SUPPLEMENT A

AN ESTIMATE OF WETLAND EXTENT IN THE LOWER YAZOO BASIN USING AN EMAP PROBABILISTIC SAMPLING DESIGN

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Contents

Introduction

The Yazoo Backwater Pumps project area encompasses 926,000 acres between the east bank of the Mississippi River Levee and the Will M. Whittington Auxiliary Channel and from Vicksburg approximately 65 miles north to a line through Belzoni, Mississippi. The area of interest in this report is the approximately 630,000 acre 100-year floodplain contained within the project area (Figure 1). The proposed project entails the construction of a series of pumps that at maximum capacity could discharge 14,000 cubic feet/ second (cfs) in an effort to decrease the effects/extent of flooding in the project area.

The National Environmental Policy Act (NEPA) (PL 91-1-90) is required for those major federal actions that significantly affect the quality of the human environment. Due to the expenditure of federal funds NEPA requires an assessment of impacts along with justification of proposed benefits for the project. Section 404 of the Clean Water Act (40 CFR Part 230) also requires the evaluation of primary and secondary impacts associated with proposed discharges of fill material into wetlands or other waters of the United States. Therefore, the establishment of the extent of the resources at risk and the expected impacts to them is pivotal to this project.

During the course of this project there have been several attempts to estimate the spatial extent of wetlands based upon remote sources of data (i.e., Geographic Information Systems (GIS), satellite images, hydrologic models). These remote-based estimates of jurisdictional wetland extent have ranged from approximately 60,000 to over 200,000 acres. Since these estimates were based on remote data with unestimated error, it was reasoned that a field-based, statistical design would provide a more precise and scientifically defensible basis for establishing the extent of wetlands in the study area.

The objective of this project was to determine the extent of jurisdictional wetlands within the 100-year floodplain with known confidence (90%). The 100-year floodplain was selected as the area of evaluation because it would be the greatest area which could be affected by the pump and is an area consistent with that used in other analyses for this project (e.g., economic).

Background

Smith and Klimas (2002) characterized the factors contributing to wetland ecology in the entire Yazoo Basin which includes the project area. The following is largely a summarization of this information in terms of historic hydrology, vegetation and soils which contributed to wetland development.

Wetlands within the Yazoo Basin are on landforms created by the action of the Mississippi River or its tributaries. Human modifications within the Yazoo Basin have significantly altered both the hydrology of the basin and certain physical features that influence wetland conditions. Thus, the history and effects of human alterations to the hydrology and vegetation of the Basin are important to understand the current extent of jurisdictional wetlands.

The dominant drainage feature of the Mississippi Alluvial Valley is the Mississippi River, which formed the topography of the basin, determined the configuration and locations of most of the existing wetlands and stream systems and dominated the hydrology of the valley during major floods. Prior to construction of modern levees, major Mississippi River floods would have inundated most or all of the Yazoo Basin. While modern main stem levees prevent overbank Mississippi River flooding, construction of these levees did not completely eliminate the influence of the river on hydrology of the Yazoo Basin. High stages on the Mississippi River cause impeded drainage of tributary streams, which results in backwater flooding (Smith and Klimas 2002).

Hydrology

In the Yazoo Basin in general, except during major floods, the dominant source of water is precipitation, and runoff from the hills along the eastern flank of the basin. The only surface outlet is through the Yazoo River, which enters the Mississippi River at the southern end of the basin near Vicksburg. Most stream flow in the Yazoo River originates in the uplands along the eastern flank of the basin, and is carried to the Yazoo via the Coldwater, Yokona, Tallahatchie, and Yalobusha Rivers as well as several smaller streams. Interior drainage is provided by numerous small streams that discharge to Deer Creek, the Big Sunflower River, or Bogue Phalia, all of which flow to the lower Yazoo River. The pattern of drainage within the basin is generally southward, but can be complicated by the topography left by the abandoned meander belts of the Mississippi River (Smith and Klimas 2002, Saucier 1994).

The hydrology of the Yazoo Basin has been modified extensively. Federal projects have largely protected the basin from the effects of major floods, allowing extensive land clearing and agricultural development. Water entering or underlying the modern basin is rerouted, stored, and exported from the system in complex patterns that can result in more or less water available to remaining wetlands. For example, heavy winter and spring rains make drainage necessary for agricultural operations while low rainfall periods in summer and fall warrant irrigation (Brown et al. 1971). Drainage may involve land leveling as well as ditching, and can have various effects on wetlands, which may serve as sumps to which adjacent fields drain, and/or they may themselves be drained to streams or larger ditches. During periods of backwater flooding, these same artificial drainage networks may function in reverse, and deliver water to low areas far from the source stream channels. (Smith and Klimas 2002).

Vegetation

Forests of the basin are referred to as bottomland hardwoods, a term which incorporates a wide range of species and community types, all of which can tolerate inundation or soil saturation for at least some portion of the growing season (Wharton et al. 1982). Most major overviews of bottomland hardwood forest ecology emphasize the relationship between plant community distribution and inundation, usually assuming that floodplain surfaces that occupy different elevations in relation to a river channel reflect different flood frequency, depth, and duration (e.g., Wharton 1978, Brinson et al. 1981, Larson et al. 1981, Wharton et al. 1982). This leads to classification of forests in terms of hydrologic "zones," each zone having characteristic plant communities. Whereas the Yazoo River floodplain is geomorphically complex and supports mosaics of communities, the general zonal models imply that the principal hydrologic controls on community composition are flood frequency, depth and duration, as indicated by elevation relative to a stream channel. Overbank flooding is just one of many important sources of water in the wetlands of the Lower Yazoo Basin, and factors such as ponding of precipitation may be more important than flooding effects in many landscape settings (Smith and Klimas 2002).

