Mississippi Water Resources Research Institute
Annual Technical Report
FY 2009

Introduction

The Mississippi Water Resources Research Institute (MWRRI) provides a statewide center of expertise in water and associated land use and serves as a repository of knowledge for use in education, research, planning, and community service.

The MWRRI goals are to serve public and private interests in the conservation, development, and use of water resources; to provide training opportunities in higher education whereby skilled professionals become available to serve government and private sectors alike; to assist planning and regulatory bodies at the local, state, regional, and federal levels; to communicate research findings to potential users in a form that encourages quick comprehension and direct application to water related problems; to assist state agencies in the development and maintenance of a state water management plan; and to facilitate and stimulate planning and management that: deals with water policy issues, supports state water agencies' missions with research on problems encountered and expected, and provides water planning and management organizations with tools to increase efficiency and effectiveness.

Research Program Introduction

The Mississippi Water Resources Research Institute (MWRRI) conducts an annual, statewide competitive grants program to solicit research proposals. Proposals are prioritized as they relate to the research priorities established by the MWRRI Advisory Board and by their ability to obtain Letters of Support or External Cost Share from non−federal sources in Mississippi. The MWRRI's External Advisory Board then evaluates all proposals. Based on the most current list of research priorities, these would include: water quality, surface and groundwater management, water quality management and water resources development, contaminant transport mechanisms, wetlands and ecosystems, groundwater contamination, as well as other issues addressing coastal and marine issues linking water associations through the state, and institutional needs that include capacity building and graduate student training.

Natural Enhanced Transport of Agricultural Pb and As Through Riparian Wetlands

Basic Information

Title:	Natural Enhanced Transport of Agricultural Pb and As Through Riparian Wetlands
Project Number:	2007MS61B
Start Date:	3/1/2008
End Date:	8/31/2009
Funding Source:	104B
Congressional District:	1st
Research Category:	Ground-water Flow and Transport
Focus Category:	Wetlands, Sediments, Non Point Pollution
Descriptors:	
Principal Investigators:	Gregg R. Davidson

Publications

1. Davidson, G.R., D.G. Wren, J.A. Ferguson, and A.C. Patton. 2009. "Variable history of containment and mobilization of trace element contaminants in riparian wetlands." Oral presentation and published abstract at the 2009 national annual meeting of the Geological Society of America in Portland, OR. http://gas.confex.com/gsa/2009AM/finalprogram/abstract_166741.htm.
2. Noakes, E., G.R. Davidson, D.G. Wren, and S.G. Utroska, 2009. "Transport of non-point source contaminants through riparian wetlands in the Mississippi Delta region" presented at the 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, p. 121. http://www.wrri.msstate.edu/conference/view_abstract.asp?id=951.
3. Davidson, G.R. Quarterly reports 2007-2009, Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
4. Davidson, G.R. 2009. "Natural enhanced transport of agricultural Pb and As through riparian wetlands." Final technical report submitted, Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS, 12 pgs.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly/Final Report – 7/1/09 – 9/30/09

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Natural enhanced transport of agricultural Pb and As through riparian wetlands

Principal Investigator: Gregg Davidson
Institution: University of Mississippi
Address: Geology & Geol. Eng., Carrier 118, University, MS 38677
Phone/Fax: 662-915-5824
E-Mail: davidson@olemiss.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal:__$ 0__, Non-Federal:__$ 0__, Cost Share: _____

Equipment (and cost) purchased during reporting period: none

Progress Report (Where are you at in your work plan):

Initial study has been completed. Additional work (using other funds) has already begun based on the findings of this study. A full report follows on page 3 of this document.

Problems Encountered:

no new problems

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

2008 Annual Meeting of the Geological Society of America, Houston, TX
2009 WRRI conference
2009 Annual Meeting of the Geological Society of America, Portland, OR

Titles and full abstracts are provided beginning on page 9 of this document.

Student Training (list all students working on or funded by this project)

Name	Level	Major
William Walker	MS student	Hydrology
Steven Utroska	BS student	Geological Engineering
Jacob Ferguson	BS student	Geological Engineering
Austin Patton	BS student	Geological Engineering

Next Quarter Plans:

finished

Section III. Signatures

Project Manager   Date

Sept 30, 2009

Final Report
September 30, 2009

Natural enhanced transport of agricultural Pb and As through riparian wetlands

Principal Investigator:	Gregg Davidson
Institution:	University of Mississippi
Address:	Geology & Geol. Eng., Carrier 118, University, MS 38677
Phone/Fax:	662-915-5824
E-Mail:	davidson@olemiss.edu

Students trained

One graduate student (William Walker) and three undergraduate students (Steven Utroska, Austin Patton, and Jacob Ferguson) received training in original research methods on this project. All students were co-authors on published abstracts at regional and national professional meetings. William Walker completed a M.S. degree working on this study and is now employed by the U.S. Army Corps of Engineers. Steven Utroska graduated in May 2009, and is now working on a Masters Degree at the University of North Florida.

Interagency cooperation

The work was done in collaboration with Dr. Daniel Wren at the USDA ARS National Sedimentation Laboratory in Oxford, MS. The project has led to additional collaborative efforts, and other students being trained in original research methods.

Information transfer

Results were presented at the national annual meeting of the Geological Society of America (GSA) in 2008 in Houston, TX, and at the 2008 annual Mississippi Water Resources conference. A presentation will also be made at the 2009 national GSA meeting in Portland, OR in October. The abstracts for each presentation are included at the end of this report.

After reviewing the data collected under this grant, Dr. Wren and I have decided that additional cores should be collected and analyzed (using other funds) before submitting the results for publication in a peer-reviewed journal. This is in process and is expected to continue into early 2010 before results are ready for manuscript preparation for publication in peer-reviewed journals. Preliminary results from this effort are included in this report.

Financial summary

A record of expenditures and cost sharing for this project is provided by the University of Mississippi Accounting Department in a separate document.

Research Summary

A complete suite of sediment cores have now been collected and analyzed from two Mississippi oxbow lakes. Cores from open water and from wetland environments in Sky Lake and Hampton Lake have been analyzed for elemental concentrations and dated using radioisotopes to establish deposition dates. Cores up to 3 m in length were collected from open water using a vibracoring rig mounted on a pontoon boat. Cores up to 2 m in length were collected from the wetland areas by driving an aluminum pipe into the ground and extracting with a jack. (Access in the wetlands by the pontoon boat is not possible.) Measurements made inside the core barrel before and after removal confirmed that no sediment was lost from the bottom of the pipe during extraction. Compaction caused by coring was determined by measuring the top of the sediment inside the pipe relative to the ground surface, and applying a linear correction term over the length of each core.

A core extrusion system was fabricated to allow precise extrusion and sectioning into 1-cm thick intervals. Samples were weighed wet, dried at 70°C, and reweighed to determine moisture content and bulk density.

A portion of every interval was crushed and split into sub-samples for elemental and radioisotope analyses. Initially, samples were processed and analyzed by ICP-MS at the USDA-ARS National Laboratory in Oxford, MS. After identifying problems with the results from some of these analyses, samples were reanalyzed using a commercial laboratory. For most cores, four to five centimeters of core were composited for each analysis.

Ten samples at distributed depths from each core were submitted to an external analytical lab for analysis of ^{210}Pb and ^{137}Cs. This enabled determination of sedimentation rates for each site sampled, and the date of deposition for each depth of interest.

The results from the two lakes indicate that the transport of trace elements through and between wetland and open water environments is complex, and likely varies with the specific hydrology and adjacent land use of each lake-wetland system. For most elements investigated, elevated concentrations observed in open-water sediments were not found in contemporaneous wetland sediments. In Sky Lake, a large Pb spike is present in two separate open-water cores that is absent in the wetland cores (Fig. 1). Elevated As and Co concentrations in the open-water cores are also absent in the wetland cores, suggesting that trace elements initially scavenged by the wetlands surrounding Sky Lake are later remobilized and eventually flushed into the open-water environment where permanent sequestration takes place.

Phosphorous behaves differently than trace metals because it is a growth-limiting nutrient, and plants are adapted to efficiently uptake P. Within the wetland, P concentrations in the sediments are low because released P gets quickly taken up into plant tissue (Fig. 2). The high concentrations of P found in open water sediments may result from outwashed organic material that is buried in the lake. As this material decays and releases P, there are no active plant roots to remove it and high concentrations remain preserved in the sediment record.

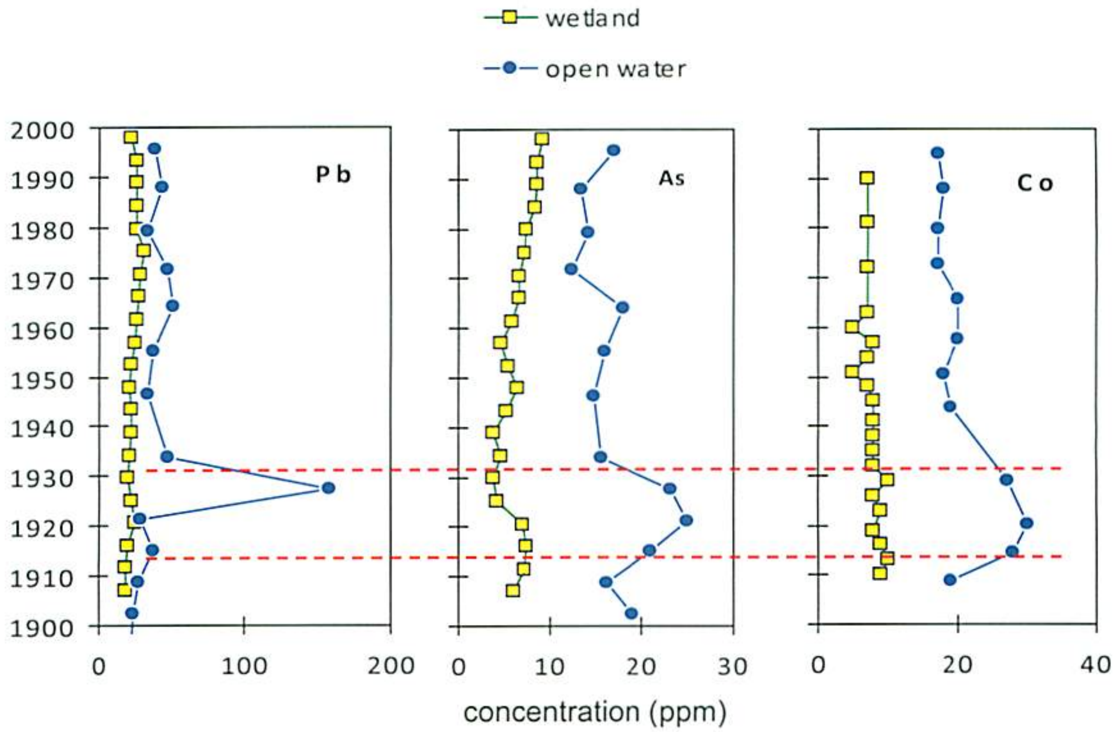


Figure 1 – Pb, As, and Co in wetland and sediment cores from Sky Lake.

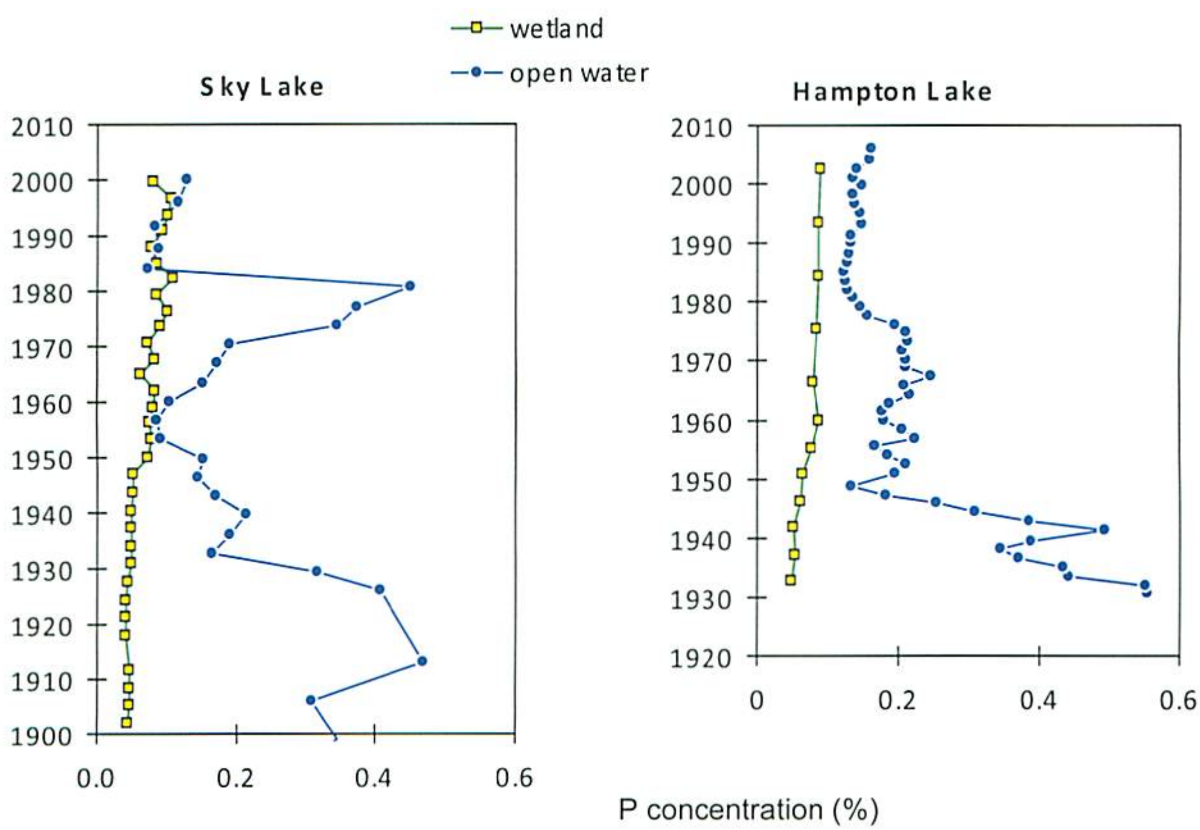


Figure 2 – Phosphorous concentrations in Sky Lake and Hampton Lake sediments.

In Hampton Lake, the rate of sediment accumulation has been approximately 4 cm/yr. The maximum depth of penetration by vibracoring was 3 m, yielding a core with sediments dating back to the 1930's. If a Pb spike exists in Hampton Lake from the same time period as found in Sky Lake, this core was not deep enough to observe it. Concentration spikes for other elements, including Co, Ni, and Cu, were found at a common depth in the open-water cores; no concentration spikes appear in the wetland cores (Fig. 3). Phosphorous concentrations are likewise high only in the open water sediments (Fig. 2). These results are consistent with what was observed in Sky Lake.

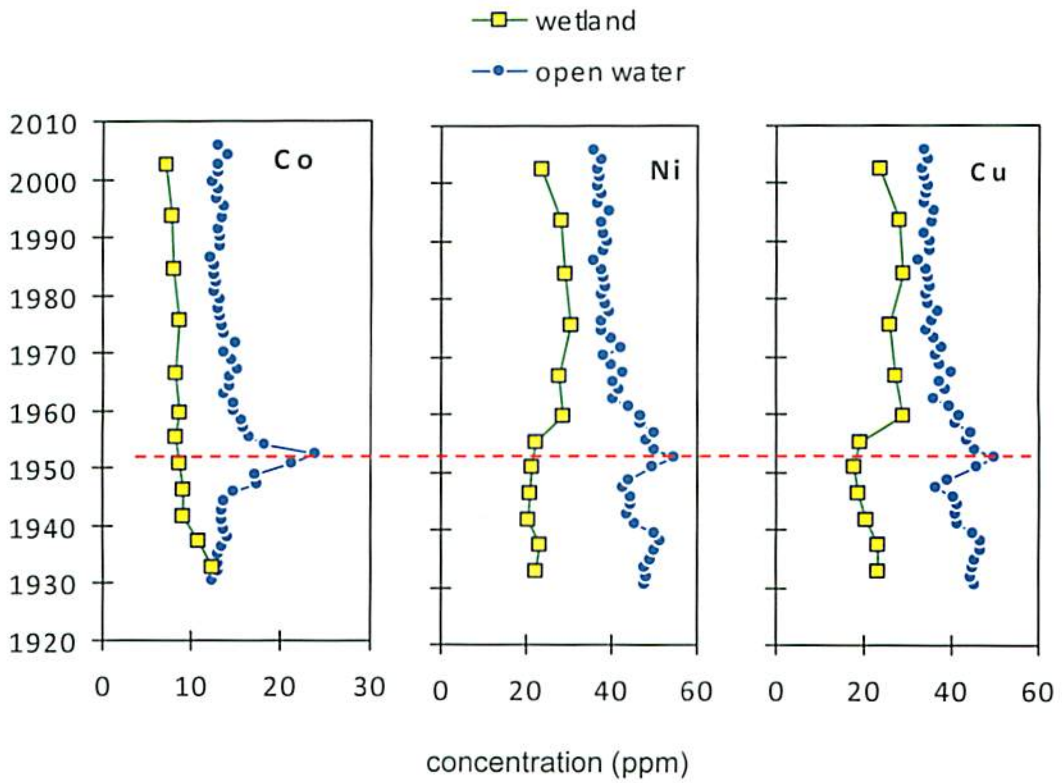


Figure 3 – Co, Ni, and Cu concentrations in wetland and open-water sediments from Hampton Lake.

Not all the Hampton Lake results are consistent with the Sky Lake results, however. The Pb and As concentrations measured in the wetland cores are equal to or higher than the concentrations in the open water cores (Fig. 4). A mechanism to explain these results is unclear. The variability observed in the Hampton Lake cores relative to Sky Lake has led us to decide to expand the study (using other funds) to include more lakes. Preliminary data has already been obtained from Lake Washington and Beasley Lake. Both open water and wetland cores have been collected and submitted for ^{210}Pb and elemental analyses, but so far only the open water results have been completed (Fig. 5). When the wetland results from these lakes become available, we will have a better idea if there is a "typical" behavior of trace metals in these lake-wetland systems.

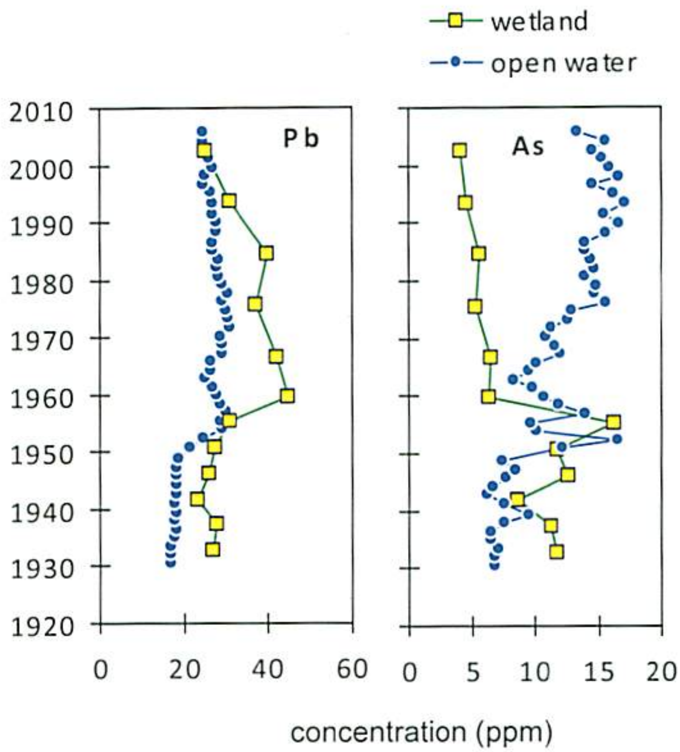


Figure 4 – Pb and As concentrations in wetland and open-water sediments from Hampton Lake.

Sequential Extractions were performed on Sky Lake and Hampton Lake sediments from the zones of high element concentrations, and from zones above and below to determine if elevated levels of trace metals could be linked to an anthropogenic source. If the source of high Co, for example, was an impurity in pesticides applied in the past, the excess Co should be simply adsorbed to solid surfaces and should come off with a high ionic strength solution. In contrast, if the high Co concentration is due to higher levels of this element in the mineral phase of the sediment, a high ionic strength solution should not wash out the excess Co mass. The results of this experiment proved to be of limited value because most element concentrations were below the detection limit of the ICP-MS.

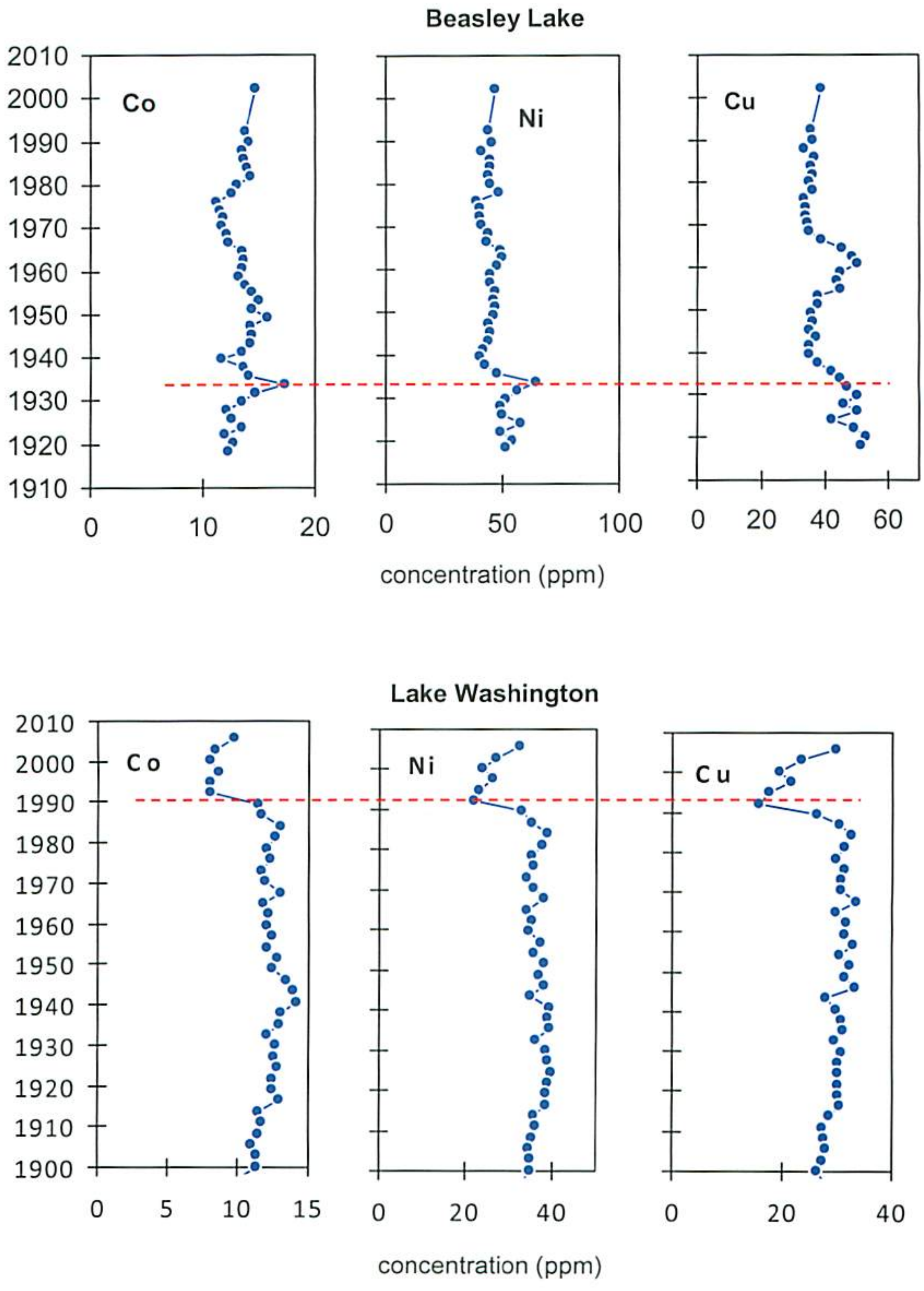


Figure 5 – Co, Ni, and Cu concentrations in open-water sediments from Beasley Lake and Lake Washington.

Oral presentation and published abstract at the 2008 national annual meeting of the Geological Society of America in Houston, Texas:

Are trace metal contaminants scavenged in riparian wetlands permanently sequestered?

Abstract

Riparian wetlands are perceived to be efficient scavengers of a wide variety of non-point source pollutants. This perception is based primarily on short-term studies, typically less than one year in duration, that have documented capture of contaminants entering a wetland. Little is known about the long-term fate of most sequestered contaminants. Preliminary results from a study of historic sediment deposits in lake-wetland systems in Mississippi suggest that sequestration of contaminants in riparian wetlands may not be permanent. At Sky Lake, an oxbow lake surrounded by agricultural lands and bordered by a cypress wetland, sediment cores were collected from the wetland and from a central open water area. Elevated Pb and As concentrations were found in sediments deposited approximately 80 years ago in only the open water environment. The most likely source of Pb and As is lead arsenate pesticide used in this area at the time these sediments were being deposited. Runoff from the surrounding fields passes through the wetland before reaching open water. Given the high affinity of Pb and As to solid surfaces, it is unlikely that either passed through the wetland without at least partial adsorption. Our hypothesis is that these contaminants were initially sequestered in the wetland when introduced in the late 1920's and 1930's, but subsequent seasonal flooding and aeration resulted in repeated remobilization and redistribution through the lake-wetland system. Permanent sequestration occurred only with burial in the perennially flooded open water environment. The work at Sky Lake is being expanded to other lake-wetland systems with similar geomorphology and anthropogenic history to determine if similar chemical distributions are preserved.

