Water Resources Update
Illinois District Newsletter

U.S. Department of Interior
U.S. Geological Survey
District Web Site: http://il.water.usgs.gov/

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Compiled by D.M. Ayers

MESSAGE FROM ROBERT R. HOLMES, JR., ILLINOIS DISTRICT CHIEF

A LOOK AT MISSISSIPPI RIVER FLOODING — 1993 AND 2001: Once again, flooding along the Upper Mississippi River caused quite a bit of problems this past year. As compared to the 1993 flood, the 2001 flood was not as widespread and far-reaching; however, it did exceed the 1993 flood in several reaches of the Upper Mississippi River above the Quad Cities area of Illinois (Rock Island, Davenport, Moline, and Bettendorf). The 2001 flood resulted from 2 to 4 inches of rain falling on a very large and rapidly melting snowpack (3 to 5 inches of equivalent water) in the upper Midwest. The 1993 flood occurred later in the year (June-August) as compared to 2001 (April-May) and resulted from a large amount of rain (as much as 40 inches) over the 7-month period from January to July 1993. This rainfall was spread out over much of the Missouri and Upper Mississippi Basins (above St. Louis). The 2001 flood exceeded the 1993 flood in the reaches above the Quad Cities, but was smaller in comparison to 1993 in the reach below the Quad Cities. The relative contribution of floodwater by the major tributaries in Iowa, Illinois, and Missouri (especially the Missouri River) was much smaller in 2001 than 1993; thus, the lesser flood elevations and flows below the Quad Cities. The table at right gives the peak stage and discharges for various locations along the Upper Mississippi River where the U.S. Geological Survey (USGS) maintains streamflow gages.

TECHNOLOGY CHANGES — 1993 AND 2001: In 1993, conventional AA Price current meter measurements of streamflow, which has been the standard USGS method since the beginning of the 20th century, is still the predominant conventional method used on the Mississippi River. The acoustic Doppler current profiler (ADCP) was used during the 1993 flood to make measurements at several locations between St. Louis and Thebes, however, it was in the mode of “how accurate is this new gadget”. In 2001, whereas conventional AA Price measurements still are used in some locales on the Mississippi, the ADCP has come into its own as the preferred USGS method of measuring streamflow. ADCP measurements are quicker (1/2 to 1 hour as compared to as much as 4 hours for a conventional measurement), do not require a bridge to measure from, and provide more accurate data in the form of 3-dimensional velocities. This allows the flexibility to measure all locations where data are needed and USGS does not have a streamflow gage. For example, during the 2001 flood, the Rock Island District Corps of Engineers (Corps) asked the USGS for measurements on the Mississippi at locations other than where we had gages, including adjacent to downtown Davenport. The use of ADCPs enabled a quick and much more cost effective manner to collect these much needed data to assist the Corps in their flood fight efforts. Of course, the final and maybe most drastic change in technology concerning the Internet. In 1993, use of the Internet by private citizens to obtain information on the flooding virtually was non-existent, during the 2001 flood, the National Weather Service, Danvenport office, reported over 1-million hits during April and May 2001 on their Web site.

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Table 1: 1993 and 2001 Flood Peaks

[Rvr, River; ft^3/s, cubic feet per second]

	1993 Flood			2001 Flood		
Mississippi Rvr Station	Date of Peak	Gage Height	Discharge (ft^3/s)	Date of Peak	Gage Height	Discharge (ft^3/s)
Clinton	07/05/93	22.98	245,000	04/24/01	23.60	260,000
				05/09/01	22.54	241,000
Keokuk	07/10/93	27.58	435,000	04/26/01	22.94	294,000
St. Louis	08/01/01	49.47	1,030,000	06/10/01	34.64	559,000

Data Collection and Analysis to Aid in Design of the Chicago Underflow Plan

BY
Gary P. Johnson, Hydrologist

BACKGROUND

Since 1995, the USGS has been involved in an on-going study with the U.S. Army Corps of Engineers, Chicago District (Corps), and the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), to aid in the design of the Chicago Underflow Plan (CUP). The CUP also is referred to as the Deep Tunnel Project or the Tunnel and Reservoir Plan (TARP) (fig.1).

