Summary of Findings

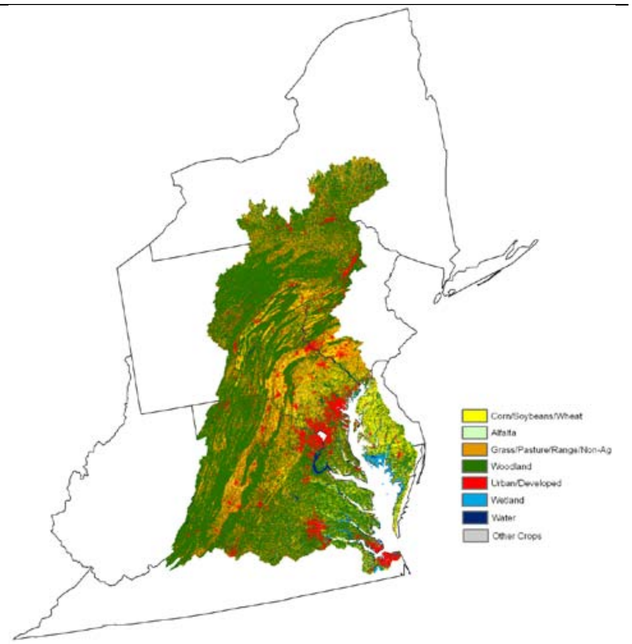
Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Chesapeake Bay Region

March 2011

The Chesapeake Bay is the largest estuary in the United States. The Bay is about 200 miles long, and the Bay and its tributaries cover about 4,500 square miles of open water. The Chesapeake Bay watershed covers about 68,500 square miles in parts of six states (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and the District of Columbia (fig. 1).

Agricultural land makes up less than 30 percent of the area of the watershed (10 percent cultivated cropland, and 18 percent pasture and hayland). Forest land covers about 59 percent and urban land about 8 percent of the watershed. The balance of the area is in wetlands or is open water. The focus of the CEAP Chesapeake Bay study is on the 10 percent of the watershed that is cultivated cropland.

Figure 1. *Location of the Chesapeake Bay watershed*



SOURCE: TEXAS AGRILIFE RESEARCH, TEXAS A&M UNIVERSITY

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.

Study Findings

The voluntary, incentives-based conservation approach is working. Farmers have made good progress in reducing sediment, nutrient, and pesticide losses from farm fields through conservation practice adoption throughout the Chesapeake Bay region. Most cropland acres have structural or management practices—or both—in place to control erosion. Nearly half the cropland acres are protected by one or more structural practices, such as buffers or terraces. Reduced tillage is used in some form on 88 percent of the cropland.

Adoption of conservation practices has reduced edge-of-field sediment loss by 55 percent, losses of nitrogen with surface runoff by 42 percent, losses of nitrogen in subsurface flows by 31 percent, and losses of phosphorus (sediment attached and soluble) by 41 percent.

Opportunities exist to further reduce sediment and nutrient losses from cropland. The assessment of conservation treatment needs presented in this study identifies opportunities to contribute to improved water quality in the Bay. The study found that 19 percent of cropped acres (810,000 acres) have a high level of need for additional conservation treatment. Acres with a high level of need consist of the most vulnerable acres with the least conservation treatment and the highest losses of sediment and nutrients. Model simulations show that adoption of additional conservation practices on these 810,000 acres would, compared to the 2003–06 baseline, further reduce edge-of-field sediment loss by 37 percent, losses of nitrogen with surface runoff by 27 percent, losses of nitrogen in subsurface flows by 20 percent, and losses of phosphorus (sediment-attached and soluble) by 25 percent.

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 over twice as much as treatment of acres with a low or moderate conservation treatment need.

Comprehensive conservation planning and implementation are essential. The most critical conservation concern related to cropland in the region is the need to reduce nutrient losses from farm fields, especially nitrogen in subsurface flows. Suites of practices that include soil erosion control and comprehensive nutrient management—appropriate rate, form, timing, *and* method of application—are required to simultaneously address soil erosion, nutrient losses in runoff, *and* loss of nitrogen through leaching.

Cultivated cropland represents only about 10 percent of the land base in the Chesapeake Bay watershed. However, cultivated cropland delivers 22 percent of the sediment, 31 percent of the nitrogen, and 28 percent of the phosphorus to rivers and streams in the watershed. Figure 2 shows the distribution of land uses within the Bay watershed, and figures 3 through 5 show the source of sediment, nitrogen, and phosphorus delivered to rivers and streams in the watershed.

