ARKANSAS WATERDROP

Arkansas Water Resources Center *University of Arkansas* *Fall 2003*
Ozark Hall 112, Fayetteville, Arkansas 72701 *Tel: (479) 575-4403* *Fax: (479) 575-3177*
e-mail: awrc@uark.edu *web address: www.uark.edu/depts/awrc*

A Coupled Biogeochemical/Hydrological Approach Elucidating N Processing In Karst

Phil Hays serves in a three-way Cooperative Studies position at the University of Arkansas. He is an Adjunct Professor in the Department of Geosciences, a Hydrologist with the Office of Ground Water of the U.S. Geological Survey, and Ground-Water Specialist with the U.S. Department of Agriculture Natural Resources Conservation Service National Water Management Center. The goal of this position is to facilitate and conduct research and education activities in science areas of common interest between these institutions, capitalizing upon the unique resources that each has to offer.

Dr. Hays received his B.S. in Geology at the University of Arkansas in 1984. He completed an M.S. and Ph.D. in Geology at Texas A&M. Prior to coming to the UofA in August of 2000, Hays worked as an Exploration Geologist with Sun Exploration in Texas and Louisiana. Hays served as the USGS Ground Water Specialist for Arkansas and taught the UofA/USGS Field Hydrogeology course during summers from 1994 to 2000.

Inside this issue…

PI and His Project	Cover - 2
Ramblings from the Director	3
Spotlight on the PI	4-7
Research Findings	8-12
New Publications	11
Have You Heard?	13

Currently with the Department of Geosciences, Dr. Hays is involved in teaching Isotope Geology, Hydrogeologic Modeling, Field Hydrogeology, and Field Geology, and serves as the Department's representative on the University of Arkansas Stable Isotope Laboratory Steering Committee.

Phil and his family—wife Danielle, son Andric, and daughter Daria—live on a small farm in Elm Springs; the farm is an appropriate spot for a hydrologist as it has seven springs and four perennial streams. During his spare time, Phil and family enjoy kayaking and riding motocross.

Projects that Phil Hays is involved with currently have varying degrees of interaction between the U of A, USDA, and USGS. These projects include:

- *Development of a GIS-based ground-water budget tool for Hardy County West Virginia*
- *Development of a conjunctive-use ground- and surface-water optimization model for the Pawcatuck watershed in Rhode Island*
- *Application of isotopic tracers and microbial source tracking in determination of ground- and surface-water discharge impact on shellfish ecosystems in Cape Cod Massachusetts*
- *Characterization of the nature and extent of contamination and monitoring of environmental and health impacts of goldmining activities in Suriname*
- *Use of carbon isotopes in alluvial sediments to reconstruct paleoclimate and vegetation history on a scalable watershed-based approach*
- *Defining the lag time and associated climatic and hydrologic implications of carbon and oxygen isotopic signatures in speleothems.*
- *Characterization of hydrologic conditions and nutrient flux in karst at the UofA Agro forestry Research Station*
- *Evaluation of NRCS Waste Facility construction standards in karst environments at the UofA Savoy Experimental Watershed.*
- *Determining the role of biogeochemical processes occurring in karst in controlling N transport and utilization.*

Phil Hays, PI and His Project (Cont'd)…

The Project

Students installing a water-quality monitoring well at the U of A Savoy Experimental Watershed.

A Coupled Biogeochemical/Hydrological Approach Elucidating N Processing In Karst

Phil Hays is collaborating with Sue Ziegler of the Department of Biological Sciences in a strongly interdisciplinary study to define biogeochemical processes occurring in karst and how N transport and utilization is controlled by the interplay of biological and hydrological inputs to the complex systems represented by karst

Land application of animal manures in karst regions poses a significant threat to water quality, and has been linked to water-quality problems that range from field to continental scale. Long-term sustainability of animal production on karst lands requires that management practices evolve to optimize effective nutrient use while minimizing environmental impacts; to manage effectively, we must thoroughly understand the processes and controls affecting nitrogen transport, transformation, and sequestration.