Soils

Parent materials of soils in the Yazoo Basin are fluvial sediments which have developed under the influence of the Mississippi River. The fluvial sorting process of sediments has produced textural and topographic gradients that are fairly consistent on a gross level, and result in distinctive soils. Generally, within a meander belt, surface substrates grade from relatively coarse-textured, well-drained, higher elevation soils on natural levees directly adjacent to river channels through progressively finer-textured, and less well-drained materials on levee backslopes and point bar deposits. Very heavy clays are commonly found in closed basins within large swales and abandoned channels as well as in backswamps between successive meander belts. Valley train deposits are the result of glacial outwash which were subsequently influenced by braided stream development. Valley train deposits typically have a top stratum (upper 1.5-3m) of fine-grained material (clays and silts) that blankets the underlying network of braided channels and bars (Brown et al. 1971, Saucier 1994,). Backswamps are typically flat, poorly drained areas bounded by uplands or other features such as natural levees. Like valley trains, backswamps consist of coarse glacial outwash deposits overlain with fine grained deposits which give rise to the heavy clay soils characteristic of the study area. However, all of these patterns are generalizations, and quite different conditions occur regularly (Smith and Klimas 2002). Within the study area Kirchner et al.(1991) considered Alligator, Calhoun/Bonn Complex, Dowling, Rosebloom, Sharkey, Souve and Waverly soil series as hydric soils. Forestdale, Tunica, and Brittain series sometimes have inclusions of coarser textured soils and could not categorically be considered hydric soils. Thus, site inspection is often the only way to determine if soils have hydric indicators. An estimated 1,196,907 acres of hydric soils existed in the 6 counties in which the project is contained (Kirchner et al. 1991). Hydric soils in these 6 counties account for approximately 30% to 80% of the county area.

Probability Survey Design Approach

Available estimates of jurisdictional wetland extent in the Lower Yazoo Basin, based on remote data with unestimated error, have ranged widely giving an unclear picture of wetland extent in the area. Field based determinations involving determining precise boundaries and areal extent of jurisdictional wetlands was not feasible due to time and resource constraints. A probability survey design approach incorporating field assessments at randomly selected sites was determined to be the best approach since it incorporated elements of both remote sensing and field determinations yielding statistically valid results within defined confidence limits. Probability survey designs for natural resources, specifically aquatic resources, have been developed by the Environmental Monitoring and Assessment Program (EMAP) of the Environmental Protection Agency's (EPA) Office of Research and Development (ORD) to advance the science of natural resource monitoring. A key aspect of EMAP is based upon the use of probabilistic sampling designs which require explicitly defined target populations; allowance for each element in the population having the opportunity to be selected with a known probability; and making the sample selection process explicitly random. These 3 characteristics, in conjunction with a well-defined field measurement protocol, ensure that data is collected without bias. Specifically, a goal of the EMAP program is to estimate the geographic coverage and extent of ecological resources such as wetlands with known confidence. EMAP achieves this goal by using statistical survey methods that allow assessment of the extent of large areas based on data collected from a representative sample of locations. By using probabilistic sampling, EMAP maximizes the efficiency of the sampling effort while permitting conclusions to be reached about the larger population within known confidence intervals. EMAP strategies and methods have been developed and tested within EPA-ORD over the past decade, and have proven to be effective, accurate, replicable, and readily available. Given the inherent uncertainty associated with remote sensing (e.g., GIS) estimates of wetland extent and the availability of EMAP protocols and technical support from EPA-ORD, EPA Region 4 initiated the EMAP survey design to provide an objective approach for assessing the extent of wetland acreage within the Yazoo Backwater project area.

Methods

The study was done following established EMAP methods (www.epa.gov/nheerl/arm). The survey design for selecting samples in order to provide valid data, was developed to accurately estimate the extent of wetlands from the entire population or area of interest. Completion of the survey design required: establishment of objectives (as elucidated above); identification of resource characteristics; establishment of the target population; development of a sample frame and sample size; a field sampling protocol and statistical analysis.

For the purposes of the survey design, the wetlands of the Yazoo Basin are considered to be a 2-dimensional areal resource. The target population for this project was defined as the entire land area within the Corps of Engineer's (Corps) designated 100-year floodplain. Each location within the target population would be classified as either a jurisdictional wetland or not. Within the target population, 3 categories of potential wetlands were identified. These three categories, or strata, arose from discussions between the Corps and EPA on the extent of wetlands in the Lower Yazoo Basin. Several GIS data layers were used to depict the potential areas containing wetlands for the purposes of drawing a probabilistic sample.

The Corps based its interpretation of jurisdictional wetlands in the Lower Yazoo Basin on those areas inundated for 5% of the growing season. This definition allowed the District to utilize flooding models (Flood Event Assessment Tool (FEAT), Ballard and Kress, 2004) and satellite imagery to indicate the location and extent of potential jurisdictional wetlands in the project area. The FEAT model is a prototype geospatial model which utilizes stream gage data, digital elevation models (DEMs), primary and secondary channel centerlines or cross-sections to generate a geospatial based flood surface (Ballard and Kress, 2004). Inputs to the FEAT model were stage data from 6 gages, 30 meter (m) DEMs, channel centerlines and secondary channels. The Corps used this model to depict the location of wetlands based upon inundation for 5% of the growing season. The results of this model were calibrated against a single satellite Thematic Mapper (TM) scene with 25 m resolution, dated March 10, 1989, and verified with another, similar satellite scene dated 13 January 1983. The Corps determined the use of these 2 scenes as adequate to determine wetland extent in the project area. The Corps' FEAT model output was used as a category of potential wetlands for the Lower Yazoo Basin from which to draw a sample for the probabilistic survey design.

EPA utilized the Federal definition of wetlands as per Corps {33 CFR 328.3(b)} and EPA {40 CFR 230.3(t)} regulations, to include "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." EPA interpretation of this definition necessitates evaluation of the presence of hydrophytic vegetation, hydric soils, and wetland hydrology. Use of this definition expanded the potential geographic extent of sample sites. The National Land Cover Dataset (NLCD) was used to represent potential wetlands beyond those captured in previous analyses (http://landcover.usgs.gov/nationallandcover.asp) using the Corps' FEAT model. The NLCD uses Landsat TM imagery terrain-corrected using 3-arc-second digital terrain elevation data. The TM data were geo-registered to the Albers Equal Area projection grid using ground control points, resulting in a root mean square error of less than one pixel (30m). Two or more TM scenes were used for the final NLCD product to represent different times of the growing season (e.g., leaf-on and leaf-off) thus improving the quality of the landcover information. In addition to the multiple TM scenes, land use-land cover data from the U.S. Geological Survey, State Soil Geographic (STATSGO) and National Wetland Inventory were used to enhance the classification of the NLCD (Vogelmann et al. 2001).

