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Agricultural Irrigated Land-Use Inventory for the Counties in the Suwannee River Water Management District in Florida, 2015

By Richard L. Marella, Joann F. Dixon, and Darbi R. Berry

Abstract

A detailed inventory of irrigated crop acreage is not available at the level of resolution needed to accurately estimate agricultural water use or to project future water demands in many Florida counties. A detailed digital map and summary of irrigated acreage during the 2015 growing season was developed for 13 of the 15 counties that compose the Suwannee River Water Management District. The irrigated areas were delineated using land-use data, orthoimagery, and information obtained from the water management district consumptive water-use permits that were then field verified between May and November of 2015. Selected attribute data were collected for the irrigated areas, including crop type, primary water source, and type of irrigation system. Results indicate that an estimated 113,134 acres were either irrigated or had potential for irrigation in all or part of the 13 counties within the Suwannee River Water Management District during 2015. This estimate includes 108,870 acres of field-verified, irrigated crops and 4,264 acres of irrigated land observed as (1) idle (with an irrigation system visible but no crop present at the time of the field-verification visit), (2) acres that could not be verified during field visits, or (3) acres that were located on publicly owned research lands.

Of the total field-verified crops, 83,721 acres were field crops; 20,962 acres were vegetable crops (sometimes referred to as row crops); 3,089 acres were in tree nurseries, ornamentals, and sod production; and 1,098 acres were fruit crops. Specific irrigated crops included 32,468 acres of corn (primarily for silage); 28,170 acres of peanuts; and 10,331 acres of hay. About 40 percent of the vegetable acreage (8,340 acres) was double cropped (planted with both a spring and a fall crop on the same field). Beans, carrots, and watermelons were the most commonly grown vegetable crops in these 13 counties in 2015.

Sprinkler irrigation systems including center pivots, portable or traveling guns, and permanent or solid overhead fixtures accounted for nearly 91 percent (102,874 acres) of the total irrigated acreage in the Suwannee River Water Management District, whereas microirrigation systems including drip irrigation accounted for 9 percent (10,260 acres) of the irrigated acreage. A total of 1,466 center pivots were observed during field verification in 2015 and accounted for 93,093 irrigated acres (which represents 82 percent of the total irrigated acreage). Most center pivots were in use at the time of the field verification, although about 3 percent appeared idle. No flood irrigation systems were observed during field verification in 2015. Overall, groundwater was used to irrigate nearly all of the field-verified acreage (99.8 percent). Dairy wastewater effluent was used on many fields during 2015; however, a quantitative estimate of acreage using effluent could not be determined.

Irrigated cropland totaled 26,927 acres in Suwannee County; 16,511 acres in Madison County; 14,862 acres in Hamilton County; and 14,155 acres in Gilchrist County; these four counties accounted for nearly two-thirds (64 percent) of the acres irrigated within the Suwannee River Water Management District during 2015. Corn (primarily for silage) and peanuts were the primary irrigated crops, accounting for 48, 70, and 71 percent, respectively, of the total irrigated acreage in Suwannee, Madison, and Gilchrist Counties; vegetables accounted for 52 percent of the total irrigated acres in Hamilton County. Other counties with substantial irrigated acreage included Levy (10,122 acres), Alachua (9,547 acres), and Lafayette (8,110 acres); these three counties, combined with Suwannee, Madison, Hamilton, and Gilchrist Counties, accounted for 88 percent of the irrigated acreage in the Suwannee River Water Management District.

The irrigated acreage that was field verified in 2015 for the 13 counties in the Suwannee River Water Management District (113,134 acres) is about 6 percent higher than the estimated acreage published by the U.S. Department of Agriculture (107,217 acres) for 2012; however, this 2012 value represents acreage for the entire portion of all 13 counties, not just the Suwannee River Water Management District portion. Differences between the 2015 field-verified acreage totals and those published by the U.S. Department of Agriculture for 2012 may

occur because (1) irrigated acreage for some specific crops increased or decreased substantially during the 3-year interval due to commodity prices or economic changes, (2) calculated field-verified irrigated acreage may be an overestimate because irrigation was assumed if an irrigation system was present and therefore the acreage was counted as irrigated, when in fact that may not have been the case as some farmers may not have used their irrigation systems during this growing period even if they had a crop in the field, or (3) the amount of irrigated acreages published by the U.S. Department of Agriculture for selected crops may be underestimated in some cases.

Introduction

Water withdrawals for agricultural irrigation generally are estimated in counties throughout Florida because most irrigators do not meter or report their usage, or the metered information obtained does not provide a cumulative total. The most common procedure used to estimate water withdrawals for agricultural irrigation in Florida is to multiply the reported or published number of acres of each crop irrigated by a crop-specific net irrigation requirement, also known as an application rate (Marella, 2014). The acreage irrigated and the application rates are estimated by each of five water management districts (WMD) for the counties within their boundaries. Many assumptions must be made to estimate water withdrawals using irrigated acreage data and application rates. Some of the problems associated with obtaining and using reported or published irrigated acreage data include

- variations in definitions, data-collection procedures, and reporting levels between agencies that compile such data, and differences in years published;
- inadequate documentation of accuracy and detail;
- missing data due to incomplete compilations or privacy restrictions or disclosures;
- inability to differentiate between irrigated and non-irrigated crop data at the county level;
- lack of information about irrigation method and water source; and
- lack of spatial data describing the location of irrigated crop lands.

Accurate and detailed estimates of irrigated acreage are not available at the level needed to improve current water-use estimates or to project future demands. The results of this study will increase the accuracy of water-use estimates and provide a more detailed summary of the irrigated crops within the 13 counties of the Suwannee River Water Management District (SRWMD) than the values published in the past for these counties. Information on crop type, irrigation system, and water source enables water managers and planners to better estimate current and future water needs. An accurate assessment of the spatial distribution of irrigated lands will allow better identification of water use at the local and regional level, and facilitate more reliable assignment of withdrawals for use in predictive hydrologic models.

