Conservation Effects Assessment Project (CEAP)
ARS Watershed Assessment Studies (WAS)
Fiscal Year 2009 Progress Report

Individual milestones for each objective are accounted for within individual CRIS projects. At the national level, progress on all 5 objectives is either fully or substantially met. The STEWARDS database is open to the public, the research infrastructure is in place, watershed modeling has been conducted at almost all watersheds and modifications to adapt to local and regional conditions have been developed, economic theory and integration of economic and biophysical models are in place with consistent comprehensive national land use and management datasets developed, and the regionalized model system has been delivered to NRCS.

STEWARDS Database - A team within the CEAP - Watershed Assessment Studies has developed a web-based data delivery system to provide access to soil, water, climate, land-management, and socio-economic data from fourteen watersheds. The system, STEWARDS: Sustaining the Earth's Watersheds, Agricultural Research Data System, allows a variety of users to search, visualize, and download data via the internet. STEWARDS consists of: 1) a centralized site with Web/SQL/ArcGIS servers and application software, including a database management system (DBMS) and a geospatial data access portal; 2) data: including measurement data, imagery/GIS, and metadata; 3) users; and 4) research watershed sites that are data sources. Anticipated benefits of STEWARDS include preservation of data, increased data use, and facilitation of hydrological research within and across watersheds with diverse collaborators. The STEWARDS web site has been made available to the public (http://arsagsoftware.ars.usda.gov/stewards/). At the current date, it is populated with data from 13 ARS benchmark watersheds, comprising more than 500 individual measurement sites of up to 35 years of records, totally well in excess of 10M geospatially and temporally documented data records and comprehensive metadata.

Soil Quality Assessment on the Benchmark Watersheds - Samples for soil quality assessment have now been collected from 14 of 15 ARS Conservation Effects Assessment Project (CEAP) benchmark watersheds. Texture, bulk density, water stable aggregation, microbial biomass carbon, acidity (pH), electrical conductivity (EC), total organic carbon and N, nitrate and ammonium N, phosphorus, and diethylene triamine pentaacetic acid (DTPA) extractable micronutrient levels measurements have been completed on samples from five of the sites and are being completed on four more. Sample processing has begun on those collected from the next 5 sites. Plans are being made to collect samples from the Upper Snake River site in autumn of 2009.

Sampling Protocols Established - The CEAP Ecology Working Group developed five guiding principles that will lead to hypothesis driven sampling protocols capable of documenting habitat and biological responses to conservation practices within wadeable streams. The guiding principles were recently published within the Journal of American Water Resources Association.

Satellite derived mapping algorithm - Conservation tillage is a commonly adopted best management practice for improving soil quality and reducing erosion. However, there are currently no methods in place to monitor conservation tillage adoption at the watershed scale. A mapping algorithm, using commonly available satellite imagery, has been developed to depict conservation tillage adoption within the Little River Experimental Watershed. The resulting map identified farm sites using conservation tillage (defined as having > 30 % crop residue cover) with 71-78 % confidence. Models used to map conservation tillage adoption were created using a subset of 44 sample points and validated using 94 sample points. Results are encouraging

and suggest that currently available satellite imagery can be used to map conservation tillage adoption with a minimum amount of ground control points. (Tifton GA)

Assessment of conservation practice placement – USDA has been tasked to determine the effectiveness of federally funded conservation programs. A 26 year history of NRCS-assisted conservation practice placement was evaluated for the Little River Experimental Watershed (LREW). Nearly 50% of all cropped fields were identified as having participated in NRCS conservation programs. Sixty-two percent of these fields (77% of land area) received assistance for soil erosion and water erosion quality control practices in high resource concern areas (slope > 2.7 % and low infiltration). Sixty percent of the fields receiving assistance for soil and water erosion control were located within 50 m of a water body. We estimated that 30-40% of the time erosion control practices were implemented in areas not rated as a high concern. A subset of the LREW was used to evaluate adoption and placement of erosion control practices both with and without NRCS assistance. Forty-seven percent of all fields in the sample implemented visible erosion control-specific conservation practices. The implementation was linearly related to slope class. The relationship observed between erosion control practice placement and slope in the sub-watershed database is encouraging and suggests a commitment to good stewardship regardless of participation in federally funded conservation programs. (Tifton GA)

