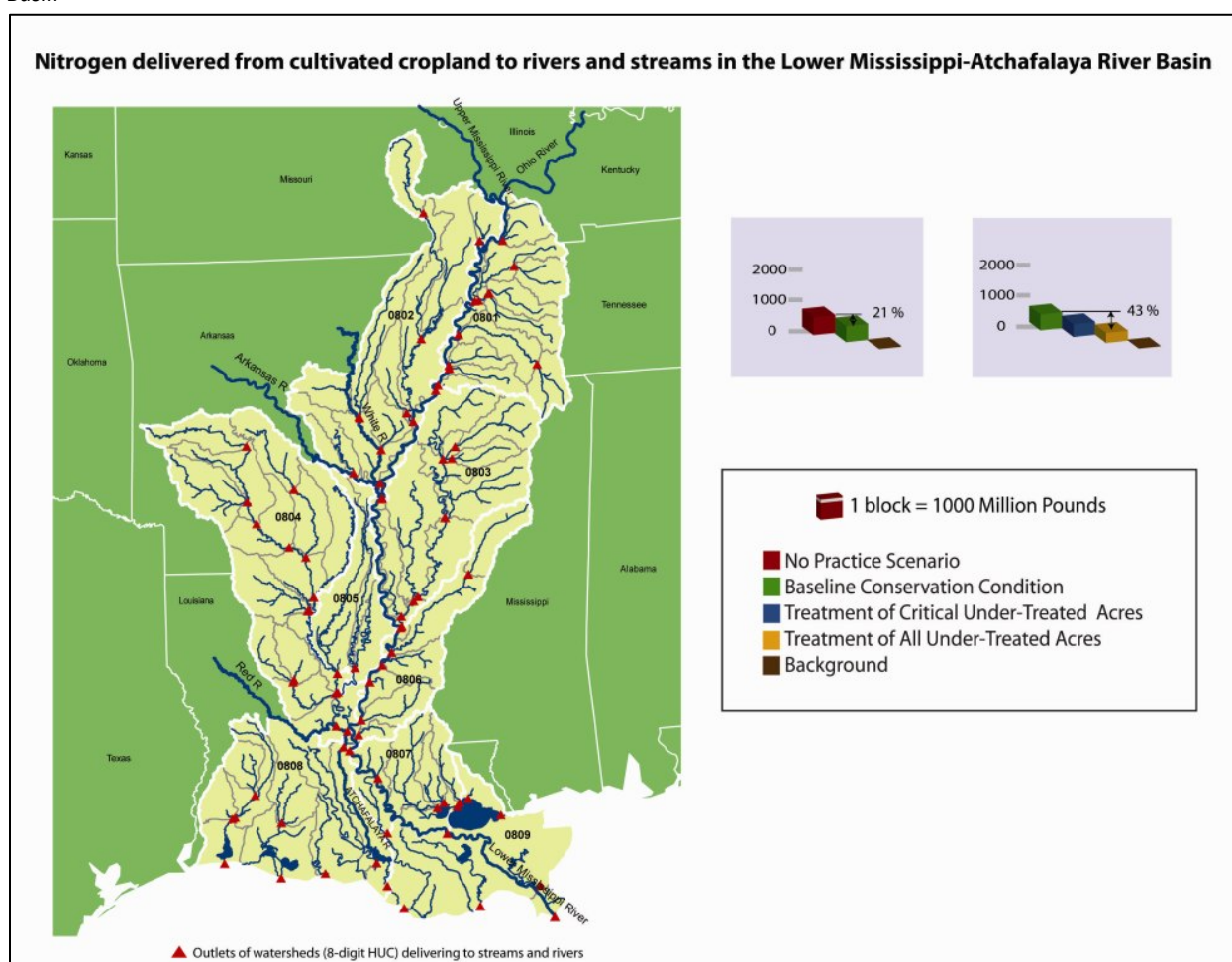


Nitrogen Loss

Figure 4 shows that the use of conservation practices has reduced **total nitrogen loads delivered from cropland to rivers and streams** in the region by 21 percent from conditions that would be expected without conservation practices. Application of additional conservation practices on the high- and moderate-treatment-need acres would further reduce nitrogen loads to rivers and streams by 43 percent.