Background

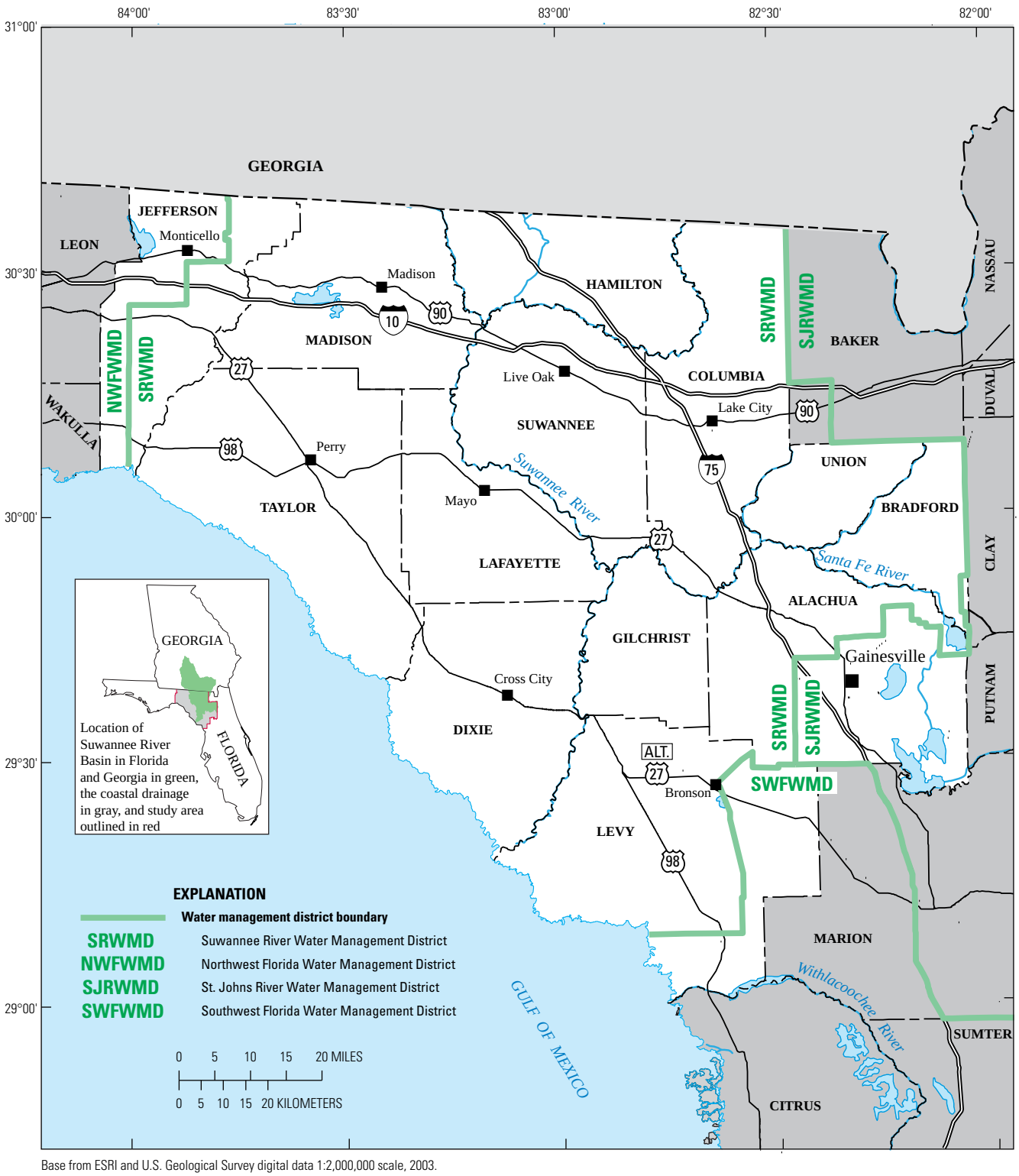
In 1998, the five Florida WMDs each prepared a detailed regional water supply plan for areas or counties within their jurisdiction to determine whether existing sources of water were adequate for current and future water needs (Florida Department of Environmental Protection, 2013). Water needs include water for public supply, domestic/small public supply, commercial/industrial/institutional self-supplied, power generation, agricultural irrigation, and recreational irrigation (mainly golf courses). The primary objective of these water supply plans was to project future water demands and develop alternative water supplies to help meet these projected demands.

In 2013, the Florida Legislature mandated that future water demand projections for the agricultural irrigation part of WMD water supply plans be provided by the Florida Department of Agriculture and Consumer Services (FDACS) for consideration by the WMDs (Marella and Dixon, 2015). The water supply plans typically project 20 years into the future and are updated by the WMDs on a 5-year cycle. Generally, all water supply plans are approved and adopted as policy guides by the governing board of each WMD.

Water withdrawals for agricultural irrigation refer to water used for crop irrigation and for non-irrigation uses associated with agricultural and farming operations (Marella, 2014). Crop irrigation includes the application of water on lands to assist in cultivation of crops or to prevent crop damage caused by harsh weather. Non-irrigation uses include withdrawals for livestock watering, washing of dairy and farm equipment, augmentation of ponds used for fish farming, and other farm uses (Marella, 2014).

Purpose and Scope

The purpose of this report is to present the results of a cooperative study between the U.S. Geological Survey (USGS), FDACS, and the SRWMD designed to provide a detailed digital map and summary of field-verified irrigated acreage within all or part of 13 of the 15 counties located within the SRWMD boundary for the 2015 calendar year. These 13 counties include Alachua, Bradford, Columbia, Dixie, Gilchrist, Hamilton, Jefferson, Lafayette, Levy, Madison, Suwannee, Taylor, and Union (fig. 1). The small areas of Baker and Putnam Counties located within the SRWMD were not included in this study. Four of the 13 counties inventoried (Alachua, Bradford, Jefferson, and Levy) are only partially within the



Base from ESRI and U.S. Geological Survey digital data 1:2,000,000 scale, 2003.

Figure 1. Suwannee River Water Management District and surrounding counties in Florida, including selected features and place names.

SRWMD boundary. For Jefferson and Levy Counties, field verification was completed for the entire county as part of this project, whereas field verification for the part of Alachua County not located within the SRWMD was completed by the St. Johns River Water Management District (SJRWMD) during this same time period. It was assumed that there were no irrigated areas in the small part of Bradford County within the SJRWMD in 2015. Results are available for each of these entire counties, but the data summarized and presented in this report represent the area within the SRWMD only.

The irrigated acreage was mapped, digitized, and field verified for the crops grown during the 2015 spring, summer, fall, and winter growing seasons in these 13 counties. Attribute data were collected for each irrigated field including crop type, irrigation system type, and primary water source. The field verification was completed between May and November of 2015, although a small amount of follow-up field verification was necessary during December. The 7-month period between May and November enabled crop identification for nearly all of the fields in these 13 counties. For those fields planted prior to the actual field verification (January–April), evidence of their planting and harvesting was still visibly present in May and June because nearly all of these fields were planted with vegetables. Spring vegetables in this area of Florida are usually planted in late February or early March to avoid the potential of freeze damage. The majority of irrigated acreage in these 13 counties was planted with field crops such as corn, peanuts, and hay, and these crops are primarily grown and harvested between May and October. All other crops, such as orchards (citrus, blueberries, and grapes), ornamentals (container nurseries and tree farms), and sod, were also field verified between May and November, even though most of these crops are grown year round.

This study focused on verifying irrigated acreage by crop type and field location and did not address any water-application rates or make any estimates of water use. The maps and acreage totals presented in this report provide estimates of irrigated acreage for 2015, additional data on irrigations systems, and spatially accurate locations of irrigation systems located within the 13 counties that compose the SRWMD. The data compiled in this study can be used by the USGS National Water-Use Information Program to develop more accurate estimates of irrigated acreage and to better distribute irrigated acreage estimates across hydrologic basins.

County Population, Land Use, and Water Withdrawals

The Suwannee River Basin is located in north-central Florida and is bordered by the SJRWMD to the east, the Southwest Florida Water Management District (SWFWMD) to the south, the Northwest Florida Water Management District (NWFWMD) to the west, and the State of Georgia to the north (fig. 1). The entire Suwannee River Basin (including coastal drainage areas) encompasses 13,800 square miles in Florida and Georgia combined (Seaber and others, 1984) (fig. 1). The SRWMD governs and oversees the Florida portion of this basin (Purdum, 1994) which includes about 7,640 square miles (nearly 4.9 million acres) in 15 counties (Fernald and Purdum, 1998). The estimated population of all or part of these 15 counties in 2015 was 318,700 (Jessica Bell, SRWMD, written commun., February 10, 2016). Most of the SRWMD is rural, with a few larger cities that include the northwestern part of Gainesville and all of Lake City, Live Oak, and Madison (fig. 1). The population of the SRWMD in Florida (fig. 2) has increased from 192,800 in 1980 (Fernald and Patton, 1984) to 251,000 in 1995 (Marella, 1999) to nearly 313,760 in 2010 and is projected to reach 332,900 by 2020 (Jessica Bell, SRWMD, written commun., April, 28, 2016).

