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Natural Resources Conservation Service
Conservation Effects Assessment Project

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Summary of Findings

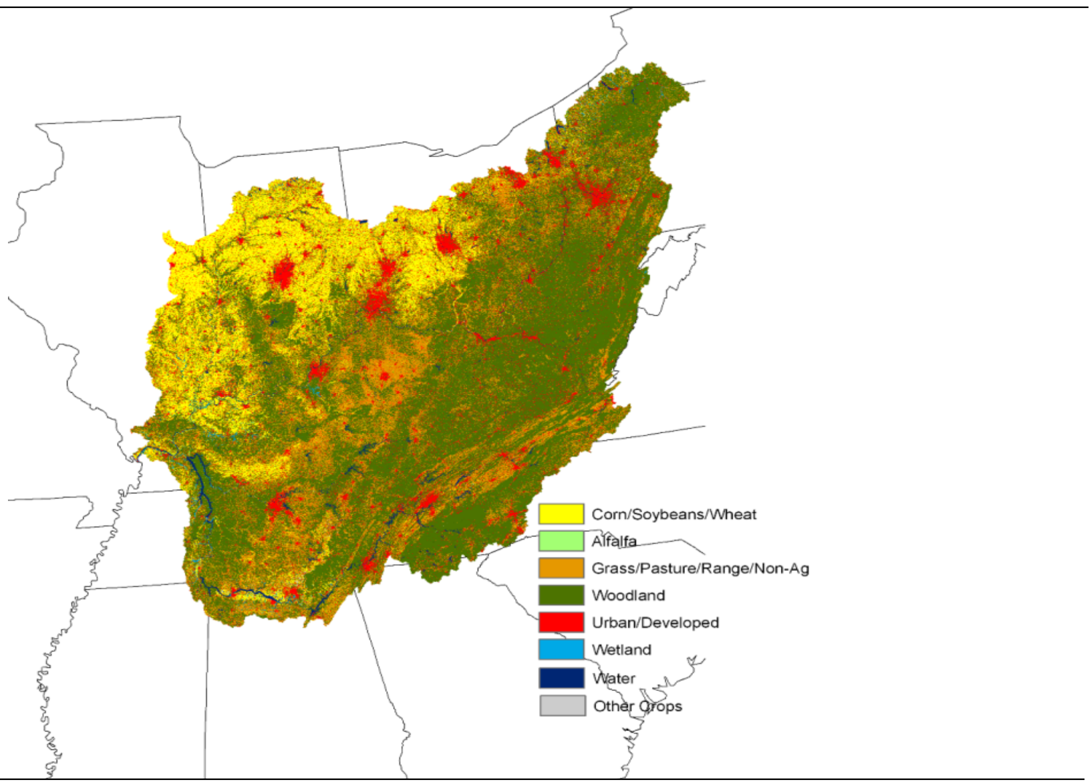
Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Ohio-Tennessee River Basin

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 fourth study in this series is on the Ohio-Tennessee River Basin. This region covers about 204,000 square miles and includes parts of 14 states (fig. 1). Cultivated cropland makes up 21 percent of the land area of the basin. This report, like all of the other reports in the series, is based on computer modeled simulations of conservation outcomes derived from the use of farming and conservation practices as reported by farmers during the period 2003 to 2006.

As with the three previously published reports in the series, CEAP modeling efforts in the Ohio-Tennessee River Basin found that farmers have reduced onsite and offsite environmental problems stemming from agricultural activities. Even so, significant additional progress can be achieved, particularly through more rigorous application of nutrient management in combination with erosion-control practices. Simulation modeling showed that conservation practices in the region have reduced edge-of-field losses of sediment, nitrogen, and phosphorus as well as loadings of these materials in rivers, streams, and the Lakes.

The resource concern with the most widespread need for additional conservation treatment related to cropland in the region is the loss of phosphorus from farm fields. This differs from the findings of the previous three studies in the series—on the Upper Mississippi River Basin, Chesapeake Bay Region, and Great Lakes Region—where nitrogen loss through subsurface flow was the primary concern.

Figure 1. *Location of and land cover in the Ohio-Tennessee River Basin*



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

Study Findings

Voluntary, Incentives-Based Conservation Approaches Are Achieving Results

Farmers have reduced sediment, nutrient, and pesticide losses from farm fields through conservation practice adoption throughout the Ohio-Tennessee River Basin, compared to a no-practice scenario that simulates losses that would be expected if no conservation practices were in use. Although only 27 percent of the cropland in the region is classified as highly erodible land, structural practices for controlling soil erosion are in place on 40 percent of all cropped acres in the region and on 59 percent of the highly erodible cropland. Ninety-three percent of the cropland acres meet criteria for no-till (52 percent) or mulch till (41 percent), and all but 4 percent have evidence of some kind of reduced tillage on at least one crop in the rotation. Ninety-eight percent have structural or management practices, or both.