Assessment of conservation practice approach - USDA has been tasked to determine the effectiveness of federally funded conservation programs. We used the SWAT model to simulate the water quality effect of upland conservation practices (CPs) commonly adopted in the Little River Experimental Watershed (LREW) for either erosion or nutrient control and compared those results to the simulated impact of the riparian forest buffers currently in the LREW. Erosion CPs resulted in the greatest reductions in sediment and phosphorus while nutrient reduction practices were most effective in reducing total stream nitrogen. We also evaluated three different prioritization scenarios for implementing CPs – random placement, stream order, and nonpoint source pollutant load. Prioritizing based upon nonpoint source pollutant load yielded more efficient (nonlinear) water quality improvements while the other implementation schemes yielded linear returns. Riparian forest buffers offered the most comprehensive reduction of all three pollutants. Simulation results indicate that the current level of riparian forest cover in the LREW may be the single greatest contributor to nonpoint source pollutant reduction. (Tifton GA)

***Environmental quality research in Beasley Lake Watershed, 1995-2007: Succession from conventional to conservation practices*.** The Mississippi Delta of the United States is an important agricultural region, and water conservation and water quality improvement are important to the well-being of the region. Over a decade ago, ARS scientists have worked with other agencies to conduct water quality research in three Delta oxbow lake watersheds. One of these, Beasley Lake, was selected as a benchmark watershed to join in a nationwide research effort, Conservation Effects Assessment Program (CEAP), to quantify effects of conservation management practices on water quality. This paper reports on CEAP research in Beasley Lake Watershed during the period from 1995 to 2006, and provides a synthesis of lake and soil chemical, biological, and physical characteristics that have changed as a result of a decade conversion of the watershed from conventional row crops (primarily cotton) to conservation practices such as reduced tillage, buffer strips, and conservation reserve. These results will be of interest to regulatory agencies, industry, farmers, and the public. (Oxford MS)

AnnAGNPS model application for Mississippi Delta Beasley Lake watershed conservation practices assessment. The USDA Annualized Agricultural Non-Point Source

Pollution (AnnAGNPS) model was developed for conservation planning and evaluation. This paper presents results from a study performed on Beasley Lake Watershed, a USDA-ARS CEAP benchmark watershed located in the Mississippi Delta, to identify critical areas where conservation practices need to be implemented and how their implementations could improve water quality. In this study, AnnAGNPS was used to simulate the amount of water and sediment produced from each field within the Beasley Lake watershed and how much enters Beasley Lake. AnnAGNPS was also utilized to simulate the impact on water quality by implementing various conservation programs recommended by the NRCS. High sediment-producing areas were identified with AnnAGNPS and targeted for non-point source pollution control measures. Alternative agricultural management options for reducing non-point source pollution, their impacts on water quality, and the capabilities of the model for conservation planning are also discussed. These results will be of interest to regulatory agencies, industry, farmers, and the public. (Oxford MS)

***Impacts of historical sediment accretion and channel straightening on the South Fork Iowa River*.** Soil erosion that followed agricultural land clearing, produced sediment that accumulated in river valleys influencing rivers and acting as a source of stream bank sediment loads today. We asked whether historical sediment has contributed to sediment loads in an Iowa watershed with low relief and limited settlement history (160 years). We found recent sediment along the South Fork Iowa River averaged 2.6 ft thick out to a distance of 260 ft from the channel, and equated to 69.8 tons per acre of soil that was eroded from uplands across this 158,000 acre watershed. The volume of this sediment has reduced the capacity of the floodplain to store floodwater by an estimated 4123 acre-ft, after discounting for the sediment's volume of pore space. In addition, channel straightening of the South Fork and its tributaries has reduced channel length by up to 15%, hastening routing of water to the Iowa River. River restoration projects need to be conducted recognizing that bank erosion and exacerbated flooding may result from historical legacies within our river valleys. This is of particular interest to water resource managers and aquatic ecologists who are developing and implementing river restoration and watershed management plans. (Ames IA)