Gregg R. Davidson
Daniel G. Wren
Steven G. Utroska
William G. Walker

http://gsa.confex.com/gsa/2008AM/finalprogram/abstract_150824.htm

Davidson, G.R., D.G. Wren, S.G. Utroska and W.G. Walker (2008) "Are trace metal contaminants scavenged in riparian wetlands permanently sequestered?" Geological Society of America *Abstracts with Programs*, Vol. 40, No. 6, p. 414.

Oral presentation and abstract at the 2008 annual Mississippi Water Resources conference:

Contaminant transport through riparian wetlands

Abstract

Riparian wetlands are perceived to be efficient scavengers of a wide variety of non-point source pollutants. This perception is based primarily on short-term studies, typically less than one year in duration, that have documented capture of contaminants entering a wetland. Little is known about the long-term fate of most sequestered contaminants. Preliminary results from a study of sediments deposited over the last century in lake-wetland systems in the Delta region of Mississippi suggest that sequestration of contaminants in riparian wetlands may not be permanent. At Sky Lake, an oxbow lake surrounded by agricultural lands and bordered by a cypress wetland, sediment cores were collected from the wetland and from a central open water area. Elevated Pb and As concentrations were found in sediments deposited approximately 80 years ago in only the open water environment. The most likely source of Pb and As is lead arsenate pesticide used in this area at the time these sediments were being deposited. Runoff from the surrounding fields passes through the wetland before reaching open water. Given the high affinity of Pb and As to solid surfaces, it is unlikely that either passed through the wetland without at least partial adsorption. Our hypothesis is that these contaminants were initially sequestered in the wetland when introduced in the late 1920's and 1930's, but subsequent seasonal flooding and aeration resulted in repeated remobilization and redistribution through the lake-wetland system. Permanent sequestration occurred only with burial in the perennially flooded open water environment. The work at Sky Lake is being expanded to other lake-wetland systems with similar geomorphology and history. Sediment cores have been collected from Hampton Lake, another oxbow lake in the Delta, to determine if a similar record is preserved.

Gregg R. Davidson
Daniel G. Wren
Steven G. Utroska
William G. Walker

Oral presentation and published abstract at the 2009 national annual meeting of the Geological Society of America in Portland, Oregon:

Variable history of containment and mobilization of trace element contaminants in riparian wetlands

Riparian wetlands are perceived to be efficient scavengers of a wide variety of non-point source pollutants. This perception is based primarily on short-term studies that have documented reductions in contaminant concentrations as runoff water passes through a wetland, but little is known about the long-term fate of scavenged contaminants. Evidence of long term processes can potentially be found retained in accumulated sediments where wetlands discharge into the quiescent waters of a lake. With this in mind, sediment cores from five different oxbow lakes and associated riparian wetlands have been sampled for trace element analysis from northwest Mississippi. This area, locally known as the Delta region, sits on the ancestral floodplain of the Mississippi River and was cleared of forests for agricultural use starting in the late 19th century. Lakes and surrounding wetlands in the Delta have had a long history of variable land use and influxes of a wide variety of agrichemicals. Sediment accumulation rates, based on ^{210}Pb and ^{137}Cs analyses, range from 0.2 to as high as 4.2 cm/yr, with well defined changes in rate corresponding to changes in land use. Trace element results obtained thus far indicate that each lake has its own unique history, dependent on the timing of clearing of surrounding lands, variability in surface water flows, and the types of agrichemicals used on adjacent fields. Some lakes show clear spikes of elements such as Pb, As and Co in open water sediments, with a complete absence of elevated concentrations in adjacent contemporaneous wetland sediments. These results suggest that at least some elements initially scavenged by the wetland are later remobilized and eventually flushed from the wetland. Other lakes contain very different records, with elevated concentrations of elements such as Cr and Zn appearing in both wetland and open water sediments deposited some time after the land was cleared.

Gregg R. Davidson
Daniel G. Wren
Jacob A. Ferguson
Austin C. Patton

http://gsa.confex.com/gsa/2009AM/finalprogram/abstract_166741.htm

Oral presentation and abstract at the 2009 annual Mississippi Water Resources conference:

Transport of non-point source contaminants through riparian wetlands in the Mississippi Delta region

Abstract

A joint research group at the University of Mississippi and the USDA ARS National Sedimentation Laboratory has been investigating the fate and transport of non-point source contaminants entering riparian wetland systems from agricultural lands. Results to date suggest that short-term studies documenting sequestration of chemically persistent contaminants in riparian wetlands are not sufficient to document long-term containment of these substances. In previously reported work, elevated concentrations of Pb and As were found at particular depths in open-water sediments in Sky Lake, but not in contemporaneously deposited sediments in the surrounding wetlands. Depositional dates of the zones of elevated concentration, based on ^{210}Pb and ^{137}Cs measurements, were consistent with the timing of lead arsenate use in the vicinity. The absence of similar concentration spikes in the wetland sediments led to the working hypothesis that contaminants such as Pb and As may be initially scavenged from water flowing through a riparian wetland, but over time are flushed out into adjacent lakes or streams. Within the wetland, seasonal inundation and aeration results in decomposition of litter, remobilization of contaminants bound to organic matter, and redistribution by rising and falling water levels. Permanent sequestration occurs only with burial in the perennially flooded open water environment. The study has been expanded to additional lake-wetland systems in the Mississippi Delta region to determine if evidence of long-term flushing of contaminants from riparian wetlands is a common occurrence.

Elizabeth Noakes
Gregg R. Davidson
Daniel G. Wren
Steven G. Utroska

http://www.wrri.msstate.edu/conference/view_abstract.asp?id=951

Monitoring and Modeling Water Pollution in Mississippi Lakes

Basic Information

Title:	Monitoring and Modeling Water Pollution in Mississippi Lakes
Project Number:	2008MS81B
Start Date:	7/1/2008
End Date:	7/31/2009
Funding Source:	104B
Congressional District:	1
Research Category:	Water Quality
Focus Category:	Water Quality, Surface Water, Recreation
Descriptors:	None
Principal Investigators:	Cristiane Q. Surbeck

Publications

1. Quarterly status reports 2008-2009 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Kinnaman, A. and C.Q. Surbeck. 2009. "The use of microcosm studies to determine the effect of sediments and nutrients on bacteria in lake water." 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS in Proceedings, p. 140. http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf
3. Kinnaman, A. 2009. The use of microcosm studies to determine the effect of sediments and nutrients on bacteria in lake water," a thesis at the University of Mississippi, University, MS, July 2009, 113 pgs.
4. Surbeck, C.Q. 2009. Final technical report on "Monitoring and Modeling Water Pollution in Mississippi Lakes: The Use of Microcosm Studies to Determine Die-Off of Fecal Pollutants," to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS, 27 pgs.

Monitoring and Modeling Water Pollution in Mississippi Lakes: The Use of Microcosm Studies to Determine Die-Off of Fecal Pollutants

A Final Project Report to the
Mississippi Water Resources Research Institute

Conducted by
Cristiane Q. Surbeck, P.E., Ph.D.
Assistant Professor
Department of Civil Engineering
The University of Mississippi

September 30, 2009

1 Abstract

The aim of this research is to determine the die-off rates of total coliform and *Escherichia coli* bacteria in lake and tributary waters in order to provide improved parameters for mathematical modeling of fecal pollution. Two field and laboratory studies were performed. One study was used to sample and monitor fecal pollution in two creeks that are tributaries to Sardis Lake. A second study used a discharge point of a tributary into Lower Sardis Lake, Thompson Creek, to better understand the concentrations and decay rates of total coliforms and *E. coli* in the lake water column and in the lake sediment. In both studies, samples were collected and tested for total coliforms, *E. coli*, dissolved oxygen (DO), temperature, nitrates, phosphate, and phenols. In both studies, microcosms were created with creek water. Samples from each microcosm were collected approximately every 12 hours for two days and 24 hours for the subsequent five days. Bacteria concentrations from the microcosms were plotted against time, and first-order decay constants were obtained. In the second study, another six microcosms (for a total of seven microcosms) were created and monitored in the laboratory. The seven microcosms consisted of (1) lake water, (2) lake water and sediment, (3) lake water and sterilized sediment, (4) sterilized lake water and sediment, (5) sterilized deionized water and sediment, (6) sterilized lake water, and (7) sterilized deionized water and sterilized sediment. *E. coli* decay rates were found to be lower when sediment was present.

2 Budget

2.1 Budget Requested

The budget requested from Federal funds, was $7500 (direct costs), and the non-Federal matching was $15,000 by the University of Mississippi in the form of salary, fringe benefits, and indirect costs.

2.2 Budget Expended

The budget expended from Federal funds, was $7431.59 (direct costs), and the non-Federal matching was $15,958.70 by the University of Mississippi in the form of salary, fringe benefits, and indirect costs. The breakdown of expended funds is shown in Table 2.1.

Table 2-1. Summary of Budget Expended.

Cost Category	Federal ($)	Non-federal (matching by UM) ($)	Total ($)
1. Salaries and wages	$2,400.00	$6,328.00	$8,728.00
2. Fringe benefits	$3.58	$2483.67	$2487.25
3. Supplies	$5,028.01	0	$5,028.01
4. Total direct costs	0	0	0
5. Indirect costs	0	$7147.03	$7147.03
6. Total estimated costs	$7,431.59	$15,958.70	$23,390.29

3 *Students Involved, Presentations, and Publications*

Five students were involved in this project. See Table 3.1 for a description.

Table 3-1. Students involved in project.

Student Name	Major	Class	Involvement
Alison Kinnaman	Environmental Engineering	Master's	Project Parts A and B (thesis is Part B)
John Mark Henderson	Civil Engineering	Senior	Project Part A
Keah Y. Lim	Civil Engineering	Senior	Project Parts A and B
Casey Wilson	Chemical Engineering	Junior	Project Part A
Shannon Wilson	Environmental Engineering	Master's	Project Part A

Project Part A was conducted as a Special Topics course in which the five students were enrolled. The course Projects in Surface Water Quality Modeling (Engr 596) was conducted in Fall 2008. During the course, academic work was conducted on surface water quality modeling, following the textbook *Surface Water Quality Modeling*, by Steven Chapra. About half of the coursework was field, laboratory, and data analysis work to conduct Part A of the study. In this study, two creeks were sampled, Davidson and Toby Tubby, from urban and rural areas leaving the general vicinity of Oxford, MS, and emptying into Sardis Lake.

Student Alison Kinnaman used Part B of this study as her thesis topic. She graduated in August 2009, and her thesis, "Using Microcosm Studies to Determine the Effect of

Sediments and Nutrients on Bacteria in Lake Water" has been submitted to the Graduate School of the University of Mississippi. Her work is summarized in Part B of this report and was presented at the 2009 Mississippi Water Resources Conference. It is anticipated that the combined work described in Parts A and B of this report will be written as a manuscript for submission in a peer-reviewed journal.

4 *Motivation for Project*

Lakes are generally understudied bodies of water due to the popularity of coastal beaches (USEPA 2009). This research aims to better understand these ignored recreational waters. Sardis Lake, a large reservoir in northern Mississippi, is an important social and economic resource. This lake is the focus of this project on the persistence of fecal indicator bacteria in recreational waters. To conduct this study, tributaries to the lake were selected as sampling sites in order to represent pollutant input.

The research goal is to determine mechanisms of die-off and survival of fecal indicator bacteria in water that is located in tributaries and in an embayment between Thompson Creek and Lower Sardis Lake in north Mississippi. To this end, several sampling events and microcosm studies were conducted. The primary mechanisms studied were the die-off rates of *E. coli* in water and suspension of *E. coli* from sediments to the water column.

5 *Project Part A: The Use of Microcosm Studies to Determine Fecal Indicator Bacteria Decay Rates in Tributary Creeks to Sardis Reservoir*

5.1 Objectives

The objective of the Part A study on tributary creeks to Sardis Reservoir as to calculate kinetic rate constants of die-off of fecal indicator bacteria in Davidson Creek and Toby Tubby Creek, which are part of an urban and sub-rural watershed.

5.2 Field Site

Sardis Lake is a dammed reservoir on the Little Tallahatchie River located between the Little Tallahatchie River's two impaired segments. The City of Oxford, Mississippi, lies south of Sardis Lake and the cities runoff enters Davidson Creek on the north side of the city. Davidson Creek and Toby Tubby Creek are located in a farming and forested sub-watershed and are classified as an irregular open channel flow body. The flow velocities of the four different sample locations varied substantially from no flow at all at location DAV1 to a much greater flow at location TT2. See sample locations in Figure 5-1.

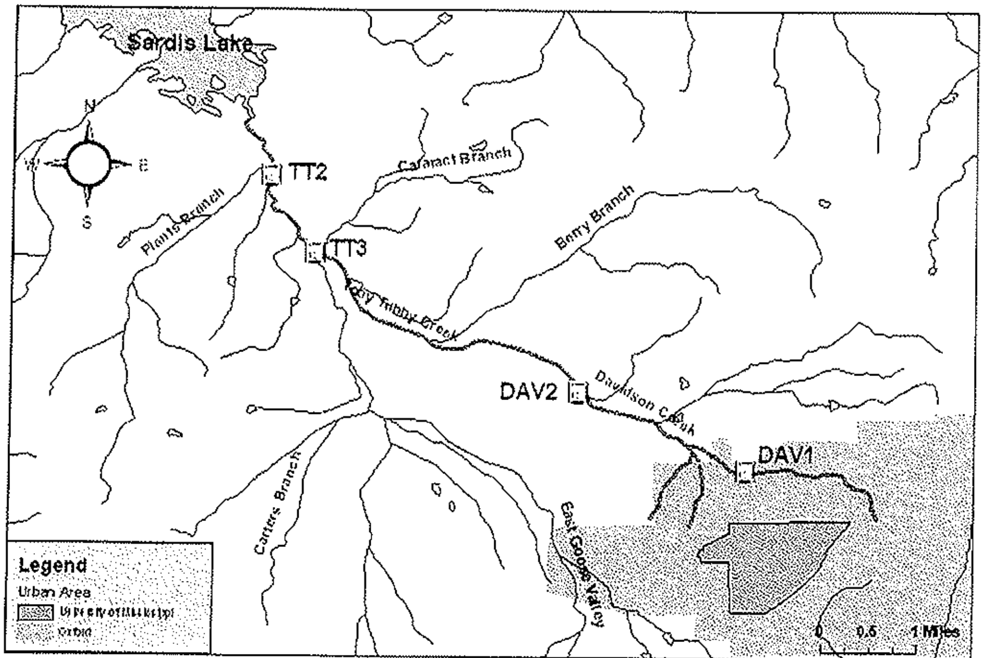


Figure 5-1. Sample locations on Toby Tubby Creek and Davidson Creek.

5.2 Materials and Methods

5.2.1 Field Locations

The sampling locations were the following:

1. DAV1 on Davidson Creek adjacent to Lamar Park on College Hill Road (34° 21.851'N, 89° 32.097'W;
2. DAV2 on Davidson Creek as it flows under Anchorage Road (34° 23' 24.59" N, 89° 33' 59.21" W);
3. TT3 on Toby Tubby Creek as it crosses County Road 105 (34° 25.321'N, 89° 36.834'W); and
4. TT2 on Toby Tubby Creek where it crosses Highway 314 (34° 25' 19.63" N, 89° 36' 51.3" W).

5.2.2 Water Quality Analyses

Several water quality analyses were performed during the sampling events conducted on September 17, September 18, September 22, and October 20, 2008. Both water samples and microcosms were examined for total coliform, *E. coli*, nitrate, nitrite, phenols, phosphate, dissolved oxygen (DO), and dissolved organic carbon (DOC).

The bacteria were cultured by a defined-substrate method called Colilert (IDEXX Laboratories, Maine). The bacteria (total coliform and *E. coli*) were counted and recorded as Most Probable Number per 100 mL (MPN/100 mL). The water samples were tested for the following parameters: dissolved oxygen, nitrite, nitrate, phosphate, and phenols. Each of these parameters was analyzed by colorimetry using vacu-vials and CHEMetrics photometer (CHEMetrics, Inc., Calverton, Virginia). Nitrite was analyzed for only in the September 17 samples because the results were below the detection limit.

DOC analysis was carried out by filtering 80-mL of sample water through 0.45-micron filters. Next, two 40-mL vials, preserved with hydrochloric acid, were filled. The vials were then placed in a refrigerator until the samples were sent to Environmental Testing and Consulting, Inc. (ETC) in Memphis, TN. A chain of custody record was also sent with the samples. In order to send the materials, a cooler was filled with ice and the sample vials. The chain of custody identified the sample identification numbers, the number of samples, date the samples were taken, times the samples were taken, the type of sample, and matrix, along with what test is required (EPA Method 415.1).

5.2.3 Microcosm Studies

Two microcosm studies were conducted. Both studies included water samples from DAV1, DAV2, TT2, and TT3, but the incubation methods employed were different. The first study involved a stationary incubator with an internal temperature of 35°C, while the second study utilized a shaker incubator at a constant temperature of 30°C. Also, some of the sampling rounds for the second study incorporated different dilutions, as will be discussed further below. Other than this, the set-up and sampling procedures for the two microcosm studies were identical.

First Microcosm Study

On September 22, 2008 water samples were collected from the following locations: DAV1, DAV2, TT2, and TT3. In the lab, bacteria were cultured as explained above. The CHEMetrics instrument was used to determine the concentrations of nitrate, phenols, and phosphates in parts per million (ppm). Initial analyses were conducted on the water in the sample bottle.

After completing these tests, the microcosms were set up. A microcosm study is a study in which one examines water samples over time in an incubator. Each sample represents the location of the sample taken. In order to set-up the microcosms, 500 mL of each sample were poured into separate sterilized Erlenmeyer flasks. A foam stopper was placed in each flask, and the flasks were labeled and placed in a stationary incubator at a temperature of 30°C. We chose a 500-mL sample because we needed enough water to last 5 days while sampling every 12 hours, to analyze nitrate, phosphate, and phenols another time and to send two dissolved organic carbon (DOC) samples to ETC Laboratory in Memphis, TN. The sampling times were roughly 7 AM and 7 PM every day. The water samples were obtained using sterile techniques and then tested in duplicate for total coliform and *E. coli* using the Colilert method. In order to sample a microcosm in a sterile manner, the stopper was removed and the opening of the flask was passed through the flame of a Bunsen burner to remove any contaminants. Then the correct amount of water was pipetted from the flask and placed in dilution vials. For the first microcosm study, 10 mL of water were removed from the flask each time and were placed in a

90 mL dilution vial to make a 10% dilution. Two aliquots of water were removed from each microcosm at each sampling time so that the bacteria test could be performed in duplicate. After sampling, each microcosm flask was sterilized in the flame and promptly stoppered. The flasks were then returned to the incubator until the next sampling event.

Second Microcosm Study

On October 20, 2008 another round was sampling was conducted at the four locations. Water quality analysis and microcosms were set up as described above. The microcosms were sampled every 12 hours for 5 days, and the same procedures were followed as described above.

5.3 Results

5.3.1 Inventory of Sample Results

The results of the initial samples are recorded in Table 5-1. The highest pollutant concentration was found at site DAV 1. The lowest pollutant concentration was found at site DAV 2.

Table 5-1. Inventory of initial sample results.

Date	Site	Total coliform (MPN/100 mL)	*E. coli* (MPN/100 mL)	DOC (mg/L)	DO (mg/L)	NO3 (mg/L)	Phenols (mg/L)	PO4 (mg/L)
9/17/2008	DAV1	24196	477	4.13	3.13	0.202	0.43	0.2
	TT2	24196	465	-	8.33	0.06	0.43	0.165
9/18/2008	DAV2	818	-	<1	8.67	0.4	0.31	0.15
9/22/2008	DAV1	21923	332	4.18	-	0.341	0.539	0.28
	DAV2	19863	651	1.39	-	0.54	0.368	0.09
	TT2	18553	756	3.07	-	0.33	0.433	0.16
	TT3	18553	508	2.75	-	0.24	0.504	0.16
10/20/2008	DAV1	23088	355	10.3	5.4	0.22	0.61	0.7
	DAV2	7715	399	3.41	8.97	0.426	0.24	0.035
	TT2	9006	356	3.77	8.995	0.29	0.28	0.09
	TT3	17795	202	4.6	8.4	0.24	0.32	0.027

5.3.2 Results of First Microcosm Study

Figures 5-2 and 5-3 show the graphs of the natural logarithm of the total coliform and *E. coli* concentrations versus time, respectively, for the first microcosm study. The graphs illustrate the net decrease in bacteria concentrations with time when a sample is isolated from its environment.

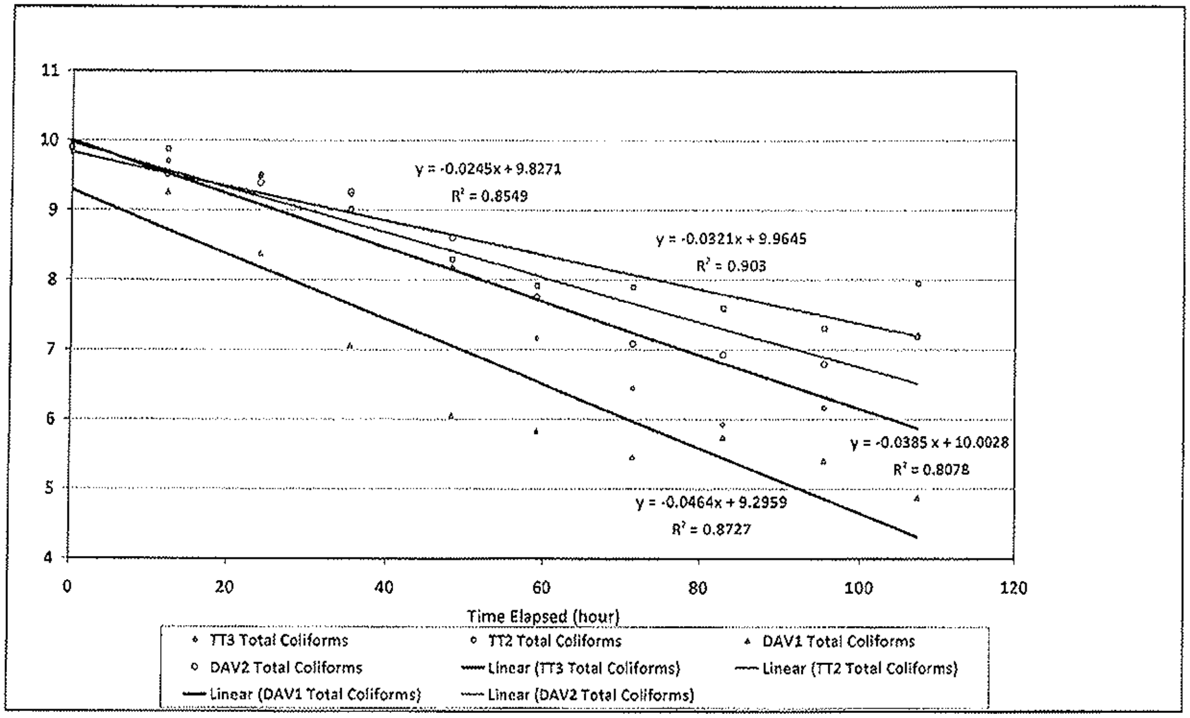


Figure 5-2. Ln(total coliform concentration) versus elapsed time for the first microcosm study. Listed equations are linear regression equations, along with R^2 values.

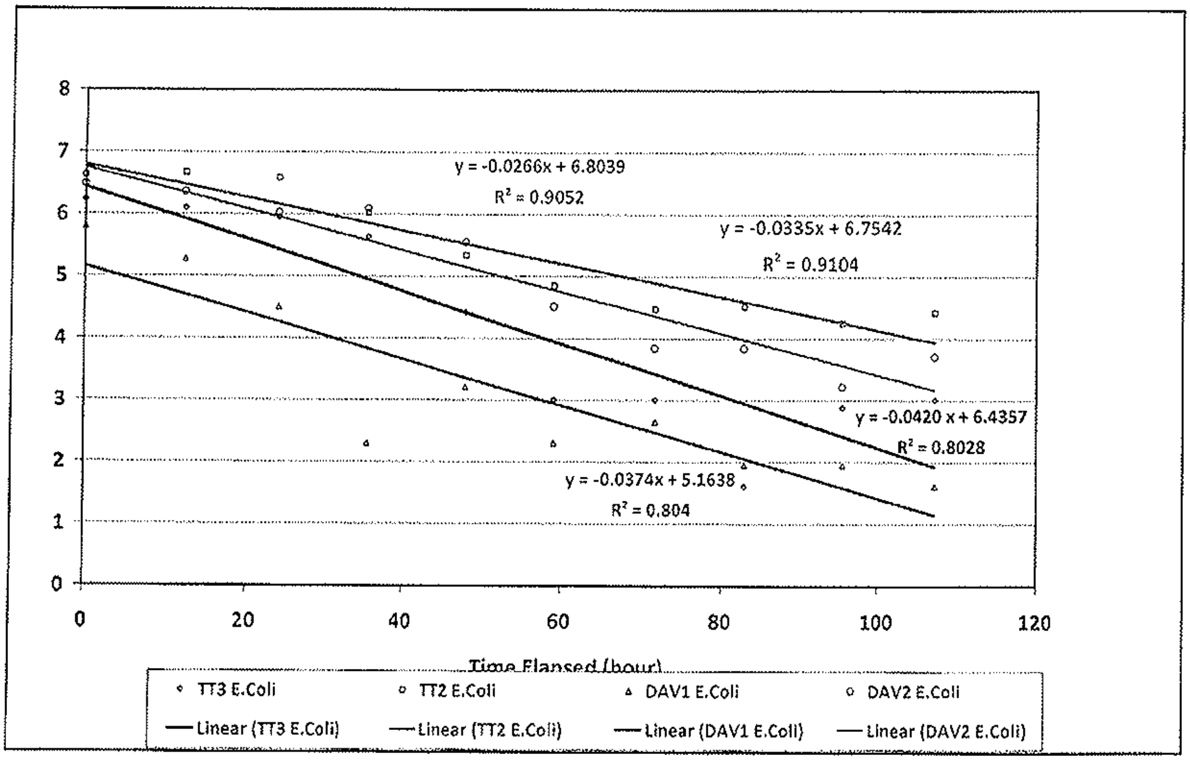


Figure 5-3. Ln(*E. coli* concentration) versus elapsed time for the first microcosm study. Listed equations are linear regression equations, along with R^2 values.

