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Agronomic and wildlife impacts from winter flooding of agricultural fields for waterfowl in western Tennessee

Tim D. Pruitt

To the Graduate Council:

I am submitting herewith a thesis written by Tim D. Pruitt entitled "Agronomic and wildlife impacts from winter flooding of agricultural fields for waterfowl in western Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

David A. Buehler, Major Professor

We have read this thesis and recommend its acceptance:

Donald D. Tyler, Paul M. Jakus

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Agronomic and Wildlife Impacts from Winter Flooding of Agricultural Fields for Waterfowl in Western Tennessee

A Thesis
Presented for the
Master of Science Degree
The University of Tennessee, Knoxville

Tim D. Pruitt
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Acknowledgments

In a project of this size and scope it is often hard to know quite where to begin thanking all the people who have contributed to its success. In 1998 I didn't know where it was going for sure, nor where it would end. As that end draws near I believe the best place to start thanking those involved is at the beginning.

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Abstract

This project was undertaken to determine the cost/benefit effects of creating temporary winter habitat for waterfowl by flooding harvested crop fields in winter. Provision of wintering habitat has become increasingly important to waterfowl managers, and the potential of using agricultural lands to replace lost wetlands is also more important than ever. Farmers and other landowners however, are not quick to turn over prime river-bottom farmland to wildlife managers without first knowing what the costs and benefits are to their agricultural production. Field studies were conducted at the West Tennessee Experiment Station from fall-1996 to fall-1999to document effects of winter flooding on soil fertility, weed control, soil retention (sedimentation), and crop production using three (3) different flooding regimes. Each winter we also monitored the numbers and species of wild birds (15,463 total) utilizing the flooded fields. Finally, we surveyed a sample of the landowners in Tennessee participating in the managed flooding (Tennessee Partners) project. From this survey we gained a general knowledge of their personal experiences with the project, documented their perceived effects to their farming operations, and personal opinions regarding the effects on both farming practices and waterbird management.

Winter weed biomass decreased between treatments (control = 69.83; treatment 1 = 15.25; and treatment 2 = 18.11 g/m^2) in 1999 ($p = 0.010$ and $p = 0.006$) in fields flooded for extensive periods of time, especially if water was held on those fields for 120 days. General soil conditions changed insignificantly between treatments: pH ($p = 0.962$, 0.808 and 0.148), phosphorus ($p = 0.429$, 0.565, and 0.676), potassium ($p = 0.198$, 0.311, and 0.377), and percent organic matter (p = 0.758, 0.395, and 0.421). There was no sign of soil loss (p = 0.878 and 0.480) during two annual surveys. Crop yields did not differ across treatments for 1997-99 (p = 0.879, 0.848, and 0.762). Soybean crop yields averaged 11.25 bu/ha, across all treatments and years, below the Madison county average. ·Any increases or declines in crop yields during the study period were attributed to normal farm practices, not to controlled winter flooding. Avian use of the area increased by 7,183 birds during the course of the project, however there was no significant difference between flood regimes (p = 0.959, 0.121, and 0.704). This lack of significant differences between treatments is largely due to counting all birds using all treatment cells. While shorebird/wading birds were using flooded cells, upland and passerine species could have been counted using the drier cells. Farmers and landowners interviewed were largely enthusiastic about this type of winter flooding management with some claiming 50% reductions in cost to control winter weeds, and overwhelmingly supporting this effort to provide winter waterfowl habitat.

CHAPTER 1

Introduction

The management of wildlife and wildlife habitat often compete directly with production agriculture and its land use practices. Agricultural crop production and other agricultural land use practices in the United States traditionally have held a higher economic priority than utilizing the land for wildlife production. The western third of Tennessee is this state's most productive agricultural area. This area also falls within the boundaries of one of the nation's great waterfowl flyways, the Mississippi Flyway.

Waterfowl and shorebirds (waterbirds) from northern breeding grounds each fall funnel down the Mississippi Flyway to their wintering grounds in the lower Mississippi Valley (Linduska 1964). The floodplains of the lower Mississippi River and its tributaries provide stopover and wintering habitat for millions of North American waterbirds each year (Reid et al. 1989).

Ducks Unlimited reported on spring waterfowl surveys conducted by U.S. Fish and Wildlife Service (USFWS) that placed breeding duck populations in 1985 at approximately 25.6 million birds, down from 1970's population estimates of 62 million ducks in North America (USFWS 1998). Williams et al. (1999) reported that the1985 population estimates possibly reflected all time lows in numbers of breeding mallards (*Anas platyrhynchos*), northern pintails (*A. acuta*), blue-winged teal (*A. discors*), canvasback (*Aythya valisineria*), and other duck species. Growing concern for the future survival of these species brought wildlife specialists from across North America together to discuss development of an international plan to address waterfowl needs. The resulting multi-national (Canada, Mexico, and the United States) agreement became known as the North American Waterfowl Management Plan (NAWMP). Since 1986, the Plan has provided a framework for the promotion and coordination of waterfowl conservation throughout North America (Williams et al. 1999). The NAWMP set a goal to achieve a stable population of 62 million breeding ducks, yielding fall migration flights of over 100 million birds (D.U. 2000).

The study area in western Tennessee falls into what has been described in the NAWMP as the northern section of the Lower Mississippi Alluvial Valley (LMAV). The LMAV is characterized as the vast Mississippi floodplains and its intricate network of tributaries (Wharton and Brinson 1978). This area is extremely important for stopover and wintering habitat for many species of migrating waterfowl in North America.

Degradation of the abundant and diverse wetlands, coupled with agricultural practices and urban development within LMAV, has long conflicted with the habitat needs of waterfowl and other wildlife species. Ditching and draining wetland areas and the construction of levees to control winter floodwater have decreased the acreage of migratory stopover and wintering habitat severely in the past 100 years. Migrating birds adapted to feeding in naturally flooded rice, corn, soybean, and other row-crop fields in winter, but in time these became less available. Levee systems and dikes kept floodwaters off these valuable production crop fields (Manley 1999, Reid et al. 1989, Reinecke et al. 1989, Twedt and Nelms 1999, and Williams et al. 1999).

As a part of the objectives outlined by the NAWMP, participation by private landowners in the overall implementation of the plan was considered very important. Production agricultural fields are often dormant throughout winter months, and great lengths are often taken to keep winter floodwaters off these fallow fields. Within the region, these bottomland fields had once been a major component of migratory waterbird habitat. The inclusion of these lands, on a seasonal basis, as stopover and wintering habitat was considered a very crucial part of the overall NAWMP. The acceptance of controlled winter flooding by landowners is a vital link to making these lands available to waterbirds.

The idea of utilizing farmland for double cropping is not new. For example, farmers may plant wheat in the fall on fields used for soybeans in the spring and summer. However, the idea of waterfowl as a second crop could be a cost-effective way to provide this critical stopover and over-wintering habitat. The use of controlled winter flooding could allow this seasonal use of croplands by wildlife. This type of land management strategy would provide seasonal habitat for migratory and over-wintering waterbirds and be farmed the balance of the year using traditional farming practices (Miller 1995).

For controlled winter flooding to become an acceptable farm management practice to agricultural producers, research was needed to better understand the effects of winter flooding on the primary use of this land, which is annual crop production. This project was designed to give farmers and wildlife managers more useful information concerning the costs and benefits of controlled winter flooding.

Within the western region of Tennessee, the Tennessee Partners Project (TPP) was initiated in 1990. This program, initiated by Ducks Unlimited (DU), Tennessee

Wildlife Resources Agency (TWRA), National Resource Conservation Service (NRCS), Tennessee Department of Agriculture (TDA), Tennessee Cooperative Extension Service (TCES), United States Fish and Wildlife Services (USFWS), and local land owners was developed to promote the winter flooding of croplands to provide needed wetland habitats for wildlife. By the end of February 2001, Tennessee had 149 participating landowners with 2685.6 ha enrolled in the program.

In most cases, flashboard riser water control structures (WCS) were installed in existing or specially prepared levees. The water control structures allow water to be held on the fields throughout the winter and the water height to be controlled. Some farmers in these programs reported significant savings in herbicide costs associated with weed control in winter flooded crop fields (Manley 1999). As a side benefit, participating farmers have the opportunity to lease these flooded fields to waterfowl hunters, thereby allowing harvested fields to bring in additional revenue.

Extensive data exist on the ability of chemicals to control the weeds which compete with crops (e.g., Shull 1914, Burns 1965), but little has been written in the use of winter flooding to control weeds. Farmers in Louisiana and Arkansas reported that fields flooded in winter reduced their chemical application costs (Manley 1999). Some research has been conducted to show the effects of standing water on weed seeds, and casual observations have revealed that rhizome Johnson grass (*Sorgum* spp.) and Bermuda grass (*Cynodon dactylon*) rarely infest fields that have been flooded over winter (Davis 1933). Generally, however, little is known about the overall benefits or costs of annual controlled flooding.

1.2 Project Objectives

1) Document the effects of controlled winter flooding on weed production in harvested crop fields.

2) Document the effects of controlled winter flooding on:
    a) soil pH;
    b) soil fertility in production row-crop fields;
    c) soil erosion or soil retention using standard survey methods;
    d) crop yields when utilizing standard farming practices.

3) Document wildlife responses to controlled winter flooding of production crop fields.

4) Document through a telephone survey the experiences of a sample group of farmers currently participating in controlled winter flooding programs in western Tennessee.

This thesis details the results of the winter flooding project conducted at the West Tennessee Experiment Station, Jackson, Tennessee, for the period of December 1996 through November 1999. This thesis is comprised of 6 chapters. Chapter 2 contains information concerning the study site, the description and layout of the experimental cells, levee construction, and water control structure design. Detailed results for specific project objectives are discussed in Chapters 3 through 6, which make up the main body of this thesis.

CHAPTER 2

STUDY SITE

2.1 Geographic Location and History

This project was conducted at the University of Tennessee's West Tennessee Experiment Station (WTES) (Fig. 2-1). WTES is located in Jackson, Tennessee (Madison County). Established in 1907, the WTES is known for its research on production agronomics and horticulture, and is the oldest branch station in The University of Tennessee Agricultural Experiment Station system. Resident scientists and staff in the Department of Plant and Soil Science and the Department of Entomology and Plant Pathology, conduct approximately 100 investigations annually designed to produce new technology for more efficient crop production and a safer environment (WTES 2000).

WTES was ideally suited for this study because it is located within the floodplain of the South Fork of the Forked Deer River where winter flooding naturally occurs. The study was conducted on fields 13 and 14 of the WTES, adjacent to the South Fork of the Forked Deer River. The installation of low-level terraces in these fields has allowed sufficient water management to provide controlled flooding of harvested crop fields to evaluate agronomic impacts to farmers.

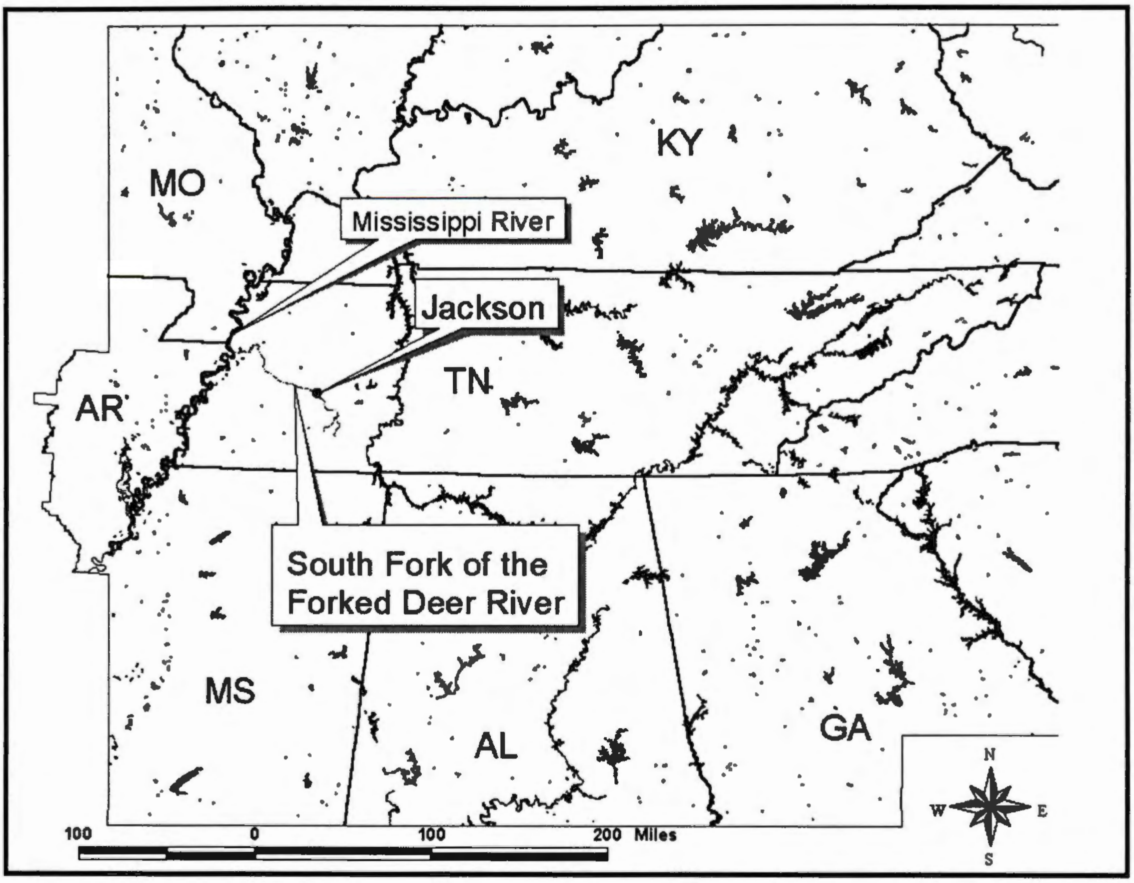


Figure 2-1 - Study Site Location: West Tennessee Experiment Station - Jackson, Tennessee.