Of the 21 landcover classes represented in the NLCD, only the forested classes were selected from the NLCD coverage and used to represent potential wetlands. This included the deciduous forest, mixed forest and woody wetland categories. The deciduous forest and mixed forest categories were included because previous wetland studies in the Yazoo Basin (Kirchner et al, 1991) found that in 275 wetland determination sites distributed in the Yazoo Basin all sites satisfied the hydrophytic vegetation criteria in the 1987 Wetland Delineation Manual (COE 1987). In addition, accuracy assessments have shown that NLCD is only 60% accurate in classifying Anderson Level 2 classes. In particular, error was associated with correctly classifying forested wetlands. Therefore, all NLCD forested classes were included in the sample frame in an effort to capture any potential wetlands. In this study the NLCD forested classes totaled 225,729 acres. Ninety-five percent (214,792) of these acres were classified as wetland forests while 5% (10,937) were classified as upland forests.

In addition, the U.S. Fish and Wildlife Service Lower Mississippi Alluvial Valley Joint Venture Office provided a shapefile depicting areas as having been enrolled in the Wetland Reserve Program (WRP) as restored wetlands. These WRP areas were included with the NLCD shapefile and the FEAT model output as potential wetlands.

Thus, the EMAP sample frame consisted of 3 sampling strata depicted as ArcView shape files in map form projected in North American Datum 27 (NAD27) (Figure 2). These previously described ArcView shape files were the basis for creating the sample frame used to generate the random sample points. A sample frame is defined as the specific information (e.g., a list or map) that identifies every unit within the population of interest. In this case the sample frame was the ArcView map with the FEAT, NLCD, WRP wetlands and the areas in between which were designated "non-wetlands". Areas which were not designated as wetlands in either the FEAT, NLCD, or WRP layers were also included in the sample frame to capture errors of omission.

Using the sample frame, the survey design was developed for the selection of a sample of units. A generalized random tessellation stratified (GRTS) design with reverse hierarchical ordering was used (Stevens and Olsen 2002). The study region polygons were assigned to one of three separate strata: FEAT model wetlands; NLCD/WRP wetlands; and other (non-wetlands). Thus the design is a stratified design. Within each stratum, instead of selecting a simple random sample a generalized random tessellation stratified survey design was applied to wetland polygons. The GRTS design maintains spatial distribution of a random sample and allows substitution of inaccessible points in an unbiased, random and spatially distributed way.

A sample size of 50 sites/strata was determined to meet the desired level of precision at a confidence of 90%. Thus a total sample of 150 sites over the 630,000 acre area was proposed to estimate wetland extent. EMAP provided geographic coordinates for the 150 sites as well as coordinates for an additional 150 oversample sites to be used in sequential order in the event one or more of the original sites was inaccessible.

Field sampling protocol

Once the sample points were selected using GIS, the spatial coordinates of each point were listed, then plotted using Mapsource (Version 4.13) Global Positioning System (GPS) compatible software (Garmin Corporation 1999-2003). This placed the EMAP generated points on digital topographic maps facilitating transportation to and from sites. Three teams of Corps, EPA, Natural Resource Conservation Service and U.S. Fish and Wildlife personnel located sites via Garmin 76S GPS units set on World Geodetic System datum 84 (WGS 84). Once on a site, a routine wetland determination as described in the 1987 Corps of Engineers Wetland Delineation Manual (1987 Manual)(Environmental Laboratory 1987) was completed (Figure 3). A wetland determination is defined by the 1987 Manual as, "the process or procedure by which an area is adjudged a wetland or nonwetland." Thus, this process did not establish wetland boundaries which are defined by the 1987 Manual as "the point on the ground at which a shift from wetlands to nonwetlands or aquatic habitats occurs" (Environmental Laboratory 1987), but determined the wetland status of the immediate area around the sample point. This determination included an ocular estimate of dominant vegetation, determination of presence of hydric soils, and notation of primary and/or secondary indicators of wetland hydrology. Data was recorded and a determination of the wetland status of the site was made at the time of the field visit. An area was determined to be wetland if it had a dominance of hydrophytic vegetation; had positive (1 primary or 2 secondary) indicators of hydrology and had hydric soils in accordance with the criteria established in the 1987 Manual. Results were reported to EMAP for statistical analysis as “wetland” or “not wetland”.

Statistical analysis

Population estimates for wetlands in the Lower Yazoo Basin can be extrapolated directly from observations at randomly selected sites. These estimates are computed using weights that are the inverse of the inclusion probabilities, and are equivalent to the number of acres in the target population that are represented by each site in the sample. For example, the number of acres with some attribute (such as being a wetland) can be estimated as the sum of the weights of the sampled sites with that attribute. If s_1, s_2, ..., s_n is a sample selected according to a design with inclusion probabilities $\pi(s)$, an unbiased estimator of the population total (acres of jurisdictional wetlands) is given by

$$\hat{z}_T = \sum_{i=1}^{n} \frac{z(s_i)}{\pi(s_i)}, \tag{1}$$

where $z(s_i)$ is data value for site s_i and the inclusion probability is $\pi(s)$ is area of a particular stratum divided by the number of sample points evaluated in that stratum (Stevens and Olsen, 2003). A variance estimator for $\hat{Z}_T$ is then

