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Nearing nationwide coverage of the Agricultural Conservation Planning Framework database to facilitate watershed-scale planning

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Spatial variability in crop and livestock production systems, climatic conditions, soils, topography, and resource management concerns in agricultural landscapes in the United States has long posed a technical challenge to effective, site-specific soil and water conservation planning. Nearly 15 years ago, we hypothesized that under a planning concept emphasizing voluntary landowner participation, high-resolution spatial data could be combined with computerized tools to identify possible conservation practice placements across agricultural watersheds (Tomer et al. 2013). We hoped this approach would enable consistency in watershed-scale conservation planning and could inform landowner decision-making on conservation practice placements in a variety of agricultural landscapes.

EARLY DEVELOPMENT AND USE OF THE AGRICULTURAL CONSERVATION PLANNING FRAMEWORK

In 2012, the concept for a watershed assessment approach was conceived based on early findings associated with effective watershed conservation strategies from the USDA Conservation Effects Assessment Project (CEAP) Watershed Assessment Studies (Tomer et al. 2014). An aim to improve our capability to effectively place new practices in watersheds for better outcomes was included as an objective in Natural Resources Conservation Service (NRCS) and Agricultural Research Service (ARS) CEAP interagency agreements. Also in 2012, work began at the USDA National Laboratory for Agriculture and the Environment

(NLAE) under a subcontract from the Environmental Defense Fund, funded by a Conservation Innovation Grant from USDA NRCS to develop a geographic information system (GIS) database structure and suite of geoprocessing tools to assist conservation planners in achieving this objective. By 2015, the Agricultural Conservation Planning Framework (ACPF) Toolbox, using ArcGIS software (Esri, Redlands, California), and databases for Iowa, Illinois, and portions of Minnesota were made public and available for download. The ACPF database, described in detail by Tomer et al. (2017), includes watershed boundaries, field-specific land uses, and soil survey data. The original database included field boundary data from the pre-2008 USDA Farm Service Agency (FSA) Common Land Unit (CLU) after all ownership and USDA program participation data were removed. The database was assembled on a small watershed (hydrologic unit code [HUC]-12) basis and made available for download through the ACPF website, hosted by the North Central Region Water Network, a multistate consortium of Midwest state extension offices hosted at the University of Wisconsin. This original database included about 5,000 HUC-12 watersheds.

Since the original release, watershed data were added to cover a total of 12,000 HUC-12 watersheds, mostly funded by a variety of small (<US\$50,000) state-specific grants and contracts. The use of ACPF data has not been tracked in detail due to resource limitations; however, using basic website-use tracking tools, we estimate that

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data for more than 9,000 HUC-12 watersheds have been downloaded. There were approximately 13,000 total downloads, meaning that data for a number of watersheds have been downloaded multiple times, which may indicate where data were used for research projects and where multiple organizations are participating in watershed conservation planning. The extent of available watershed data for download is shown in [Figure 1A](#). The database covered most of the US Midwest's Corn Belt. The ACPF has been extensively used in Iowa and other areas of the Midwest (Gesch et al. 2020; Lewandowski et al. 2020; Srinivas et al. 2020). These studies have included social assessments of farmers' responses to ACPF outputs mapped for their lands (Ranjan et al. 2020, 2022).

RECENT EFFORTS TO EXTEND THE FRAMEWORK

A multistate trial funded by an NRCS and ARS interagency agreement was conducted by USDA NLAE from 2019 to 2021 to evaluate use of the ACPF beyond the Midwest Corn Belt. The project was hampered by contact and travel restrictions during the COVID-19 pandemic. Yet, results of this remotely conducted project showed that ACPF results had some utility in most trial watersheds, albeit with caveats. In several of these watersheds, output from the ACPF tools prompted alternative interpretations that would not apply in the Midwest but could be useful in the coastal, karst, and subhumid watersheds included in the trial. These findings were tantalizing, but they were not possible to pursue during the pandemic. From this study, we concluded that adaptation of existing tools and development of new tools could expand the utility of the ACPF and that use and interpretation of results from the practice placement tools required firsthand knowledge of the subject watershed and its resource concerns (a similar caution was also included in the original ACPF user manual).