Table 1 shows estimated reductions in losses of sediment and nutrients from farm fields and reductions in loadings of sediment and nutrients to rivers, streams, and the Lakes.

Table 1. Reductions in edge-of-field losses and in loadings of sediment and nutrients from cultivated cropland through existing conservation treatment, Ohio-Tennessee River Basin

Pollutant	Reduction in edge of field losses	Reduction in loads to rivers and streams	Reduction in loads to the Mississippi River (all sources)
	- -	*Percent*	- -
Waterborne Sediment	52	55	16
Total Nitrogen	17	26	15
Total Phosphorus	33	32	21

Opportunities Exist to Further Reduce Sediment and Nutrient Losses from Cultivated Cropland

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 soluble 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 nitrogen 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 million acres—24 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 11.5 million acres—46 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 7.5 million acres—30 percent of the cultivated cropland in the region—have a low level of need for additional conservation treatment.*

Table 2 shows potential reductions in sediment, nitrogen, and phosphorus losses and delivery to rivers and streams in the Ohio-Tennessee River Basin and to the Mississippi River. Potential reductions are those that could be achieved from existing levels through implementation of suites of conservation practices on cropped acres having high or moderate levels of treatment need.

Table 2. Potential for further reductions in edge-of-field losses and in loadings of sediment and nutrients from cultivated cropland through comprehensive conservation treatment of high- and moderate-treatment-need cropland, Ohio-Tennessee River Basin

Pollutant	Potential reduction in edge of field losses	Potential reduction in loads to rivers and streams	Potential reduction in loads to the Mississippi River (all sources)
	- - - - - - - - - - - -	*Percent*	- - - - - - - - - - - -
Sediment	83	81	15
Total Nitrogen	40	41	20
Phosphorus	61	58	31

Comprehensive Conservation Planning and Implementation Are Essential

The resource concern with the most widespread need for additional conservation treatment related to cropland in the region is the loss of soluble phosphorus in surface runoff. About 20 percent of the cropped acres have a high need for additional nutrient management to address this need, and an additional 43 percent have a moderate need. Twenty-nine percent of cropped acres in the region have a high or moderate need for additional treatment to reduce nitrogen loss in surface runoff, and 17 percent have a high or moderate need for additional treatment to reduce nitrogen loss through leaching.

Suites of practices that include both soil erosion control and nutrient management—appropriate rate, form, timing, *and* method of application—are required to simultaneously address soil erosion and nutrient losses in runoff and through leaching. Increased water infiltration and loss of nutrients through subsurface pathways can be unintended consequences of using structural and residue management practices to control runoff, erosion, and sedimentation without appropriate nutrient management.

Targeting Enhances Effectiveness and Efficiency

Targeting critical acres significantly improves the effectiveness of conservation practice implementation. Use of additional conservation 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 sediment and nutrient per-acre losses by about twice as much on average as treatment of acres with a moderate level of need. Even greater efficiencies can be achieved when comparing treatment of high- or moderate-need acres to low-treatment need acres.

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 2, 3, and 4 summarize the extent to which conservation practices on cultivated cropland acres have reduced, and can further reduce, sediment, nitrogen, and phosphorus loads in the Ohio-Tennessee River Basin, on the basis of the model simulations. In each figure, the top map shows delivery from cultivated cropland to rivers and streams within the region and the bottom map shows delivery from all sources to the Lakes after accounting for losses and gains through instream processes. On all three figures—

- "baseline" refers to estimates of conditions based on farming and conservation practices in use during 2003–06;
- "no-practice scenario" refers to conditions that would be expected if no conservation practices were in use;
- "critical under-treated acres" refers to land with a high level of conservation treatment need, as defined on page 2;
- "all under-treated acres" refers to land with high and moderate levels of conservation treatment need, as defined on page 2; and
- "background" refers to expected levels of sediment and nutrient loadings if there were 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—as well as point sources.

The effects of practices in use during 2003–06 are seen by contrasting loads for the baseline conservation condition to loads for the no-practice scenario. The effects of additional conservation treatment on loads are seen by contrasting the loads for the baseline condition to either loads for treatment of acres with a *high* level of treatment need (6 million critical under-treated acres), or loads for treatment of all under-treated acres (17.5 million acres with either a *high* or *moderate* level of treatment need).

