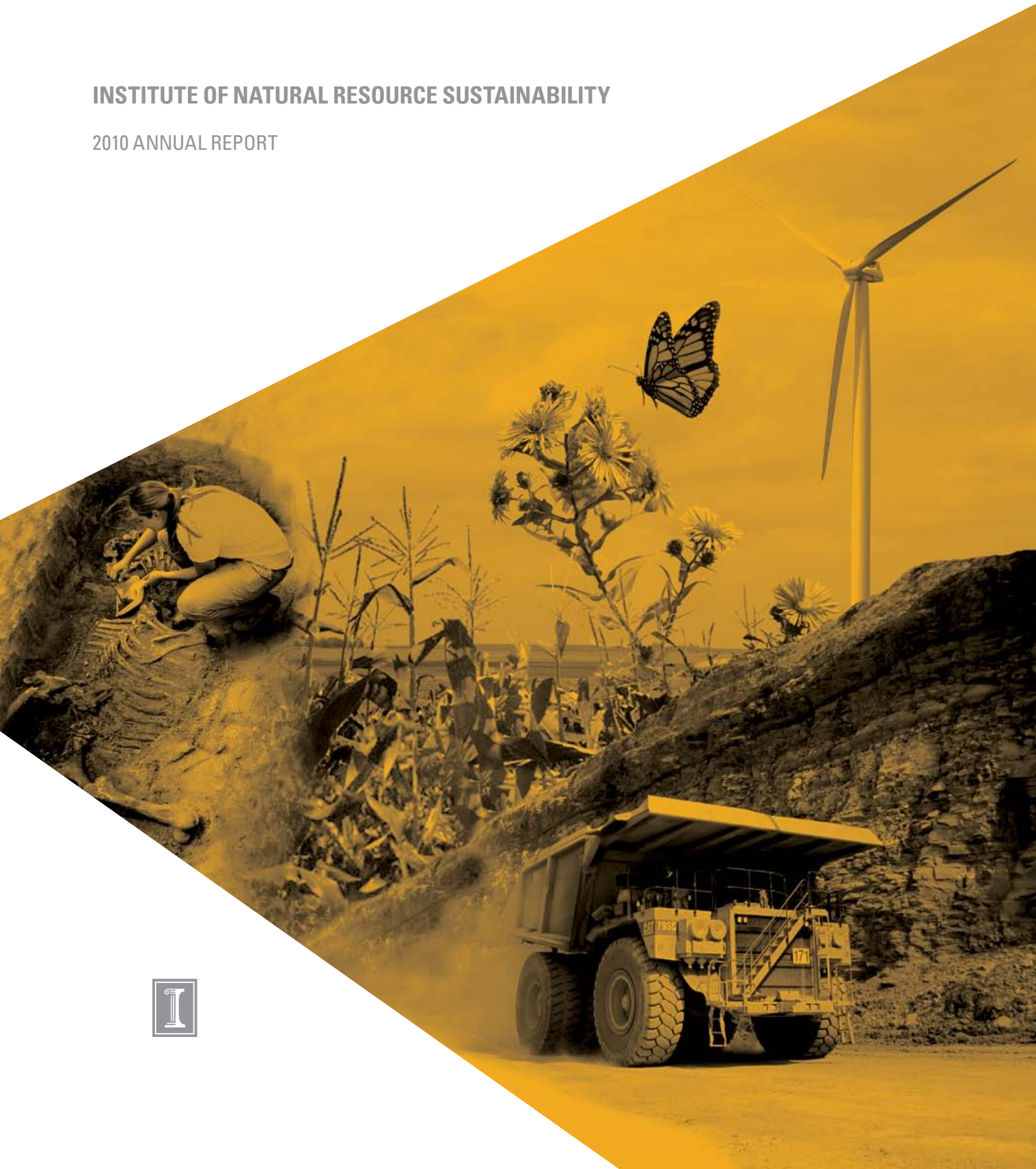


INSTITUTE OF NATURAL RESOURCE SUSTAINABILITY

2010 ANNUAL REPORT



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Mission: To provide objective, integrated scientific research and service, in cooperation with other academic and research units of the University of Illinois and elsewhere, that allow citizens and decision-makers to make choices that ensure sustainable economic development, enduring environmental quality, and cultural resource preservation for the people, businesses, and governments of Illinois.

Vision: The Institute of Natural Resource Sustainability will serve as a model of proactive, multidisciplinary research and service as a key to economic development, environmental quality, and cultural resource preservation. The incorporation of the Institute into a major research university is a unique opportunity to integrate the University's intellectual capital with the Institute's ability to apply science to societal challenges as an example for the nation and the world.

FROM THE EXECUTIVE DIRECTOR



Year Two—We Settle In

With the addition of the Illinois State Archaeological Survey (ISAS) to the Institute of Natural Resource Sustainability (INRS) in February of 2010, the collective missions of the State Scientific Surveys expanded beyond our traditional role in supporting stewardship of the natural resources of Illinois to stewardship of its rich cultural resources as well. The addition of ISAS, largely funded by the Illinois Department of Transportation, consolidates our \$11.8 M (million) role in carrying out biological, geological, and archaeological research associated with transportation projects.

As you can see from the fiscal data in this report, the Surveys continue to thrive at the University of Illinois. But those numbers tell only part of the story that is unfolding as the merger between the Surveys and the University matures. With a separate funding line appropriated by the legislature to ensure the Surveys core funding to carry out our statutory mandates, the Institute has so far weathered the financial storm that affects all state-based budgets.

It is increasingly obvious from observing national trends and from comments made by senior administrators on campus that the fundamental roles of public higher education institutions are in flux. Primary among the many questions regarding the future of these institutions is, what are the incentives for students to bear the ever-increasing costs of being physically on campus, particularly with the growth of much less expensive online education?

One of the answers to that question is that research universities, like the University of Illinois, provide abundant opportunities for students to gain "real world" research and employment experiences. The four large institutes on the Urbana-Champaign campus, INRS perhaps foremost among them, provide unique translational research opportunities. INRS employs upwards of 400 students at the height of the summer field season. Having such an experience detailed on a graduate's CV is an important plus for employers evaluating a graduate's university record. Thus, I intend to continue to emphasize the important role that the Institute increasingly plays in enriching the educational experience of University of Illinois undergraduate and graduate students on campus.

The Institute continues to yield substantial benefits for the state's environment, economy, and the health and welfare of its citizens. While the Surveys that make up the Institute are known for their scientific expertise and service, they are also a powerful economic asset for the state. In FY2010, the Institute leveraged its \$16 M state appropriation to secure an additional \$52 M in other funds. These funds support research and service that in turn help create, attract, or support billions of dollars of economic activity for the state.

Major projects are described in the pages that follow, but a few have such national and international significance that I would like to recognize them here. As you may know, the Illinois State Geological Survey (ISGS) chose the sites that Illinois put forward to attract the original FutureGen project. In addition, they provided the geological expertise that became an integral part of the successful proposal. In August, the original proposal was restructured, and an existing power plant in Meredosia, Illinois, was chosen to be the site of a facility that would burn

coal in an oxygen atmosphere to produce a nearly pure carbon dioxide (CO₂) exhaust stream, to be geologically sequestered at an as-yet-to-be-named site. The Advanced Energy Technology Initiative of the ISGS has been tasked with playing the major role in evaluating and choosing pipeline routes and one carbon sequestration site from among several volunteered for this \$1.8 B, first-of-its-kind energy project.

The Illinois Natural History Survey (INHS) continues to play a pivotal role in the Asian Carp saga. Suggestions that the locks on the waterways that connect Lake Michigan and the Illinois River be closed to prevent the carp from entering the lake have billions of dollars in economic consequences, so both INHS and the Illinois State Water Survey (ISWS), with their rich archives of data and research, play significant roles in the analysis of options.

Finally, ISAS has been charged with excavating and documenting one of the largest prehistoric cities in the New World, which is about to be bisected by the footings of a new bridge and roadway across the Mississippi River at St. Louis. The scope of the excavations and their significance for understanding Native American culture and history are probably unparalleled in North America.

This year, the Institute hired Manohar Kulkarni as Director of the Illinois Sustainable Technology Center (ISTC). Dr. Kulkarni previously chaired the Department of Mechanical Engineering at the University of North Dakota. Also, Don McKay was named Director of the ISGS. Dr. McKay had served as Interim Director since July 2008 and as Chief Scientist since 2000.

As I report on our second year as a University of Illinois unit, I am very optimistic about the Surveys' prospects and about the increasingly important role we are playing in the lives of Illinoisans and in the educational experience of their children. I hope that you can see also from this brief report our role in contributing to the solutions of societal issues that reverberate far beyond Illinois.

Bill Shilts

William W. Shilts, Ph.D.
Executive Director



PROJECTS HIGHLIGHT VALUE OF INSTITUTE'S WORK ACROSS ILLINOIS

Knowledge and informed management of our state's vast natural and cultural resources are vital to the health, welfare, and quality of life of every Illinois citizen. Every day, INRS research and expertise are used by state and local government, industry, and citizens to support economic development and natural and cultural resource management decisions.

Our work addresses energy, water, transportation, manufacturing, agricultural, environmental, climate change, and natural hazard issues affecting rural as well as metropolitan areas. The combination of five applied science research organizations within an institute of a major research university provides the state and the University with an advantage and an opportunity. INRS is a unique source of applied research, expertise, and data, providing a sound basis for independent scientific analysis and decision-making.

Carbon Capture and Storage

Eighteen scientists in the Illinois State Geological Survey's (ISGS) Advanced Energy Technology Initiative (AETI) are leading over \$200 million in carbon capture and storage (CCS) research and demonstration projects. Storing carbon dioxide (CO₂) emissions associated with industrial, biofuel, and energy production has enormous potential for addressing climate change. It also presents a strategy to use Illinois' estimated 96 billion tons of minable coal with reduced environmental impacts.