5.3.3 Results of Second Microcosm Study

Figures 5-4 and 5-5 show the graphs of the natural log of the total coliform and *E. coli* concentrations versus time, respectively, for the second microcosm study. The graphs illustrate the net decrease in bacteria concentrations with time when a sample is isolated from its environment.

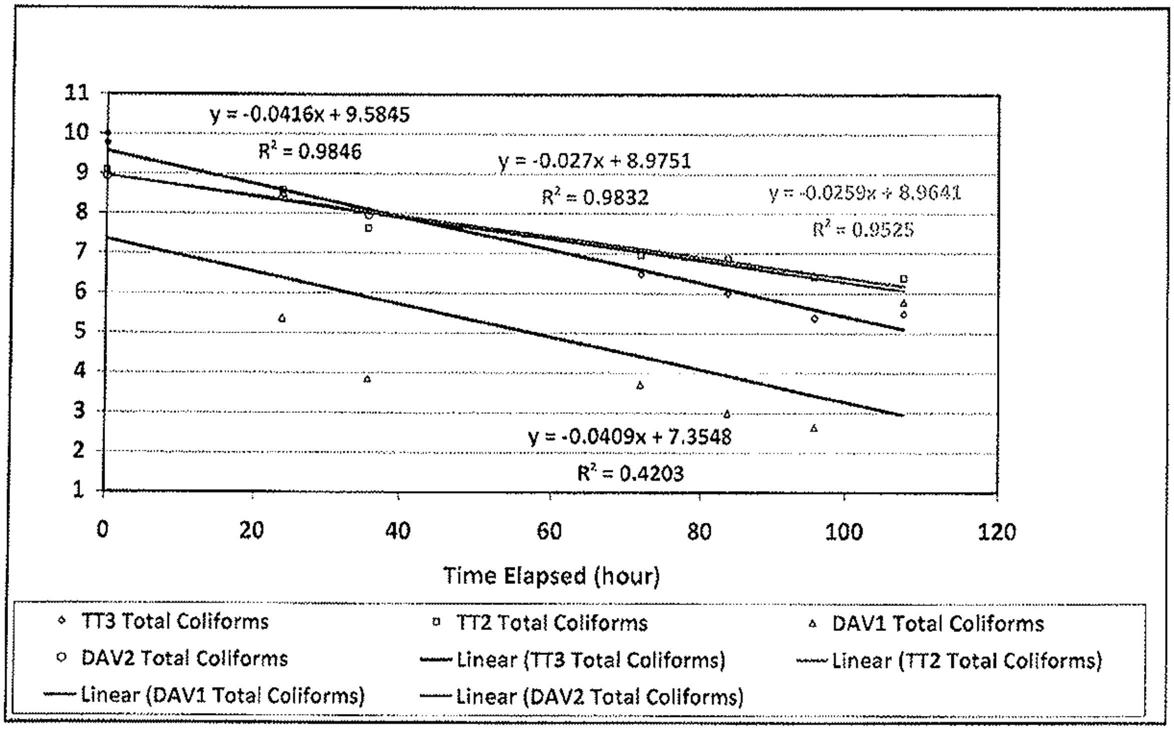


Figure 5-4. Ln(total coliform concentration) versus elapsed time for the second microcosm study. Listed equations are linear regression equations, along with R^2 values.

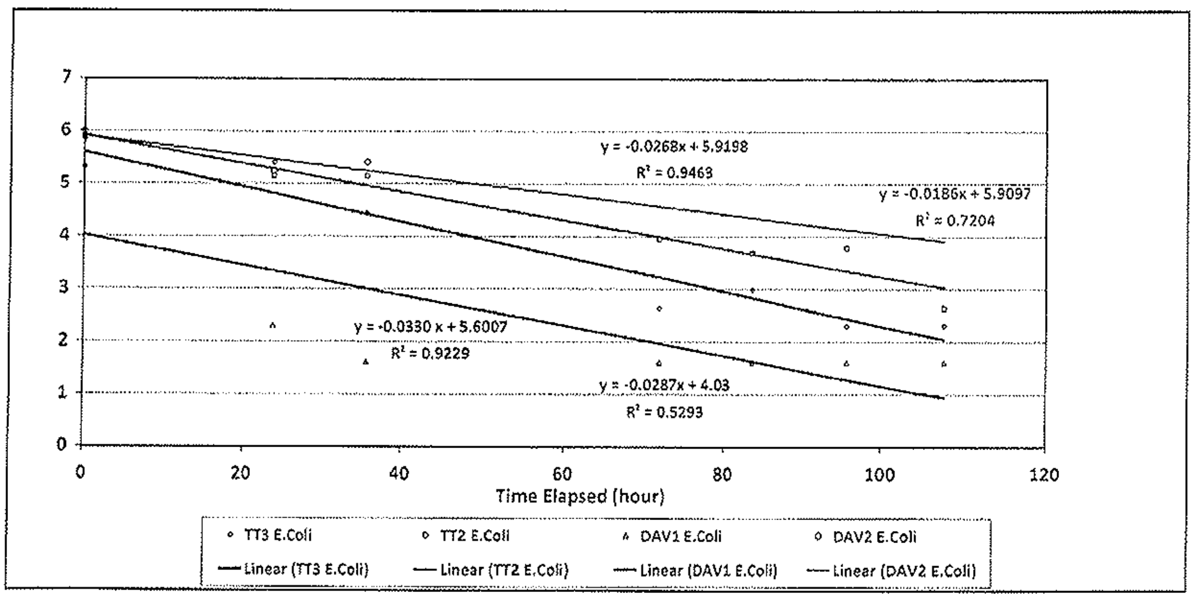


Figure 5-5. Ln(*E. coli* concentration) versus elapsed time for the second microcosm study. Listed equations are linear regression equations, along with R^2 values.

5.3.4 Kinetic Rate Constants

The kinetic rate constants obtained for the decay of bacteria in the microcosms are summarized below. These values were obtained by the integral method. For the first microcosm study, concentration, ln(concentration), and 1/concentration were all graphed vs. time elapsed. Concentration vs. time represents a zero-order reaction, ln(concentration) vs. time represents a first-order reaction, and (1/concentration) vs. time represents a second-order reaction. A linear trend line was fit to each of these graphs. The trend lines for the first-order reactions had the highest R^2 value, so the reactions were assumed to be first order. The decay constants are the slopes found from the trend lines. For analysis of the second microcosm study, all reactions were assumed to be best modeled by first-order reactions and the decay constants were obtained as described from the graph of ln(concentration) vs. time.

Table 5-2. Kinetic rate constants for fecal indicator bacteria in water from Davidson Creek and Toby Tubby Creek.

		Total Coliform		*E. coli*	
	Site Name	Decay Constant, k (hr^{-1})	R^2	Decay Constant, k (hr^{-1})	R^2
First Microcosm Study	TT2	0.0245	0.8549	0.0266	0.9052
	TT3	0.0385	0.8078	0.0420	0.8028
	DAV1	0.0464	0.8727	0.0374	0.8040
	DAV2	0.0321	0.9030	0.0335	0.9104
Second Microcosm Study	TT2	0.0259	0.9526	0.0268	0.9482
	TT3	0.0416	0.9846	0.0330	0.9236
	DAV1	0.0408	0.4202	0.0287	0.5293
	DAV2	0.0270	0.9832	0.0186	0.7231

6 Project Part B: The Use of Microcosm Studies to Determine the Effect of Sediments and Nutrients on Fecal Indicator Bacteria in Lake Water

6.1 Research Objectives

The research objectives were to determine how *E. coli* decay rates in lake water are affected by sediments. The hypothesis is that the presence of sediments increases the persistence of the fecal indicator bacteria (FIB) in lake water. The FIB groups studied in this research are total coliforms and *Escherichia coli*. The information on die-off rates and on *E. coli* dependence on sediment is useful to determine parameters for numerical modeling in lakes. This research may also have an impact on lake water quality management.

Many computer models, including Soil & Water Assessment Tool (SWAT), Hydrologic Simulation Program-Fortran (HSPF), and the National Center for Computational Hydroscience and Engineering's CCHE-2D, use first-order decay models for fecal coliforms in surface waters for predicting water quality both spatially and temporally. These models only perform well if the parameters for decay are accurate. In addition, they often do not consider the impact of sediment on the decay rates of bacteria. Therefore, this research is innovative because it uses a methodology to determine decay rates that are influenced by sediment.

The results of this research also have implications for lake water quality management. The results from this study could indicate whether bacteria concentrations are above or below U.S. Environmental Protection Agency criteria, which could indicate that the sampling location might need special attention.

6.2 Materials and Methods

6.2.1 Sample Collection

Sediment and water samples were collected where Thompson Creek feeds into the lower Sardis Lake in northern Mississippi. The water and sediment samples were collected in Nalgene bottles (Nalgene Company, Rochester, NY) previously autoclaved at 121°C in an EZ 9 autoclave (2340EA, Tuttnauer, Hauppauge, NY). Sediment samples were collected with 2-inch by 4-inch aluminum sediment core sleeves previously autoclaved at 134°C in an EZ 9 autoclave. The sleeve was approximately half-way filled so that the sediment would represent the top 5 cm, which contains the most recent nutrient influx. Water samples were collected from the water surface, and sediment samples were collected from the embayment bank above the water surface. All samples were cooled and transported to the laboratory at the University of Mississippi.

Four sampling events were conducted on the following dates: July 11, 2008, August 19, 2008, January 7, 2009, and April 10, 2009. Figure 6-1 is a photograph of the sample collection site.

Figure 6-1. Sample collection at Thompson Creek's inlet to the lower Sardis Lake.

Microcosm set up began once the samples were brought to the laboratory.

6.2.2 Pre-Microcosm Preparation (sediment measurement, separation of bacteria, autoclaving and water filter-sterilization)

First, the sediment was mixed to make a homogeneous soil matrix in order to provide each applicable microcosm with a representative sediment sample. This was accomplished by putting the sediment from the Nalgene bottles in an aluminum pan and mixing. Afterwards, approximately 500 cm^3 (bulk) of sediment was autoclaved at 121°C to eliminate the bacteria for two of the microcosms. Second, bacteria were extracted from the unsterilized sediment within three hours of collection. This was done following a procedure adapted and modified from Craig et al. 2002 and Jeong et al. 2005. A 0.1% peptone solution was prepared by dissolving 0.5 g of peptone in 400 mL deionized (DI) water. Then more deionized water was added to increase the volume to 500 mL.

Twelve and a half grams (wet weight) of sediment were weighed using sterilized equipment and transfer media (beaker, centrifuge tube, and spatula). In addition, the dry weight of sediment was determined by weighing 2 grams of wet sediment in an aluminum weighing dish (Fisher Scientific, Pittsburgh, PA) and placing the dish with sediment in a Thelco oven (Precision Scientific Co., Chicago, IL.) for 24 hours at 110°C and re-weighing the remaining sediment.

The 12.5 g of sediment were added to a sterile 50-mL centrifuge tube (Fisher Scientific, Pittsburgh, PA), then suspended in 37.5 mL of 0.1% peptone solution. The tube was closed and hand shaken for one minute.

The sediment-peptone mixture was centrifuged at 2500 rpm for 10 minutes in a MARATHON 3200 (Fisher Scientific, Pittsburgh, PA) centrifuge. This was done to separate the bacteria from the sediment to a liquid supernatant.

6.2.3 *Bacteria Analysis for Sediment*

Once the supernatant was retrieved, 1 mL of it was added to a dilution vial (Hardy Diagnostics, Santa Maria, CA) filled with 99 mL of deionized water and Colilert powder (Idexx Laboratories, Inc., Westbrook, Maine) to fill the vial to a total of 100 mL. Two dilution vials were filled with one sample each of the supernatant so that the geometric means of the results could be calculated. The dilution vials were then capped and shaken until the Colilert was dissolved. Next, the solutions were poured into Quanti-Trays (Idexx Laboratories, Inc., Westbrook, Maine) and sealed using a Quanti-Tray Sealer Model 2X (Idexx Laboratories, Inc., Westbrook, Maine), then incubated at 35 degrees Celsius in a Presision (Precision Scientific, Inc., Winchester, VA) incubator for 24 hours. The Quanti-Tray wells indicating total coliforms and *E. coli* were counted, converted to units of most probable number (MPN) per 100 grams, and recorded. Based on Jeong 2005's formula, the sediment bacteria concentration (Cs) in units of MPN per 100 grams was calculated as follows:

$$C_s = \frac{C_t \times 37.5\ mL \times 100}{W_s r}$$

where C_t is the bacteria concentration calculated from the 1 mL of supernatant, W_s (grams) is the wet weight of sediment suspended in the 0.1% peptone solution, and r is the sediment's dry-to-wet weight ratio.

6.2.4 *Bacteria Analysis for Water*

Bacteria analysis was performed on water pre-microcosm experiments using the same technique described in the Bacteria Analysis for Sediment section, with the following exceptions. Depending on previous weather conditions, either 1 mL or 10 mL of water sample was pipetted into a dilution vial (in the case of recent rain or no previous rain, respectively). Each sample was analyzed in duplicate. The concentration was determined by converting the Quanti-Tray well counts to MPN per 100 mL using the chart issued by Idexx Corporation.

6.2.5 *Microcosm Preparation*

Following the sediment preparation and lake water bacteria analysis described above, seven microcosms were made in 500-mL flasks: Microcosm 1 (water), Microcosm 2 (water and sediment), Microcosm 3 (water and sterilized sediment), Microcosm 4 (sterilized water and sediment), Microcosm 5 (sterilized deionized water and sediment), Microcosm 6 (sterilized water control), Microcosm 7 (sterilized DI water and sterilized sediment control). The following is a detailed description of each microcosm.

Microcosm 1. Composed of water, this microcosm is used to monitor the kinetic rate constant of total coliforms and *E. coli* due to die-off without the effect of nutrients and bacteria associated with sediment. See Figure 6-2, Microcosm 1, for a schematic showing bacterial die-off in the water.

Microcosm 2. Composed of water and sediment, this microcosm is used to monitor the kinetic rate constant of total coliforms and *E. coli* in water under the effect of nutrients and bacteria associated with sediment. See Figure 6-2, Microcosm 2, for a schematic showing bacterial die-off in water and sediment, and bacterial and nutrient suspension from sediment to water.

Microcosm 3. Composed of water and sterilized sediment, this microcosm is used to monitor the kinetic rate constant of total coliforms and *E. coli* with the effect of nutrients, but not bacteria, associated with sediment. See Figure 6-2, Microcosm 3, for a schematic showing bacterial growth in water, and nutrient suspension from sediment to water.

Microcosm 4. Composed of sediment and sterilized water, this microcosm is used to monitor the kinetic rate constant of total coliforms and *E. coli* in water associated with sediment but without the effect of bacteria from the water. See Figure 6-2, Microcosm 4, for a schematic showing bacterial die-off in sediment, and bacterial and nutrient suspension from sediment to water.

Microcosm 5. Composed of sediment and sterilized deionized water, this microcosm is used to monitor the kinetic rate constant of total coliforms and *E. coli* in water associated with sediment without the effect of bacteria and nutrients from the water. See Figure 6-2, Microcosm 5, for a schematic showing bacterial die-off in sediment, and bacterial and nutrient suspension from sediment to water.

Microcosm 6. Composed of sterilized water, this microcosm is used as a control to monitor whether filter sterilizing the water was successful. See Figure 6-2, Microcosm 6, for a schematic showing nutrients in water.

Microcosm 7. Composed of sterilized DI water and sterilized sediment, this microcosm is used as a control to monitor whether autoclaving the sediment and filter sterilizing the DI water were successful. See Figure 6-2, Microcosm 7, for a schematic showing nutrient suspension from sediment to water.

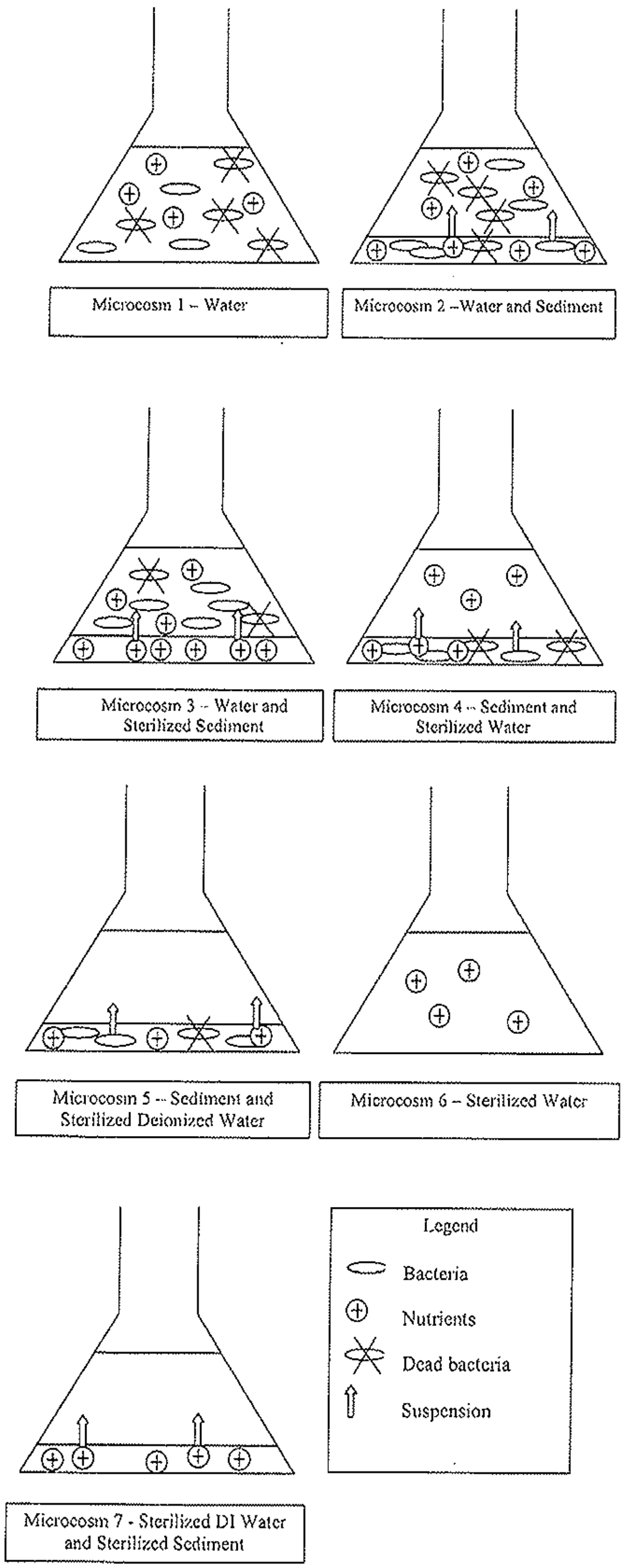


Figure 6-2. An illustration of the mechanisms occurring in Microcosms 1 through 7.

Each sediment-water microcosm consisted of approximately 200 grams of sediment and 300 to 500 mL of water, depending on the microcosm study. The microcosms of water alone had a known volume of aqueous solution, approximately 230 to 500 mL. Water was sterilized using filter sterilization with a 0.22 micron filter (Model number 8532, Corning, Corning, NY). The microcosms were incubated at 30 degrees Celsius in a shaker incubator (Classic C24, New Brunswick Scientific, Edison, NJ) at 60 revolutions per minute, as seen in Figure 6-3.

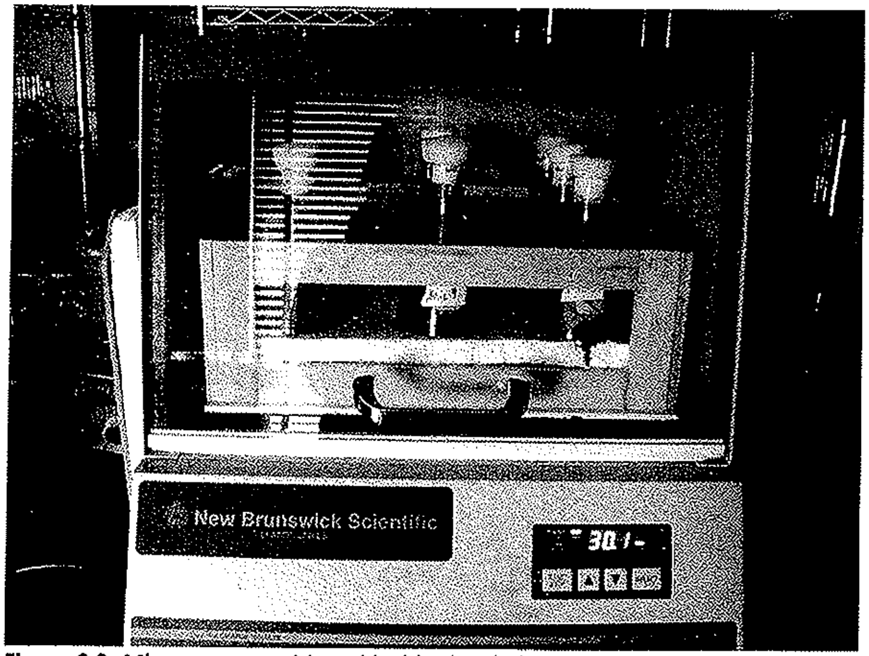


Figure 6-3. Microcosms positioned inside the shaker incubator.

6.2.6 Microcosm Monitoring

Water samples were collected from the microcosms at twelve-hour intervals in the first two days and at 24 hour intervals for the next five days. Each sample was analyzed following the procedures described above in the section Bacteria Analysis for Water (6.2.4). A total of 8 rounds of microcosm sampling were conducted. After the final round of sampling, the sediment from microcosms 2 to 5 were also tested following the procedures described above.

Depending on the previous bacteria reading, dilutions were either 1 mL sample: 99 mL water or 10 mL sample: 90 mL water. If previous bacteria concentrations were high, dilutions were 1% (1 mL); if previous bacteria concentrations were low, dilutions were 10% (10 mL).

6.2.7 Data Analysis

Data analysis was performed on all the water quality data. To determine the decay rate constants for bacteria in the microcosms, a graph of the natural log of the concentration vs.

time was created and a trendline was fitted to the data. Decay rate constants (k) were found using the linear trendline's slope value.

To determine a possible relationship between the sediment-water ratio, nutrients, and bacteria concentrations, Spearman's rank correlations were performed. Because Microcosms 1 and 2 differed only due to the sediment in Microcosm 2, it was assumed the concentration difference between them could be attributed to the sediment. Because Microcosms 4 and 5 differed due to the nutrients in the water in Microcosm 4, it was assumed the concentration difference between them could be attributed to the nutrients. Because Microcosms 2 and 4 differed due to the bacteria in the water in Microcosm 2, the concentration difference between them could be attributed to the bacteria. Because Microcosms 2 and 5 differed due to the bacteria and nutrients in the water in Microcosm 2, the concentration difference between them could be attributed to the bacteria and nutrients.

The sediment-water ratio was noted each time a water sample was taken and, for comparability, was used in the analysis up to the point where the ratio between microcosms differed only by one-hundredth of a point.

6.3 RESULTS

6.3.1 Water Quality Analyses

The initial concentrations of total coliforms and *E. coli* ranged between 8,177 – 33,718 MPN/100mL and 381–913 MPN/100mL, respectively. Nutrient concentrations ranged between 2.95 – 7.64 mg/L for dissolved organic carbon (DOC), 0.19 – 0.34 mg/L nitrate as N, 0.33 and 0.53 mg/L phosphate, 6.77 – 12.14 mg/L for dissolved oxygen (DO), and 0.59 -1.29 mg/L for phenols.

6.3.2 Bacteria Decay Rates

Four sampling events were conducted in which bacteria data were gathered and analyzed, and decay rate constants were found using the slope value of a linear trendline. Bacteria concentrations vs. time was plotted for Microcosms 1, 2, 4, and 5 by taking the geometric mean of the duplicate samples for each round and incorporating those data in an Excel graph. Microcosms 6 and 7 were excluded from the graphs because there were no bacteria present. Microcosm 3 was excluded from the graphs because it experienced bacterial growth and was, therefore, not applicable to the particular study of decay rates. However, this microcosm will be addressed in section 6.4.