***Hydrologic changes in the Midwest result more from shifts in climate than land use*.** Hydrologic shifts towards greater discharge have been observed in the Midwest but it is not certain whether this trend results from changes in agricultural land use or changes in climate. When evaluating simultaneous shifts in how energy (evaporative demand) and water (precipitation) was partitioned during a long-term, small-watershed experiment, effects of land use (watershed treatment) and climate trend (time) became readily distinguished. Applying the technique to four larger watersheds across the Midwest, increasing discharge was shown more attributable to climate change than land-use change. Changes in land use, in particular increased soybean acreage, did show a shift towards increasing discharge that could be attributed to decreased crop water use. But, since 1975 and after this change in cropping occurred, changing climate in the form of increased precipitation and decreased evaporative demand has been the dominant influence on watershed hydrology. The trend impacts issues such as Gulf of Mexico hypoxia, which expands as both nutrient losses and discharge increase. Results are of interest to all groups interested in conservation effectiveness in the Midwest (i.e., conservation groups, policy developers, environmental and commodity groups), because increased discharge from agricultural watersheds, due to climate change, inherently increases the challenges of retaining agricultural nutrients within soils. (Ames IA)

Major pathways followed by multiple pollutants in an agricultural watershed segregated. Water quality studies are typically conducted on single contaminants, but developing comprehensive water quality strategies in watersheds usually requires an understanding of the

sources and dynamics of multiple contaminants. We analyzed four contaminants (i.e., nitrate, phosphorus, E. coli, and sediment) at three locations during a single runoff event in a tile-drained watershed. The finding that nitrate loads were dominantly carried via tile drainage was expected, and that sediment was dominated by channel and bank sources was expected but not necessarily to the extent observed (78%). The most unexpected result was that about half the phosphorus and a third of the *E. coli* loads were attributed to surface intakes that drain surface depressions and road ditches in this glacial landscape. Conservation strategies in this watershed are currently focused on erosion control and nutrient management; but these results suggest that buffering of tile intakes and stream bank stabilization are now just as important. This study is of interest to conservation and environmental professionals and policy makers, as well as agricultural stakeholders, who seek to develop improved strategies to comprehensively address agricultural water quality issues. (Ames IA)

Predicting sulfamethazine behavior in soil. Antibiotics administered to swine enter the environment when swine manure is land applied and have been detected in surface and groundwater. Leaching to subsurface drainage tiles is affected by sorption to the soil and a method of predicting this binding from soil organic matter and pH was developed. Potential leaching is greatest in soil with higher pH and low organic matter. The degradation of sulfamethazine in water and soil is characterized by a biphasic pattern with rapid degradation followed by a slower phase. Degradation becomes limited by decreased bioavailability with increased time in the soil. This research contributes to the knowledge of how these contaminants behave in the environment and may allow the development of manure management practices that decrease the risk to water quality. The research is of interest to scientists, environmental groups and farm producer organizations. (Ames IA)

Practices altering the distribution of cattle in riparian pastures may reduce nonpoint source pollution of surface water. Understanding how grazing management can impact water quality is important in a number of Midwest watersheds. Research in southern and central Iowa has shown that restricting access of cattle to pasture streams by using either stabilized crossings or rotational grazing reduces the risk of phosphorus losses by altering where and when grazing takes place. While grazing management will affect the risk of phosphorus and sediment losses from direct fecal deposition or in precipitation runoff, stream bank erosion is more dependent on stream hydrology and precipitation events than grazing management. These results are of interest to the conservation community, both practitioners and scientists, who need to understand the linkages between pasture management and stream water quality. (Ames IA)