For more than nine years, the AETI has investigated the geology and sequestration potential of the Mt. Simon Sandstone, which underlies most of Illinois. The Mt. Simon's favorable geological characteristics, combined with AETI's research experience, give Illinois a world-leading role in developing CCS strategies. Our work has put Illinois at the forefront of the nation's clean energy future.

AETI leads the ongoing Illinois Basin-Decatur Project, a demonstration carbon sequestration test site at the Archer Daniels Midland Company (ADM) ethanol plant in Decatur. ISGS is the lead technical partner in the project, funded by an \$84.4 million U.S. Department of Energy (DOE) grant. This year, a 7,230-foot-deep injection well was completed, a baseline 3-D seismic survey was collected, and a deep observation well was drilled and cased.

The first CO₂ injections are expected in April 2011. One million metric tons of CO₂ will be

injected over three years. This project will have implications for the design and development of power plants and ethanol plants across the state and throughout the Midwest.

AETI research on the Mt. Simon Sandstone and the Decatur project are benefiting similar projects. In June, ADM was awarded a \$99.2 million U.S. DOE grant for an industrial CCS project to capture and store an additional half million tons of CO₂ annually from the company's ethanol facility in Decatur. AETI will provide technical expertise and is a partner in this project. Though not the ultimate goal of the project, this second sequestration site will provide the first opportunity in the world to study the interaction of two industrial-scale CO₂ plumes derived from injection wells about a mile apart.

ISGS scientific expertise and data were critical to the decision to site the FutureGen clean coal project in Illinois in 2007. At the time of this report, the U.S. Department of Energy is pursuing plans to construct the \$1.8 billion FutureGen 2.0 project, which will also rely on ISGS technical support.

Illinois Coal

Coal has the potential to play a substantial role in fueling the state's present economic recovery, and to remain an economic pillar in future years.

The advent of CCS has brightened the long-term economic outlook for Illinois' coal industry. Reversing a 20-year trend, coal

investment and production are increasing, partially as a result of the more favorable geological conditions for mining coal in Illinois compared to other nearby coal fields. ISGS scientists support this economic activity by placing raw data, coal resource maps, and the entire catalog of coal-related ISGS publications online for free.

Mercury Emissions

Controlling mercury in coal-fired power plant emissions continues to be costly. ISGS and the Electrical Power Research Institute (EPRI) have developed and successfully demonstrated a new sorbent activation process that can cut these costs in half. EPRI estimates potential savings for the power generation industry could exceed \$500 million per year.

Ameren and ISGS engineers demonstrated the process, a technology that uses on-site coal to produce activated carbon for direct injection into flue gas for mercury control in one of Ameren's power plants. The U.S. Environmental Protection Agency is developing national standards for mercury at coal- and oil-fired plants, and many states have called for the reduction of mercury emissions as well.

Opposite, clockwise from top-left: ISAS archaeologists conduct field excavations in Hancock County; Ecologists Greg Sass and Matt O'Hara monitor Asian carp on the Illinois River; ISWS researcher Kristy Vicari measures the flow of Poplar Creek, a tributary to the Fox River; Geologist John Nelson takes notes at a coal surface mine in southern Illinois.

Asian Carp

The Institute's Illinois Natural History Survey (INHS), with the support of partners in the Illinois Department of Natural Resources, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers, has been instrumental in documenting the advance of Asian carp (silver carp and bighead carp) up the Mississippi River, into the Illinois River, and upstream toward Lake Michigan. INHS scientists have also studied the effectiveness of electric barriers and bubble curtains in halting the advance of these invasive species.

With new sources of support from federal and state partners, current studies by INHS scientists will help guide management efforts designed to prevent the spread of Asian carp into the Great Lakes, and may help formulate effective control strategies in the Mississippi River basin. The results of this research will affect the \$7 billion Great Lakes fishery and \$500 million per year river-based transportation industries as well as Illinois natural and agricultural resources.

A team of scientists from INHS will be expanding sampling efforts and exploring new methods to detect and capture Asian carp in the Illinois River and the Chicago area waterways system where carp population levels are low. Data collected will be used to identify relationships among productivity, zooplankton abundance, and Asian carp densities, which will provide information on foraging ecology and habitat use and help managers target areas where Asian carp are most likely to occur. The study will help determine appropriate levels of sampling and improve monitoring programs. Larval fish sampling will be used to assess the timing and location of Asian carp reproduction in the Illinois River, and may prove to be an early detection method. New studies will also evaluate the eDNA method to determine its effectiveness as an early warning tool.

Researchers will also study contaminants in Asian carp to better assess the risks associated with its potential use as a commercial protein source. A 2005 INHS pilot study determined that elevated mercury concentrations are present in some individuals of both species which could trigger consumption alerts. Polychlorinated biphenyls (PCBs) were detected in a few fish but at concentrations well below the U.S. Food and Drug Administration's action level. Currently, the State of Illinois issues fish consumption

advisories for chlordane, mercury, and PCBs. The current study will measure concentrations of nine contaminants from a larger number of silver and bighead carp specimens from four locations on the Illinois River.

New Mississippi River Bridge

Considered vital to the St. Louis region's economic growth, the \$670 million Mississippi River Bridge project will alleviate congestion on the Poplar Street Bridge, which now carries Interstates 55, 64, and 70. As required by federal law, the Institute's Illinois State Archaeological Survey (ISAS) began conducting preliminary surveys of bridge impact areas during the mid-1990s and is now deep into a multi-year effort to excavate archaeological sites in the Metro East area.

The touchdown area of the bridge in Illinois was formerly the location of a Mississippian period monumental site, the East St. Louis Mound Group. In the twelfth century A.D., this site was second only to Cahokia as the largest mound group in North America. One highlight of the excavation is the discovery of a 2-inch-tall red stone figurine depicting a kneeling female holding a shell cup. It is a rare and unique piece that helps us to interpret early Cahokian religion.

The East St. Louis Mound Group was leveled by nineteenth century industrial development including one of the largest meat-packing centers in the world, which is currently part of a decaying urban landscape. Yet underneath the modern rubble, ISAS archaeologists found virtually intact remains of a large Mississippian residential neighborhood occupied during the eleventh and twelfth centuries. More than 200 structures have been uncovered to date. This ongoing excavation is a once-in-a-lifetime opportunity to explore a large section of one of the great early native towns of Illinois and to preserve Illinois' earliest history for generations to come.

Northeastern Illinois Water Supply

The Institute's Illinois State Water Survey (ISWS) scientists are providing a sound scientific foundation for how the highly-populated region of northeastern Illinois plans for future water supply. Providing an adequate supply of water to northeastern Illinois has obvious economic and environmental value, touching not only the lives and businesses of the region but also those across the Midwest and beyond.

This 11-county region uses nearly 1.5 billion gallons of water each day (bgd), according to an Illinois Department of Natural Resources-commissioned analysis. By 2050, that amount could rise to 2.4 bgd. The region depends on three principal water sources: Lake Michigan, the Fox and Kankakee Rivers, and groundwater. Over the past four years, the ISWS and ISGS have assessed the availability of these water resources to meet future water demands, with an emphasis on the Fox River and the principal aquifers of the region.

A regional groundwater flow model developed by ISWS hydrologists shows that deep bedrock aquifers are already being over-pumped along a corridor between Aurora and Joliet. As groundwater levels drop, well yields will decrease and water quality will likely degrade. Where can affected communities turn for water?

Greater use of shallow aquifers is possible, but shallow aquifers are not available everywhere in the region. Also, because shallow aquifers are more intimately connected to surface waters, increasing withdrawals will potentially affect wetlands and stream flows and thus affect dependent aquatic ecosystems. Shallow groundwater also is more vulnerable to contamination. ISWS studies reveal a trend in shallow groundwater of increasing chloride levels, a result of winter road de-icing.

ISWS modeling of the Fox River suggests that the river can provide additional water for the region. Flows on the Fox continue to increase as more treated effluent is discharged to the river. ISWS investigations show the river could be tapped to meet downstream demand while also meeting low-flow requirements to protect wildlife. Similar water resource planning efforts by ISWS are underway in east-central Illinois and the Kaskaskia River Basin.

Technical Assistance

Scientists throughout the Institute provide technical assistance to every sector of society. Engineers at the Institute's Illinois Sustainable Technology Center (ISTC) help manufacturers and organizations become more sustainable through pollution prevention, energy efficiency, water purification, water use reduction, and innovative technologies. The staff works with more than 100 clients each year, having helped 36 organizations to reduce or recycle two million pounds of waste annually between 2006 and 2008, and up to ten million pounds per year over the long term. Those same organizations

saved 2.8 million gallons of water annually and 119.4 million kilowatt hours (kWh) per year of electricity and, with full implementation, will save 13.9 million gallons of water annually and 597 million kWh per year. These reductions translate into millions of dollars in savings. The overall goal is to reduce or eliminate all forms of waste and pollution at the source.

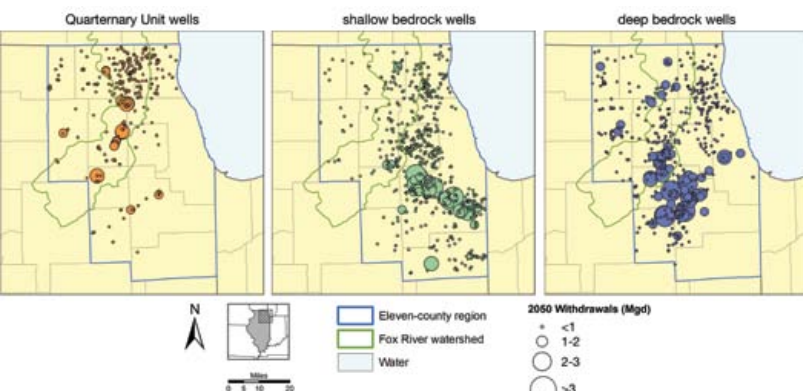
ISTC conducts business sustainability workshops at community colleges and collaborates with organizations such as the Illinois Conservation of Resources and Energy (ICORE) program, which assists municipalities and

businesses in southern Illinois. ISTC specialists work closely with wastewater treatment operators, publicly owned treatment works, and other water producers to help achieve water and wastewater efficiencies. ISTC staff help ICORE identify and implement practices and technologies that reduce energy consumption and greenhouse gas emissions to help make communities greener and more sustainable.

