Chapter 10

Little River Experimental Watershed, Georgia: National Institute of Food and Agriculture–Conservation Effects Assessment Project

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The Georgia National Institute of Food and Agriculture–Conservation Effects Assessment Project (NIFA–CEAP), Long-Term Water Quality Responses to Conservation Practices in Nested Coastal Plain Watersheds (Little River Experimental Watershed), included the following overall objectives:

1. To evaluate the effects of past and potential conservation practices on water quality in a coastal plain watershed
2. To evaluate social and economic factors influencing implementation and maintenance of these conservation practices
3. To train and educate stakeholders about these issues and the effects that their actions have on watershed-scale water quality

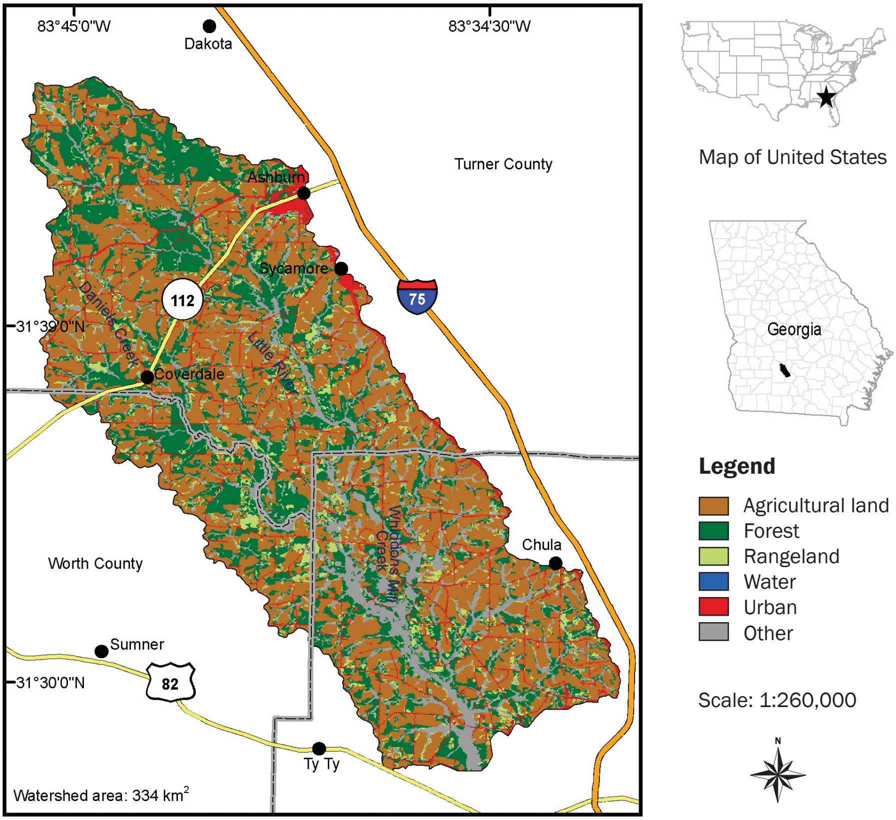
Watershed Information

The Little River Experimental Watershed is a 33,400 ha (82,500 ac) watershed located in the Gulf-Atlantic Coastal Plain region within the Suwannee Basin in south-central Georgia (figure 10.1). The region has low topographic relief and is characterized by broad, flat alluvial floodplains, river terraces, and gently sloping uplands. This is a humid region with low-gradient drainage networks and wide, poorly defined channel systems with dense dendritic streams and heavily vegetated flood plains and riparian areas. An underlying shallow impermeable layer forces infiltrating water to flow laterally, leading to many seeps and the characteristically dense drainage network.

The Little River Experimental Watershed encompasses the headwaters area of the Little River (tributaries and main stem) and is located in Tift, Turner, and Worth Counties in south-central Georgia. The watershed is similar to other mixed-use, agricultural watersheds of the middle coastal plain. The middle coastal plain is characterized by crop production on moderately to well-drained upland soils and riparian forests and wetlands on poorly and very poorly drained soils along streams.