During periods of heavy rainfall in the greater Chicago area, MWRDGC sewage-treatment plants often are overwhelmed by the incoming combined raw sewage and storm water. Historically, when the capacity of the plants is exceeded, this combined sewer overflow (CSO) has been released, untreated, directly into streams. The goal of the CUP is to construct a series of dropshafts from the sewage-treatment plants connected to a deep tunnel system (fig. 2) under the City of Chicago that will route the CSO to storage reservoirs where it can be stored until after the storm when it can be treated and released. The concerns are that the chemical and oxygen demand of the CSO could consume all of the oxygen (anoxic) in the CSO (resulting in serious odor and treatment problems) during storage in the reservoirs. To address these problems, information was needed as to the quantity and quality of the CSO; and aeration and/or a mixing system is needed in the reservoirs to prevent the CSO from becoming anoxic. A three-dimensional hydrodynamic model, PAR3D, has been developed by the Corps to aid in the design of the aeration and/or mixing system for the reservoirs.

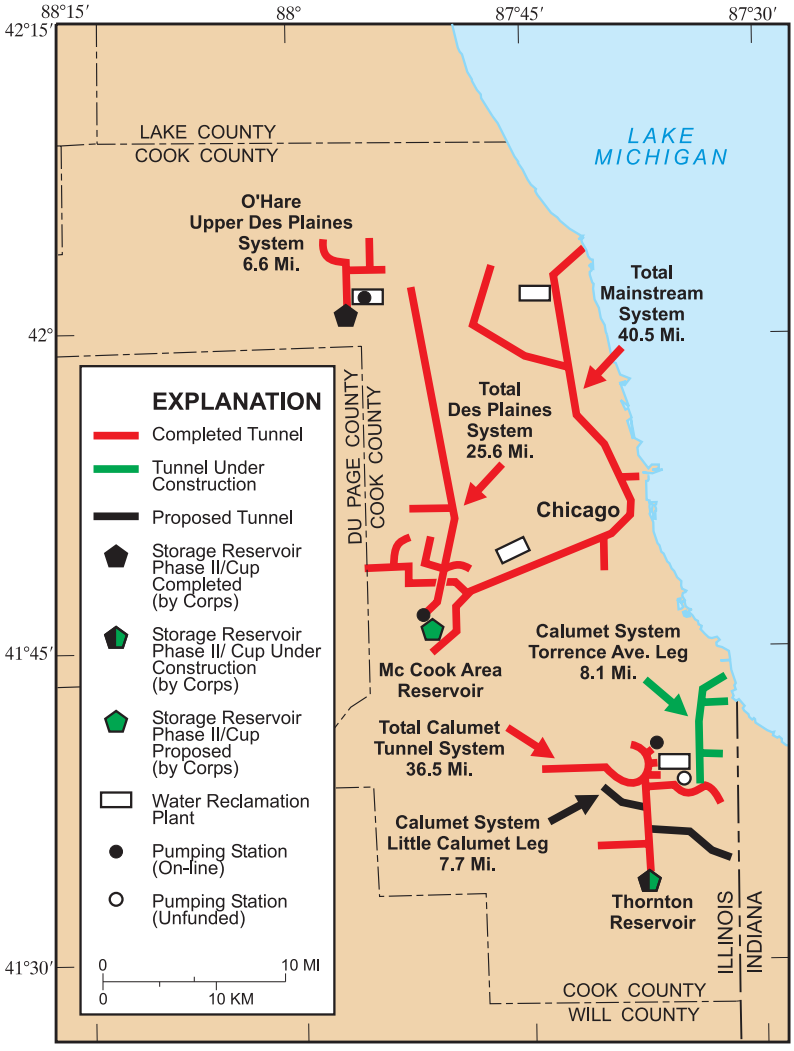

Figure 1. Tunnel and Reservoir Plan (TARP) for greater Chicago.