The ICORE program has worked with 13 water providers, municipalities, and organizations during the past three years. During the past year, these organizations saved

more than 4.5 million gallons of water through ISTC recommendations, more than 3.5 million kWh of electricity, and more than \$330,000.

Clockwise from top-left: This kneeling figurine was unearthed during Mississippi River Bridge 2009 excavations; ISTC helps businesses implement practices to reduce energy consumption; Invasive Asian Carp are abundant in the Illinois River; An ISWS regional groundwater flow model projects 2050 withdrawals from shallow sand and gravel wells, shallow bedrock wells, and deep wells in northeastern Illinois.



NATURALLY ILLINOIS EXPO AND OUTREACH PROGRAMS

The Institute and its many partners use science and technology to solve real-world problems, protect the environment, promote economic development, avoid waste, and save money. By definition, this work involves active engagement with public and private-sector managers and users of natural and cultural resources. In addition, we conduct education and outreach programs targeted to specific audiences and the public. These programs range from our large and successful annual exposition, Naturally Illinois, to workshops, lectures, tours, and classes around the state.

Left to right: (top) Brooklyn residents gather to hear ISAS archaeologist Joe Galloy; (bottom) The INHS Traveling Science Center tours the state; Geologist Brandon Curry and young Expo visitors examine microscopic fossils; A family explores the ISAS touchable collection of faunal bones; (top) Watershed specialist John Beardsley discusses stream dynamics with Expo visitors; (bottom) ISTC helps select recipients of the Governor's Sustainability Award; Geochemist Keith Hackley demonstrates the influence of liquid nitrogen on certain gases.



Naturally Illinois Expo

In March 2009 and again in March 2010, Institute scientists invited schoolchildren, families, and the public to come see, interact, touch, and experience the wonder of our state's diverse natural and cultural resources and cutting-edge sustainable technologies. More than 2,300 people attended the 2010 Expo, which featured nearly 50 exhibits.

Each year the Expo highlights the Institute's most exciting research and innovative projects, and offers the public a chance to meet and talk with Institute experts on energy, water, ecosystems, cultural resource management, sustainable technology, and more. The Expo is entirely planned and staged by staff volunteers and supported by donations. The 2011 Expo will be held March 11 and 12.

Outreach Programs

The two Illinois Natural History Survey mobile science centers feature biodiversity topics and have reached more than 180,000 people at 700 sites in Illinois since 2003. In 2009, new panels were added to highlight the importance of Illinois waterways. Continuing education workshops have integrated art, writing, and photography to train citizens in nature identification and stewardship. Each

year INHS scientists give presentations to more than 17,000 K-12 students, 100 college classes, and 100 clubs and organizations. In addition, the INHS Outreach Lab creates exhibits for nature centers, museums, and classrooms across the state.

The Illinois State Archaeological Survey gives more than 30 lectures per year to students and public organizations and leads tours of ISAS collections and project sites. Staff also stage exhibits on Illinois archaeology and provide an artifact identification service for the public. On-going outreach efforts include a grassroots archaeological and historical public engagement project in Brooklyn, near East St. Louis, which was the first majority African American town in the U.S. to incorporate.

The Illinois State Geological Survey conducts four public field trips per year to various sites in Illinois, a weekly seminar series, and occasionally hosts large public lectures. Field trip destinations were the Garden of the Gods area in Shawnee National Forest in Fall 2009 and Mississippi Palisades State Park in Spring 2010. Beginning with its centennial in 2005, the ISGS held spring open houses, which were the precursor to the Naturally Illinois Expo. In addition, ISGS scientists conduct teacher workshops, provide lectures and

educational material to classrooms and organizations, and participate in the regional, state, and national Science Olympiad.

The Illinois State Climatologist at the Illinois State Water Survey conducts numerous outreach activities, including hosting a blog, maintaining an active media presence, and giving numerous talks around the state. In a typical year, the State Climatologist provides data to 90 media outlets and nearly 500 individuals. This office's website receives 1.5 million hits per year, 150,000 unique visitors, and 34,000 repeat visitors. In addition, ISWS staff attend agency and citizen group meetings to provide expertise and advice on water resource topics, are technical advisors to the Mahomet Aquifer Consortium, and participate in the regional, state, and national Science Olympiad.

ISTC reaches over 200 businesses a year to assist with sustainability, pollution prevention, and efficiency. Other outreach activities include the Governor's Sustainability Awards in cooperation with the Office of the Governor (2009 winners listed on page 26), the Sustainability Seminar Series, the ISTC Sponsored Research Symposium, and "Greening Your Organization" workshops. The Sustainable Electronics Initiative also has outreach components.



ILLINOIS NATURAL HISTORY SURVEY

The INHS has provided information on Illinois' plants, animals, prairies, savannas, woodlands, forests, and agricultural lands, and their ecological interactions, for more than 150 years. We deliver this information to federal, state, and municipal agencies that manage Illinois' biotic resources. Agricultural, environmental, hunting, fishing, and other groups also use our information. Fishing, hunting, and wildlife-associated recreation is a \$2.4 billion industry in Illinois which depends on the quality of our natural environment. INHS data are used to comply with regulations, prioritize natural resource investments, and respond to environmental threats such as human disease vectors, agricultural pests, invasive species, and climate change. INHS scientists routinely attract \$4 for every state dollar invested which provide jobs as well as financial support for graduate students. Beyond all the research, our scientists actively educate the citizens of Illinois about the natural world around us. The return on that investment has and will continue to accrue over generations.



Brian D. Anderson, PhD
Director

Mission: To investigate and document the biological resources of Illinois and other areas, and to acquire and provide natural history information that can be used to promote the common understanding, conservation, and management of these resources.

Research Shows Behavior of Beetles Crucial to Transgenic Technology

INHS research on insect behavior has helped ensure that transgenic crop technology continues to pay off for everyone who uses or benefits from it. Transgenic or insect-resistant hybrids are the new gold standard for pest management in corn, an annual \$7.5 billion crop in Illinois. Unlike broad-spectrum insecticides, transgenic corn targets a few specific pests, including the western corn rootworm, the most serious pest of U.S. corn. However, the durability of transgenic corn is limited if insects develop resistance to the pest-specific toxins that give these plants their "punch." To delay resistance, the U.S. Environmental Protection Agency mandates that farmers set aside a small portion of each field as a non-transgenic refuge, an area where susceptible pests can develop without exposure to the toxin. Susceptible rootworm beetles are expected to move into adjacent transgenic corn and mate with resistant beetles that survive exposure to the toxin. Interbreeding between these beetles effectively dilutes the impact of resistance.

Transgenic crop technology relies on an intimate knowledge of pest ecology to design and situate refuges that promote desirable pest behavior. However, a consequence of the rapid adoption of rootworm-resistant transgenic corn is a lack of data about small-scale movements and mate-finding behaviors that are fundamental to preventing resistance using refuges. The INHS approach to studying whether a refuge functions in a sustainable way focuses on letting the beetles tell their own story. Throughout the summer, a small army of undergraduates observes and collects beetles moving and mating within refuge and transgenic corn. Analyses of the insects and their activity are used to compare the consequences of different refuge configurations on rates of beetle movement, mating, and egg-laying. Increasingly, poor grower compliance with refuge requirements is actually pushing the system toward a product in which the proper percentage of refuge seed is blended in the bag with the transgenic seed. Not only does a "refuge in the bag" system ensure compliance, but the INHS results show that it promotes mixing of male and female beetles at the right time in the right place. Paying



attention to what really happens in cornfields is the logical way to ensure that transgenic crop technology is sustainable.

Research Measures Prairie Restoration as a Carbon Sink

INHS researchers have found that prairie restoration of agricultural lands may provide significant below-ground carbon sequestration that reduces CO₂ concentrations linked to global climate change. Midewin National Tallgrass Prairie in Wilmington, Illinois, the largest prairie restoration east of the Mississippi River, provided a unique opportunity to investigate prairie restoration as a carbon sink. Researchers found that conversion of row-crop lands to both pasture and newly restored prairie almost doubled, on average, the below-ground stock of carbon. Remnant prairie soils contained about three times the carbon stocks as row crop soils.

While the effectiveness of prairie restoration to offset climate change should not be overstated, it will contribute in the short term. More significantly, the results highlight the great benefits of maintaining intact native ecosystems. In fact, worldwide, native ecosystems disturbance releases from 40 to 60 percent of stored, underground carbon to the atmosphere. The INHS research provides a strong incentive for conservation and maintenance of native ecosystems worldwide.

Long-Term Fish Monitoring Program Expanded

In 2010, INHS expanded the Long-Term Illinois River Fish Population Monitoring Project, also known as the Long-Term Electrofishing program (LTEF), to include Illinois portions of the Mississippi, Ohio, and Wabash rivers. Standardized fish community sampling of the Illinois River has been conducted since 1957 to evaluate human influences on annual fish population trends. The longevity of this program has made the LTEF one of the premier riverine fish community evaluations in the country.

New directives for the LTEF program call for the specific monitoring of invasive Asian carp in all four rivers and near the aquatic nuisance species dispersal barriers in the Chicago Sanitary and Ship Canal, as

well as monitoring the fish community within main channel habitats of the Mississippi River. The expanded program uses the same protocols as the Long-Term Resource Monitoring Program on the Upper Mississippi River System to allow for comparability over broad spatial scales. The expanded LTEF also incorporates several specific directives outside of the base monitoring program, which allow for graduate student participation from the University of Illinois and Eastern Illinois University.

Historically, the program has provided a wealth of information for scientists and managers along the Illinois River. Relative abundances, relative biomass, and species diversity assessments provide the records necessary to document fish community improvements in conjunction with improved water quality in the Illinois River.

With support from the Federal Aid in Sportfish Restoration program and the Illinois Department of Natural Resources, the expanded program will enhance river fish knowledge on a much broader scale within the state and increase the amount of scientific information available to scientists and managers beyond Illinois borders.