The surface-water/ground-water interface and interflow zones in the vadose region overlying karst aquifers represent one of the few areas of these flow systems where diffuse flow occurs, and with extended residence time and exponentially increased particle surface area for soil-water interaction, these are optimum zones for biogeochemical processing. In addition, these zones are likely to be the most impacted by agricultural practices at the surface {that can enhance or degrade the potential for nutrient processing in karst}. The research underway is defining biogeochemical processes occurring at interface and interflow zones and assessing their role in controlling N transport and uptake. The objectives of this project are being met using two synoptic sampling events that target all hydrologic zones of the shallow flow system. Concentration and isotopic composition of NO_3^- are being used to determine the extent of denitrification and immobilization. Controlled experiments are showing the relative bioavailability of dissolved organic carbon, and its role in the cycling of N in each zone. Once the biogeochemical mechanisms proposed are elucidated and these approaches verified, we will be poised to test the impact of agricultural practices on the integrity of these zones, and on how the processes occurring within these zones can be capitalized upon for nutrient management in karst watersheds.

Ramblings From The Director…

This is our first attempt at putting out the Waterdrop as an entirely WEB based newsletter. In an effort to control costs and provide full color product we decided to discontinue the distribution of the paper copy of our newsletter in favor of posting the Waterdrop on the AWRC WEB site followed by an email notice of availability. Of course, if you're reading this you already know that!! The cost savings are really quite significant and the opportunities provided are endless. Not only can we provide a full color product, but in the future we can add animation, links, and other useful components. Barbara Parker, AWRC Administrative Assistant, has been busy over the past few months obtaining emails for the 500+ people and organizations on our active newsletter mailing list. She did a tremendous job finding email addresses and in the process cleaned up the existing mailing list by eliminating records with bogus addresses.

There is a high probability that a few folks may have been inadvertently dropped and for this we truly apologize, but progress is not without some cost. Having ready access to an electronic mailing list provides opportunity for more regular communication allowing more timely updates about conferences, workshops, grant opportunities and potential collaborative efforts. We hope that you enjoy our new format. If we have included you on our list by mistake, or if you no longer want to receive the newsletter or water related information, please send an email to Barbara at btparker@uark.edu and she will remedy the problem. If you know of others who might benefit from the newsletter and other communications from AWRC send us their name and email address and we'll see they are added to the list. If you have comments or suggestions about articles or news items you might like included in future newsletters please forward these to Barbara as well.

Arkansas Water Resources Center Annual Conference Scheduled for April 21 and 22

To be held in Fayetteville, Arkansas at the University of Arkansas, Division of Continuing Education. **Mark your Calendars** and plan to attend this event. I attended a research update meeting sponsored by the U.S. Geological Survey Little Rock District Office earlier this fall. This event was well attended and proved to be very beneficial. It gave me some great ideas for conference speakers and I will be contacting some of these folks in the next month or so to twist their arms just a little. Dave Friewald, USGS, pointed out at this meeting that there really are only limited opportunities to exchange ideas between water and environmental groups with the AWRC annual spring conference being one of these. We usually try to select a theme of sorts for the conference and arrange the speakers in clusters related to the theme. I have not yet decided on a theme or the list of speakers for this year. **If you have thoughts about either, or if you are interested in presenting your research or research program at the conference, then give me a call or send me an email**. We really strive to present all sides of an issue so people can make informed decisions based on the best science available.

SPOTLIGHT ON THE PI…

THE PI - MATLOCK

Marty Matlock is an associate professor in the Ecological Engineering Group of the Biological and Agricultural Engineering Department at the University of Arkansas. He is a Certified Senior Ecologist with the Ecological Society of America, and a Registered Professional Engineer (Texas). He teaches courses in ecological risk assessment, as well as ecological engineering principles and practices.

Matlock has been at the University of Arkansas for two years; he was a faculty member in the Agricultural Engineering Department at Texas A&M University for five years prior to coming to Arkansas. He received his Ph.D. in Biosystems Engineering at Oklahoma State University in 1996. Matlock is actively involved in several professional societies; the Ecological Society of America, the Ecological Engineering Society of America, the Institute for Biological Engineering, the American Water Resources Association, and the Water Environment Federation. Matlock's work has attracted international attention; he was an invited keynote speaker this year at the United Kingdom's Department for Environment, Food, and Rural Affairs meeting to explore watershed-level phosphorus thresholds.