Sediment Loss

In figure 2, the top map shows that the use of conservation practices has reduced ***sediment loads delivered from cropland to rivers and streams*** in the region by 55 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline sediment loads delivered to rivers and streams within the region by 60 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a "high" or "moderate" need for treatment) would reduce baseline sediment loads delivered to rivers and streams within the region by 81 percent.

The bottom map shows that the use of conservation practices on cropland has reduced ***sediment loads delivered to the Mississippi River from all sources*** by 16 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline sediment loads delivered to the Mississippi by 11 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a" high" or "moderate" need for treatment) would reduce baseline sediment loads delivered to the Mississippi by 15 percent.

Nitrogen Loss

In figure 3, the top map shows that the use of conservation practices has reduced ***total nitrogen loads delivered from cropland to rivers and streams*** in the region by 26 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total nitrogen loads delivered to rivers and streams within the region by 19 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a" high" or "moderate" need for treatment) would reduce baseline nitrogen loads delivered to rivers and streams within the basin by 41 percent.

The bottom map shows that the use of conservation practices on cropland has reduced ***total nitrogen loads delivered to the Mississippi River from all sources*** by 15 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total nitrogen loads delivered to the Mississippi by 9 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a "high" or "moderate" need for treatment) would reduce baseline nitrogen loads delivered to the Mississippi by 20 percent.

Phosphorus Loss

In figure 4, the top map shows that the use of conservation practices has reduced ***total phosphorus loads delivered from cropland to rivers and streams*** in the region by 32 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total phosphorus loads delivered to rivers and streams by 26 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a "high" or "moderate" need for treatment) would reduce baseline phosphorus loads delivered to rivers and streams within the basin by 58 percent.

The bottom map shows that the use of conservation practices on cropland has reduced ***total phosphorus loads delivered to the Mississippi River from all sources*** by 21 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total phosphorus loads delivered to the Mississippi by 13 percent by treating acres with a "high" level of treatment need. Treating *all* under-treated acres (acres with either a "high" or "moderate" need for treatment) would reduce baseline phosphorus loads delivered to the Mississippi by 31 percent.

Figure 2. *Summary of the effects of conservation practices on sediment loads in the Ohio-Tennessee River Basin*

