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

April 2015

Summary of Findings

Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Texas Gulf Basin

CONTENTS

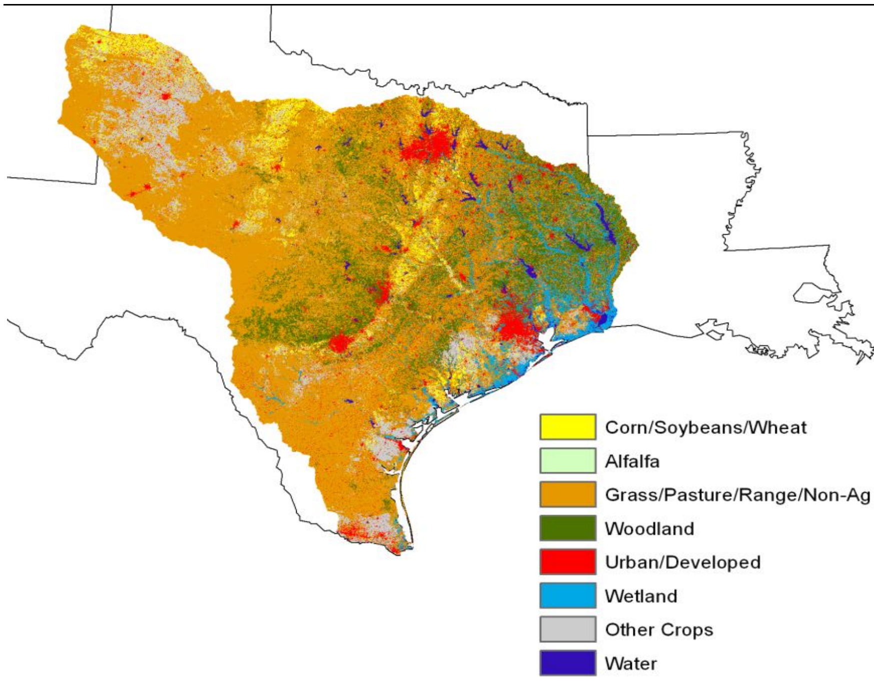
To view or download a PDF version of the full report, visit the NRCS Web site, http://www.nrcs.usda.gov, and follow links to Technical Resources / Natural Resources Assessment / CEAP

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 final study in this series is on the Texas Gulf Basin.

The Texas Gulf Basin covers most of Texas, the western part of Louisiana, and a small part of eastern New Mexico (fig. 1). More than half of the area of the region is grazing land (rangeland or pasture). Urban land makes up about 8 percent of the region; the major metropolitan areas are Houston, Dallas-Fort Worth, San Antonio, and Austin, TX.

About 15 percent of the region is cultivated cropland, including land enrolled in the General Signup of the Conservation Reserve Program. The main crops are upland cotton, sorghum, hay, and wheat. In 2007, the region had 40 percent of the Nation's upland cotton acres and 29 percent of the Nation's sorghum-for-grain acres.

Figure 1. *Location of and land cover in the Texas Gulf 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.

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

The national sample for the farmer survey consists of 18,700 sample points with 693 of these sample points located in the Texas Gulf 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.

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 Texas Gulf Basin, compared to losses that would be expected if no conservation practices were in use. Structural practices for controlling water erosion are in place on 37 percent of all cropped acres in the region. Thirty percent of cropped acres meet criteria for mulch till. Only 5 percent meet criteria for no-till, however, a much lower percentage than in the other regions studied for this series. Reduced tillage methods are used less in this region than in other regions studied because cotton, a major crop in the Texas Gulf region, requires conventional tillage to control pests. Farmers meet criteria for good nitrogen management on about 22 percent of the cropped acres (an additional 17 percent had no nitrogen applications) and good phosphorus management on 10 percent (an additional 34 percent had no phosphorus applications).

Table 1 shows that conservation practice use has significantly reduced waterborne losses of sediment; nitrogen, including nitrogen lost through subsurface pathways; and phosphorus. Structural practices for controlling wind erosion, however, are in place on only 3 percent of the cropped acres. Thus, reductions of losses of sediment and nutrients due to wind erosion are marginal.