Bottom from left: Undergraduate Tommy Parkhill prepares a mating rootworm sample for storage; This orange-spotted sunfish was collected during LTEF sampling; Restored prairies store carbon at about twice the rate of row crops; Ecologist Thad Cook records length and weight information from a bluegill collected during LTEF sampling; Graduate student Sarah Hughson gathers corn rootworm beetles.



ILLINOIS STATE ARCHAEOLOGICAL SURVEY

It has been nine months since the creation of the Illinois State Archaeological Survey within the Institute—an exciting new beginning for a half-century-old program. ISAS researchers provide archaeological expertise to the Illinois Department of Transportation that enables \$2.5 billion (plus \$1 billion in American Recovery and Reinvestment Act funds) in road, rail, and airport projects to move toward construction. Survey archaeologists continue one of the largest excavations in North America at a 1,000-year-old ceremonial center ahead of construction of a vital \$670 million Mississippi River Bridge at East St. Louis. We have launched an initiative with the Illinois Historic Preservation Agency to systematically re-inventory the state's 9,000+ mound sites utilizing ISGS's LiDAR topographic data to aid planners and developers. Survey researchers continue their statewide efforts to educate Illinois citizens about the state's rich past.



Thomas E. Emerson, PhD
Interim Director

Mission: To investigate, preserve and interpret the archaeological heritage of Illinois within the contexts of long-term public needs and sustainable economic development through its scientific research, public service, education, and outreach activities.

ISAS Contributes to Improvements in Tribal Consultation and Notification

ISAS played a significant role in a follow-up tribal consultation workshop in July 2009, which resulted in two significant improvements. A Memorandum of Understanding to guide tribal consultation in Illinois was developed and is currently being finalized as part of the compliance process of the National Historic Preservation Act. ISAS staff provided organizational and logistical support for the workshop and invited more than two dozen tribes. Participants included representatives from nine tribes: Absentee Shawnee, Ho-Chunk, Iowa (of Kansas and Nebraska), Kaw, Kickapoo (of Kansas), Osage, Ponca, Pokagon Band-Potawatomi, and Sac-Fox (of Oklahoma) as well as staff from ISAS, Illinois Department of Transportation (IDOT), Federal Highway Administration (FHWA), the Illinois State Historic Preservation Office, and the Illinois State Museum.

While IDOT and FHWA have actively consulted on transportation projects over the past decade with federally recognized tribes, including the Illinois (Peoria), Ho-Chunk, Kickapoo, Potawatomi, and others that ceded lands in Illinois to the federal government nearly two centuries ago, there are a number of tribes that did not historically cede lands who believe they have ancestral connections to the state. The 2009 workshop and one in 2008 were held to address issues of interest to these tribes.

Another product of the tribal consultation workshop is the creation of a computerized Project Notification System (PNS). The PNS, created by ISAS for IDOT and FHWA with technical assistance from the University of Illinois, has become a key component of the consultation process in Illinois. The system is a Web-based, interactive method of communicating with the tribes to provide project information as soon as it is available to IDOT engineers and allow tribe members to immediately transmit any concerns to IDOT.

The PNS was used in 2009 to post more than 250 IDOT projects. The PNS is now accepted as the standard method of project notification, and it has proven to be an extremely effective means of tribal consultation, attracting the attention of Departments of Transportation across the U.S.



It was recognized by the FHWA in their 2010 selection for Exemplary Human Environment Initiatives which recognize outstanding examples of transportation projects that either create or improve conditions for human activities while protecting the natural environment.

ISAS Begins Statewide Re-Inventory of Burial Sites

To better manage the sensitive resources of burial mounds and cemeteries, ISAS, in cooperation with the Illinois Historic Preservation Agency and at the direction of IDOT, has undertaken a systematic re-inventory of all burial sites within areas affected by transportation projects. Illinois has more than 58,000 reported archaeological sites containing 9,000+ prehistoric earthen mounds. Most Illinois mound sites were reported in the 1930s and 1940s and have not been revisited. With continued suburban and industrial expansion into less developed regions, ISAS staff often encounter early mound and burial sites as well as pioneer cemeteries while conducting surveys for new transportation network projects.

To increase the accuracy and ease of this process, staff now have access through the ISGS to new LiDAR images that provide highly accurate topographic data. Mounds are protected by state law, so their location and condition are valuable to both the preservationist and development communities.

As part of the new tribal consultation process, when feasible, native mortuary sites located within two miles of IDOT projects are revisited to ensure that the sites will not be affected by IDOT projects, that their locations are correctly reported, and that their current condition is documented.

To preserve mound groups in northwestern and western Illinois, ISAS staff have engaged in volunteer partnerships with groups such as the Quincy Park District, the Illinois Department of Natural Resources, and the Jo Daviess Conservation Foundation. Staff provide professional expertise and field assistance, and help in promotion and acquisition activities. Volunteer partnerships helped bring several privately owned mound sites into public ownership.

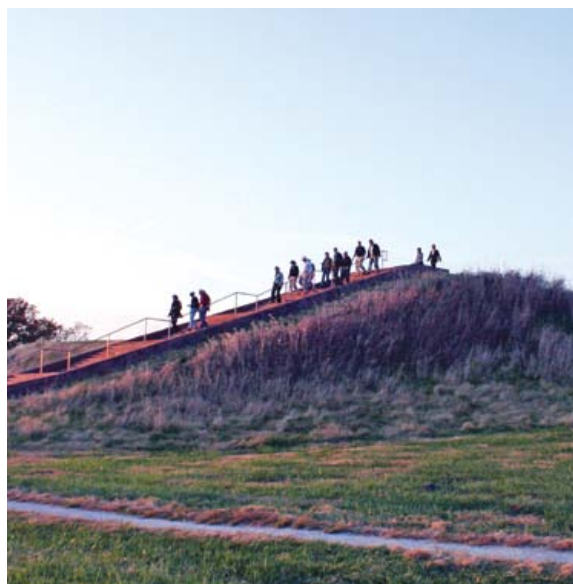
Grant Increases Accessibility of World-Famous Artifacts

ISAS made progress in 2009 on increasing the visibility and accessibility of its Cahokia archaeological collections to the general public and scientific researchers as well as on re-housing those collections according to modern museum standards. A new website will contain descriptions of archived field notes and photos as well as thumbnail photographs of notable artifacts. This effort serves to make these world-famous artifacts and collections once hidden in “back rooms” accessible to a wide spectrum of society.

ISAS received a \$111,000 multi-year grant in 2008 from the National Endowment for the Humanities to help catalog and re-house its Cahokia collections, approximately 550 boxes of artifacts. Cahokia, the largest archaeological site north of Mexico, has worldwide importance and is widely acclaimed by its recognition as a United Nations World Heritage site, acknowledgement on the National Register of Historic Places, and as a National Historic Landmark.

The University of Illinois has been involved in Cahokia archaeology since the 1920s, and excavations have produced the collections that are now curated at ISAS. The collection sources include (1) privately and U of I-funded excavations in the 1920s through 1930s to either conduct research investigations (“expeditions”) or to rescue the context and artifacts from mounds being destroyed; (2) archaeological field schools; and (3) highway salvage excavations undertaken in the 1960s–1980s as part of IDOT construction projects. These irreplaceable collections are from mounds, plazas, and habitation areas, many of which have been destroyed by modern development, and include many unique artifacts.

Bottom from left: ISAS staff measure a mound near Quincy; Student worker Regena Pauketat catalogs artifacts; A carved shell with human effigy is part of the Cahokia collections; Tribal consultation workshop participants return from the top of Monks Mound; An Illinois Tribal Consultation Workshop facilitator thanks a participant.



ILLINOIS STATE GEOLOGICAL SURVEY

Research, mapping, and technical assistance provided by the ISGS supports primary sectors of Illinois' economy, including mineral, stone, and aggregate production (\$1.22 billion), coal mining (\$1.04 billion), and petroleum production (\$0.6 billion). Recently, ISGS carbon sequestration projects have attracted nearly \$100 million in federal funding and leveraged private-sector funds. ISGS expertise and data were critical to siting the FutureGen project in Illinois. At the time of this report, the U.S. Department of Energy is pursuing construction of the \$1.8 billion FutureGen 2.0 project which will also rely on ISGS technical support. Our geologic maps, which benefit the state up to \$39 for every dollar invested, are used for land-use and development decisions, yielding savings through prevention of environmental damage and mitigation of natural hazards. Recent technical collaboration with utilities led to development of a new process for capturing mercury in coal-fired power plant emissions that could save utilities in Illinois an estimated \$5 million each year and benefit rate payers.



E. Donald McKay III, PhD
Director

Mission: To provide the citizens and institutions of Illinois with earth science research and information that are accurate, objective, and relevant to our State's environmental quality, economic prosperity, and public safety.

ISGS Exploration Seeks to Ease Rare Earth Elements Shortage

Through cooperation with the U.S. Geological Survey, the ISGS has been exploring the Illinois-Kentucky Fluorite District in southern Illinois for a potential new source of rare earth elements (REE). The United States currently imports more than 90 percent of REEs from China, and China has recently reported that it will decrease its world-wide export of REEs in 2011 by 40 percent. According to a 2010 U.S. General Accountability Office report, the tight supply of REEs has already created some disruption and military weapons systems production delays.

Preliminary results of the ISGS work indicate that REEs may be concentrated in Permian Age igneous breccia pipes and diatremes that underlie the Illinois-Kentucky Fluorite District; a serious effort by commercial enterprises is underway to develop this resource.