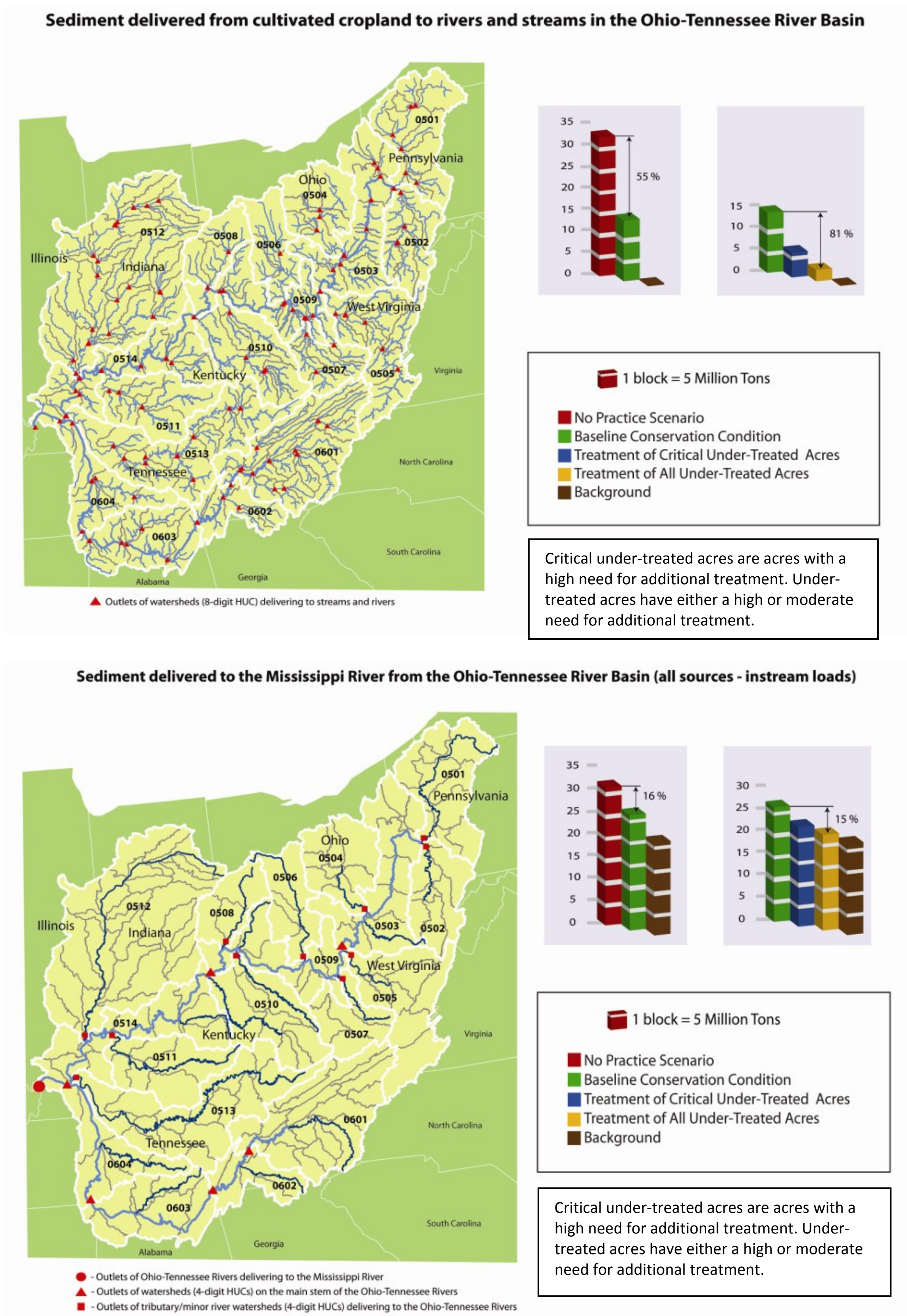


Figure 3. *Summary of the effects of conservation practices on nitrogen loads in the Ohio-Tennessee River Basin*

