ASSESSING EFFECTS OF CONSERVATION AT THE WATERSHED SCALE

Tom Drewes, CEAP Watershed Coordinator, Resource Inventory & Assessment Division, Natural Resources Conservation Service, U.S. Department of Agriculture, Beltsville, MD, tom.drewes@wdc.usda.gov; Kelsi S. Bracmort, Ph.D., Agricultural Engineer, Conservation Engineering Division, Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC, kelsi.bracmort@wdc.usda.gov ; Jerry Bernard, National Geologist, Conservation Engineering Division, Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC, jerry.bernard@wdc.usda.gov

Abstract: CEAP, the Conservation Effects Assessment Project, will assess the effects of conservation practices at both the watershed and national levels. The focus of the national assessment is to track environmental effects of conservation practices installed on a national scale. The watershed assessment studies will complement the national assessment, provide additional field and watershed data, and develop a set of regionalized models for future national assessments. Three categories of watershed studies will be conducted as part of CEAP: Special Emphasis watersheds, Benchmark Research watersheds, and Competitive Grants watersheds. This paper introduces the eight CEAP Special Emphasis watersheds and their respective strategies for assessing the effects of conservation practices at a watershed scale. At the end of this coming year, these eight projects will provide early results and assessment of their modeling efforts.

INTRODUCTION

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and the Agricultural Research Service (ARS) have joined with other USDA and Federal agencies to initiate studies that will quantify the environmental effects of conservation practices implemented through USDA conservation programs on retired and working cropland, grazing land, agro-forest land, and wetlands by way of the Conservation Effects Assessment Project (CEAP) (Table 1). CEAP addresses issues regarding the growing need to scientifically quantify natural resources effects of conservation practices. Moreover, CEAP comes at a time where there is a greater government-wide emphasis on performance outcome measures. Estimating environmental effects of the 2002 Farm Bill programs will allow policymakers and program managers to improve implementation of existing conservation programs and design new programs to meet the goals of Congress more effectively.

Table 1 CEAP Partners

USDA Partners	Non-USDA Partners
Natural Resources Conservation Service (NRCS)	U.S. Geological Survey (USGS)
Agricultural Research Service (ARS)	U.S. Environmental Protection Agency (EPA)
Cooperative State Research, Education and Extension Service (CSREES)	U.S. Fish and Wildlife Service (FWS)
National Agricultural Statistics Service (NASS)	Conservation districts
Farm Service Agency (FSA)	Local governments
Economic Research Service (ERS)	Universities
Office of Risk Assessment and Cost benefit Analysis (ORACBA)	Producers
	Agricultural and environmental organizations

A watershed studies assessment and national assessment comprise CEAP. The focus of the national assessment is to track environmental effects of conservation practices installed on a national scale. The watershed assessment studies will complement the national assessment, provide additional field and watershed data, and develop a set of regionalized models for future national assessments. This paper introduces eight CEAP Special Emphasis watersheds and their respective strategies for assessing the effects of conservation practices at a watershed scale.

CEAP WATERSHED STUDIES ASSESSMENT

The watershed studies component will provide more detailed assessments of environmental effects and benefits, a framework for evaluating and improving the performance of the national assessment models, and additional research on conservation practices and their expected effects at the watershed scale. The results of the watershed studies will be used to improve the performance of the national assessment models and to demonstrate that a richer set of benefits can be identified and measured when assessed at a finer scale. The watershed studies will demonstrate that an optimal collection and placement of conservation practices can achieve specific water quality and other environmental goals. NRCS, ARS and the Cooperative State Research, Education, and Extension Service (CSREES) will lead the effort for watershed assessment studies.

There are three categories of watershed studies that will be conducted as part of CEAP:
1. Special Emphasis Watersheds: Eight watersheds were selected to address specific resource concerns such as manure management for animal feeding operations and water use on irrigated cropland.

2. ARS Benchmark Research watersheds: In these 12 research watersheds, ARS already has long-term conservation effects research projects in progress. Development of regional watershed models is associated primarily with these research watersheds.

3. Competitive Grants watersheds: As of summer 2005, eight watersheds were selected through the CSREES Water Quality Initiative Competitive Grants Program. The ultimate goal of the program is to understand how to optimally locate and schedule the implementation of conservation practices within a watershed to achieve locally defined water quality and other environmental goals.

The five objectives for the CEAP watershed assessment studies are:
1. Assess water quality, soil quality, and water conservation effects and benefits of conservation practices at the watershed scale, and begin investigations into how to quantify wildlife and air quality benefits beyond the edge of the farm field;
2. Develop a set of regional watershed assessment models that can be used to address benefits of conservation practices and other environmental issues in the major agricultural regions of the nation and for use in future national assessments;
3. Develop water quality, soil quality, and water conservation databases that can be used to evaluate effects of conservation practices, and to compile air quality and wildlife habitat data for future assessment;

4. Develop indicators or performance measures for documenting water quality, soil quality, air quality, and aquatic and terrestrial habitat benefits from implementing conservation practices at selected watersheds; and
5. Expand research on the effects of conservation practices at the watershed scale for different soils, climates, topography, farming practices, cropping systems, and other land uses.