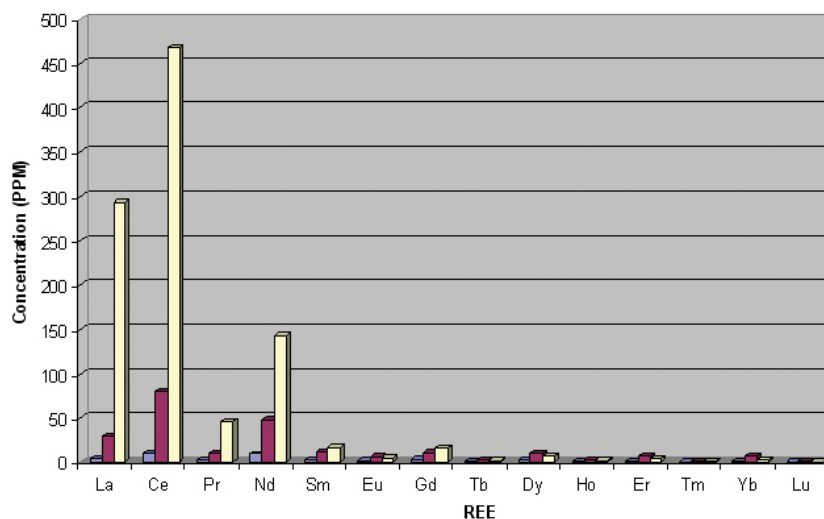
Rare earth elements, 17 chemical elements found in rocks, are becoming in short supply because of their low natural concentrations and their increasing use in high tech industries. REEs are essential in magnetic refrigeration, high-temperature superconductivity, safe storage and transport of hydrogen, and the manufacture of lasers, magnets, and batteries. REEs are also used for military purposes and in precision-guided munitions that rely on permanent rare earth magnets that have unique properties, such as the ability to resist demagnetization at very high temperatures.

ISGS Helps Central U.S. Prepare for Major Earthquakes

The ISGS coordinated the efforts of eight central U.S. state geological surveys to produce maps showing surface soils' abilities to amplify earthquake ground motions and also their susceptibility to earthquake-induced liquefaction. These maps were used by the Mid-America Earthquake Center (U of I), under contract to the Federal Emergency Management Agency (FEMA), to estimate the catastrophic impacts in eight states of a repeat of the 1811–1812 New Madrid earthquakes, the largest historic earthquakes in the lower 48 states. They are also being used by state and county emergency managers to develop and coordinate response plans.



Rare Earth Elements (REE)



In particular, these maps are being used to develop scenarios for the nation's first national-level exercise based on a catastrophic disaster such as New Madrid. The exercise will be conducted in May 2011, and will test the response to catastrophic earthquakes in the eight potentially impacted states. In addition to the maps, the ISGS is working with representatives of FEMA and state emergency managers to develop components of the exercise. For several years, state geological surveys in the central U.S. have been preparing for the bicentennial of the 1811–1812 New Madrid earthquakes, as well as the first national-level exercise.

As part of the exercise, the ISGS is coordinating its earthquake response plans with the U.S. Geological Survey and state emergency managers. Earthquake information and potential impacts will be presented to federal, state, county, and city emergency managers and various volunteer groups throughout the region. The multi-year effort is designed to provide this region with background information, improved plans, and coordination across many agencies to respond to a disaster. This includes those who reside beyond the direct impact area, as they would be able to provide valuable assistance.

Visualization Lab Expands Understanding of Sequestration Project Geology

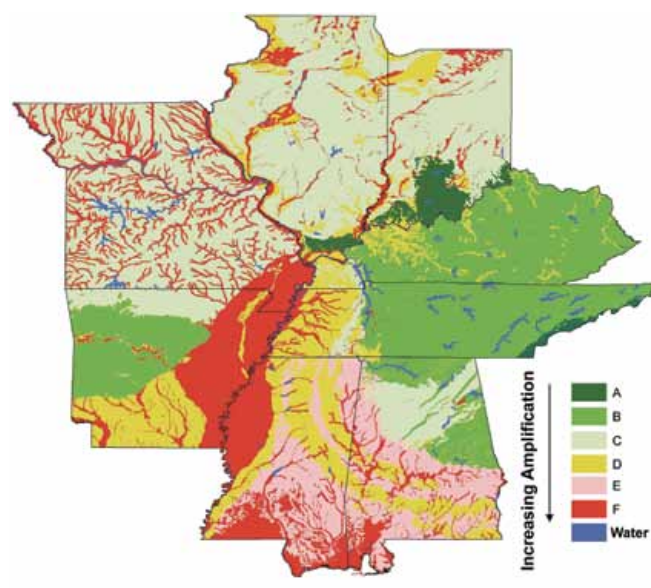
ISGS's new Earth Systems Visualization Laboratory provides an unprecedented interpretation opportunity for new 2-D and 3-D seismic reflection data and a 3-D vertical seismic profile of the Illinois Basin-Decatur sequestration project area geology. Gaining a better understanding of subsurface geology prior to injection of CO₂ allows researchers to confirm site quality, predict target CO₂ injection intervals, and evaluate the distribution of the subsurface CO₂ plume. The Advanced Energy Technology Initiative of the ISGS is leading this world-class project for reducing carbon dioxide emissions, which have been linked to global climate change.

The Visualization Lab uses a 14- by 8-foot screen and specialized software to provide realistic three-dimensional views of subsurface

borehole data, geophysical records, and geologic units. It allowed team members from the ISGS and Schlumberger Carbon Services to collaborate and openly discuss the geology of the Illinois Basin-Decatur project site. Interpretation of seismic reflection data, which are often very complex, is best accomplished as a collaborative effort by groups of individual experts. Without the use of the Visualization Laboratory, the data would have been difficult to view and analyze since regular computer monitors limit effective viewing and analysis to two individuals.

Current research involves interpreting seismic reflection data in terms of geologic variables that describe reservoir geometry and quality. Calculated attributes derived from the seismic data show the variation in reservoir geometry and quality across the injection project area and were used to help select the location of a verification well at the Decatur sequestration site.

Bottom from left: The Visualization Lab enables groups of scientists to collaborate; Preliminary geochemical analyses from the Karbers Ridge Quad-range use inductively coupled plasma atomic emission spectroscopy (ICP-AES) to measure rare earth elements; An explosion breccia or diatreme sample shows elevated concentrations of light rare earth elements; A soil amplification map shows variable earthquake severity.



ILLINOIS STATE WATER SURVEY

The ISWS has been a leader in the study of water and atmospheric resources in Illinois for more than a century. Today, our scientists are engaged in projects throughout the state, from the Fox River Watershed in northern Illinois, to the Cache River Watershed in southern Illinois. In the Chicago region, researchers provide data for Lake Michigan diversion accounting and investigate how the Great Lakes affect the complex weather of coastal cities. Water supply planning, which is vital in light of vigorous population growth and urban development, is a major commitment for ISWS. Our commitment continues until we develop the scientific information for sustainable water resources planning for the entire state. Recent efforts focus on north-eastern Illinois, east-central Illinois, and the Kaskaskia River basin. We continue to attract strong support from federal agencies for the Coordinated Hazard Assessment and Mapping Program, the Midwest Climate Center, and the National Atmospheric Deposition Program. It is our mission to continue to provide strong leadership in research, information dissemination, and outreach to address topics that are important to the well-being of Illinois and the nation.



Misganaw Demissie, PhD
Director

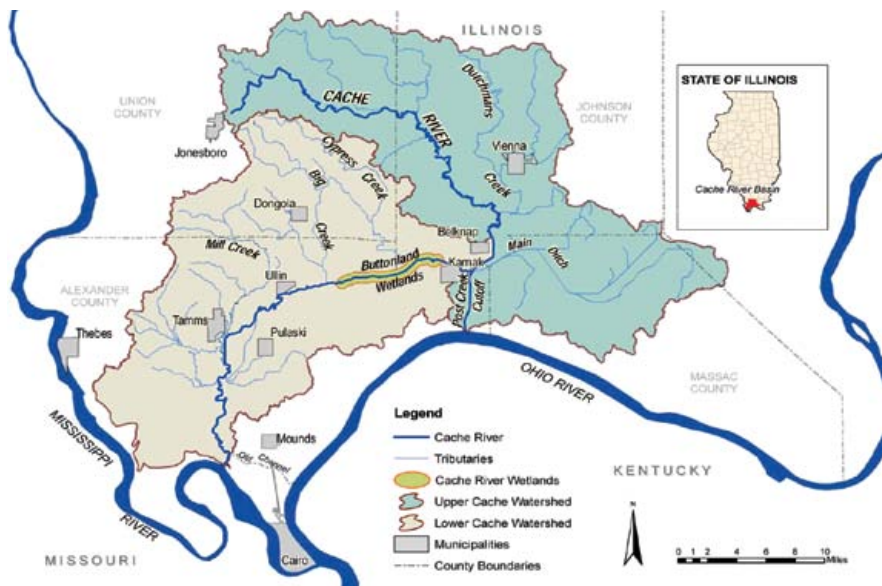
Mission: To characterize and evaluate the quality, quantity, and use of surface water, groundwater, and atmospheric resources of Illinois through basic and applied research; collecting, analyzing, archiving, and disseminating objective scientific and engineering data and information; and providing service, education, and outreach programs.

ISWS Completes Cache River Modeling and Analysis

This year, ISWS completed the second phase of modeling and analysis for restoration alternatives for the Cache River basin. The Cache River Wetlands Joint Venture Partnership now has the information and objective analyses needed to formulate restoration management plans and pursue funding to accomplish restoration goals based on detailed scientific results. The Partnership includes the Illinois Department of Natural Resources, The Nature Conservancy, U.S. Fish and Wildlife Service, Ducks Unlimited, the Natural Resources Conservation Service, and several local organizations.

The Cache River basin is located in the extreme southern tip of Illinois near the confluence of the Ohio and Mississippi rivers. Because of its unique location at the junction of major rivers and physiographic regions, the basin exhibits some of the most diverse natural wetland communities in the state with many plant and animal species on the edge of their geographic range. Some communities are relatively undisturbed. However, land use and drainage modifications have threatened the ecological integrity of the wetlands that now contain more than 100 endangered or threatened species.