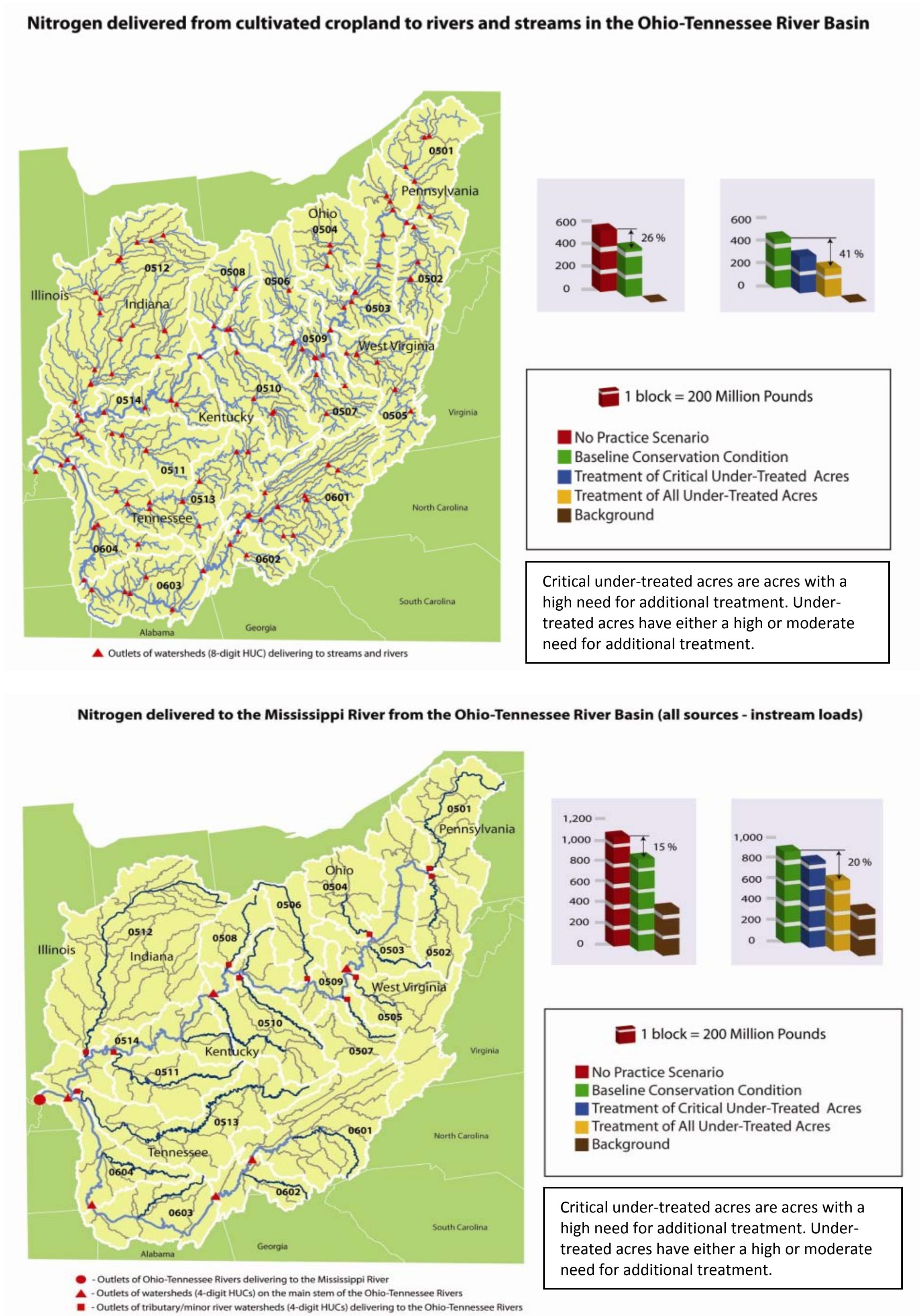
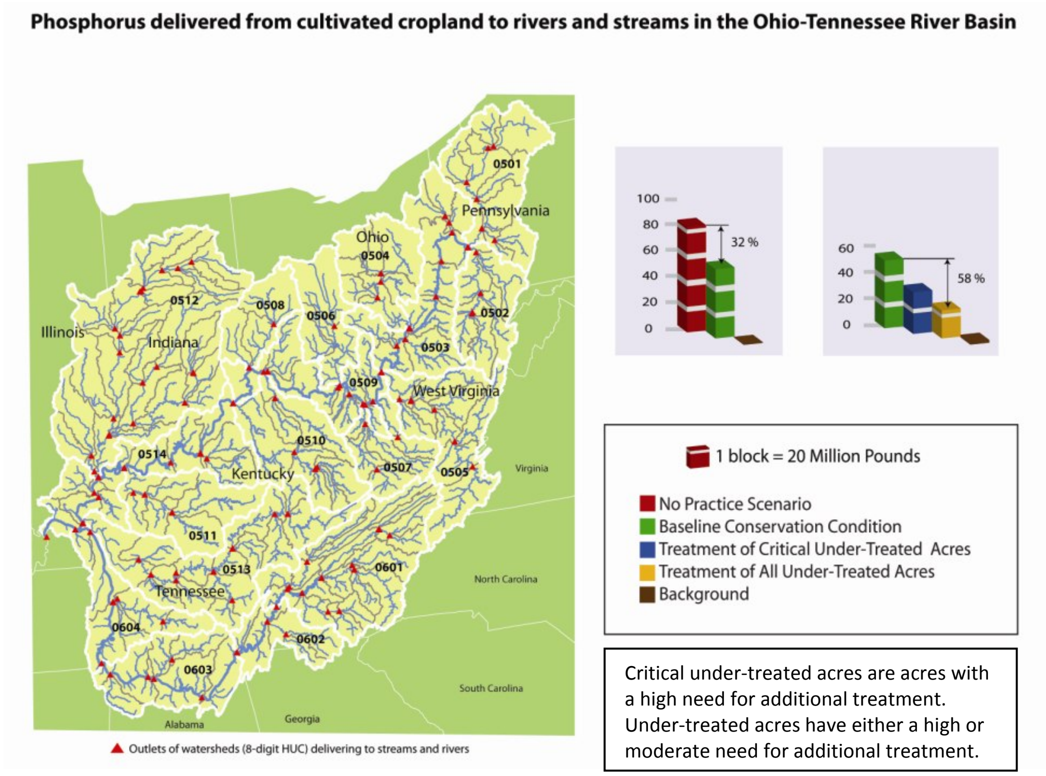
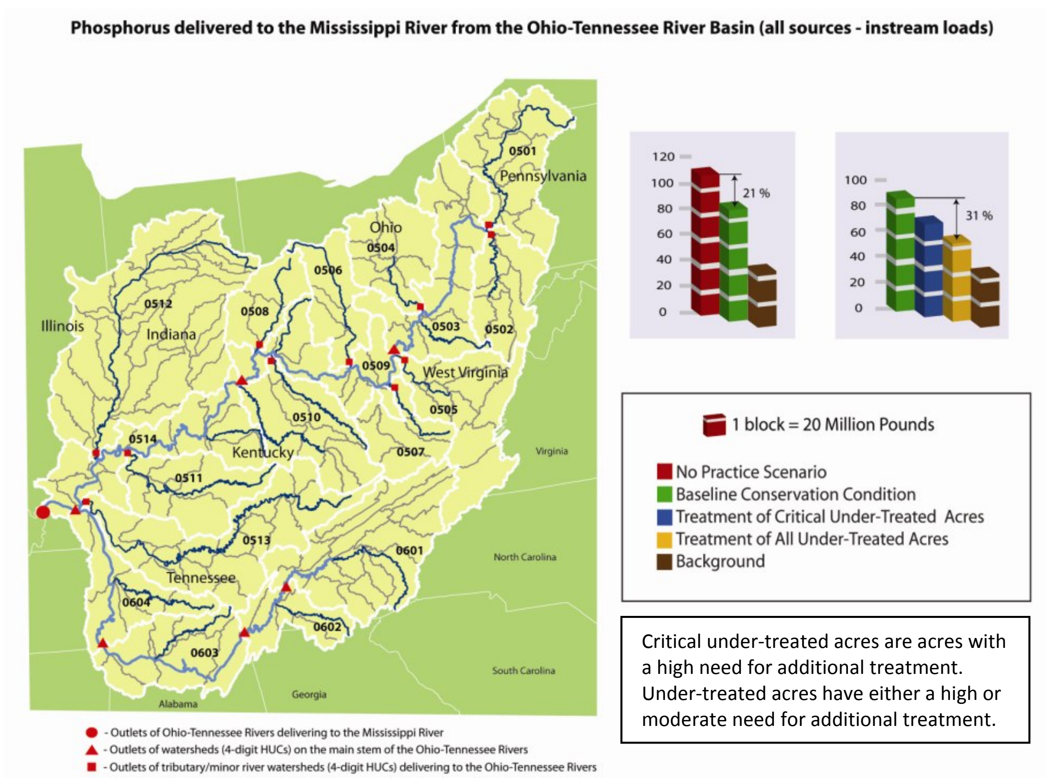