The soils are typically loamy sands with a plinthic layer of low hydraulic conductivity soil underneath the plow layer at a depth of 0.9 to 1.2 m (3 to 4 ft). Uplands range from flat to 12% slopes. Dense dendritic stream networks result in the typical farm being drained by two or

Figure 10.1
Little River Experimental Watershed, Georgia, land use and stream networks.



three small streams. The shallow and impermeable Hawthorne formation in the soil restricts downward movement of infiltrated precipitation and leads to lateral movement to the stream channels. Between 60% and 70% of all baseflow is due to shallow groundwater flow.

The climate of the Little River Experimental Watershed is humid subtropical with a long growing season. Rainfall is unevenly distributed throughout the year, with the greatest rainfall occurring from January through March and June through August. Summer rainfall often occurs as short-duration, high-intensity convective thunderstorms (Cho et al. 2009).

In the 1970s and 1980s, the subwatersheds of Little River Experimental Watershed ranged from 36% to 54% total cropland with row crops occupying 31% to 41% of total area (Lowrance et al. 1985; Lowrance and Leonard 1988). Based upon 2003 satellite data, the watershed is 31% row crops and fallow agricultural land, 50% forest, 7% urban, 10% pasture, and 2% water (Bosch et al. 2006). Most pastureland is used for cow-calf operations. The forested areas are in upland pine forest (both natural regeneration and pine plantation) and riparian forest (natural regeneration), which is primarily wetland. Because of wet soil conditions near streams, much of the riparian area is not cropped and is naturally in forest. There have been minor increases in suburban development, mostly in the very lower portions of the watershed near the outlet. There are no permitted point sources of pollution.

Almost year-round production of vegetables and row crops, such as peanuts and cotton, on upland areas between stream channels has led to extensive and sustained use of fertilizer and pesticides in the watershed. Over the past 32 years, there has been a decrease in corn acreage, while cotton acreage has increased, although peanut was the dominant crop until 1995. In the late 1970s, major crops, roughly in order of acreage, were corn, soybeans, peanuts, sorghum, tobacco, and vegetables (Lowrance et al. 1985); there was little cotton grown during this period. Cotton has been the dominant crop in the watershed since the mid-1990s. By 1995, major crops were cotton (about 60% of cropland), peanuts (about 38%), very small acreages of corn (about 3%), and no soybeans. This change in cropping systems should have reduced nitrogen (N) fertilizer inputs as corn requires about twice as much N as cotton–peanut rotations. Center-pivot sprinkler irrigation is increasingly used.

There is one broiler chicken operation with eight houses roughly in the middle of the watershed and a university facility that consists of a 200-cow dairy and approximately the same number of beef cattle. There are some pasture-based cow-calf operations in the watershed.

Water Quality Information

Segments of the main reach of the Little River within the Little River Experimental Watershed are on the 2002 (most recent available) Section 303(d) list of the Clean Water Act (USEPA 2011) for low dissolved oxygen (DO) impairment attributed to nutrient enrichment from nonpoint source pollution, although low DO may be due to natural decomposition of organic materials and high temperatures in watershed wetlands. Tributaries of the Little River are listed for low DO, fecal coliforms, and sediment. These impairments are very common in coastal plain streams of Georgia and other southeastern states. During summer months, the Little River regularly violates the state DO standard (5 mg L^{-1} average, 4 mg L^{-1} minimum), according to the project's long-term database. Georgia does not currently have nutrient enrichment criteria, but when these are implemented, many of the Little River Experimental Watershed streams will probably be nutrient impaired as well. Depending on the data source, there may be a long-term downward trend of total phosphorus (TP) concentration in runoff, no trend for nitrate-nitrogen or total nitrogen (TN), and an upward trend in DO levels .