$$\hat{V}_{IRS}(\hat{Z}_T) = \sum_i \left(\frac{z(s_i)}{\pi(s_i)} \right)^2 - \frac{1}{n-1} \sum_{i \neq j} \left(\frac{z(s_i)}{\pi(s_i)} \right) \left(\frac{z(s_j)}{\pi(s_j)} \right) = \frac{n}{n-1} \sum_i \left(\frac{z(s_i)}{\pi(s_i)} - \overline{\left(\frac{z}{\pi} \right)} \right)^2 = nV_{SRS}(z/\pi) \quad (2)$$

where $V_{SRS}(z/\pi)$ is the usual estimator of the population variance for a simple random sample (SRS) design applied to $z(s_i)/\pi(s_i)$ (Stevens and Olsen, 2003). Stevens and Olsen (2003) give an improved local neighborhood variance estimator that was used in this study. Further details on the estimation of weighted population statistics are available in Diaz-Ramos et al. (1996). For the Lower Yazoo Basin, a stratified GRTS survey design was implemented, estimates for each of the three strata were calculated as indicated above, and then the three estimates combined which is the norm for a stratified survey design (Cochran 1987).

Results & Discussion

Field sampling was completed from June 2 - 14, 2003. Initially the three teams of interagency personnel worked together to discuss issues that might arise in the field and to develop consistency between teams in interpreting wetland field indicators. The members of the teams making the wetland determinations were all trained in the use of the 1987 Wetland Delineation Manual and followed procedures outlined in the Manual.

As noted previously, the original sample frame for the EMAP design were ArcView shapefiles of the FEAT delimited area, NLCD forested areas and WRP lands, and the area not included in the first two categories (Low Potential), all projected in NAD 27. Hence, the EMAP potential sample points were also projected in NAD 27. However, the GPS units were set to the default setting of WGS 84. This resulted in approximately a 25m shift to the south of each potential point. Thus each sample point evaluated in the field was located 25m south of the intended location. This difference in datums resulted in some of the original sample points actually being shifted into one of the other 2 strata. Table 1 shows the distribution of sampled points after field sampling. The original design entailed sampling 50 sites in each of the 3 strata. Table 1 indicates that only 2 points in the FEAT Potential stratum shifted to the Low Potential strata, 3 points shifted from the NLCD/WRP stratum, and 2 shifted from the Low Potential stratum. However, despite this shift, the survey design, field determinations, and statistical design remained intact.

Table 1. Strata shifts in EMAP sample points in the Lower Yazoo Basin Project.

Stratum	Subpopulation			Total Number of sites
	FEAT Potential	NLCD/WRP Potential	Low Potential	
FEAT Potential	55	0	2	57
NLCD/WRP Potential	0	55	3	58
Low Potential	0	2	53	55
Total	55	57	58	170

Table 2 presents the results of the EMAP survey design. A total of 169 sites was evaluated in the field (Figure 4). Of this total, 12 sites were determined to be inaccessible due to flooded conditions or landowner restricted access and were not sampled. These 12 sites were substituted for with 12 sites from the oversample list in order to preserve the minimum sample size of 50 sites/category.

Table 2. EMAP Wetland Results for Lower Yazoo Basin

Wetland Category	**Wetland Status**	**N Resp**	**Estimate (%)**	**StdErr. (%)**	**LCB90 (%)**	**UCB90 (%)**	**Estimate (ac)**	**StdErr. (ac)**	**LCB90 (ac)**	**UCB90 (ac)**
Study region	no	82	67.8	2.1	64.3	71.3	446244	14023	423178	469311
Study region	yes	70	32.2	2.1	28.7	35.7	**212284**	14023	189218	235351
Study region	Total	152	100.0				658529			
FEAT Potential	no	8	16.3	4.0	9.8	22.9	25544	6207	15335	35753
FEAT Potential	yes	41	83.7	4.0	77.1	90.2	**130914**	6207	120705	141123
FEAT Potential	Total	49	100.0				156458			
NLCD/WRP Potential	no	25	51.5	6.2	41.3	61.7	70161	8431	56294	84028
NLCD/WRP Potential	yes	27	48.5	6.2	38.3	58.7	**66091**	8431	52224	79959
NLCD/WRP Potential	Total	52	100.0				136252			
Low potential	no	49	95.8	2.6	91.6	100.0	350539	9330	335192	365818
Low potential	yes	2	4.2	2.6	0.0	8.4	**15279**	9330	0	30626
Low potential	Total	51	100.0				365818			
LCB90 = Lower Confidence Band, 90th percentile										
UCB90 = Upper Confidence Band, 90th percentile										

Eighty-two sites (67.8%) did not meet the criteria in the 1987 Manual and were categorized as “non-wetlands” (Figure 5), while 70 sites (32.2%) did meet the 3 criteria for being considered jurisdictional wetlands (Figure 6). Based on this sample, an estimated 212,284 ± 14,023 acres of wetlands occur in the 100-year floodplain of the Lower Yazoo Basin leaving 446,284 acres of non-wetland in the study area.

A comparison of the total number of sites sampled from Table 1 and Table 2 indicate a difference of 18 sites. Table 1 represents the total number of sites (170) which were attempted to be physically sampled in the field. Of these 170 sites, 12 sites were inaccessible and could not be located, and 1 site was deleted from the sample population. Hence, 13 sites were considered "inaccessible" and were not sampled. As a result of changes in the GIS shapefiles after the sample frame had been sampled, 5 additional sites were removed from further analysis due to their GIS location outside the boundary of the 100 year floodplain (i.e., the study boundary). Therefore, as indicated in Table 2, 152 sampled sites, were included in the analysis of the spatial extent of wetlands in the 100 year floodplain.

The highest percentage of wetlands in the study area occurred in the area the FEAT model predicted flooded for 5% of the growing season (Figure 6). In this case, 130,914 ± 6,207 acres, or 83.7 ± 4.0 % of the area was determined to be wetland, while 16.3 ± 4.0 % did not meet wetland criteria. Previous interpretations of the FEAT model outputs determined that the entire area depicted by the model as flooded for 5% of the growing season was wetland. Thus the FEAT predicted 189,600 acres of wetland. Differences with the EMAP estimate of 130,914 acres are due to the inclusion of nonwetland areas (i.e., agricultural fields, open water areas, and uplands) which EMAP detected but the FEAT model did not. Inaccessibility of 5 sites in this category was due to deep water caused by backwater flooding at the time of sampling. Substitute sites from the EMAP oversample list for this category were selected and sampled in the given sequence.