We estimate that the four major upstream river basins deliver a total of some 2.8 billion pounds of nitrogen to the Lower Mississippi River Basin annually, on average. This nitrogen originates not only on cultivated cropland but also other agricultural lands, forest land, urban point sources, and other rural and urban nonpoint sources. The Lower Mississippi River Basin contributes an additional 469 million pounds of nitrogen to deliver a total of 3.2 billion pounds of nitrogen annually to the Gulf of Mexico. Model simulations estimate that the use of comprehensive conservation treatment on all high- and moderate-treatment-need cropland in the Mississippi River drainage system could reduce nitrogen loads to the Gulf by about 17 percent from baseline levels.

Figure 4. Summary of the effects of conservation practices on nitrogen loads delivered to rivers and streams in the Missouri River Basin

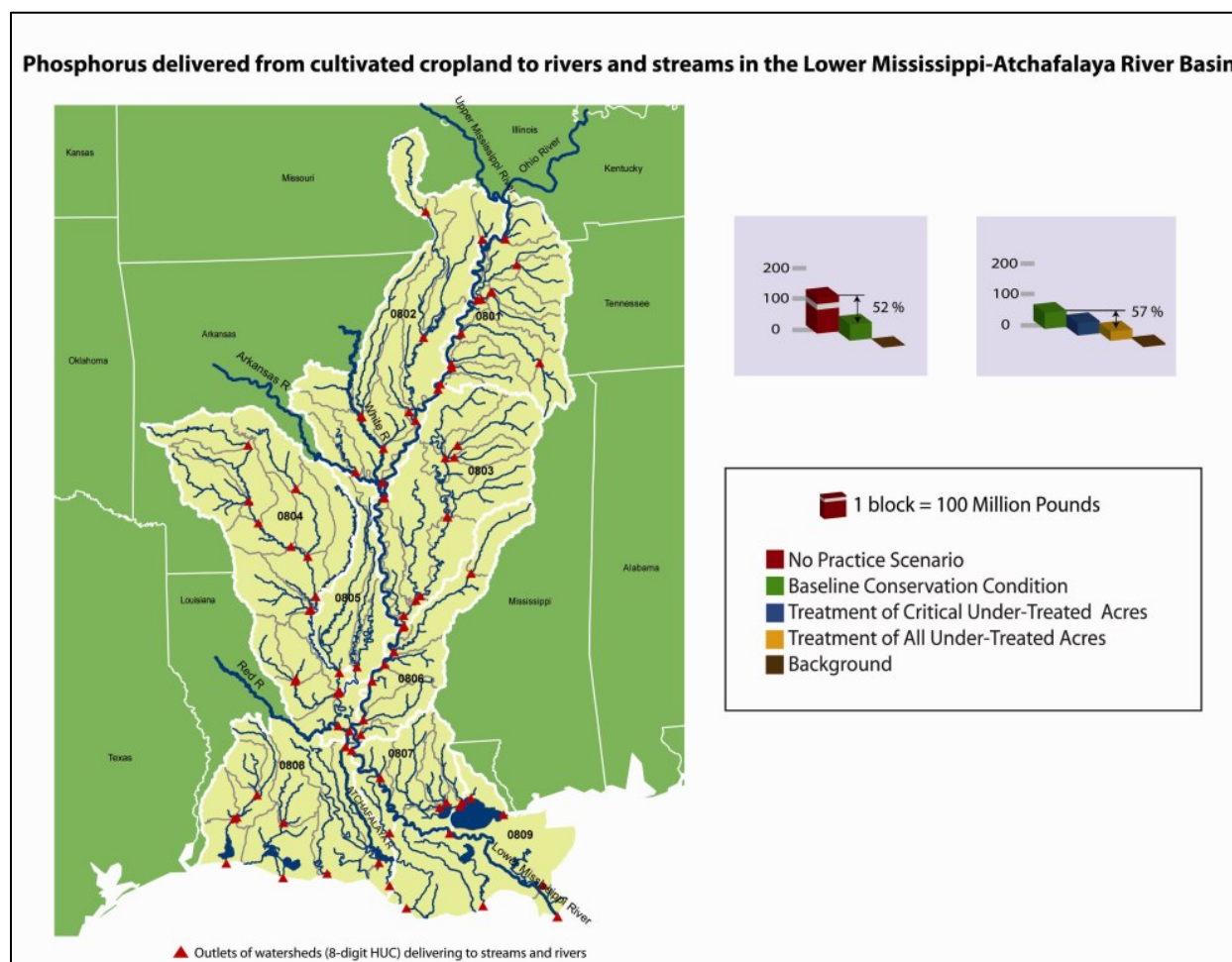


Phosphorus Loss

Figure 5 shows that the use of conservation practices has reduced **total phosphorus loads delivered from cropland to rivers and streams** in the region by 52 percent from conditions that would be expected without conservation practices. Application of additional conservation practices on the high- and moderate-treatment-need acres would further reduce phosphorus loads to rivers and streams by 57 percent.

We estimate that the four major upstream river basins deliver a total of some 250 million pounds of phosphorus to the Lower Mississippi River Basin annually, on average. This phosphorus originates not only on cultivated cropland but also other agricultural lands, forest land, urban point sources, and other rural and urban nonpoint sources. The Lower Mississippi River Basin contributes an additional 75 million pounds of phosphorus to deliver a total of 326 million pounds of phosphorus annually to the Gulf of Mexico. Model simulations estimate that the use of comprehensive conservation treatment on all high- and moderate-treatment-need cropland in the Mississippi River drainage system could reduce phosphorus loads to the Gulf by about 22 percent from baseline levels.

Figure 5. Summary of the effects of conservation practices on phosphorus loads delivered to rivers and streams in the Missouri River Basin



Regional Comparisons:

Upper Mississippi, Ohio-Tennessee, Missouri, Arkansas-White-Red, and Lower Mississippi River Basins

The Upper Mississippi, Ohio-Tennessee, Missouri, Arkansas-White-Red, and Lower Mississippi River Basins make up the Mississippi River drainage area—a vast area covering about 40 percent of the land area of the United States. Average annual precipitation in the Lower Mississippi River Basin—53 inches per year on average across the region—ranges from 20 percent more than in the Ohio-Tennessee River Basin to more than twice as much as in the Missouri River Basin. This high precipitation, coupled with intense rainfall events, results in significant overland losses of sediment and nutrients.

Table 3 compares several factors across the five regions. Conservation practice use is extensive in all four basins. Structural or tillage and residue management practices for erosion control are in use on 87 percent or more of cropped acres in all five basins. Farmers' use of structural and tillage practices has reduced sediment and nutrient losses in all five regions. Few farmers, however, are using complete and consistent nutrient application *rate, form, timing, and method* on all crops in all years, although many farmers successfully meet one or more of these criteria on some crops in the rotation.

Several vulnerability factors—percentage of cropland soils having slope of 2 percent or less, percentage of cropland that is highly erodible, and leaching potential—are lower in the Lower Mississippi than in the other basins in the Mississippi River drainage system. Consequently, conservation practice use in the region is somewhat less extensive than in the other regions. However, the high annual rainfall totals and intensity lead to extensive losses of sediment and nutrients.

Sediment losses, nitrogen losses through surface and subsurface pathways, and phosphorus losses are higher in the Lower Mississippi than in any of the other regions in the Mississippi River drainage. Reductions in sediment and nitrogen losses due to conservation practice use are lower in the Lower Mississippi than in the other regions. Only in the Ohio-Tennessee River Basin are phosphorus loss reductions less than in the Lower Mississippi. As a result, the percentage of high- and moderate-treatment-need cropland in the Lower Mississippi River Basin is much higher than in the other four regions (fig. 6).