Interest in the ACPF has grown, and the utility of the data has been recognized beyond the extent shown in [Figure 1A](#). Although we have seen the ACPF used on a limited basis in a few other states, in most of these cases customized

databases were built for a limited number of watersheds, usually by state agencies and universities (e.g., watersheds shown in Arkansas and Michigan; [Figure 1A](#)). Selected publications discuss adaptation of the ACPF for agricultural landscapes in the eastern and southeastern United States (Duncan et al. 2021; Respess et al. 2022). There has also been some adoption of the ACPF outside the United States. In Canada, the ACPF core data and a modified toolbox have been developed for the Province of Ontario (Bodrud-Doza 2023). A number of watershed modeling studies have utilized ACPF watershed databases to provide land use inputs and have used toolbox results to build modeling scenarios (Gordon et al. 2021; Ha and Wu 2022; Rohith et al. 2024; Yuan and Whisenant 2023).

Our recent efforts to extend the ACPF have been through follow-on tools like the Financial and Nutrient Reduction Toolbox (Zimmerman 2019; Bravard 2022) and the Manure Map Toolbox (Porter and James 2020), application of the Soil Vulnerability Index (SVI) (Lohani et al. 2020; Thompson et al. 2020; Audia et al. 2021), and partnership with the Daily Erosion Project (Luquin et al. 2024). These extensions have enabled the use of the framework to address issues related to watershed-scale nutrient budgeting and erosion assessments and financial optimization of conservation investments (Bravard et al. 2022).

In 2021, with funding from the USDA NRCS, a National Hub for the ACPF was established that provided access to the database and software and extended ACPF's use through outreach and training. Details on ACPF applications and training resources were discussed by Lewandowski et al. (2020). Training materials developed by USDA NLAE staff were used by University of Wisconsin extension education staff to develop remote ACPF training courses. Demand for training resources and courses has kept the focus of the National Hub on training. Due in part to this focus, efforts to extend the ACPF database beyond the Midwest Corn Belt have been limited.

EXPANSION OF THE DATABASE

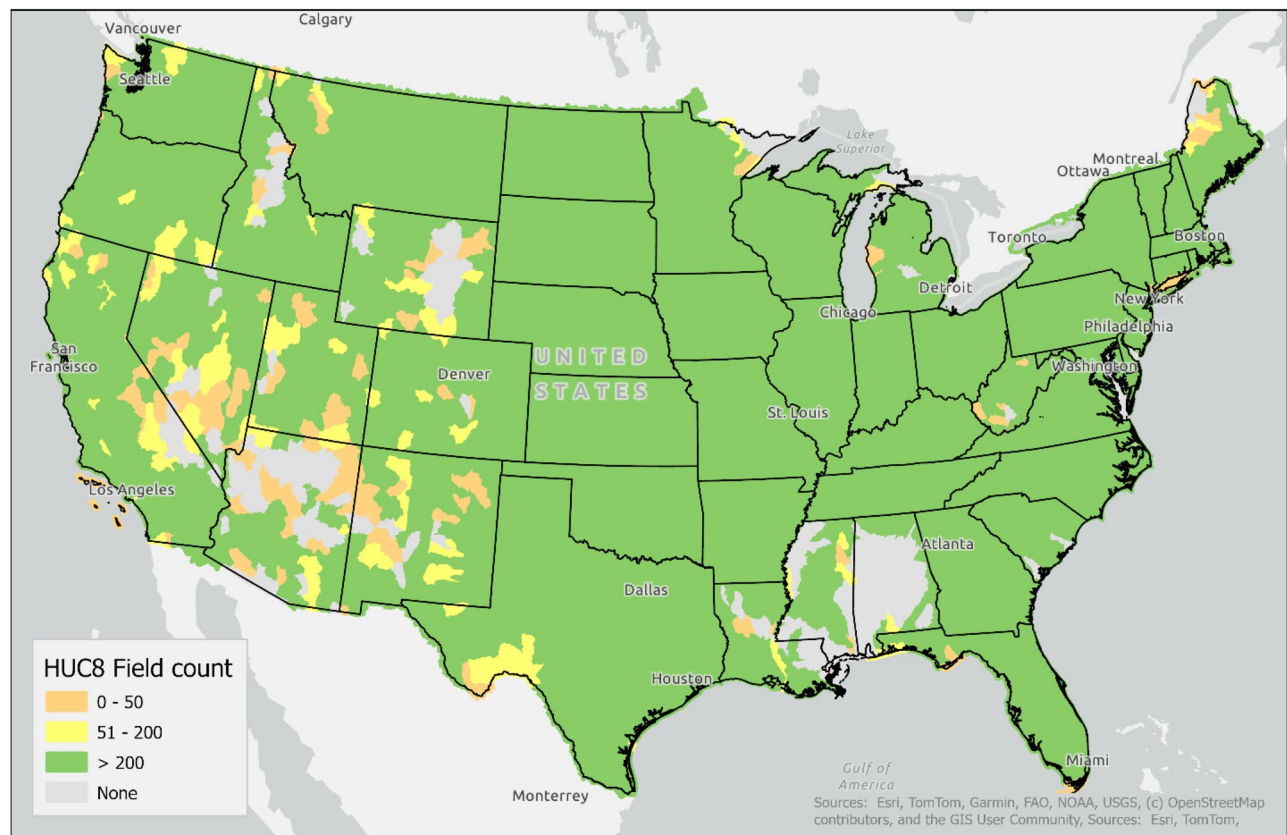
In-house assembly of ACPF databases by watershed has been a time-consuming process.