The water quality monitoring program was designed for long-term trend monitoring for the USDA Agricultural Research Service (ARS) experimental purposes rather than to assess any specific land-treatment program. The monitoring design consists of eight nested watersheds with v-notch weirs that have had a continuous flow record at the main watershed outlet since 1971 and have had a mostly continuous water quality record since 1974. The sampling locations are currently equipped with automated, refrigerated autosamplers programmed to take flow-proportional samples. Composite samples are collected weekly and are analyzed for suspended solids, nutrients (nitrate-nitrogen, ammonium, ortho-phosphorus, TN, TP, potassium), chloride, and dissolved organic carbon. In addition, weekly measurements of DO are made at all of the stations. Some stations have dedicated probes to record DO continuously. The record length for each constituent depends on the previous research objectives. The current water quality sampling system for the Little River Experimental Watershed has been in place on subwatersheds J,

Table 10.1
Station and years different constituents were monitored (Vellidis et al. 2005).

LREW subwatershed	NO_3, PO_4, Cl, conductivity	NH_4, TN, TP, DO, pH	Sediment	Turbidity	Chl *a*	K	DOC	Fecal coliform bacteria
B	1974 to 2005	1979 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2005
F	1974 to 2005	1979 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2003
I	1974 to 2005	1979 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2003
J	1974 to 2005	1979 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2003
K	1974 to 2005	1979 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2003
M	1982 to 1986, 2002 to 2005	1982 to 1986, 2002 to 2005	1998 to 2005	2002 to 2005	2003 to 2005	1979 to 1981	2001 to 2005	2002 to 2003
N	1974 to 1981, 2002 to 2005	1974 to 1981, 2002 to 2005	1998 to 2005	2002 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2002 to 2005	2002 to 2003
O	1974 to 1981, 1993 to 2005	1974 to 1981, 1993 to 2005	1998 to 2005	1997 to 2005	2003 to 2005	1979 to 1981, 2002 to 2005	1979 to 1981, 2001 to 2005	1996 to 2005

Notes: LREW = Little River Experimental Watershed. DOC = dissolved organic carbon. NO_3 = nitrate. PO_4 = phosphate. Cl = chloride. NH_4, = ammonia. TN = total nitrogen. TP = total phosphorus. DO = dissolved oxygen. Chl *a* = chlorophyll *a*. K = potassium.

K, I, F, and B since 1998 and on watersheds N and M since 2002 (table 10.1). An additional site at the headwaters of subwatershed O, called O3, has been monitored since 1999. Grab samples were collected at this site from 1999 to 2004. Composite samples and flow measurements have been collected since 2004. Subwatershed O3 samples an intensive animal production watershed that has been the subject of numerous documented conservation practices.

All samples are taken as either grab samples or as weekly flow-weighted composites by autosamplers with the inlets located at the center of the stream channel and upstream of the weir. Regardless of whether sampling is conducted through grab sampling or an autosampler, all samples are collected on a weekly basis, in general, and are analyzed for nutrients, sediment, and carbon. Field probes have been used to measure DO, pH, and conductivity for long record periods with more recent measurements of turbidity and chlorophyll *a* on a weekly basis. Grab samples for bacterial analyses and laboratory analysis of chlorophyll *a* have been collected on a biweekly basis.

A data management system for editing and correction of field data and for storage, summarization, and retrieval by hydrologic databases was developed to provide preliminary analyses and summarization of hydrologic and water quality data and to generate first-level data summaries and statistical information for use by the Southeast Watershed Research Laboratory and University of Georgia research personnel and their cooperators, as well as other natural resource and environmental quality professionals. All water quality data are stored as Excel files and as ASCII files. Data for portions of the long-term record period have been summarized in publications (Lowrance et al. 1984; Lowrance and Leonard 1988; Bosch et al. 1999; Suttles et al. 2003; Hubbard et al. 2004; Bosch et al. 2007; Feyereisen et al. 2007).