SPECIAL EMPHASIS WATERSHEDS

The Special Emphasis watersheds (SEW) will concentrate on the NRCS core four conservation practices (conservation buffers, nutrient management, pest management, and tillage management) plus irrigation management practices, manure management practices, establishment of wildlife habitat, and wetland protection and restoration. Environmental effects will be estimated for each of the five resource concerns (in priority order) that conservation programs are designed to address:

- Water quality (nutrient, pesticide, and sediment delivery to lakes, rivers, and streams)
- Soil quality (including soil erosion and carbon storage)
- Water conservation (including flood and drought protection)
- Air quality (including particulates and odors)
- Wildlife habitat (including aquatic and terrestrial habitats)

Benefits will be estimated separately for the four agricultural land use categories (in priority order) to which most conservation practices apply:

- Croplands, including croplands enrolled in CRP
- Grazing lands
- Wetlands
- Agro-forestry lands

The eight Special Emphasis watersheds selected in FY 2004 cover the Northeast, North Central, South Central, and Northwest major land resource areas. Figure 1 displays the general locations of the watersheds because the watershed boundaries shown on this map are at the 8-digit Hydrologic Unit Code resolution, which average over 700 square miles in drainage area. The Special Emphasis watersheds are generally focused on assessing the effects of conservation treatments in much smaller watershed drainage areas. Land use, conservation practice type and quantity, resource concerns, and pre-treatment data availability were the predominant criteria for watershed selection (Table 2). Watershed study objectives will be attained by water sampling, water quality monitoring, watershed hydrology modeling, and field trials. Financial support for the watersheds ranges from $200,000 to $600,000 per watershed study over three years, with an average of $330,000, excluding support received from non-USDA partners.