Figure 2. *Distribution of land use/cover types in the Chesapeake Bay watershed*

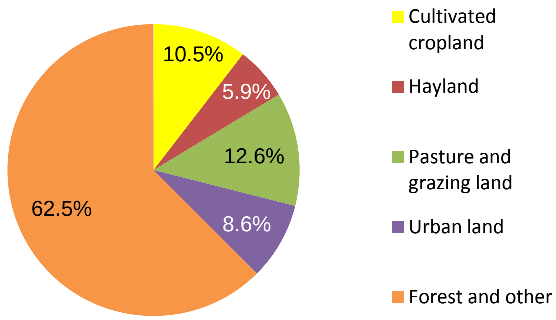


Figure 3. *Percentage of average annual sediment loads delivered to rivers and streams in the Chesapeake Bay watershed, by source*

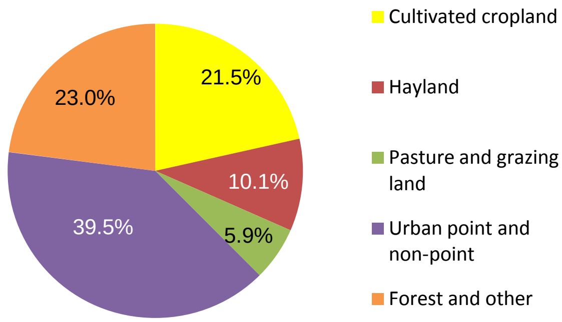


Figure 4. *Percentage of average annual nitrogen loads delivered to rivers and streams in the Chesapeake Bay watershed, by source*

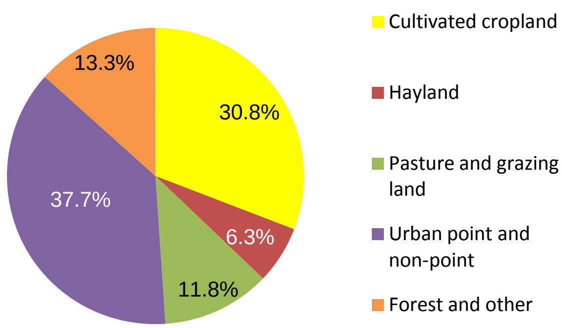
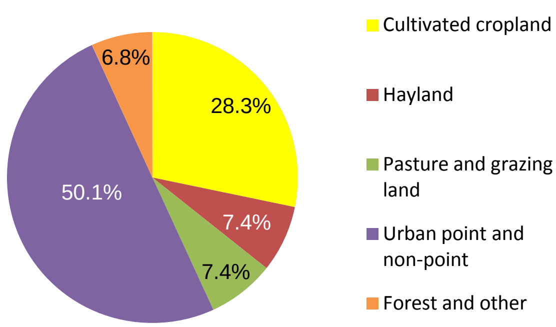


Figure 5. *Percentage of average annual phosphorus loads delivered to rivers and streams in the Chesapeake Bay watershed, by source*



Need for Additional Conservation Treatment

The need for additional conservation treatment in the Chesapeake Bay watershed 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 810,000 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 2.6 million acres—61 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 872,000 acres—20 percent of the cultivated cropland in the region—have a low level of need for additional conservation treatment.

Figures 6 through 9 show the average annual per-acre rates of sediment loss, nitrogen loss through surface and subsurface pathways, and phosphorus loss among the three levels of treatment need. The red bar across each chart represents the average loss across the region, and the green bar shows model simulations of losses that could be achieved with full, comprehensive treatment of acres with high and moderate treatment needs for sediment and nutrient loss.

Figure 6. *Average annual per-acre sediment loss for three levels of conservation treatment need, Chesapeake Bay Region*

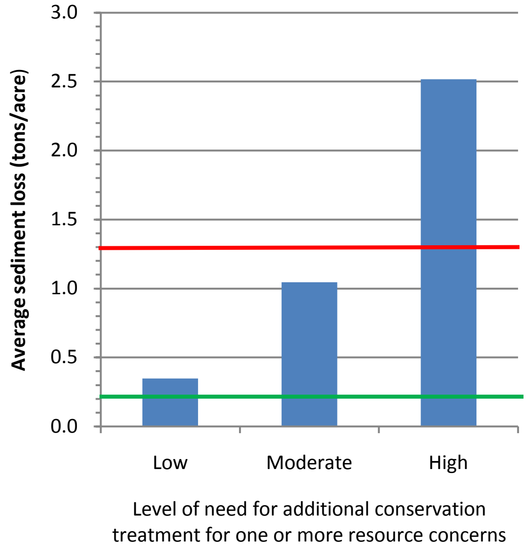


Figure 7. *Average annual per-acre nitrogen loss with surface runoff for three levels of conservation treatment need, Chesapeake Bay Region*