Measuring the effectiveness of winter cover crops on Maryland's Eastern Shore. We have continued to develop and evaluate an innovative methodology that combines farm program records, satellite remote sensing, and on-farm sampling to calculate the amount of nitrogen sequestered in cover crop biomass on farms enrolled in state cover crop cost share programs within the Choptank and Chester River watershed, increasing our sample size to over 1400 fields per year. Results were transferred to the Chesapeake Bay Program, assisting in the development of efficiency estimates for various cover crop scenarios. Additionally, on-farm field experiments have been planned and funded (Targeted Watersheds Grant) for implementation in the fall of 2008. These experiments will evaluate the effect of reduced fall fertilization on wheat yield and soil nitrate leaching, with implications for setting appropriate incentive rates for commodity cover crops (non-fertilized fall grains). (Beltsville MD)

Successful integrated application of radar and lidar to monitor wetlands in agricultural landscapes. Wetland restoration is an important component in water quality improvement

strategies in the Choptank River and for the Chesapeake Bay. Wetlands have great potential for mitigating agricultural pollution but managing agricultural landscapes to maximize their effectiveness requires detailed information hydrology of wetlands and their connection to the larger landscape. Radar and lidar are two remote sensing approaches involving active sensors that show great promise for providing spatial information for mapping and hydroperiod characterization of the wetland. ARS research has shown great synergy of information can be gained by the combined use of these active sensors. Radar can provide detailed temporal information on hydroperiod and lidar can provide detailed surface elevation maps and instantaneous inundation maps useful for mapping wetland. This synergy of information improves understanding of ecological services provided by wetlands and their connection to the larger landscape which will have bearing on management and conservation of wetland ecosystems within agricultural landscapes. (Beltsville MD)

Overview of the Missouri Conservation Effects Assessment Project. The Mark Twain Lake/Salt River Basin was selected as one of 12 USDA-Agricultural Research Service benchmark watersheds for the Conservation Effects Assessment Project (CEAP) because of documented soil and water quality problems and broad stakeholder interest. The basin is characterized by the predominance of claypan soils that result in especially high vulnerability to soil erosion and surface transport of herbicides. Results from cropping system best management practice (BMP) studies showed that no-till cropping systems did not reduce surface runoff compared to tilled systems and led to increased transport of soil-applied herbicides. Grass filter strip studies showed that warm and cool season grasses can reduce herbicide transport in surface runoff. A major challenge in the claypan region is the need to develop cropping systems that incorporate soil-applied herbicides yet minimize soil erosion. Current and future research efforts will continue to focus on BMP studies, development of needed tools to improve watershed management, and refinements in the calibration and validation of the Soil and Water Assessment Tool (SWAT) model. (Columbia MO)

Habitat vegetation of seasonal wetlands changes under flooding with wastewater effluent. Soils from seasonal wetlands established within a wildlife management area using municipal wastewater effluent (WWE) were assessed for seed bank composition to determine effects on subsequent plant community structure. Vegetative taxa richness, plant density, and biomass were significantly reduced in WWE-irrigated soils compared with Missouri river water; salinity and sodicity also increased with WWE and was linked to inhibition of germination or seedling growth of many plant species. Results are important because potential detrimental effects on wildlife habitat due to use of WWE for seasonal wetland management are documented as well as demonstrating a need for strategies to overcome such effects of an otherwise attractive application of a waste treatment by-product for environmental conservation. (Columbia MO)

Modeling flow and pollutant transport in a karst watershed with SWAT. The Soil and Water Assessment Tool was assessed for its ability to simulate stream flow and water quality in a karst watershed, and changes were introduced to simulate the rapid transport of water and pollutants through sinkholes and losing streams. These changes improved the partition between surface and groundwater flow, which is particularly critical in karst geologic contexts. Results demonstrate that SWAT can be used to compare risks of contamination from different management strategies in karst areas, thus extending applicability of an important ARS decision support tool to include these environmentally vulnerable regions of the country. (Columbia MO)