Matlock works with the Ecological Engineering Group at the University of Arkansas on watershed-scale approaches to investigate, remediate, and manage ecological services. The Ecological Engineering Group is an association of faculty, graduate students and undergraduate students in the Biological Engineering Department. They collaborate with faculty from the Dale Bumpers College of Agriculture, the Fulbright College of Arts and Sciences, the Engineering College, and the Walton College of Business. They also work with municipal, state, and federal agencies, as well as non-profit organizations, to better understand and manage ecological services in Arkansas and the region.

Matlock and his wife, Stephenie Foster, have an eight-year-old daughter and two-year-old twin son and daughter. They enjoy the rivers and lakes of the Ozark Plateau, fishing, hiking, canoeing, camping, and generally getting out of the house.

THE PROJECT

Matlock does the Kings River Jig to collect benthic macro-invertebrates while Andrea Ludwig, U of A Ecological Engineering student and Luanne Diffin, City of Rogers, hold the kick net.

DEMONSTRATION OF GREENWAY DEVELOPMENT TO PROTECT ECOLOGICAL SERVICES IN URBAN STREAMS

The goal of this project, funded by the Arkansas Soil and Water Conservation Commission and

SPOTLIGHT ON THE PI…

EPA-Region VI, is to work with the City of Rogers, Arkansas to develop a demonstration greenway for preserving ecological services on Blossom Branch of Osage Creek. The Blossom Branch Greenway will be designed and implemented with public participation to preserve and restore ecosystem services in the riparian zone and creek. The educational objective of the greenway is to provide an outdoor classroom for stream ecology, hydrology, and watershed science courses for Rogers High School and the University of Arkansas, provide a public recreation area for Citizens of Rogers, and to demonstrate to urban planners and developers the value of greenways in terms of market-rewarded aesthetics and ecological services. The design approach will blend conservation and preservation ethics, setting aside specific areas for refugia (wildlife habitat), and enhancing human access and utility from other sites. Specific design criteria will include increased sediment stabilization and retention, peak flow amelioration, increased pollution assimilation/reduction, and increased biological diversity.

Matlock checks the treatment blocks on the raft of Matlock Periphytometers – passive diffusion nutrient enrichment bioassays for algal growth.

SPOTLIGHT ON THE PI…

THE PI - SOERENS

Thomas Soerens is an Associate Professor in the Department of Civil Engineering at the University of Arkansas. He teaches and performs research in the areas of environmental engineering, water quality sampling and data analysis, and ground water remediation. Before joining the University in 1996, he worked as an environmental engineer for a consulting firm in Oklahoma and as an environmental scientist for the USEPA. He holds M.S. and Ph.D. degrees from the University of Oklahoma and a B.S. degree from the University of Wisconsin – Milwaukee. He is a registered professional engineer in the state of Arkansas. Before pursuing his graduate degrees, he spent several years working on rural development projects in Pakistan and in the Maldive Islands. Soerens is actively involved in the American Society of Civil Engineers, the International Water Association, and the American Geophysical Union. He formerly served as the chair of the University's Radiation Safety Committee.

Thomas and his wife of 18 years, Kelly, serve in a number of capacities at their church. Thomas plays electric guitar in a worship band; Kelly teaches several classes to youth. Kelly homeschools their two older children Katie, 12, and Stephen, 10 and teaches horseback riding. Katie and Stephen have been playing violin and cello, respectively, for over five years and play in local symphonies. Katie is an amazingly prolific bookworm and Stephen is way too involved in his traveling basketball team. The Soerens family also includes two-year-old identical twin girls, Evie and Abbie. Thomas enjoys running, playing basketball, and playing guitar, all of which he does with much passion and little skill.

THE PROJECT

EVALUATING THE INFLUENCE OF LAKE FRANCES ON PHOSPHORUS CONCENTRATIONS AND TRANSPORT AT THE ILLINOIS RIVER, NORTHWEST ARKANSAS

Gim Goh takes field readings on a water sample and prepares it for lab analysis.

Lake Frances is a small impoundment that spans the border between Arkansas and Oklahoma on

SPOTLIGHT ON THE PI…

Thomas Soerens and University of Arkansas graduate student Gim Goh collect a water sample from an Illinois River tributary.

the Illinois River. Results of water sampling have shown apparent differences between nutrient concentrations upstream (Arkansas) and downstream (Oklahoma) of the lake. The goal of this project is to investigate the influence of Lake Frances on phosphorus concentrations and transport in the Illinois River between northwest Arkansas and northeast Oklahoma. Dr. Brian Haggard is co-PI on this project and the methods use closely follow his previous work.