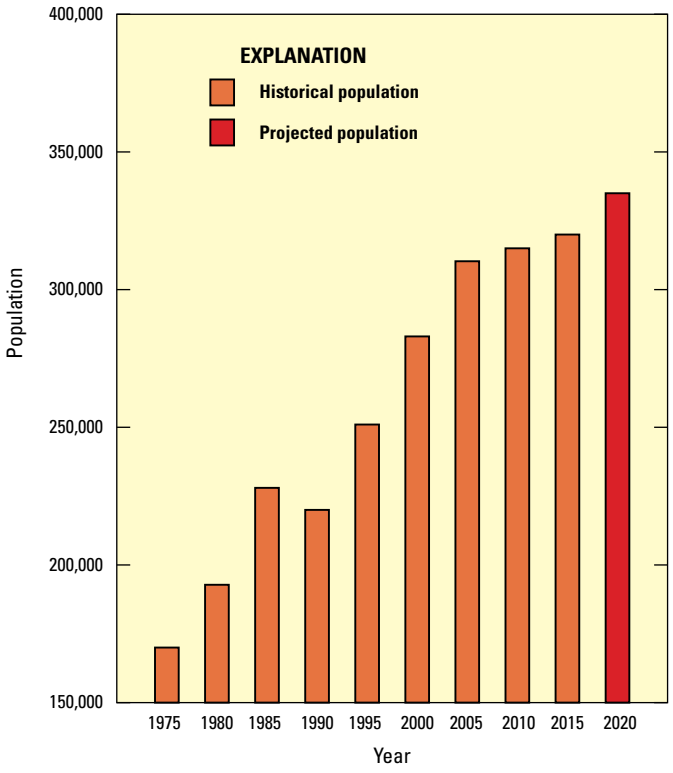


Figure 2. Historical and projected population of the Suwannee River Water Management District in Florida, 1975–2020 (from Fernald and Patton, 1984; Marella, 1999, 2004, and 2009; and Jessica Bell, Suwannee River Water Management District, written commun., April 28, 2016).

According to the U.S. Department of Agriculture (USDA), total cropland for all of the 13 counties totaled 427,288 acres in 2012, of which 328,974 acres (77 percent) were harvested (U.S. Department of Agriculture, 2014). Because four of these counties (Alachua, Bradford, Jefferson, and Levy) are split between other WMDs, it is difficult to determine the actual acreage (cropland, harvested, and irrigated) within these counties in each WMD; therefore, the information presented from the USDA represents acreage totals for the entire 13 counties and may overestimate these district totals in these four counties. Of this total harvested cropland, about 107,217 acres (33 percent) were irrigated (U.S. Department of Agriculture, 2014). A large part of the land in agricultural production within the SRWMD is located along or near the Suwannee River as it flows through the district from north to south (fig. 1). In addition to crop acreage, a large amount of acreage in these 13 counties remains in silviculture production or is in wetlands (Fernald and Purdum, 1998).

Groundwater has been the predominant water source for all uses other than power generation in the SRWMD since 1985 (fig. 3*A*). Since 1980, nearly all of the surface-water withdrawals within the SRWMD have been for once-through power generation. In 2010, groundwater withdrawals totaled nearly 220 million gallons per day (Mgal/d), of which 51 percent were for agricultural irrigation uses and 32 percent for commercial-industrial self-supplied uses (Marella, 2014). The remaining groundwater was withdrawn for domestic self-supplied (9 percent), public supply (7 percent), and recreation-landscape irrigation and power generation (1 percent). Surface-water withdrawals totaled 110 Mgal/d in the SRWMD for 2010, and nearly all (98 percent) of the surface water withdrawn was used for once-through power generation (Marella, 2014). All of the groundwater withdrawn in the SRWMD was obtained from the Floridan aquifer system, and 98.5 percent of the surface water withdrawn was from the Suwannee River (Marella, 2014). Total water withdrawals did not change much within the district between 1980 and 2010, with the exception of a significant dip in 1985. Water withdrawals over that 30-year period ranged from a high of 335 Mgal/d in 1990 and 1995 to a low of 264 Mgal/d in 1985 (fig. 3*A*). The low 1985 value was a direct result of an extended down time during that period at one of the powerplants within the district when cooling water was not withdrawn. Overall, water withdrawals during this 30-year period between 1980 and 2010 increased for agricultural irrigation and decreased for commercial-industrial self-supplied and power generation (fig. 3*B*).

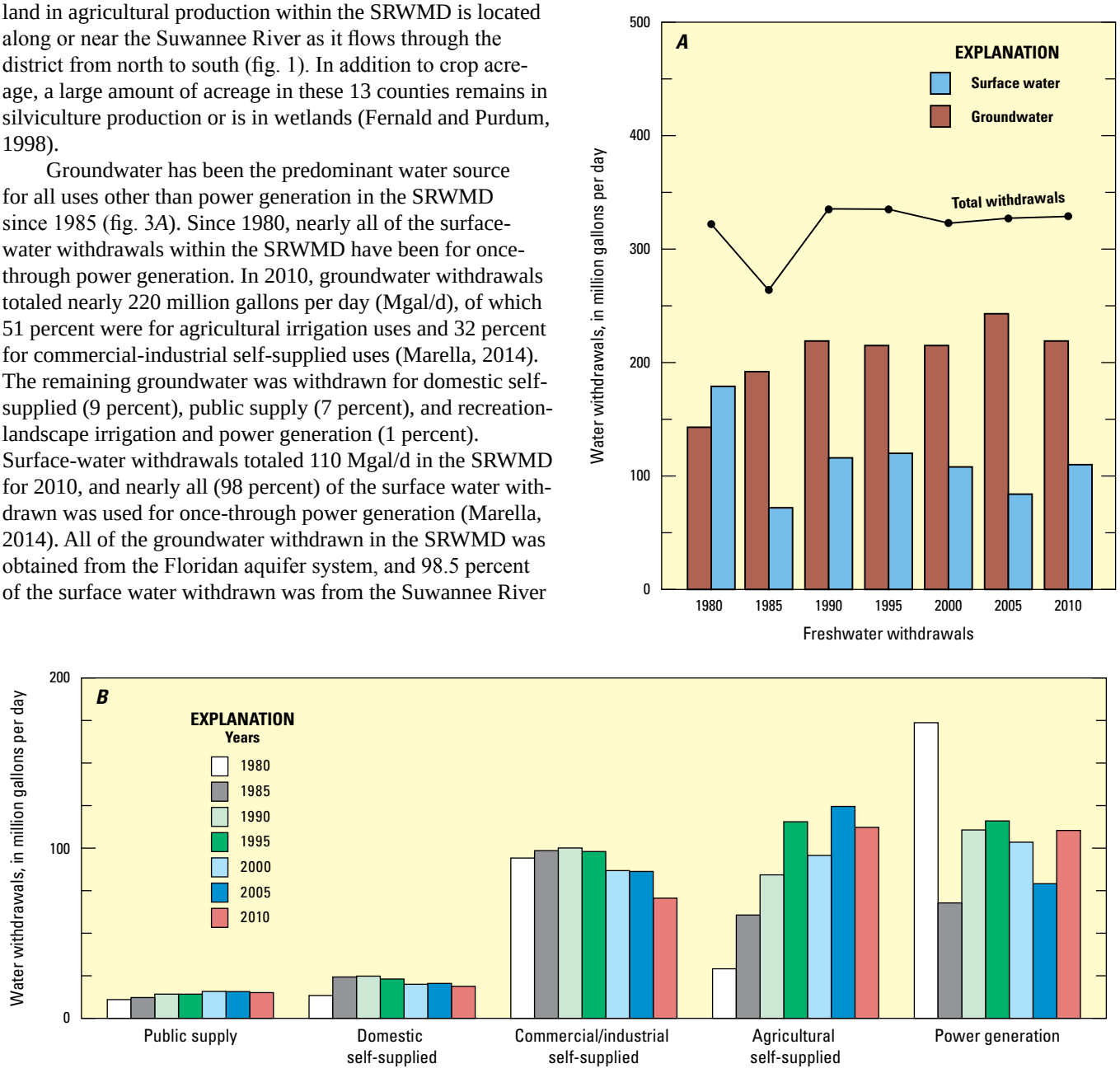


Figure 3. Water withdrawals in the Suwannee River Water Management District in Florida, 1980–2010; *A*, by source; *B*, by category (from Marella, 2004, 2009, and 2014).

