United States Department of Agriculture
Natural Resources Conservation Service
Conservation Effects Assessment Project

September 2011

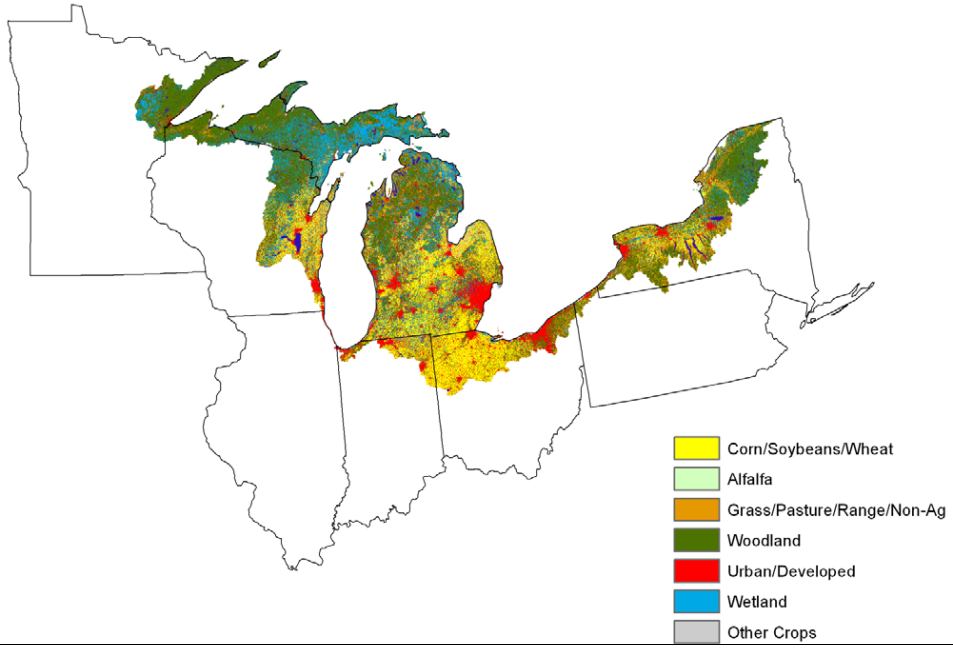
Summary of Findings

Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Great Lakes Region

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 third study in this series, on the *U.S. portion* of the Great Lakes drainage, is referred to as the Great Lakes Region. This region covers about 174,000 square miles and includes parts of eight states—nearly all of Michigan, significant parts of Wisconsin, New York, and Ohio, and small parts of Minnesota, Indiana, Illinois, and Pennsylvania. Cultivated cropland makes up 24 percent of the land area of the Great Lakes Region (fig. 1). All of the reports in the series are 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 two previously published reports in the series, CEAP modeling efforts 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 nitrogen loss in subsurface flows. Additional conservation practices to address excessive phosphorus loss (sediment adsorbed and soluble) from fields are also important but the need for these practices occurs on a smaller proportion of the cropland than treatment needs for nitrogen loss.

Figure 1. *Location of and land cover in the U.S. portion of the Great Lakes drainage*



SOURCE: TEXAS AGRILIFE RESEARCH, TEXAS A&M UNIVERSITY

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 Great Lakes Region, compared to a no-practice scenario that simulates losses that would be expected if no conservation practices were in use. Although only 17 percent of the cropland in the region is classified as highly erodible land, structural practices for controlling soil erosion are in place on 26 percent of all cropped acres in the region and on 37 percent of the highly erodible cropland. Eighty-two percent of the cropland acres meet criteria for no-till (32 percent) or mulch till (50 percent), and all but 9 percent have evidence of some kind of reduced tillage on at least one crop in the rotation. Ninety-four percent have structural or management practices, or both.

Table 1 shows 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, Great Lakes Region

Pollutant	Reduction in edge-of-field losses	Reduction in loads to rivers and streams	Reduction in loads to the Lakes (all sources)
	Percent		
Sediment	47	50	12
Total Nitrogen	28	37	21
Total Phosphorus	39	36	20

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 2.8 million acres—19 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 5 million acres—34 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 6.9 million acres—47 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 Great Lakes Region and to the Lakes themselves. 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, Great Lakes Region

Pollutant	Potential reduction in edge-of-field losses	Potential reduction in loads to rivers and streams	Potential reduction in loads to the Lakes (all sources)
	Percent		
Sediment	64	58	9
Total Nitrogen	31	37	16
Phosphorus	36	33	15

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 nitrogen loss in subsurface flows. Additional conservation practices are also needed to address excessive phosphorus loss (sediment adsorbed and soluble) from fields, but on a smaller proportion of the region's cropland.