This study is using water sampling and historical data and to evaluate changes in phosphorus concentrations and load upstream and downstream of Lake Frances during base flow and surface runoff flow regimes. Phosphorus loads are compared to determine when Lake Frances is a source or sink of phosphorus.
Sediment columns have been collected from Lake Frances to estimate aerobic and anaerobic phosphorus fluxes from Lake Frances sediments and to assess sediment-phosphorus interactions between bottom sediments and overlying water column.

Because the costs of reducing phosphorus loads by 40 percent and complying with Oklahoma's water-quality standards are considerable, these results will provide valuable information and direction regarding watershed phosphorus management strategies in the Illinois River Basin. For example, if bottom sediments in Lake Frances are a potential phosphorus source, then Arkansas and Oklahoma must consider the impact of this small impoundment on watershed management strategies. In this situation, Lake Frances may inhibit Arkansas' efforts to improve water quality at the Illinois River. Furthermore, the bottom sediments may require some chemical treatment to reduce sediment – phosphorus interactions, resulting in reduced phosphorus concentrations and transport across the Arkansas and Oklahoma border. This research should also provide information on phosphorus dynamics that will be of more general interest and applicability.

RESEARCH FINDINGS…

SPARTA AQUIFER RECOVERY STUDY

"Real-time" water-level monitoring equipment

A 5-year study by the U.S. Geological Survey (USGS) to document the recovery of ground-water resources in the Sparta aquifer as a result of implementing conservation measures and importing surface water in Union County, Arkansas is currently underway. The Union County Water Conservation Board with funding from the U.S. Environmental Protection Agency have begun a study with the USGS Arkansas District, the Union County Conservation District, and Burns & McDonnell to monitor the impact of water-level recovery and water-quality characteristics of the Sparta aquifer system in southern Arkansas and northern Louisiana.

The Sparta aquifer is a confined aquifer of great regional importance and is a major water resource for municipal, industrial, and agricultural uses. A large cone of depression is centered around the city of El Dorado. Local industry, the city of El Dorado, and Union County are currently working to reduce withdrawals from the Sparta aquifer through water reuse, conservation, and importing surface water from the Ouachita River. The objectives of this study are to: 1) provide continuous, real-time, internet accessible water-level data from a network of 8 wells to document potential recovery of water levels within the Sparta aquifer; 2) determine structural controls and stratigraphy using borehole geophysical logs obtained from new and existing monitor wells to identify and delineate the elevation of the top and bottom of the Sparta aquifer; 3) provide periodic water-quality data from a network of 12 wells withdrawing water from the Sparta aquifer to detect trends.

Six pre-existing wells and 2 newly drilled wells are equipped with a pressure transducer connected to a digital data logger and downloaded via a telephone modem every 6-hours for near real-time water-level data and placed on the USGS webpage (http://ar.water.usgs.gov). Borehole geophysical logging has been performed on selected wells to delineate structural and lithologic features to better identify the thickness

Well Drilling for the Sparta Aquifer Recovery Study south of El Dorado, Arkansas

of the Sparta aquifer. Water-quality samples are being collected two times per year from 12 existing wells and measured for temperature, specific conductance, and chloride concentrations. The results of this study will provide the Union County Water Conservation Board with documentation of baseline water-level and water-quality conditions in the aquifer to evaluate current and future aquifer management activities.

For additional information contact Dave Freiwald at e-mail address: freiwald@usgs.gov

MAPPING BATHYMETRY AND SEDIMENT DISTRIBUTION OF UPPER BEAVER RESERVOIR, NORTHWEST ARKANSAS

During July and August 2003, a dual frequency (28/200 kHz) echo sounding survey of bathymetry and sediment distribution of upper Beaver Lake (Benton and Washington counties, Arkansas; Fig. 1) was conducted by Dr. Stephen K. Boss (University of Arkansas Department of Geosciences) and Ms. Dorothy G. Neely (University of Arkansas Environmental Dynamics Program). This survey was the first phase of a two-year study funded by the Beaver Water District (BWD) wherein state-of-the-art echo sounding and side-scan sonar systems will be integrated with Global Positioning System and Geographic Information Systems to create detailed maps of the upper Beaver Lake basin.