OMS-Based Prototype Watershed Model, Version 0.10. New watershed models are needed that can assess the outcome of implementing conservation practices at multiple spatial scales

and also be customized to regional processes and concerns. An initial version of a Java-based prototype watershed model (containing verified modular components for water balance, infiltration, groundwater recharge, runoff and stream flow dynamics, erosion, nutrient cycling, and plant growth) was developed and applied for simulation of runoff and stream flow between land units and stream reaches. The model is now ready for evaluation of nitrogen and sediment transport, and has the potential (due to fully-distributed simulation capability) to better quantify conservation impacts on water quality at field to watershed scales. (Ft. Collins, CO)

Observed pesticide MCL excess related to sampling protocol. Drinking water treatment plants are required to sample intake water and analyze for potential contaminants. Maximum contaminant levels (MCLs) have been established for many pesticides. Work at the National Soil Erosion Research Laboratory has taken data from our daily water quality samples and evaluated how different sampling strategies (i.e. daily, weekly or quarterly sampling) may impact the reporting of MCL exceedance. From this work, we observed that as the sampling strategy becomes less intense, the error associated with MCL exceedance estimates increases. We also discovered that drinking water treatment plants may be able to avoid MCL exceedance if they schedule their sampling around times when pesticides are expected to be in the water, and also avoid sampling when storm runoff water is contributing to the flow. The impact of this research is to demonstrate to regulators that in order to accurately reflect MCL exceedance estimates, water quality samples for drinking water systems should include samples from when potential contaminants (i.e. pesticides) are expected to be in the water and/or at least one sample taken during times when storm runoff contributes to flow. (West Lafayette IN)

Influence of drainage class on water quality. In most modeling activities, when a digital elevation model, DEM, is used to develop water routing for the watershed, the depressions are mathematically filled in. When evaluating data from the St. Joseph River watershed, we determined that these depressional areas are very important for determining nutrient concentrations or nutrient loads. Regression models were used to assess the influence of 4 drainage classes (direct drainage, depressional drainage, indirect drainage and indeterminate drainage). With both concentrations and loads for NH4-N, NO3-N, TKN, soluble P and total P, every time direct drainage or depressional drainage was found to be significant, there was a positive correlation. Conversely for these dependant variables, every time indirect or indeterminate drainage was found to be significant, there was a negative correlation coefficient. This information indicates that isolated depressions, which are scattered throughout the St. Joseph River watershed, and the Midwest, are very important with respect to nutrient transport to agricultural drainage ditches. As such, greater emphasis should be placed on placing conservation practices in these critical areas. (West Lafayette IN)

Water quality modeling in a large-scale watershed. For watershed models to be useful in assessing water quality in different cropping and management systems, as well as their use in decision support systems, it is critical that the model be properly calibrated and validated. The Soil Water and Assessment Tool (SWAT) was successfully calibrated and validated for modeling stream flow and atrazine concentrations in the Cedar Creek Watershed (CCW) in Indiana. The scope of this modeling research, in terms of calibration and validation procedures, is necessary for further use of SWAT as an assessment tool in evaluating the long-term effects of different management practices on chemical transport in large, tile-drained agricultural watersheds in the U.S. Midwest region. Additional investigations have addressed the use of different combinations of soil and land use geospatial datasets and watershed scale and the effects on stream flow estimates using SWAT, a significant area of research lacking study. The results are significant in that Cedar Creek is the main tributary to the St. Joseph River, the source water supply for Ft. Wayne Indiana where concentrations of atrazine and other

agricultural pollutants have been a concern. Thus, with the successful calibration and validation of SWAT in the CCW, the model may now be used to assess the impacts of management practices on soil and water quality. (West Lafayette IN)