Land Treatment

This project focused on assessing the water quality effects of previously implemented conservation practices using an existing long-term water quality dataset; most land treatment was implemented through traditional USDA Natural Resources Conservation Service (NRCS) programs. Documentation of implemented conservation practices was obtained as a digital dataset from USDA NRCS files for the 1980 to 2005 time period. During that time period, there were no stated nonpoint pollution control objectives. The objectives of the funded practices were to reduce soil loss and off-site impacts of nonpoint source pollution from agricultural fields. Most of the implemented practices emphasized on-farm conservation of soil resources, rather than off-site water quality. The USDA NRCS conservation programs are voluntary so landowner requests and needs drove practice implementation; no critical areas were identified in advance for primary conservation implementation.

The USDA NRCS has had an active role in the watershed, working with producers to reduce soil loss mainly through terraces, grassed waterways, and conservation tillage. The four practices with the largest number of acres are nutrient management, pest management, grassed waterways, and tree plantings. Although nutrient management is frequently mentioned, the full scope of nutrient management (i.e., NRCS Practice 590) does not seem to be used based on the high fertilizer application rates that producers are still using.

The most dominant conservation practice is riparian forest buffers. These forest buffers left along most streams are an important voluntary (not cost shared) conservation practice in the Little River Experimental Watershed. The presence of buffers was confirmed through a farmer survey.

Other practices present are terraces, drainage of wetland areas (which ended in the 1980s), grassed waterways, cover crops, conservation tillage, farm ponds, nutrient management, and filter strips. Initial conservation practices applied through USDA programs were mainly terraces on highly erodible land (generally 5% to 8% or 8% to 12% slopes) and drainage of wet field margins. Drainage of wet field margins to convert riparian forests to pasture and cropland was taking place on small acreages (typically less than 4 ha [10 ac]) through the early 1980s. In the 1980s and 1990s, there was continued installation of terraces and more emphasis on grass waterways and cover crops.

Some fields were taken out of production through the Conservation Reserve Program (CRP). Most CRP land was planted to slash pine with a few smaller acreages planted with loblolly pine. Most land planted to CRP pines has remained in forest with the oldest trees approaching 20 years old. In general, the original upland pine species, longleaf pine, was not planted on CRP lands. In the 1980s and early 1990s, numerous farm ponds were built for irrigation or livestock watering purposes.

In the late 1990s through the early 2000s, longleaf pines were established on some cropland using the practice of restoration of declining habitats. In the late 1990s through 2012, additional practices, such as nutrient management, conservation tillage, manure management, cover crops, filter strips, and farm ponds, were applied through technical assistance programs and the Environmental Quality Incentives Program (EQIP).

In 2004, the Little River Experimental Watershed was selected in the first round of watersheds for the Conservation Security Program (CSP), and select producers within the Little River received support for existing conservation practices under CSP. The CSP was designed to promote conservation practice maintenance and to reward good environmental stewardship. Beginning in 2005, selected producers in the Little River Experimental Watershed received recurrent annual payments for implementing conservation tillage (strip tillage) under the EQIP program.

In 2006, 5,145 ha (12,714 ac) or 57% of the agricultural land had some conservation practice installed or implemented by the USDA NRCS. Forty-seven different practices were implemented in the watershed with technical assistance by the USDA NRCS and/or through federal cost-share conservation programs (Cho et al. 2010b). Of that total area, 13% was signed up for nutrient management, 13% was signed up for pest management, 9.6% was signed up for grassed waterways, 10% was signed up for contour farming, 9% was signed up for residue management, and 9% was signed up for terraces. The EQIP and CRP programs were the most widely used USDA conservation programs. Analysis of the USDA NRCS practice database revealed that 42% of producers apply the same practice to different fields concurrently, many applied more than one practice (e.g., nutrient management + pest management and grassed waterway + residue management), nearly half of producers employed more than one practice in a single year, and 61% enrolled multiple fields in the same program. Conservation practices may have also been applied to some of the remaining Little River Experimental Watershed cropped area by landowners without USDA NRCS assistance. However, the authors do not have records of these practices, and for the purposes of this study, it was assumed that no practices were implemented on this land area (Cho et al. 2010b).