About 16 percent of the cropped acres have a high need for treatment to reduce subsurface losses of nitrogen, and 29 percent have a moderate need. Twelve percent of cropped acres in the region have a moderate need for additional treatment to reduce phosphorus loss. 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 Great Lakes Region, 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 (2.84 million critical under-treated acres), or loads for treatment of all under-treated acres (7.9 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 50 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 25 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 58 percent.

The bottom map shows that the use of conservation practices on cropland has reduced ***sediment loads delivered to the Lakes from all sources*** by 12 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline sediment loads delivered to the Lakes by 4 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 Lakes by 9 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 37 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 18 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 37 percent.

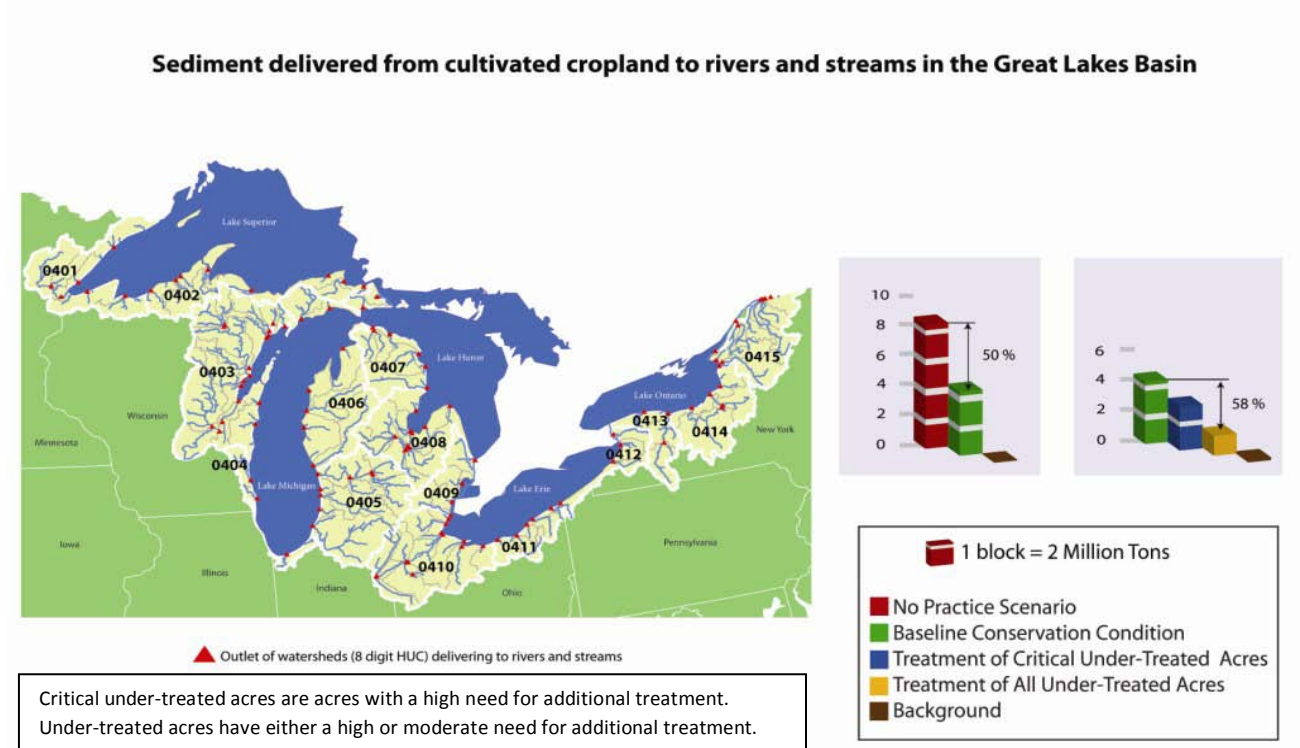
The bottom map shows that the use of conservation practices on cropland has reduced ***total nitrogen loads delivered to the Lakes from all sources*** by 21 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total nitrogen loads delivered to the Lakes by 8 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 Lakes by 16 percent.