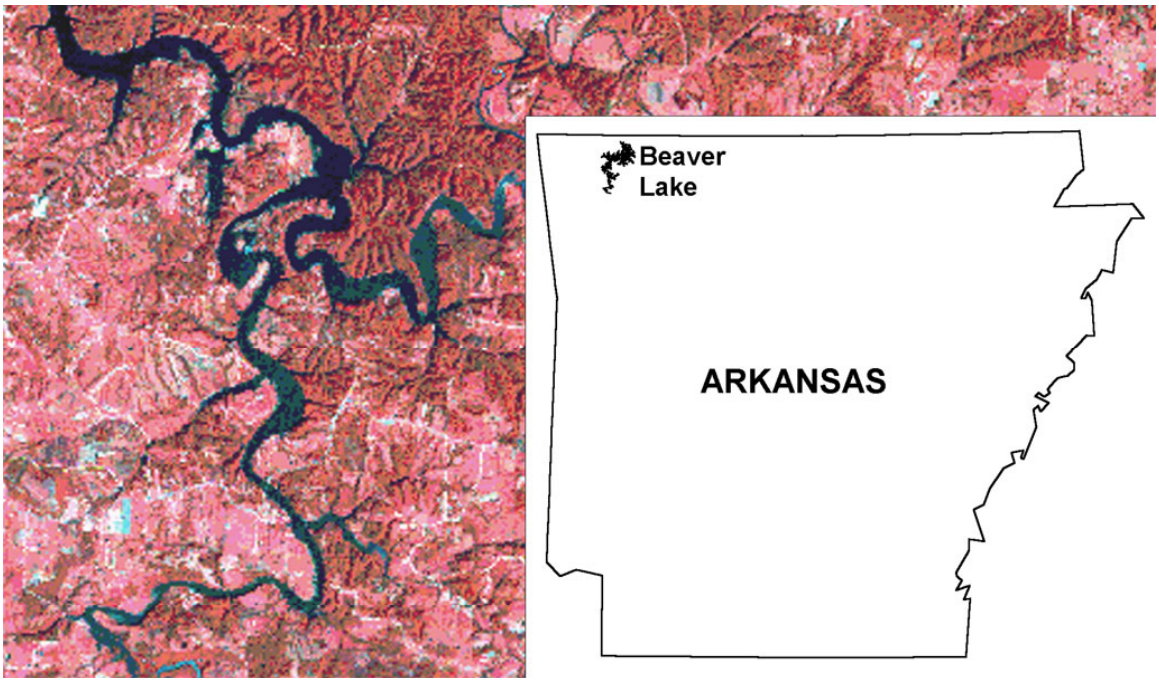


Fig. 1 Location map (inset) showing Beaver Lake in northwest Arkansas and Landsat false color infrared image of upper Beaver Lake area surveyed using dual frequency echo sounding system July-August 2003. Landsat image obtained from the Arkansas Interactive Mapper (http://www.cast.uark.edu/local/mapper/).

The echo sounding system records echo sounder profiles (Fig. 2), georeferenced to output from a GPS receiver in digital format, which can then be processed using geographic information systems to create digital and hardcopy maps. The area surveyed over three weeks in July-August 2003 extended from Eden Bluff on Beaver Lake southward to near the HWY 45 bridge over the White River in Washington County and upstream on War Eagle Creek to near the War Eagle Mill (Fig. 1). The total mapped area encompassed 18 km^2 (7 mi^2) and yielded over 5 gigabytes of raw echo sounder data that will be processed to produce high-resolution maps of the lake bottom.

RESEARCH FINDINGS…

Comparison of bathymetry from this survey to bathymetry derived from pre-impoundment maps of the upper Beaver Lake basin will reveal changes in sediment thickness and distribution since impoundment in 1966.