A historical database of conservation practice adoption within the Little River Experimental Watershed for 1975 to 2006 was created and entered into a geographic information system (GIS) (Southeast Watershed Research Laboratory 2011). Extensive land-use information and physical characterization data (Sheridan and Ferreira 1992) have been developed for the Little River Experimental Watershed. A GIS database of all conservation practices applied and recorded in USDA NRCS files has been developed that represents fields delineated according to farm tract using 1999 digital orthophoto quarter quadrangles (Sullivan et al. 2007). Each of the delineated fields contains information regarding program, conservation practice(s), implementation date, total area, expected lifetime of the practice, and cost-share versus noncost-share practices. These data can be queried to show spatial distributions by year, program, or practice. The limitation to the database is that there is no end date for practice implementation and no information on continued use or operation and maintenance status. Although field inspection of practices is done by USDA NRCS personnel, this was not part of the record that was accessed to develop the conservation practice database.

Water Quality Response

Although there are no specific numerical water quality objectives, nutrient loads are low in this watershed, and N and P are dominated by organic forms, 78% to 87% and 66%, respectively (Feyereisen et al. 2007). Data demonstrated that only 1% to 2% of the applied N fertilizer reaches the streams. These loads are less than the N delivered through precipitation. There are no statistically significant water quality trends for most constituents, except an increasing trend for chloride and a decrease in TP concentrations. Statistically nonsignificant downward trends were noted for precipitation and flow (Feyereisen et al. 2007). A statistically nonsignificant increase in DO concentration was also observed (Todd et al. 2009, 2010).

Much of this watershed, like many southeastern watersheds, is forested, which reduces the overall nutrient load from agricultural practices. The largest land cropped area occurred in the mid-1920s—about 50%. Currently the watershed is only 41% agriculture, of which cropland area is 31%; the intensity of agriculture is much lower in this watershed compared to Midwestern watersheds.

Model Application

The Soil and Water Assessment Tool (SWAT) was used to model the nested watersheds for actual and alternative conservation practice scenarios in order to look at changes in sediment, TN, and TP following implementation of agricultural conservation practices. The SWAT model was selected primarily because it is the USDA ARS watershed model of choice and because SWAT was being used by team members in the watershed. Consequently, some of the parameterization had already been done prior to the NIFA–CEAP. The SWAT model was also selected because it was used by several other NIFA–CEAP watershed studies.

The SWAT model was calibrated on subwatershed K and then was applied to the outlet of the Little River Experimental watershed (Cho et al. 2010b). The data used to calibrate and validate the model were from a long-term water quality database collected by the USDA ARS and the University of Georgia. The crop rotations were then simplified, and management actions were defined for major crops.

The error statistics used included percent error (PE) and daily, monthly, and annual Nash-Sutcliffe efficiency (NSE) indices. Calibration in one subwatershed (K) indicated acceptable model performance for total, monthly, and daily streamflow and resulted in NSE indices greater than 0.7 (very good). Percent error was within the range of calibration error: 0% for streamflow, 1.5% for total sediment, 9% for TP, and 8.6% for TN. Validation of the calibrated model at the outlet led was very good for streamflows (low percent error, 7.8%). Validation for nutrients was not as good: –37.8% for total sediment, –25.7% for TP, and –42% for TN (Cho et al. 2010b).

The SWAT model was then used to assess effects of spatial distribution of conservation practices by comparing the current (random) approach to implementation against targeting implementation by stream order or critical source areas. Critical source areas were identified by SWAT as the hydrologic response units (HRUs) with the highest nonpoint source pollution loads. The HRUs were areas (polygons) containing unique combinations of soil and land use. Pollutant loading from individual HRUs was reported by SWAT. There were two sets of conservation practices: nutrient management, which included a 30% decrease in applied nutrients, and conservation management practices, which consisted of terraces, grassed waterways, conservation tillage, and contour farming. These sets of conservation practices were selected because it was difficult to consider the actual year of conservation practice application and changes in crop rotations within a SWAT simulation due to a lack of detail within historical records. Thus intensity of conservation practice implementation was set at 0%, 88%, and 100% of the agricultural area (Cho et al. 2010b).