Table 1. Reductions in edge-of-field losses of sediment and nutrients from cultivated cropland through conservation treatment in place during 2003–06, Texas Gulf Basin

Sediment		Nitrogen			Phosphorus *	
Windborne	With runoff	Windborne	With runoff	Through leaching	Windborne	All pathways
Percent reduction						
2	52	<1	45	29	19	33

Opportunities Exist to Further Reduce Soil Erosion 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 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 7.6 million acres—41 percent of the cultivated cropland in the region—have a high level of need for additional conservation treatment, nearly all for reduction of wind erosion.*
- **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 10.3 million acres—56 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 500,000 acres—3 percent of the cultivated cropland in the region—have a low level of need for additional conservation treatment.*

The 7.6 million high-treatment-need acres need treatment primarily for wind erosion control. Wind erosion averages 14.2 tons per acre per year on these high-treatment need acres. We estimate that use of erosion control practices could cut wind erosion losses on these acres by 45 percent. Significant reductions in waterborne sediment and nutrient loss from baseline levels could also be achieved through implementation of suites of conservation practices. Table 2 shows potential for reductions (beyond 2003–06 baseline levels) in *edge-of-field* sediment, nitrogen, and phosphorus losses with additional treatment of all acres with a high or moderate treatment need.

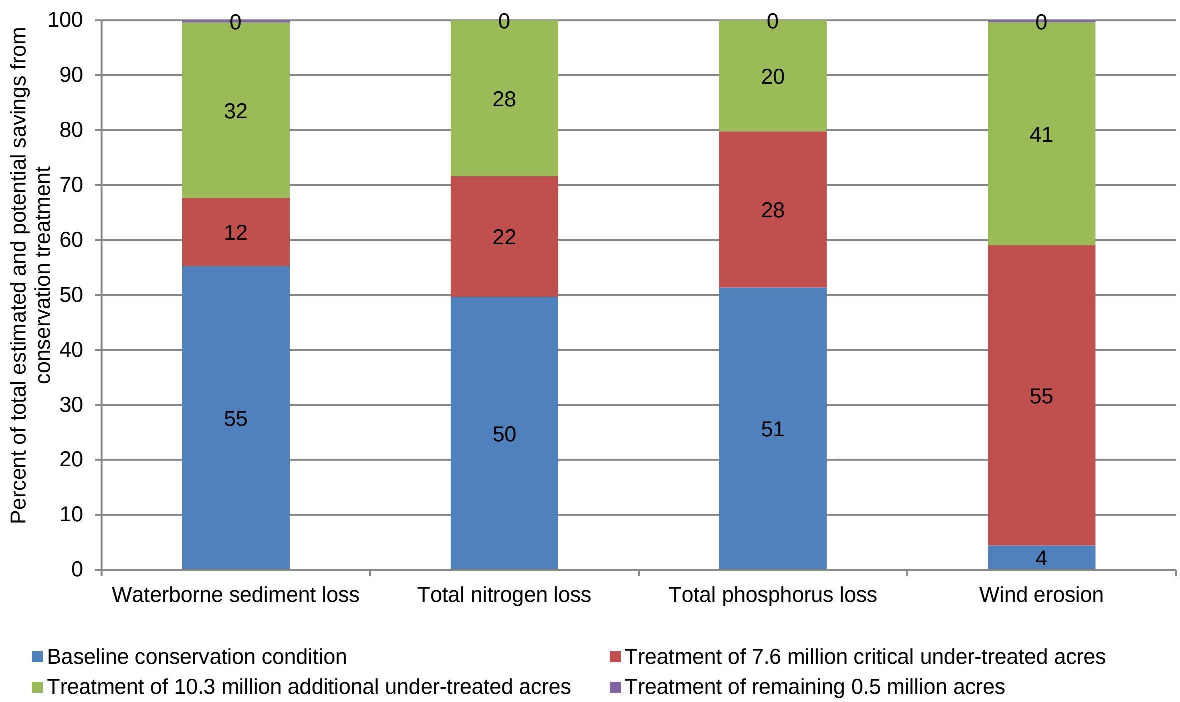
Table 2. Potential reductions in the regional average annual edge-of-field losses of sediment and nutrients with additional erosion control and nutrient management treatment on high- and moderate-treatment-need cropland, Texas Gulf Basin

Sediment		Nitrogen			Phosphorus	
Windborne	With runoff	Windborne	With runoff	All pathways	Windborne	With runoff
Percent reduction						
47	86	55	76	27	66	60

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

The edge-of-field reductions in sediment and nutrient loss shown in table 1 represent average annual declines in sediment and nutrient loss resulting from conservation practices in use during the period 2003 to 2006, when compared to the no-practice scenario. As a share of potential savings through full conservation treatment on all cropped acres, these reductions represent 55 percent of potential savings in waterborne sediment loss, 50 percent of potential savings in total nitrogen loss, and 51 percent of potential savings in total phosphorus loss, but only 4 percent of potential savings in wind erosion losses (fig. 2).