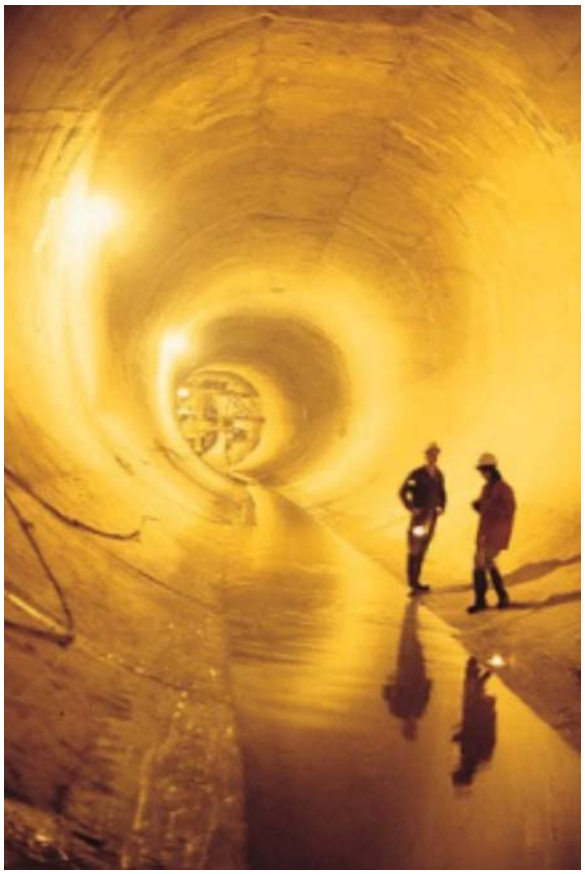

Figure 2. The Deep Tunnel under greater Chicago.

USGS EFFORTS

Combined Sewer Overflow Monitoring. The USGS installed acoustic velocity meters and water depth sensors in several sewer pipes to quantify flow through the pipes. These flow data were coupled with water-quality samples taken by MWRDGC to determine the quantity and quality of CSO in the sewer pipes. Results of the analyses then were used by the Corps in computer flow-routing models to determine the quantity and quality of CSO entering the reservoirs during periods of heavy rainfall. Results of the analyses and the data collected by the USGS and MWRDGC are planned to be made available in a report scheduled to be printed by early 2002 titled, ***Monitoring and Analysis of Combined Sewer Overflow, Riverside and Evanston, Illinois, 1997-1999, by Andrew M. Waite, Nancy J. Nornewer, and Gary P. Johnson.***

Pilot-Scale Tank Tests and Field-Scale Reservoir Tests. The USGS collected and analyzed water-velocity and water-quality data in a 10-meter deep tank and a 13-meter deep reservoir to describe the mixing patterns induced by the operation of aerators, a submersible mixer, and a surface mixer. These data were collected to aid in the verification and calibration of PAR3D. Bubble-plume characteristics and effects during the tests were documented and compared with characteristics simulated by other computer models. Finally, on the basis of temporal and spatial dissolved oxygen measurements in the reservoir, the volumetric quantity of oxygen before and after the operation of the surface mixer was calculated. A detailed description of the tests and the data collected are available in two reports, ***One-Dimensional Simulation of Stratification and Dissolved Oxygen in McCook Reservoir, Illinois, WRIR 00-4258, by Dale M. Robertson***, and ***Methodology, Data Collection, and Data Analysis for Determination of Water-Mixing Patterns Induced by Aerators and Mixers, WRIR 00-4101, by Gary P. Johnson and others***.

Future Tests. The USGS currently is working with the University of Illinois to conduct pilot-scale tests during summer 2001 and 2002 in another tank, this time filled with different blends of combined sewer overflow water. Finally, the USGS is planning deep-water field scale tests in a 100-meter deep reservoir during summer 2002. These tests should provide further insight about the effects of aeration and mixing in deep water.

EMPLOYEE SPOTLIGHT

LES DIPPEL
ADMINISTRATIVE OFFICER

Les Dippel began his career in the U.S. Geological Survey at the Illinois District Office in Urbana in 1993 as an Accounting Technician. He became the Administrative Officer in 1999. Les received a Bachelor of Science degree in Business Finance from Eastern Illinois University in 1975. He started his career shortly afterward as a Technical Training Instructor in the 3360th Training Group, Chanute Air Force Base, in Rantoul, Illinois. Les taught basic electronics to technicians learning navigation systems, flight simulators, missile systems, and weather equipment. He received Master Instructor status in 1980 and in 1981 oversaw the training of 18 instructors training over 2,500 students per year. In 1991, he was promoted to Resource Manager. His duties included oversight of a $1.5 million budget and management of over $45 million of equipment used in the fire school, liquid refueling, life support, and vehicle maintenance at the Air Force Base. In 1993, Les was awarded the Exemplary Civilian Service Award for his over 18 years of service to the Air Force.

As an Administrative Officer for the Illinois District, Les' duties include program planning, development, and execution; human resources planning and development, performance planning and employee relations; financial management and administrative services; and general office communications. Les supervises three persons in the Administrative Unit. Les is a key member of District Management and is the primary advisor to the District Chief on all administrative management matters.