Of the approximately 136,000 acres represented by NLCD/WRP ArcView shapefiles as potential wetlands, 66,091 ± 8,431 acres or 48.5 ± 6.2 % were wetland by virtue of meeting the hydrologic, soils and vegetative criteria in the 1987 Manual. While the shapefiles for the NLCD/WRP overlap with portions of the FEAT shapefiles, the EMAP sample points for the NLCD/WRP category were all beyond the boundary of the area defined by the FEAT model. Consequently, at least 50 samples were taken from the FEAT area and 50 from the NLCD/WRP area that did not
include overlaps with the FEAT area. Inaccessibility of 3 sites due to landowner restriction and flooded site conditions were substituted from the EMAP oversample list.

Finally, 15,279 ± 9330 acres or 4.2 ± 2.6 % of the "Low potential" areas were found to be wetlands. Of the 2 sites which were determined to be wetlands 1 was an area dominated by buttonbush (*Cephalanthus occidentalis*) and a variety of sedges and rushes (*Carex and Juncus spp*.) and the other was determined by the Natural Resources Conservation Service (NRCS) to be "farmed wetland". Areas determined to be nonwetlands in this category were primarily agricultural sites and catfish ponds. Of the 49 nonwetland sites in the Low Potential category none had hydrophytic vegetation, 31 sites had hydric soils, and none had indicators of hydrology.

Conclusion

The spatial extent of wetlands in the Lower Yazoo Basin was determined with known confidence using an EMAP survey design and analysis. Based on this design the total wetland extent for the 100-year floodplain of the Lower Yazoo Basin is approximately 212,000 acres. This provides a sound, scientifically defensible basis for establishing the area of wetlands that can currently be identified using the 1987 Wetland Delineation Manual. The highest percentage of the total

wetland acreage was found in the FEAT predicted area, with substantial acreage occurring outside this boundary. This study indicates that wetlands occur throughout the project area although they are concentrated in the southern half. The study also indicates that wetlands occur not only within the area modeled as wetland by the FEAT model, but also outside the modeled area in areas depicted by the NLCD/WRP shapefile and in low potential areas.

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Figures

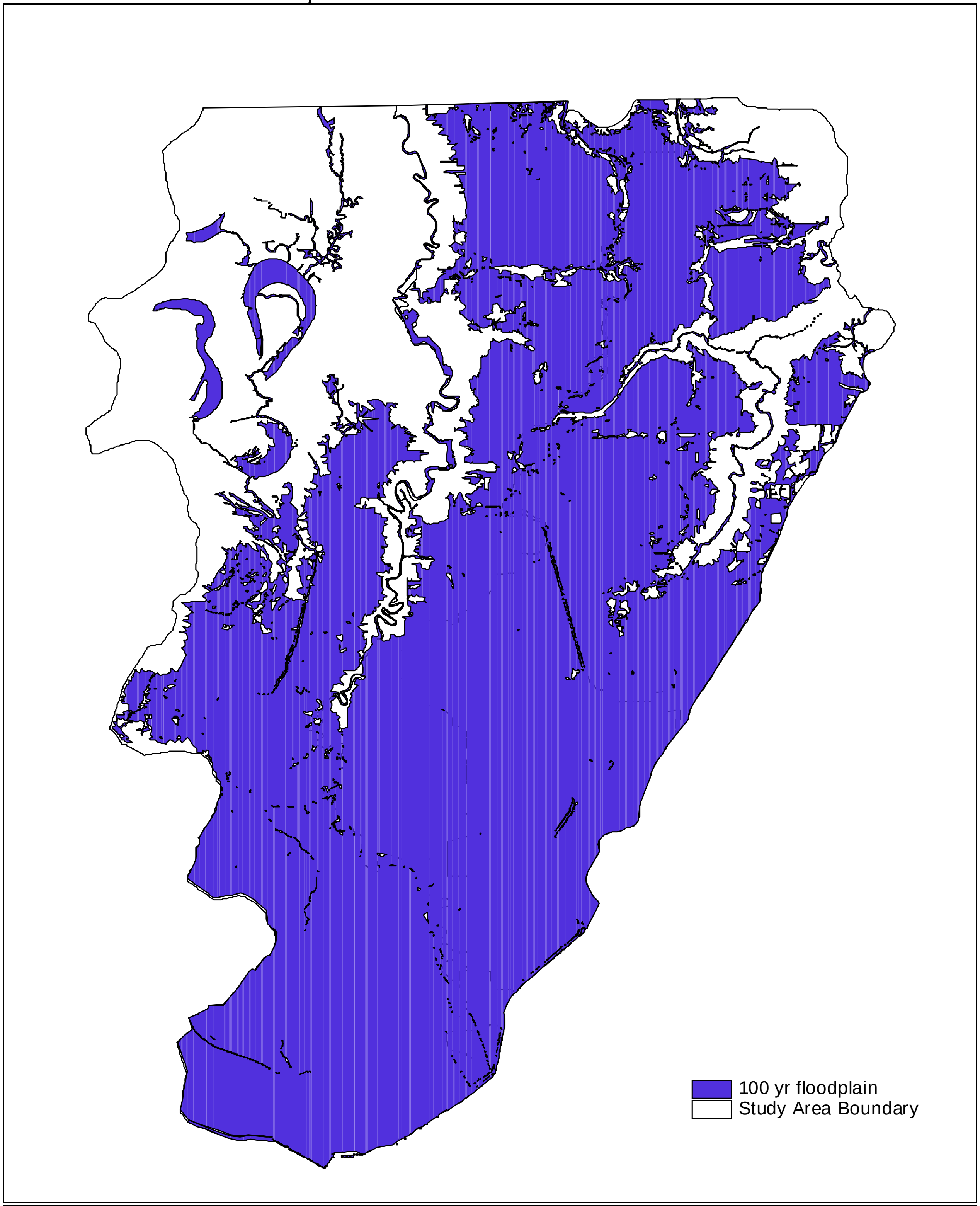

Figure 1. Study area and 100 year floodplain of the Lower Yazoo basin.