For the past 30 years, concerned citizens, nongovernmental organizations, and state and federal agencies have been collaborating to protect and restore these valuable natural resources. The scale and complexity associated with successful restoration, preservation, and management resulted in the formation of the Partnership. With the common goal of restoring as much of the Cache River system's natural hydrology as possible, the ISWS was funded to develop the necessary hydrologic and hydraulic models to objectively evaluate the benefits and potential impacts of proposed restoration alternatives from both ecological and regulatory perspectives. ISWS produced detailed models that determined water levels associated with various combinations of flow conditions and control structures as compared to a reference condition to address regulations.



Center Research Targets Severe Weather Forecasting Near Lake Michigan

The Center for Atmospheric Science Mesoscale/Boundary Layer Meteorology (M/BLM) group has improved the understanding of the physical processes that drive Great Lakes climate and helped weather forecasters. Large coastal cities such as Chicago have highly complex climates. Air masses come from both the nearby land and water, severe weather can be generated by the interaction of the two air masses, and the urban area itself modifies the atmosphere. With such a large population of Illinois affected by this complex weather, increased knowledge can have a significant impact on lives and property.

Recent intensive observations by M/BLM staff using instrumented aircraft have indicated that methods of incorporating ice cover in current numerical model forecasts can systematically underestimate lake-effect snow intensity. It is common for northeastern Illinois to receive heavy lake-effect snow behind a departing cyclone, as the winds can flow toward the west across Lake Michigan, adding heat and moisture to the atmosphere. How the bands are organized over the lake, which determine the intensity of the snow, and which communities are affected also have been extensively investigated by M/BLM staff. All of these findings have been shared through scientific publications and public presentations, as well as through meetings at regional National Weather Service offices.

Forecasts of severe weather conditions during the warm season months are perhaps more difficult. M/BLM staff have found that the inland movement of the afternoon lake breeze is strongly linked to the Chicago heat island intensity the night before, providing the possibility for more accurate local forecasts of coastal urban afternoon temperatures. Staff have been conducting novel climatological analyses of thunderstorm system interactions with the lakes as well as seeking ways to obtain over-lake observations. With funding from the Illinois-Indiana Sea Grant Program and the U.S. National Science Foundation, atmospheric profiles over and near Lake Michigan were obtained using a unique, mobile weather balloon system. These data

should provide an opportunity to develop a more complete model of how storms react to moving over the lakes.

CHAMP Team Identifies Flood Hazards

Illinois suffers significant economic and personal losses due to flooding. Because flooding is the most predictable natural hazard, the first step to reduce these losses is to accurately show where flooding is likely to occur. Coordinated Hazard Assessment and Mapping Program (CHAMP) staff, in cooperation with the Federal Emergency Management Agency (FEMA) and the Illinois Department of Natural Resources, Office of Water Resources, have produced updated digital maps showing areas prone to flooding in 75 Illinois counties which will be finalized by 2012. These Flood Insurance Rate Maps show the areas that have a 1 percent chance of inundation in any given year. Communities can use these maps to avoid putting citizens at risk by steering development away from high flood risk areas.

The CHAMP team takes the message a step further. Working with University of Illinois Extension, the team has provided data for mitigation planning in four counties. Mitigation plans are the basis for FEMA funding for community projects that reduce exposure to flood losses. The CHAMP staff will continue to partner with FEMA in the five-year Risk MAP program, which includes extensive outreach initiatives on a watershed basis. CHAMP staff will collaborate with Extension on these outreach efforts to inform the public about flood hazards and alternatives for mitigating risk with the ultimate goal of saving lives, reducing property loss, and minimizing economic disruption.

Since 2004, FEMA has provided more than \$13 million to the ISWS CHAMP program to prepare maps and technical data, creating over 25 jobs in Illinois.

Bottom from left: CHAMP staff members train as a team to improve effectiveness; The Upper and Lower Cache River watersheds contain some of the most diverse wetland communities in the state; Many fields were flooded in the Main Ditch watershed of the Cache River Basin in March 2008; Atmospheric scientist David Kristovich launches a Graw radiosonde from the Lake Michigan Carferry Service's SS Badger.



ILLINOIS SUSTAINABLE TECHNOLOGY CENTER

It is my pleasure indeed to forward the accomplishments of our scientists, faculty associates, staff, and students on sustainable technology development. Sustainability is achieved through activities that satisfy today's needs without diminishing the prospects of future generations. ISTC scientists focus on biofuels, advanced energy technologies, e-waste, and engineered materials to provide economical and innovative yet practical solutions to today's most critical sustainable technology needs. The Center has provided assistance to Illinois businesses and the public since 1985. Since 1987, we have facilitated the Governor's Sustainability Awards in cooperation with the Office of the Governor to honor organizations across the state for their efforts in sustainability and pollution prevention. ISTC is a catalyst for sustainable economic growth through applied research and development, demonstration projects, and the transfer of innovative solutions.



Manohar R. Kulkarni, PhD
Director

Mission: To conserve natural resources and energy, reduce waste, promote pollution prevention, and increase economic viability by providing information, research, innovative technologies, education, and technical assistance.

Biochar Provides Source of Renewable Fuel, Soil Amendment, and Carbon Sequestration

ISTC researchers are investigating the use of waste biomass to produce biochar to increase crop yields and reduce the need for chemical fertilizers. This will potentially benefit agriculture and the environment in Illinois as well as in other countries. Biochar could be important in helping increase food supply and improve cropland, especially in areas with depleted soils, scarce organic resources, and inadequate water and chemical fertilizer supplies.

Sustainable biochar is a carbon-enriched material derived from waste biomass such as crop, timber and forest residues, and manure. It is made by heating biomass at low temperatures in the absence of air (pyrolysis) in a specially designed furnace to drive off volatile gasses, leaving behind carbon or "biochar." This process can produce a series of clean energy products such as bio-oil and syngas along with biochar.

Biochar can be used as a fuel or as a soil amendment. ISTC scientists are currently conducting studies on biochar production from a variety of biomass sources and testing its characteristics, use as a soil amendment for sustainable agriculture, and potential environmental implications. With an Illinois Department of Agriculture grant, scientists are undertaking greenhouse and field experiments in collaboration with Illinois Natural History Survey scientists and other researchers at the University of Illinois. While biochar is being produced around the world, research and development are needed to establish standardized production, improve desired traits, and assess the impact of biochar on soil ecology and processes.

Another potential environmental benefit associated with biochar applied to soil is that it can sequester atmospheric carbon. In the natural carbon cycle, plants take up CO₂ as they grow, and CO₂ is emitted rapidly when plants die and decompose—a carbon-neutral cycle. In contrast, pyrolysis can potentially lock up this atmospheric carbon as biochar for hundreds of years. Considering that CO₂ is pulled from air to make biochar, the net process is carbon-negative. Therefore, biochar is an attractive strategy to reduce atmospheric carbon. Biochar is one of several innovative ways that ISTC scientists are exploring to off-set fossil fuel use and reduce greenhouse gas emissions.



Sponsored Research Advances Knowledge on Key Sustainability Issues

ISTC sponsors research projects through a competitive grant program. In FY2010, examples of ongoing projects included emerging contaminants in Great Lakes fish; antimicrobial products in Illinois rivers; effects of denitrifying strategies for farm drainage on mercury levels in water; endotoxin detection in industrial environments; stabilization of biodiesel fuels; and monitoring and documenting performance of stormwater best management practices in the Chicago area.

Based on its mission, ISTC administers a Sponsored Research Program which provides funds to researchers to advance the state of knowledge in areas of pollution prevention, water conservation, environmental assessment, biofuels, and other sustainability issues of importance to the State of Illinois. The results of these projects provide valuable information to the scientific and regulatory communities and assist Illinois decision-makers in their efforts to develop sound environmental, energy, and economic policies.

Researchers from Loyola University, Chicago; Center for Neighborhood Technology, Chicago; Departments of Natural Resources and Environmental Sciences, Agriculture and Biological Engineering, and Chemistry at the University of Illinois, Urbana-Champaign; Illinois Natural History Survey; and ISTC are currently working on projects funded through this program.

Sustainable Electronics Initiative Draws International Attention to U of I Campus

In its second year, the Sustainable Electronics Initiative (SEI) hosted its first symposium, "Electronics & Sustainability: Design for Energy and Environment" in February 2010. Speakers included representatives from Wal-Mart, Dell, ReCellular, Motorola, and the Green Electronics Council; Illinois policymakers; and faculty and graduate students from the University of Illinois and other academic institutions. Every stage of the electronics life cycle was represented by participants, providing opportunities for a wide range of collaboration and discussion.

The e-waste (waste electronics of all types) issue not only affects Illinois communities but also is important on a national and global scale. A second symposium is being planned for March 2011.

The educational component of SEI was expanded with ISTC's first faculty affiliate, Department of Industrial Design Professor William Bullock, who once again taught a class on e-waste issues. This popular class drew approximately 100 students. The e-waste design competition associated with this class became an international event this year. Applicants were asked to create appealing, useful products from e-waste and submit videos of their entries online. Entries were received from multidisciplinary teams of approximately 200 college students and recent graduates from Australia, Canada, Cyprus, South Korea, and Turkey, and jurors included design industry leaders, U.S. Environmental Protection Agency staff, and electronics manufacturers and retailers. Approximately \$20,000 was awarded in tuition support and prize money from industry sponsors to winning teams. Extensive media coverage of the competition included an interview with *Discovery News* for a second-place University of Illinois team that created an algae cultivation reservoir for use in bio-fuel production.

Professor Bullock also taught a sustainable product development course through his Design for Energy and Environment (DEE) Lab located at ISTC. Multidisciplinary teams of research faculty and 50 students from design, engineering, and marketing addressed leading-edge challenges. SEI corporate members have priority for sponsored research through the DEE Lab, which focuses on sustainable, energy-efficient products and product systems.

Bottom from left: This bioswale in Chicago is being studied in the Stormwater Best Management Practices Project; Research chemist Wei Zheng works with plants growing in biochar-amended soil; The Chicago area stormwater project evaluates rain gardens with native plants and regular turfgrass; ISTC researchers compared radishes grown in soil with and without the addition of biochar; Students compete in SEI's International Sustainable E-Waste Design Competition.