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



The most pervasive conservation concern in the region is excessive rates of wind erosion during dry periods, including windborne losses of nitrogen and phosphorus. Conservation practices in use during 2003–06 have been relatively ineffective in reducing wind erosion. Model simulations show that the average annual rate of wind erosion is 8.55 tons per acre for cropped acres in the region—12.38 tons per acre per year for highly erodible land and 6.65 tons per acre for non-highly erodible land. About 54 percent of total phosphorus and 21 percent of total nitrogen lost from fields is with windborne sediment.

Targeting program funding and technical assistance for accelerated treatment of acres with the most critical need for additional treatment is the most efficient way to reduce agricultural sources of contaminants from farm fields in this region. Conservation treatment of the 7.6 million high-treatment need acres would reduce wind erosion by an average of 5.5 tons per acre per year on those acres. In comparison, additional treatment of the 10.3 million acres with a moderate need for treatment would reduce wind erosion by an average of about 3.0 tons per acre per year on those acres. Treatment of the remaining 0.5 million acres would reduce wind erosion by only about 0.5 ton per acre, on average.

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 the delivery of sediment, nitrogen, and phosphorus loads to rivers and streams in the Texas Gulf Basin, on the basis of the model simulations. Further, they show potential for further reductions after application of additional erosion control and nutrient management practices on the high- and moderate-treatment-need acres. On all three figures—

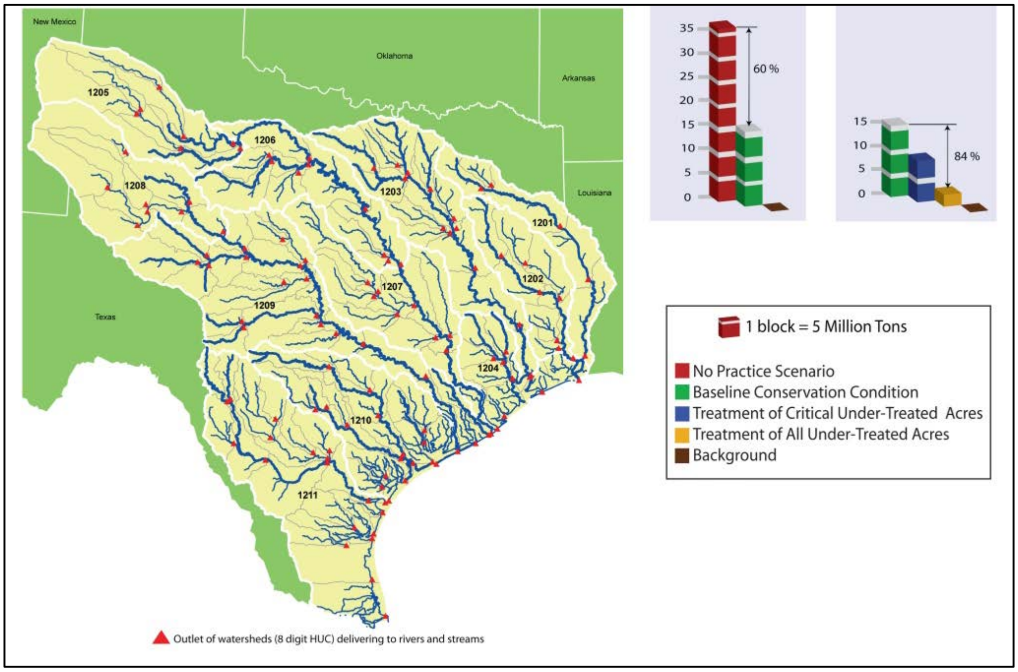
- "no-practice scenario" refers to conditions that would be expected if no conservation practices were in use;
- "baseline conservation condition" refers to estimates of conditions based on farming and conservation practices in use during the period 2003–06;
- "critical under-treated acres" refers to 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 (7.6 million acres), or loads for treatment of cropped acres with a *high* or *moderate* level of treatment need (17.9 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 60 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 84 percent.