Les' wife, Lisa, is the principal at St. John's Lutheran School in Buckley, Illinois. Les and Lisa have one daughter, Alexis, who is 8 years old. Les enjoys tail gaiting at various University of Illinois athletic events and at Chicago White Sox games. He also enjoys coaching t-ball, gardening, and golf.

METRO EAST SEDIMENT AND GEOMORPHIC STUDY

BY

TIMOTHY D. STRAUB, HYDROLOGIST

Judys Branch, a small basin (8.33 square miles) near Glen Carbon, southwestern Illinois, has been selected as a pilot site to analyze sediment delivery and stability of streams draining the bluff-line hills of the American Bottoms in the Metro East area of Illinois (fig. 1). In the 1800s, much of the forest and prairie in the watershed, which includes the upland bluffs, was converted to agricultural land. Since the 1940s urbanization has resulted in the uplands. These land-use changes have caused increased stream flows to the river that result in higher rates of erosion. Erosion of the upland bluffs has resulted in the loss of private land and deposition of sediment in the American Bottoms has resulted in increased flooding.

Sediment, hydraulic, geomorphic, and hydrologic data are needed in Judys Branch to assist the Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR), St. Louis Corps of Engineers, and the U.S. Department of Agriculture, Natural Resources Conservation Service in their analysis of river rehabilitation and watershed-management alternatives to help control erosion in the upland bluffs. This project advances the knowledge and understanding of sediment processes and erosion of wind-blown deposits of loess in Illinois and similar streams in the Midwest.

Automated streamflow equipment and sediment samplers are installed at three sites in the watershed. Information collected at the gages will be used to calculate sediment yield of the watershed and compare effects of urbanization on the stream flow and sediment delivery to the river. All streamflow data will be used by IDNR-OWR staff to verify a step-backwater hydraulic model and a hydrologic model developed for the Judys Branch and watershed. The streamflow and sediment data also will help determine the channel-forming discharge. Lastly, collecting sediment data throughout the life of the project will be useful in evaluating the effectiveness of the rehabilitation and management decisions.

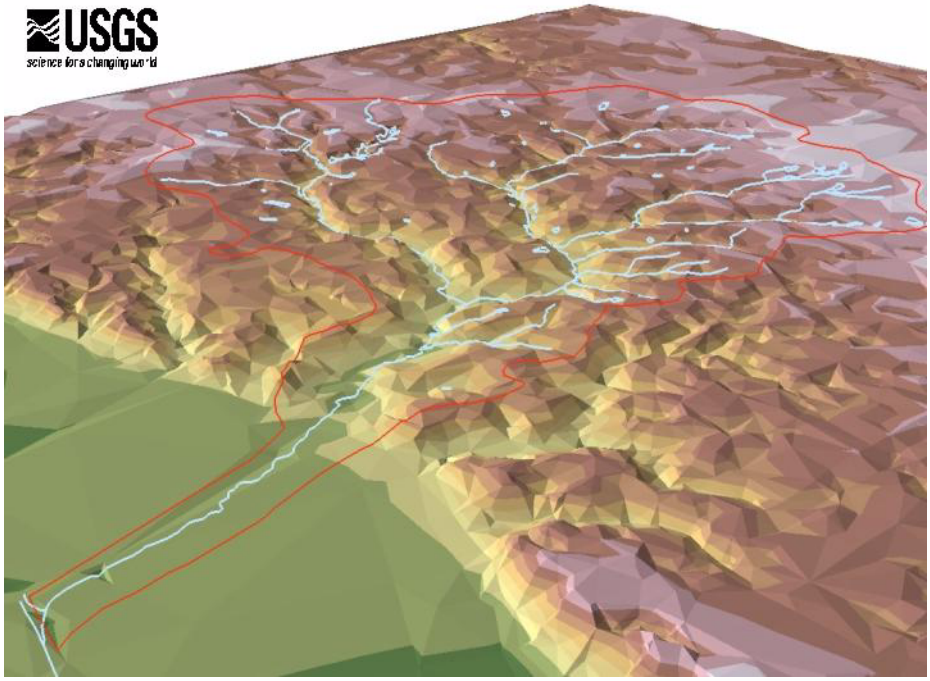

Figure 1. A 3-dimensional view of the study area shows the change from the lowland (green) to the upland bluff area.