Figure 4. *Summary of the effects of conservation practices on phosphorus loads in the Ohio-Tennessee River Basin*





Regional Comparisons

The differences in findings among the four regional studies completed so far—Upper Mississippi River Basin, Chesapeake Bay Region, Great Lakes Region, and Ohio-Tennessee River Basin—are more in degree than in kind. Table 3 compares several factors across the four regions. The major difference is that in the Upper Mississippi, Chesapeake Bay, and Great Lakes regions, the most widespread agricultural conservation concern is the loss of nitrogen through leaching, while in the Ohio-Tennessee, the most widespread concern is the loss of soluble phosphorus in surface runoff.

Conservation practice use is widespread in all four regions. Structural or tillage practices used alone or in combination are in use on 94 percent or more of the acres in all regions, and farmers' use of structural and tillage practices has reduced sediment and nutrient losses in all regions. In all four regions, few farmers are using complete and consistent nutrient application *rate, form, timing,* and *method* on all crops in all years, although many farmers are successfully meeting one or more of these criteria on some crops in the rotation. Although conservation practice use has reduced such losses, in some places the effectiveness of erosion-control practices in reducing runoff and erosion has encouraged soil infiltration of water and soluble nutrients. Figure 5 compares the extent of high- and moderate-treatment-need cropland in the four regions.

Figure 5. *Extent of high- and moderate-treatment-need cropland in the Upper Mississippi River Basin, Chesapeake Bay Region, Great Lakes Region, and Ohio-Tennessee River Basin*