Phosphorus Loss

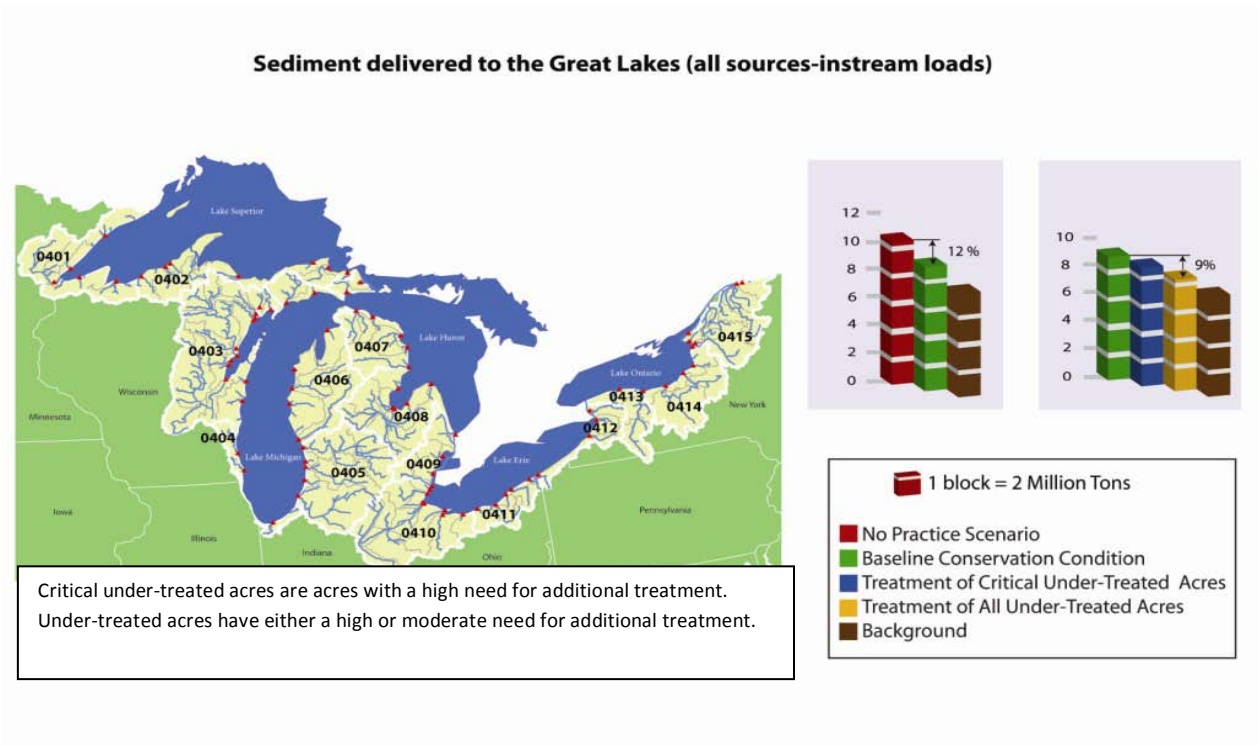
In figure 4, the top map shows that the use of conservation practices has reduced ***total phosphorus loads delivered from cropland to rivers and streams*** in the region by 36 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total phosphorus loads delivered to rivers and streams by 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 phosphorus loads delivered to rivers and streams within the basin by 33 percent.

The bottom map shows that the use of conservation practices on cropland has reduced ***total phosphorus loads delivered to the Lakes from all sources*** by 20 percent from conditions that would be expected without conservation practices. Application of additional conservation practices would reduce baseline total phosphorus loads delivered to the Lakes by 5 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 Lakes by 15 percent.