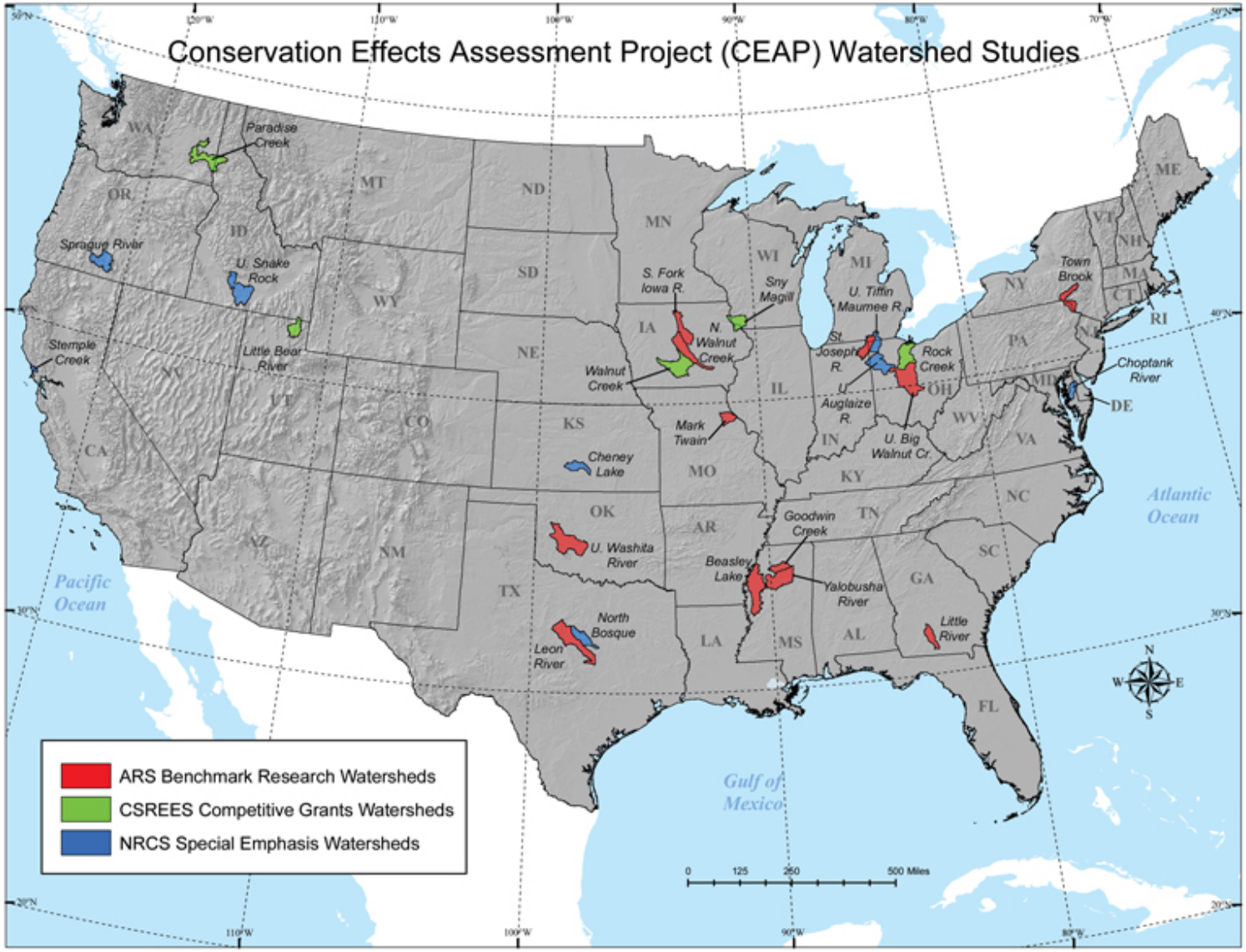

Figure 1 CEAP Watershed Studies Assessment Map

Table 2 Resource measurements, conservation practices, duration of records, and experimental approaches planned for CEAP Special Emphasis Watersheds

Special Emphasis Watershed	**Resource Measurements**			**Conservation Practices[4/]**	**Years of pre-treatment data available**	**Probable experimental design[5]**
	Water Quality[1/]	**Water Quantity[2/]**	**Economics[3/]**			
Stemple Creek, CA	S, N*, DO*, NH3*, TKN*, TU, pH*, W*, NO2*, BOD*, COD*,OPO4*	D, P	E	M, B, CM, LM	4	PP, UD
Upper Snake Rock, ID	S, P	D, I, P, G	P	B, C, D, N, T	Not provided	-
Cheney Lake, KS	pH*, DO*, TU*, W*, N, P	D, P	E, O	M, N, T, LM	5	PP, UD
Choptank River, MD	W*, pH*, DO*,P*, NH3* . Sa*, S*, N*, Se*, C*	D, I, G	E	B, N, CM	19	PP, UD
Maumee River, Upper Tiffin, MI	S*, N*, P*, DO*, Pa	A, D	E, O	D, M, T	26	PW, PP
Maumee River, Upper Auglaize, OH	S*, N*, P*, Pe*, M*	A, D, G	E	B, D, T	26	PP, UD
Upper Klamath River, OR	No specific parameters given, Sn	G, I	E	B, D, N, I	Not provided	PP
N. Bosque River, TX	P*, N*, S*	D, P	E	M, N, R	~14	PP

[1/]Water Quality Measurements:
DO - dissolved oxygen
N - nitrate-nitrogen
P – phosphorus
Pa – pathogens
Pe – pesticides
S – sediments
T – temperature
NH3 - ammonia
TKN – total kjeldahl nitrogen
TU - turbidity
pH - pH
W – water temperature
BOD – biological oxygen demand
COD – chemical oxygen demand
NO2- nitrogen dioxide
OPO4 – Orthophosphate
Sa – salinity
Se – Secci depth
C – chlorophyll
M – metals
Sn – SNOTEL site

[2/]Water Quantity Measurements:
A – Artificial drainage
C – Channel geomorphology
D – Discharge
I – Irrigation
G – Groundwater
P – Precipitation
S – Soil Water

[3/]Economic Measurements:
E – Program Efficiency
O – Optimal Placement
P – Profit

[4/]Conservation Practice Categories:
B – Buffers
C – Channel Management
D – Drainage Management
M – Manure Management
N – Nutrient Management
P – Pest
R – Range
T – Tillage
L – Land conversion
CM -Cover Management
LM - Livestock Management

[5]Probable experimental design
PW - Paired watersheds
PP - Pre and post studies and analysis of effects since initiation of CPs
UD – Upstream/downstream studies

* From previously collected data.

A synopsis detailing the more significant aspects for each of the Special Emphasis watersheds follows. Information furnished is current as of the fall of 2005. Additional information can be obtained by visiting the CEAP website at http://www.nrcs.usda.gov/technical/nri/ceap. Changes, some certainly to be unanticipated, to the goals and progress of CEAP watershed projects will be continually updated and available via the CEAP website. The website will also host materials that communicate project results, such as scientific and technical papers, outreach materials, and conference presentations.

Cheney Lake Watershed: The Cheney Lake watershed drains into the Cheney reservoir. Impacted with sediments and phosphorus, the reservoir provides the city of Wichita, Kansas with 70% of it daily water supply. Land use for the 630,000 acre watershed, is primarily cropland and range land. The primary objective of the watershed project is to evaluate downstream effects of current Conservation Reserve Program (CRP) and Environmental Quality Incentives Program (EQIP) practices.

