Chapter 1

Introduction and Approach to Synthesis of Lessons Learned: National Institute of Food and Agriculture–Conservation Effects Assessment Project

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Over the past three decades, considerable resources have been invested in implementing farm-related conservation practices in an effort to reduce the impacts of nonpoint source (NPS) pollution on the United States' waters, to restore and protect soil and water quality, and to ensure continued agricultural productivity. While research has documented the effectiveness of conservation practices in reducing pollutant export from farmland and rangeland at the plot, practice, and/or field scales (Jokela et al. 2004; Richards and Baker 2002; Sharpley et al. 2006a, 2006b; Shepard 2005; Smith et al. 2006; Tomer and Burkart 2003; Schnepf and Cox 2006), relatively few studies have adequately or successfully evaluated the cumulative effects of a program designed to implement numerous practices at the watershed scale (Edwards et al. 1997; NRC 1999, 2000).

In 1977, the USDA and the US Environmental Protection Agency (USEPA) examined several methods of implementing agricultural and silvicultural NPS pollution components of water quality management plans developed under Section 208 of the Clean Water Act. From this examination, the Model Implementation Program was developed. It consisted of seven watershed projects (Indiana, Nebraska, New York, Oklahoma, South Carolina, South Dakota, and Washington) conducted between 1978 and 1982. The Model Implementation Program was designed to study and demonstrate a concerted attempt by the USDA and USEPA to address agricultural NPS problems by using existing USDA and USEPA programs. Evaluation of the Model Implementation Program was performed by North Carolina State University (Dressing et al. 1983). Resulting recommendations for future programs were incorporated in the subsequent Rural Clean Water Program (RCWP), another joint effort of the USDA and USEPA, and included longer project duration, preimplementation planning and documentation, documentation of both land treatment/use and water quality, and use of state of the art best management practices to target agricultural NPS pollutants.

The RCWP (1980 to 1995) was one of the earliest national NPS control programs that combined land treatment and water quality monitoring in order to document NPS pollution control effectiveness at the watershed scale (Gale et al. 1993). Experience gained from the 21watersheds studied made significant contributions to the knowledge of NPS pollution origination and transport, control measures, conservation practice effectiveness, water quality monitoring, and the ability of voluntary cost share programs to assist farmers in reducing agricultural NPS pollution (USEPA 1992).

From 1991 to 1994, the USDA initiated two programs—the Hydrologic Unit Area and the Demonstration Project programs—designed to improve and protect water quality by reducing agricultural nonpoint source pollution. The Hydrologic Unit Area projects focused on remediation of documented water quality problems by providing educational, technical, and financial assistance to support adoption of USDA Natural Resources Conservation Service (NRCS)–approved practices by farmers. The Demonstration Project programs were located in areas of actual or potential water quality impairment and combined demonstration of innovative practices at a limited number of sites with education efforts to promote wider adoption of the practices by farmers. As the programs were ending, the USDA conducted an analysis of a case study group of Hydrologic Unit Area and Demonstration Project programs to determine progress toward improving and protecting water quality from agricultural NPS pollution (Meals and Sutton 1996). Progress was assessed using three indicators: (1) farmer adoption of conservation practices and changes in agrichemical management, (2) model-simulated reductions in pollutant loadings, and (3) monitored water quality changes in receiving water bodies. Few of the projects were able to convincingly demonstrate success in achieving water quality goals.

Another successor to the RCWP, the USEPA Section 319 National Nonpoint Source Monitoring Program (NNPSMP) was established in 1991 to improve technical understanding of NPS pollution, document the feasibility of NPS pollution control, and scientifically evaluate effectiveness of strategic watershed technologies (conservation practices) designed to control NPS pollution (Spooner et al. 2010). More than 25 projects included in the USEPA Section 319 NNPSMP conducted 6 to 10 years of intensive water quality and land treatment monitoring following a nationally consistent set of guidelines. Many of these projects demonstrated significant success in documenting effectiveness of grazing management, erosion and sediment control, nutrient management, urban runoff control, and stream restoration for improving water quality at the watershed scale (Lombardo et al. 2000; Meals and Dressing 2006; Spooner et al. 2010).