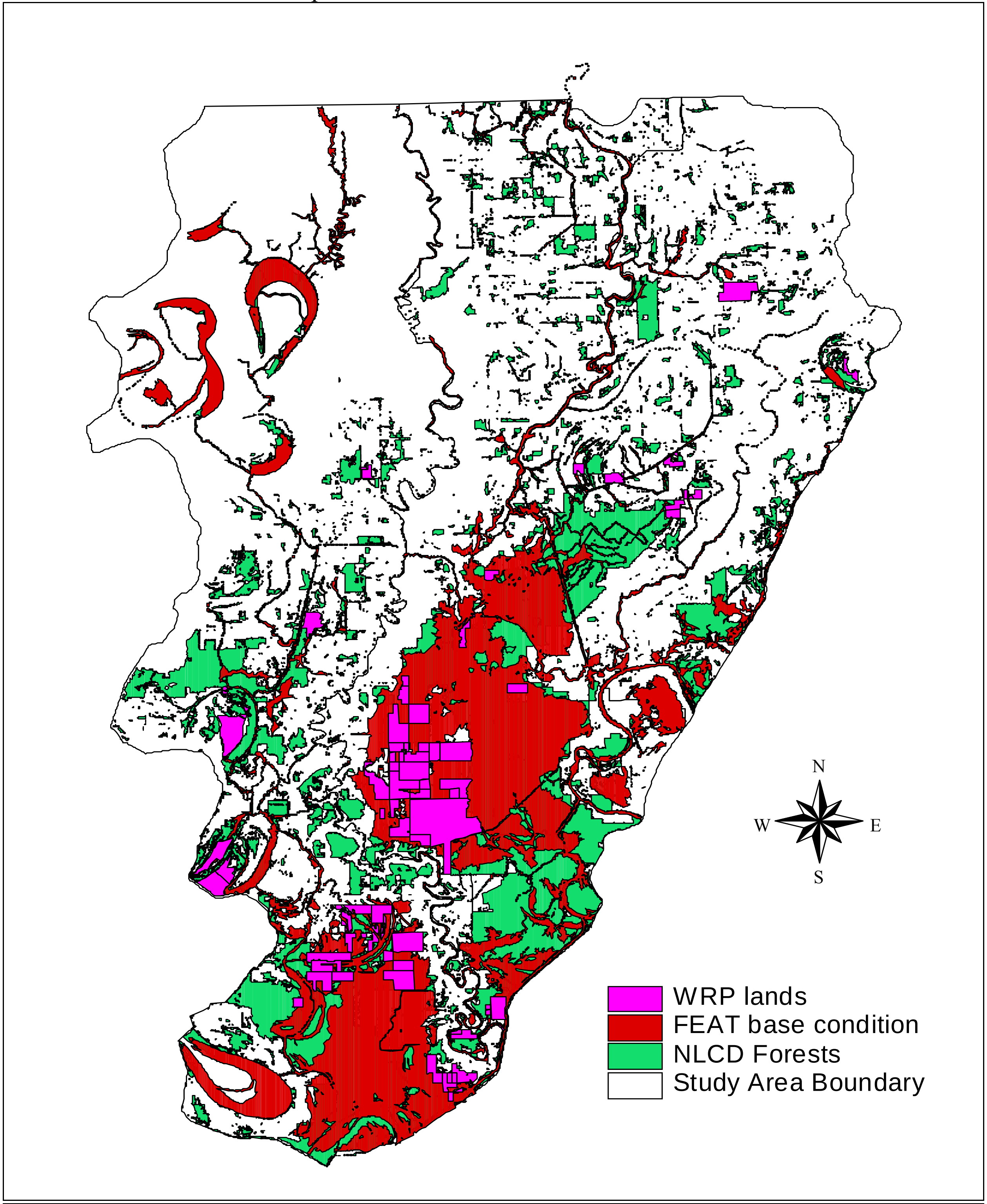

Figure 2. EMAP sample frame with FEAT model-predicted wetland area, and NLCD/WRP- predicted wetland area in the Lower Yazoo Basin.

Figure 3. Routine wetland determination form from the Corps 1987 Manual (Environmental Laboratory 1987).

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project Site:			Date:
Applicant/Owner:			County:
Investigator:			State:
Do normal circumstances exist on the site?	Yes	No	Community ID:
Is the site significantly disturbed (atypical situation)?	Yes	No	Transect ID:
		No	Plot ID:
Is the area a potential problem area? (If needed, explain on reverse.)	Yes		

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1.			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

Remarks:

HYDROLOGY

____ Recorded Data (describe in remarks): ____ Stream, Lake, or Tide Gauge` ____ Aerial Photographs ____ Other ____ No Recorded Data Available	Wetland Hydrology Indicators: Primary Indicators ____ Inundated ____ Saturated in Upper 12 Inches ____ Water Marks ____ Drift Lines ____ Sediment Deposits ____ Drainage Patterns in Wetlands
Field Observations: Depth of Surface Water ____(in.) Depth to Free Water in Pit: ____(in.) Depth to Saturated Soil: ___ (in.)	Secondary Indicators (2 or more required): ____ Oxidized Root Channels in Upper 12 inches ____ Water-Stained Leaves ____ Local Soil Survey Data ____ FAC-Neutral Test ____ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase):

Drainage Class:
Field Observations
Confirm Mapped Type Yes No

Taxonomy (Subgroup):

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concentrations Structure, etc.