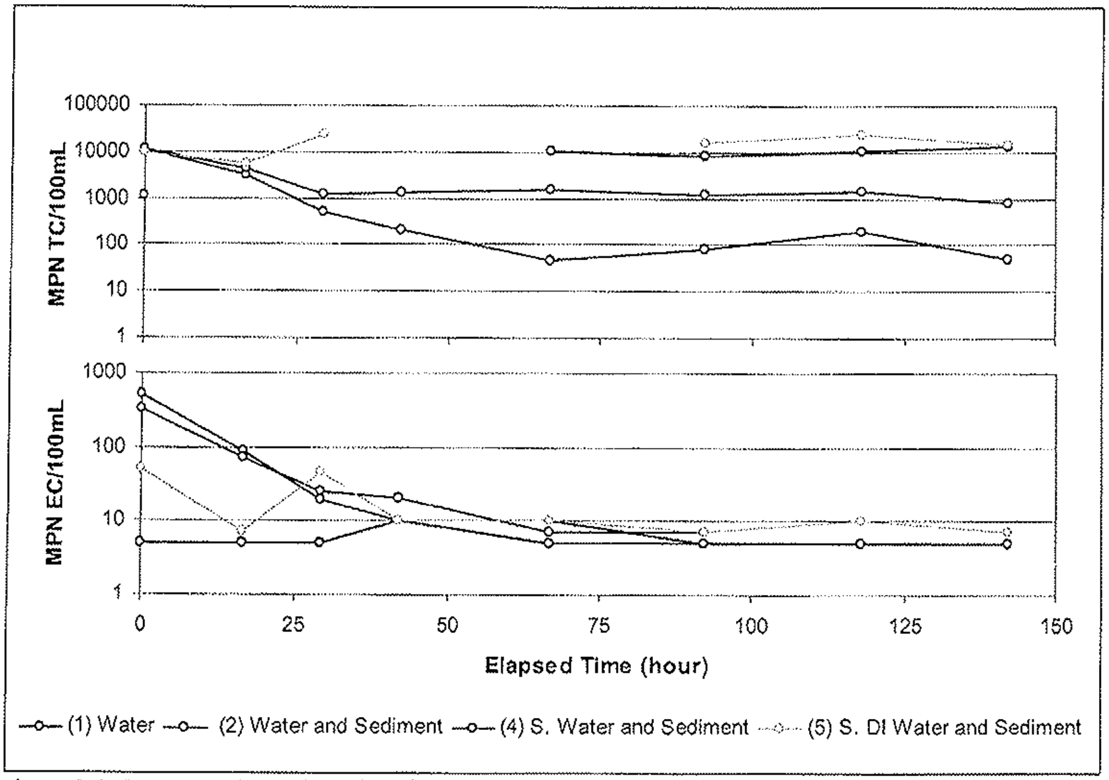


Figure 6-4. Concentrations of total coliforms and *E. coli* versus elapsed time during Study 1 (July 11, 2008). Numbers in parentheses indicate microcosm numbers.

Figure 6-4 shows that in Study 1, the total coliform and *E. coli* concentrations decreased faster in Microcosms 1 and 2. The total coliforms in Microcosms 4 and 5 increased; missing data points indicate concentrations that were above the method's upper detection limit. This bacterial growth could be attributed to many factors. One consideration is that the environments of Microcosms 4 and 5 are more conducive to growth because the bacteria concentration was reduced by filtration. Therefore, the bacterial population was initially below carrying capacity. Another explanation could be that the concentration of waste products will reach toxic levels sooner in Microcosms 1 and 2 because of the lower initial microorganism populations in Microcosms 4 and 5. Also, the nutrient concentrations could limit the amount of growth. The nutrient concentration in Microcosm 1 would be limited due to water being the sole source of nutrients. The nutrient concentration could possibly increase in Microcosm 2 due to sediment as a possible nutrient source. However, the bacteria in Microcosms 4 and 5 are less limited by nutrients because they do not compete with other organisms. *E. coli* concentrations follow a similar pattern of decay in Microcosms 4 and 5.

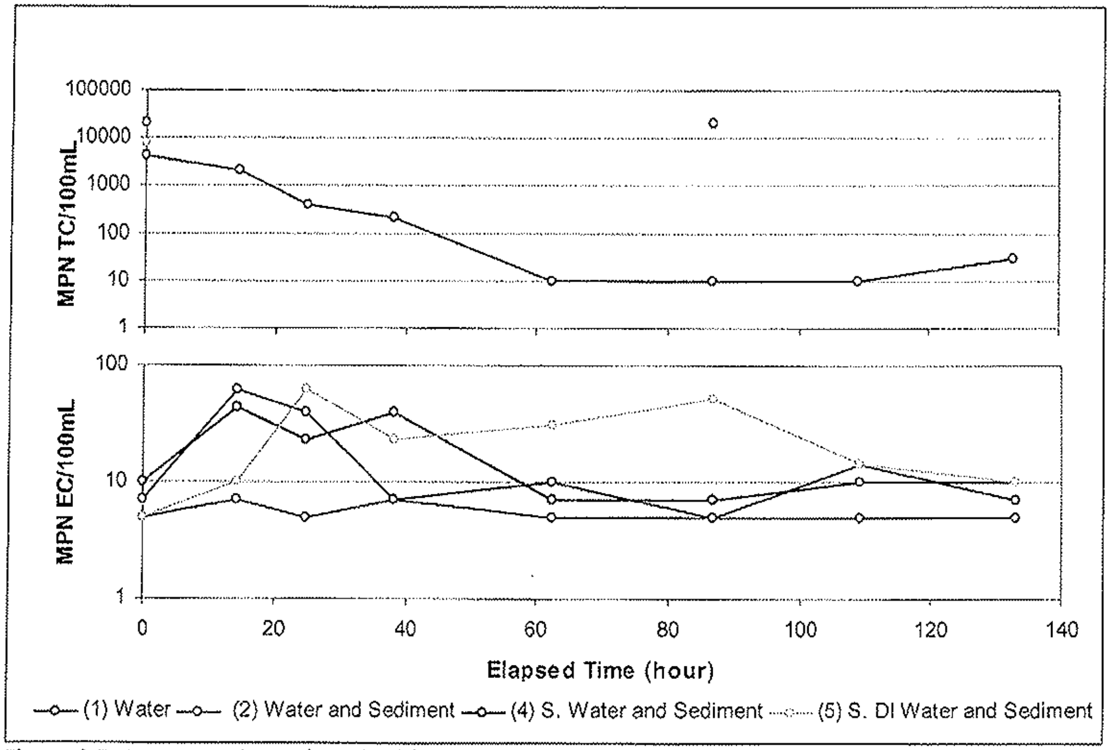


Figure 6-5. Concentrations of total coliforms and *E. coli* versus elapsed time during Study 2 (August 19, 2008).

Figure 6-5 shows that in Study 2, the concentrations in Microcosms 2, 4 and 5 were too large to be identified. This may be attributed to the estimated high DOC concentration in the initial water sample. Although the initial water DOC was not measured, it was assumed to be high based on the typical occurrence of the ending DOC concentrations being lower than the initial measurement; the final concentrations were high compared with the other studies.

All of the *E. coli* concentrations, excluding in Microcosm 1, increased in the beginning, then tapered off, except for Microcosm 5, which persisted longer than the others. These increases are also thought to be due to the DOC concentration.

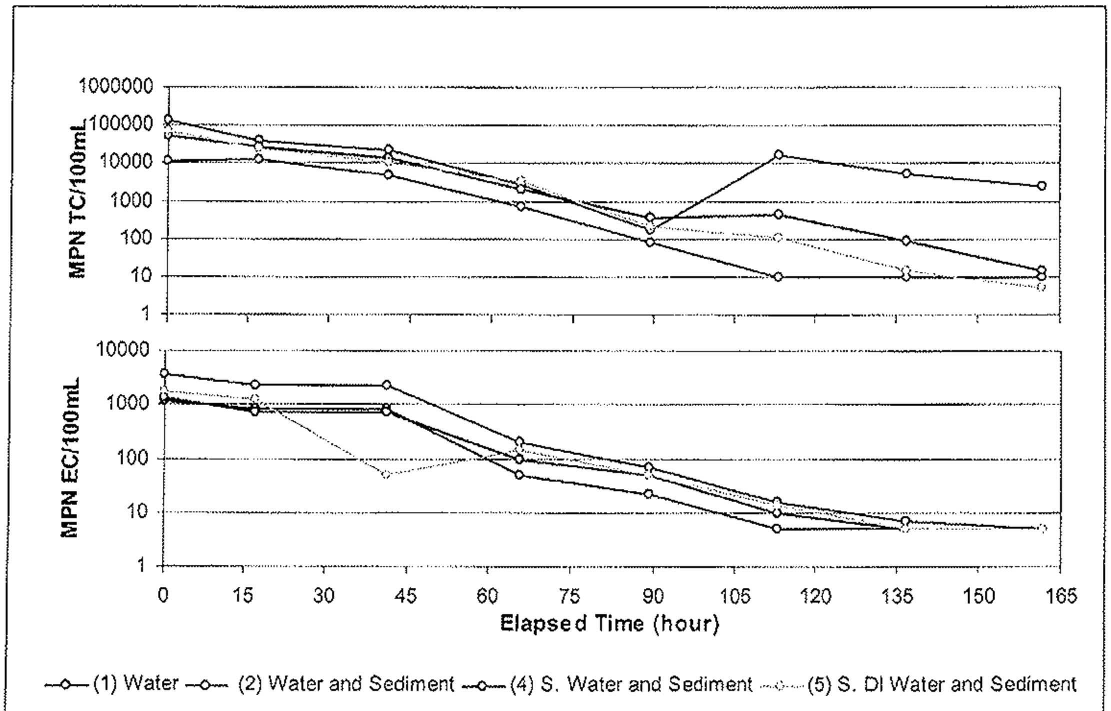


Figure 6-6. Concentrations of total coliforms and *E. coli* versus elapsed time during Study 3 (January 7, 2009).

Although the total coliform concentrations in Figure 6-6 (Study 3) seem to have increased in two Microcosms (2 and 4) around hour 115, this time is when the dilutions changed to accommodate a smaller bacteria concentration. When dilutions switched from 1 part sample water and 99 parts sterilized deionized water to 10 parts microcosm water and 90 parts sterilized deionized water, the accuracy of the reading may have increased, or human error occurred in filling the pipets.

This is the only study which yielded similar results for the total coliforms and *E. coli* in all microcosms. Possibilities for this could be the nutrient interactions. This study yielded high dissolved oxygen, nitrate, and DOC concentrations. These nutrients together may be most conducive to bacterial survival.

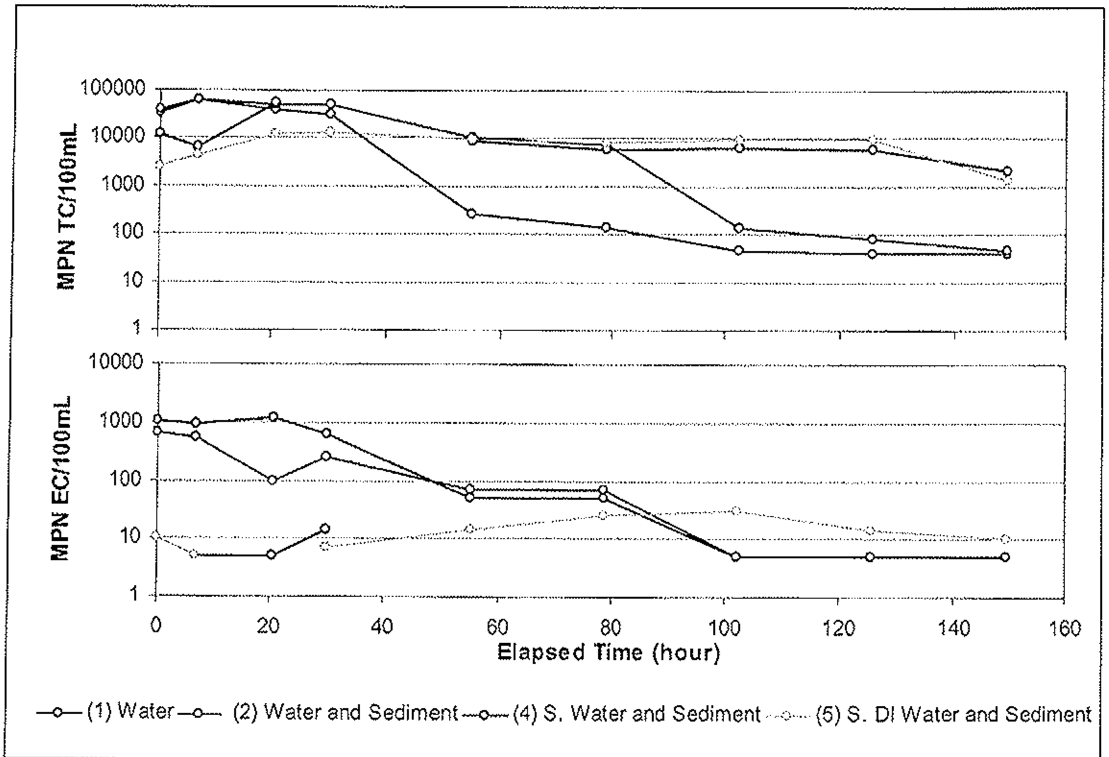


Figure 6-7. Concentrations of total coliforms and *E. coli* versus elapsed time during Study 4 (April 10, 2009).

Microcosms 4 and 5 are missing data points for the *E. coli* concentrations in Figure 6-7 (Study 4) because the dilutions made for those rounds were too large to give plausible measurements, i.e. the concentration was less than 100 MPN/100mL, so estimating 50 MPN/100mL for a microcosm that previously had less than 3.5 times that concentration is not appropriate. This is another study where Microcosm 1 and 2's total coliform concentration decrease faster than Microcosm 4 and 5's. Microcosm 1 and 2's last concentrations differ from Microcosm 4 and 5's by an order of magnitude. Microcosm 1 and 2's *E. coli* concentrations follow the same basic decrease while Microcosm 4's *E. coli* concentration stays practically the same. Microcosm 5's *E. coli* concentration shows a steady increase, and then starts to decrease towards the end.
The following are graphs of the natural log of the concentrations of total coliforms and *E. coli* versus elapsed time.

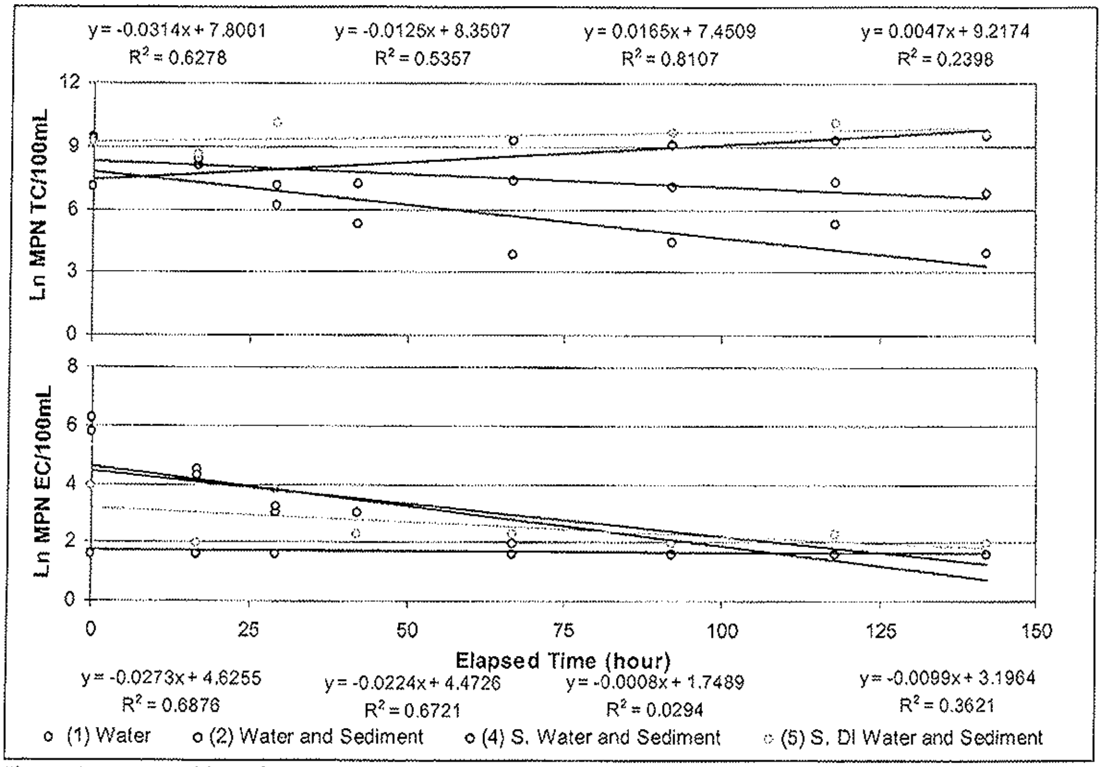


Figure 6-8. Natural log of the concentrations of total coliforms and *E. coli* versus elapsed time during Study 1 (July 11, 2008).

A first–order rate constant quantitatively expresses the decay that can be expected per unit time. The equation to integrate for a first-order model is

$$\frac{dc}{dt} = -kc$$

where k has units of t^{-1}. If $c = c_0$ at $t = 0$, then this equation can be integrated by separation of variables to yield

$$\ln c - \ln c_o = -kt$$

Taking the exponential of both sides gives

$$c = c_o e^{-kt}$$

Study 1 (Figure 6-8) resulted in total coliform rate constants of k_W= 0.031 hr^{-1}, k_{ws}= 0.012 hr^{-1}, k_{sws}= 0.016 hr^{-1}, and k_{sdws}= 0.005 hr^{-1} with R^2 values of 0.63, 0.54, 0.81 and 0.24 respectively, located in the top row of Figure 6-8. Study 1 resulted in *E. coli* decay rate constants of k_W= 0.027 hr^{-1}, k_{ws}= 0.022 hr^{-1}, k_{sws}= 0.001 hr^{-1}, and k_{sdws}= 0.010 hr^{-1} with R^2 values of 0.69, 0.67, 0.03 and 0.36 respectively, located in the bottom row of Figure 6-8.

In this study, the *E. coli* decay rate constant for Microcosm 4 was the lowest for all the studies. This is due to the concentration essentially not changing throughout the study.

Similar plots were carried out for Studies 2 through 4, as described below.

Study 2 resulted in a total coliform rate constant of k_W= 0.044 hr^{-1} with an R^2 value of 0.71. Study 2 resulted in *E. coli* rate constants of k_W= 0.001 hr^{-1}, k_{ws}= 0.008 hr^{-1}, k_{sws}= 0.008 hr^{-1}, and k_{sdws}= 0.002 hr^{-1} with R^2 values of 0.17, 0.18, 0.29, and 0.01 respectively. In this study, the *E. coli* decay rate constant for Microcosm 1 was the lowest for all the studies. This is another case where the concentration essentially did not change throughout the study.

Study 3 resulted in total coliform rate constants of k_W= 0.054 hr^{-1}, k_{ws}= 0.021 hr^{-1}, k_{sws}= 0.049 hr^{-1}, and k_{sdws}= 0.061 hr^{-1} with R^2 values of 0.93, 0.34, 0.97 and 0.98 respectively. Study 3 resulted in *E. coli* rate constants of k_W= 0.040 hr^{-1}, k_{ws}= 0.046 hr^{-1}, k_{sws}= 0.039 hr^{-1}, and k_{sdws}= 0.037 hr^{-1} with R^2 values of 0.90, 0.96, 0.96, and 0.89 respectively.

Study 4 resulted in total coliform rate constants of k_w= 0.058 hr^{-1}, k_{ws}= 0.054 hr^{-1}, k_{sws}= 0.011 hr^{-1}, and k_{sdws}= 0.003 hr^{-1} with R^2 values of 0.86, 0.91, 0.46 and 0.04 respectively. Study 4 resulted in *E. coli* rate constants of k_W= 0.043 hr^{-1}, k_{ws}= 0.035 hr^{-1}, k_{sws}= 0.003 hr^{-1}, and k_{sdws}= 0.006 hr^{-1} with R^2 values of 0.92, 0.90, 0.22, and 0.26 respectively.

Decay rate constants for total coliforms ranged between 0.03 hr^{-1} and 0.058 hr^{-1} for Microcosm 1, 0.012 hr^{-1} and 0.054 hr^{-1} for Microcosm 2, 0.011 hr^{-1} and 0.049 hr^{-1} for the Microcosm 4, and 0.003 hr^{-1} and 0.061 hr^{-1} for Microcosm 5.

Decay rate constants for *E. coli* ranged between 0.001 hr^{-1} and 0.043 hr^{-1} for Microcosm 1, 0.008 hr^{-1} and 0.046 hr^{-1} for Microcosm 2, 0.001 hr^{-1} and 0.039 hr^{-1} for Microcosm 4, and 0.002 hr^{-1} and 0.039 hr^{-1} for Microcosm 5.

6.4 Special Case: Microcosm 3 – Sterilized Sediment and Water

Microcosm 3 was to be used to demonstrate how bacteria would behave in water affected by nutrients suspending from sterilized sediment. To set up Microcosm 3, the sediment was autoclaved at 121°C for 1 hour and then added to the flask which was filled with water. Microcosm 3 was then monitored with the others. However, the results were very different. Bacteria concentrations increased dramatically then showed signs of decay towards the end of the studies.

DOC was measured in the water of all microcosms at the end of the studies. Microcosm 3 always had the highest DOC concentration at the end of the studies, and in studies 1 and 4, it was the only microcosm that had a higher final DOC concentration.

Table 6-1. Initial and final DOC concentrations for the four studies.[1]

ID	Date Sampled	DOC in water (mg/L)
TCR	7/11/08	2.95
Mic 3	7/18/08	6.57
TCR	8/19/08	NM
Mic 3	8/26/08	9.06
TCR	1/7/09	7.64
Mic 3	1/14/09	20.9
TCR	4/10/09	6.16
Mic 3	4/16/09	12.9

Because bacteria concentrations increased, decay rate constants were not calculated for this microcosm. However, there is a significant finding here that autoclaving sediment may release organic carbon to the water, possibly contributing to bacterial growth. After autoclaving the sediment, the DOC concentrations increased. This is based on each Microcosm 3 having a higher DOC value at the end of the studies.

It was observed that nutrient levels also increased in Microcosm 3, evident from the water sample inventory summary located in the appendix. However, nutrient concentrations also increased in the other microcosms. It is inconclusive whether the DOC or nutrient concentrations or both are responsible for the bacterial growth in Microcosm 3.

7 Conclusions

7.1 Part A: Creek Studies

The mean kinetic rate constant (k) for total coliform, which includes all of the total coliform k values from both experiments is 0.0346 hr^{-1}; the k for *E. coli* is .0308 hr^{-1}. These values are very similar, only differing by nearly four thousandths of a decimal.

The k values for September and October are similar with the largest difference between the *E. coli* for DAV2 (0.0149 hr^{-1}).

7.2 Part B: Lower Lake Studies

7.2.1 Water Quality

The maximum allowable concentration of *E. coli* for recreational waters is 235 MPN/100 mL for any single water sample (EPA 1986). The lowest initial water concentration measured during

[1] Although the DOC sample was not measured in the second study, the final DOC concentration in Microcosm 3 was approximately 27% greater than the second highest DOC concentration.

the study was 355 MPN/100 mL. According to Stevens Institute of Technology (2009) the nitrate and phosphate concentrations exhibited excellent water quality, and the dissolved oxygen concentrations exhibited fair to good water quality.

7.2.2 Bacteria Decay Rates

Microcosm 1's total coliform concentration decreased the fastest in all studies, excluding study 3's Microcosm 5. Microcosm 1's *E. coli* concentration decreased the fastest in studies 1 and 4. Microcosm 2's total coliform and *E. coli* concentration decreased second fastest to Microcosm 1 in Studies 1 and 4.

Comparing Microcosms 1 and 2, a lower decay rate is expected from Microcosm 2, since it contained sediment, which contained nutrients. Microcosm 2, did, however, have a higher *E. coli* decay rate constant in Study 2 and 3 than Microcosm 1.

The highest concentrations of dissolved oxygen, nitrate, and DOC were recorded during studies 3 and 4. The bacteria concentrations were also the largest during these studies. It should be noted that the initial TOC concentration in the sediment was below the detection limit (< 0.05%) during these studies. It is assumed that the nutrients in the water were responsible for the high concentrations of both bacteria groups.

During Study 3, Microcosm 5's total coliforms decreased the fastest, which was followed by Microcosm 1. This is the only study where Microcosm 1's total coliforms did not have the highest decay rate. This study is also the only one in which Microcosm 2's total coliform concentration decreased the slowest. These findings may be due to the high initial DOC concentration.

During Study 4 the total coliforms in Microcosm 1 decreased the fastest, followed Microcosm 2. Microcosm 5's *E. coli* concentration slightly increases while Microcosm 4's *E. coli* concentration nearly remains unchanged. This study is the only one in which *E. coli* showed growth (5). Based on the cumulative microcosm graphs, Microcosm 1 yielded the highest decay rates for total coliforms (0.047/hr) and *E. coli* (0.037/hr). Microcosm 2 yielded the highest decay rate for *E. coli* (0.032/hr) while Microcosm 4 had the third highest decay rate for *E. coli* (0.024/hr). Microcosm 4 is the only microcosm that shared the values (0.024/hr) for total coliform and *E. coli* decay rate constants, suggesting that the microcosm environment had similar impacts on both bacteria populations. These graphs show that bacterial decay will occur faster when not influenced by sediment.

7.2.3 Special Case: Microcosm 3 – Sterilized Sediment and Lake Water

Results of Microcosm 3 suggested that autoclaving sediment may release DOC to the water, possibly contributing to bacterial growth. After autoclaving the sediment, the DOC concentrations increased. This is based on each Microcosm 3 having a higher DOC value at the end of the studies. Bacteria concentrations were always higher in Microcosm 3, excluding the last two rounds of the first study in which microcosms four and five had higher concentrations of total coliforms.

7.2.4 Implications for Water Quality Modeling

Distinct decay rates for bacteria were found specific to each microcosm. These rates can be taken into account when modeling for water quality. Whereas today's models consider only published decay rates of bacteria in water, this research aims to introduce decay rates, or at least a methodology to generate decay rates, that are influenced by sediment and nutrients.

7.2.5 Implications for Water Quality Management

It was found that in the sampling location for this study, *E. coli* concentrations were always above the maximum concentration allowed by USEPA (see section 4.1). The likely cause of the high concentrations is the consistent presence of dozens of birds in the vicinity. While the sampling collection site is not a swimming beach, it is within 600 m of a swimming beach. If the swimming beach were affected by bacteria contributed by the birds, one management option would be to establish an alternate bird habitat farther from the lake.