WTES also provided an experienced staff at the station, and the resources of UT's Institute of Agriculture for assistance and helped evaluate agronomic practices and other impacts resulting from this study.

The study site lies along the cusp conterminous United States Southeastern Plains eco-regions and the Mississippi Loess Plains (MLP). The Southeastern Plain Region (SPR) that falls within Tennessee can be further subdivided into the Southeastern Plains and Hills Region. This sub-region of the SPR typically contains north-south trending bands of sand and clay formations. The study site is located near the western edge of the sub-ecoregion and tertiary age sand, clay, and lignite dominant soil composition.

The MLP generally consists of gently rolling irregular plains 75-150 m in elevation, with loess depths up to 15 m thick. This loess plain region of Tennessee is highly productive agriculturally, with soybeans, cotton, corn, milo, and sorghum crops dominant. Soil erosion can be problematic with upland Alfisol soils and silty bottomland Entisols (Griffith et al. 1998). Soils throughout Madison County have low organic-matter content, tend to be strongly acidic unless limed recently, and phosphorus (P) and potassium (K) are generally low to medium in content, unless added. Addition of lime and fertilizer, coupled with good farm management practices, will usually result in positive effects in Madison County soils (National Cooperative Soil Survey 1978). The predominant soil type within the study site cells (WTES fields 13 and 14) is Waverly silt loam. The fields lie parallel to a drainage ditch which bisects the study site and is generally west to east in direction. The average elevation of the study site is 96 m above mean sea level (m.s.l.).

Geographically located in the western quarter of Tennessee, Madison County is within the Mississippi Embayment of the East Gulf Coastal Plain province, which includes much of the area between the Mississippi River and the lower Tennessee River. The major rivers draining this region west into the Mississippi are the Obion, Forked Deer (South Fork, Middle Fork, and North Fork), Hatchie, Loosahatchie, and the Wolf. The coastal plain is Tennessee's leading agricultural region (Etnier and Starnes 1993).

Historically, the rivers of western Tennessee flooded seasonally, dumping their suspended load of sand, silt, and clay upon the adjacent bottomlands. However, over the past 50–80 years many of these rivers have been channelized and their riparian forest systems removed to improve drainage from the forest and conversions of forest to agriculture (Etnier and Starnes 1993).

2.2 Study Site Preparation

Fields 13 and 14 have been the sites for previous agricultural projects, including a production cropland drainage study. Site preparation for this winter flooding project began in 1995, and was completed in the summer of 1996.

2.2.1 Experimental Design and Cell Layout

Fields 13 and 14 were subdivided into 3 and 6 experimental cells, respectively. Each cell was surrounded on 3 sides by a constructed levee, and was identified by an individual cell number. A terracing plow was used to construct earthen levees that encircled the experiment cells. At the lowest corner of each cell a steel box and culvert water control structure was installed. The area of each cell was approximately 1.6 ha.

Costs of levee construction for the Jackson Study site totaled $9,933.00, which averaged $0.90/ft. This cost per foot is approximately $0.66 greater than is normally expected on a typical basis. This additional cost per foot is reflective of variations in the levee system to allow for experimental studies such as this. There was an additional cost of $1,200.00 per experimental cell for the water control structures (Table 2-1).

Table 2-1 –Cost for levee construction at West Tennessee Experiment Station study site and average cost in conventional farming situations, WTES 1996-1999.

	Study Levee Construction	Typical TWRA Levee Construction
Levee Length (ft)	11,029	1,000
Hours		
TWRA Terrace Plow	60	8
Contracted Bulldozer	129.50	
Contracted Track Hoe	10	
UT Tractor and Disk	25	
Cost/hr.		
TWRA Terrace Plow	$29.80	$29.80
Contracted Bulldozer	$60.00	
Contracted Track Hoe	$65.00	
UT Tractor and Disk	$29.80	
Total Cost		
TWRA	$1,788.00	$238.40
Contracted Equipment	$7,400.00	
UT Tractor	$745.00	
Grand Total	**$9,933.00**	
Cost/ft.	**$0.90**	$0.24

Three cells were controls. Rain and/or floodwater were allowed to naturally flow to and from these control cells. Treatment 1 cells were short-duration flood cells(60 days) and treatment 2 cells were long-duration flood cells (120 days). Short-duration cells were closed by 5 December each year of the study and allowed to fill with water, either by natural rainfall, flooding, or through pumping and were drained 60 days later (1 February). The short-duration-flooding period paralleled the Tennessee waterfowl-hunting season. Long-duration cells were closed and allowed to flood by 5 December each year of the study and drained 120 days later 1 April (Fig. 2-2). See Appendix I for actual flooding data.

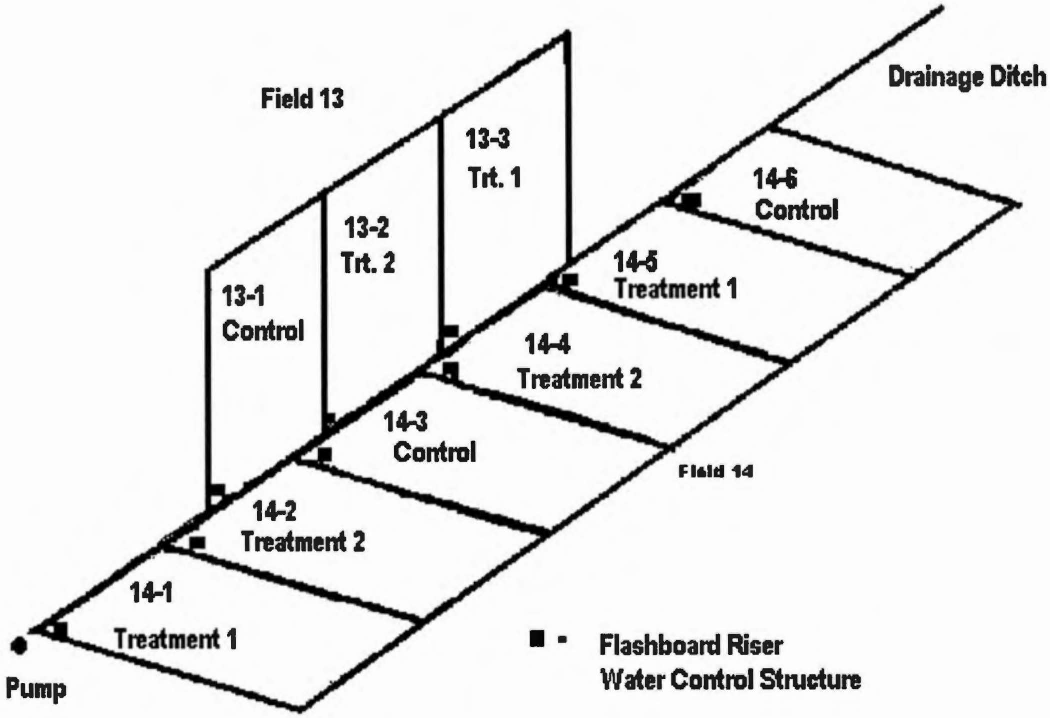


Figure 2-2 – Basic study design and cell layout. Treatment 1 cells were flooded 60 days; treatment 2 cells were flooded 120 days, and control cells were subject to natural flooding and drying, WTES 1996-1999.

2.2.2 Water Control Structure Description

Each flashboard riser water control structure (WCS) consisted of a fabricated steel box, an attached drainage pipe, and 5 cm x 15 cm lumber cut to fit the cell end of the structure. A water control structure was installed on the inside of the levee at the lowest elevation point in each experimental cell. Attached to the control structure, and penetrating the levee, was 60 cm diameter discharge pipe. This pipe allowed the water to run out of the cell into the center drainage ditch. Welded onto the cell side of each control structure were slots to hold the 5 cm x 15 cm blocking boards (Figure 2-3).

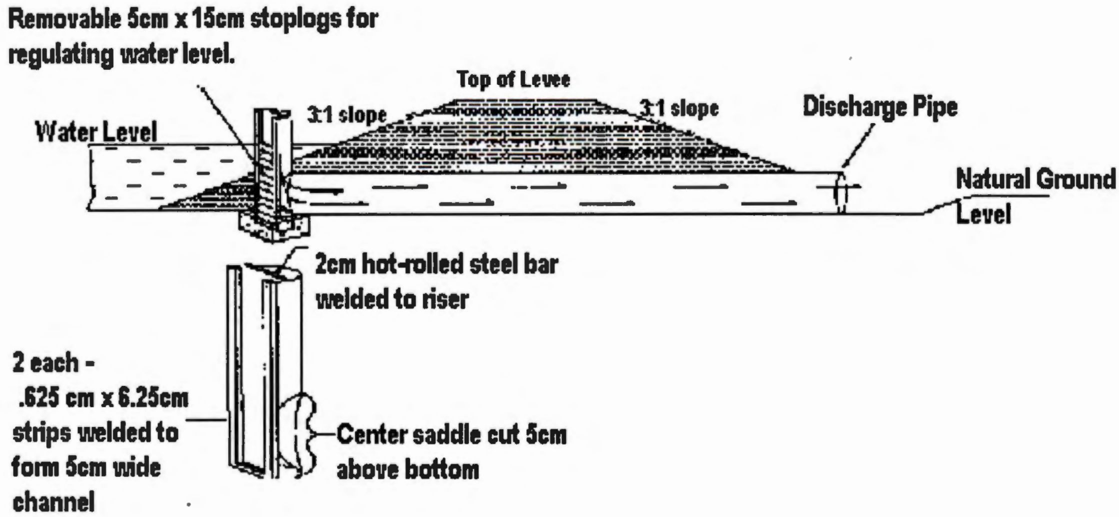
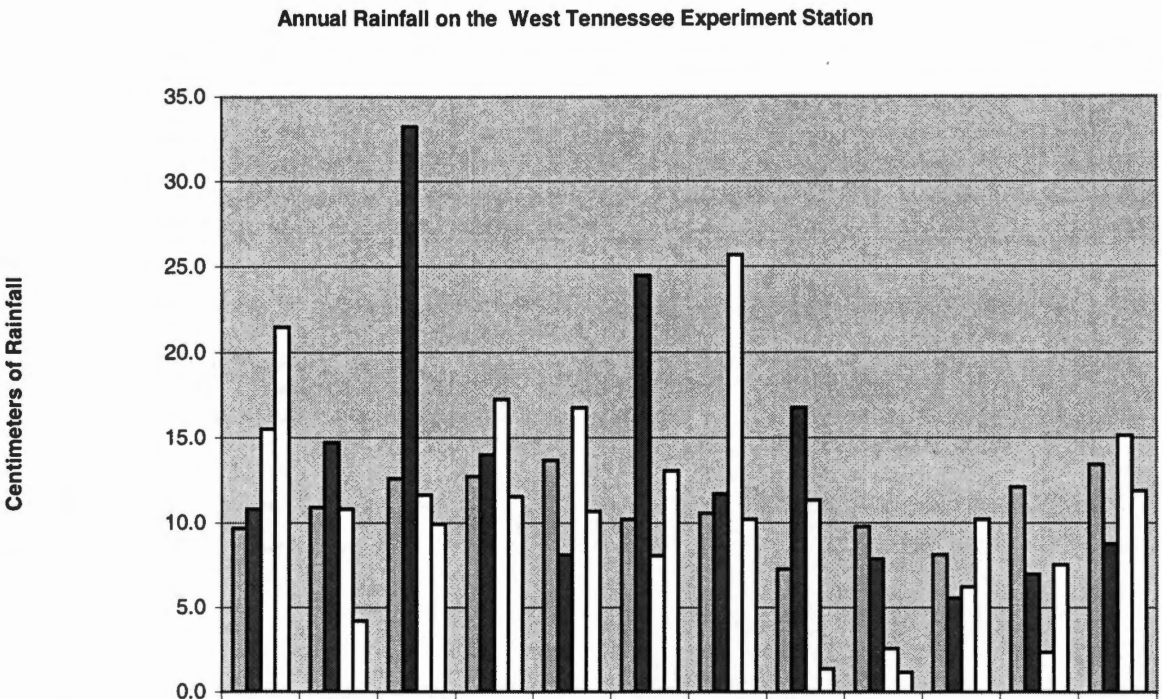


Figure 2-3 –Basic design of a flashboard riser. This type of water control structure allows managers to control water levels for varying management strategies.