Figure 2. *Summary of the effects of conservation practices on sediment loads in the Great Lakes Region*

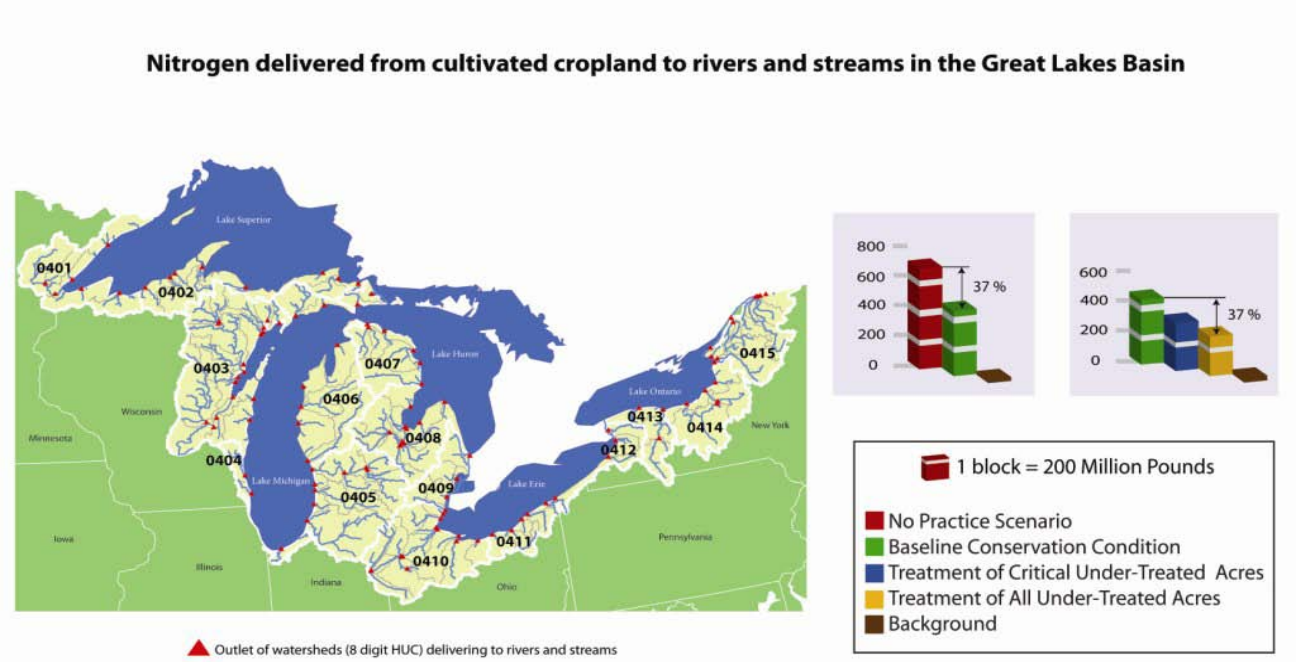


Critical under-treated acres are acres with a high need for additional treatment. Under-treated acres have either a high or moderate need for additional treatment.