7.3 Recommendations for Further Analysis and Future Research

Recommendations for further research include conducting an investigation with a sufficient number of repetitions to enable a comprehensive statistical analysis of results. Perhaps multiple studies during the different seasons would suit research needs better by indicating when bacteria concentrations are at their highest and what water quality indicators are a primary influence on bacteria concentrations.

Although the sediment-water ratio showed no correlation with bacteria concentration, further studies could incorporate microcosms of similar composition but with different sediment-water ratios. For example, comparing a microcosm of water alone with 1) a microcosm consisting initially of a two-to-one sediment-water ratio and 2) a microcosm consisting initially of a four-to-one sediment-water ratio could possibly show an effect that sediment has on the bacteria concentration in the water.

For further studies a sediment particle size analysis should be conducted on the initial sediment sample from each study. This could possibly show an association of sediment particle size with bacteria concentration.

Watershed Assessment and Education

Basic Information

Title:	Watershed Assessment and Education
Project Number:	2008MS82B
Start Date:	7/1/2008
End Date:	6/30/2010
Funding Source:	104B
Congressional District:	02
Research Category:	Water Quality
Focus Category:	Water Quality, Education, Surface Water
Descriptors:	None
Principal Investigators:	Maifan Silitonga

Publications

1. Quarterly reports 2008-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Silitonga, M. and A. Johnson. 2009. "Watershed Assessment and Education" presentation made at the 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, in Conference Program, p. 6, http://www.wrri.msstate.edu/conference.asp.
3. Silitonga, M., Watershed Assessment and Education. 2009, oral presentation at 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, Conference Proceedings, p. 152, http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/09 – (To) 02/28/10

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Watershed Assessment and Education
Principal Investigator: Maifan Silitonga, Ph.D.
Institution: Alcorn State University
Address: 1000 ASU Drive, Alcorn State, MS 39096
Phone/Fax: 601-877-6534; 601-877-6523
E-Mail: msilitonga@alcorn.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: $8,791.00, Non-Federal (WRRI): $______, Non-Federal (ASU): $17,783.90, In-Kind: $________, Total Cost Share: $17,783.90

7/1/-09 – 9/30/09
Federal expenses include travel and student hourly pay to collect samples and conduct lab tests. Cost share was incurred from faculty, staff, and 1 student to assist in collecting samples. Efforts include going to sites, preparing ways to make some locations accessible, collecting samples, and testing samples. Project required more time on lab work, sampling and travel. In the month of August, PI participated in the MS Annual Water conference and presented.

10/1/09 – 12/31/09
Federal expenses include travel and student hourly pay to collect samples and conduct lab tests. Cost share was incurred from faculty, staff, and 1 student to assist in collecting samples. Efforts include going to sites, preparing ways to make some locations accessible, collecting samples, and testing samples. Materials and supplies for E. coli testing were overlooked and were not incorporated in the expenses contributed by the MS River Research Center.

1/1/10 – 3/31/10
Federal expenses covers partial student wages for the month of February.

Equipment (and cost) purchased during reporting period:
4/1/09 – 6/30/09
Nitrate sensor have been ordered and calibrated.

Progress Report (Where are you at in your work plan):
4/1/09 – 6/30/09
Collected and tested samples from 21 locations.

7/1/-09 – 9/30/09
Continued collecting and tested samples in July, August, and September from 22 locations each month.

10/1/09 – 12/31/09
Continued collecting and tested samples in 22 locations each month. The dried up creek has

not been filled.
1/1/31 – 3/31/10
Continued collecting and tested samples in 22 locations each month. The dried up creek has not been filled.

Problems Encountered:
4/1/09 – 6/30/09
Solutions to test for Phosphorus were ordered. However, we need a technician to operate the instrument. Some locations are difficult to reach, and we needed other field equipment as well as external manpower assistance to allow access to these water bodies. Travel and time (cost share) expenses were under-estimated.

7/1/09 – 9/30/09
One stream dried up in the summer time but two more locations were identified. Instruments needed calibration due to significant errors during quality assurance/quality control analysis.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Quarterly Report 2009-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.

Silitonga, M., Watershed Assessment and Education, 2009, oral presentation at 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, Conference Program, p. 6, http://www.wrri.msstate.edu/conference.asp.

Silitonga, M., Watershed Assessment and Education, 2009, oral presentation at 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, Conference Proceedings, p. 152, http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf.

Student Training (list all students working on or funded by this project)

Name	**Level**	**Major**
Rosner Buie	MS	Plant & Soil Science, Environmental Science
Dominique Davis	MS	Plant & Soil Science, Environmental Science

Next Quarter Plans:
1. Continue to collect water samples
2. Test water samples and send soil samples for testing

Section III. Signatures

Project Manager	**Date**
Maifan Silitonga, Ph.D.	3/31/10

Assessing the effectiveness of measures to reduce sediment loads in surface waters using 210Pb activity in lacustrine sediments

Basic Information

Title:	Assessing the effectiveness of measures to reduce sediment loads in surface waters using 210Pb activity in lacustrine sediments
Project Number:	2009MS84B
Start Date:	3/1/2009
End Date:	1/31/2011
Funding Source:	104B
Congressional District:	1st
Research Category:	Water Quality
Focus Category:	Sediments, Water Quality, Wetlands
Descriptors:	
Principal Investigators:	Gregg R. Davidson

Publications

1. Quarterly Reports, 2009-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Davidson, G.R., D.G. Wren, A.C. Patton and Z.A. Williams. 2010. Assessing the effectiveness of historic erosion control measures in watersheds using 210Pb in lake and wetland sediments. Baltimore, MD, March 14-16, 2010, GSA Abstracts with Programs, vol. 42, No. 1, p. 107

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/09 – (To) 02/28/10

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Assessing the effectiveness of measures to reduce sediment loads in surface waters using ^{210}Pb activity in lacustrine sediments

Principal Investigator: Gregg Davidson
Institution: University of Mississippi
Address: Geology & Geol. Eng., Carrier 118, University, MS 38677
Phone/Fax: 662-915-5824
E-Mail: davidson@olemiss.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: $6,607.38, Non-Federal (MWRRI): $3,469.57, Non-Federal (UM): $1,278.00, In-Kind: $________, Total Cost Share: $4,747.57

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):

4/1/09 – 6/30/09

Significant work has been done. Cores have been collected from three lakes: Moon Lake, Beasley Lake, and Lake Washington. Three cores were collected from each lake, sectioned, dried, and select intervals crushed. Samples from three of the cores have been submitted for ^{210}Pb analysis.

7/1/09 – 9/30/09

Limited funds have been spent to date because analyses are billed after completion. Several thousand dollars worth of samples are at two different labs waiting to be processed and will be billed upon completion.

Cores have now been collected from five lakes: Moon Lake, Beasley Lake, Lake Washington, Hampton Lake, and Roundaway Lake. At least three cores were collected from each lake, sectioned, dried, and select intervals crushed. Samples from four of the cores have been submitted for ^{210}Pb analysis, and results have been obtained for two of them. Preliminary analysis indicates that the method will be successful in quantifying the reduction in erosion in the watershed due to the implemented erosion control measures.

10/1/09 – 12/31/09

Cores have now been collected from five lakes: Moon Lake, Beasley Lake, Lake Washington, Hampton Lake, and Roundaway Lake. At least three cores were collected from the open water region each lake, sectioned, dried, and select intervals crushed. An additional core has also now been collected from wetland areas surrounding each lake. Partial ^{210}Pb results have been obtained from all five lakes. A complete set from Beasley Lake shows a very clear reduction in sediment accumulation rate at approximately the time when erosion control measures were implemented. Partial results from Moon Lake also show a reduction in the rate of sediment accumulation. Partial results from the other three lakes are more equivocal.

1/1/10 – 3/31/10

During the past quarter, cores were collected from the sixth and final lake. Four open-water cores were collected from Wolf Lake. These cores are being sectioned in preparation for the last round of ^{210}Pb analyses. Additional ^{210}Pb data has been obtained for three of the previously collected cores. Low expenditures this quarter reflect the fact that invoices have not yet been issued for this work. The bulk of the analytical expenditures will come in the next two quarters.

Some of the lakes show very clear reduction in sediment accumulation rate at approximately the time when erosion control measures were implemented. Data from Beasley Lake has been attached as an example.

Problems Encountered:

Slow turn-around of results from the analytical labs

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Quarterly reports 2009-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.

Davidson, G.R., D.G. Wren, A.C. Patton and Z.A. Williams. 2010. Assessing the effectiveness of historic erosion control measures in watersheds using ^{210}Pb in lake and wetland sediments. Baltimore, MD, March 14-16, 2010, *GSA Abstracts with Programs*, vol. 42, No. 1, p. 107

Published abstract:

Much effort and money has been invested in reducing erosion from watersheds in recent decades, both to protect the land surface and to decrease sediment loading in associated streams. Documenting the effectiveness of these efforts has been difficult. Erosion is often localized in small gullies or at meander bends making it difficult to normalize across an entire watershed. Assessing erosion by measuring sediment loads in streams is also complicated by large spatial and temporal variability and the inherent difficulties in measuring sediments transported in channels. One way of getting around these difficulties is to quantify the rate of sediment accumulation in the lakes or wetlands that ultimately receive sediment-laden runoff. If a lake has not been subject to scour from high flow events or storm activity, the rate at which sediment has been accumulating can be determined using radioisotopes deposited along with the sediment. For sediments deposited within the last century, ^{210}Pb is ideally suited with a half life of 22 years. If sediment accumulation has been constant over time, the natural log of excess ^{210}Pb activity verses depth will plot as a straight line. If erosion control efforts have been effective, a reduction in sediment accumulation should be apparent as a change in slope in the ^{210}Pb data.

Five lakes are under investigation in northwestern Mississippi on the ancestral floodplain of the Mississippi River. This region is under intensive agricultural production, and erosion of fields and subsequent degradation of associated water bodies is a concern. Four of the lakes have had erosion control measures implemented in the last 20 to 30 years, including installation of riparian buffer zones, slotted-board risers, and elevated berms at the edge of fields. Preliminary results from two of these lakes show clear changes in slope for the ^{210}Pb data, indicating a 75% reduction in sediment accumulation rate in Beasley Lake (2.0 to 0.5 cm/yr) and an 80% reduction in Moon Lake (1.5 to 0.3 cm/yr). Data from Lake Washington is erratic with no clearly defined trend, possibly indicating significant

turbation of these sediments. Results from the fourth lake, Roundaway Lake, are currently in process. As a control, cores taken from an unimproved section of Sky Lake show no change in the slope of ^{210}Pb data over the last 50 years.

Student Training (list all students working on or funded by this project)

Name	**Level**	**Major**
Jacob Ferguson	BS student	Geological Engineering
Austin Patton	BS student	Geological Engineering
Zach Williams	BS student	Geology

Next Quarter Plans:

4/1/09 – 6/30/09

Results are expected from the samples submitted thus far during the second quarter that will give a rough idea of the depth at which changes in sedimentation rates may have occurred in the first three lakes. These results will be used to select additional samples from the same cores to refine our understanding of the sediment accumulation history.

Samples will be submitted for Lake Washington, and a fifth lake is being considered for sampling.

7/1/09 – 9/30/09

Submission of samples from the fifth lake. Analysis of preliminary data from lakes sampled earlier to determine what additional samples need to be submitted to refine the ^{210}Pb curves.

10/1/09 – 12/31/09

(An abstract was submitted for review for the SE GSA meeting in Baltimore in the spring.)

10/1/09 – 12/31/09

An additional core will be collected from Beasley Lake to determine how reproducible the ^{210}Pb profile is. A single core will also be collected from Wolf Lake to add a sixth lake.

1/1/10 – 3/31/10

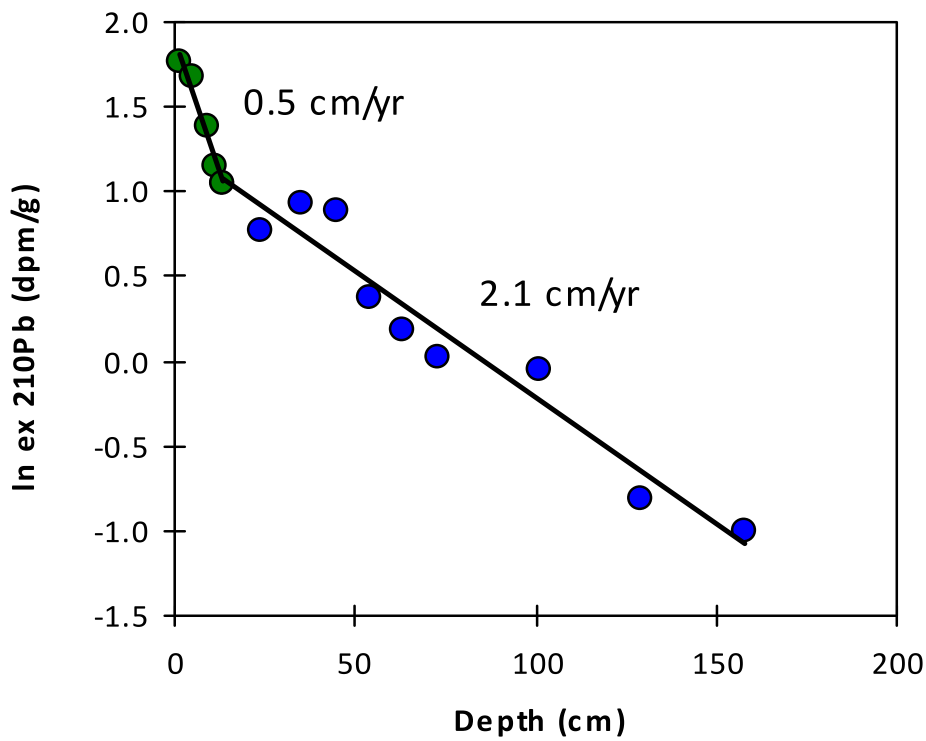
Submit the final sediment samples for ^{210}Pb analysis.

Section III. Signatures

Project Manager **Date**

3/31/10

Data from Beasley Lake, Mississippi.
A clear break in the ^{210}Pb data occurs at a depth consistent with the installation of erosion control measures in the mid-1990's, and indicates a 75% reduction in erosion losses from the surrounding watershed.



Influences of Land Surface / Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain

Basic Information

Title:	Influences of Land Surface / Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain
Project Number:	2009MS85B
Start Date:	3/1/2009
End Date:	11/30/2010
Funding Source:	104B
Congressional District:	3rd
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Water Quantity, Hydrology
Descriptors:	
Principal Investigators:	Jamie Dyer

Publications

1. Quarterly reports 2009-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Dyer, J.L. 2009. "Influences of Land Surface Characteristics on Precipitation over the Lower Mississippi Alluvial Plain," presented at the 2009 Mississippi Water Resources Conference, August 5-7, 2009, Tunica, MS, in Proceedings, 14 pgs. http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf
3. Dyer, J.L. 2009. Evaluation of Surface and Radar Estimated Precipitation Data Sources over the Lower Mississippi River Alluvial Plain. Physical Geography, 30, 430-452.
4. Dyer, J.L. 2009. Influence of Land Surface/Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain, a status report presented to the Mississippi Water Resources Research Institute Advisory Board, November 17, 2009, Mississippi State, MS.
5. Dyer, J.L. 2010. Four-dimensional visualization and analysis of convective rainfall generation along an abrupt land use/land cover boundary in northwest Mississippi, presented at the 91st Annual Meeting / 24th Conference on Hydrology, American Meteorological Society, Atlanta, GA.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/09 – (To) 02/28/10

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Influences of Land Surface / Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain

Principal Investigator: Jamie Dyer
Institution: Mississippi State University
Address: P.O. Box 5448 Mississippi State, MS 39762-5448
Phone/Fax: 662-325-5802
E-Mail: Jamie.dyer@msstate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: $8,058.69, Non-Federal (MWRRI): $6,917.01, Non-Federal (Dept.) $6,247.36,
In-Kind: ________, Total Cost Share: $13,164.37

Equipment (and cost) purchased during reporting period:
2 laptops at $349.99 each (plus $1.99 S&H) for use during project (data analysis, presentations, data storage). Total cost of $701.97. Details of equipment is as follows:

Acer Aspire One Netbook – Intel Atom N270 1.6GHz, 1 GB DDR2, 160GB HDD, 10.1" WSVGA, Windows XP

Purchased a 500 GB serial ATA hard drive for a computer in my office that is used by the funded graduate student ($62.98).

Purchased a SATA network available storage box to house 4 1 TB hard drives purchases previously ($401.98).

Progress Report (Where are you at in your work plan):
3/1/09 – 6/30/09

At this point, all necessary multi-sensor precipitation data has been prepared and archived. Additionally, meteorological analysis has been completed to determine appropriate days to include in analysis of precipitation over the study area. The next step in this project is to acquire and analyze satellite and soil moisture data to determine the specific influences and spatial extent of possible precipitation modification over the study area.

With regards to the second project, the WRF model domain has been generated over the project region and tests are being run to determine the best choice for model parameterization. Since high-resolution precipitation output is necessary for analysis, the methods by which cloud and precipitation processes are simulated are extremely important and must be chosen carefully.

7/1/09 – 9/30/09

At this point in the project I have completed the interpretation and analysis of precipitation and cloud features over the Mississippi Delta. This was done to identify the existence and location of possible mesoscale convective boundaries associated with vegetation and/or soil variations along the eastern edge of the Mississippi Delta. The results of this research have been presented at the (PDF attached). The manuscript associated with this presentation is in progress.

Additionally, the manuscript comparing the various precipitation estimation sources over the Mississippi Delta has been accepted by *Physical Geography*, and is currently in press. The results of this research will be combined with the research mentioned previously to continue examining the causes and influences of precipitation modification within and along the boundaries of the Mississippi Delta.

The budgeted money to be used for student funding has been given to Mark Baldwin, a first-year Ph.D. student interested in precipitation distribution and processes. Mr. Baldwin will assist in acquiring and interpreting precipitation data used in the second stage of the project, and will hopefully use the experience to develop related research projects.

Other expenditures during this reporting period include registration and travel costs to the 2009 annual Mississippi Water Resources Association conference as well as abstract fees for the annual meeting of the American Meteorological Society.

10/1/09 – 12/31/09

I am currently in the second stage of the project, which includes numerical weather simulations of a mesoscale boundary over the eastern Mississippi Delta boundary. The simulations are complete, and I am entering the analysis phase at this point. Recent research from an external project has allowed me to use 4D visualization methods to more fully interpret the simulated data, and some initial results have been obtained using these methods.

Results from this will be presented at the annual meeting of the American Meteorological Society (AMS) in Atlanta, Georgia in January; therefore, my current status also includes the generation of a presentation and short pre-print for the conference. The project results will also be included in a publication, which I have started working on as well.

1/1/10 – 3/31/10

During this reporting period I attended the annual meeting of the American Meteorological Society (AMS) in Atlanta, Georgia from January 17–21, 2010 and presented results from a project entitled "4D Analysis of Convective Rainfall Along a Surface Boundary in Northwest Mississippi".

Additionally, I completed a manuscript entitled "Analysis of a Warm-Season Convective Rainfall Event along an Abrupt Land Use / Land Cover Boundary in Northwest Mississippi", which is currently being reviewed by colleagues before submission to a peer-reviewed journal. I anticipate submission of the manuscript in late March or early April.

Problems Encountered:

None

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Dyer, J.L. 2009. Influences of land surface characteristics on precipitation over the lower Mississippi River alluvial plain. *2009 Annual Conference*, *Mississippi Water Resources Association*, Tunica, MS.

Dyer, J. L. 2009. Evaluation of Surface and Radar Estimated Precipitation Data Sources over the Lower Mississippi River Alluvial Plain. *Physical Geography*, **30**,430-452*.*

Dyer, J.L. 2009. Influence of Land Surface/Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain, a status report presented to the Mississippi Water Resources Research Institute Advisory Board, November 17, 2009, Mississippi State, MS.

Dyer, J.L. 2010. Four-dimensional visualization and analysis of convective rainfall generation along an abrupt land use / land cover boundary in northwest Mississippi. *91st Annual Meeting / 24th Conference on Hydrology*, *American Meteorological Society*, Atlanta, GA.

Student Training (list all students working on or funded by this project)

Name	Level	Major
Mark Baldwin	Ph.D.	Earth and Atmospheric Science

Next Quarter Plans:

3/1/09 – 6/30/09

Next quarter plans include completion of regional precipitation analysis over the study region and presentation of findings at the Mississippi Water Resources Conference. It is expected that these results will also be included in a manuscript to be submitted to a peer-reviewed journal, although the specific location where the manuscript will be submitted has yet to be determined.

As fall semester begins in August, partial student funding will be given to an incoming Ph.D. candidate, William (Mark) Baldwin. Mark will begin working with the WRF model to develop data sets for use in the simulational study of precipitation processes and patterns over the MS Delta. Additional computer equipment may be purchased during this time to aid in this.

7/1/09 – 9/30/09

Next quarter plans include completion of the manuscript associated with the presentation given at the 2009 annual Mississippi Water Resources Association conference. This manuscript is expected to be completed by early October. The next stage of the project dealing with simulated surface heat and moisture conditions over the Mississippi Delta will begin in earnest upon completion of the document.

The input data needed to run the numerical weather simulations over the Mississippi Delta have already been acquired; therefore, the next step is to prepare the model domain and perform the simulations. This is expected to be completed by early November, at which point the analysis and interpretation of the data will commence. The analysis should continue through the end of December, at which point I will begin preparation of the final manuscript as well as the presentation to be given at the annual meeting of the American Meteorological Society in Atlanta, GA.

10/1/09 – 12/31/09

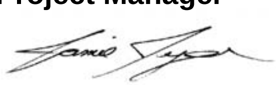
Next quarters plans include a presentation at the AMS annual conference in Atlanta, Georgia, as well as the development and submission of a publication on recent work involving the numerical simulation and analysis of a mesoscale boundary over the eastern border of the Mississippi Delta.

1/1/10 – 3/31/10

Next quarters plans include submission of a manuscript related to warm-season convective rainfall over the Mississippi Delta (see “Progress Report” section above). Additionally, further analysis into surface influences on the convection will be done, which will be presented at the Mississippi Water Resources Conference in November.

Section III. Signatures

Project Manager



Date

3/11/10

Water quality and other ecosystem services performed in wetlands managed for waterfowl in Mississippi

Basic Information

Title:	Water quality and other ecosystem services performed in wetlands managed for waterfowl in Mississippi
Project Number:	2009MS86B
Start Date:	3/1/2009
End Date:	7/31/2010
Funding Source:	104B
Congressional District:	3rd
Research Category:	Biological Sciences
Focus Category:	Wetlands, Ecology, Water Quality
Descriptors:	
Principal Investigators:	Richard Kaminski, Amy B. Spencer

Publications

1. Quarterly reports 2009-2010 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Spencer, A.B. and R.M. Kaminski. 2009. Preliminary assessment of ecosystem services provided by moist-soil wetlands, a poster presented at the 2009 Mississippi Water Resources Conference, Tunica, MS, August 5-7, 2009, in Proceedings, p. 31. http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf
3. Spencer, A.B., H.M. Hagy, and R.M. Kaminski. 2009. Crayfish-harvest potential in natural wetlands managed for waterfowl in Mississippi, a poster presented at the 5th North American Duck Symposium, Toronto, Ontario, Canada, August 17-21, 2009.
4. Spencer, A.B., H.M. Hagy, and R.M. Kaminski. 2009. Crayfish-harvest potential in wetlands managed for waterfowl in Mississippi, a poster presentation at the 139th meeting of the American Fisheries Society, Nashville, TN. August 31-September 3, 2009.
5. Spencer, A.B. and R.M. Kaminski. 2009. Crayfish-harvest potential in moist-soil wetlands, status report presented to the Mississippi Water Resources Research Institute Advisory Board, Mississippi State, MS, November 17, 2009.
6. Spencer, A.B. and R.M. Kaminski. 2009. Crayfish-harvest potential in moist-soil wetlands. Delta Wings Hunt Club. Batesville, MS. November 20, 2009.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/09 – (To) 02/28/10

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Water quality and other ecosystem services performed in wetlands managed for waterfowl in Mississippi
Principal Investigators: Richard M. Kaminski, Ph.D., and Amy B. Spencer
Institution: Department of Wildlife, Fisheries and Aquaculture, Mississippi State University
Address: 775 Stone Blvd.
Phone/Fax: 662-325-2623
E-Mail: rkaminski@cfr.msstate.edu; aspencer@cfr.msstate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: $6,044.34, Non-Federal (WRRI): $7,648.30, Non-Federal (Dept.): $9,564.00, In-Kind: $991.50, Total Cost Share: $18,203.80

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):
3/1/09 – 6/30/09
We selected 10 moist-soil wetlands (i.e., dominated by annual grasses and sedges) on public and private lands in Mississippi that were managed to retain water during spring 2009 and enable sampling for native crayfish, water quality, and other wetland metrics. Locations of moist-soil wetlands were: Yazoo National Wildlife Refuge, Hollandale, Mississippi; Panther Swamp National Wildlife Refuge, Yazoo City, Mississippi; Morgan Brake National Wildlife Refuge, Tchula, Mississippi; Coldwater National Wildlife Refuge, Charleston, Mississippi; York Woods, Charleston, Mississippi; Noxubee National Wildlife Refuge, Brooksville, Mississippi; Trim Cane Wildlife Management Area, Starkville, Mississippi; Property of Mr. Ray West, Pheba, Mississippi; and Property of Mr. C. Clark Young, West Point, Mississippi. We sampled moist-soil wetlands for crayfish and other aquatic macro-invertebrates, water quality metrics, and detrital composition between mid-March through mid-June 2009. As water temperatures warmed (>18 C), we sampled wetlands for crayfish on alternate weeks using conventional pyramid crayfish traps. We delineated 1-2 ha areas of each wetland and set traps at a density of ~25 traps/ha. We baited traps with a combination of cattle feed and chicken gizzards, crayfished for 48 hours, and transported all crayfish to the lab where we identified each crayfish to species, sex, measured their carapace from rostrum to posterior margin of the carapace (mm), and weighed (g) each individual. During each trapping event, we took random grab samples of water and analyzed them for PO_4, NH_3, and NO_3 within 24 hours. We will also analyze these samples for total suspended solids. We also measured morning water temperature, dissolved oxygen, pH, and conductivity. We also took monthly samples of plant detritus and macroinvertebrates. Finally, as wetlands were dewatered in June,, we took grab samples to analyze effluent water for PO_4, NH_3, NO_3, and total suspended solids. We collected a total of 90698 g of crawfish and the cumulative catch of crawfish per wetland ranged from 500 g to 21630 g.