Water levels could be adjusted at 15 cm increments by adding or removing these boards. During all planting/growing seasons, no boards were present in the control structure, allowing rainwater to freely drain from each cell.

2.2.3 Agricultural Practices

For the duration of this study, all agricultural practices used were considered normal farming practices. The crop grown was soybeans. Study fields received no special cropping treatments or precautions to accommodate this study. After long term cells were drained and allowed adequate time to dry, each field was disked, fertilized as required, planted in soybeans, monitored for weed growth, and post-emergence herbicide was applied as needed. Harvest of soybeans occurred in October.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual Rainfall	9.7	10.9	12.6	12.8	13.7	10.2	10.6	7.3	9.8	8.2	12.1	13.4
1997 Rainfall	10.8	14.7	33.2	14.0	8.1	24.5	11.7	16.8	7.9	5.6	7.0	8.8
1998 Rainfall	15.5	10.8	11.7	17.3	16.8	8.1	25.7	11.4	2.6	6.3	2.4	15.1
1999 Rainfall	21.5	4.2	9.9	11.6	10.7	13.1	10.2	1.4	1.2	10.2	7.5	11.9

Monthly Averages

Figure 2-4 - Average monthly rainfall and values during the winter flooding study (1997-99), West Tennessee Experiment Station, Jackson, Tennessee, 1996-1999.

2.2.4 Study Site Annual Rainfall

Precipitation for the winter months during 1997, 1998 and 1999 averaged 16.3 cm, 14.1 cm, and 11.8 cm respectively (Fig.2-4). The average rainfall for WTES during these months is 11.9 cm (Gibson, J. WTES personal communication). The flooding regime was 3 cells flooded for 60 days and 3 cells flooded for 120 days. In winter 1997-98, the short term flood (60-day) cells did not fill until later in the year than normal (25 December), however the basic flood regime of 60 days was met.

CHAPTER 3

WEED RESPONSE TO CONTROLLED WINTER FLOODING OF HARVESTED CROP FIELDS

3.1 Introduction

Weed control is a significant challenge for row-crop producers. Estimates of weed control costs vary depending on agricultural practices and methods. Machinery expenditures, fuel prices, and labor expenses affect mechanical weed control costs. Chemical costs can vary greatly depending on the type of application used and tillage methods. Conservation tillage (no-till) farming may require the use of a burndown herbicide such as Gramoxone or Touchdown 5, and costs range from $7.50 to $107.00 per hectare. Pre-emergent herbicides for soybeans cost $17.50 to $50.00 per hectare, and post-emergent, or over the top, herbicides can cost up to $107.00 per hectare (York et al. 2000 and UT 2000).

There are also landscape-wide environmental impacts that must be considered when the use of herbicides is being considered. The long-term effects of agricultural run-off on groundwater, streams, and rivers are of growing concern in many areas where these water sources are used in drinking water systems (USEPA 1998a). Herbicides are often the most frequently detected chemical groups found in surface and ground water in agricultural areas. There is also the possibility of affecting non-target species that could run-off affected 25% of the rivers and streams surveyed by the United States Environmental Protection Agency (USEPA) in the last 10 years, and contributed to 70% of the water quality problems identified in those streams and rivers (USEPA 1998a). Organic compounds, such as herbicides and pesticides, are often released into the environment through production field run-off. In 1977, there were approximately 2 million man-made organic compounds known, with 250,000 new formulations developed each year (USEPA 1999). Limiting this continued flood of new man-made chemical compounds into the water supply is of national concern (USEPA 1998, Manley 1999).

The use of herbicides can also affect the agricultural producer in a more obvious fashion. Use of certain chemical herbicides can potentially restrict future field use in some cases because of cumulative build-up. Some herbicides that are effective in soybean fields can require a 9–18 month waiting period prior to using that field for certain other rotational crops such as cotton, corn, or sorghum. Accurate records of use must be kept to prevent planting hybrid seed that are intolerant of the herbicide of choice. Herbicides must be chosen with the target weed species in mind as well. Herbicides can be weed species specific, or require unusually high concentrations to be effective on various species. All of these factors increase overall costs to farmers.

A potential cost saving alternative to chemical and mechanical weed control could be controlled winter flooding of production crop fields. Some research has been conducted to show the effects of standing water on weed seeds (Thornber 1908). Casual observations revealed that rhizome *Sorgum* spp. (Johnson grass) and *Cynodon* spp. (Bermuda grass) rarely infest fields that have been flooded over winter (Davis 1933). Researchers in Louisiana and Arkansas reported that rice fields flooded in winter could result in an 86% reduction in winter weeds, thereby reducing chemical application costs (Manley 1999). Reducing pre-planting spring disking to only one pass saved farmers approximately $13.00 per hectare for soybeans, and reduced the need to use aerially applied burndown herbicides by as much as $32.00 per hectare. These reductions in mechanical and chemical weed control could represent significant savings to agricultural producers.

Problem weeds vary between geographic regions and often are related to the specific crops being grown. Sicklepod (*Cassia occindentalis*), for example, can be a frequent and serious problem weed that occurs most often in soybean and corn crops in the United States. Sicklepod seed germinates best when soil moisture is near 75% field capacity, but will not germinate when the soil is completely saturated. Sicklepod seed will germinate after 28 days underwater, however if submerged longer than 28 days little is known about germination rates. Little growth occurs if submerged again after germination or if soil remains waterlogged (Holm et al. 1997).

If winter flooding reduces or retards weed seed germination, winter flooding of fields may be of economic advantage to farmers. Controlled flooding, and the subsequent creation of temporary wetlands, could also retard chemicals entering streams and drinking water supplies. Wetlands, either natural or constructed, can act as sponges holding water and allowing agricultural run-off to settle limiting ground water and stream pollution (USEPA 1997).

The purpose of this chapter is to characterize the weed growth in fields 13 and 14 at WTES after a winter of controlled flooding. Each experimental cell will be studied to determine whether the weed community that developed within each differed by total weed cover and weed biomass.

3.2 Methods

3.2.1 Experimental Cell Treatments

Three replicates of 3 treatments were implemented in fields 13 and 14 at WTES, 1996-1999. Cell construction necessitated that cells sloped toward the WCS. This slope resulted in a water depth in each cell ranging from 0 cm near the upper end of each cell to 45 cm at the WCS. Cell treatments included controls, short-duration (60 day) cells, and long-duration (120 day) cells. Controls allowed for the natural flow of winter floodwater into and out of the cell as precipitation (usually rain) events occurred. Short-duration cells were closed by 5 December each year of the study and allowed to fill with water, either by natural rainfall or through pumping. Short-duration cells were drained 60 days later (1 February). Long-duration cells were closed and allowed to flood by 5 December each year of the study and drained 120 days later (1 April). Post-harvest soybean stubble was left on each cell, and spring preparation involved disking twice, then a do-all was pulled over each field, after which soybeans were planted. Fields were fertilized according to soil testing results dictated per cell, and post-emergent herbicides were used if required.

3.2.2 Weed Monitoring

Thirty, 1-m^2 weed-sampling plots were systematically located across each cell. Field shapes dictated cell layout and dimensions. Sample plots in each cell were separated by at least 10 m to allow for sampling the naturally random clustering of weeds (Colbach et al. 2000). Cells in field 13 were divided by 3 transects each containing 10 sampling plots. Cells in field 14 contained 2 transects each, with 15 sampling plots along each. For testing flood treatment effects on weed biomass, samples were collected at 2 intervals during the growing season in 1998 and 3 in 1999 (Manley 1999).

Weed samples were collected in two consecutive years. In 1998, samples were collected in July and October. In 1999, three samples were collected; we sampled weeds first in April before planting season, but 2 weeks after long-duration flood cells were drained to evaluate weed development at the start of the growing season. We also sampled weeds in June prior to any herbicide application, and then again in October prior to soybean harvest. Each 1-m^2 plot was surveyed and sampled for the percentage of weed cover and weed biomass. The percentage of weed cover per square meter was visually estimated for each weed species in each plot. Weeds were then collected (pulled and all loose attached dirt removed) by hand. All samples were dried in drying ovens for a minimum of 2 weeks and then weighed (within 0.5g) to determine biomass. Biomass was averaged within cells and then within treatments.

All data analyzed were collected in 1997-98 and 1998-99 sample years. Two sampling periods were used in 1997-98 and 3 sampling periods were used in 1998-99. Results for treatment effects are given by sampling year. Sampling year 1998-99 is also broken out and analyzed separately. Statistical analysis was performed using SPSS Statistical Software (Gerber and Voelkl 1999). All means for percent coverage and biomass were compared using one-way analysis of variance (ANOVA).

3.3 Results

Weed Cover – Weed cover did not differ among treatments in 1998 (p = 0.863); weed cover averaged 1.98, 2.32, and 2.64% for short-duration flooding, long-duration, and control treatments, respectively (Table 3-1a)

In 1999, weed cover was least in long-duration flooding treatments (mean = 0.94%), intermediate in short-duration treatments (mean = 12.62%), and greatest in control cells (mean = 23.67%; p = 0.01; Table 3.3.1a). When analyzed per sampling period in 1999, weed cover differed among treatments during the April sampling period (p = 0.037). Long-duration and short-duration treatments had the least early season weed coverage and controls produced the greatest weed coverage. June and September 1999 samples showed no significant difference between any treatments, similar to 1998 results during similar sampling periods (Table 3-1b).

Biomass – Weed biomass did not differ among treatments in 1998 (p = 0.814); weed biomass averaged 3.66, 4.31, and 5.29 g/m^2, for short-duration flooding, long-duration flooding, and control treatments, respectively (Table 3-2a). In 1999, weed biomass was least in long-duration flooding treatments (mean = 3.03 g/m2), intermediate in short-duration treatments (mean = 25.14 g/m2), and greatest in control cells (mean = 60.24 g/m2, p = .006; Table 3-2b). When analyzed per sampling period in 1999, weed biomass differed among treatments during the April sampling session (p = 0.015). Long-duration had the least early season weed biomass and controls produced the most early season weed biomass. June and September 1998 and 1999 samples showed no significant difference between treatments.

Table 3-1 Statistical results for percent of weed coverage in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee; a) in 1998 and 1999.

Sample Year	TRT	N	Mean Percent Coverage	SE	df	F	Sig. (p)
1997-98	Control	3	2.64	1.26	2	0.151	0.863
	1	3	1.98	0.53			
	2	3	2.32	0.53			
1998-99	Control	3	23.67	3.28	2	11.08	0.010
	1	3	12.62	4.47			
	2	3	2.07	0.94			

b) 1999 sampling regime per sampling period.

Sample Month	TRT	N	Mean Percent Coverage	SE	df	F	Sig. (p)
April	Control	3	69.83	9.95	2	6.03	0.037
	1	3	15.25	8.16			
	2	3	18.11	17.43			
June	Control	3	1.57	1.11	2	0.315	0.741
	1	3	3.83	3.20			
	2	3	2.72	0.85			
September	Control	3	0.50	0.35	2	0.419	0.676
	1	3	1.90	1.82			
	2	3	2.16	1.51			

Table 3-2 Statistical results for biomass (g/m^2) in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee; a) 1997-98 and 1998-99.