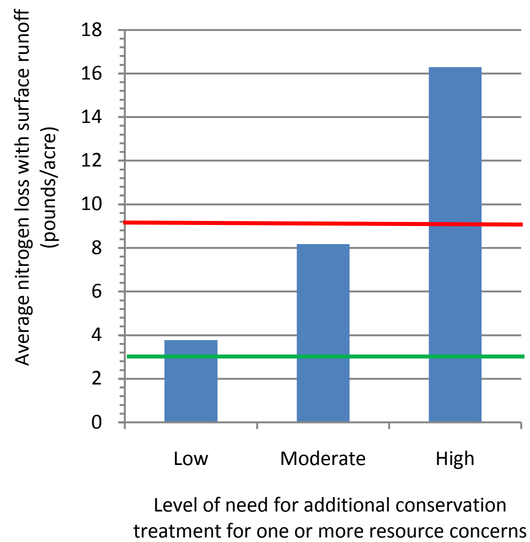


Figure 8. *Average annual per-acre nitrogen loss with subsurface flow pathways for three levels of conservation treatment need, Chesapeake Bay Region*

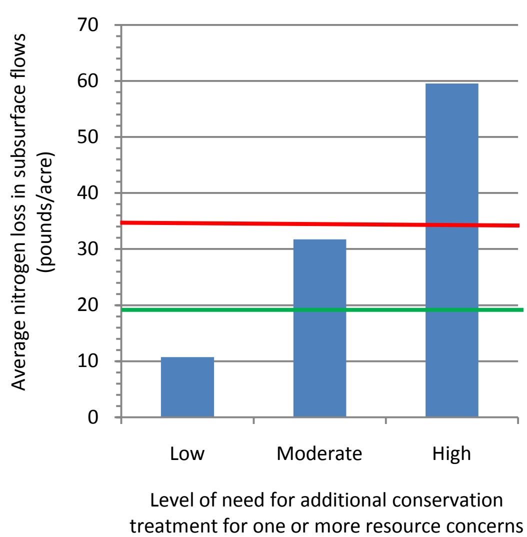
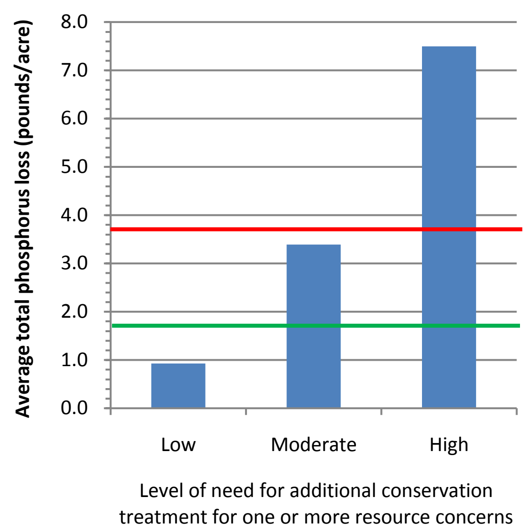


Figure 9. *Average annual per acre phosphorus loss to surface water for three levels of conservation treatment, Chesapeake Bay Region*



Current and Potential Reductions in Sediment and Nutrient Loadings

Table 1 shows current and potential reductions in sediment, nitrogen, and phosphorus delivery to rivers and streams in the Chesapeake Bay watershed and to the Bay itself.

Table 1. Current and potential reductions in sediment, nitrogen, and phosphorus loadings to surface waters, Chesapeake Bay watershed

	Reduction in load to rivers and streams		Reduction in load to the Bay (all sources)	
Pollutant	Current	Potential additional	Current	Potential additional
	- Percent	- -		
Sediment	57	84	10	6
Nitrogen	36	52	14	15
Phosphorus	39	51	14	12

The use of conservation practices on cropland has reduced ***total sediment and nutrient loads delivered to rivers and streams*** in the watershed compared to conditions that would be expected without conservation practices: Sediment loads have been reduced by 57 percent, total nitrogen loads by 36 percent, and total phosphorus loads by 39 percent. Additional conservation practices on all cultivated cropland acres having high and moderate treatment needs could further reduce sediment delivery to rivers and streams by 84 percent from current levels, total nitrogen loads by 52 percent, and total phosphorus loads by 51 percent.