Modeled results showed that the current area of riparian buffers reduced sediment by 75% compared to no buffers (0%). If riparian buffers were increased from 88% to 100%, then sediment reduction would be 21% greater. Total P results followed sediment reductions. When current nutrient management was compared to no nutrient management, TN was reduced by 32%. If buffers were increased from 88% to 100%, there was an additional 7% reduction in TN. Research results combined with the modeled data point to the current importance of buffers in protecting water quality (Cho et al. 2010b). At 100% implementation, conservation management practices reduced sediment and TP by ~50%, while nutrient management plans reduced TN by ~10% and TP by ~4%. When riparian buffer (14 m [46 ft]) effects were modeled at 100% implementation of the land area, sediment and TP were reduced by about 20%, while TN was reduced by 20% (Cho et al. 2010b).

Modeling results showed that targeting to critical source areas gave faster improvement in water quality than targeting to stream order; both targeting approaches gave more rapid results than the conventional random approach (Cho et al. 2010b). All approaches ultimately achieved the same target load reductions at 100% implementation. At any given implementation level (except 100%), the targeted load reduction approach reduced pollutants the most.

Readily available GIS databases were used to characterize terrain, soils, and land use and to identify current buffer widths in the study area. Landsat Thematic Mapper images (1998) were also analyzed to derive the type and distribution of land cover and land uses in the Little River Experimental Watershed. Representation of riparian forest buffers within SWAT presented a challenge. The filter strip parameter (FILTERW) in SWAT was used, although it does not account for interactions between upland and the riparian forest buffer. In addition, there is no dynamic nutrient conversion and/or reduction captured within the riparian forest buffer. Specifically, Cho et al. (2010a) stated,

> Streamflow predictions were stable regardless of changes in watershed subdivision and FILTERW (four different widths were used) configuration. Predicted sediment and nutrient loads from upland areas decreased as CSA [critical source area] increased when spatial variations of riparian buffers are considered. Sediment and nutrient yield at the watershed outlet was responsive to different combinations of CSA and FILTERW depending on selected in-stream processes. CSA ranges which provide stable sediment and nutrient yield at the watershed outlet was suggested for avoiding significant modifications in selected parameter set.

The targeting approach in this project was not based on a spatial search engine; rather, it hinged on prioritizing subwatersheds based on stream order and/or critical source areas identified based on their runoff potentials. Then a detailed field-scale multicriteria decision analysis was used to reconcile economic and environmental criteria and to expose the set of practices in each field that was most consistent with the priorities of farmers. This multiscale decision analysis tool—The Little River Experimental Watershed conceptual model—aided in the selection of appropriate conservation practices from the USDA NRCS conservation toolbox. This tool performed the following functions:

- Helped users make complex decisions among alternatives involving multiple criteria
- Calculated which alternative best met the criteria of decision makers
- Evaluated how likely that alternative was to be truly the best choice in the face of uncertainty

There were three selection options in the tool:

1. Expert panel selected criteria to apply to universe of practices based on water quality and producer objectives
2. USDA NRCS conservation practice physical effects were used to rank practices
3. Concise prioritization model was proposed by the USDA NRCS district conservationist

Multiple datasets were used within this project. A large database of geospatial data existed for the entire Suwannee Basin, which included demographic, infrastructure, land-use planning and cultural datasets, as well as land, water, and wildlife resource data. The library contained 1993 and 1999 digital orthophoto quarter quadrangles for the Suwannee Basin. The library held 1998 land-cover data for the Little River Experimental Watershed, derived from Landsat Thematic Mapper imagery. Similar land-cover data for 2004 became available in September of 2005. A digital database of animal production confinement facilities and larger beef cattle (cow/calf) operations within the Suwannee Basin was created. Interviews with USDA NRCS staff and county agents and poultry processors provided facility locations, numbers of animals, and on-farm management practices. These data, along with nutrient estimates, were included in the database. To better understand watershed-scale processes and potential impacts of conservation programs on water quality, additional GIS datasets were assembled. These included a 30 m (98.5 ft) digital elevation model, two soil coverages, and multiyear land-use and land-cover data. The USDA NRCS Soil Survey Geographic database (SSURGO) (county soil surveys) soils data were digitized for the Little River Experimental Watershed. General land-use coverages were available for 1980, 1993, 1998, and 2004. Detailed crop data for all fields on five subwatersheds (M, J, K, I, and F for 1982 to 1988 and for subwatersheds J and K from 1997 to 2004) were also included in the GIS database. In addition, Landsat imagery for 1980, 1985, 1990, 1995, and 2003, was classified. The land-use classes included mixed forest, pine, water, urban, fallow, general agriculture (primarily row crops), and pasture. Beginning in 2005, detailed land-use studies in three subwatersheds (J, K, and N) were paired with satellite and aircraft image acquisitions.