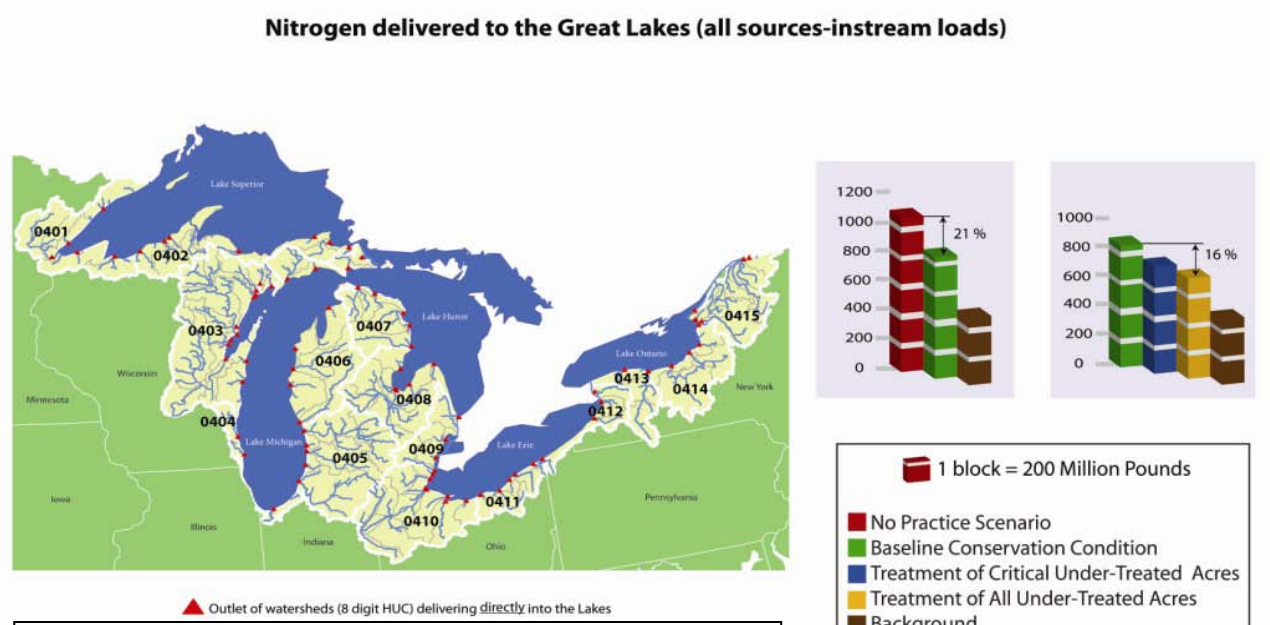


Critical under-treated acres are acres with a high need for additional treatment. Under-treated acres have either a high or moderate need for additional treatment.

Figure 3. *Summary of the effects of conservation practices on total nitrogen loads in the Great Lakes Region*