Sample Year	TRT	N	Mean Biomass	SE	df	F	Sig. (p)
1997-98	**Control**	3	5.29	2.28	2	0.213	0.814
	1	3	3.66	1.41			
	2	3	4.31	1.11			
1998-99	**Control**	3	60.24	6.56	2	13.80	0.006
	1	3	25.14	11.70			
	2	3	3.03	1.00			

b) 1998-99 sampling regime per sampling period.

Sample Month	TRT	N	Mean Biomass	SE	df	F	Sig. (p)
April	**Control**	3	187.77	29.62	2	9.30	0.015
	1	3	24.66	13.28			
	2	3	41.58	39.26			
June	**Control**	3	1.10	0.73	2	0.46	0.652
	1	3	3.51	2.91			
	2	3	2.80	1.01			
September	**Control**	3	1.90	1.51	2	0.55	0.602
	1	3	4.47	4.02			
	2	3	7.49	4.91			

3.4 Discussion

Weed coverage and weed biomass were lowest in the flooding treatments during April in 1999. In April 1999, long-duration and short-duration flood treatment cells showed significantly less weed coverage and weed biomass (15.25%; 24.66g/m^2 and 18.11%; 41.58g/m^2 respectively) than did control cells (69.83%; 187.77 g/m^2). Both long-duration and short-duration treatments were effective at controlling early season weed growth.

The difference in total weed coverage and weed biomass between 1998 and 1999 can be attributed primarily to the different sampling routines for the two years. In 1998, the first sampling (July) occurred after planting and application of post-emergence herbicide. In 1999, sampling began two weeks after the water was drained off Treatment 2 cells (April) and prior to any field preparation had begun. The second sampling (June) occurred prior to application of post-emergence herbicides after soybeans had been planted. The third and final samples in 1998 and 1999 were collected just prior to harvest. The April sampling in 1999 indicated that holding winter floodwaters on agricultural crop fields did indeed help to control or limit winter weed growth. Less winter weeds at planting could reduce the amount of pre-emergent herbicide, pre-planting ground preparation, and this could result in cost savings to farmers in spring field preparation.

By sampling two weeks after floodwaters were drained the full effect of holding floodwater longer was more apparent. Long-duration flooding treatments were "brown" when compared to control cells, which were green with weeds by April. Control cells best represented the natural effects of crop fields subjected to occasional winter flooding. If the season was especially wet, then natural flooding might also inhibit or stunt winter weed growth. However, in "normal" years, (e.g. winter 1998-99), weed growth was significant in control cells, often nearing 100% coverage in many of the sample plots prior to spring disking. In contrast, flooding treatments had minimal coverage with little or no weeds to sample. Weed growth in some of the lower wet areas closely resembled Treatment 2 cells, while drier upper areas began to resemble growth in Control cells.

Weed species composition within the treatment cells was not a principal concern of this study, and could be the subject of future studies (Appendix II). However, when observed on a casual basis there appears to be no direct correlation between treatment type and species composition. Common weeds found in long-duration and short-duration flooding treatments reflected species found in control treatments. Morning glory (*Ipomoea coccinea*), teaweed or prickly sida (*Sida spinoosa*), buttercup (*Ranunculus* spp.), and various grass species seem to be the predominate groups found regardless of flood regime (Muenscher 1980 and Holm et al. 1997). Only the quantity appears to vary, with less in long-duration and short-duration flooding treatments and the highest density in control cells.

Controlled winter flooding on crop fields does appear to inhibit winter/early spring weed growth. Flood treatments in April 1999 averaged 74% less weed coverage than control cells, and 78% less biomass was produced. These figures are similar to those reported by Manley (1999) in Arkansas, where he observed 86% reduction in winter weeds after controlled winter flooding. While holding water on fields for at least 60 days did seem to produce less weed growth than normal unflooded fields, long term flooding of 120 days or more produced the most positive results. Holding water the additional 60 days did not delay spring planting and provided wildlife habitat at no additional cost. The differences between years can best be explained by the difference in sampling periods, allowing for the lack of a pre-planting sample in 1997-98.

Initial differences in weed coverage and biomass suggest that fields managed with winter flooding could potentially result in less application of pre and post-emergent herbicides. Additional studies are warranted to determine whether winter flooding provides adequate weed control in total absence of post-emergence herbicides or with reduced applications of pre-emergence herbicides. This management practice could potentially save farmers considerable production costs on an annual basis.

CHAPTER 4

AGRONOMIC RESPONSES - FERTILITY, SEDIMENT RETENTION, AND CROP YIELD EFFECTS

4.1 Introduction

Soil pH levels, soil fertility, soil retention, and annual crop yields are always fundamental concerns to farmers. With any recommended change in land management, such as using controlled winter flooding on production crop fields, there needs to be preliminary and follow-up research to evaluate the process and to identify any positive or negative agronomic effects.

To meet ever increasing demands for high yield production of food crops at the lowest production costs, soil nutrient levels must remain high, and soil pH levels must remain within a range that allows plants best access to the nutrients available (Tisdale et al. 1985). Most soils in Tennessee range in pH from 4.5 to 7.5, and soil tends to drop in pH (more acidic) over time. Soil erosion, crop removal, and leaching are 3 of the most common reasons for this decrease in pH (Tisdale et al.1985, UTAES 1994). For soil nutrients to be the most available to crop plants, soil pH needs to be regulated between 6.0 and 7.0. This is most often accomplished by systematic testing of the soil and applying agricultural lime to the soil to put pH in the proper range.

River-bottom land tends to be the most productive for agriculture, but is also the most susceptible to erosion. Retention of that valuable soil on production fields is always a first concern to farmers. Production fields in the Southeast that are disked and left exposed to winter rains and normal flooding may lose as much as 1,200 kilograms/ha of soil each year. United States Department of Agriculture (USDA) estimates 2.7 billion metric tons (MT) of soil were lost to erosion in the 1980's alone (USDA 1990). Constructed winter wetland areas created by controlled winter flooding management schemes, could provide a settling pond effect on agricultural crop fields, and retain this topsoil where it is needed most.

Ultimately Tennessee farmers are concerned about crop production. Any agricultural operation depends on the quantity and quality of the crops it produces. In 1997, 1998, and 1999 soybeans were planted on about 500,000 ha of agricultural land in Tennessee, and produced 32,436,000 bushels of soybeans. In 1998 these soybeans were worth $196 million. Soybean production must not suffer as a result of land management practices, such as controlled winter flooding, if it is going to be accepted as a viable wildlife management tool.

This chapter explores the results of controlled winter flooding at WTES during 1997, 1998 and 1999. It looks at the effects of winter flooding on soil pH, soil fertility, soil erosion, and annual soybean yields.

4.2 Methods

4.2.1 Soil Sampling

Soil samples were collected from each study site cell in 1997, 1998, and 1999. Ten soil sampling sites were located systematically across each cell. WTES personnel collected and processed all soil samples. The University of Tennessee Agricultural Extension Soil and Forage Lab in Nashville, Tennessee analyzed all soil samples. At each site, 4 samples were collected from the following depths: 0-2.5 cm, 0-7.5 cm, and 15-30 cm. Samples from 0-7.5 cm through 15-30 cm depths were collecting using a 7.5 cm (diameter) bucket auger. All 0-2.5 samples were collected using a soil sample tube around the hole created by the bucket auger (UTAES 1999, J. Gibson, WTES personal communication).

After all samples were gathered, each sample was thoroughly mixed, and a representative sub-sample was taken. Samples were placed in a lab soil sample box, and then shipped to Nashville, Tennessee. Each sample was tested for pH, phosphorus, potassium, and organic matter.

4.2.2 Soil Retention Survey

Soil retention was measured by standard survey methods. J. Sarten, University of Tennessee Agricultural Experiment Station Engineer, conducted all survey work. Baseline survey data were collected in fall, 1997. Subsequent surveys were conducted in spring and fall, 1998, and spring, 1999. Fall surveys were conducted after crops were harvested prior to flooding. Spring surveys were conducted prior to field preparation and planting.

The equipment used in the survey process were a Pentax Total Station PTS III_{10}, and a Hewlett-Packard HP48GX data logger, running Tripod Data System's Survey Pro ver. 5.01 software. The Pentax Total Station unit is capable of 10 second horizontal and vertical accuracy, and can measure up to 1590 m within 3mm/2ppm. Each year's recorded data were accurate within ±1.2 cm vertically and ±3 cm horizontally. This equipment represents technology with accuracy suitable for this type of study.

The fall 1997 baseline survey established all benchmarks and cell diagonal transects. Benchmarks consisted of fixed utility pole markers and water control structure corner gussets. Benchmarks were re-checked for positional accuracy each year prior to conducting the survey with the exception of the spring 1999 survey. Having surveyed each benchmark in 3 previous surveys, benchmark positions were considered stable. Transect lines were laid out beginning at each cells' water control structure (cell low point). Transects then ran diagonally to the opposite corner (cell high point). Transect data points were established at 3 m intervals. The PTS III unit records and checks individual data points for positional accuracy for each previous survey, thus allowing for positional corrections during the current survey. Transect length varied depending upon overall cell size, resulting in 54 to 78 data points collected per cell.

4.2.3 Monitoring Harvest - Yield Data

All experimental cells used for this study were annually planted in soybeans. Typical standard farming practices were followed each spring. These included disking of experimental cells, using a do-all on each cell after disking, and fertilizing per soil sample recommendations. No agronomic practices were changed for the sake of this experiment. This was considered the best way to replicate typical harvest results from this experiment.

WTES personnel conducted all ground preparation, planting, and harvesting of soybeans. A Massey-Ferguson (Model 8) plot combine with a 160 cm soybean-header was used to harvest the soybeans from all fields. The combine was equipped with a scale and moisture sensor. This sensor system allows for simplified calculation of weights minus moisture in obtaining yield/hectare data.

Near the center of each cell a sample harvest strip was laid out. Each strip was 36.3 m long, by 3.2 m wide, resulting in a sample harvest of 0.02 ha per cell (1.25%). This was accomplished by passing the combine over the 36.3 m long sample area in two consecutive side-by-side passes. Harvested beans were weighed and a moisture content value placed on them at the point of harvest. Those converted weights were then used to calculate harvest yield per hectare. Calculations used the harvested weight, moisture content, and actual hectares harvested to ascertain weight per hectare.

A soil nutrient baseline was established by sampling cells in 1995, prior to the first winter (1996-97) of controlled flooding. Soil surveys were conducted in fall 1997, spring 1998, fall 1998 and spring 1999. Crop yields were calculated during fall harvest of each year. Statistical analysis was performed using SPSS Statistical Software (SPSS 1999).

4.3 Results

4.3.1 Soil Sample Analysis – Soil Fertility Effects

Soil pH – Soil pH did not differ among treatments throughout the study years ($p = 0.808$, 0.148, and 0.962; Table 4-1). Acidity, however, slightly increased in each cell over the duration of the study, except in control cells where it actually fluctuated down one year and up the next. Overall soil pH decreased 3% in short flood treatment cells and 3% in long-duration flood treatment cells. Soil pH fluctuated in cells from 6.31 in 1995 to 6.30 in 1998, and then back up to 6.36 in 1999, representing less than 1% change. However, these differences are all well within the margin of error and are of no statistical significance.

Table 4-1. Average pH levels in soils of fields 13 and 14 West Tennessee Experiment Station, Jackson, Tennessee, 1995-1999.

Sample Year	TRT	N	Mean pH	SE	df	F	Sig. (p)
1995	Control	3	6.31	0.004	2	0.039	0.962
	1	3	6.33	0.112			
	2	3	6.28	0.160			
1998	Control	3	6.30	0.136	2	0.221	0.808
	1	3	6.22	0.126			
	2	3	6.18	0.127			
1999	Control	3	6.36	0.007	2	2.67	0.148
	1	3	6.15	0.008			
	2	3	6.09	0.104			

Soil Phosphorus (P) Levels – Soil P levels did not differ among treatments in any year (p = 0.565, 0.676, and 0.429; Table 4-2). Phosphorus did show signs of slightly decreasing overall in the study fields over the 4-year sample period. Phosphorus levels in short-duration cells declined by 25%, in long-duration cells by 19%, and in open cells decreased by 18%. These changes are all well within the statistical margin of error.

Soil Potassium (K) Levels - Soil Potassium (K) levels did not differ among treatments in the sample years (p = 0.311, 0.377, 0.198:Table 4-3), although again K appears to be decreasing, at least in the treatment 1 and 2 cells.