Therefore, modifications have been made to allow ACPF databases to be built under software control. Initially, tools were added to the ACPF Toolbox to enable users to create and edit ACPF watershed databases. These tools continued to evolve to enable much of the ACPF core data to be created by users through automated data delivery techniques. In the current version, ACPF Toolbox version 7, these tools have been modified to build the full ACPF core database under software control. As of June 2025, under the current ACPF National Hub interagency agreement, the ACPF core database can be created in approximately 53,000 HUC-12 watersheds across the conterminous United States. Collectively, these watersheds cover more than 90% of row crop agriculture in the continental United States. The agricultural field boundary feature class used to support this near-national scale consists of more than 21 million individual field boundaries. The extent of watershed coverage is shown in Figure 2;

note that the areas that are missing are those that were not covered by the original field boundary dataset. We note that four states—California, Colorado, Florida, and Washington—regularly publish their states' agricultural field boundaries in a publicly available GIS format. These data have been collected and incorporated into the ACPF national field boundary collection. In some instances, state-provided ancillary data are also harvested and delivered to the user for the selected watershed. The potential exists to add field boundaries as they become available or generate them using new techniques, including future machine-learning methods that can identify boundaries in high-resolution aerial imagery.

The expansion of the ACPF database availability to a near-national scale presents remarkable opportunities for farmers, conservationists, and other stakeholders to investigate how agricultural conservation can be implemented effectively at a small watershed scale for improved outcomes

Figure 2. Map showing the extent of field boundary and land use data coverage enabling automated development of watershed databases. Data are missing where field boundary data could not be obtained or where land use is predominantly nonagricultural.



across the variety of agricultural landscapes in the United States. As we developed the ACPF, we always understood that the nuances of agricultural landscapes would present different conservation opportunities, and that these differences would require modifying existing tools and adding new ones to the toolbox. This was assumed because we expect that a wider set of resource management concerns will need to be addressed as the full array of production systems and soil landscape-watershed processes found across the nation's agricultural landscapes are considered.

Interest continues to build for expanding the reach of the ACPF Toolbox both in the United States and other countries. Through ongoing support from the USDA NRCS under two agreements in 2021 and 2025, we have expanded the toolbox with additional practices (e.g., two-stage ditches, phosphorus traps) and enhanced existing tools (e.g., incorporating high-resolution data into the SVI) to make new analyses available to users. We expect that, with the addition of data from across the United States, many more opportunities exist to create new tools and information sets to evaluate different agricultural landscapes and address resource concerns. This expansion may also facilitate new approaches and wide-scale analyses of the soil landscapes and agricultural systems found in the United States while considering field-scale detail.

This article is an open invitation to contribute to this effort and extend the utility of the ACPF data for conservation planning across the full variety of US agricultural landscapes. Readers are encouraged to visit the ACPF website (www.acpf4watersheds.org) to access data and for additional details.

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