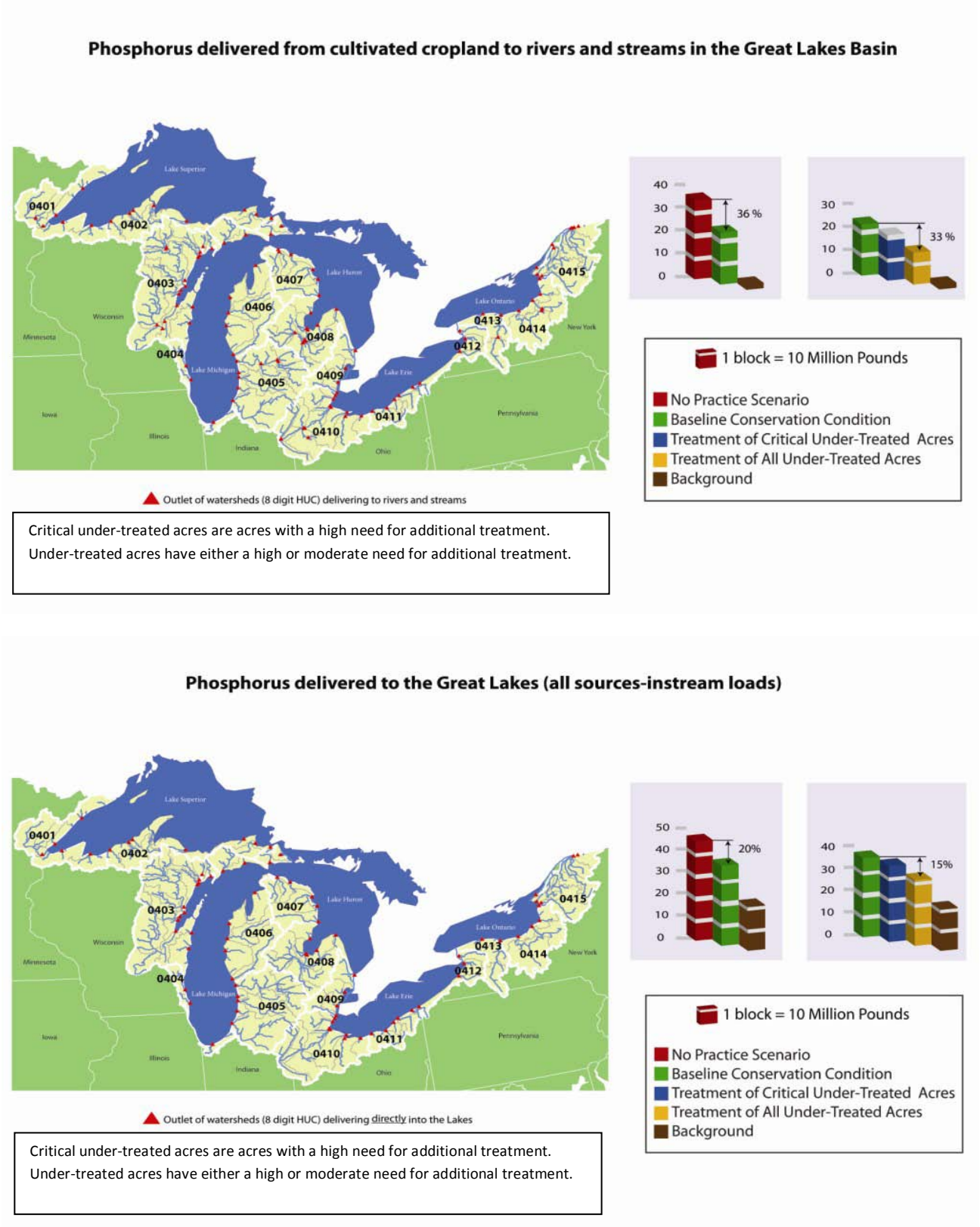


Critical under-treated acres are acres with a high need for additional treatment.
Under-treated acres have either a high or moderate need for additional treatment.



Critical under-treated acres are acres with a high need for additional treatment.
Under-treated acres have either a high or moderate need for additional treatment.

Figure 4. *Summary of the effects of conservation practices on total phosphorus loads in the Great Lakes Region*



Regional Comparisons

The differences in findings among the three regional studies completed so far—Upper Mississippi River Basin, Chesapeake Bay Region, and Great Lakes Region—are more in degree than in kind. Table 2 compares several factors across the three regions. By most measures, the inherent vulnerability factors for sediment and nutrient losses are less severe in the Great Lakes Region than in the other two.

Conservation practice use is widespread in all three 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 three regions. The lower percentage of structural erosion control practice use in the Great Lakes Region is due not to a lessened conservation ethic in the region but to the much lower percentage of sloping cropland and thus less need for terraces and other structural practices.

Reducing the loss of nitrogen through subsurface pathways is the most extensive conservation need in the Upper Mississippi and the Chesapeake as well as the Great Lakes. Controlling these losses is a high treatment need on 45 percent of cropped acres in the Great Lakes Region, compared to 47 percent in the Upper Mississippi River Basin and 62 percent in the Chesapeake Bay Region. In all three 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. 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. *Extent of high- and moderate-treatment-need cropland in the Upper Mississippi River Basin, Chesapeake Bay Region, and Great Lakes Region*