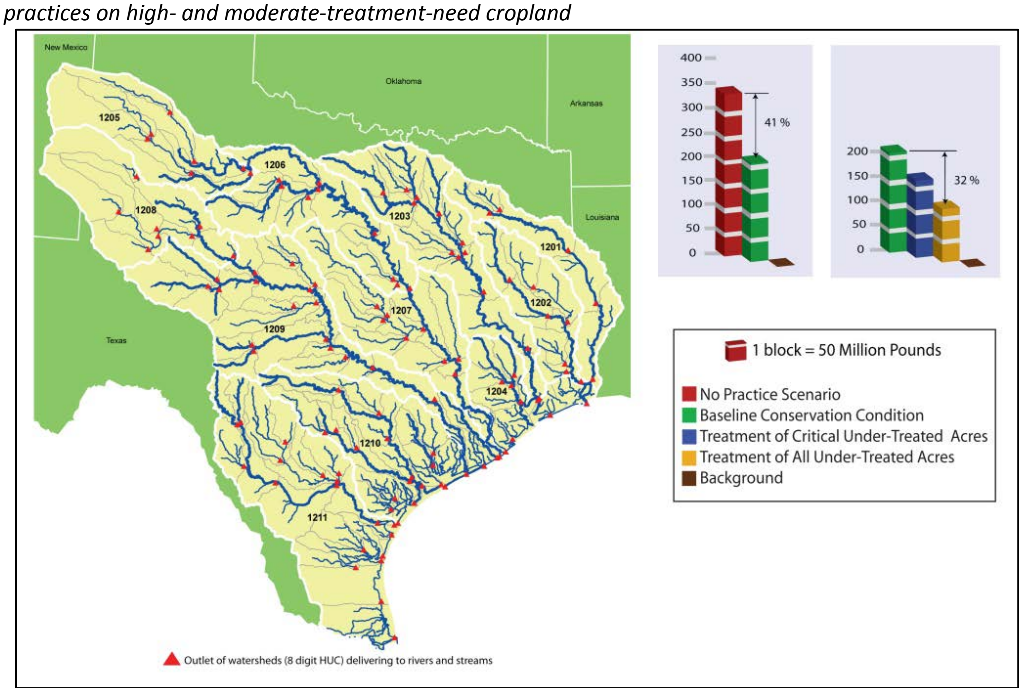
Figure 3. *Summary of the effects of conservation practices on annual sediment loads delivered from cultivated cropland to rivers and streams in the Texas Gulf Basin and potential for further reductions through application of additional erosion control and nutrient management practices on high- and moderate-treatment-need cropland*



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 41 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 32 percent.

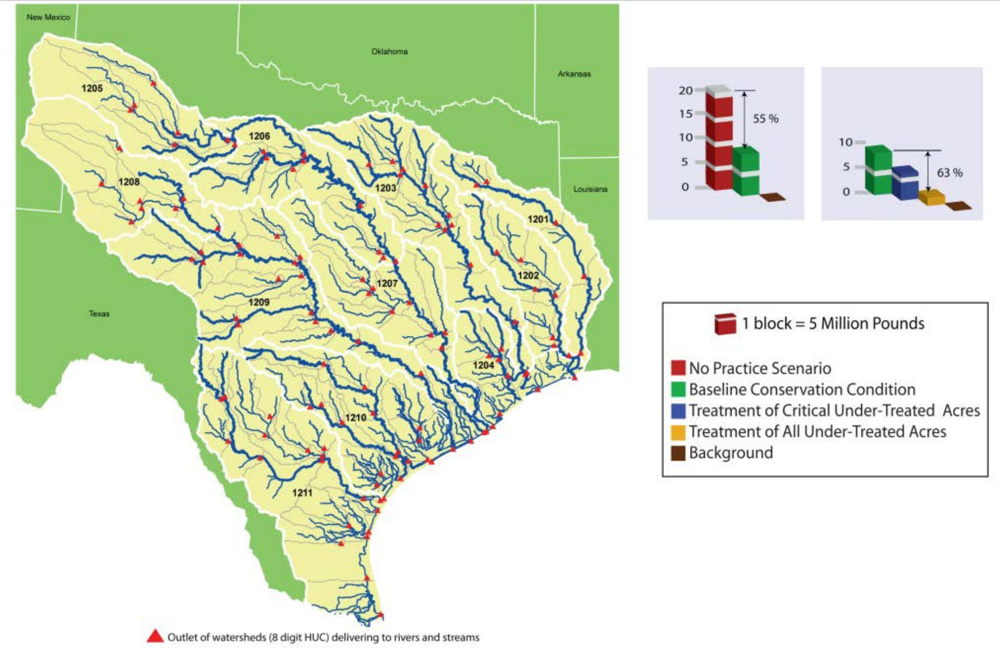
Figure 4. *Summary of the effects of conservation practices on annual nitrogen loads delivered from cultivated cropland to rivers and streams in the Texas Gulf Basin and potential for further reductions through application of additional erosion control and nutrient management practices on high- and moderate-treatment-need cropland*



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 55 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 63 percent.