The purpose of the geomorphic assessment is to link processes operating on the bed and banks of the unstable stream, Judys Branch, which is responding to changes in land use and river management. The geomorphic assessment includes channel evolution and bank stability analysis. To help determine the rate of streambank erosion of Judys Branch, 26 bank-rod locations are installed. Riverbed and bank samples have been collected at each of the bank-rod locations. The undisturbed strength of the riverbanks was determined at the 26 bank-rod locations by means of a field measurement instrument, vane shear apparatus. Soil corings have been collected at six locations throughout the stream network. IDNR-OWR personnel have surveyed the majority of the stream channel and surrounding floodplain at approximately 300 to 500 feet intervals. Future survey information will assist in documenting the overall geomorphic progression of the river. The above data are being used to determine the stability of the stream.

Detailed sediment and geomorphic data are being collected on a pilot-bluff watershed, Judys Branch, in the Metro East area of Illinois. Data collected in the present monitoring program will help facilitate river engineering analysis and decisions to help control erosion in the bluff stream.

COOPERATOR SPOTLIGHT

DUPAGE COUNTY
DEVELOPMENT AND ENVIRONMENTAL CONCERNS

DuPage County, in northeastern Illinois, is one of the fastest growing counties in the United States and includes 39 municipalities as well as unincorporated areas. Within the 332-square mile county are 6 major watersheds: Salt Creek, East Branch DuPage River, West Branch DuPage River, Sawmill Creek, Des Plaines River tributaries, and Fox River tributaries. In 1933, the county first adopted a countywide zoning ordinance to regulate land use in the unincorporated areas. After the record-breaking flood of August 1987, the DuPage County Stormwater Management Committee was established under enabling Illinois State legislation as a joint committee of county and municipal representatives, which authorized regional stormwater management programs for the collar counties surrounding Cook County. The Stormwater Management Committee oversees the Department of Development and Environmental Concerns (DEC). The responsibilities of DEC include watershed planning; floodplain map development; county ordinance implementation and enforcement; regional stormwater management project design and construction oversight; stream maintenance; and wetland plan and Wetland Banking Program implementation.

The DuPage County Stormwater Management Plan was adopted in late 1989 by the 24-member DuPage County Board. In 1991, the DuPage County Countywide Stormwater and Flood Plain Ordinance was adopted. The Department of Development and Environmental Concerns and its predecessors, together with municipal engineers, cooperated in drafting the ordinance that details specific responsibilities for nearly every aspect of stormwater and floodplain management. All development within the county must meet the requirements of the ordinance. This comprehensive ordinance includes requirements for detention storage and zero increase in floodplain elevation for all new development; compensatory storage; avoidance of direct and indirect wetland impacts, regardless of size, where practicable, or wetland mitigation where avoidance is not practicable; and mitigation for all riparian functions impacted by new development. The county has negotiated delegation authority with the Illinois Department of Natural Resources (IDNR) and review authority with the U.S. Army Corps of Engineers (Corps) to enable "one-stop" permitting. DuPage County is the only county in the United States with the authority to review wetland permit applications for the Corps, and also has been delegated floodway permitting by IDNR.

In 1983, engineers in DuPage County had begun utilizing the innovative Hydrologic Information Package (HIP) for stormwater planning. The HIP incorporated continuous rainfall-runoff simulation and unsteady-flow hydraulic routing. This package particularly was applicable to DuPage County because of the generally flat topography and poorly drained watersheds, and the availability of long-term meteorologic records. In 1986, the USGS began cooperating with DEC to develop a countywide network of long-term streamflow- and rainfall-gaging stations for use in rainfall-runoff model calibration. An important aspect of this cooperation was the inclusion of smaller watersheds to be used in defining hydrologic response units for better understanding of hydrologic relations region wide. Additional USGS-DEC cooperative studies were to verify and document the one-dimensional, unsteady-flow Full Equations model (together with IDNR-OWR) that subsequently was approved by the Federal Emergency Management Agency for use in the National Floodplain Insurance Program; and the development of a near real-time flood simulation system that incorporates the continuous simulation-hydrologic/unsteady-flow hydraulic modeling and a radio-telemetered dense raingage network. The data collected in cooperation with the USGS are available on the USGS Web site, and ongoing studies are developing improved ways to visualize rainfall distribution and simulate potential flooding and reservoir management scenarios in near real-time. These tools enable effective operation of the extensive flood control facilities and reservoirs managed by DEC, as well as assist in rapid response to flooding issues.