Methods of Investigation

A preliminary map showing agricultural land and acreage by crop type was developed using existing land-use data collected during 2013–14 or obtained from various outside sources. Obvious and potential irrigation fields on the preliminary map were added using more recent orthoimages from 2014 and 2015 and digitized to produce an adjusted map that was used for field verification. This adjusted map became the working field map that was used during field verification. Field verification was conducted between May and November of 2015, at which time all fields with potential irrigation shown on the working map were observed from public roads at least once during this period. Once the field verification was completed and changes were made on the adjusted map (and corresponding shape files), a final field-verified map was produced. All data and results presented in this report are compiled from the final field-verified map.

Map Development and Data Sources

The preliminary maps for all 13 counties were developed from data obtained from the geographic information system (GIS) layers digitized by FDACS as part of the Florida Statewide Agricultural Irrigation Demand (FSAID) geodatabase (Daniel Dourte, the Balmoral Group, written commun., March 3, 2015, and October 14, 2015). The FSAID maps provided a spatial representation of the location of potential irrigated fields. These fields were then digitized using the most recent orthoimages, and an adjusted field map was created. Fields with irrigation equipment visible from the orthoimages were added to the adjusted field map. Orthoimages are a composite of high resolution aerial images (obtained from either an aircraft or a satellite) that combine the visual attributes of an aerial photograph with the spatial accuracy and reliability of a planimetric map (http://nationalmap.gov/ortho.html). Orthoimages obtained from the USGS Earth Resources Observation and Science (EROS) Center (https://lta.cr.usgs.gov/high_res_ortho) primarily represent images from 2012 and 2013 for the counties within the SRWMD. Google Earth images from January and February of 2013, 2014, and 2015 were also used during digitizing. Another source used for reference was the World Imagery base map from Esri ArcGIS online (http://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9). Questions or concerns about several of the digitized field shapes or locations on the adjusted map were answered during field verification or resolved during conversations with local experts.

Also added to the adjusted map was a point layer of the current agricultural irrigation consumptive water-use permits (CUP) for the SRWMD, along with a shape file with each permit property boundary (Glenn Horvath, SRWMD, written commun., May 11, 2015). The locations of CUPs (wells or surface-water intakes) in addition to the permit property boundaries, helped identify fields that were new or may not have been visible on the FSAID maps or orthoimages. For the parts of Jefferson and Levy Counties not in the SRWMD, the FSAID maps and orthoimages were also used, along with CUP locations obtained from the NWFWMD (Ken Friedman, NWFWMD, written commun., July 28, 2015) and the SWFWMD shapefile library (http://www.swfwmd.state.fl.us/data/gis/layer_library/category/regulatory). Groundwater was assigned as the default water source for fields where a water source could not be verified through a CUP or a visual observation. These assumptions and other limitations were documented in the attribute files.

Center pivot irrigation is the most common system used throughout the SRWMD. Details of how irrigated acreage is determined for center pivot irrigation are presented herein because the process differs from other systems in use. This type of irrigation system rotates around a center point (usually where the source water pipe enters the structure) and carries water laterally across multiple spans 10 to 15 feet above the ground that spray water onto the field through multiple sprinkler heads (Izuno and Haman, 1987) (fig. 4*A*). On many center pivots, a large irrigation sprinkler head (often referred to as an end gun) irrigates an area beyond the area that is directly under the center pivot structure (fig. 4*B*). For the purpose of this study, the areas digitized for each center pivot only include the area under the center pivot structure and do not include the area irrigated by the end gun (as often this area is not entirely planted). The area under the center pivot was digitized by using GIS tools to trace a line the length of the center pivot structure (as seen from the orthoimages) and to draw a circle based on the length of the structure. These center pivot areas were then compared to the orthoimages or aerials and modified to fit the shape of the field that the center pivot covered because in many cases the center pivot did not make a complete circle. Also, some areas under many center pivots did not have the capacity to grow a crop (in most cases they were either wet or underwater), and these areas were digitized separately and excluded from the acreage totals if they were large enough to be seen on the orthoimages. Overall, the deliberate exclusion of the non-planted areas and the areas sprayed by the end guns (as not all areas under the end gun are planted) provides a more accurate representation of the actual irrigated crop acreage under each center pivot than would otherwise be obtained. If a portable or traveling gun or drip irrigation system was observed, the entire field was digitized and labeled as irrigated.

Field Verification, Limitations, and Crop Delineation

During field verification of the irrigated areas on the adjusted map, specific attributes were recorded for each field. Attributes included crop type, irrigation system (micro, which includes drip systems, and sprinkler, which includes center pivots, portable or traveling guns, and permanent or solid overhead fixtures) (Izuno and Haman, 1987; Marella, 2014),

Figure 4. *A,* A center pivot irrigation system with end gun irrigating corn in Suwannee County, Florida, May 2015; *B,* A center pivot irrigation system with end gun irrigating corn and a non-planted area in Gilchrist County, Florida, June 2015.

and water source (groundwater, surface water, or wastewater effluent from dairies). The field verification was conducted in Madison, Hamilton, and Suwannee Counties beginning in early May 2015 and concluded in early December, whereas field verification in the remaining counties began in early June and ended in November. Some of the early field verification in Madison, Hamilton, and Suwannee Counties was conducted by Wesley Thomas from the SRWMD; all other remaining field verification was conducted by USGS staff. Early field verification was scheduled to ensure that fields from spring vegetable production in 2015 could be verified and not missed. Throughout the Suwannee River Basin, most spring vegetables were either harvested or in the process of being harvested by April or May. Those fields that had been harvested weeks prior to our visit were documented as a spring vegetable crop because evidence of irrigation was still visibly present (field plastics, drip lines, portable hoses were still visible in the fields, or unpicked crops were still present in or along the field edges) and included as part of the total irrigated acres. These fields were all labeled as spring vegetables, and the specific crop was noted in the attribute file if it was known. Most of these fields with a spring vegetable were revisited again in October and November (some in early December) to determine if a fall or winter crop was present. If a crop was present during this visit, it was labeled as a fall vegetable field, and the specific crop was noted in the attribute file if it could be identified. Any field that had a crop present during both the spring and fall was labeled as double cropped, and the acreages were accounted for twice. Vegetables observed during field verification in the SRWMD commonly included beans, carrots, cucumbers, peppers, tomatoes, and watermelons. In July 2015, field verification in all other counties began and continued into November; this accounted for most all other crops, nurseries, and grasses.

In addition to the SRWMD and USGS joint field-verification effort, the SRWMD provided specific crop data for fields under a voluntary irrigation metering program. Throughout this metering program, during which the district staff obtains flow meter or electric running time from 368 irrigation sites, the current crop from each field was also recorded during their monthly visit. These data were provided to the USGS twice, once for the period between January and July of 2015 (Megan Wetherington, SRWMD, written commun., August 4, 2015) and once for the period between August and November of 2015 (Glenn Horvath, SRWMD, written commun., December 17, 2015). This metering program provided crop and acreage data for each field monthly, and each digitized field was assigned the appropriate crop and growing season (spring, summer, and fall).

Each field shown on the adjusted map with an irrigation system or a withdrawal permit was observed from a nearby road at least once during the study period, and the crop type was identified if one was planted. Some fields were plowed and vacant while others were idle with grass cover; however, most fields were active with field corn, peanuts, or hay in various stages of growth between July and October 2015. During the summer months, some fields could not be seen clearly enough to properly identify a crop without accessing private property (at no time was private property entered during field verification). These unverified fields represented less than 5 percent of the total fields and were labeled as inaccessible; however, with assistance from the SRWMD and FDACS, some of these fields were subsequently identified and labeled. A few fields were revisited in November (some in early December) 2015 when most vegetation was dormant or no longer present to obscure observations. In some cases, the existence of center pivots could be confirmed, and evidence of a crop type could still be seen on many of these fields. Ultimately, about 54 fields could not be visibly verified at any time between May and November 2015. Some of these fields that had an irrigation system that could be seen, but the crop could not be clearly identified, were labeled as having the same crop as neighboring fields if they were within the same permit boundary. All other fields remained unverified, and no crop was assigned.