Socioeconomic Analysis

Farmers in the Little River Experimental Watershed were surveyed to identify socioeconomic factors determining the adoption of conservation practices, including farmers' attitudes and values, the availability of cost-share funds from the USDA, the rental payments for CRP lands, and the requirements for maintenance and inspection of practices. To address these issues, the following three analyses were conducted:

- Evaluate socioeconomic factors influencing application of conservation practices for the period 1975 to 2005
- Develop prioritization methods based on interacting socioeconomic and biophysical factors to establish alternative conservation practice scenarios (see decision support system)

- Evaluate socioeconomic and program constraints on implementation of recent conservation practices, including conservation tillage and conversion of marginal pasture to riparian forest buffer and restoration of longleaf pine habitats

Interviews were conducted with farmers who have participated in conservation at different levels to identify significant factors affecting their participation decisions. A pilot interview with nine farmers was used to refine the survey instrument. A map of the farmers' fields was used with the producer to determine what conservation practices were being used and where the practices were located. More importantly, the pilot interviews were conducted to learn the language of the farmers.

In 2009, 23 more producers were surveyed with the objective of populating the decision support model with how farmers make decisions on conservation practices; information on conservation practice implementation and riparian buffers was determined. Farmers who farm large areas of land own about 45% of their land and rent 55%. Long-term leases (greater than five years) allowed farmers to install terraces; farmers have been reluctant to install practices on short-term or annual rental land.

During interviews, the researchers took the producer information and put it into their decision support system—Decision Plus by Info Harvest—which ranked the practices according to a multicriteria model (Vellidis et al. 2009). The farmers reviewed the rankings and changed them if necessary, but there was good agreement between the decision criteria rankings from the software and farmers' opinions.

Typical farm size for these producers was around 283 ha (700 ac), with most of it irrigated. Farmers with rivers and streams tended to leave natural buffers along the banks. Some farmers practiced controlled burns and harvested a few trees out of the buffers, but most left the buffers as unmanaged areas. These areas were considered unproductive for crops or animal grazing. Many of the farmers interviewed practiced conservation tillage. Soil quality and cost benefits of conservation tillage were stated reasons for implementing the practices. Most farmers sampled soils to determine fertilizer applications, although some do not. Chicken litter was identified as a desirable nutrient source but was difficult to acquire. All farmers had some knowledge of conservation practices and programs, though not all implemented conservation practices on their farms. Eight of nine farmers indicated that they relied heavily on the advice of their local county extension agent. Farmers generally indicated that farming input prices were too high and farm revenues were too low and that farmers do not have much control over the prices of commodities they produce. They also indicated that farming in the area was likely to change in the future due to increased pressure to sell or develop the land, increased farm input costs, and foreign imports.

Conservation practice adoption was said to be due to standard USDA NRCS incentives—technical assistance and cost share. The two most popular programs were EQIP and CRP. There was true interest on the part of the farmers to keep their soil on their fields so terraces, conservation tillage, and grassed waterways were accepted more readily than nutrient management. Farmers in charge of larger farms were less likely to adopt contour farming (probably because of equipment size limitations) and were more likely to adopt irrigation.