COLLECTIONS, DATA, LIBRARIES, AND MAPS

The Scientific Surveys collect and manage natural and cultural resource specimens and samples, and produce and collect information, maps, and data. Assembled over the span of more than 15 decades, these irreplaceable collections and data continue to inform research, economic development, resource management, and conservation across the state and beyond.

Collections

The Institute's physical collections, many of which are mandated under Illinois statute, are an irreplaceable resource to the citizens of Illinois. Integral to the original concept of the Scientific Survey, they continue to provide a foundation for basic and applied research as well as economic development in Illinois. Overall, more than 400 researchers directly accessed the INRS collections in FY2010, and thousands more accessed the collections through online catalogues, public exhibits, tours, or loans.

The Illinois Natural History Survey's biological collections—over 9.4 million specimens—rank among the world's largest, and are the most complete documentation anywhere of the flora and fauna of Illinois. Large biological collections provide baseline data for inventorying species, recognizing and protecting natural areas, restoring disturbed ecosystems, recognizing and controlling exotic species, and identifying organisms. The collection is fully indexed in a public online database and includes:

7,000,000 Insects – 9th largest collection in North America

875,000 Plants and fungi – 13th largest in North America

850,000 Fish – 15th largest in North America

327,000 Annelids – the only large collection of Illinois material

120,000 Mollusks – 15th largest in North America

120,000 Amphibians and reptiles – 9th largest in North America

85,000 Crustaceans – 15th largest in North America

In FY2010, 102,417 specimens were added to the INHS collections, and nearly 33,000 specimens were loaned to researchers around the world.

The Illinois State Archaeological Survey curates a collection of 1,500,000 specimens and artifacts, which represent one of the finest regional data sets in the Eastern Woodlands region of North America. ISAS houses some 18,000 boxes of artifacts, and is growing each year by about 800 new boxes from about 250 cultural resource management projects. In FY2010, there were 9 accessions totaling 22 boxes.

The ISAS collections are available to qualified individuals for study, exhibit, teaching, public interpretation, religious use, scientific

analysis, and scholarly research; outloans are made only for the purpose of exhibits. In FY2010, some 5,500 boxes of artifacts were moved from substandard warehouse conditions to secure, climate-controlled space.

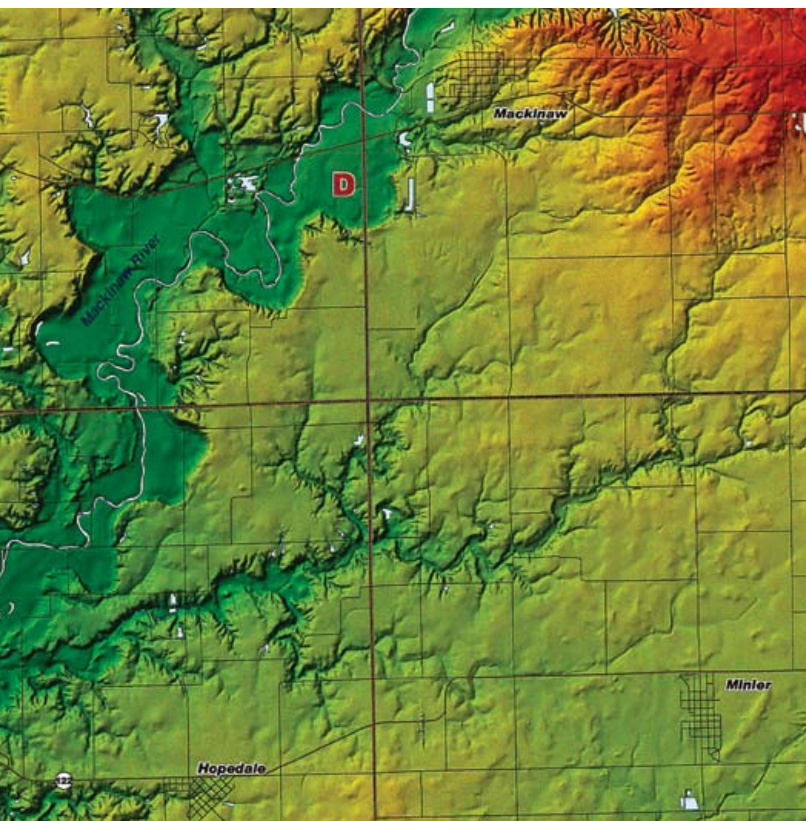
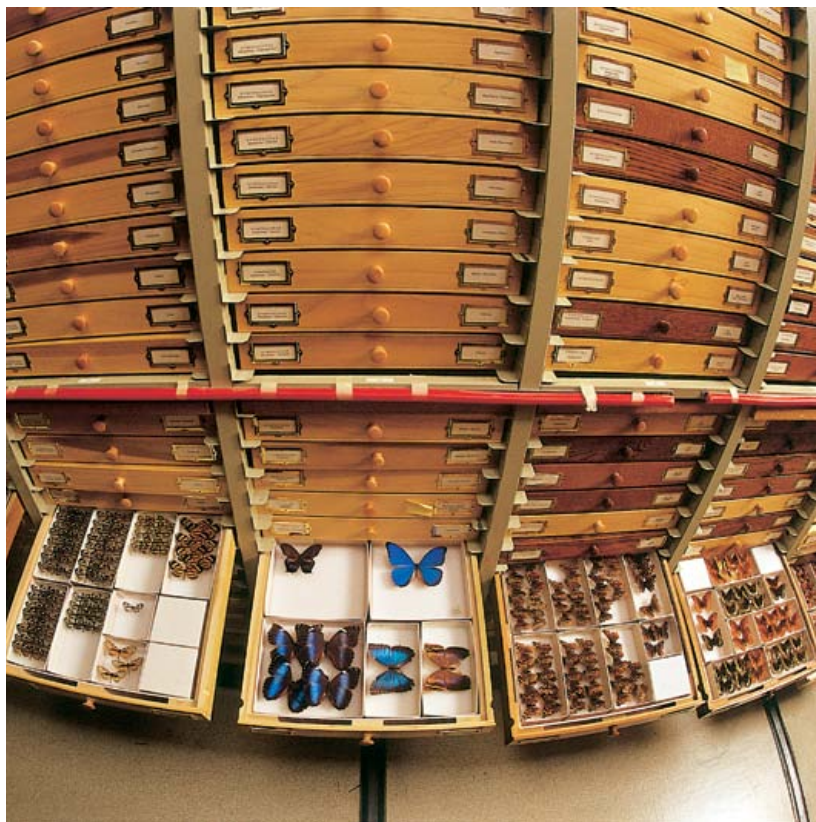
The Illinois State Geological Survey has one of the nation's largest collections of geologic core samples, growing larger every year. The Geologic Samples Library contains 70,000 well cuttings and 15,000 drill cores that combined span more than 3.5 million vertical feet of the Illinois subsurface. ISGS drilling rigs add over 15,000 feet of new core annually in support of geologic and groundwater research and service. The ISGS is also home to the Albert V. Carozzi Petrological Collection. ISGS paleontological collections numbering more than 150,000 specimens in over 200 individual collections date to the 1850s and contain many "type specimens" on which fossil species were originally defined. The collections also include 79 drawers of microfossils. In FY2010, collections staff are creating a thin section file, cataloging over 1,000 slides to date, with hundreds more in process.

Records and Data

The Illinois Natural History Survey manages a variety of ecosystem, habitat, and species monitoring programs compiling time-series data spanning many years, many of which are available on the Web. These include the Critical Trends Assessment Program, Long-Term Resource Monitoring Program, Cooperative Agricultural Pest Surveys, land cover data, hunter harvest reports, waterfowl inventories, and creel surveys. Biological collections databases provide records of species geographic distribution over time, and the Species File databases track species taxonomic information.

ISAS is the only institution to host archaeological databases online in Illinois. The Cultural Resource Management Report database represents a comprehensive effort to make available all unpublished reports deposited at the Illinois Historic Preservation Agency since

Opposite, clockwise from top-left: The fossil collection at ISGS dates back to the 1800s; The Natural History Survey's insect collection is the 9th largest in North America; ISAS artifacts include this bear effigy vessel; A surface relief map of Tazewell County is revealed in detail with LiDAR technology.



1990; currently, there are over 18,000 reports with several hundred added each year. This repository for all records relating to cultural resource management performed by the Illinois Department of Transportation since 1956 is accessible to qualified researchers. The Illinois Burial Survey, also available to qualified researchers, contains information on more than 3,000 previously recorded burial mounds, cemeteries, or grave sites that are not registered with the state. Additionally, ISAS hosts the award-winning Project Notification System, which automatically notifies up to 23 separate Indian tribes of federally funded projects to be undertaken in Illinois. ISAS records also include the Cahokia Archaeological Artifacts database and the Illinois Historic Bridges database, both of which have unrestricted public access.

The Illinois State Geological Survey is the official state repository for drilling permits, logs, and geologic information from oil, natural gas, and water wells. These records, assembled over 100 years, include more than 580,000 wells. They are used by geologists, engineers, the oil and gas industry, and water well drillers, and can be accessed online or in person. The Geological Records Unit received 245 visits in FY2010.

The Illinois State Water Survey collects and manages comprehensive climate and weather data over the period of record in Illinois, water quality and quantity data, well records, stream flows, and sediment surveys, and is the official depository for all data compiled under the National Atmospheric Deposition Program, which includes the National Trends Network, the Atmospheric Integrated Research Monitoring Network, the Mercury Deposition Network, and the Atmospheric Mercury Network.

Specific databases and websites include the State Climatologist's website, home to a vast array of weather and climate records and data, the Domestic Wells Database, Illinois Water Inventory Program, Watershed Monitoring Data, Water and Atmospheric Resources Monitoring, soil temperatures, a crop degree calculator and degree-day accumulations for crops and pests, the Illinois Climate Network, and the Nitrogen Cycles Project. In addition, the Midwest Regional Climate Center's Applied Climate System is an online climate data and information system that allows users to custom-tailor a wide variety of climate and information products at different spatial and time scales for decision support.