For the purpose of this study, it was assumed that if an irrigation system was observed, the system would be in use for the current crop at some time during its growing period. This assumption was necessary because irrigation systems were observed in operation in many but not all of the fields that were visited between May and November 2015. The irrigation totals calculated for this report may be overestimated because of this assumption. In addition, a small percentage of fields in the 13 counties either used a portable irrigation system (for example, a portable or traveling gun) or had center pivots that were moved from field to field. If so, unless the portable or traveling gun was visibly in use or still connected to a pump, the acres would not be counted as irrigated, and if a center pivot was moved from one field to another during the same growing season, only the field where the center pivot was present on the day of the visit would be counted as irrigated.

Because of the large number of dairy and livestock operations within the SRWMD and surrounding areas, many types of grass growing operations were present. For this study, grasses were divided into three types (hay, pasture, and forage) and were included under field crops. Hay includes grass grown for the purpose of cutting and bailing and usually had evidence of bailed or stored hay along field edges; in some cases, livestock was present. Pasture is defined as grass that was usually maintained (mowed and relatively weed free), had the presence of livestock on the fields in some cases, and had no evidence of bailed or stored hay nearby. Forage grass was most often un-maintained (usually not mowed, often with weeds, or had multiple bare areas present) or was recently planted as a cover crop after a field or vegetable crop was harvested. Many of these forage grass fields had livestock present, and in some cases the pivot was spraying water as a means of cooling livestock (fig. 5). Most of the hay, pasture, or forage fields with an irrigation system present were counted as irrigated unless there was obvious evidence that the irrigation system was not in operation (for example, disconnected center pivot spans, obstructions within the center pivot areas such as ditches or fences, or no sign of movement because weeds or plants had over grown the center pivot structure).

Figure 5. A center pivot irrigation system being used to cool livestock in Gilchrist County, Florida, June 2015.

Figure 6. Peanuts being harvested in Suwannee County, Florida, September 2015.

Upon completion of the field verification, a draft map was produced. This draft map was reviewed by the SRWMD to help identify any missing fields, and a final verified map was produced for publication (appendix 1). After changes were made and questions resolved, the results of the field-verified data were compiled and summarized to produce this report.

Results

The results of data compilation and field verification indicate that during the growing season of 2015 (spring, summer, fall, and winter), an estimated 113,134 acres were irrigated within all or part of the 13 counties within the SRWMD. This estimate includes 108,870 acres of field-verified, irrigated crops and 4,264 acres of irrigated land (1) observed as idle (with an irrigation system visible but no crop present at the time of the field verification visit), (2) acres that could not be verified during field visits, or (3) acres that were located on publicly owned research lands and not truly in production (table 1). Of the total field-verified crops, 83,721 acres were field crops; 20,962 acres were vegetable crops (sometimes referred to as row crops); 3,089 acres were in tree farms, ornamentals, and sod production; and 1,098 acres were in fruit crops (table 1). Specific irrigated crops included 32,468 acres of corn (primarily for silage); 28,170 acres of peanuts (fig. 6); and 10,331 acres of hay (table 1). About 40 percent of the vegetable acreage (8,340 acres) was double cropped (planted with both a spring and fall crop on the same field). A few of these double-cropped fields had a vegetable planted in the spring and a field crop (corn or peanuts) planted during the summer or fall. This acreage was also included under the appropriate field crop if it was observed as irrigated. Beans, carrots, potatoes, and watermelons were the most commonly occurring vegetable crops in the study.

Sprinkler irrigation systems, which include center pivots, portable or traveling guns, and permanent or solid overhead fixtures, accounted for 91 percent (102,874 acres) of the total acreage irrigated in the SRWMD, whereas microirrigation systems, which include drip, accounted for 9 percent (10,260 acres) of the irrigated acreage. A total of 1,466 center pivots were observed within the SRWMD during field verification in 2015 and accounted for 93,093 acres, which represents 82 percent of all irrigated acres. Most center pivots were in use in some capacity during field verification, although 3 percent appeared idle. Corn, peanuts, hay, and most other field crops were irrigated with a center pivot system (fig. 7). Other sprinkler irrigation systems observed include permanent or solid overhead fixtures, or a portable or traveling gun. No flood irrigation systems were observed during field verification in 2015. Vegetable irrigation used both center pivots and drip systems (figs. 7 and 8), with the majority of acreage (65 percent) irrigated by a center pivot or traveling gun, and 35 percent was irrigated by a drip irrigation system. Nurseries (tree farms and ornamentals) used either a micro (drip) system or a sprinkler (permanent or solid fixture).

Overall, groundwater was used to irrigate 102,895 acres (99.8 percent) of the field-verified acreage as only 239 acres (4 center pivots) were observed using surface water. Wastewater effluent (primarily from dairies) was used on several fields within the SRWMD during 2015; however, an estimate of acreage using effluent could not be determined because groundwater and effluent can often be used interchangeably on many fields.

Seven counties (Alachua, Gilchrist, Hamilton, Lafayette, Levy, Madison, and Suwannee) accounted for 88 percent of the SRWMD irrigated acreage (fig. 9). Irrigated cropland totaled 26,927 acres in Suwannee County; 16,511 acres in Madison County; 14,862 acres in Hamilton County; and 14,155 in Gilchrist County. These four counties accounted for nearly two-thirds (64 percent) of the acres irrigated within the SRWMD during 2015 (table 1). Corn (primarily for silage) and peanuts were the primary irrigated crops in Suwannee, Madison, and Gilchrist Counties, accounting for 48, 70, and

Table 1. Inventoried irrigated acreage summarized by crop and county in the Suwannee River Water Management District, Florida, 2015.

[Data were compiled by the U.S. Geological Survey (USGS), Caribbean-Florida Water Science Center, Orlando; –, no data]

Crop type	Alachua[1]	Bradford	Columbia	Dixie	Gilchrist	Hamilton	Jefferson[1]	Lafayette	Levy[1]	Madison	Suwannee	Taylor	Union	Totals
Vegetables-row crops														
Spring vegetables	725	167	–	24	1,336	2,319	–	477	1,226	1,428	3,365	–	143	**11,210**
Fall vegetables	–	–	123	–	–	499	–	30	–	247	513	–	–	**1,412**
Vegetables double crop[2]	82	–	64	–	–	4,892	–	52	–	906	2,344	–	–	**8,340**
Fruit crops	701	17	–	13	9	90	5	–	–	–	80	–	183	**1,098**
Field crops														
Corn	1,669	–	422	1,942	6,776	1,993	486	2,162	3,461	5,819	7,723	–	15	**32,468**
Cotton	–	–	–	–	–	460	141	154	–	207	–	–	–	**962**
Peanuts	1,575	–	780	3,380	3,364	1,868	182	2,496	3,665	5,693	5,152	–	15	**28,170**
Sorghum	107	–	–	–	–	26	–	145	–	–	57	–	–	**335**
Soybeans	551	226	515	–	149	775	257	349	96	345	462	–	–	**3,725**
Hay	2,294	375	231	30	1,115	523	–	1,273	480	226	3,580	–	204	**10,331**
Pasture	474	383	–	132	324	245	–	116	119	–	655	–	–	**2,448**
Other field crops[3]	339	30	83	–	654	879	–	553	780	450	1,378	–	136	**5,282**
Ornamentals-nursery-sod														
Ornamentals[4]	254	–	–	–	25	27	525	46	–	75	294	–		**1,246**
Tree nursery	410	–	–	–	90	5	–	46	269	–	332	–	–	**1,152**
Sod	61	–	–	156	–	–	337	–	–	–	29	–	108	**691**
Idle[5]	305	187	238	–	313	31	238	211	–	942	717	–	–	**3,182**
Other[6]	–	–	–	–	–	30	–	–	–	–	125	–	–	**155**
CNV[7]	–	–	–	–	–	200	–	–	26	173	121	403	4	**927**
2015 Total acres irrigated	**9,547**	**1,385**	**2,456**	**5,677**	**14,155**	**14,862**	**2,171**	**8,110**	**10,122**	**16,511**	**26,927**	**403**	**808**	**113,134**
Irrigation system type														
Micro[8]	1,446	184	64	–	1,190	2,227	333	520	1,495	555	1,943	–	303	**10,260**
Sprinkler[9]	8,101	1,201	2,392	5,677	12,965	12,635	1,838	7,590	8,627	15,956	24,984	403	505	**102,874**

[1]County is only partially within the Suwannee River Water Management District. Acreage values shown reflect the total within the district only.