7/1/09 – 9/30/09
We selected 10 moist-soil wetlands (i.e., wetlands dominated by annual grasses and sedges) on public and private lands in Mississippi that were managed to retain water during spring 2009 and enable sampling for native crayfish, water quality, and other wetland metrics. Locations of moist-soil wetlands were: Yazoo National Wildlife Refuge, Hollandale, Mississippi; Panther Swamp National Wildlife Refuge, Yazoo City, Mississippi; Morgan Brake National Wildlife Refuge, Tchula, Mississippi; Coldwater National Wildlife Refuge, Charleston, Mississippi; York Woods, Charleston, Mississippi; Noxubee National Wildlife Refuge, Brooksville, Mississippi; Trim Cane Wildlife Management Area, Starkville, Mississippi; Property of Mr. Ray West, Pheba, Mississippi; and Property of Mr. C. Clark Young, West Point, Mississippi. During each crayfish trapping event, we took random grab samples of water and analyzed them for PO_4, NH_3, NO_3, and total suspended solids.

We collected a total of 90.7 kg of crawfish and the cumulative catch of crawfish per wetland ranged from 0.5 kg to 21.6 kg. The harvestable size of individual crayfish and the expected daily catch of crayfish from rice fields in Louisiana is 20 g and 10.5 kg/ha/day respectively. These values are the only available estimates to compare with our catches of moist-soil crayfish. The pooled mean daily catch for all wetlands was lower than this comparable estimate at 1.75 kg/ha/day although some wetlands yielded 4-7 kg/ha/day. Although total catches were lower than commercial yields, individual crayfish averaged 28.3 g and were much larger than commercially harvestable crayfish. We compared crayfish length-frequency distributions to evaluate relative differences in sizes of crayfish in different wetlands. Because the two species that we captured (*Procambarus clarkii* and *P. acutus*) may have different growth parameters, we separated the two species for further analysis. We found that *P. clarkii* individuals were much larger in wetlands that were located in the southern delta of Mississippi (Kruskal-Wallis, $p<0.0001$). Additionally, *P. acutus*, which was a ubiquitous species, was larger in wetlands in the delta. In east Mississippi wetlands, *P. acutus* was the only species captured and the mean size differed significantly among all wetlands (Kruskal-Wallis, $p<0.0001$).

We compared pooled mean values of water quality variables over the sampling time period. Mean total suspended solids (TSS) declined from 32.2 mg/L to 15.1 mg/L over the 3 month sampling period. Additionally, NH_3-N declined from 0.82 mg/L to 0.52 mg/L. Nitrate-Nitrogen and Phosphate did not change and averaged 0.02 and 0.44 mg/L. Whereas vegetation in each wetland changed over time, there was no relationship between crayfish and vegetative biomass in sampled moist-soil wetlands.

We conclude that although our catches were lower than expected from traditional crayfish harvest operations, a potential for crayfish harvest exists in moist-soil wetlands. We estimated natural crayfish yield, a possibly cost-effective alternative to stocked commercial operations. Additionally, whereas rice fields and moist-soil wetlands both provide habitat for wetland wildlife, specifically wintering waterfowl, moist-soil wetlands may provide a more diverse array of habitat components such as food resources and thus managing moist-soil wetlands for natural crayfish harvest will provide beneficial wildlife habitat. Finally, although we have only provided estimates of water quality parameters within moist-soil wetlands, the ability of wetlands within agriculture wetlands to transform and remove imported nutrients from receiving watersheds within agricultural landscapes such as the Mississippi Alluvial Valley is well documented. We therefore endeavor to demonstrate that establishing moist-soil wetlands for waterfowl habitat and crayfish harvest opportunities may change nutrient imports and exports that effect imperiled ecosystems such as the Lower Mississippi River Basin and the Gulf of Mexico.

10/1/09 – 12/31/09
We completed all field work and crayfish laboratory and statistical analyses for the 2009 field season. Since the last quarter, we developed and submitted grant proposals to the Mississippi Water Resources Research Institute and to the EPA Science To Achieve Results Fellowship

program, and Ms. Spencer has submitted her academic research proposal to the graduate committee and with her committee members, Drs. Avery, D'Abramo, Grado, Kaminski, and Kroger. In collaboration with Dr. Robert Kroger, we are drafting wetland water quality sampling and analysis protocols for the 2010 sampling season. We have also visited with MSU Department of Food Science faculty and have begun collaboration on a crayfish palatability and consumer acceptability experiment.

1/1/10 – 3/31/10
We completed all field work and crayfish laboratory and statistical analyses for the 2009 field season. We collected a total of 90.7 kg of crawfish and the cumulative catch of crawfish per wetland ranged from 0.5 kg to 21.6 kg. The harvestable size of individual crayfish and the expected daily catch of crayfish from rice fields in Louisiana is 20 g and 10.5 kg/ha/day respectively. These values are the only available estimates to compare with our catches of moist-soil crayfish. The pooled mean daily catch for all wetlands was lower than this comparable estimate at 1.75 kg/ha/day although some wetlands yielded 4-7 kg/ha/day.

We purchased an additional 160 crayfish traps to expand our research into Arkansas and Louisiana. We now have a total of 390 traps. We have visited prospective sites for crayfish sampling in 2010. Sites visited include National Wildlife Refuge and Wetland Reserve Program lands in MS, AR, and LA. We will begin crayfish and water quality sampling 4 April 2010. In these 3 states of the MAV, we will harvest crayfish from 5 wetlands in Louisiana, 4 wetlands in Arkansas, and 9 wetlands in Mississippi. Additionally, we will continue to sample crayfish in 2 wetlands in east Mississippi: Noxubee National Wildlife Refuge and the property of Mr. Clark Young. These sites serve as demonstration sites for area high school students and will be used to provide estimates of crayfish production to landowners that practice moist-soil wetland management in east Mississippi. We have also purchased water level loggers and constructed storm flow samplers. We will sample effluent water quality from 6 wetlands distributed across the Mississippi MAV. We are sampling these 6 wetlands to estimate total loads of sediment and nutrients delivered by the wetlands into receiving waterbodies. We also will install water samplers in adjacent ditches draining agriculture fields. We have designed an experiment to compare loads of nutrients and sediments delivered by agricultural ditches and wetlands in the same watershed. We have hired a field technician, a B.S. candidate in wildlife and fisheries sciences (Mason Conley, MSU; listed below) who will gain valuable field and laboratory experience being associated with this research project.

Problems Encountered:
3/1/09 – 6/30/09
We were limited by the number of crawfish traps this year. We had 100 traps donated to us by Mr. C. Clark Young, West Point, Mississippi and Dr. Lou D'Abramo (MSU Graduate School) purchased another 130 traps. Most wetlands were >10 acres and therefore, we did not have enough traps to simultaneously sample the entire area of numerous wetlands. We adapted to this problem by limiting of sphere of inference in each wetland to 2-4 acres. We were then able to trap at least 4 wetlands simultaneously and transported traps to and from each wetland with a trailer on loan from the Mississippi Extension Service. We plan on obtaining additional traps for subsequent years. Additionally, at the beginning of the sampling period, access was limited to field water quality monitoring equipment and we were unable to gather information on temperature, dissolved oxygen, pH, and conductivity during a small number of sampling events. Finally, some wetlands were scheduled not to be drained this year or had dried prematurely and we did not sample effluent water at these sites.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Spencer, A. B. and R. M. Kaminski. 2009. Preliminary assessment of ecosystem services provided by moist-soil wetlands. Poster. Presented at the Mississippi Water Resources Conference, Tunica, MS. August 5-7, 2009.

Spencer, A.B., H.M. Hagy, and R.M. Kaminski. 2009. Crayfish-harvest potential in natural wetlands managed for waterfowl in Mississippi. Poster. Presented at the 5th North American Duck Symposium, Toronto, Ontario, Canada, August 17-21, 2009.

Spencer, A.B., H.M. Hagy, and R.M. Kaminski. 2009. Crayfish-harvest potential in wetlands managed for waterfowl in Mississippi. Poster Presentation presented at the 139th meeting of the American Fisheries Society, Nashville, TN. August 31-September 3, 2009.

Spencer, A.B. and R.M. Kaminski. 2009. Crayfish-harvest potential in moist-soil wetlands. Mississippi Water Resources Research Institute. Advisory Board Meeting. Starkville, Mississippi. November 17, 2009.

Spencer, A.B. and R.M. Kaminski. 2009. Crayfish-harvest potential in moist-soil wetlands. Delta Wings Hunt Club. Batesville, Mississippi. November 20, 2009.

Student Training (list all students working on or funded by this project)

Name	**Level**	**Major**
Amy B. Spencer (Co-PI)	Ph.D.	Forest Resources
Christian Singleton (Wage)	High School	Starkville (MS) High
Alan Leach (Volunteer)	M.S.	Wildlife and Fisheries
Matt Palumbo (Volunteer)	M.S.	Wildlife and Fisheries
Jacob Straub (Volunteer)	Ph.D.	Forest Resources
Mason Conley (Wage Tech)	B.S.	Wildlife and Fisheries
Justyn Foth (Volunteer)	M.S.	Wildlife and Fisheries
Heath Hagy (Volunteer)	Ph.D.	Forest Resources

Next Quarter Plans:

3/1/09 – 6/30/09

We are in currently processing vegetation and invertebrate samples in the laboratory. Additionally, we will be processing all water samples for total suspended solids. We are in the process of entering crayfish population data. When all data have been compiled, we will describe the crayfish populations and harvest statistics and describe ecosystem services provided by moist-soil wetlands. We will also begin locating additional wetlands to incorporate in this study for next year. Finally, we have developed and submitted two additional grant proposal for supplemental funding and expansion of our research to Arkansas and Louisiana.

7/1/09 – 9/30/09

We will further analyze length-frequency distributions of crayfish. Parameters than can be determined from these distributions include size class structure and individual growth rates that can be used to describe the fishery of crayfish in moist-soil wetlands. We will also complete processing of invertebrates. We have submitted two grant proposals. One was not accepted and the other is still in review. We will be submitting again to the Mississippi Water Research Resources Institute for another year of funding for the current project and submit another grant to the Environmental Protection Agency.

10/1/09 – 12/31/09

We are grateful for receiving funding for 2010-2011 from MWRRI. We will select and visit sample wetlands for the 2010 field in January-February 2010. Additionally during this period, we will finalize water quality, wetland mapping, and crayfish harvesting protocols. Sampling will commence in March 2010. We will design an experiment on palatability and nutrient qualities of native crayfish from moist-soil wetlands and those commercially cultured in rice fields. This experiment will be performed in cooperation with Dr. Wes Schilling of the Department of Food Science, Nutrition, and Health Promotion. We anticipate development of a public media article regarding the comprehensive environmental and economic benefits of moist-soil management, including crayfish harvest. We will also complete processing of other invertebrate samples and estimate recruitment of crayfish in the wetlands sampled last year.

1/1/10 – 3/31/10
We are grateful for receiving funding for 2010-2011 from MWRRI. We anticipate development of a public media article regarding the comprehensive environmental and economic benefits of moist-soil management, including crayfish harvest. We will also complete processing of other invertebrate samples and estimate recruitment of crayfish in the wetlands sampled last year. We will complete crayfish harvesting in late June. Water quality sampling will continue through 2011. Additionally, our research has been incorporated in the 2009 and 2010 College of Forest Resources Natural Resources Summer Camps. In June, high school students from across the Southeast will participate in a crayfish harvest at Noxubee National Wildlife Refuge. The students will then learn about wetlands and crayfish and other invertebrate ecology and have opportunity to sample some ‘crayfish cuisine.’

Section III. Signatures

Project Manager **Date**

Molecular Identification of Bacterial Communities Associated with Biodegradation of Pentachlorophenol in Groundwater

Basic Information

Title:	Molecular Identification of Bacterial Communities Associated with Biodegradation of Pentachlorophenol in Groundwater
Project Number:	2009MS87B
Start Date:	3/1/2009
End Date:	6/30/2010
Funding Source:	104B
Congressional District:	3rd
Research Category:	Water Quality
Focus Category:	Groundwater, Toxic Substances, Water Quality
Descriptors:	
Principal Investigators:	M Lynn Prewitt, Hamid Borazjani, Susan Diehl

Publications

1. Quarterly reports (2009-2010) submitted to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Stokes, C.E., M.L. Prewitt, and H. Borazjani. 2009. Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater," poster presentation given at the 2009 Mississippi Water Resources Conference, Tunica, Mississippi, August 5-7, 2009. Proceedings, p. 32, http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf.
3. Beth Stokes made a presentation on Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater to the Mississippi Water Resources Research Institute Advisory Board, November 17, 2009, Mississippi State, MS.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/09 – (To) 02/28/10

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Molecular Identification of Bacterial Communities Associated with Biodegradation of Pentachlorphenol in Groundwater

Principal Investigator: M. Lynn Prewitt, Hamid Borazjani and Susan V. Diehl
Institution: Mississippi State University/Forest Products Department
Address: 100 Blackjack Road
Phone/Fax: 662-325-4083
E-Mail: lprewitt@cfr.msttate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: $10,039.34, Non-Federal (WRRI): $13,541.00, Non-Federal (Dept.): $12,514.30, In-Kind: $________ Total Cost Share: $26,055.39

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):
4/1/09 – 6/30/09
We are in the initial phase of this work plan which is to identify a method for extracting microbial DNA from contaminated groundwater. Several DNA extraction kits were evaluated on quality control samples containing inoculated bacteria and found to be successful. The first set of eight water samples from wells on the wood treating site have been collected, extracted for DNA and pentachlorophenol. Bacterial plating indicated that the total bacteria counts ranged from 200,000 to 300,000 colonies per milliliter in the eight samples and there were PCP tolerant bacteria on some samples but not on all.

7/1/09 – 9/30/09
The second set of samples was collected this month. Bacterial enumerations were performed and indicate a decrease in the total bacterial colonies and the PCP acclimated bacterial. This decrease ranged from 50% up to no bacteria detected. We are speculating the increase in rainfall during the month of September may have impacted the number of bacterial colonies. DNA has been recovered on 5 of the 8 samples from the original set of water samples. The 16s DNA fragment was amplified and cloned into E. coli transformants. Identification based on sequencing is in process.

10/1/09 – 12/31/09
The third set of samples were collected on December 3rd , 2009 and December 10th 2009. After reviewing the data from the previous sampling period and determining the microbial population was insufficient to recover adequate DNA, nutrients were added to the groundwater. On December 3rd, water samples were collected from the wells in order to achieve a baseline. Approximately 250 ml of a solution containing nitrogen, potassium and phosphorus was then added to each of the eight monitoring wells. Adjustments were made to the procedure for

derivatizing PCP and the average PCP concentration in the wells was determined to be 37.4 ppm on wells located above the air injection wells and 11.8 ppm below the air injection wells prior to the addition of the nutrients. One week later another set of samples were collected from the wells for analyses. The PCP tolerant bacteria present in the groundwater after the addition of the nutrients increased by an average of 44% over the 8 wells. The PCP tolerant bacteria have been extracted and the DNA seems adequate for identification. Both identification of the bacteria and PCP concentration determinations are in process.

1/1/10 – 3/31/10
During this quarter, water sampling was done on eight monitoring wells monthly; both pre- and post nutrient amendment at a former wood treating site in Mississippi. Microbial counts for total bacteria increased from 4% to 64 % after nutrient addition at the first sampling in January. No PCP tolerant bacteria were detected in the pre-amendment samples and only two of the 8 wells showed any PCP tolerant bacteria at the post-amendment sampling. By February and March, six and seven, respectively of the 8 wells showed PCP tolerant bacteria. The addition of nutrients did increase the population of both PCP tolerant bacteria and total bacteria. Two PCP degrading bacteria were identified using cloning and sequencing technology as *Bacteriodetes bacterium* and *Sphingomonas sp* isolated from well # 51 located down stream of the air blowers.

Problems Encountered:
4/1/09 – 6/30/09
DNA was recovered in only two of the eight samples collected from the wells. We speculate that the poor recovery is due to the bacteria attaching to the sediment in the samples and the fact that the samples were centrifuged in order to will remove the sediment. Other methods of removing the sediment from the water while retaining the bacteria such as filtering through sterilized cheesecloth and glass wool are being evaluated. In addition if these methods fail, as an alternative, bacterial colonies can be isolated from selective media and identified.
7/1/09 – 9/30/09
Preparation of PCP for analysis by gas chromatograph did not work the first time. The procedure will be repeated. If this does not work another derivatizing reagent will be used.
10/1/09 – 12/31/09
After modifying the procedure for analyzing the PCP and after addition of the nutrients, no problems were encountered.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):
Stokes, C.E., M.L. Prewitt, and H. Borazjani. 2009. Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater," poster presentation given at the 2009 Mississippi Water Resources Conference, Tunica, Mississippi, August 5-7, 2009. Proceedings, p. 32, http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf.

Beth Stokes made a presentation to the MWRRI advisory committee on November 17, 2009 at Mississippi State University on the Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater.

Student Training (list all students working on or funded by this project)

Name	**Level**	**Major**
C. Elizabeth Stokes	PhD graduate student	Forest Resources

Min Lee	BS	Forestry

Next Quarter Plans:
4/1/09 – 6/30/09
The plans for the next quarter will be to determine PCP concentration and work out procedures for identifying the bacteria found in the water samples. Samples will be collected and analyzed for three more quarters.

7/1/09 – 9/30/09
Plans for the next quarter will be to work out procedures for PCP analysis and perform PCP analysis on the first and second sets of samples.

10/1/09 – 12/31/09
Bacterial identification and PCP concentrations will continue. Another set of samples before and after addition of nutrients will be collected and analyzed.

1/1/10 – 3/31/10
Identification of the bacterial clones will continue in the next quarter and PCP concentration will be determined.

Section III. Signatures

Project Manager	**Date**
M. Lynn Prewitt Assistant Research Professor Forest Products Department	4/1/10

Information Transfer Program Introduction

The Mississippi Water Resources Research Institute addresses research and outreach efforts targeted at maintaining plentiful, quality water supplies throughout the state. The Institute is a hub for information and expertise on water resources issues within the state and region. We do this in full partnership with our public and private cooperators.

The Mississippi Water Resources Research Institute is committed to providing public outreach, education opportunities, and assisting with economic development activities. Researchers and students have the opportunity to present their research by giving oral and poster presentations. Also included are plenary sessions and workshops. Those persons subscribed to the MWRRI listserv receive newsletters, award opportunity notices, job opportunities, conference information, and timely water-related information.

Information Transfer Program-Publications

Basic Information

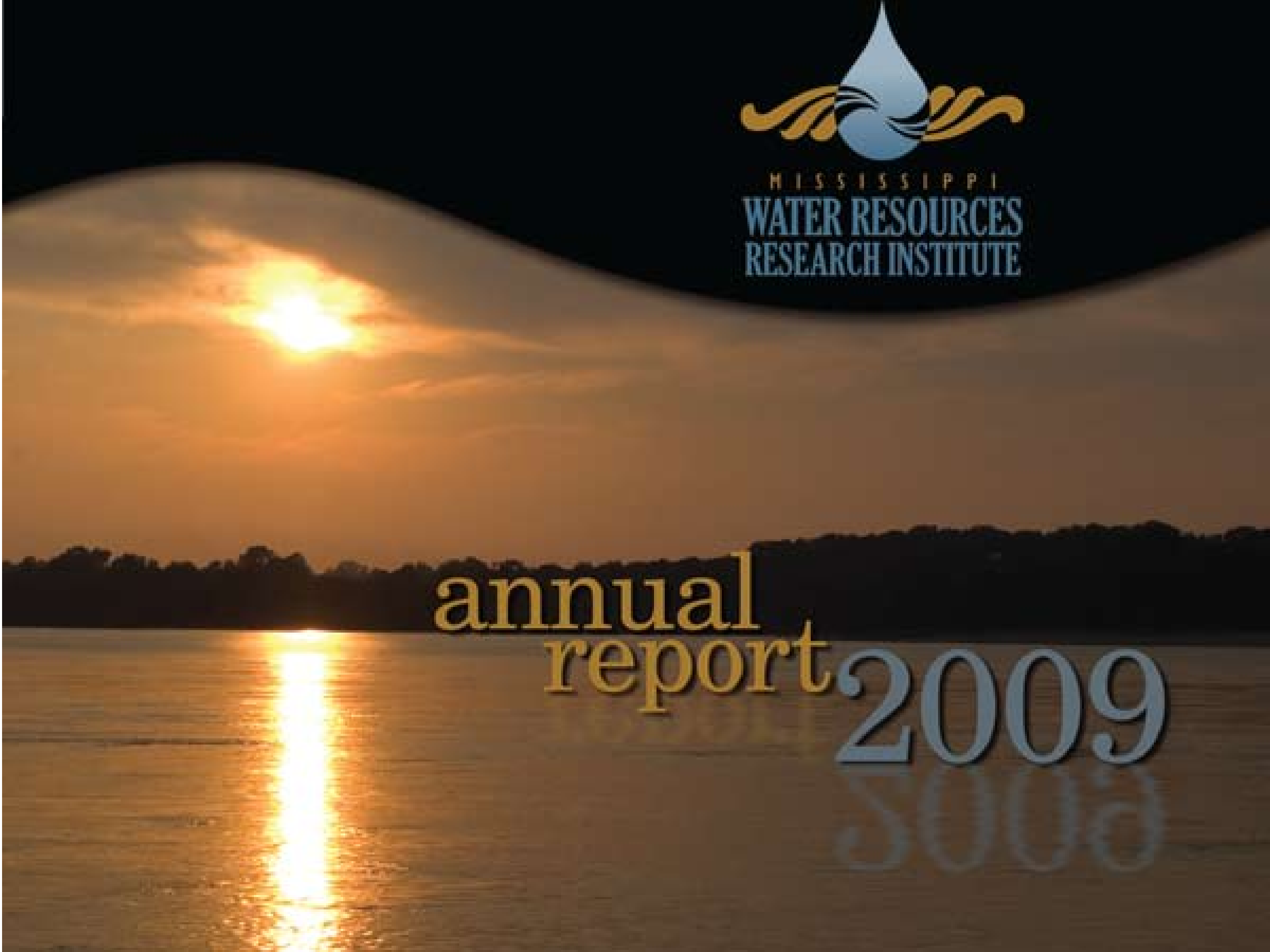
Title:	Information Transfer Program-Publications
Project Number:	2009MS124B
Start Date:	3/1/2009
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	3rd
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	George M. Hopper

Publications

1. Mississippi Water Resources Research Institute. 2009. 2009 Annual Report. Mississippi State University, Mississippi State, MS, 28 pages.
2. Mississippi Water Resources Research Institute. 2009. Newsletter, Summer 2009, Vol. 2(2), 7 pages. http://www.wrri.msstate.edu/newsletter_v2.2.asp
3. Mississippi Water Resources Research Institute. 2010. Newsletter, Winter 2010, Vol. 3(1), 6 pages. http://www.wrri.msstate.edu/newsletter_v3.1.asp

MISSISSIPPI
WATER RESOURCES
RESEARCH INSTITUTE

annual report 2009



MISSISSIPPI

WATER RESOURCES RESEARCH INSTITUTE

2009 ANNUAL REPORT

Director's Notes

Mississippi has a distinguished history of protecting water resources. In 1956, the Mississippi legislature passed surface water legislation, the first piece of legislation to address surface and ground water resources. Mississippi was the first state east of the Mississippi River to address water resources for the future.

As other states throughout the nation deal with water issues, we should all be grateful that our legislature had the foresight to establish water permitting and regulations some 53 years ago. This legislation has benefitted the state through data collection and allows for proactive management of water resources.

While Mississippi is fortunate to have plentiful supplies of clean water, we should never take these resources for granted. Because the legislature took a long thoughtful approach so many years ago to protect the water resources of the state, as consumers, we also must be vigilant in ensuring water resources are available for the future.

The Mississippi Water Resources Research Institute at Mississippi State University was established to address water issues facing our state. Working with our many partners throughout the state, the Institute is committed to providing public outreach, educational opportunities, and assisting with economic development activities. We are also committed to ensuring plentiful water resources for the next generation of Mississippians. This report details many of the activities the institute is addressing on the most pressing water-related problems. Thank you for participating in these endeavors.

George M. Hopper

Mississippi Water Resources Research Institute

The Mississippi Water Resources Research Institute (MWRRI) provides a statewide center of expertise in water and associated land use and serves as a repository of knowledge for use in education, research, planning, and community service.

The MWRRI goals are to serve public and private interests in the conservation, development, and use of water resources; to provide training opportunities in higher education whereby skilled professionals become available to serve government and private sectors alike; to assist planning and regulatory bodies at the local, state, regional, and federal levels; to communicate research findings to potential users in a form that encourages quick comprehension and direct application to water related problems; to assist state agencies in the development and maintenance of a state water management plan; and to facilitate and stimulate planning and management that:

- deals with water policy issues,
- supports state water agencies' missions with research on problems encountered and expected,
- provides water planning and management organizations with tools to increase efficiency and effectiveness.