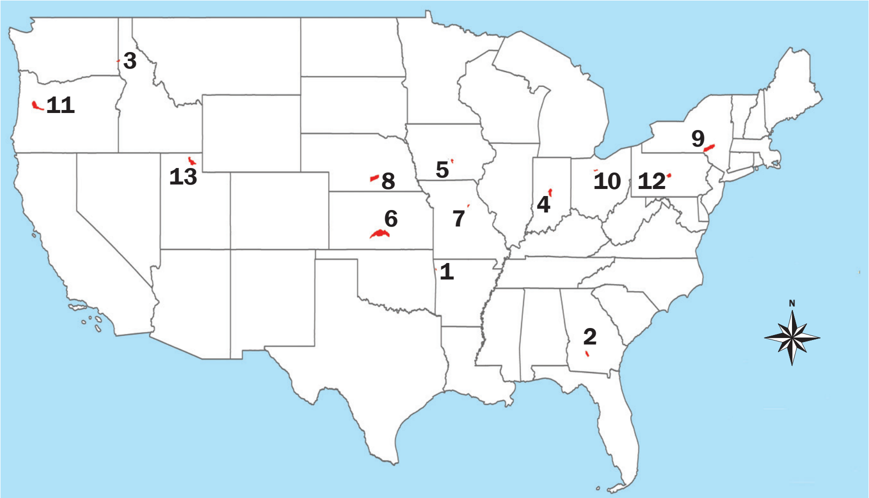
In 2003, the Conservation Effects Assessment Project (CEAP) began as a multiagency effort to quantify, understand, and optimize environmental benefits of conservation practices implemented via selected USDA conservation programs (USDA NRCS 2010a). The major participating USDA agencies included the NRCS, the Agricultural Research Service, the National Institute of Food and Agriculture (NIFA), and the Farm Service Agency. The overall goal of CEAP was to improve the efficacy of conservation practices and programs by quantifying conservation effects and providing the science and education base needed to improve future conservation planning, implementation, management decisions, and policy (Duriancik et al. 2008; Maresch et al. 2008). The project was also designed to conduct outreach education for knowledge transfer from this effort to farmers, ranchers, community leaders, and other stakeholders. Not surprisingly, multiple resource concerns at multiple scales have been studied during the CEAP (Tomer and Locke 2011; USDA NRCS 2010b, 2011). Overall, CEAP includes 42 funded watershed studies: 14 USDA Agricultural Research Service Benchmark Watersheds, 11 USDA NRCS Special Emphasis Watersheds, and 17 USDA NIFA Competitive Grants Watersheds (13 cropland and 4 rangeland).

By design, the NIFA–CEAP responded to a need to evaluate the impacts of interactions among conservation practices and their biophysical settings on water quality at a watershed scale, while simultaneously evaluating social and economic factors influencing implementation and maintenance of practices (USDA NIFA 2010). From fiscal years 2004 to 2011, the following 13 NIFA–CEAP cropland projects were funded (figure 1.1):

- Cannonsville Reservoir Watershed (New York)
- Central Platte Natural Resources District (Nebraska)
- Cheney Lake Watershed (Kansas)
- Eagle Creek Watershed (Indiana)
- Goodwater Creek Watershed (Missouri)
- Lincoln Lake Watershed (Arkansas)
- Little Bear River Watershed (Utah)
- Little River Watershed (Georgia)
- Lower Calapooia River Watershed (Oregon)
- Paradise Creek Watershed (Idaho)
- Rock Creek Watershed (Ohio)
- Spring Creek Watershed (Pennsylvania)
- Walnut Creek and Squaw Creek Watersheds (Iowa)

In order to assemble and apply critical lessons from the CEAP, the USDA NIFA commissioned a synthesis of the information derived from the 13 competitively funded NIFA–CEAP watershed studies. Each NIFA–CEAP made contributions to the understanding of the effective-

Figure 1.1
Map showing USDA National Institute of Food and Agriculture–Conservation Effects Assessment Project locations.



Legend

1. Lincoln Lake, Arkansas
2. Little River, Georgia
3. Paradise Creek, Idaho
4. Eagle Creek, Indiana
5. Walnut Creek/Squaw Creek, Iowa
6. Cheney Lake, Kansas
7. Goodwater Creek, Missouri
8. Phase III: Central Platte Natural Resources District, Nebraska
9. Cannonsville Reservoir, New York
10. Rock Creek, Ohio
11. Lower Calapooia, Oregon
12. Spring Creek, Pennsylvania
13. Little Bear River, Utah

NIFA–CEAP watershed
Scale: 1:10,000,000

ness of conservation practices for improving water quality at the watershed scale (e.g., Brooks et al. 2010; Chaubey et al. 2010; Cho et al. 2010; Flores-Lopez et al. 2010; Gassman et al. 2010; Gitau et al. 2010; Jackson-Smith et al. 2010; Jha et al. 2010; Mudgal et al. 2010; Rabotyagov et al. 2010; Richards et al. 2010; Tosakana et al. 2010). The references listed are only a small representation of the body of literature developed through NIFA–CEAP. However, to meet the goals of the USDA and the need to generate policy-relevant information, it was essential to take a broader, more thorough and systematic look at each project's results in order to synthesize lessons and derive key principles capable of guiding future watershed management efforts.