[2]Acreage includes vegetables that were planted in the spring and fall on the same field. This acreage is referred to as double cropped, and the actual physical acreage would be one-half of the totals shown.

[3]Acreage includes tobacco, wheat (for grain), oats (for grain), proso millet, rice, rye (for grain), dry southern peas (cowpeas), grass and grass seeds, hay, forage, and silage crops.

[4]Acreage includes floriculture and bedding crops reported as "acres in the open" but does not include "square footage under glass or protection."

[5]Acreage includes idle land with no specific crop (a grass cover was most often observed) or vacant with an irrigation system present.

[6]Includes acres with an irrigation system located at a governmental or university research facility with a variety of planted crops.

[7]CNV - Could Not Verify, the existence of an irrigated crop could not be verified at the time of observation; however, the presence of an irrigation system was observed.

[8]Microirrigation includes drip, spray, jet, and bubbler systems.

[9]Sprinkler irrigation includes portable and traveling guns, solid or permanent overhead fixtures, center pivots, and periodic moving systems.

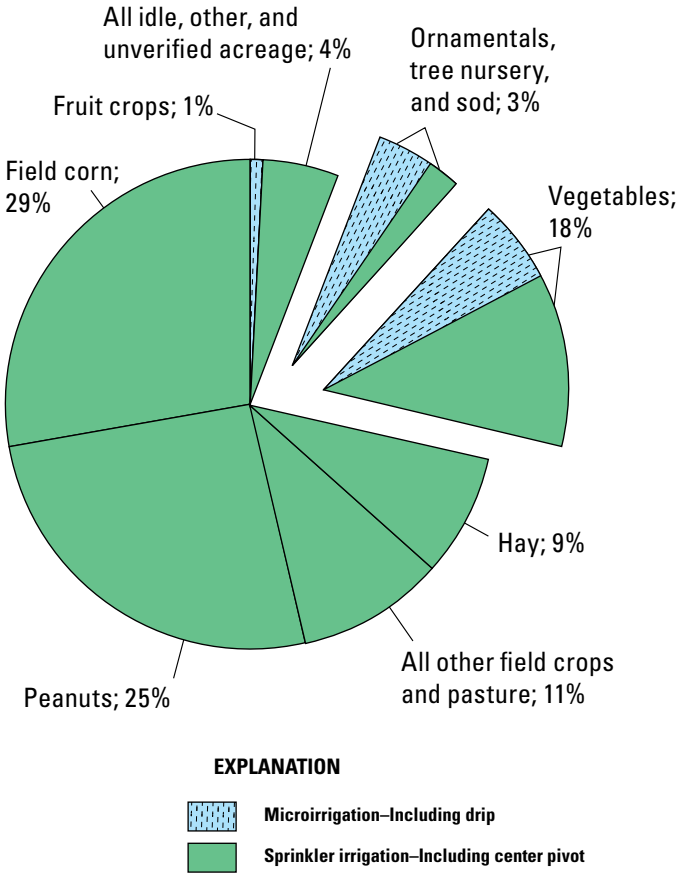


Figure 7. The distribution of inventoried irrigated crops by irrigation system type in the Suwannee River Water Management District, Florida, 2015.

71 percent of the total, respectively; vegetables accounted for 52 percent of the total irrigated acreage in Hamilton County (fig. 9). Other counties with substantial irrigated acres include Levy (10,122 acres), Alachua (9,547 acres), and Lafayette (8,110 acres).

It is difficult to compare the field-verified results compiled in this study to estimates made in previous years by the SRWMD and the USGS because methods and sources of data differed during the past 40 years. A comparison of previous compilations indicates a wide range in results (fig. 10 and table 2) and therefore emphasizes the value of doing a field-verified inventory such as this study. Most of these earlier crop compilations, completed jointly by the USGS and the SRWMD for water-use estimates, were a composite of information obtained from district CUP files, published data from the USDA or the Florida Agricultural Statistics Service, or estimates made by local County Extension Agents.

In addition, it is difficult to compare the USGS estimates tabulated for 2015 with county estimates published by the USDA for 2012 because of differences in reporting years and methods used to compile or tabulate data. Overall, the irrigated acreage estimated by the USGS for the 13 counties that were inventoried in the SRWMD is about 6 percent higher than the 2012 estimated acreage published by the USDA (107,217 acres) (U.S. Department of Agriculture, 2014); however, because the USDA does not subdivide county values into WMD areas, this value represents the entire acreage for all 13 counties and may be high (individual county acreage totals published by the USDA are presented in appendix 2 and include inventoried acreage for those areas in the split counties outside the WMD). The 2015 inventoried acreage was very similar to the 2012 values published by the USDA for Gilchrist and Suwannee Counties; however, for Dixie, Hamilton, and Madison

Figure 8. A center pivot irrigation system irrigating fall vegetables in Hamilton County, Florida, December 2014.