Adventures in Collecting Aquatic Macroinvertebrates
By
Mitchell A. Harris, Ecologist

For over 100 years scientists have used aquatic macroinvertebrates as indicators of water quality. Using the macroinvertebrate community as an indicator of water quality is the most common reason that USGS Illinois District scientists collect and evaluate macroinvertebrate community samples, but it is the behavioral, physical, and life history characteristics of aquatic macroinvertebrate species that make their study especially interesting. Macroinvertebrates are animals without a backbone that can be seen with the naked eye. Many aquatic macroinbertebrates are the immature stages (larvae) of insects (including mayflies, caddisflies, beetles, and flies), but also include adult stages of insects in some groups, and noninsects, such as worms, snails, and crustaceans.

Aquatic macroinvertebrates are often most diverse in stream riffle habitat. The modified Hess sampler (fig. 1) is a common device used to sample macroinvertebrates in stream riffles. The sampler is a cylinder with two windows that allows water to flow through. The upstream window is outfitted with a mesh net and the downstream window is trailed by a mesh net and capture bucket. The sampler is pushed and rotated into the stream bottom, and then the stream bottom is disturbed or organisms and debris are carried by the water current into the capture bucket.

Common organisms in stream riffles are flat-headed mayfly larvae (fig. 2) and casebuilding caddisfly larvae. Flat-headed mayflies have bodies that are compressed top-to-bottom that allow themselves to hold close to rocks in the stream current while they eat algae and organic matter off the rock surface. Case-building and net-spinning caddisflies are the engineers of the insect world. Several types of caddisflies build cases that enclose their bodies, and others live in tubular nets that filter organic matter from the flowing water (fig. 3). Depending on the species, the cases may be made of small stones, leaves, or sticks. One caddisfly builds a “log cabin” of sticks that is square in cross-section. The cases offer protection, camouflage, and aid in the flow of water across the gills on their abdomens.

USGS scientists used the Hess sampler in a recent study in the Chicagoland area and calculated the “EPT Index” on the aquatic macroinvertebrate community samples. The EPT Index is calculated by counting the number of species in the insect orders mayflies (**E**phemeroptera), stoneflies

Figure 1. Using modified Hess sampler in stream riffle. Photo by Sarah Tegt, USGS, July 2000.

Figure 2. Flatheaded mayfly (Heptageniidae). Photo by Howell Daly, from the North American Benthological Society slide library.

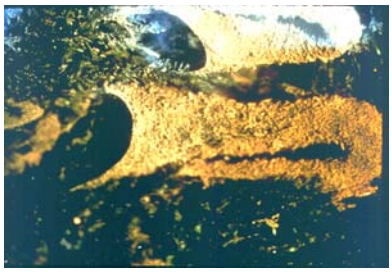

Figure 3. Tubular capture net of caddisfly (*Neureclipsis bimaculata*: Polycentropodidae). Photo by Richard Merritt, from the North American Bethological Society slide library.

(**P**lecoptera), and caddisflies (**T**richoptera) in the samples. Many species in these orders are considered sensitive to changes in water quality. The scientists found that the greater the amount of urban land in a stream basin, the lower the number of sensitive aquatic macroinvertebrate species were in a sample.

Illinois District scientists also use other collecting techniques. More than one habitat may be sampled in order to examine the types of aquatic macroinvertebrates in an entire stream reach. The D-frame aquatic dip net (fig. 4) commonly is used to collect invertebrates from habitats such as riffles, snags, leaf packs, undercut banks, and pools.

Figure 4. The author sampling aquatic vegetation with D-frame net aquatic dip net. Photo by Debbie Adolphson, USGS, July 1999.

The larvae of the Ebony Jewelwing damselfly commonly are found in the vegetation of stream margins. The beautiful adult Ebony Jewelwing (fig. 5) is a damselfly that has black wings and an iridescent blue-green abdomen. Burrowing mayflies are found in the stream depositional areas and sport "mandibular tusks."

Figure 5. Ebony Jewelwing damselfly (*Calopteryx*). Photo by John Wallace, from the North American Benthological Society slide library.

A technique to collect the adult stages of many aquatic insects is the use of an ultraviolet light at night. It can be advantageous to have adult specimens of insects because they are more readily identified down to the species level than the larval stages. It is best to go out to the streamside during warm humid summer nights, when the scientist will suspend the ultraviolet light bulb above a white sheet and wait for the insects to fly in. Usually, you don't have to wait long for thousands of insects to descent upon you and the light.