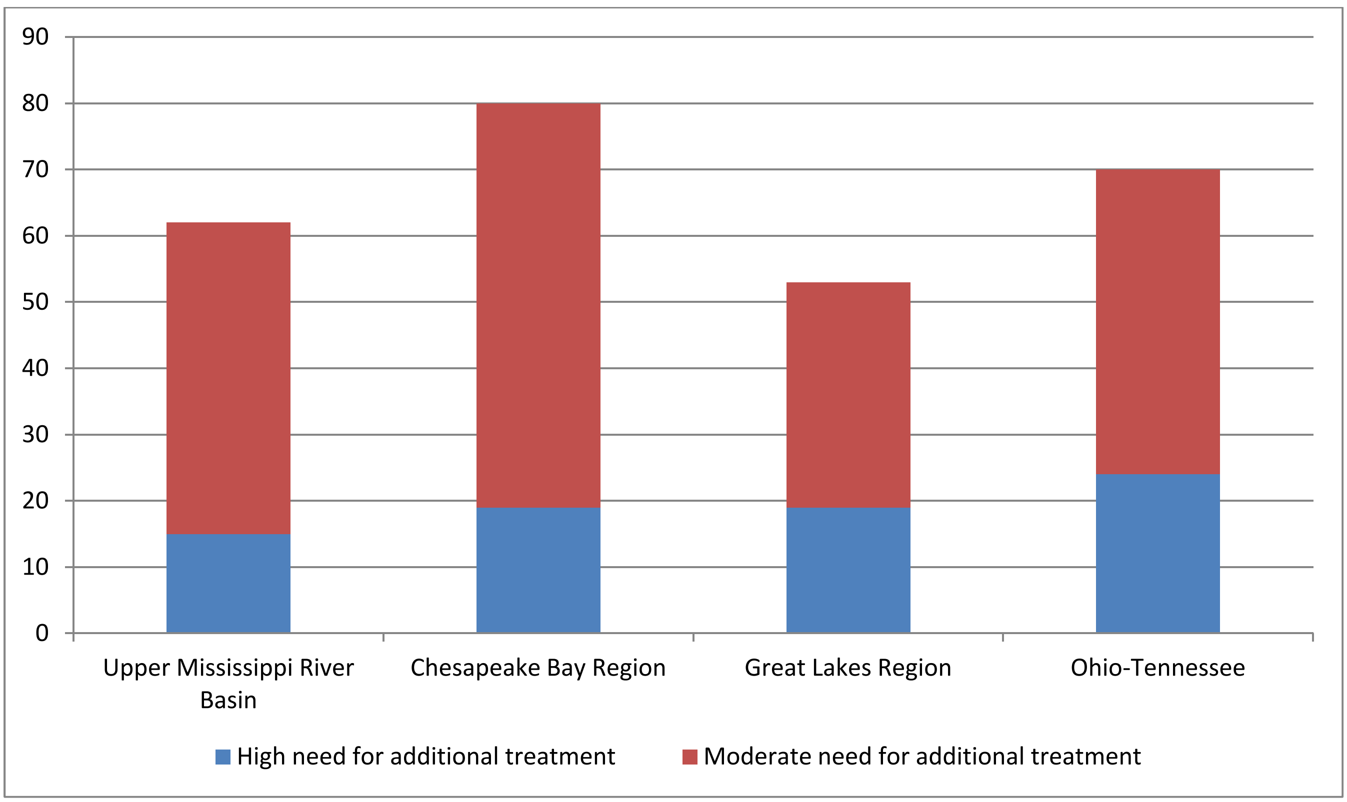


Table 3. Comparison of conservation factors in the Upper Mississippi River Basin, Chesapeake Bay Region, Great Lakes Region, and Ohio-Tennessee River Basin

Factor	Upper Mississippi River Basin*	Chesapeake Bay Region	Great Lakes Region	Ohio Tennessee River Basin
Basin Overview				
Total acres (million acres excluding water)	118.2	42.7	73.3	128.5
Acres of cultivated cropland (million acres)	63.5	4.6	17.8	26.8
Percent cultivated cropland (excluding water)	54	11	24	21
Percent urban land (excluding water)	8	9	10	9
Vulnerability Factors				
Average annual precipitation (inches)	34	42	34	42
Slopes >2% (% of cropped acres)	42	60	34	33
Highly erodible cropland (% of cropped acres)	18	44	17	27
Prone to surface water runoff (% of cropped acres)	13	23	6	9
Prone to leaching (% of cropped acres)	9	46	30	8
Conservation Practice Use (2003–06)				
Mulch till or no-till (% cropped acres)	91	88	82	93
Structural practices for water erosion control:				
Percent of all cropped acres	45	46	26	40
Percent of HEL cropland	72	63	37	59
Reduced tillage or structural practices (% cropped acres)	96	96	94	98
High or moderately high nitrogen management (% cropped acres)	41	38	45	42
High or moderately high phosphorus management (% cropped acres)	54	38	47	43
Sediment and nutrient losses, baseline (average annual)**				
Wind erosion (tons/acre)	0.23	0.27	0.85	0.02
Sediment (tons/acre)	0.9	1.2	0.6	1.6
Nitrogen (surface) (pounds/acre)	9	9	6	13
Nitrogen (subsurface) (pounds/acre)	19	33	26	19
Phosphorus lost to surface water (pounds/acre)	2.7	3.7	2.1	4.5
Edge-of-Field Reductions Due to Conservation Practice Use (2003-06)				
Sediment (% reduction)	61	55	47	52
Nitrogen (surface) (% reduction)	45	42	43	35
Nitrogen (subsurface) (% reduction)	9	31	30	11
Total Phosphorus (% reduction)	44	40	39	33
Conservation treatment needs				
Treatment need for one or more resource concerns:				
Cropland with high need (% of cropped acres)	15	19	19	24
Cropland with moderate need (% of cropped acres)	45	61	34	46
High or moderate need (% of cropped acres)	60	80	53	70
High or moderate need by resource concern:				
Wind erosion (% of cropped acres)	0	0	2	0
Sediment loss due to water erosion (% of cropped acres)	10	24	6	25
Nitrogen loss with surface water (% of cropped acres)	24	24	6	29
Nitrogen loss in subsurface flows (% of cropped acres)	47	62	45	17
Phosphorus loss (% of cropped acres)	22	51	12	63
Most extensive need:	Subsurface nitrogen loss	Subsurface nitrogen loss	Subsurface nitrogen loss	Phosphorus loss