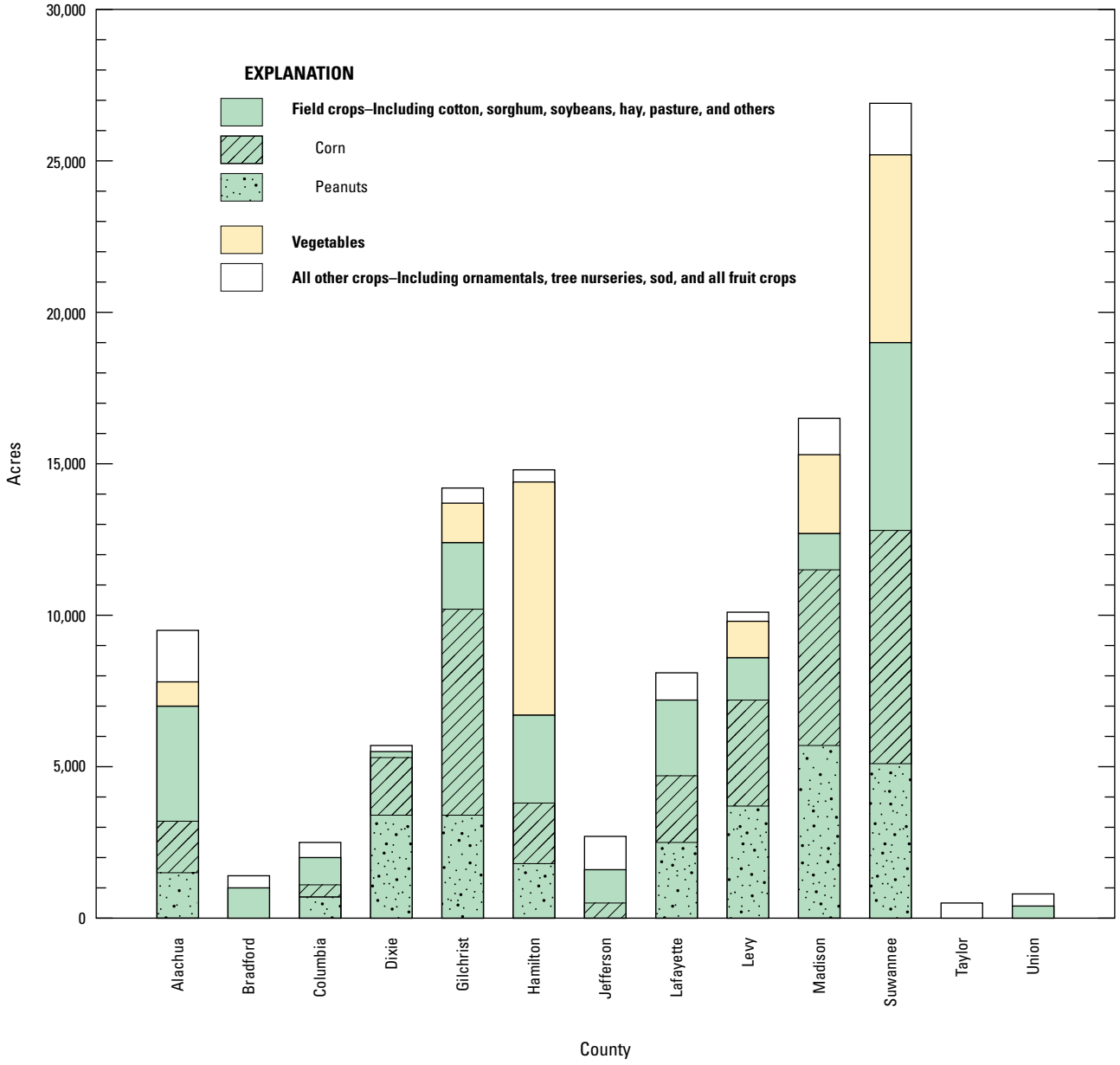


Figure 9. The distribution of inventoried irrigated crops by county in the Suwannee River Water Management District, Florida, 2015.

Counties the 2015 inventoried acreage values were much higher than those published for 2012, and in Columbia and Lafayette Counties the 2015 inventoried acreage values were much lower than those published in 2012 (fig. 11). Alachua, Bradford, Jefferson, and Levy Counties were not compared because the 2015 inventoried acreage totals only represent the SRWMD part of the counties, whereas the USDA acreage values represent the totals for the entire county.

Differences between the 2015 field-verified acreage totals and those published by the USDA for 2012 may occur because (1) irrigated acreage for some specific crops increased or decreased substantially during the 3-year interval due to commodity prices or economic changes, (2) irrigated acreage calculated by the USGS for 2015 may be an overestimate because irrigation was assumed if an irrigation system was present and therefore the acreage was counted as irrigated, when in fact some farmers may not have used their irrigation systems during this growing period even if they had a crop in the field, or (3) the amount of irrigated acreage published by the USDA for selected crops may be an underestimate in some cases as a result of how they obtain information. In addition, according to the SRWMD, a noticeable increase in well construction permits issued for agriculture wells occurred in several of the 13 counties within the district between 2010 and 2015 (Glenn Horvath, SRWMD, written commun., August 2015).

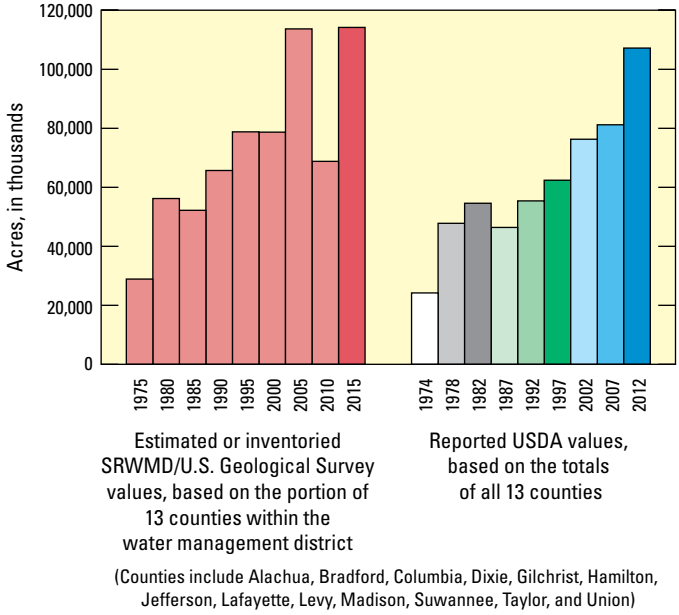


Figure 10. Estimated, inventoried, and reported acreage for the counties in the Suwannee River Water Management District (SRWMD), Florida, 1974–2015 (from Leach 1978 and 1983; Marella, 2004, 2009, and 2014; U.S. Department of Commerce, 1977 and 1984; and U.S. Department of Agriculture [USDA], 1989, 1994, 1999, 2004, 2009, and 2014).

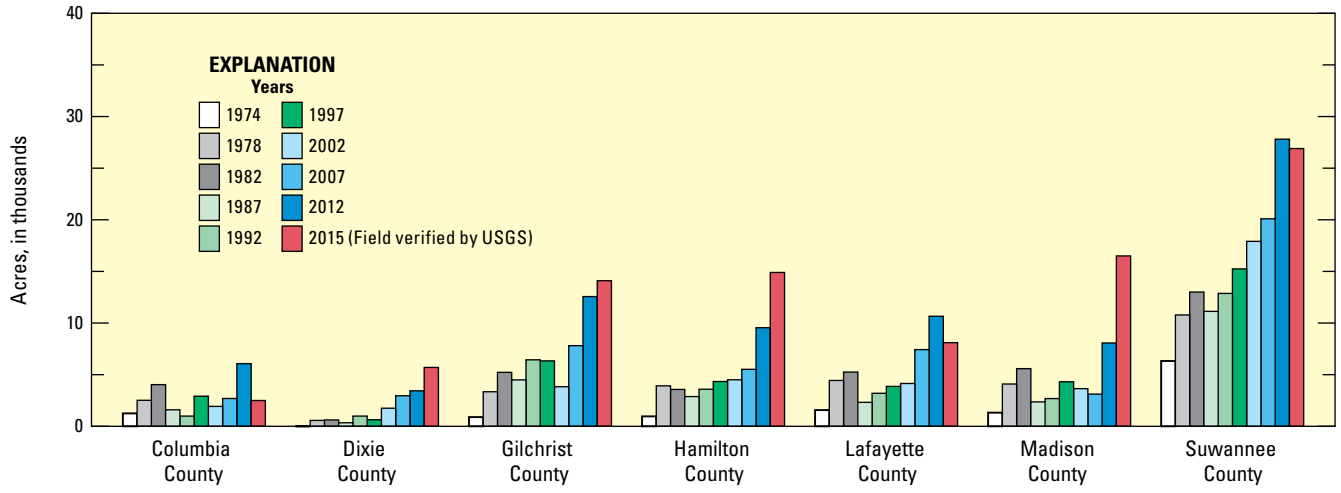


Figure 11. Irrigated acreage reported by the U.S. Department of Agriculture and inventoried by the U.S. Geological Survey (USGS) for selected counties in the Suwannee River Water Management District, Florida, 1974–2015 (from U.S. Department of Commerce, 1977 and 1984, and U.S. Department of Agriculture, 1989, 1994, 1999, 2004, 2009, and 2014).

Table 2. Reported irrigated acreage by the U.S. Department of Agriculture and inventoried irrigated acreage by the U.S. Geological Survey by crop and irrigation system type in the Suwannee River Water Management District, Florida, 1974–2015 (from U.S. Department of Commerce, 1977 and 1984, and U.S. Department of Agriculture, 1989, 1994, 1999, 2004, 2009, and 2014).