Outreach

The objective of the outreach program was to provide information and to engage farmers, local elected officials, community leaders, students, and other watershed residents in programs and activities that examine cumulative environmental impacts and water quality benefits of conservation practices in the Upper Suwannee Basin. Most of the water quality outreach to landowners and farmers was conducted through presentations by team members at the annual Upper Suwannee River Watershed Initiative Conference. Presentations were on water quality concerns in the Upper Suwannee River Watershed, conservation tillage, etc. Team members also conducted workshops on conservation practices at the University of Georgia Cooperative Extension's Winter School—a three-day event where extension specialists train county extension agents on emerging issues. At Winter School, county agents enroll in workshops offering topics for which they need additional training. Conservation tillage and nutrient management were the two topics of greatest interest with agents from northern Georgia interested in nutrient management and agents from southern Georgia interested in conservation tillage. The University of Georgia Cooperative Extension specialists, who were members of the project team, worked directly with USDA ARS to provide two conservation tillage field days and other activities related to the overall Little River Experimental Watershed and surrounding areas. There has been a long history of educating producers on conservation practices in this watershed. An extension bulletin was also produced to provide information to farmers and landowners on conservation programs available from various agencies.

Outreach to community leaders, including local elected officials and existing watershed organizations, in education and outreach efforts to achieve watershed protection goals, was conducted primarily through the South Georgia Regional Development Center (now the South Georgia Regional Commission). Two slide sets were developed by project team members and were provided to South Georgia Regional Development Center staff. These slide sets were used by the South Georgia Regional Development Center to educate the above-mentioned stakeholders on water quality and the role of conservation practices in maintaining good water quality during regular meetings throughout the project.

Through the project's extension and outreach efforts, Upper Suwannee River Watershed residents and local decision makers were empowered to advance land conservation programs that maintain and enhance water quality and support existing watershed protection or restoration plans.

Little River Watershed National Institute of Food and Agriculture–Conservation Effects Assessment Project Publications

This project's results have been published in numerous journal articles, abstracts, and conference publications. The list is provided below.

Publications

Cho, J., D. Bosch, R. Lowrance, T. Strickland, Y. Her, and G. Vellidis. 2010a. Effect of watershed subdivision and filter width on SWAT simulation of a coastal plain watershed. Journal of the American Water Resources Association 46(3):586-602, doi:10.1111/j.1752-1688.2010.00436.x.

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Bosch, D.D., D.G. Sullivan, and J. Cho. 2009. Impacts of conservation tillage on streamflow and baseflow within the Little River Experimental Watershed. Abstract. Soil and Water Conservation Society Annual Conference. Dearborn, Michigan. July 11-15, 2009.

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Project Personnel

George Vellidis was the project investigator, and Susan Crow and Gary Hawkins were coproject investigators for this project; all are affiliated with University of Georgia. Other participants included David Bosch (research hydraulic engineer), Richard Lowrance (research ecologist), Dana Sullivan (soil scientist), who are all affiliated with the USDA ARS; Jeff Mullen (agricultural economist with the University of Georgia), Angela Wall (environmental planner with the Southern Georgia Regional Commission), and Mary Leidner (district conservationist with the USDA NRCS). Jaepil Cho was a postdoctoral research associate on this project.

Participating institutions included the following:

- The University of Georgia was the lead institution, responsible for project coordination, multicriteria decision analysis modeling, and extension and outreach activities.
- The USDA ARS Southeast Watershed Research Laboratory was responsible for water quality data trend analysis and SWAT modeling.
- The South Georgia Regional Development Center (now South Georgia Regional Commission) was responsible for outreach to local governments and watershed organizations.
- The USDA NRCS was responsible for providing conservation practice information, contacting individual landowners, and providing data for multicriteria decision analysis modeling.

The project held semiannual project meetings and project component meetings as needed. Intraproject reports were created annually in order to comply with Current Research Information System reporting requirements. Project findings were communicated to stakeholders using appropriate forums. Scientific reporting was done through technical presentations and proceedings papers or journal articles. Project findings were reported to local stakeholder groups via workshops and other meetings.

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