Soil Percent Organic Matter (OM%) - The percent of soil organic matter (OM%) showed no significant changes across treatments during this study (Table 4-4). There were slight increases across the years however. Treatment 1 cells increased 4.5%, Treatment 2 cells increased by 12.6%, and Control cells increased by 18.2% between 1995 and 1999 samplings.

4.3.2 Survey Results – Soil Retention Effects

Soil Retention/Sedimentation - No significant change in soil retention was observed between treatments (Table 4-5). Soil movement in a positive or negative direction changed less than 1% across all treatments in all years. There was less than .003 cm change in a positive or negative direction in 1997-1998 and 1998-1999.

Table 4-2. Average Phosphorus levels in soils of fields 13 and 14 West Tennessee Experiment Station, Jackson, Tennessee, 1995-1999.

Sample Year	TRT	N	Mean P	SE	df	F	Sig. (p)
1995	Control	3	40.77	3.86	2	0.979	0.429
	1	3	60.53	16.26			
	2	3	47.32	5.61			
1998	Control	3	40.55	2.64	2	0.629	0.565
	1	3	57.00	20.06			
	2	3	39.77	6.52			
1999	Control	3	33.28	2.58	2	0.418	0.676
	1	3	44.95	12.50			
	2	3	38.45	9.08			

Table 4-3. Average Potassium levels in soils of fields 13 and 14 West Tennessee Experiment Station, Jackson, Tennessee, 1995-1999.

Sample Year	TRT	N	Mean K	SE	df	F	Sig. (p)
1995	Control	3	149.42	4.65	2	2.147	0.198
	1	3	173.00	15.61			
	2	3	146.92	4.90			
1998	Control	3	139.08	11.25	2	1.427	0.311
	1	3	158.91	13.71			
	2	3	135.45	4.55			
1999	Control	3	147.52	8.24	2	1.154	0.377
	1	3	155.52	11.04			
	2	3	134.03	10.81			

Table 4-4. Average percent of Organic Matter in the soil in Fields 13 and 14 at West Tennessee Experiment Station, Jackson, Tennessee, determined from soil tests in 1995, 1998, and 1999.

Sample Year	TRT	N	Mean OM%	SE	df	F	Sig. (p)
1995	Control	3	1.31	0.004	2	0.290	0.758
	1	3	1.24	0.008			
	2	3	1.21	0.129			
1998	Control	3	1.53	0.008	2	1.090	0.395
	1	3	1.33	0.125			
	2	3	1.32	0.121			
1999	Control	3	1.55	0.138	2	1.002	0.421
	1	3	1.30	0.007			
	2	3	1.37	0.159			

Table 4-5. Soil Retention Survey Data for fields 13 and 14 at West Tennessee Experiment Station, Jackson, Tennessee. Mean change in soil elevation is given in centimeters, 1997-1999.

Sample Year	TRT	N	Mean Elevation Change	SE	df	F	Sig. (p)
1997-98	Control	3	0.003	0.007	2	0.136	0.878
	1	3	-0.002	0.125			
	2	3	-0.002	0.002			
1998-99	Control	3	0.006	0.001	2	0.947	0.480
	1	3	0.002	0.003			
	2	3	0.006	0.002			

4.3.3 Annual Crop Yield Effects

Soybean Yields – There was no significant change in harvest yields between treatments during this study (Table 4-6). However, over the period of the study yields in Treatment 1 cells decreased by 59%, in Treatment 2 cells by 60% and Control cells yields decreased by 73%. These decreases across years can best be explained by regional droughts and reflect harvest trends across Madison County, Tennessee in those years where soybean yields averaged 15 Bu/ac in 1999 (TDA 1999 and 2000).

4.4 Discussion

The steady decline of pH within the treatment cells is a normal condition for soils in Tennessee. This decline is due to the continuous leaching effect of water through the soil, and of the plant's uptake of more basic nutrients such as phosphorus and potassium (Tisdale 1985, UT 1994). The decline in pH requires that periodic liming of the soil is necessary to maintain the proper pH levels (6.0-7.2). Liming was not conducted during the course of this study on the study cells. Standard practice of applying agricultural lime as required would eliminate this problem, and is not a response to the flood regime treatments.

Both P and K are most readily available for plant absorption within this pH range, therefore, the decreased levels of P and K in the treatment cells are not due to the flooding regime but to the optimum conditions for plant absorption (Tisdale 1985). Test cells were fertilized according to soil tests conducted by the WTES personnel and which followed the normal practices of the experiment station. In 1996, cells 13-1, 13-2, and 13-3 each received no nitrogen, 45 kg of P and 45 kg of K per hectare. All of field 14 cells received 67 kg of P and K per hectare. In 1997, all cells received no nitrogen,

Table 4-6. Annual Crop Yields for fields 13 and 14 West Tennessee Experiment Station, Jackson, Tennessee, 1997, 1998, and 1999.

Sample Year	TRT	N	Mean Yield Bu/Ac	SE	df	F	Sig. (p)
1997	Control	3	47.33	1.50	2	0.132	0.879
	1	3	43.00	8.69			
	2	3	46.37	6.35			
1998	Control	3	21.65	2.54	2	0.169	0.848
	1	3	21.25	3.93			
	2	3	18.57	5.27			
1999	Control	3	12.35	4.49	2	0.285	0.762
	1	3	17.60	7.33			
	2	3	18.20	5.92			

22.5 kg/ha P and 45 kg/ha K. In 1998, all cells again received no nitrogen and each cell received 45kg/ha of both P and K. No fertilizer was applied to any cell in 1999 (J. Gibson, WTES personal communication).

The percent of organic matter increased during the study, but not at a significant rate. However, the rate of increase was not affected by the flooding regime. Increase across treatment cells was uniform, showing no effect of organic material by any treatment.

With soil loss under normal farming conditions reaching 1,200 kg/ha in this part of Tennessee and in other areas of the Southeast, no significant changes within the study site is an important finding. However, this lack of soil loss is not directly attributed to the individual flooding treatments, but more likely to the levees themselves, which created a settling basin effect. Constructing levees to hold water on crop fields slows down water movement and velocity and prevents rapid loss or movements of soils further downstream. An important factor to consider in this study is the short-term nature of this experiment. While soil erosion can occur very quickly, soil sedimentation occurs at a much slower rate and therefore a longer study period is required for proper analysis of soil movement. A study of period of 10-30 years will most likely yield more accurate results in the area of soil retention. Another important factor in recording soil movement data are the procedures used to acquire that data. Survey methods, as used in this study, may be replaced by even more accurate systems. Evolving technologies, such as Global Positioning Satellite systems (GPS) are becoming more available, and may be the preferred method in the future for this type of data collection. These new technologies should enable future studies to more accurately record minute changes in soil movement.

There were no significant decreases in crop yields across all treatment cells during this experiment. However, yields did decrease during that same time period overall. These decreases were the likely result of climatic conditions (drought) outside the control of this study, and generally reflect trends throughout Tennessee in the corresponding years, especially in Madison County (TDA 1999). Flash flooding after planting, as well as drought conditions during the latter part of the growing season resulted in these decreased crop yields. After planting in 1999, a sudden summer storm dropped 12.5 cm of rain in less than 3 hours. This caused a sudden inundation of some of the lower lying cells. The resulting damaged seedlings were not replaced due to the nature of the research being conducted. After the June downpour, weather conditions changed and the experimental cells received little rain for the remainder of the growing season. As a result yields actually matched countywide yields for 1999.

Controlled winter flooding, when used in conjunction with normal agricultural practices, should allow farmers to realize more long term cost benefits in their annual farming operations. Soil nutrient availability, such as P and K, can be easily maintained with periodic liming to moderate soil pH levels, which should not exceed normal farming practices or costs. While data, gathered during this study period does not indicate significant soil retention, it does reveal a lack of soil loss, and this in itself is significant with soil losses so high under normal operations. Under favorable climatic conditions and proper levee construction, crop yields should not be affected by controlled winter flooding. Within the scope of this study controlled winter flooding has shown some positive impacts to normal farming operations. Positive impacts such as, weed control with less dependence upon chemical herbicides, can result in a reduction of production costs to the landowner, however, future long-term studies on each of the individual treatments are needed to determine the full potential of these impacts.

CHAPTER 5

WILDLIFE RESPONSE TO WINTER FLOODING OF HARVESTED CROP FIELDS

5.1 Introduction

The Lower Mississippi Alluvial Valley (LMAV) and its related tributary streams and watersheds were once the primary wintering grounds for many of North America's waterfowl and wetland bird populations. Stretched all along these rivers were flooded hardwood forests and millions of acres of natural wetlands. These areas provided wintering habitat for 1.5 million mallards and hundreds of thousands of wood ducks, northern pintails, other species of both dabbling and diving ducks and geese (Reinecke et al. 1989). For many years the abundance and quality of this wintering habitat seemed unimportant and of little consequence to waterfowl populations. However, that thinking has changed.

With waterfowl populations in decline, the NAWMP set as one of its main objectives the restoration and creation of habitat for these migrating and wintering populations of waterfowl (Graziano and Cross 1993). Of prime importance was the inclusion of privately owned lands, currently in agricultural production, into the overall scheme of creating wintering habitat. Croplands used in summer months to provide cash crops of corn, milo, soybeans, rice, etc. for the landowners are used to provide feeding and wintering areas for waterfowl in the winter months (Reinecke et al. 1989). While soybeans do not provide as durable a food source in flooded conditions as rice or corn, soybean fields in western Tennessee still play a key role in providing this essential wintering habitat (Shearer et al.1969, Nelms and Twedt 1996, Manley 1999).

Managing seasonally flooded wetlands or controlled winter flooding on farmlands for moist soil habitats is fairly widespread across the United States. This practice usually involves the manipulation of seasonally flooded wetlands or created impoundments utilizing a levee system to control water levels. These habitats can provide nutritionally valuable seed and invertebrate food sources for wintering waterbirds. If managed primarily for moist soil plant production, mowing, disking, and tilling often produce the greatest seed dispersal and subsequent biomass. However, if invertebrate food sources are the desired target, then post harvest stubble and residue may prove the most effective method (Gray et al. 1999a). The resulting decaying biomass also settles and adds to the organic material in the upper soil layers.

In recent years wildlife managers within this region have sought to establish new temporary stopover and over-wintering habitats for the thousands of migrating waterfowl and shorebirds, which pass through the western Tennessee region. Continuing losses of over-wintering habitat as well as a better appreciation of waterfowl requirements throughout the annual cycle have led to a more balanced concern for conservation of breeding, migration, and over-wintering habitats (Reinecke et al. 1989). Waterbirds require high quality foraging habitat during migration and it is generally accepted scientifically that, winter habitat and winter foraging opportunities are linked directly to waterbird survival. Winter conditions play a pivotal role in subsequent breeding season success and recruitment (Reid et al. 1989, Reinecke et al. 1989, Manley 1999).

Within the region some cooperative agreements between wildlife managers and farmers have been developed to promote winter flooding of croplands to provide these much needed wetland habitats for wildlife (Twedt and Nelms 1999). This program utilizes a system of controlled-natural flooding. Flashboard riser water control structures (WCS), which allow water to be held on the fields throughout the winter and the water height to be controlled, are installed in already existing or specially prepared levees. Rice farmers in the program have reported significant savings in herbicide costs associated with weed control in winter flooded crop fields. As a side benefit, participating farmers have the opportunity to lease these flooded fields to waterfowl hunters and receive income during the fallow period.

In this chapter we will discuss if small pockets of winter habitat created in urban and rural areas can be attractive to waterfowl. Such small isolated pockets of habitat could provide waterfowl with mini-refuge areas during waterfowl hunting seasons, and supplement food and cover requirements for migrating birds of all sorts. This study evaluated one such area and the observed bird usage in 3 consecutive seasons (1996-97, 1997-98, 1998-99).

5.2 Methods

Mr. Ed Harsson, Tennessee Wildlife Resources Agency (TWRA) was the primary monitor of bird use at the study site. Bird counts were conducted every 1-3 days during the flooding season, beginning in early December and concluding in early April of the following year. Counts were conducted from December 1996 until April 1999. Most counts were conducted in the morning hours, and ranged from 20 to 40 minutes each.

All birds within the confines of each cell's levees were counted. Each individual cell was visually scanned for bird activity from the levees. Individuals were identified to species after observation with binoculars or a 25x spotting scope. Bird species outside of the cell perimeters, but within the field area were counted, but not used in the final analysis. Along with the individual bird data, weather data were recorded each day, including wind speed, air temperature, rainfall occurring within the previous 24 hours, and cloud cover. Percent flooding of each cell was also recorded.