During a recent study, several species of net-spinning caddisflies dominated ultraviolet light-collected samples from large rivers in central Illinois. The immature larval stages of these caddisflies live on hard surfaces in the current of streams of all sizes. They build nets of silk to capture food from the water current.

During the winter months many scientists take a break from collecting insects. Nevertheless, you can walk near a stream and sometimes find adult "winter stoneflies" crawling on the snow or branches in search of a mate.

These are a few of the devices and techniques used by the Illinois District scientists to collect aquatic macroinvertebrates, and some notable characteristics of the organisms that live in central Illinois streams.

From the Mailbag

If you have comments about our newsletter or our Web site, please use the form on the back page. Comments also can be sent to dc_il@usgs.gov.

"... I must mention I have found the real-time data to be very interesting and we have found it to be quite helpful in our pursuit of our river survey. Again, thank you for your reply."

"Ran across your fascinating website, and have added it to my favorites, as well as subscribing to your mailing list. I am a third gr. teacher in OK and cover earthquakes/volcanoes in my class..."

"...Anyway thanks for your response and I love your web site, very helpful in trying to determine when the Fox River will open up to boating again."

"Great CD! It's great having the material on CD."

"This newsletter is excellent in every way. It contains timely information of interest to me. Please keep me on the mailing list."

"Great report! Very useful."

"Checking the latest Illinois District Newsletter (which is a nice feature, by the way), ..."

"I've found your precipitation graphs to be extremely useful for our farm near Effingham, IL. Keep up the great work! ..."

"I have always found your site useful, and the recent upgrades are great. Good work!!"

"... I should add that both the newsletter and the district web site are exceptional in there combination of accessible data and brevity (an undervalued quality in these times of information overload)."

Outreach Activities

The USGS participated in the Illinois State Fair in Springfield, Illinois August 9-19, 2001. Over 1.13 million people attended the State Fair from across the State and surrounding areas. The USGS exhibit was a two tiered sand flume used to demonstrate geomorphic and hydraulic principals. The sand was a prefabricated plastic that allowed easy transport and visibility when observing sediment transport. Children and teachers enjoyed the opportunity to get hands-on experience in stream modification. Information on the USGS data collection sites, Web access information, magnets, bookmarks, and educational materials were distributed to many interested citizens. The excitement from the visitors was inspiring. Two parents of a family of four told Jim Duncker (Illinois District hydrologist), "We gave our children the option of returning to one exhibit in the time remaining at the fair, and they wanted to return here (USGS exhibit)."

Illinois District Publications

Listed below are publications that were recently published. District policy is to provide copies of our publications to requestors at no cost as long as the publication is in stock in the District office. To obtain copies of the following, or any other Illinois District publication, you may contact Donna Ayers at (217) 344-0037, extension 3053 or by email at dmayers@usgs.gov.

FY 2001

OFR 00-400, Geology, Hydrology, and Water Quality in the Vicinity of a Brownfield Redevelopment Site in East Moline, Illinois, by R.T. Kay

WRIR 00-4152, Geology, Hydrology, and Ground-Water Quality of the Galena-Platteville Aquifer in the Vicinity of the Parson's Casket Hardware Superfund Site, Belvidere, Illinois, by R.T. Kay

Circular 1209, Water Quality in the Lower Illinois River Basin, Illinois, 1995-98, by G.E. Groschen, M.A. Harris, R.B. King, P.J. Terrio, and K.L. Warner

WRIR 00-4184, Equations for Estimating Clark Unit-Hydrograph Parameters for Small Rural Watersheds in Illinois, by T.D. Straub, C.S. Melching, and K.E. Kocher

WRIR 01-4056, Uranium and Radon in Ground Water in the Lower Illinois River Basin, by W.S. Morrow

OFR 01-50, Introduction to Field Methods for Hydrologic and Environmental Studies, by R.R. Holmes, Jr., P.J. Terrio, M.A. Harris, and P.C. Mills

Hydrogeologic inventory of the upper Illinois River Basin—Creating a large data base from well construction records by T.L. Arnold, J.J. Friedel, and K.L. Warner in Geological models for groundwater flow modeling–Workshop extended abstracts: convened on April 22, 2001, Illinois State Geological Survey Open File Series 2001-1, p.1–5

Arsenic in glacial drift aquifers and the implication for drinking water—lower Illinois River Basin by K.L. Warner in Ground Water, vol. 39, No. 3, May–June 2001 (p. 433–442)