As a result, the USDA NIFA project, Synthesizing and Extending Lessons Learned from the 13 NIFA–CEAP Watersheds, was funded to identify critical lessons learned for translation and extension to policymakers, watershed planners, and other stakeholders. The synthesis team was multidisciplinary, had over 150 years of watershed and water quality experience, and represented specialties in water quality monitoring, agronomy, soil science, biological and agricultural engineering, rural sociology, economics, statistics, and modeling. Synthesized lessons learned, as well as descriptions of each of the 13 projects, are presented in this book.

The purpose of this effort is to use the results and lessons from the 13 projects to explicate the current state of the art on watershed land treatment/water quality projects and programs and to apply this knowledge in order to improve the next generation of land treatment/water quality projects and programs. It is essential not only to learn from the experience of the 13 projects but also to apply that knowledge so that conservation professionals can move forward more effectively.

Methods

The synthesis relied on a series of nested, science-based strategies to evaluate the effects of conservation practices used in each of the 13 NIFA–CEAP watershed studies. The authors began with a review of the approaches and structures for collecting and organizing assessment information used by previous national watershed-scale conservation effects assessments (e.g., RCWP, USEPA Section 319 NNPSMP), which allowed construction of a preliminary template for assembling the NIFA–CEAP assessment information in a consistent framework.

Analysis of previous watershed-scale projects (RCWP, USDA Hydrologic Unit Area and Demonstration Project programs, and USEPA Section 319 NNPSMP assessments performed by members of this synthesis team) focused primarily on experimental design, conservation practice implementation, project management, and documentation of water quality change. However, final assessment of the RCWP did not compare findings across regions or agricultural practices. Case study projects in the former USDA RCWP assessment were deliberately selected to represent different geographical, agricultural, and NPS settings so generalization of results across locations or practices was not feasible. The ongoing USEPA Section 319 NNPSMP assessment has organized lessons learned by water quality problem/agricultural practice (e.g., grazing/riparian zone management, erosion and sediment, animal waste management, stream and watershed restoration) but has not examined issues of timing and location of practices within a watershed or of interactions among combinations of practices. There is, however, commonality between NIFA–CEAP objectives and project analyses of these earlier watershed studies that facilitate some immediate comparisons. For example, social and economic factors and outreach techniques were assessed in the RCWP. The USEPA Section 319 NNPSMP lessons-learned assessment uses access to information on how NPS pollution sources were identified, how critical areas for treatment were selected, and how water quality response was monitored and quantified.

Because of specific questions driving the NIFA–CEAP, the assessment focused on delineating underlying water quality changes based on agroecosystem and conservation practice location. This is a central point of distinction with earlier national water quality watershed assessments. The authors used an initial draft template developed from prior national watershed assessments and then modified that framework to capture the three key questions to be integrated across the 13 NIFA–CEAP watershed studies:

1. Across the 13 Cooperative State Research, Education, and Extension Service (now NIFA) watersheds, what are the key findings from projects that addressed the original four CEAP questions (bulleted below)? How do these findings differ by location and agricultural production activities, social, or economic factors? What patterns emerge from this effort?
   - Within the hydrologic and geomorphic setting of a watershed, how do the timing, location, and suite of implemented agricultural conservation practices affect surface and/or ground water quality at the watershed scale?
   - What are the relationships among conservation practices implemented in a given watershed with respect to their impact on water quality? Are the effects additive, contradictory, or independent?
   - What social and economic factors within the study watershed either facilitate or impede implementation or proper maintenance of conservation practices?
   - What is the optimal set or suite of conservation practices and what is their optimal placement within the watershed in order to achieve water quality goals or to provide acceptable reductions in water quality impairments?
2. What combinations of practices work to protect or improve water quality in different geographic settings?
3. What outreach techniques were most effective at communicating information for different audiences, achieving adoption of practices, and improving management and/or maintenance of practices in different geographic settings?

Once developed, the template was reviewed by investigators from the 13 NIFA–CEAP watershed studies and members of the CEAP Steering Committee, which was composed of representatives from federal government agencies directly or indirectly involved in the CEAP and with the results generated from the CEAP. Because the NIFA–CEAP watershed studies were retrospective and did not all evolve from the same original initiative, the template, by design, had to be robust enough to capture diverse information developed by project teams (Chapters 9 to 21). Major sections for the template included the following: Watershed Information, Water Quality Information, Modeling Application, Land Treatment, Water Quality Response, Socioeconomic Analysis, and Outreach.