5.3 Results

Fifty-seven species of birds, including 15,463 individuals, were observed at the site during the study period (Appendix III). The total species observed can be broken into 5 individual groups –

19 waterfowl species, 12 wading or shorebirds species, 2 gull species, 1 rail species, and 21 upland /passerine species (Table 5-1, 5-2, and 5-3).

All Birds – Bird use did not differ among treatments in 1996-97 and 1998-99, although bird use did differ among treatments in 1997-98. The increased use in 1997-98 resulted from greater use of the 120-day flood cells in 1997-98 by waterfowl. Average bird use increased in every cell from 1996-97 through 1998-99, except in 1997-98 when control cell usage dropped 20%. Avian use of short-duration flood cells increased by 38% in 1997-98 and 237% in 1998-99 over 1996-97 levels. Avian use of long-duration cells increased by 144% in 1997-98 and 300% in 1998-99 over 1996-97 levels. Average use in control cell decreased in 1997-98, but increased by 360% in 1998-99 (Table 5-4).

Table 5-1. Total number of bird count days including all cells at the West Tennessee Experiment Station, Jackson, Tennessee 1996-97, 1997-98, and 1998-99.

Flood Season	Number of Observations
1996-97	67
1997-98	76
1998-99	82

Table 5-2. Total of birds counted in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee 1996-97, 1997-98, and 1998-99.

Treatment	1996-97 Flood Season	1997-98 Flood Season	1998-99 Flood Season	Total
Control	751	632	3,638	**5,021**
1	733	967	2,460	**4,160**
2	854	2,005	3,423	**6,282**
Total	**2,338**	**3,604**	**9,521**	**15,463**

Table 5-3. Total birds within groups in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee 1996-97, 1997-98, and 1998-99.

Bird Groups	1996-97	1997-98	1998-99	Total
Waterfowl	1050	1380	2898	**5328**
Wading Bird	655	1255	1028	**2938**
Gulls/Terns	8	48	48	**104**
Upland and Passerine	625	921	5547	**7093**
Total	**2338**	**3604**	**9521**	**15463**

Table 5-4 Use of study site by all bird types (waterfowl, wetland species, gulls/terns and upland/passerines) fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee, 1996-97, 1997-98, and 1998-99.

Sample Year	TRT	N	Mean Birds/Day	SE	df	F	Sig. (p)
1996-97	**Control**	67	11.21	4.61	2	0.042	0.959
	1	67	10.94	3.36			
	2	67	12.75	5.98			
1997-98	**Control**	76	8.32	3.33	2	2.132	0.121
	1	76	12.72	4.53			
	2	76	26.38	9.66			
1998-99	**Control**	82	44.37	15.04	2	0.352	0.704
	1	82	30.00	9.44			
	2	82	41.74	13.57			

Waterfowl – Waterfowl use differed in long-duration flood cells in 1997-98 (P = 0.012). The remaining 2 years of the study there was no significant preference shown by waterfowl for any particular treatment regime. Waterfowl use of short-duration flood cells increased by 14% in 1997-98 and by 114% in 1998-99. Use of long-duration cells increased by 92% in 1997-98 and by 177% in 1998-99. Control cell use showed the only decrease in use in 1997-98 when it declined by 58%, however, in 1998-99 use was up by 200% (Table 5-5).

Wading and Shorebird Species - Wetland bird species use did not differ among treatments. Short-duration flood cells increased in use by 27% in both 1997-98 and 1998-99. Long-duration flood cell use decreased slightly in 1998-99 approaching 1996-97 counts, after increasing by nearly 360% in 1997-98. Use of control cells increased 10% in 1997-98 and increased 250% in 1998-99 (Table 5-6).

Table 5-5. Use of study site by waterfowl across all treatments in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee, 1996-97, 1997-98, and 1998-99.

Sample Year	TRT	N	Mean Birds/Day	SE	df	F	Sig. (p)
1996-97	Control	67	9.09	5.74	2	0.432	0.650
	1	67	3.21	1.81			
	2	67	7.90	5.55			
1997-98	Control	76	1.46	0.68	2	3.43	0.034*
	1	76	3.49	1.84			
	2	76	13.21	5.53			
1998-99	Control	82	11.62	7.27	2	0.461	0.631
	1	82	8.30	4.86			
	2	82	17.70	8.03			

Table 5-6. Use of study site by wading and shorebird species across all treatments in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee, 1996-97, 1997-98, and 1998-99.

Sample Year	TRT	N	Mean Birds/Day	SE	df	F	Sig. (p)
1996-97	Control	67	2.30	2.19	2	0.165	0.848
	1	67	4.13	2.33			
	2	67	3.27	2.26			
1997-98	Control	76	2.25	1.95	2	0.597	0.551
	1	76	4.21	3.62			
	2	76	10.05	8.11			
1998-99	Control	82	6.29	4.10	2	0.446	0.640
	1	82	3.84	2.74			
	2	82	2.34	1.54			

Upland and Passerine Species –Upland/passerine use did not differ among treatments. Upland and passerine species use increased, however, across all treatments over the course of this study. Short-duration flood cell use increased 36% in 1997-98 and 55% in 1998-99. Use in long-duration flood cells increased 100% in 1997-98 and 1225% in 1998-99. Control cell use increased 2.5% in 1997-98 and 638% in 1998-99 (Table 5-7).

Gulls/ terns – Observations did not differ among treatments. The number of these birds was very low when compared to other species groups, however, with the first year observations recording no use of short-duration flood and long-duration flood cells, any use in later years was noted. Two species of gulls were observed at the study site. These two species were, Herring Gull (*Larus argentatus* – HEGU) and Ring-billed Gull (*Larus delawarensis* – RBGU). Since these counts were made their totals are presented. (Table 5-8).

5.4 Discussion

Controlled winter flooding of agricultural fields produces usable winter habitat for wild birds. Even given the setting of the study site, adjacent to the city of Jackson, avian use increased each year of the study. Availability and access to such areas, even small avian refuges such as we created at WTES, can become an important and desirable component of waterfowl management for local managers (Shearer 1969, Schultz 1990, Cox and Afton 1998). These mini-refuges can serve not only waterfowl, but also to other migrating and wintering bird species (Brown and Smith 1998).

Table 5-7. Use of study site by upland/passerine species across all treatments in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee, 1996-97, 1997-98, and 1998-99.

Sample Year	TRT	N	Mean Birds/Day	SE	df	F	Sig. (p)
1996-97	Control	67	4.04	2.35	2	0.443	0.643
	1	67	3.58	1.94			
	2	67	1.70	1.08			
1997-98	Control	76	4.18	2.62	2	0.142	0.867
	1	76	4.72	2.33			
	2	76	3.09	1.50			
1998-99	Control	82	25.98	12.76	2	0.100	0.904
	1	82	20.02	8.91			
	2	82	19.79	11.16			

Table 5-8. Use of study site by gull/tern species across all treatments in fields 13 and 14 at the West Tennessee Experiment Station, Jackson, Tennessee, 1996-97, 1997-98, and 1998-99.

TRT	Gull/Tern Species	Sampling Year – 1996-97	Sampling Year – 1997-98	Sampling Year – 1998-99	Total In TRT
Control	HEGU	8	5	5	18
	RBGU	0	0	0	0
1	HEGU	0	24	16	40
	RBGU	0	17	0	17
2	HEGU	0	2	27	29
	RBGU	0	0	0	0
Total		8	48	48	104

Waterfowl need stopover and winter feeding areas. These areas need to provide safe resting areas and nutritional food sources (Anderson et al. 2000). As migrating flocks become more acclimated to such available areas, use increases (Reid et al. 1989). When private lands are managed for wetlands both the birds and the landowner benefit Birds use these areas to rest, feed, and rejuvenate on long migratory trips. Landowners get the aesthetic benefit of observing flocks of waterfowl and the potential benefit of additional revenues from usable lands through leasing. When properly managed, duck hunting leases bringing an average of $330/acre per year to the landowner (Jakus et al. 1998 and UTAES 1999).

The importance of winter habitat to waterfowl populations can not be overlooked. Certain species spend as much as 8 months each year on their winter feeding grounds with most others spending in excess of 7 months. Most return each year to areas visited in previous years if habitat and food remain suitably available. All major duck concentrations have one thing in common: food. Since the 1930's it has been common waterfowl management practice to supplement winter food sources with cultivated grain and soybean crops.

Waterfowl densities can vary depending on food-type availability. Mallard densities tend to be greater on moist-soil managed fields than in either soybean or rice fields. Northern shovelers varied greatly, often showing preference for soybean fields over all others, and never tending to favor rice fields. Most other species tended to favor moist-soil fields over soybeans or rice respectively (Twedt and Nelms 1999). Changes in moist-soil, soybean, corn, rice or other cultivated crop food sources might depend greatly on deterioration rates of seeds and thus their availability as the winter season progresses.

Moist-soil weed seeds tend to deteriorate slower than corn or soybeans. Rice was the only cultivated crop to last longer than most moist-soil plants (Nelms and Twedt 1996). Shorebirds on the other hand tended to prefer soybeans to both rice and moist-soil field thus making shallow-water flooding of soybean fields a vital tool in wildlife managers' management strategies (Twedt and Nelms 1998). The best overall strategy for waterfowl and shorebird management is to plant and use a wide variety of agricultural and natural foods to supply migrating birds with the best possible balanced diet (Petri et al. 1998). From the wildlife manager's perspective this may prove to make moist-soil field management much more cost effective than cultivated crops in waterfowl management programs. However, this does not lessen the importance of cultivated seed residue available to wintering waterfowl and shorebirds on flooded crop fields.

Overall bird use increased over the length of the study. Within 3 years after controlled winter flooding began this area drew large flocks of mixed migratory birds, including regular use by raptors, songbirds, and upland game birds such as snipe and woodcock. Bryan and Best (1991) noted an increase in bird abundance along grassed waterway when compared to normal crop fields. The study site's drainage ditch and its levee system provide additional habitat, for both food and cover for these varied non-game bird species. These levee systems could be planted in shrubs and low trees to hold them against flooding and to further enhance wildlife habitat (Whitaker and Montevecchi 1999).

There was no attempt in this study to manage for waterbirds. However, steps could be taken to manage food and water levels to maximize bird use. For example, state or federally owned wildlife or waterfowl refuges can be managed and manipulated according to the exact needs and requirements of waterfowl and other birds utilizing the areas. Crops can be planted to both attract target species and provide them with the nutritional foods needed to recover from lengthy fall migrations, survive winter, and be in good physical health for the spring migrations. Water levels can be altered to produce the best moist soil species of plants and highest densities of invertebrate species for wading, dabbling, or diving feeders. Tree species can be planted which produce nuts or seeds representing original flooded hardwood bottoms were these species once over-wintered (Burgess 1969, Reid et al. 1989, Reinecke et al. 1989, Gray et al. 1999a, and Stanturf et al. 2000). These naturally provided foods are often better suited for native bird species than "crop" species often planted to supplement this loss of natural foods.

However, successful farming operations are not likely to completely turn over their production crop fields to moist soil weed production or reforest them for bottomland hardwoods. In these cases, agricultural crops can be sowed to supplement natural food sources. Corn, oats, soybeans, wheat, millets, sorghums, and other agricultural crops have also been used (Shearer et al. 1969, Nelms and Twedt 1996, and Manley 1999). Among the domestic seed producers, rice tends to hold up best in flooded areas managed for waterfowl. Agricultural producers involved in no-till conservation planting can leave stubble on soon to be flooded fields producing a deteriorating base of organic matter for their soil while also producing an invertebrate food base for feeding birds. Levee tops and water-edge areas can be left with standing stubble to provide "weedy" habitat for cover and foraging of upland birds and passerines. Some moist soil management can take place during this process by manipulating water levels through the use of WCS placed within the levee system. These water level and moist soil management processes will be subject to the landowner or producer's available time and willingness to provide this habitat to the migrating flocks (Short 1999, Jackson 2000).

Controlled winter flooding when used in conjunction with normal farming practices can provide useful and significant winter habitat not only for waterfowl, but also a great variety of other bird species. Even given the relatively small size of the experimental cells used in this study (1.6 hectare) and its proximity to Jackson, Tennessee, the birds did use this small refuge. Species diversity and use increased each year of the study. While natural wetlands should be protected and restored, these methods provide a viable means for getting some wildlife value out of production croplands from agricultural practices altogether. Overall value of these areas will vary depending on availability of natural habitat in any given area, but can provide much needed benefits in areas where most natural wetlands have been removed.