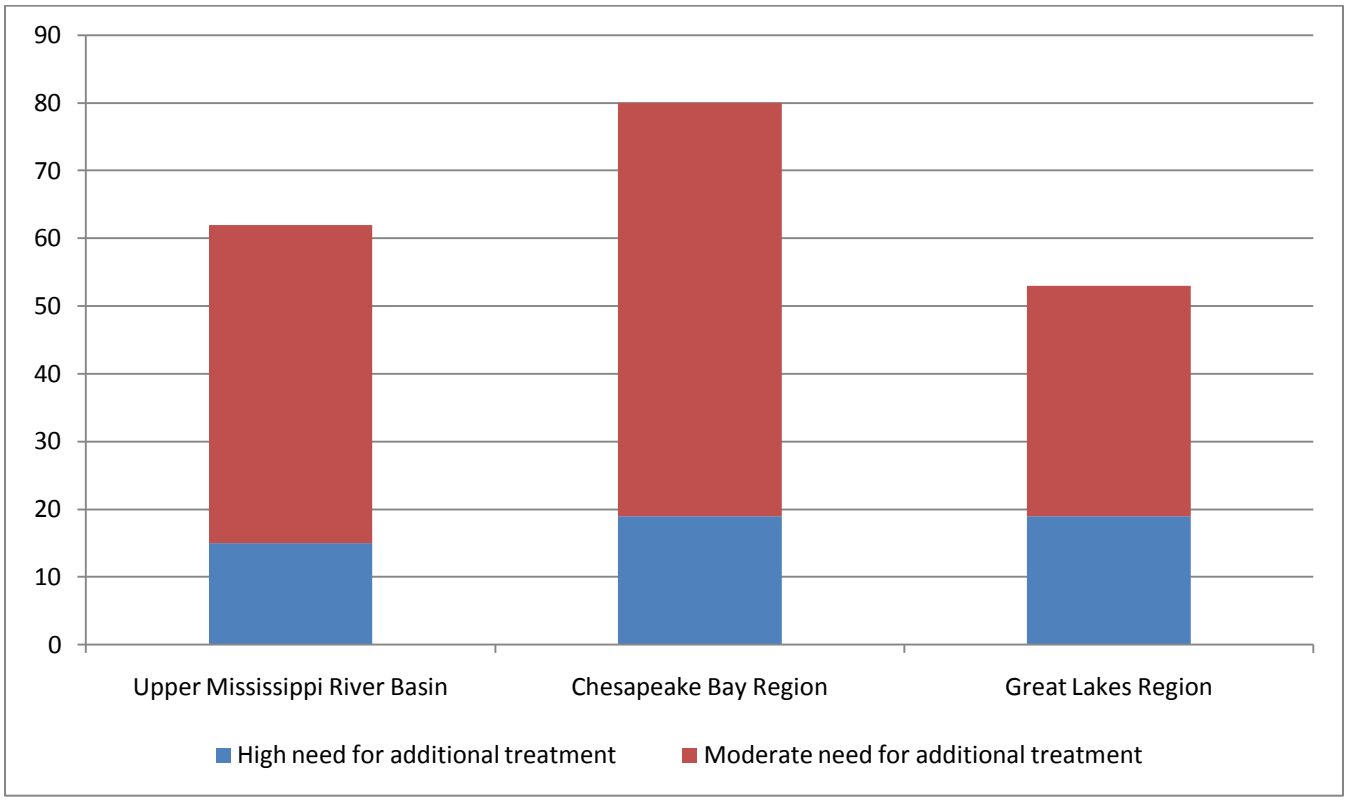


Table 3. Comparison of conservation factors in the Upper Mississippi River Basin, Chesapeake Bay Region, and Great Lakes Region

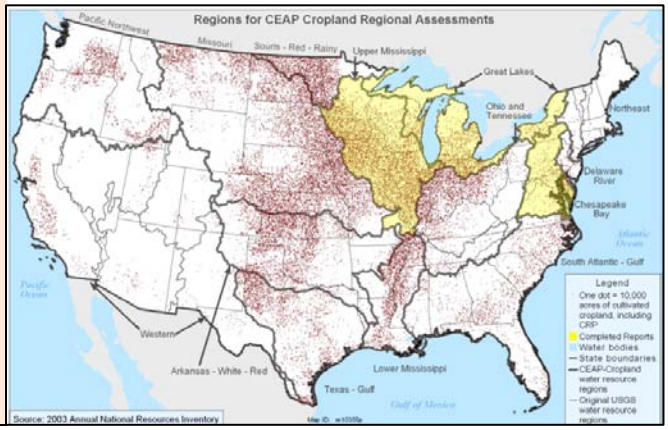
Factor	Upper Mississippi River Basin	Chesapeake Bay Region	Great Lakes Region
Basin Overview			
Total acres (million acres excluding water)	118.2	42.7	73.3
Acres of cultivated cropland (million acres)	63.5	4.6	17.8
Percent cultivated cropland (excluding water)	54	11	24
Percent urban land (excluding water)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

*"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 Great Lakes Region* is the third 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 (released June 2010)
Chesapeake Bay Region (released March 2011)
Great Lakes Region (released September 2011)
Ohio-Tennessee River Basin
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

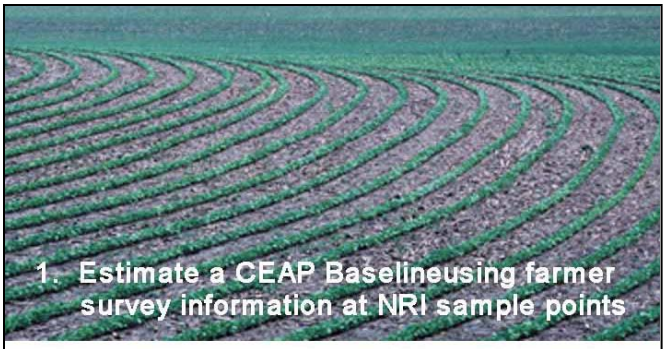
Expect release of these reports through early 2012.



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.



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.