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- ____ Reducing Conditions
- ____ Gleyed or Low-Chrome Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- ____ Listed on Local Hydric Soils List
- ____ Listed on National Hydric Soils List
- ____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes No (Circle)

Wetland Hydrology Present? Yes No

Hydric Soils Present? Yes No

(Circle)

Is this Sampling Point Within a Wetland? Yes No

Remarks:

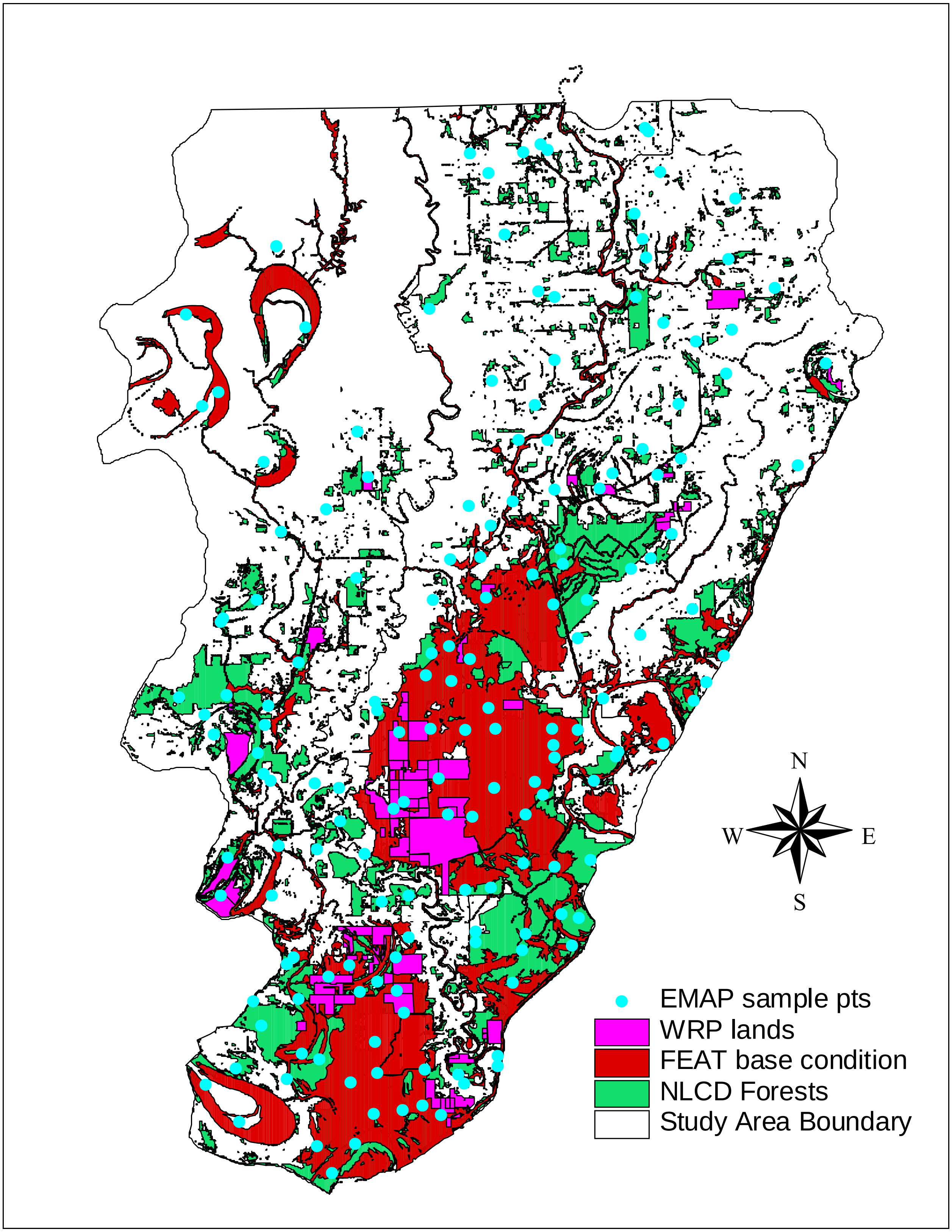

Figure 4. EMAP sample points in the Lower Yazoo Basin.