The Mississippi Water Resources Research Institute is a unit of the Forest and Wildlife Research Center, Mississippi State University.

2008 Water Resources Conference

The 38th Annual Mississippi Water Resources Research Conference was held April 15-16, 2008 at the Hilton Convention Center in Jackson. More than 160 individuals attended the two-day conference, which included 13 student presenters. The conference included nine keynote speakers and offered 10 technical tracts including Delta Water Resources, Sedimentation, Groundwater, Coastal and Wetlands, Water Supply, Surface Water Quality, Agriculture, Modeling, Water Supply Systems, and Invasives.

A student competition was offered for oral and poster presentations. Four students posters were presented with Curtis Gebhard, a Clemson University graduate student garnering the top prize. Curtis is working on projects with USGS in the Jackson, Miss. office. Nine students made oral presentations during the conference. Jared McKee, an engineering graduate student at Mississippi State University garnered the top prize with his presentation on a water budget from the Tenn-Tom Waterway from Whitten Lock to Heflin Lock and Dam. University of Mississippi civil engineering graduate student Leili Gordji received second place for her presentation on movement and water pollutants in Sardis Lake. The third place winner was Seiji Miyazono, a Mississippi State University wildlife and fisheries graduate student. Seiji spoke on the effects of landscape factors on limnological conditions of floodplain lakes in the Yazoo River Basin. All of the students did an exemplary job and it was hard to pick three out of this excellent group of students.

The conference was sponsored by the Mississippi Department of Environmental Quality, Mississippi Public Service Commission, Mississippi Water Resources Association, National Oceanic and Atmospheric Administration, Mississippi Water Resources Research Institute, and the U.S. Geological Survey. Student prizes were funded by Clearwater Consultants, Pickering Inc., and Weyerhauser. Conference exhibitors included the Army Corps of Engineers, Mississippi World Trade Center, Pat Harrison Waterway, National Oceanic and Atmospheric Administration, National Aeronautic and Space Administration, and Yazoo-Mississippi Delta Levee Board.

USGS-funded Projects

Over the past six years (2003-2008) topics for research have included water quality, biological sciences, groundwater flow and transport, and climate and hydrologic processes with focus areas in non-point pollution, sediments, invasive species, management and planning, nutrients, pesticides, toxic substances, surface water, water use, and climatological processes. There have been **23 presentations** made at the Annual Mississippi Water Resources Research Conference, **26 written papers** and final reports submitted, and **17 peer-reviewed journal articles**. Three master's students wrote theses on their USGS-funded research. Training potential has included **one high school student**, **24 undergraduate students**, **26 master's students**, and **11 doctoral candidates**. There were **18 assistant professors**, **13 associate professors**, and **3 professors** performing research at **four Mississippi universities**.

MWRRI-funded Projects

These projects reflect the success of the institute to facilitate strong relationships between university researchers and Mississippi's state agencies and other organizations to identify and address priority water resource issues. These projects all include partial cost share from a participating non-federal agency or organization.

Natural Enhanced Transport of Agricultural Lead and Arsenic through Riparian Wetlands

Gregg Davidson, Geology and Geological Engineering, University of Mississippi

Riparian wetlands are widely regarded as efficient scavengers of a broad range of contaminants. Confidence in the ability of riparian zones to buffer anthropogenic inputs has derived primarily from studies of active inflow and outflow of chemical-laden water and sediment entering and exiting riparian systems. While such studies document short-term scavenging of specific chemicals, they do not reveal the permanence of sequestration. In Sky Lake, an oxbow lake-wetland in the Delta region of Mississippi, sediment cores representing 100 years of accumulation contain evidence that inorganic pesticides applied in the past were not permanently sequestered in the wetland surrounding the lake. Lead and arsenic spikes clearly present in open water sediments deposited approximately 75 years ago are entirely absent in the wetland sediments. The age of these sediments and elevated concentrations match historical records of lead and arsenate used for boll weevil control in surrounding cotton crops. The geomorphology, sediment distribution, and hydrology of the lake suggest that these contaminants could not have reached the lake without depositing a significant mass of contaminated sediment within the wetland.

The relative mobility of elements within and outside the high-concentration zones in the open-water cores was evaluated by completing a series of sequential extractions. Crushed sediment was placed on a multitiered filter rack and several solutions passed through in sequence: distilled water, a high ionic strength solution, a strong reducing agent, and a strong oxidizing agent. The leachate from each solution was analyzed by inductively coupled plasma mass spectrometry (ICP-MS), a type of mass spectrometry that is highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below one part in 10^{12}. It appears that the elements found in the high concentration zones are easily mobilized with a high ionic strength solution, which is consistent with the hypothesis that the source of elevated element concentrations is anthropogenic. Concentrations above background can be attributed to adsorption on solid surfaces and bound to organic material.

The results of this work have encouraged a follow up study that will include chemically persistent pesticide analyses (such as DDT) from one or both of these lakes, and additional elemental analyses in other lakes before submitting our findings.

MWRRI-funded Projects

Water Quality and Floristic Habitat Assessments in the Coldwater and Sunflower River Basins: Comparing Traditional Measures of Water and Habitat Quality to Index of Biotic Integrity Findings

Todd Tietjen, Wildlife and Fisheries; Gary N. Ervin, Biological Sciences, Mississippi State University

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The Coldwater and Sunflower Rivers in Northwest Mississippi are listed on the EPA Section §303(d) list of Impaired Waterbodies for Mississippi. Different river segments and tributaries in the basin are listed as impaired by biological impairment, nutrients, low dissolved oxygen, organic enrichment, pesticides, pathogens, and sediments. Total maximum daily loads have been developed for impaired reaches in the Coldwater and Sunflower River Basins, and water quality improvements are being implemented. Stream quality reference conditions are also being established based on industrial and engineering inspection scores rather than the narrative standards used in the past. This project is refining the development of water quality standards in the Lower Mississippi Alluvial Valley using a combination of additional measures of system status. Scientists will evaluate the incorporation of traditional measures of water quality and stream/river habitat quality measurements, such as floristic quality assessments or riparian areas, with the fish-based data that has already been collected to improve the establishment of appropriate water quality standards. It is expected that this research will enhance management of Lower Mississippi Alluvial Valley surface waters for human use, wildlife value, and water quality, as well as facilitate the administrative determination of water quality standards.

Further refinement of the IBI procedures are needed prior to their use as surrogate measures of water quality. The extremely low level of correlation between traditional measures of water quality and IBI scores were worse than anticipated. While the IBI procedure is defined by its ability to integrate water quality over long periods of time by using the fish community as an indicator was expected to result in relatively low levels of correlation, the extremely poor correlations were unexpected. A review of any of the parameters considered demonstrated that high or low levels of the parameter can be associated with high or low IBI scores. It may be necessary to re-evaluate the IBI scoring criteria in light of these results.

MWRRI-funded Projects

A Continuation of Climatological and Cultural Influences on Annual Groundwater Decline in the Mississippi Delta Shallow Alluvial Aquifer: Modeling Potential Solutions (Year Two)

Charles L. Wax, GeoSciences, Jonathan W. Pote, Agricultural and Biological Engineering, Joseph Massey, Plant and Soil Sciences, Mississippi State University; and Dean Pennington, Yazoo Mississippi Delta Joint Water Management District

Previous research resulted in a model that can simulate the effects of climatological variability, crop acreage changes, and specific irrigation methods on consequent variations in the water volume in the aquifer. The objective of this research is to continue development and refinement of the model by using 2007 climatological and water use data to validate the model results and to then use the model to test and recommend specific management strategies aimed at stabilizing the drawdown in aquifer water volume. The simulation model will be a valuable tool that can be easily used to reflect climatic variability and changes in the cultural practices in the region, and easily modified as new information becomes available. The model will enable management decisions to be made that will allow sustainable use of the groundwater resource.

Water use from the delta aquifer, contributed as in-kind contribution to the project by the Yazoo-Mississippi Delta Joint Water Management District, has been quantified by crop, acreage, and irrigation method. A relationship between growing season rainfall and irrigation water use has been developed to link interannual variations in water use to variations in climate (rainfall). Water use coefficients have been developed to link each specific type of irrigation on each crop type with a water use amount in acre feet per acre. A complete prototype water use model has been completed using acreages, irrigation methods, and management strategies in place

during 2006 in Sunflower County to predict annual water demand for cotton, rice, soybeans, corn, and catfish.

Identifying controls of aquifer recharge rates has not been successful. Attempts to relate recharge to Mississippi River stage on the west, to Grenada Lake stage on the east, and to non-growing season precipitation totals on both east and west sides of the delta have not been successful. Annual recharge used in the model scenarios was the average of the 19 years of measured recharge supplied by Yazoo Mississippi Delta Joint Water Management District. Changes in cultural practices adopted for the various model run scenarios are not known to be practical or economically feasible—these need to be confirmed as valid possibilities before rigid recommendations are developed. An attempt to make the model represent total water use across the entire delta region (not just Sunflower County) was not successful. All acreages of the five crop types were collected, but irrigated acreages were not available for all counties. Using the percentages of irrigated to non-irrigated acres measured for Sunflower County was not considered accurate after several unsuccessful attempts to estimate total delta-wide water use.

MWRRI-funded Projects

Multi-scale Evaluation and Analysis of Precipitation Patterns over the Mississippi Delta

Jamie Dyer, GeoSciences, Mississippi State University and Dean Pennington, Yazoo Mississippi Delta Joint Water Management District

The Mississippi River floodplain in northwestern Mississippi, often referred to as the Mississippi Delta, is extremely important for regional economic stability and growth due to widespread agriculture in the area. In terms of water resource management and climatological precipitation research, quantitatively defining the biases associated with available precipitation data sources is critical in choosing which source to use for a given application. These precipitation patterns should be reevaluated in terms of duration, frequency, and extent. Including long-term data from surface gauges along with shorter-term but higher resolution radar-derived rainfall estimates allow for a detailed analysis of past and current precipitation trends. This knowledge will allow a more thorough understanding of rainfall trends and patterns and potentially a better prediction model of future rainfall.

The energy, moisture, and turbulent fluxes all have strong influences on the generation and strength of mesoscale circulations, and therefore precipitation. Similar soil contrasts exist within the lower Mississippi River alluvial valley, and results indicate that precipitation patterns in and around the Mississippi Delta may be influenced by changes in land use, soil type, and/or soil moisture.

To better understand the causes of the observed rainfall distribution, it is necessary to perform a sensitivity analysis of convective forcing mechanisms and the associated precipitation generation. This type of study is best performed through numerical modeling; therefore, a second future project involves the use of the Weather Research and Forecasting model to identify the surface and atmospheric mechanisms most responsible for the existing rainfall distribution. Subsequent studies using mesoscale numerical models may then be appropriate to quantify the sensitivity of surface convergence zones to soil and vegetation. This strengthens the validity of performing an observational analysis of rainfall, followed by an associated analysis of simulated rainfall distribution over the same region.

The results of this research can be directly used by water resource managers as well as local and regional agricultural consultants and departments to identify local areas that are more or less sensitive to rainfall during the summer growing season. Agricultural producers in the region as well as planners will benefit from the model for forecasting. Additional results offer winter patterns that can be identified to quantify recharge rates of groundwater systems.

Monitoring and Modeling Water Pollution in Mississippi Lakes

Cristiane Q. Surbeck, Department of Civil Engineering, University of Mississippi

Pathogenic organisms have become a significant problem in the nation's surface waters as a result of non-point source pollution. For example, the Little Tallahatchie River in northern Mississippi contains two segments that are impaired for fecal coliform bacteria, an indicator of pathogenic pollution. These two segments of the river are included on the EPA Section §303(d) list of impaired waters in need of monitoring. The EPA requires state environmental protection agencies, such as the Mississippi Department of Environmental Quality, to provide total maximum daily loads for waters on the 303(d) list.

Lakes are one type of waterbody that has been typically left out of the process because of a lack of knowledge of the physical, chemical, and microbiological processes. This research is providing the necessary knowledge base to improve water quality in lakes.

Two lakes in northern Mississippi are being used as the field site to understand the processes. Sardis Lake is a dammed reservoir on the Little Tallahatchie River. The discharge from the reservoir forms a smaller lake adjacent to the dam, named Lower Lake. Both Sardis and Lower Lakes are located between the Little Tallahatchie River's two impaired segments. Given their location between segments containing high concentrations of fecal coliforms and their importance as recreational waterbodies, the lakes are important study areas to monitor and model the fate and transport of fecal coliform bacteria and other fecal indicator bacteria.

MWRRI-funded Projects

Watershed Assessment and Education

Maifan Silitonga, Mississippi River Research Center, Alcorn State University

The Coles Creek Watershed, located in the southwestern quadrant of the state of Mississippi, is in the EPA Section §303(d) list of impaired waters. Degradation of the ponds/lakes and streams/creeks in this watershed is caused mostly by biological impairment, followed by nutrients, organic enrichment or low dissolved oxygen, sediment/siltation, pesticides, and pathogens. These impairments cause the degradation of water quality thus causing euthrophication or algal bloom that can lead to fish kills and can also adversely affect human health.

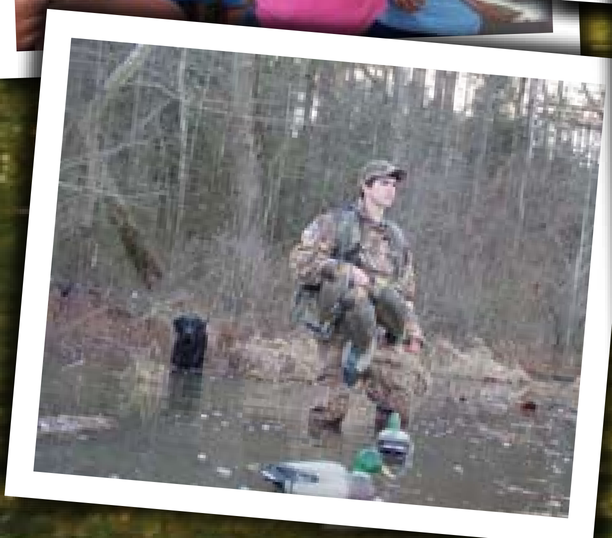
Water and soil samples from these ponds have been collected and are being analyzed for nutrient contents, and physical and biological parameters. The analysis will allow scientists to determine the best alternative management practices to be adopted and implemented in the community. Based on the results and findings, educational materials will be developed and disseminated to the communities. This effort will help increase the community awareness of their environment and encourage them to adopt and implement best management practices on their land which will lead to promoting environmental health and its sustainability. In addition, information will be posted on the Mississippi River Research Center's web site for accessibility and continuous support and assistance to the public.

Economic Development

Grenada County Economic Development Project

Mary Love Tagert, Mississippi Water Resources Research Institute; Jon Rezek and Ben Blair, Finance and Economics; Wayne Wilkerson, Landscape Architecture, Mississippi State University

Grenada Lake encompasses over 35,000 acres of water and welcomes some 2 million visitors annually. The U.S. Army Corps of Engineers lake began in 1954 to help control flooding in the Yazoo River Basin. The lake generates about $42 million in visitor spending each year, according to the U.S. Army Corps of Engineers. While the impact of the lake and facilities is significant to the surrounding area, the Grenada Chamber of Commerce is seeking to increase these numbers. The Chamber contacted the Mississippi Water Resources Research Institute for assistance in promoting economic development around the lake. The multi-use facility is managed by the Corps' Vicksburg District not only for flood control, but also for public recreation, conservation of fish and wildlife, and public forests. Grenada Lake is also home to Hugh White State Park and a recently constructed 18-hole golf course. The Chamber sought help in working with the Corps to promote economic development based on the lake's numerous recreational opportunities and bountiful natural resources. Institute staff led two public meetings to obtain feedback on amenities and opportunities Grenada's citizens would like to see around the lake. The Institute then teamed with faculty in Mississippi State's departments of landscape architecture and finance and economics to develop a preliminary master plan and conduct marketing and economic feasibility studies, respectively, for the area currently occupied by the Hugh White State Park. After receiving feedback on three alternative plans that were presented to the Chamber and various Grenada Lake stakeholders, various components of these plans were combined into one final conceptual plan for the Hugh White State Park area. Results of the plan and marketing and economic feasibility studies were recently presented at a public forum in Grenada.



Economic Development

Support for a Northeast MS Regional Water Management Plan

Mary Love Tagert, Mississippi Water Resources Research Institute

Water and wastewater infrastructure are national priority issues for economic development, public health and environmental concerns. To address these issues, the Tombigbee River Valley Water Management District formally created two new multi-county water and sewer organizations within their twelve member counties. A water management plan must be submitted for each of the new regional districts to obtain approval from the Mississippi Department of Environmental Quality . The district requested the Institute's assistance in organizing and drafting a water management plan for Itawamba, Prentiss, and Tishomingo Counties. A series of public meetings were held in Northeast Mississippi to discuss the contents of the plan and request input and help from regional and local stakeholders. A draft water management plan has been completed and circulated to the stakeholder group. Once the stakeholder group has been given an opportunity for feedback, the water management plan will be submitted to the district. Given the growing concern about long-term water supplies in the Southeastern United States and new development projects currently located in Northeast Mississippi, regional water and wastewater organizations are critical. Northeast Mississippi counties must plan, build, operate and maintain the necessary infrastructure to ensure an adequate water supply for the future and adopt a viable rate schedule for self-sufficiency.

Water Quality

Southeastern Regional Small Public Water Systems Technical Assistance Center (SE-TAC)

Mary Love Tagert, Mississippi Water Resources Research Institute; Jonathan Pote and Amy Schmidt, Department of Agricultural and Biological Engineering, Mississippi State University

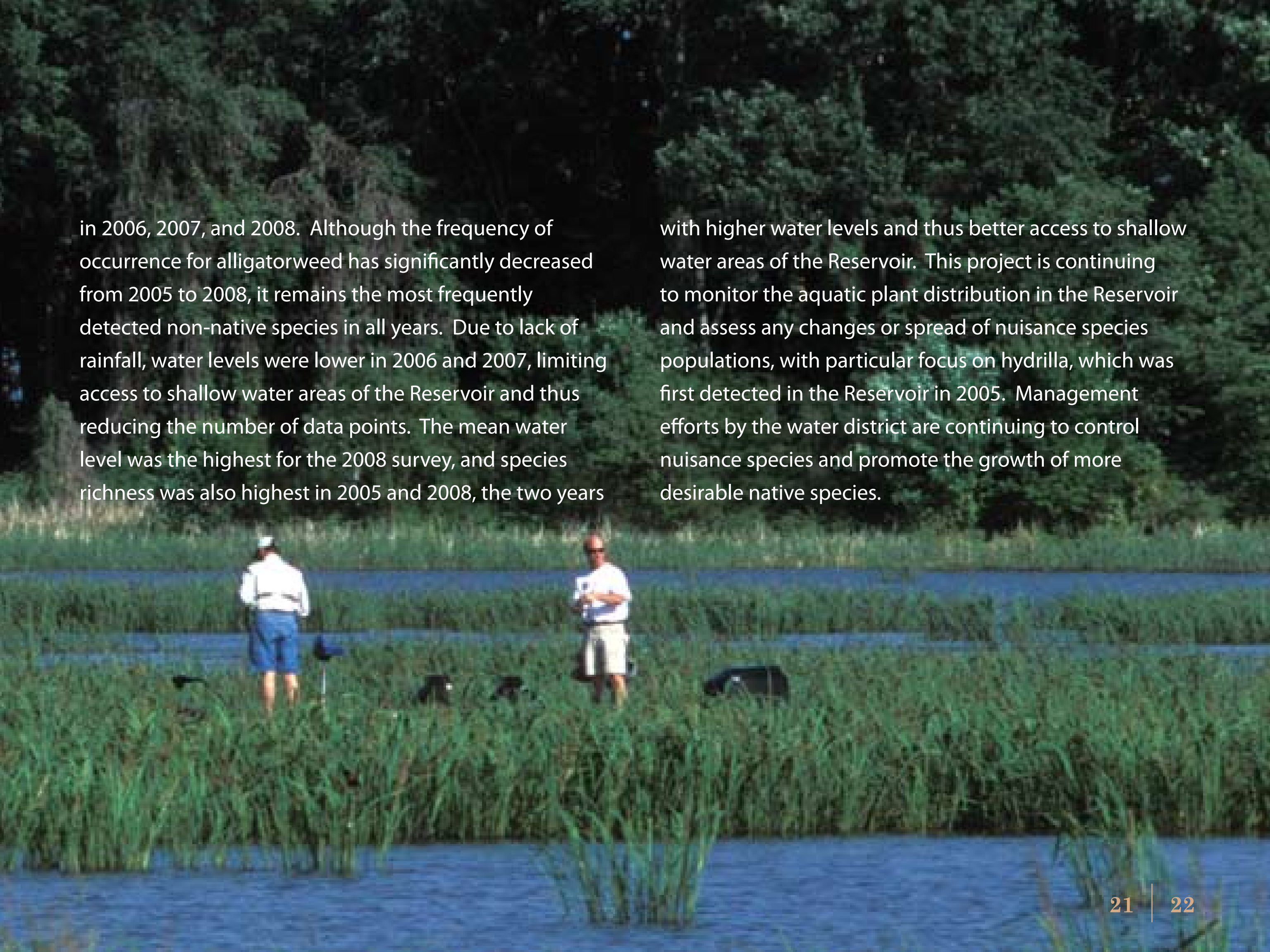
The Institute recognizes the need for assisting small public water systems in Mississippi and the southeastern United States to provide safe, clean drinking water to the public. The Southeastern Regional Small Public Water Systems Technical Assistance Center, funded by the Environmental Protection Agency, was established in 2000 and is administered by the Institute. The assistance center works with state and regional agencies to assist small public water systems in acquiring and maintaining the technical, financial, and managerial capacity to provide safe drinking water and meet the Safe Drinking Water Act's public health protection goals. SE-TAC has provided nearly $2 million on over 40 projects that have directly assisted small drinking water systems across the southeast region of the United States. Hundreds of small water systems have received training and assistance through SE-TAC funded projects.

Water Quality

Aquatic Plant Management Support for the Pearl River Valley Water Supply District

Mary Love Tagert, Mississippi Water Resources Research Institute; John D. Madsen, Geosystems Research Institute, Mississippi State University

The Ross Barnett Reservoir is Mississippi's largest surface water impoundment and serves as the drinking water supply for Jackson. The 33,000 acre waterbody is managed by the Pearl River Valley Water Supply District. This management includes the recreational amenities provided by the reservoir as well as the water and sewer services in the 50 nearby subdivisions. In recent years, invasive species have become an increasing problem in the Reservoir, clogging navigation channels, reducing recreational opportunities, and limiting access for users. The water supply districted requested the Institute's assistance in assessing the distribution of aquatic vegetation, monitoring the spread of invasive species, and evaluating ongoing treatment efforts throughout the Reservoir. Scientists in the Institute and the university's Geosystem Research Institute have conducted plant surveys since 2005. During the first plant survey, 19 plant species were observed. Alligatorweed was the most frequently detected species in 2005, and the native plant American lotus was the most frequently detected species



in 2006, 2007, and 2008. Although the frequency of occurrence for alligatorweed has significantly decreased from 2005 to 2008, it remains the most frequently detected non-native species in all years. Due to lack of rainfall, water levels were lower in 2006 and 2007, limiting access to shallow water areas of the Reservoir and thus reducing the number of data points. The mean water level was the highest for the 2008 survey, and species richness was also highest in 2005 and 2008, the two years with higher water levels and thus better access to shallow water areas of the Reservoir. This project is continuing to monitor the aquatic plant distribution in the Reservoir and assess any changes or spread of nuisance species populations, with particular focus on hydrilla, which was first detected in the Reservoir in 2005. Management efforts by the water district are continuing to control nuisance species and promote the growth of more desirable native species.

Publications

Davidson, G.R., D.G. Wren, S.G. Utroska and W.G. Walker. 2008. Are trace metal contaminants scavenged in riparian wetlands permanently sequestered? GSA Abstracts with Programs, Houston, TX, October 5-9, 2008, 40(6):414. http://gsa.confex.com/gsa/2008AM/finalprogram/abstract_150824.htm

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Schmidt, J., K.A. Brasher 2009. Mississippi Water Resources Research Institute Newsletter 2(2).

Schmidt, J., K.A. Brasher 2008 Mississippi Water Resources Annual Report.