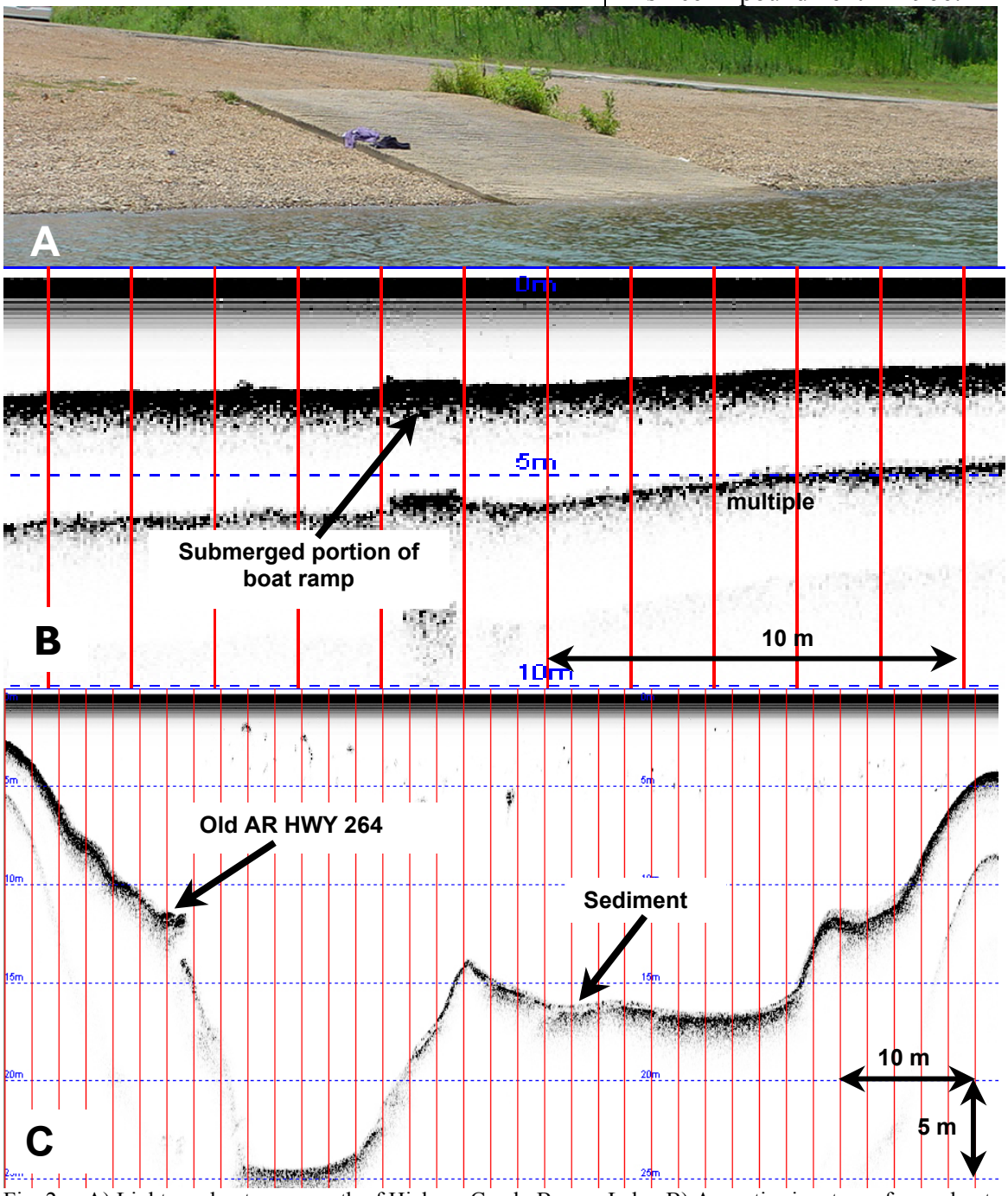


Fig. 2 A) Light-use boat ramp north of Hickory Creek, Beaver Lake; B) Acoustic signature of same boat ramp on detail of echo sounder profile. The secondary echo is an acoustic artifact known as a "multiple"; C) Echo sounder profile across mouth of Nelson Hollow, Beaver Lake. Note acoustic signature of target believed to be old Arkansas Highway 264, relief up to 25 m across Nelson Hollow, and sediment approximately 0.7 m thick deposited on lake floor

RESEARCH FINDINGS…

Data from the 2003 echo sounder survey will be used to plan a side-scan sonar survey of the same area during summer 2004 as phase II of the project. Side-scan sonar uses relatively high frequency (300kHz) sound to generate acoustic images over broad areas of submerged terrain. The system works by emitting rapid pulses of acoustic energy to produce an acoustic image of the lake bottom that is analogous to an aerial photograph.