Creation of historical conservation practices database. Implementation of conservation practices is often considered and accepted as the best method for sustaining agricultural production and minimizing nonpoint source pollution. To quantify the effects of conservation practice implementation, information on the temporal and spatial resolution of the practices is required. In collaboration with the Delaware County Ohio Soil and Water Conservation District, a database containing cost-shared practices was created identifying the conservation practice, attributes of the practice (i.e. acreage, length, and proximity to water body) and date of installment. The database records date back to 1952. The information contained within the database when used with existing water chemistry and ecology measurements will permit an environmental assessment of the historic practices. (Columbus OH)

Hydrologic impacts of headwater stream channelization. Headwater streams comprise greater than 2/3 of all streams in any given watershed and are critical to biogeochemical processing. Biogeochemical processing is governed by the hydrology of the streams. Many headwater streams in the Midwestern United States have been channelized for agricultural drainage. Understanding the hydrologic impacts of stream alteration is necessary for identifying or designing best management practices aimed at restoring natural flow regimes and/or achieving optimal environmental services. Hydrology data was collected from channelized and unchannelized streams within the UBWC watershed. Differences were noted for several flow response variables that characterized the magnitude, frequency, and rate of change in the measured streams. The differences generally followed a seasonal pattern. Knowing that stream types do possess different seasonal hydrology will aid conservationists, watershed planners, and environmental engineers in developing and selecting conservation practices that account for the differences in hydrology and biogeochemical processing. (Columbus OH)

A calibrated SWAT model for portions of UBWC. In collaboration with Ohio State University, the Soil and Water Assessment Tool (SWAT) was populated with the required physical and management parameters and calibrated for hydrology, crop yield, and nitrogen loss on selected subwatersheds of the UBWC. Additionally, uncertainty was quantified for the most sensitive of the hydrology, crop prediction, and nitrogen loss parameters. Application of the calibrated model will aid selection, placement, and extent of best management practices (BMPs). The impact of a suite of individual and combined practices will be investigated. Collected data is being used to verify the model predictions. Varying degrees of practice adoption and number of practices can also be assessed. The calibrated model is currently being used to perform a cost-benefit analysis for multiple nitrogen management scenarios. (Columbus OH)

Effects of conservation practices on fishes in agricultural drainage ditches. Agricultural drainage ditches are created or modified headwater streams that are managed to remove excess water from agricultural fields. Conflicts between water quality laws and drainage laws have been identified and stakeholders in the Midwestern United States are seeking new ways of managing these modified streams. A literature review was conducted to identify the current state of information on ecology of fishes, the influence of conservation practices, and the influence of agricultural contaminants on fishes within agricultural drainage ditches. This literature review identified that most research involving fishes in drainage ditches has documented the negative effects of channelization of existing streams and only limited information is available on the effects of conservation practices intended to provide ecological benefits. Conservation practices that enable the movement of fishes within drainage ditches

and those that created needed pool habitat and physical structure are likely to have positive benefits on fish communities. This literature review provides four key concepts that will assist state agencies, federal agencies, and NGOs with developing novel management strategies capable of incorporating environmental considerations into the management of agricultural drainage ditches. (Columbus OH)

Water-chemistry fish relationships provide insights towards designing conservation plans for agricultural watersheds. The ecological effect of conservation practices designed to reduce sediment, nutrient, and pesticide loadings from agricultural activities to streams is unclear due to the lack of evaluations and the limited information on the relationships between water chemistry and fishes. The relationships between water chemistry and fishes within agricultural drainage ditches were documented. The research results suggest that conservation practices intended to reduce nutrient, sediment, and pesticide loadings may only have limited ecological benefits. Thus, those conservation plans that use a combination of conservation practices capable of addressing physical habitat and water chemistry degradation are most likely to provide the greatest benefits for fish communities within these impacted headwater streams. These results provide NRCS, Soil and Water Districts, and other stakeholders guidance for designing conservation plans for agricultural drainage ditches. (Columbus OH)