The use of conservation practices on cropland has reduced ***total loads delivered to Chesapeake Bay from all sources*** in the watershed compared to conditions that would be expected without conservation practices: Sediment loads have been reduced by 10 percent, total nitrogen loads by 14 percent, and total phosphorus loads by 14 percent. Additional conservation practices on all cultivated cropland acres having high and moderate treatment needs could further reduce sediment delivery to the Bay by 6 percent from current levels, total nitrogen delivery by 15 percent, and total phosphorus delivery by 12 percent.

The Potential of Cover Crops for Reducing Nonpoint Source Pollution

The evaluation of conservation practices and associated estimates of conservation treatment needs are based on practice use derived from a farmer survey conducted during the years 2003 to 2006. Since that time, however, the six States in the Chesapeake Bay watershed have continued to work with farmers to enhance conservation practice adoption in a joint effort to reduce nonpoint source pollution contributing to water quality issues in the Bay. In Maryland, for example, the state offered expanded incentive payments for the planting of cover crops starting in the 2008–09 growing season.

When used properly, cover crops protect the soil from erosion during the winter months, take up nutrients remaining in the soil, and release plant available nutrients slowly over the subsequent cropping period, thereby reducing nutrient leaching and runoff during the non-growing season. Figures 10 and 11 compare the percentage of cropped acres with high or moderate treatment need to projected treatment need if winter cover crops were planted on all cultivated cropland in the region.

Figure 10. Percentage of cropped acres that have high or moderate treatment need, by resource concern, Chesapeake Bay Region

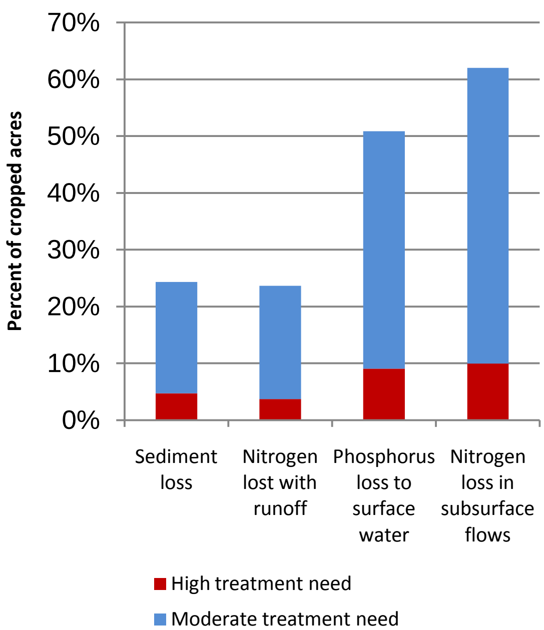
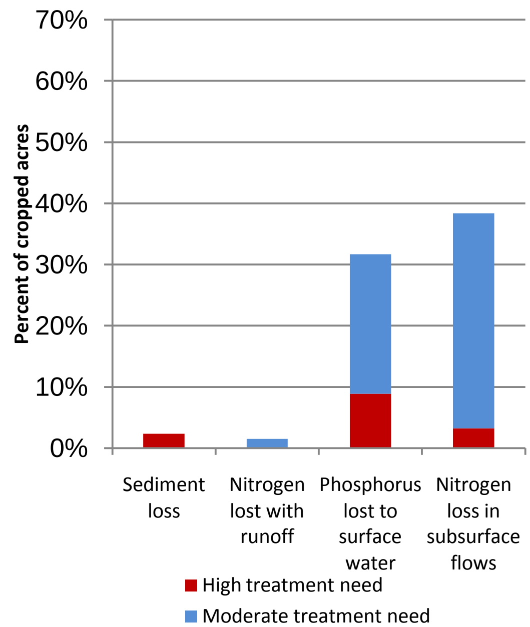


Figure 11. Percentage of cropped acres that would be expected to have high or moderate treatment need if cover crops were in use on all acres, by resource concern, Chesapeake Bay Region



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 Chesapeake Bay Region* is the second 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
Chesapeake Bay Region
Ohio-Tennessee River Basins
Great Lakes Water Resource Region
Delaware River Watershed
Northeast Water Resource Region
South Atlantic-Gulf Water Resource Region
Missouri River Basin
Arkansas-White-Red River Basins
Texas Gulf Water Resource Region
Lower Mississippi River Basin
Souris-Red-Rainy Water Resource Regions
Pacific Northwest and Western Water Resource Regions

Expect release of these reports through 2011.