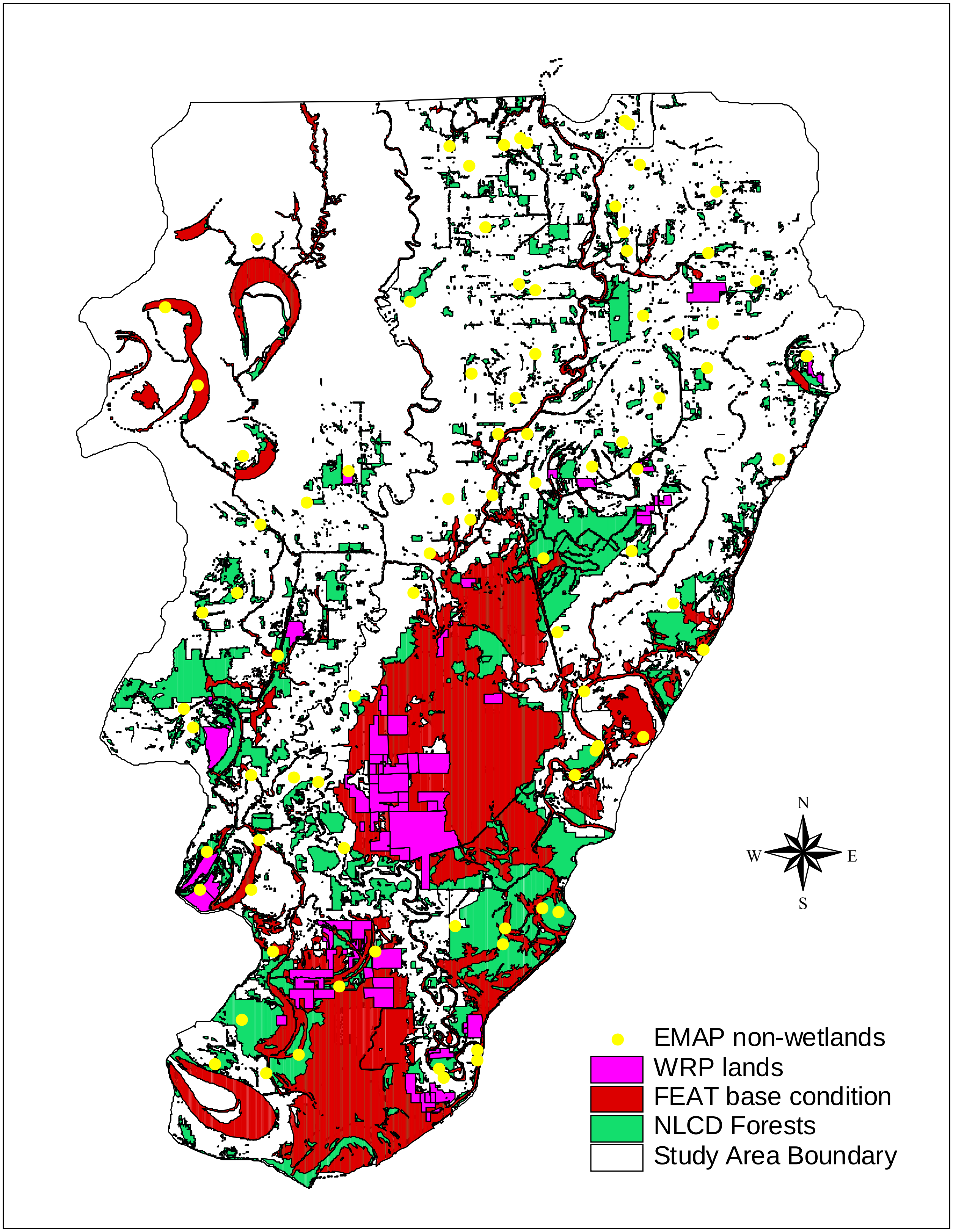

Figure 5. EMAP sample points that were found to be non-jurisdictional areas in the Lower Yazoo Basin.

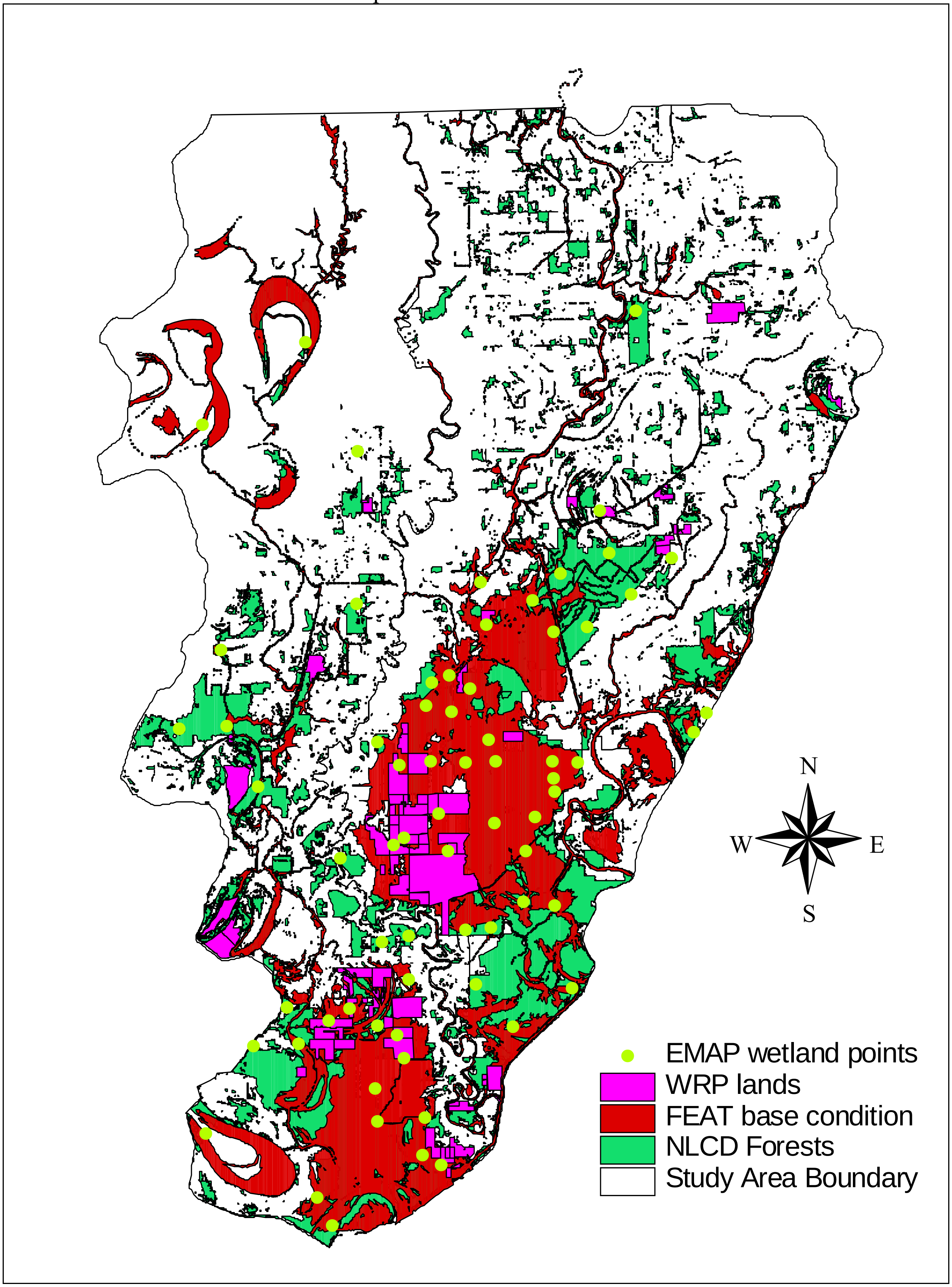

Figure 6. EMAP sample points that were determined to be jurisdictional wetlands in the Lower Yazoo Basin.