[Data were compiled by the U.S. Geological Survey (USGS), Caribbean-Florida Water Science Center, Orlando. USDA, U.S. Department of Agriculture; USGS, U.S. Geological Survey; N/A, data not available; –, no data]

	Reported acreage by the USDA, Census of Agriculture[a]									USGS field-verified irrigated acreage[b, c]			
Crop type	**1974**	**1978**	**1982**	**1987**	**1992**	**1997**	**2002**	**2007**	**2012**	**2015**	**Micro**	**Sprinkler**	**Flood**
Row crops (vegetables)[1]	**N/A**	**N/A**	**N/A**	**13,036**	**17,857**	**15,836**	**15,035**	**15,417**	**15,820**	**20,962**			
Spring[2]										11,210	5,962	5,248	–
Fall[3]										1,412	322	1,090	–
Double crop[4]										8,340	1,052	7,288	–
Fruit crops	**N/A**	**N/A**	**N/A**	**1,657**	**2,622**	**1,946**	**1,436**	**1,516**	**2,870**	**1,098**			
Berries[5]										1,098	876	222	–
Fruits (all) and nuts[6]										0	–	–	–
Field crops	**N/A**	**N/A**	**N/A**	**14,620**	**17,473**	**17,435**	**26,859**	**31,038**	**57,792**	**83,721**			
Corn										32,468	–	32,468	–
Cotton										962	–	962	–
Peanuts										28,170	–	28,170	–
Sorghum										335	–	335	–
Soybeans										3,725	–	3,725	–
Hay										10,331		10,331	
Pasture[7]										2,448	–	2,448	–
Other field crops[8]										5,282	–	5,282	–
Ornamentals/grasses	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**3,089**			
Ornamentals[9]										1,246	939	307	–
Tree nursery[10]										1,152	1,040	112	–
Sod[9]										691	–	691	–
All other										**4,264**			
Idle[11]										3,182	69	3,113	–
Other[12]										155		155	
CNV[13]										927		927	–
Irrigated land	**24,188**	**47,760**	**54,598**	**46,445**	**55,350**	**62,444**	**76,291**	**81,148**	**107,217**	**113,134**	**10,260**	**102,874**	**0**
Number of farms	**557**	**812**	**801**	**812**	**944**	**838**	**950**	**1,003**	**1,146**	**Percent**	**9**	**91**	**–**
Harvested cropland	**307,927**	**376,284**	**321,630**	**208,833**	**201,934**	**224,693**	**211,851**	**242,891**	**326,270**				
Number of farms	**4,067**	**4,386**	**3,647**	**3,189**	**3,044**	**2,848**	**2,618**	**3,032**	**3,544**				
Total cropland	**693,672**	**802,310**	**674,448**	**567,004**	**528,172**	**493,720**	**427,423**	**406,748**	**422,886**				
Number of farms	**5,247**	**5,738**	**5,183**	**4,733**	**4,427**	**4,275**	**4,152**	**4,465**	**4,420**				

Table 2. Reported irrigated acreage by the U.S. Department of Agriculture and inventoried irrigated acreage by the U.S. Geological Survey by crop and irrigation system type in the Suwannee River Water Management District, Florida, 1974–2015 (from U.S. Department of Commerce, 1977 and 1984, and U.S. Department of Agriculture, 1989, 1994, 1999, 2004, 2009, and 2014).—Continued

[Data were compiled by the U.S. Geological Survey (USGS), Caribbean-Florida Water Science Center, Orlando. USDA, U.S. Department of Agriculture; USGS, U.S. Geological Survey; N/A, data not available; –, no data]

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[a]Data for 1974, 1978, 1982, 1987, 1992, 1997, 2002, 2007, and 2012 for Florida were obtained from the Census of Agriculture (U.S. Department of Commerce, 1977, 1984, and the U.S. Department of Agriculture, 1989, 1994, 1999, 2004, 2009, and 2014). The values shown under the USDA heading represent the acreage totals for entire counties of Alachua, Bradford, Columbia, Dixie, Gilchrist, Hamilton, Jefferson, Lafayette, Levy, Madison, Suwannee, Taylor, and Union.

[b]The values reported by the USGS represent observed acreage for the spring, summer, and fall growing seasons of 2015.

[c]Microirrigation includes drip, spray, jet, and bubbler systems; sprinkler irrigation includes portable and traveling guns, solid or permanent overhead fixtures, center pivots, and periodic moving systems; flood irrigation (including seepage systems) includes open-field ditch (furrows), semi-closed conveyance, subsurface conduit, crown flood, and continuous flood (Izuno and Haman, 1987, and Marella, 2014).

[1]Acreage may include beans (lima, pole, and snap), broccoli, carrots, cauliflower, celery, collards, garlic, herbs, kale, mustard greens, okra, onions, parsley, peas (black-eyed, crowder, green, and southern), potatoes, pumpkins, spinach, sweet corn, turnip greens, radishes, and watercress (as listed in tables 28 and 29, USDA 2012 Census of Agriculture [USDA, 2014]).

[2]Acreage includes vegetables that were planted in the spring (primarily between February and May) for a spring or summer harvest (primarily between April and July).

[3]Acreage includes vegetables that were planted in the fall (primarily between August and November) for a fall or winter harvest (primarily between November and February).

[4]Acreage includes vegetables that were planted in the spring and fall on the same field (see above for time frames). This is referred to as double cropped, and actual physical acreage would be one-half of the totals shown.

[5]Acreage includes blackberries, dewberries, blueberries (tame and wild), loganberries, raspberries, and strawberries (as listed in table 33, USDA 2012 Census of Agriculture [USDA, 2014]).

[6]Acreage includes apples, avocados, bananas, cherries, figs, grapes, guavas, mangoes, papayas, passion fruit, peaches, pears, pecans, persimmons, plums, and all citrus fruit (as listed in table 31, USDA 2012 Census of Agriculture [USDA, 2014]).

[7]Acreage includes pasture and other land listed under "Irrigated Land" (as listed in table 10, USDA 2012 Census of Agriculture [USDA, 2014]).

[8]Acreage includes tobacco, wheat (for grain), oats (for grain), proso millet, rice, rye (for grain), dry southern peas (cowpeas), grass and grass seeds, hay, forage, and silage crops (listed as forage in table 26, USDA 2012 Census of Agriculture [USDA, 2014]).

[9]Acreage includes all outdoor container nursery crops and tree farms (as listed in table 34, USDA 2012 Census of Agriculture [USDA, 2014]). Sod is also listed in table 34 but is listed here separately.

[10]Acreage includes floriculture and bedding crops reported as "acres in the open" but does not include "square footage under glass or protection" (as listed in table 34, USDA 2012 Census of Agriculture [USDA, 2014]).

[11]Acreage includes idle land with no specific crop (a grass cover was most often observed) or vacant with an irrigation system present.

[12]Includes acres with an irrigation system located at a governmental or university research facility with a variety of planted crops.

[13]CNV–Could Not Verify, the existence of an irrigated crop could not be verified at the time of observation; however, the presence of an irrigation systems was observed.

Further Information

Additional information about current and future water demands for agricultural irrigation in the SRWMD can be obtained by contacting the SRWMD (http://www.srwmd.state.fl.us) or the FDACS (http://www.freshfromflorida.com/Divisions-Offices/Agricultural-Water-Policy/Agricultural-Water-Supply-Planning). The final field-verified map (appendix 1), the individual county acreage totals published by the USDA (appendix 2), along with the digital layers and attribute files described in this report, are available for download from the USGS Science-Base-Catalog Web site https://www.sciencebase.gov/catalog/item/56bcb099e4b08d617f6682d4.

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U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Director

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For additional information about this report, contact:

Richard L. Marella
U.S. Geological Survey, Caribbean-Florida Water Science Center
12703 Research Parkway
Orlando, FL 32826
rmarella@usgs.gov
Or visit the Caribbean-Florida Water Science Center Web site at
http://fl.water.usgs.gov

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Hay field after harvesting in Suwannee County, Fla., 2015.
Photo by R. Marella