CHAPTER 6

TELEPHONE SURVEY OF TENNESSEE PARTNERS PARTICIPANTS

6.1 Tennessee Partners Project Description

Private agricultural producers control 45% of the nation's land area in the United States. This is approximately 409 million ha of land (Conover 1998). Within this 409 billion ha of land are privately owned wetlands that provide habitat for much of the country's waterfowl and other wetland bird species. The protection of these wetland areas for wildlife use has often taken "backseat" to agricultural and urban development. It is estimated that 56 million ha of these wetlands have already been lost to development, including 80% of the bottomland hardwood forest once found in the MAV (Zekor and Kaminski 1987). Because these wetland areas are rapidly diminishing, the remaining areas are becoming increasingly important wintering habitat for many North American waterfowl.

The Tennessee Partners Project (TPP) was created in Tennessee in 1990 to begin utilizing some of these private lands in cooperative wetlands management efforts for private landowners and wildlife managers. Currently there were 149 participating private landowners with 2,685.6 ha enrolled in the program in 1999-2000. The TPP gives farmers and landowner limited financial and technical assistance to seasonally flood their agricultural production fields. This type of controlled flooding allows the farmer to control the length of time floodwaters are held on their fields. It allows farmers to continue growing the crops that best suit their own agricultural needs while at the same time providing much needed winter habitat for migrating waterfowl and other wetland wildlife.

Americans place a high value on their native wildlife. Voters in Colorado chose to use all state lottery proceeds for improvements in parks, open space, and wildlife (Bright et al. 2000). A reportedly high percentage of people in the U.S. generally believe that wildlife add value to their lives and property, and that wildlife conservation issues are important (Mankin et al. 1999). Mississippi Delta farmers, where much winter waterfowl habitat exists, believe that waterfowl are important and beneficial to their property (Zekor and Kaminski 1987). However, there is an understandable resistance to the large-scale restoration of these highly productive agricultural lands back into productive wildlife habitat. That resistance to total restoration makes controlled winter flooding projects, such as the Tennessee Partner's Project (TPP) even more desirable.

To gain insight into how controlled winter flooding is perceived by working farmers and other landowners in western Tennessee, we interviewed participants in TPP through a telephone survey. Survey participants were randomly selected from lists supplied by DU and NRCS. All participants were interviewed anonymously by survey personnel to provide the maximum privacy to the landowners.

6.2 Methods

A telephone list of TPP landowners was obtained through Ducks Unlimited and U.S. Department of Agriculture Natural Resources Conservation Services (NRCS). Potential survey participants were selected randomly from that list. Out of a possible 90 potential phone numbers, approximately 60 proved to be viable numbers. Of the 60 landowners contacted, 35 chose to participate in the survey. A total of 26 questions (Appendix IV) could potentially be asked each participant, depending on current participation. The primary goal of the phone survey was to gain insight into landowner perceptions of effects of controlled winter flooding on standard farming practices and TPP.

Interviewers were instructed in proper telephone survey techniques (Dillman 1978). Each caller used a standard introductory form. Participants with work numbers provided were called during normal business hours, and respondents who provided only "home" numbers were called between 7:00 and 9:00 p.m. CST.

Questions were designed to gain general attitudes and perceptions of participating landowners rather than to document absolute facts. Landowners were asked for approximate dates of flooding and draining fields, length of time in program, and observed effects on day to day farming operations (Table 6-1).

6.3 Results

Participants in this survey averaged holding water on their land for 129 days. The first two questions each interviewer asked each respondent concerned their current participation of the Tennessee Partners Project. If the respondents indicated they were

Table 6-1 Results of key questions taken from telephone survey. When asked: On the fields you manage with controlled winter flooding:

Question	Increased	Decreased	Made no Difference
Has the need for herbicide application?	**0**	**90%**	**10%**
Has the need for fertilizer application?	**0**	**90%**	**10%**
What do you think the overall effect was to erosion on your fields?	**0**	**90%**	**10%**

no longer involved in the program they were asked the reason why they no longer participated and thanked, with no further questions being asked (Appendix IV).

The vast majority of respondents (81%) did not lease their flooded lands for hunting. Of the 19% that did lease the land, no one was willing to say how much money was received per acre for the hunting rights.

Most farmers (97%) grew soybeans and corn on the acreage's they flooded with one respondent planting lima beans. Ninety one percent of respondents answered that herbicide and fertilizer costs were reduced and soil erosion decreased noticeably, while 9% answered that there had been no difference. The majority of respondents (90%) said they experienced no delays in their normal farming/planting practices. Most farmers (86%) responded they did need water control structures (WCS – including levees, dikes, and flashboard risers) for normal farming operations.

The remaining questions dealt with the aesthetic and recreational reasons for participation in the program and the usefulness of the program itself. Participants responded to the statement, "I hold winter water on my harvested crop fields because I…" in the following manner:

- 100% like having ducks and other waterfowl on their property.
- 48% believe there is a need for more wetlands.
- 52% responded that creating new wetlands made no difference to them.
- 91% responded they wanted a place to hunt.
- 86% believes winter flooding management practices benefit farming operations.
- 24% think winter flooding management practices promotes farmers as good stewards of the land, but 76% responded makes no difference.
- 24% want to provide habitat for wading birds and shorebirds, 5% responded no, and 71% responded makes no difference.
- 19% desired to generate additional income by leasing their winter-flooded fields, 71% responded no, and 10% responded makes no difference.

The final two questions on the survey dealt with participation in the program itself. Landowners were asked to rate the importance of financial and technical assistance to their continued participation in the TPP.

- 57% believed cost share assistance (water-control structures, levee construction/maintenance) was very important while 33% responded it was somewhat important, and 10% responded it made no difference.
- 43% believed technical assistance (management tips, water depth, etc...) was very important in their participation in the winter flooding management program, while 38% responded it was somewhat important, and 19% responded it made no difference.

6.4 Discussion

The purpose of the phone survey was to gain some general insight into the TPP from the landowning participant. We wished to get a notion of their perceived costs and benefits as well as their general opinion of the program. All landowners currently enrolled and participating liked and praised the effort.

Most landowners interviewed (46%) had been involved with the TPP 3-4 years. The majority of landowners also held water on their crop fields for approximately 120 days. Their recollection of when they began flooding and subsequently drained their fields in spring varied somewhat but most began in mid to late November and drained in mid to late March, very similar to our experimental design.

When asked how the winter flooding affected weed growth and the subsequent need for herbicide applications at planting, the general comments were that there was less unwanted vegetation and weed growth and the subsequent need for herbicide applications were significantly less then in prior years. As far as changes in fertilizer needs, most farmers noticed significant decreases. In one case the cost was cut in half. All respondents felt that erosion on their crop fields had noticeably decreased and 90% of the respondents reported no significant delays in planting or other field preparation. All these results, or opinions, illustrate the perceived benefits to participating farmers.

All of the landowners replied that they held water to benefit waterfowl, and 90% replied that they hunted their own flooded land. However, only 19% leased their land out to other duck hunters. There was a general reluctance among respondents to discuss any leasing, and no respondent was willing to disclose how much additional income they received for their leased lands. While a potential source of supplemental income for landowners, leasing appears to be an option few are exploring, or at least are reluctant to discuss.

The fact that 86% of farmers questioned needed WCS to farm their land reflects the use of bottomland fields that were historically most likely bottomland hard wood areas now cleared for agricultural use. This also reflects the landowners desire to create personal hunting areas and the need by some to replace lost wintering habitat with seasonally available areas for migrating waterfowl, shorebirds, and other bird species.

The perceived need for more wetland areas for waterfowl was evenly split between those who felt there was a need (48%) and those who felt that it was not important or had no opinion (52%). In turn, only 24% of respondents felt controlled winter flooding actually improved habitat, with 76% either saying it did not (2%) or that they did not know if it helped (74%). This could be an indication that more educational efforts should be made to demonstrate not only the need for wintering habitat, but also the role programs such as TPP play in overall waterfowl ecology and management.

Conversely, while 82% of respondents felt this program actually benefited farmers and farming operations, few (23%) actually felt it encouraged good farming stewardship practices. This may reflect the general feeling that farmers do what is best for crop production, but are somewhat less concerned about the resulting wildlife benefits, even if they hunt waterfowl themselves.

Overall, the TPP seems to be a successful and popular program. All of the respondents felt very positive about the purpose and results of the controlled winter flooding. They all encouraged other landowners to participate and openly invited interested parties to schedule a visit to their site to see the program in use. Technical assistance was highly regarded and appreciated, with several landowners believing professional assistance saved them from making many costly errors. Some felt the financial requirements were a bit too strict, and may have excluded some landowners from participating in the program, and some admitted that if not for the cost-share incentives they would not have been able to participate. Cost share assistance was felt to be a key element to encouraging other landowners to participate.

With sufficient monetary assistance and a readily available supply of practical technical advice available, projects such as TPP could significantly increase and improve stop over and wintering habitat for migratory waterbirds. This program's ultimate success will rely on the landowner willingness to participate and understand its importance within the context of the NAWMP. State and federal conservation agencies and private conservation organizations will play a key role in educating and promoting such programs on both the state and national level. Such efforts should culminate in increased waterbird habitat and significantly impact waterbird management in a most positive direction.

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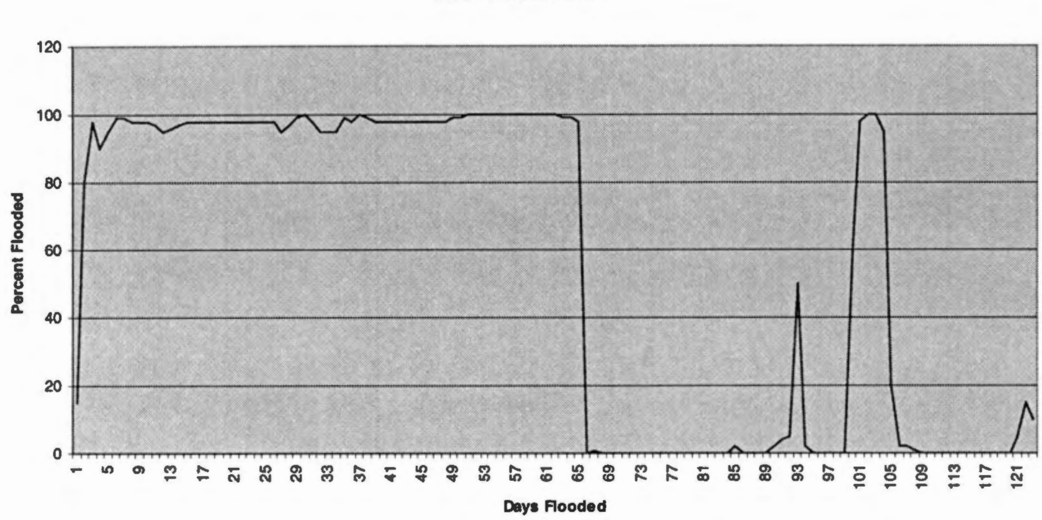
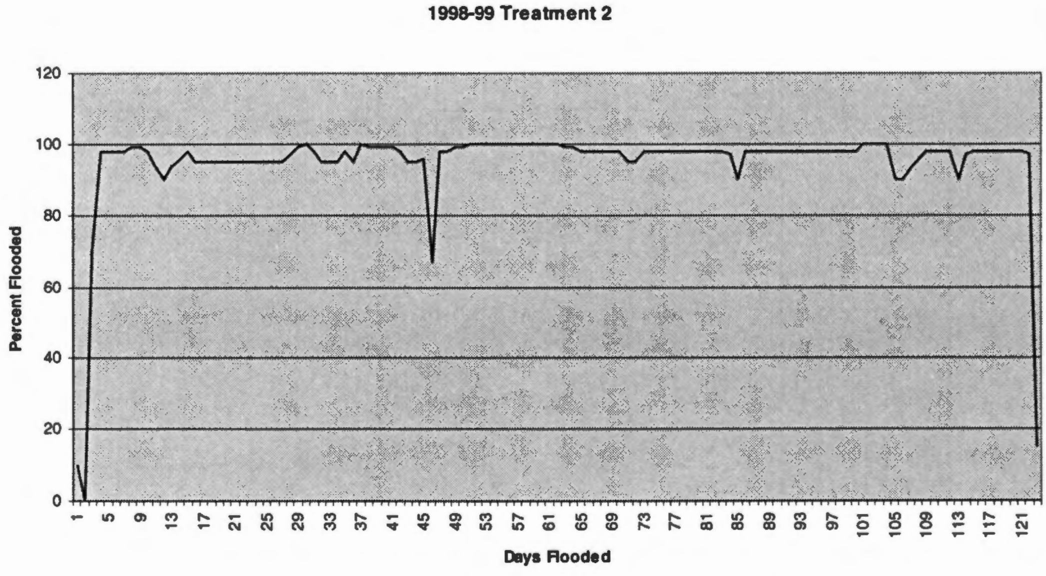
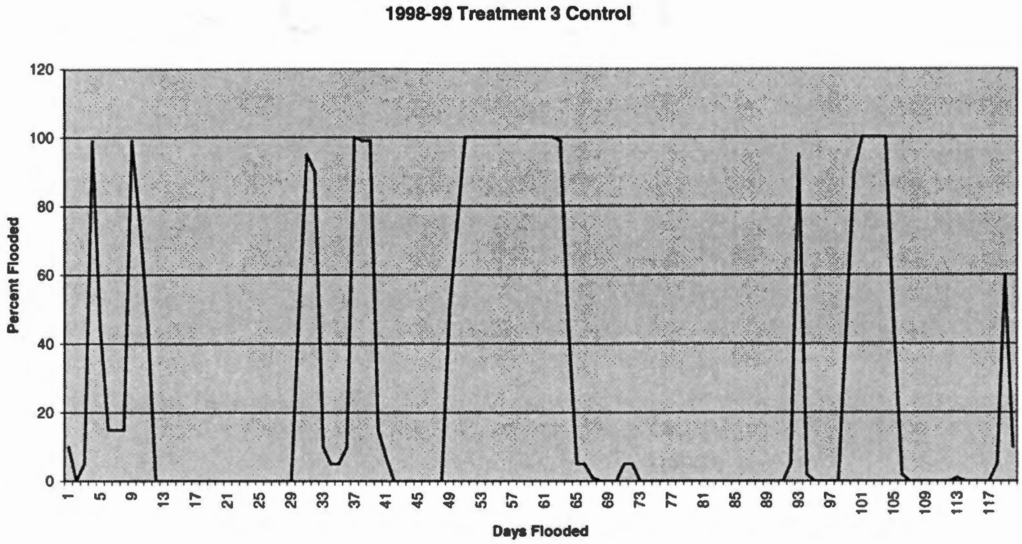
Appendices