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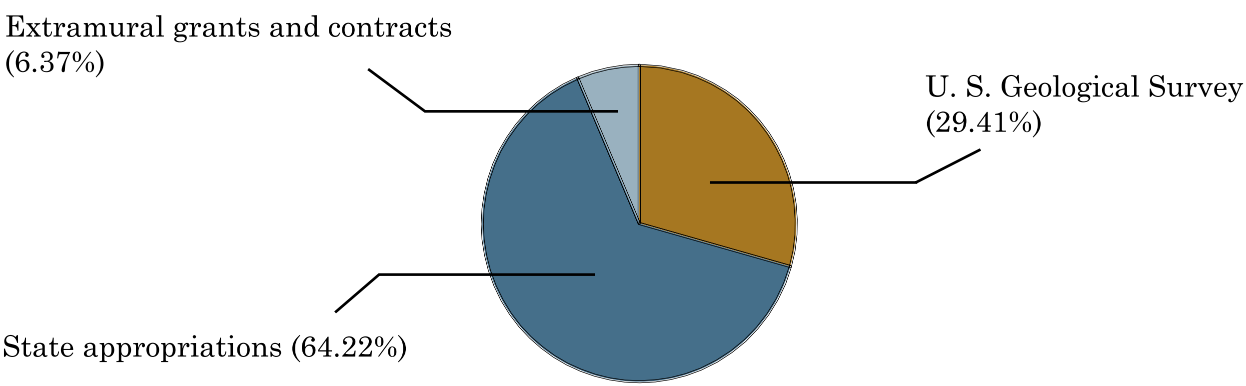
Financial Summary

Program Component	Federal	Non-Federal	Total
U.S. Geological Survey grant	$92,335		$92,335
State appropriations		$201,627	$201,627
Extramural grants and contracts		$20,000	$20,000
TOTAL	$92,335	$221,627	$313,962



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Information Transfer Program-Conferences

Basic Information

Title:	Information Transfer Program-Conferences
Project Number:	2009MS125B
Start Date:	3/1/2009
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Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	George M. Hopper

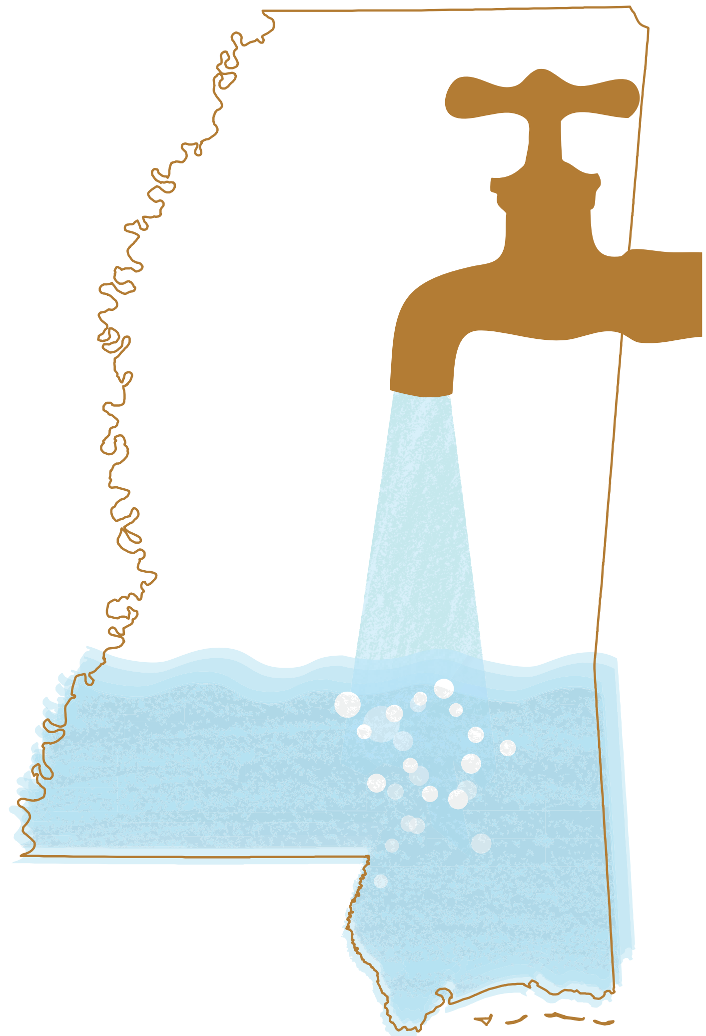
Publications

1. 2009, Mississippi Water Resources Conference Program and Abstracts, Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS, 12 pages. http://www.wrri.msstate.edu/conference.asp
2. 2009, Mississippi Water Resources Conference Proceedings, Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS, 260 pages. http://www.wrri.msstate.edu/pdf/2009_wrri_proceedings.pdf

2009

Mississippi Water Resources Conference

Harrah's Mid-South Convention Center Tunica, MS



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August 5 Wednesday

7:30 a.m.	**Registration and Continental Breakfast**
8:30 a.m.	**PLENARY SESSION** *(Moderator: George M. Hopper, Mississippi Water Resources Research Institute)*

Scott Mowery
National Oceanic and Atmospheric Administration

NOAA Gulf of Mexico Climate Services related to SLR, climate change, impact of climate change on ecosystems, watersheds, and others

Dean Pennington
Yazoo Mississippi Delta Joint Water Management District

Future of Water Supplies in the Mississippi Delta

DEAN PENNINGTON

Dean Pennington is the Executive Director of the Yazoo Mississippi Delta Joint Water Management District. The District works on water supply and related water quality problems facing irrigated agriculture, the environment and cities of the Delta. He received a bachelor's degree in chemistry and a doctoral degree in soil science from the University of Idaho. Prior to his current position, Pennington worked at the University of Arizona as an extension soils specialist and at Mississippi State University where he researched water resources and irrigation in the Delta. Pennington is a member of the Mississippi Water Resources Research Institute's advisory board, a director for the Groundwater Management Districts Association, and president of the Mississippi Water Resources Association.

SCOTT MOWERY

Scott Mowery began his career with the National Oceanic and Atmospheric Administration's National Coastal Data Development Center in 2006 as the Northeast Liaison Officer. Mowery received a bachelor's degree in oceanography from the United States Naval Academy, a master's degree in strategic intelligence from the Defense Intelligence College, and a juris doctorate from the University of Hawaii William S. Richardson School of Law. Prior to joining NOAA, Mowery as a Program Manager and Legal Policy Director for the Honolulu based firm Helber, Hastert and Fee, and is a former Naval Reserve Officer.

9:30 a.m. **POSTER SESSION**

Jason Barrett *Mississippi State University*	Improving the Capacity of Mississippi's Rural Water Associations Through Board Management Training
John Blakely *Mississippi State University*	Education of Phosphate Treatment Methods to Reduce Lead Mobility at Military Small Arms Training Ranges
Matthew R. Carr *University of Southern Mississippi*	Detection of Salmonella from Mississippi Coastal Waters and Sediment
Melissa Cook *Mississippi State University*	Recycling CCA-Treated Wood Waste: Design and Operation of a Laboratory Scale Pyrolysis System
Christopher Flood *University of Southern Mississippi*	Using Human Specific Molecular Markers to Monitor Water Quality Along the Mississippi Gulf Coast
Rachel Jolley *Mississippi State University*	Restoring Canebrakes to Enhance Water Quality Along the Upper Pearl River
Kenny Langley *Mississippi University for Women*	Science Education on the Tennessee-Tombigbee Waterway: An Out-Reach Effort for K-12 Students and Teachers in Northeast Mississippi
Richard Lusk *Mississippi State University*	Electrokenetic Treatment of Mercury Contaminated Soil at the Mercury Refining company Superfund Site
James O. Palmer *Mississippi State University*	Possible Correlations Among Simple Visual Disturbance Estimates and Hydrologic and Edaphi Parameters in Forested Headwaters of Mississippi
Amy M. Parker *Mississippi State University*	Environmental Impact and Disposal of CCA-Treated Wood Waste
John J. Ramirez-Avila *Mississippi State University*	Identification of streambank erosion processes and channel changes in Northeastern Mississippi
David R. Reed *National Weather Service*	Hydrologic Services Provided by the National Weather Service
Guillermo Sanchez-Rubio *University of Southern Mississippi*	Oceanic-Atmospheric Modes of Variability and their Effects on River Flow in the Northcentral Gulf of Mexico
Amy Spencer *Mississippi State University*	Preliminary Assessment of Ecosystem Services Provided by Moist-Soil-Wetlands
Jim Steil *Institutions of Higher Learning*	A New Hydro-Enforced, 1:24,000 Digital Elevation Model for Mississippi
C. Elizabeth Stokes *Mississippi State University*	Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater
Heather Thomas *Mississippi State University*	Life Cycle Assessment of Bio-Oil Production by Pyrolysis of Wood

August 5 Wednesday

9:50 a.m. **TECHNICAL PRESENTATIONS**

Track 1

Session #1 - Delta Water Quality
Moderator: Dean Pennington, Mississippi Water Resources Association

Stephanie Showalter *(University of Mississippi)* - Water Quality Trading: Is it Realistic for the Mississippi River?

Billy Justus *(U.S. Geological Survey)* - Water Quality of Least-Impaired Lakes in Eastern and Southern Arkansas

Karen Myers *(U.S. Army Corps of Engineers)* - Methyl Mercury in Water and Fish Tissue in the Lower Yazoo Basin

Matthew B. Hicks *(U.S. Geological Survey)* - Water-Quality Data of Selected Streams in the Mississippi River Alluvial Plain, Northwestern Mississippi September - October 2007-08

Matthew B. Hicks *(U.S. Geological Survey)* - Water-Quality Monitoring Plan and Implementation, Lake Washington, Mississippi, 2008

Track 2

Session #2 - Delta (Ag) Water
Moderator: Matt Romkens, ARS National Sedimentation Laboratory

Heather Welch *(U.S. Geological Survey)* - Occurrence of Nitrate in the Mississippi River Valley alluvial aquifer at a site in Bolivar County, Mississippi

Jeannie R.B. Barlow *(U.S. Geological Survey)* - Evaluating the Role of Groundwater and Surface-Water Interaction on the Transport of Agricultural Nutrients to the Shallow Alluvial Aquifer Underlying Northwestern Mississippi

Antonio L. Cerdeira *(Brazilian Department of Agriculture)* - Effects of Glyphosate-Resistant Crops on Water Quality

Jamie Dyer *(Mississippi State University)* - Influences of Land Surface Characteristics on Precipitation Over the Lower Mississippi River Alluvial Plain

Charles Wax (Mississippi State University) - Climatological and Cultural Influences on the Potential for Conservation of Groundwater in the Mississippi Delta Shallow Alluvial Aquifer by Substituting Surface Water for Irrigation

Track 3

Session #3 - Wetlands
Moderator: Jim Shepard, Mississippi Water Resources Research Institute

Gary N. Ervin *(Mississippi State University)* - Exploring Biologically Relevant Buffer Zones for Aquatic and Wetland Ecosystems in Northern Mississippi

Casey N. Wilson *(University of Mississippi)* - Management of a Natural Floodplain Wetland for Mitigation of Nonpoint source Pollution

Cristina Nica *(Jackson State University)* - A Study of Seagrass, Ruppia Maritima and Halodule Wrightii, at Grand Bay National Estuarine Research Reserve

David R. Johnson *(U.S. Army Corps of Engineers)* - Flooding or Precipitation: What is the Dominant Source of Moisture Sustaining a Backwater Bottomland Hardwood Forest?

Daniel Wren *(USDA ARS National Sedimentation Laboratory)* - Transport of Non-Point Source Contaminants Through Riparian Wetlands in the Mississippi Delta Region

August 5 Wednesday

11:30 a.m. **LUNCH AND KEYNOTE ADDRESS** *(Moderator: Mickey Plunkett, U.S. Geological Survey)*
Bruce Hanson *Workforce Services, East Mississippi Community College*

BRUCE HANSON

Bruce Hanson is employed in Workforce Services at East Mississippi Community College. Hanson received a bachelor of arts in political science and a master's degree in Urban and Regional Planning from the University of Mississippi. He is currently pursuing a doctoral degree at Mississippi State University. He is a public school board member and president of the Columbus Municipal School District. Hanson previously worked in industry for 37 years and served for 12 years in the Mississippi House of Representatives.

1:00 p.m. **Technical Presentations**

Track #4 - Delta Water

Moderator: Dean Pennington, Mississippi Water Resources Association

Charlotte Bryant Byrd *(Mississippi Department of Environmental Quality)* - Hydrogeology of the Central Delta

Paul C. Parrish *(Mississippi Department of Environmental Quality)* - Ground Water-Surface Water Interaction in the West-Central Delta (Washington County)

James E. Starnes *(Mississippi Department of Environmental Quality)* - Mississippi River Bluff Line Streams

Olivier Bordonne *(U.S. Geological Survey)* - Interaction of the Mississippi River with the Mississippi River Valley Alluvial Aquifer in Northwestern Mississippi

Pat Mason *(Mississippi Department of Environmental Quality)* - Recharge in the Water Budget of the Delta's Alluvial Aquifer

Track #5 - Sediments

Moderator: Janet Dewey, Mississippi State University

Trey Davis *(Mississippi State University)* - A Study of the Effectiveness of Various Sedimentation Solutions and Practices

Christopher L. Hall *(Mississippi State University)* - Modeling Fluid Mud

Michael S. Runner *(U.S. Geological Survey)* - Turbidity as a Surrogate for the Estimation of Suspended-Sediment Concentrations in Mississippi Streams

John J. Ramirez-Avila *(Mississippi State University)* - Sediment Budget Analysis for Town Creek Watershed, MS

Byoungkoo Choi *(Mississippi State University)* - Headwater Hydrologic Functions in the Upper Gulf Coastal Plain of Mississippi

Track #6 - Water Quality

Moderator: Jim Shepard, Mississippi Water Resources Research Institute

Richard Rebich *(U.S. Geological Survey)*- Sources and Transport of Total Nitrogen from Major River Basins of the South-Central United States, 2002

Zhengzhen Zhou *(University of Southern Mississippi)* - Composition and Size Distribution of Colored Dissolved Organic Matter in River Waters as Characterized using Fluorescence EEM and Field-Flow Fractionation Techniques

Billy Justus *(U.S. Geological Survey)* - Fish and Invertebrate Assemblage Relations to Dissolved Oxygen at 35 Sites in Southern Louisiana

Bonnie Earleywine *(Mississippi State University)* - The Effects of Land Use on Streams along the Natchez Trace Parkway Using Rapid Bioassessment Protocols

Alison Kinnaman *(University of Mississippi)* - The Use of Microcosm Studies to Determine the Effect of Sediments and Nutrients on Fecal Indicator Bacteria in Lake Water

August 5 Wednesday

2:40 p.m. **Break and Poster/Exhibitor Viewing**

3:00 p.m. **MWRA Board of Directors Meeting**

3:00 p.m. **TECHNICAL PRESENTATIONS**

Track #7 - Non-Point *Moderator: Pat Deliman, U.S. Army Corps of Engineers*	**Track #8 - Management/Sustainability** *Moderator: Mary Love Tagert, Mississippi Water Resources Research Institute*	**Track #9 - Wood Treatment** *Moderator: Jim Shepard, Mississippi Water Resources Research Institute*
Scott Perry *(Ibrium Systems Corporation)* - Urban Stormwater Runoff Phosphorus Loading and BMP Treatment Capabilities	**Mary Love Tagert** *(Mississippi State University)* - Support for a Northeast Mississippi Regional Water Management Plan	**Lauren Mangum** *(Mississippi State University)* - Treatment of Timtek Process Water by Co-Composting
Maifan Silitonga *(Alcorn State University)* - Watershed Assessment and Education	**Kelly Hurt** *(Chickasaw Nation Division of Commerce)* - The Oklahoma Water Bank Project	**Amy M. Parker** *(Mississippi State University)* - Environmental Impact and Disposal of CCA-Treated Wood Waste
Sandra L. Ortega-Achury *(Mississippi State University)* - Water Quality Assessment in the Town Creek Watershed, Mississippi	**Chad Miller** *(Mississippi State University)*- Collective Action Regimes in Inland Marine Port Clusters: The Case of the Tenn-Tomm Waterway System	**Heather Thomas** *(Mississippi State University)* - Life Cycle Assessment of Wood Pyrolysis for Bio-Oil Production
Marvin Washington *(Jackson State University)* - Development of Water Correction Algorithm for Underwater Vegetation Signals	**David T. Dockery, III** *(Mississippi Department of Environmental Quality)* - Sequence Stratigraphy, Depositional Systems, and Ground-Water Supply	**Melissa Cook** *(Mississippi State University)* - Recycling CCA-Treated Wood Waste: Design and Operation of a Laboratory Scale Pyrolysis System
Cristiane Surbeck *(University of Mississippi)* - Monitoring and Statistical Analysis of Fecal Indicator Bacteria in Lower Sardis Lake, Mississippi	**Richard H. Coupe** *(U.S. Geological Survey)* - Anthropogenic Chemicals in the Source and Finished Water from three Mississippi Communities that use Surface Water as their Drinking-Water Supply	**Mark Bricka** *(Mississippi State University)* - Laboratory Scale Treatment of CCA Contaminated Wood Waste
Jairo N. Diaz-Ramirez *(Mississippi State University)* - Runoff Modeling of the Luxapaillila Creek Watershed Using Gridded and Lumped Models	**Jason Barrett** *(Mississippi State University)*- Drinking Water Systems in Mississippi: Public Owned or Government Owned?	

5:00 p.m. **Welcome Reception and Poster/Exhibitor Viewing**

6:00 p.m. **Dutch Treat at Hollywood Café or dinner on your own.**

August 6 Thursday

7:00 a.m. **Registration, Continental Breakfast, and Poster/Exhibitor Viewing**

8:00 a.m. **TECHNICAL PRESENTATIONS**

Track #10 - Non-Point
Moderator: Tom Bryant, Pickering Engineering

Renee Clary *(Mississippi State University)* - Gulf Coast Watersheds and Water Education: Outreach Alignment and Best Practices

Michael S. Runner *(U.S. Geological Survey)* - Collection of Hydrologic Data on Tidally Affected Streams

Kenny Langley *(Mississippi State University)* - The Effect of Policy and Land Use Change on Water Quality in a Coastal Watershed City: An Analysis of Covington, Louisiana

Nathaniel Jourdan *(Mississippi Transitional Recovery Office)* - Drainage Improvement Project Development for Successful Hazard Mitigation Funding

Casey DeMoss Roberts *(Gulf Restoration Network)* - Protecting Water Quality in Your Community

Track #11 - Modeling
Moderator: Jim Shepard, Mississippi Water Resources Research Institute

Jim Steil *(Institutions of Higher Learning)* - A New Hydro-Enforced, 1:24,000 Digital Elevation Model for Mississippi

John B. Czarnecki *(U.S. Geological Survey)* - Conjunctive-Use Optimization Modeling of the Mississippi River Valley Alluvial Aquifer: Evaluation of Groundwater Sustainable Yield

Terrance W. Holland *(U.S. Geological Survey)*- Arkansas' Expanded Relational Water-Use Program

Claire E. Rose *(U.S. Geological Survey)* - Simulated Solute Transport and Shallow Subsurface Flow in Northwestern Mississippi

Brian R. Clark *(U.S. Geological Survey)* - The Mississippi Embayment Regional Aquifer Study (MERAS) - Model Construction, Simulation of Groundwater Flow, and Potential Uses of a Regional Flow Model

Track #12 - Soil & Water Treatment
Moderator: Don Underwood, Mississippi Soil and Water Conservation Commission

Richard Lusk *(Mississippi State University)* - Electrokinetic Treatment of Mercury Contaminated Soil at the Mercury Refining Company Superfund Site

John Blakely *(Mississippi State University)* - Evaluation of Phosphate Treatment Methods to Reduce Lead Mobility at Military Small Arms Training Ranges

Mark Bricka *(Mississippi State University)* - Sulfate Removal from Ground Water

Rheannon M. Hart *(U.S. Geological Survey)* - Use of Borehole Geophysics to Determine Zones of Radium Production in Northern Arkansas

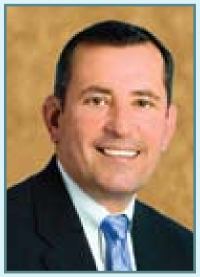
Wayne Kellogg *(Chickasaw Nation Division of Commerce)* - Beneficial Use of Marginal Quality Water

9:40 a.m. **Break and Poster/Exhibitor Viewing**

August 6 Thursday

9:55 a.m. **PLENARY SESSION** *(Moderator: Deirdre McGowan, Mississippi Water Resources Association)*

Duane Smith *Oklahoma Water Resources Board*	Organization of Water Resources for Effective Management
Eric Evenson *U.S. Geological Survey*	Plans for a National Water Census
Amy Larson *National Waterways Conference, Inc.*	Emerging and Current National Water Issues
Gene Sullivan *Bayou Meto Water Management District*	Arkansas Watershed Progress



DUANE A. SMITH

Duane A. Smith has served on the Oklahoma Water Resources Board since 1978, as Executive Director for the last 12 years. He has comprehensive knowledge in the administration of Oklahoma's Groundwater and Stream Water Law and the management of state water resources through the water rights appropriative process. Smith received a bachelor's degree in meteorology from the University of Oklahoma. He serves on the USEPA National Drinking Water Advisory Council, is a member of the Interstate Council on Water Policy, and recently served as Chairman of the Western States Water Council.

ERIC J. EVENSON

Eric J. Evenson has been the USGS Coordinator for the National Water Census since 2008. Evenson received a bachelor's degree in zoology and a master's degree in ecology from the University of Nebraska. Prior to joining USGS, he worked in the New Jersey District Office as the Associate District Chief and the District Chief. He has served as an alternate commissioner representing the State of New Jersey on the Delaware River Basin Commission and as a member of the Management Committee of the Delaware Bay National Estuary Program.

AMY W. LARSON

Amy W. Larson is the President of the National Waterways Conference Inc. Larson is a graduate of Wheaton College, and Columbus School of Law, Catholic University of America. She is a member of the District of Columbia and Maryland bars. Mrs. Larson currently serves as chair of the Waterways team of the Marine Transportation System National Advisory Council and is a member of the Board of Governors of the D.C. Chapter of the Propeller Club of the United States. Prior to joining NWC, Mrs. Larson served as the General Counsel of the Federal Maritime Commission.

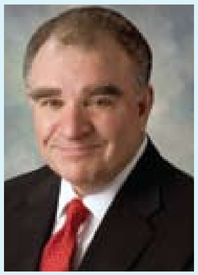
GENE M. SULLIVAN

Gene Sullivan is the Executive Director of the Bayou Meto Regional Irrigation Water Distribution District. He is an Agricultural Engineering Graduate of the University of Arkansas. Throughout his career he has been active in developing state and national legislation concerning water resources and at the present time is involved in developing numerous water projects in eastern Arkansas. He is a registered licensed professional engineer and land surveyor.

11:55 a.m. **LUNCH AND KEYNOTE ADDRESS** *(Moderator: George M. Hopper, Mississippi Water Resources Research Institute)*
Jimmy Palmer *Butler-Snow*
Musings of a Recovering EPA Regional Administrator

AWARDS PRESENTATION

MWRA CAPTAIN ROBERT ENGRAM SCHOLARSHIP AWARD RECIPIENT
Julianna Jones, Vicksburg High School
as presented by Mrs. Robert (Carmen) Engram



JAMES I. PALMER, JR.

James I. Palmer Jr. is a member of the Public Law and Finance Group at Butler Snow. He concentrates his practice in the areas of environmental Law, natural resources law, energy law and administrative law. He received a bachelor of science in civil engineering from Mississippi State University and a juris doctorate from the University of Mississippi. Prior to joining Butler Snow, he held numerous positions in state government. He is a member of the Environmental Council of the States and the American Bar Association and a registered professional engineer.

1:00 p.m. **Storm Water Management Workshop**

1:00 p.m. **Golf Tournament**

1:00 p.m. **Tour of the Tunica River Museum**

1:00 p.m. **Skeet Shooting**

6:30 p.m. Transportation to Tunica RiverBoat Cruise

7:00 p.m. **Tunica RiverBoat Cruise**

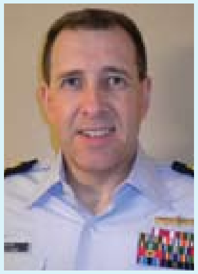
9:00 p.m. Return from cruise - Transportation back to The Veranda

August 7 Friday

7:30 a.m.	**Plated Breakfast**	
8:30 a.m.	**PLENARY SESSION** *(Moderator: Dean Pennington, Mississippi Water Resources Association)*	
8:30 a.m.	**Colonel Thomas P. Smith** *U.S. Army Corps of Engineers*	National Levee Safety Program Implications for Mississippi Water Resources Infrastructure
9:00 a.m.	**Commander Dan Norton** *U.S. Coast Guard*	Security Concerns at Our Ports and on the Inland Waterways
9:30 a.m.	**Colonel Michael C. Wehr** *U.S. Army Corps of Engineers*	What's the 200 Year Vision for the World's 3rd Largest Watershed?
10:00 a.m.	**MWRA General Membership meeting and voting**	
10:30 a.m.	Adjourn	

COLONEL THOMAS SMITH

Colonel Thomas P. Smith took command of the Memphis District, U.S. Army Corps of Engineers in 2007. His military career includes a commission in the Corps of Engineers upon graduation from the U.S. Military Academy, followed by a wide range of command and staff positions both within and outside the United States. Smith holds a bachelor's degree from the U.S. Military Academy, a master's degree in civil engineering from the University of Missouri-Rolla, and a master's degree in national security and strategic studies from the National War College. He is a registered Professional Engineer in the Commonwealth of Virginia.



COMMANDER DAN NORTON

Commander Dan Norton is the Deputy Sector Commander for the U.S. Coast Guard's Sector Lower Mississippi River in Memphis, Tennessee. In this capacity, he serves as Alternate Captain of the Port, Alternate Federal Maritime Security Coordinator, Alternate Federal On Scene Coordinator, Acting Officer in Charge of Marine Inspection, and Acting Search and Rescue Mission Coordinator. Norton received two bachelor's degree in zoology and science education from Oregon State University and a master's degree in environmental sciences and policy from Johns Hopkins University.

COLONEL MIKE WEHR

Colonel Mike Wehr is the District Engineer for the U.S. Army Corp of Engineers Vicksburg District. In this role he is responsible for navigation on 300 miles of the Mississippi River and charged with flood damage reduction, environmental restoration and other projects within a 68,000 square mile area covering the Mississippi, Louisiana and Arkansas. Wehr studied Civil Engineering, and was commissioned a Second Lieutenant through ROTC at Santa Clara University and holds a master's degree from the University of Texas. He is a registered professional engineer in the Commonwealth of Virginia.

Proceedings from this conference and past water resources conferences are available online at

www.wrri.msstate.edu

MISSISSIPPI
WATER RESOURCES
RESEARCH INSTITUTE

USGS Summer Intern Program

None.

Notable Awards and Achievements

Publications from Prior Years