Figure 5. *Summary of the effects of conservation practices on annual phosphorus loads delivered from cultivated cropland to rivers and streams in the Texas Gulf Basin and potential for further reductions through application of additional erosion control and nutrient management practices on high- and moderate-treatment-need cropland*

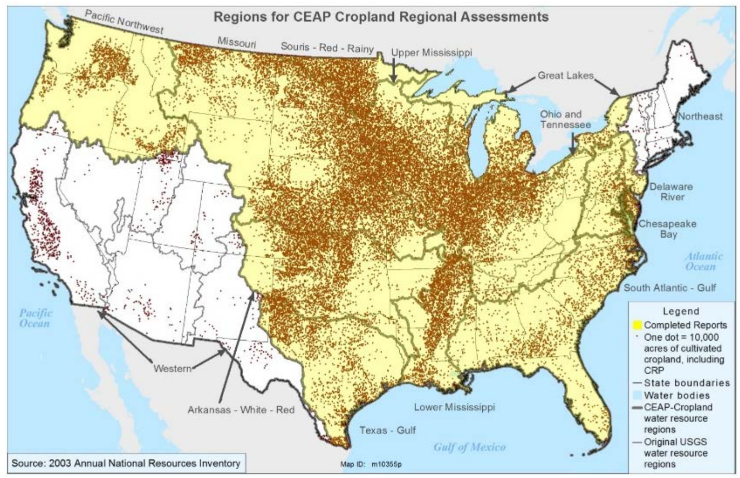


Regional Comparisons

A comparison of the results of the Texas-Gulf Basin study against those of the five studies that make up the Mississippi River Basin (Upper Mississippi, Ohio-Tennessee, Missouri, Arkansas-White-Red, and Lower Mississippi) reveals the following:

- **Wind erosion, the chief conservation concern in the Texas Gulf Basin, is also primary in the western parts of the Arkansas-White-Red and Missouri Basins, to the north. The principal concern in the rest of the Mississippi River drainage is the loss of waterborne sediment and nutrients, which is a lesser concern in the Texas Gulf Basin, limited mostly to the eastern portion of the basin and some irrigated acres in the western portion.**
- The use of structural practices to control water erosion is only slightly less than in most of the Mississippi River drainage basins, but the use of no-till or mulch-till practices is significantly lower than in those other basins.
- Wind erosion rates in the Texas Gulf Basin far exceed those in the Mississippi River drainage basins. However, rates of waterborne sediment and nutrient losses are lower, on average, than in those other basins.
- Reductions in wind erosion are much less in the Texas Gulf Basin than in any of the Mississippi River drainage basins. By contrast, reductions in waterborne sediment and nutrients—especially nitrogen—compare favorably with most of the Mississippi River drainage basins.
- Ninety-seven percent of the cropped acres in the Texas Gulf Basin have a high or moderate need for additional conservation treatment, with 84 percent of cropped acres needing additional treatment for wind erosion. None of the other basins in the Mississippi River drainage approaches this level of treatment-need cropland acres.
- The potential for further reductions in wind erosion is significantly higher in the Texas Gulf Basin than in the Mississippi River drainage basins. Potential for reductions in waterborne sediment and nutrient losses are equal to or lower than in the Mississippi River drainage basins.

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 Texas Gulf Basin* is the twelfth and last 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 Texas Gulf 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, updated December 2013)
Great Lakes Region (September 2011)
Ohio-Tennessee River Basin (February 2012)
Missouri River Basin (August 2012)
Arkansas-White-Red River Basin (April 2013)
Lower Mississippi River Basin (August 2013)
South Atlantic-Gulf Basin (June 2014)
Pacific Northwest Basin (June 2014)
Souris-Red-Rainy Basin (August 2014)
Delaware River Basin (November 2014)
Texas Gulf Basin (February 2015)

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