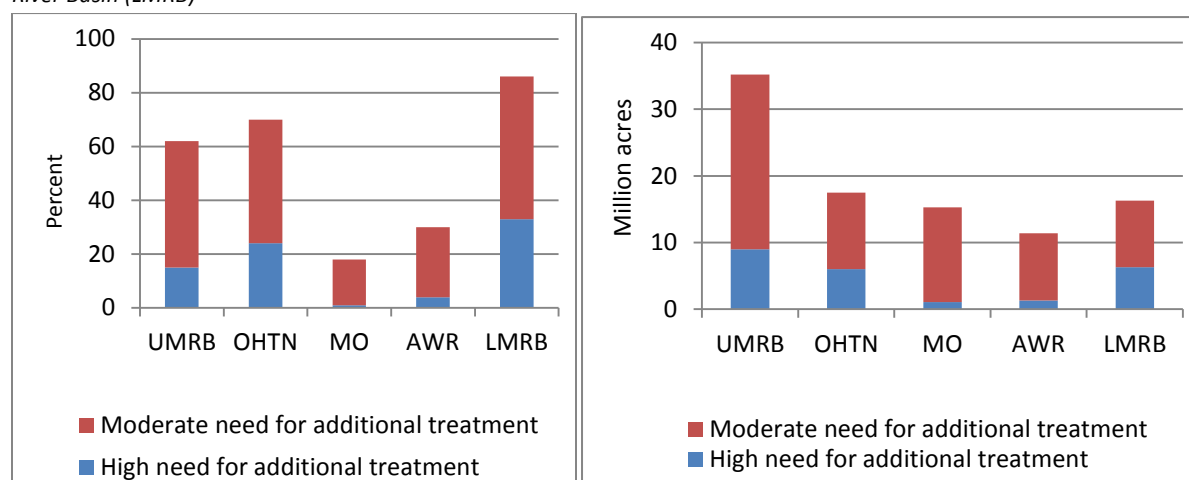
Table 3. Comparison of conservation factors in the five basins that make up the Mississippi River drainage system

Factor	Upper Mississippi River Basin*	Ohio-Tennessee River Basin	Missouri River Basin	Arkansas-White-Red Basin	Lower Mississippi River Basin
Basin Overview					
Total acres (million acres excluding water)	118.2	128.5	322.2	156.5	61.6
Acres of cultivated cropland (million acres)	62.9	26.8	95.1	35.3	20.2
Percent cultivated cropland (excluding water)	53	21	30	23	33
Percent urban land (excluding water)	8	9	3	5	6
Vulnerability Factors					
Average annual precipitation (inches)	34	42	23	27	53
Slopes >2% (% of cropped acres)	42	33	48	15	8
Highly erodible cropland (% of cropped acres)	18	27	40	32	12
Prone to wind erosion (% of cropped acres)	1	0	28	14	0
Prone to surface water runoff (% of cropped acres)	13	9	12	<1	12
Prone to leaching (% of cropped acres)	10	8	11	13	2
Conservation Practice Use (2003–06)					
Mulch till or no-till (% cropped acres)	91	93	93	58	81
Structural practices for water erosion control:					
Percent of all cropped acres	45	40	41	46	21
Percent of HEL cropland	72	59	49	47	42
Reduced tillage or structural practices (% cropped acres)	96	98	98	87	90
High or moderately high nitrogen management (% cropped acres)	41	42	65	63	44
High or moderately high phosphorus management (% cropped acres)	54	43	63	62	34
Land in long-term conserving cover (% of cropped acres)	5	4	12	17	5
Sediment and nutrient losses, baseline** (average annual)					
Wind erosion (tons/acre)	0.23	0.02	1.13	2.17	0.12
Waterborne sediment (tons/acre)	0.9	1.6	0.3	0.3	3.0
Windborne nitrogen (pounds/acre)	2.1	0.2	5.8	6.5	0.4
Waterborne nitrogen (surface) (pounds/acre)	8.8	13.2	2.6	2.5	14.1
Waterborne nitrogen (subsurface) (pounds/acre)	18.7	19.2	6.9	11.3	25.7
Windborne phosphorus (pounds/acre)	0.4	0.0	1.0	1.5	0.1
Phosphorus lost to surface water (pounds/acre)	2.7	4.5	0.7	0.8	5.2
Edge-of-Field Reductions Due to Conservation Practice Use (2003–06)					
Wind erosion (% reduction)	64	60	58	31	20
Sediment (% reduction)	61	52	73	61	27
Windborne nitrogen (% reduction)	37	47	46	27	14
Waterborne nitrogen (surface) (% reduction)	45	35	58	51	26
Waterborne nitrogen (subsurface) (% reduction)	9	11	45	57	5
Windborne phosphorus (% reduction)	55	63	58	40	34
Phosphorus lost to surface water (% reduction)	42	33	59	57	39
Conservation treatment needs					
Treatment need for one or more resource concerns:					
Cropland with high need (% of cropped acres)	15	24	1	4	33
Cropland with moderate need (% of cropped acres)	45	46	17	30	53
High or moderate need (% of cropped acres)	60	70	18	34	86
High or moderate need by resource concern:					
Wind erosion (% of cropped acres)	0	0	12	23	0
Sediment loss due to water erosion (% of cropped acres)	10	25	3	3	74
Nitrogen loss with surface water (% of cropped acres)	24	29	4	0	59
Nitrogen loss in subsurface flows (% of cropped acres)	47	17	2	9	38
Phosphorus loss (% of cropped acres)	22	63	1	2	67
Most extensive need:	Subsurface nitrogen loss	Phosphorus loss	Wind erosion control	Wind erosion control	Sediment and nutrient loss