Because the NIFA–CEAP watershed studies were funded in a staggered fashion (four in 2004, four in 2005, and five in 2006), development of information for each project occurred as projects were completed and their results finalized. The original structure of the NIFA–CEAP was framed around a three-year study; however, nearly all projects requested and were granted two one-year, no-cost extensions. The authors collected electronic information (technical reports, surveys, media reports, posters, etc.) and published papers from each NIFA–CEAP as they became available. This information was used to complete relevant sections of the template.

Following the assembly of project information, a two- to five-member synthesis team visited each of the NIFA–CEAP watersheds. This visiting team was multidisciplinary, with expertise in water quality modeling, water quality assessment and design, economics or rural sociology, and extension; specific team members were selected based on the particular characteristics of the project. During each site visit, project investigators provided the synthesis team with a project overview, technical presentations of specific areas (e.g., water quality monitoring, modeling, conservation practice implementation), a field tour, and informal discussions. Most site visits lasted one day, but a few were as long as two days. On-the-ground information gathered through these visits increased data reliability and validity and provided context for much of the previously collected information. All members of the synthesis team involved in each site visit contributed to the template completed for the visited project.

Completed templates were then sent to each NIFA–CEAP team for review, editing, and revision. In turn, the reviewed templates were then converted to a narrative and were rereviewed by the members involved in the site visit. The narratives were again sent to the NIFA–CEAP team for input. The results of this iterative process are included in Chapters 9 to 21 of this book and provide details about each of the NIFA–CEAP watershed studies based on these narratives.

In addition to development of narratives, the project team conducted in-person interviews of key informants (stakeholders) at each of the 13 NIFA–CEAP sites. The purpose of these stakeholder interviews was to supplement the first phase in order to develop a broader, more systematic look at individual project results, interpret them, and derive key principles for use in guiding future watershed management efforts. In Chapter 2, project authors describe the methodology of the key informant survey and discuss the results and interpretations. The authors also used some of the information derived from the key informant interviews in Chapters 3 to 8 to develop a more robust and inclusive discussion of land treatment, socioeconomics, and outreach.

After each NIFA–CEAP visit, the authors developed lessons learned from the watershed around the functional areas of water quality monitoring, land treatment, modeling, socioeconomics, and outreach. Conservation practice adoption was analyzed from social and economic perspectives. By using information drawn from the 13 NIFA–CEAP watershed studies and key informant interviews, the authors were better able to understand practice choices, acceptance, and implementation, and the degree to which implemented conservation practices were regularly maintained.

In retrospect, some NIFA–CEAP watersheds had very targeted conservation practice implementation, while others were completely voluntary. Such a range facilitated an assessment of the role of voluntary compliance in conservation practice selection, location, and management. Moreover, it enabled an evaluation of acceptance of structural conservation practices compared with the implementation of management conservation practices. Finally, where data were collected by the NIFA–CEAP studies, they were evaluated in terms of the sustainability of adopted practices when assistance was removed.

The authors also compared outreach techniques and effectiveness among the NIFA–CEAP watershed studies. Education and outreach efforts differed among the NIFA–CEAP studies due to many factors, including project duration, the project's emphasis on outreach, farmer populations, outreach organization, and the agroecological area. Such an analysis enabled the identification of outreach and education factors critical to conservation practice implementation and successful maintenance.

In the synthesis of the projects, it was useful initially to compare projects across commonalities. With one exception, two or more of the projects shared common pollutants, water quality impairments, or water quality concerns: sediment (Cheney Lake, Kansas; Paradise Creek, Idaho; Sny Magill, Iowa; Rock Creek, Ohio); phosphorus (Cannonsville Reservoir, New York; Little Bear River, Utah); nitrogen (Central Platte Natural Resources District, Nebraska; and Walnut Creek, Iowa); herbicides (Goodwater Creek, Missouri; Eagle Creek, Indiana); biota (Lower Calopooia River, Oregon; Spring Creek, Pennsylvania); nonspecific (Little River, Georgia). However, due to the numerous differences between individual projects (including agroecological regions) and lack of water quality change in many projects, it was concluded that projects could not be effectively grouped based on pollutant or hydrologic and geomorphic response.

The synthesized lessons learned are presented in Chapters 2 to 7 by the functional areas of key informants, land treatment, water quality monitoring, modeling, socioeconomics, and outreach. A final recommendations chapter (Chapter 8) includes our vision of how the lessons learned from the NIFA–CEAP watershed studies can be applied to improve future USDA, state-funded, and nonprofit organizations' agricultural conservation and water quality programs.

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