Echo sounder data and side-scan sonar imagery will be merged to derive three-dimensional visualizations of the lake floor to assess changes in post-impoundment bathymetry related to sedimentation during the 37 years since impoundment. Analysis of sedimentation patterns will provide baseline data for utilization in the development of reservoir management plans that will ensure the continual supply of high quality water to the rapidly growing population of NW Arkansas. The project findings will also aid in the delineation of sedimentation "hot spots" where detailed studies of sediment chemistry and effects of sediment on water quality may be investigated in the future. For information regarding availability of this technology for investigation of lakes and reservoirs, contact Dr. Stephen K. Boss, Department of Geosciences, 113 Ozark Hall, University of Arkansas, Fayetteville, AR 72701, e-mail sboss@uark.edu, PH: 479-575-6630.

New Publications

Two U.S. Geological Survey Reports were Released Concerning Water-Quality in Arkansas and Oklahoma:

Haggard, B.E., J.R. Masoner, and C.J. Becker. 2003. Percentile distributions of median nitrate plus nitrite, total nitrogen and total phosphorus concentrations in Oklahoma streams: U.S. Geological Survey Water Resources Investigation Report 03-4084.

Pickup, B.E., Andrews, W.J., Haggard, B.E., and Green, W.R. 2003. Phosphorus concentrations, loads, and yields in the Illinois River Basin, Arkansas and Oklahoma, 1997-2001: U.S. Geological Survey Water-Resources Investigations Report 03-4168.

Two Journal Articles:

Haggard, B.E., P.A. Moore, Jr., I. Chaubey and E.H. Stanley. 2003. Nitrogen and phosphorus concentrations and export in an Ozark Plateaus catchment in the United States. Biosystems Engineering 86(1): 75-85.

Haggard, B.E., T.S. Soerens, W.R. Green and R.P. Richards. 2003. Using regression methods to estimating stream phosphorus loads at the Illinois River, Arkansas. Applied Engineering in Agriculture 19(2): 187-194.

New AWRC Publications

Soerens, T.S., M.A. Nelson. 2003. Evaluation of Sampling Strategies on Load Estimation for Illinois River at Hwy 59, Arkansas Water Resources Center Publication No. MSC-306.

Brown, A.V., A.J. Radwell, R.A. 2003. Bioassessment of the West Fork of the White River, Northwest Arkansas, MSC-307.

Nelson, M.A.,2003, Illinois River 2002 Pollutant Loads at Arkansas Highway 59 Bridge, Arkansas Water Resources Center Publication No. MSC-308.

Nelson, M.A., 2003, Water Quality Sampling, Analysis and Annual Load Determinations for TSS, Nitrogen and Phosphorus at the Washington County Road 76 Bridge on Ballard Creek, Arkansas Water Resources Center Publication No. MSC-309.

Nelson, M.A., 2003, 2002 Pollutant Loads Kings River Near Berryville, Arkansas Water Resources Center Publication No. MSC-310.

Nelson, M.A., 2003, Water Quality Sampling, Analysis, and Annual Load Determinations for TSS, Nitrogen and Phosphorus at the Washington County Road 195 Bridge on the West Fork of the White River, Arkansas Water Resources Center Publication No. MSC-311.

Nelson, M.A., 2003, Water Quality Sampling, Analysis, and Annual Load Determinations for TSS, Nitrogen and Phosphorus at the Wyman Road Bridge on the White River, Arkansas Water Resources Center Publication No. MSC-312.

Nelson, M.A., 2003, Water Quality Monitoring of Moores Creek above Lincoln Lake, Arkansas Water Resources Center Publication No. MSC-313.

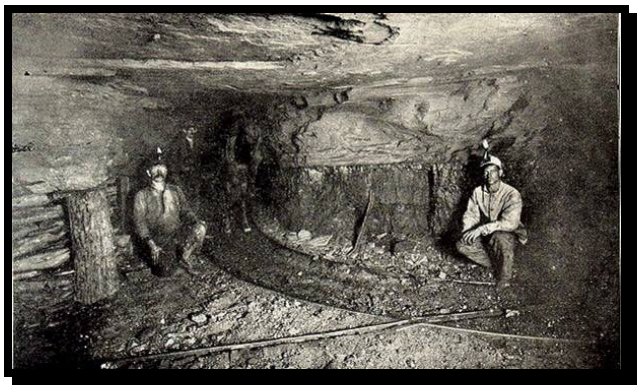
Coal Miner's Water

Greenwood, Arkansas, a city of 7,112 people in south Sebastian County, is utilizing the services of the AWRC and the University of Arkansas to investigate the feasibility of developing a potable water source from flooded coal mines located near the city.