*Findings from the Upper Mississippi River Basin study were revised in December 2010 (revision published August 2012).

**“Baseline” refers to estimates of conditions based on farming and conservation practices in use during the period 2003–06.

Figure 6. Percentage (left) and acreage (right) of high- and moderate-treatment-need cropland in the Upper Mississippi River Basin (UMRB), Ohio-Tennessee River Basin (OH-TN), Missouri River Basin (MO), Arkansas-White-Red Basin (AWR), and Lower Mississippi River Basin (LMRB)



River Basin Cropland Modeling Study Reports The U.S. Department of Agriculture initiated the Conservation Effects Assessment Project (CEAP) in 2003 to determine the effects and effectiveness of soil and water conservation practices on agricultural lands. The CEAP report *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Lower Mississippi River Basin* is the sixth in a series of studies covering the major river basins and water resource regions of the conterminous 48 United States. It was designed to quantify the effects of conservation practices commonly used on cultivated cropland in the Lower Mississippi River Basin, evaluate the need for additional conservation treatment in the region, and estimate the potential gains that could be attained with additional conservation treatment. This series is a cooperative effort among USDA's Natural Resources Conservation Service and Agricultural Research Service, Texas AgriLife Research of Texas A&M University, and the University of Massachusetts.

Upper Mississippi River Basin (draft released June 2010, revision completed July 2012)

Chesapeake Bay Region (released March 2011)

Great Lakes Region (released September 2011)

Ohio-Tennessee River Basin (released February 2012)

Missouri River Basin (released August 2012)

Arkansas-White-Red River Basin (April 2013)

Lower Mississippi River Basin (August 2013)

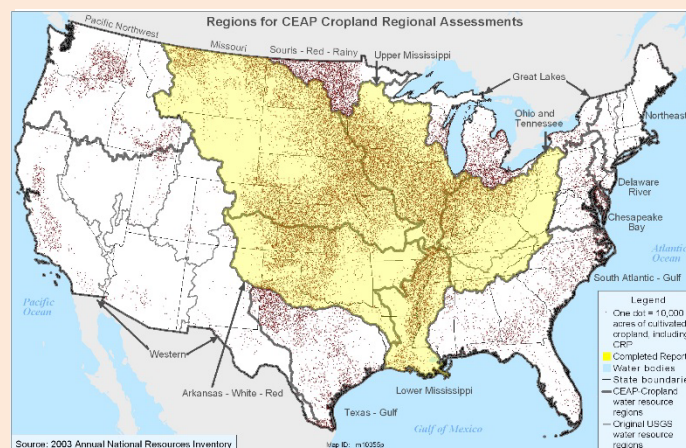
Texas Gulf Water Resource Region

South Atlantic-Gulf Region

Pacific Northwest and Water Resource Region

Souris-Red-Rainy Water Resource Region

Delaware River Watershed



The Northeast and Western Water Resource Regions cannot be completed because there are too few National Resources Inventory sample points for reliable statistical estimation.

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