Appendix I

**Example of flooding regimes on each treatment type during the Winter Flooding study, West Tennessee Experiment Station, Jackson, Tennessee.
1998-1999**


1998-99 Treatment 1
Percent Flooded
120
100
80
60
40
20
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
121
Days Flooded


1998-99 Treatment 2
Percent Flooded
120
100
80
60
40
20
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117
121
Days Flooded



1998-99 Treatment 3 Control
Percent Flooded
Days Flooded
120
100
80
60
40
20
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117

Appendix II

**Weed species (common and scientific names) most commonly collected during the Winter Flooding study, West Tennessee Experiment Station, Jackson, Tennessee.
1998-1999**

Appendix II List of Weed species (common and scientific names) most commonly collected during the Winter Flooding study, West Tennessee Experiment Station, Jackson, Tennessee, 1998-1999.

Weed Species – Common Name	**Weed Species – Scientific Name**
Alligator weed	*Alternanthera philoxeroides*
Arrowleaf sida	*Sida rhombifolia*
Bermuda grass	*Cynodon dactylon*
Buttercup	*Ranunculus spp.*
Carpetweed	*Mollugo spp.*
Chickweed	*Stellaria media*
Crab grass	*Digitaria spp.*
Curly dock	*Rumex crispus*
Goose grass	*Eleusine indica*
Johnson grass	*Sorgum halepense*
Jungle Rice	*Echinochloa colonum*
Milkweed	*Asclepias syriaca*
Morning glory	*Convolvulus spp.*
Mustard	*Brassica spp.*
Nettle	*Galeopsis spp.*
Nightshade	Solanaceae Family
Panicum	*Echinochloa spp.*
Pigweed	*Chenopodium paganum*
Plantain	*Plantago spp.*
Purslane	*Portulaca spp.*
Red stem	*Ammania exaltata*
Sicklepod	*Cassia occindentalis*
Spurge	*Euphorbia spp.*
Teaweed, Prickly sida	*Sida spinosa*
Wild turnip	*Raphanus raphanistrum*
Vetch	*Vicia cracca*
Yellow foxtail	*Setaria glauca*
Yellow nutsedge	*Cyperus esculentus*

Appendix III

Bird species (common and scientific names) encountered during the study, West Tennessee Experiment Station, Jackson, Tennessee.

1997-1999

Appendix III List of Bird Species Observed at West Tennessee Experiment Station, Jackson, Tennessee - Winter 1996-97, 1997-98, and 1998-99.

Common Name	Scientific Name
Waterfowl	
American Black Duck	*Anas rubripes*
American Coot	*Fulicia americana*
American Wigeon	*Anas americana*
Blue-winged Teal	*Anas discors*
Bufflehead	*Bucephala islandica*
Canada Goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Common Goldeneye	*Bucephala clangula*
Gadwall	*Anas strepera*
Green-winged Teal	*Anas crecca*
Hooded Merganser	*Lophedytes cucullatus*
Lesser Scaup	*Aythya affinis*
Mallard	*Anas platyrhyncos*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Pied-bill Grebe	*Podilymbus podiceps*
Ring-necked Duck	*Aythya collaris*
Ruddy Duck	*Oxyura jamaicensus*
Wood Duck	
Shorebirds and Wading Birds	
American Woodcock	*Philohela minor*
Common Snipe	*Capella gallinago*
Common Tern	*Sterna hirundo*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Greater Yellowlegs	*Tringa melanoleuca*
Killdeer	*Charadrius vociferus*
Lesser Yellowlegs	*Tringa flavipes*
Pectoral Sandpiper	*Calidris melanotos*
Semipalmated Plover	*Charadrius semipalmatus*
Stilt Sandpiper	*Micropalama himantopus*
Willet	*Catoptraphorus semipalmatus*

Common Name	Scientific Name
Gulls and Terns	
Herring Gull	*Larus argentatus*
Ring-billed Gull	*Larus delawarensis*
Rails	
Virginia Rail	*Rallus limicola*
Upland and Passerine	
American Crow	
American Robin	*Turdus migratorius*
Black-throated Green Warbler	*Dendroica virens*
Brown-headed Cowbird	*Molothrus ater*
Chipping Sparrow	*Spizella passerina*
Common Grackle	*Quiscalus quiscula*
Eastern Bluebird	*Sialia Sialis*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
House Finch	*Corpodacus mexicanus*
House Sparrow	*Passer domesticus*
Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Red-Tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Savannah Sparrow	*Passerculus sandwichensis*
Slate-colored Junco	*Junco hyemalis*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Water Pipit	*Anthus spinoletta*
Yellow-throated Warbler	*Dendroica dominica*

Appendix IV

Telephone survey of Tennessee Partners Participants

2000

Telephone Survey Introduction Page

Winter Flooding Phone Survey

Participant Name ________________ **ID Number** _________________

State ___________________ **Phone** ____________________

County _______________________

Hello, my name is_________________and I am calling for the University of Tennessee – Knoxville. We are contacting people throughout the state to ask questions about winter flooding.

For the purposes of this survey, I need to speak with the person in charge of general farm operations.

______Self ______Someone else

IF IT'S THE PERSON ON THE PHONE: CONTINUE.
WHEN CORRECT PERSON ANSWERS REPEAT FIRST PARAGRAPH AND CONTINUE BELOW. IF PERSON IS NOT THERE AT THE TIME, FIND OUT WHEN TO CALL BACK.

Is this a good time to ask you some questions or would another time be better for you? When would be a good time? And what is your first name so I'll know whom to ask for?

Callback:_________________________ First Name:_____________________

PHONE NUMBER:_________________ Eastern/Central Rural/Metro

ID#		CODES		FOR CALLBACKS		
	Date	Time	Results	Date	Time	
_____	_____	_____	______	_____	_____	#1
_____	_____	_____	______	_____	_____	#2
_____	_____	_____	______	_____	_____	#3
_____	_____	_____	______	_____	_____	#4
_____	_____	_____	______	_____	_____	#5

Telephone Survey Form

THIS SURVEY IS STRICTLY CONFIDENTIAL. YOUR RESPONSES WILL NOT BE ASSOCIATED WITH YOUR NAME. YOU ALSO HAVE THE RIGHT TO REFUSE TO ANSWER ANY OF THE QUESTIONS.

1) Did you participate in the NRCS Managed Winter flooding project during the winter of 1999-2000?

a. Yes_____
b. No_____

2a) If yes - How many acres did you manage with winter flooding?
________ (Approximate is OK) Continue on to Question #3

2b) If no - Did you participate in previous years? Yes_____ No_____

What year did you stop? Year______

Why? (Brief explanation is sufficient)______________________________

Thank them for their cooperation.

3) How many years have you been managing winter flooding on your crop fields?
______________ (Approximate is OK)

4) About what date do you begin holding water on your harvested crop fields?
__________________ (Approximate date)

On about what date do you begin draining your flooded fields?
__________________ (Approximate date)

5) While you were holding water on your fields did you lease them for hunting?
Yes ________ No________

If No - skip to #6

If Yes – Do you lease all of your flooded acreage? _______yes ______no

Approximately how much do you receive in hunting lease fees per year?_________________________

(This is just to compute an average statewide figure)

Farming Practices

6) What crop do you normally produce in the fields you manage with winter flooding?

(Write whatever they say – including nothing if the fields are not used in crop production) ____

7) **On the fields you manage with winter flooding –**

7a) Has the need for herbicide application –
increased _______
decreased _______
remained the same _______

7b) Has the need for fertilizer application –
increased _______
decreased _______
remained the same _______

7c) Has erosion –
increased _______
decreased _______
remained the same _______

7d) Do you experience any unusual planting delays?
Yes _______ If Yes – Reason? ______________________________
No _______

How would you respond to the following statements?

I hold winter water on my harvested crop fields because I…

8) Like having ducks and other waterfowl on the property.
Yes _____
No _____
Makes no difference _____

9) Need water control structures for farming purposes.
Yes _____
No _____
Makes no difference _____

10) Think there need to be more wetlands.
Yes _____
No _____

Makes no difference _____

11) Want a place to hunt.
Yes _____
No _____
Makes no difference _____

12) Believe winter flooding management practices benefit farming operations.
Yes _____
No _____
Makes no difference _____

13) Think winter flooding management practices promotes farmers as good stewards.
Yes _____
No _____
Makes no difference _____

14) Want to provide habitat for wading birds and shorebirds.
Yes _____
No _____
Makes no difference _____

15) Desire to generate additional income by leasing my winter flooded fields.
Yes _____
No _____
Makes no difference _____

IF YOU CONTINUE WITH THIS PROGRAM, HOW WOULD YOU ANSWER THE FOLLOWING QUESTIONS?

16) How essential is cost-share assistance (water-control structures and levee construction/maintenance) to your participation in the winter flooding management program?

Very important _____
Somewhat important _____
No difference _____
Not very important _____
Not important _____

17) How important is technical assistance (management tips, water depths, etc…) to your participation in the winter flooding management program?

Very important _____
Somewhat important _____

No difference _____
Not very important _____
Not important _____

VITA

Born Timothy Donald Pruitt 28 March 1957, Tim is the oldest son of Don and Peggy Pruitt, of Jonesborough, Tennessee. Tim attended Elementary, Middle, and High School in the Washington County, Tennessee school system, and graduated from David Crockett High School in 1975. Beginning in 1975 and finishing in 1977, Tim was trained at Emory Riddle Aeronautical University and Piedmont Aerospace Institute as an aircraft technician. In December 1977, Tim married Brenda Sue Holloway. While working on his graduate studies, Tim and Brenda celebrated their 23rd wedding anniversary.

Tim worked in the Aviation Industry from 1979 until 1993. In the fall of 1993 Tim enrolled in Middle Tennessee State University's pre-forestry program, and in 1994 he transferred into the University of Tennessee's Forestry, Wildlife, and Fisheries program to complete his undergraduate degree.

After graduating in the spring of 1997 Tim began working as an intern for the Tennessee Valley Authority (TVA). Tim entered the graduate program at UT in the spring of 1998, while continuing to work as a contract Biologist for TVA. As a result, Tim was offered a permanent position with TVA in the spring of 2000, which he has accepted. Mixing a full family life, work, and the rigors of academia has often been a complicated, but very rewarding, experience, and one which Tim will cherish for the rest of his life.