Large underground coal mines and surface pits near the city were flooded and closed in the late 1920's. Former university geology student, Grubbs suggested to the city that they might use the stored water to augment the present reservoir which can no longer supply the needs of the rapid growing community. Using grant money supplied by the city and by matching grants through the AWRC, U of A hydrology professor J. Van Brahana and ENDY PhD candidate Curtis Varnell have conducted research at the site during the last two years.

Using historical data, mine maps, topographic maps, and GPS technology, the scientists have determined the boundaries of the coal mine and have estimated the water storage within the system to exceed 650 million gallons. The water within the mines is directly connected to and recharged by the nearby surface supplies. In essence, the mines act as a huge storage tank that could supply the needs of the city for the foreseeable future.

Area surface water as well as water within the mines have been monitored and sampled for water quality continuously for the past two years. Water quality has been determined to be highly variable within the mine, but at this time appears to be of sufficient quality to justify additional testing. This testing will be accomplished by a major draw down in excess of 3 million gallons of water and will be conducted during the fall of 2003. This test should allow a determination of the recharge ability of the reservoir, check water quality within the mine, and determine the chemical changes that might occur when highly oxygenated water is reintroduced into the mine void. Geophysical tools will also monitor water flow, check for subsidence, and provide images of the mines interior during this testing phase.



Miners in Excelsior Mine, circa 1930's

If the water from the coal mines is determined to be of sufficient quality, the city may save in excess of 20 million dollars. Greenwood would be the first city in Arkansas, and one of only a handful nationwide to obtain a water supply from abandoned coal mines.

Programs Available at the Washington County Soil and Water Conservation District

The Washington County Soil and Water Conservation District provides programs in the Ballard Creek, Beaver Lake, and Illinois River watersheds. These programs preserve and improve water quality, increase landowner awareness of water quality issues, and implement conservation practices designed to preserve water quality.

The Ballard Creek and Beaver Lake watersheds have cost share programs available to landowners in those areas. This conservation program shares the cost of Best Management Practices (BMP's) at the rate of 40% of the estimated costs with a maximum payment of $7,500. Examples of cost shareable BMP's include cross-fencing, pasture and hayland planting, watering facilities, and waste storage facilities.

The Illinois River watershed has a nutrient management planning project designed to aid urban landowners in implementing BMP's. This project will aid urban landowners in reducing non-point source pollution, while making nutrient application recommendations. The project will also include integrated pest management strategies, and recommendations for vegetative plantings, lawn maintenance, and structural (landscape) practices.

For more information about any of these programs please contact the Washington County Soil and Water Conservation District at (479) 442-4160, ext. 3.

AWRC Employee News

Amanda Walrod, left the AWRC Water Quality Laboratory in June to move to Mountain View, Arkansas with her family. She intended to enjoy the summer with her two girls before looking for employment this Fall.

Yuling Ji, AWRC Water Quality Lab, has taken a job with the University of Arkansas Medical School in Little Rock. Yuling is looking forward to being closer to her son, daughter-in-law, and grandson, who live in Pine Bluff.

Ryan Polite, AWRC Water Quality Lab, has taken a job with Ella's Restaurant, which is part of the newly renovated Carnall Hall on the campus of the University of Arkansas, Fayetteville. Ryan is excited about his new job as a bartender at Ella's Restaurant.

Best of Luck!

Arkansas Water Resources Center

University of Arkansas
Ozark Hall Room 112 -- Fayetteville, AR 72701
(479) 575-4403 – (479) 575-3177 FAX – awrc@uark.edu

NON-PROFIT ORGANIZATION
U.S. POSTAGE
P A I D
PERMIT NO. 278
FAYETTEVILLE, ARKANSAS

RETURN SERVICE REQUESTED

AWRC Staff:

Director
Ralph K. Davis

Associate Directors
Thomas S. Soerens
Marc A. Nelson

Accountant
Melpha Speak

Administrative Assistant
Barbara Parker

Water Quality Laboratory:

Lab Supervisor
Marc Nelson

Research Personnel
Wade Cash
Jennifer Purtle
Keith Trost