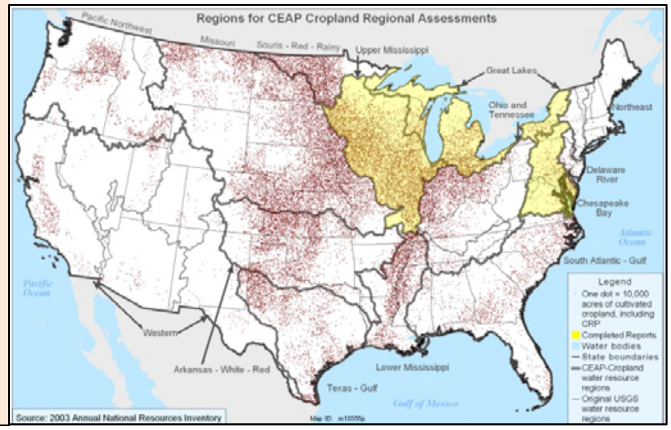
*Findings from the Upper Mississippi River Basin study are preliminary pending final.

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

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 Ohio-Tennessee River Basin* is the fourth is a series of studies covering the major river basins and water resource regions of the contiguous 48 United States. It was designed to quantify the effects of conservation practices commonly used on cultivated cropland in the Chesapeake Bay Watershed, 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)
Chesapeake Bay Region (released March 2011)
Great Lakes Region (released September 2011)
Ohio-Tennessee River Basin (released February 2012)
Missouri River Basin
Arkansas-White-Red River Basins
Lower Mississippi River Basin
Delaware River Watershed
Northeast Region
South Atlantic-Gulf Region
Texas Gulf Water Resource Region
Souris-Red-Rainy Water Resource Regions
Pacific Northwest and Western Water Resource Regions

Expect release of these reports through 2012.



Methodology Used for the Cropland Assessments
A simulation model was used to estimate the effects of conservation practices that were in use during the period 2003 to 2006, but does not capture practices implemented since then. The NRCS National Resources Inventory, a statistical survey of conditions and trends in soil, water, and related resources on U.S. non-Federal land, provided the statistical framework. Information on farming activities and conservation practices was obtained from a farmer survey. Using those data, conservation practice effects were evaluated in terms of—

- reductions in losses of sediment, nutrients, and pesticides from farm fields;
- enhancement of soil quality through increases in soil organic carbon in the field; and
- reductions in instream loads of sediment, nutrients, and pesticides in the region's rivers and streams.

The physical process models used in this study are mathematical representations of the real world designed to estimate complex and varying environmental events and conditions. To estimate the effects of conservation practices, model simulation results were used to make *relative comparisons* between two model runs—one that includes conservation practices and one that excludes conservation practices. All other aspects of the input data and the model parameters were held constant. Model results are scientifically defensible to the level of 4-digit hydrologic unit code (HUC) (subregion) watersheds in most cases.

Difference between these two scenarios represents the benefits of the accumulation of conservation practices currently in place on the landscape.

The assessment includes conservation practices in use regardless of how or why they came to be in use. It is not restricted to only those practices associated with Federal conservation programs; the assessment also includes the conservation efforts of States, independent organizations, and individual landowners and farm operators.

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