Choptank River Watershed: The Choptank River watershed is located on the Delmarva Peninsula of the Chesapeake Bay. This poultry dominated region has major issues with accelerated eutrophication due to nutrients, seasonal hypoxia, soil management and carbon sequestration, air quality, and disappearance of submerged aquatic vegetation. The main goals for the project are to detect differences in nutrient concentrations in basins with similar amounts of agriculture but varying amounts of acres in Conservation Reserve Enhancement Program (CREP), cover crops, and Concentrated Animal Feeding Operations (CAFO) sites, and to determine the effect of land application of poultry litter on stream water quality.

North Bosque River Watershed: The 800,000-acre North Bosque River watershed contains the largest concentration of dairy animals in Texas. Mostly pasture and range, the watershed provides 75% of the drinking water for the city of Waco. The quality of water entering Lake Waco, air quality, and soil quality are all natural resource concerns for the watershed. A top priority for the study is to evaluate the ability of conservation practices to reduce phosphorus flow to Lake Waco.

Sprague River Watershed: The Sprague River watershed is experiencing issues with water shortages, irrigation water demands, water quality, streambank erosion, fish and wildlife habitat. One-million acres in size, the watershed consists of 56% public lands, 24% private forest lands, and 11% rangeland. The objectives of this watershed assessment are to evaluate effects of improving agricultural irrigation water management, restoring wetland/riparian areas, and conducting forest and range management on water quantity and quality.

Stemple Creek Watershed: The Stemple Creek watershed is a part of the Gulf of the Farallones National Marine Sanctuary. Natural resource issues for the 33,000 acre watershed include loss of riparian vegetation on over 70% of its waterways, nutrients in runoff from dairy manure, and sediment loads to the estuary, Estero de San Antonio. Land use for the watershed is about 90% grazing land. This watershed study will evaluate water quality and wildlife effects of dairy waste management systems, riparian restoration, and soil erosion control.

Upper Auglaize River Watershed: The Upper Auglaize River watershed contributes a significant amount of sediment to the Maumee River, which is then transported to Toledo

Harbor, Ohio. The watershed is 212,000-acres in size and more than 80% tile-drained. Effects of subsurface drainage and other related best management practices on water quality will be assessed.

Upper Snake Rock Watershed: The 1.5 million acre Upper Snake Rock watershed receives approximately 10 inches of precipitation per year. Primary land uses for the watershed are rangeland and cropland. Irrigation return flows laden with sediment and nutrients, runoff from dairies and feedlots, effluent from aquaculture, industrial and municipal facilities, and storm water runoff are significant natural resource concerns. The effects of changing surface to overhead irrigation systems on water quality of return flows and the effects of conservation practices on sediment and phosphorus in irrigation return flows will be evaluated.

Upper Tiffin Watershed: The Upper Tiffin watershed is utilizing a paired watershed approach to address issues of manure and nutrient loading from large livestock farms that are polluting waterways. The Lime Creek and Bean Creek watersheds, subwatersheds of the Upper Tiffin, are both representative of intensively drained watersheds in the Great Lakes region. Various manure management and drainage practice combinations will be compared to determine the best ways to reduce movement of manure via underground drainage tiles.

EARLY RESULTS

The Special Emphasis Watershed Studies will provide annual progress summaries for each of their respective three year activities. Generally the first year activities include collecting additional monitoring data for input to calibrate, validate and run the respective models. There are several models being utilized within the eight projects including Annualized Agricultural Non Point Source (AnnAGNPS), Soil and Water Assessment Tool (SWAT), Riparian Ecosystem Management Model (REMM), Conservation Channel Evolution and Pollutant Transport System (CONCEPTS), Agricultural Policy/Environmental Extender (APEX), MODular three-dimensional finite-difference ground-water FLOW model (MODFLOW), Distributed Hydrology Soil Vegetation Model (DHSVM), and MIKE SHE. The second year begins the running of models and the initial assessment of conservation practices effects. Year three reports will provide a summary of modeling results and assessment conclusions.

Each of these eight projects is studying a different set of resource issues with varying degrees of available data and modeling support. The Choptank River Watershed Study is progressing somewhat faster than the other studies. Like the others, it has established a strong collaboration of public and private organizations working within their watershed. In their work, AnnAGNPS is being used to study the role of practices, such as nutrient management, in reducing pollutant loads of nitrogen, phosphorus, and sediment. REMM is being utilized to evaluate the buffers within the subwatersheds. The outputs from these two models are then entered into SWAT to better understand the regional impacts to water quality. Remote sensing data for model inputs is also being explored to offer more time dynamic comparisons and evaluations.