The Illinois Sustainable Technology Center hosts the website for the Great Lakes Pollution Prevention Roundtable, a consortium of eight regional information centers. The website was visited over 60,000 times in FY2010 and provides detailed, practical information, organized by industrial sector and by topic. The site has a blog, a help desk, and a variety of listservs covering environmental topics for state, regional, national, and international subscribers.

ISTC also hosts the Printers' National Environmental Assistance Center, which offers online and direct technical and compliance assistance to printers. The site is heavily utilized by the printing industry, drawing over 180,000 visits in FY2010.

INRS Libraries

The INRS libraries contain over 165,000 volumes, plus large map and image collections, including the historical output of the Illinois State Scientific Surveys. The combined topical strengths of the collections are natural resources of all types, earth and environmental sciences, environmental protection, natural history, and ecology, with considerable Illinois-specific content. Our librarians assist INRS staff, U of I faculty, staff, students, and the general public. They create online research guides and bibliographies to expose collections and highlight INRS research.

INRS has begun the process of consolidating INRS library collections and services by adding the book collections of the Illinois Sustainable Technology Center and Illinois State Water Survey to the University Library catalog, where they are readily available to borrowers statewide.

Maps and Geospatial Information

The Institute produces and maintains a vast library of maps focused on Illinois, covering a comprehensive range of resource topics at various scales.

The ISGS hosts the Illinois Natural Resources Geospatial Data Clearinghouse, a website that provides free public access to terabytes of Geographic Information Systems (GIS) data that were collected, compiled, and contributed from the Scientific Surveys and external sources. The Clearinghouse hosts GIS data sets and documentation (metadata) for ArcIMS Interactive Map Services, USGS digital topographic maps, aerial photography, orthoimagery, orthophotography, geology, land use, natural resources, and infrastructure. Illinois data sets and map data layers are available for downloading free of charge.

ISGS constructs high resolution, three-dimensional computer models and maps of the subsurface, which are then used to locate and delineate aquifer capacity, recharge areas, natural hazards, and aggregate and mineral resources. The new Earth Systems Visualization Laboratory and associated software has significantly advanced this effort and is being used in conjunction with data collections to select and develop carbon sequestration sites.

In addition, ISGS continues to acquire and compile LiDAR maps of Illinois. These maps offer detailed coverage of surface elevation, with accurate resolutions of 2 feet or less. LiDAR maps are leading to breakthroughs in understanding our landscape, affecting everything from floodplain mapping to highway engineering.

The ISWS's Midwestern Regional Climate Center provides automatically updated maps of temperature, precipitation, soil moisture, and other climate parameters, providing near real-time assessment of the climate of the Midwest. It is able to respond quickly to requests for specialized products and information relevant to various sectors, including agribusiness, energy, risk management, health, transportation, and water resources.

Finally, the Institute's ESRI Development Center trained 87 students in FY2010 in the use of GIS software, co-hosted the first GIS fair at the University of Illinois, supported research projects, and supported staff participation in numerous conferences.

PUBLICATIONS

Much of the Institute's work is conducted in partnership with public and private-sector clients. Research findings are conveyed in written reports to the various groups that contract for our services; more than 750 such reports were delivered this fiscal year. In addition, Institute scientists actively publish and present their work in outside venues, contributing to the advancement of

knowledge in their respective disciplines. In FY2010, Institute researchers published 208 journal articles, 2 books, 32 book chapters, and 23 magazine articles, and delivered 127 presentations at regional, national, and international conferences. Also in FY2010, the Institute's in-house publication programs published 26 peer-reviewed monographs, reports, and maps,

and 31 reports, educational materials, and fact sheets intended for industry, educators, and the public. More than 1,200 documents of all types have been added to the University of Illinois online institutional repository, IDEALS, and a total of 46,981 document downloads were reported from Institute collections in IDEALS during FY2010.

Examples of peer-reviewed works published by the Institute during the 2010 fiscal year.

Complete lists of Institute publications may be found on the INRS Division websites.

Demissie, M., E. Bekele, Y. Lian, and L. Keefer. 2010. *Hydrologic and Hydraulic Modeling for Evaluating Alternatives for Managed Connection of the Upper and Lower Cache Rivers*. Illinois State Water Survey Contract Report 2010-06. 131 pp.

Korose, C. P., A. G. Louchios, and S. D. Elrick. 2009. *The Proximity of Underground Mines to Urban and Developed Lands in Illinois*. Illinois State Geological Survey Circular no. 575. 92 pp.

Strege, J. R. 2010. *Low-Temperature Diesel Additives from Extracted Oil*. Illinois Sustainable Technology Center Technical Report no. TR-041. 34 pp.

Taylor, C. A., J. B. Taft, and C. E. Warwick. 2009. *Canaries in the Catbird Seat: The Past, Present, and Future of Biological Resources in a Changing Environment*. Illinois Natural History Survey Special Publication no. 30. 306 pp.

Examples of outside publications by INRS staff.

Complete lists of external publications by INRS authors may be found on the INRS Division websites.

Angel, J. R., and K. E. Kunkel. 2010. The response of Great Lakes water levels to future climate scenarios with an emphasis on Lake Michigan-Huron. *Journal of Great Lakes Research* 36(Supplement 2): 51–58.

Emerson, T. E., D. L. McElrath, and A. C. Fortier [eds.]. 2009. *Archaic societies: Diversity and complexity across the midcontinent*. Albany, N.Y.: State University of New York Press, 867 pp.

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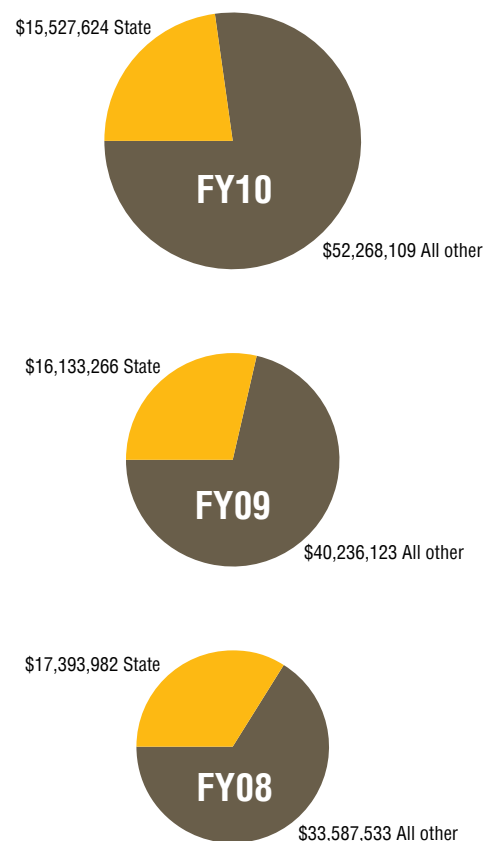
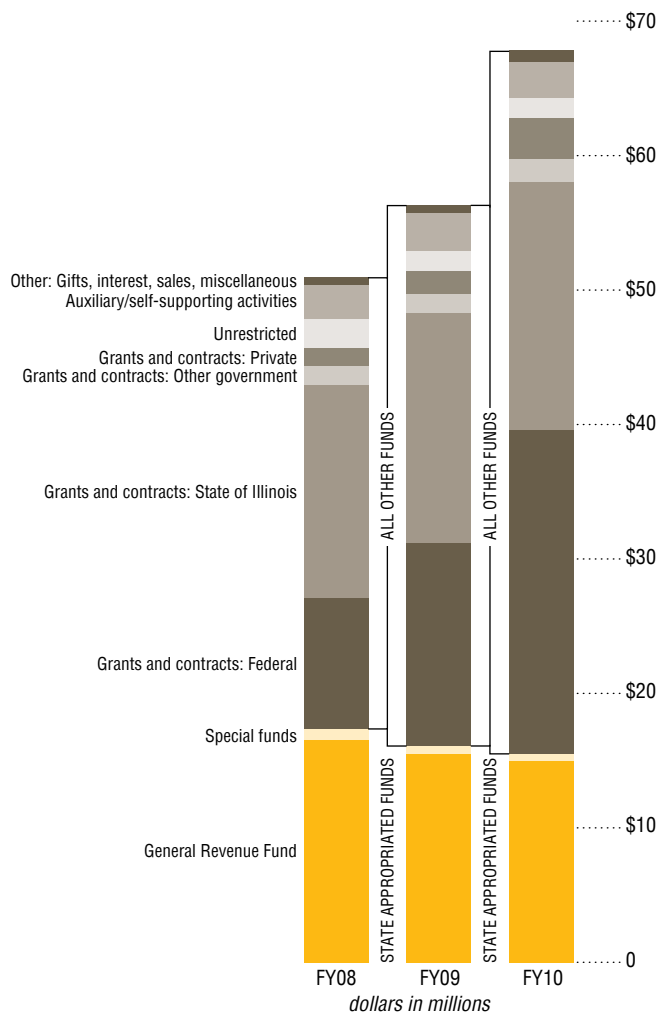
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EXPENDITURES: FISCAL YEARS 2008 THROUGH 2010

The Institute's budget consists of state appropriations from the General Revenue Fund (GRF) and three special state funds, numerous grants and contracts, donations, and income derived from services such as laboratory analysis and publication sales. Two state agencies, the Illinois Department of Natural Resources and the Illinois Department of Transportation, accounted for almost 30 percent of FY2010 total grant and contract funding. ISAS joined INRS in February 2010, and its FY2010 expenditures are reported for February through June 2010. ISAS was 4 percent of the total INRS grant and contract expenditures in FY2010. Total expenditures were nearly \$51 million in FY2008, more than \$56 million in FY2009, and nearly \$68 million in FY2010. A list of major grant and contract funders is provided on the following page.

Since FY2008, state expenditures have declined almost 11 percent, or about \$1.4 million. Much of this was due to the reduction in appropriations that occurred in FY2009 when the Institute transitioned from state government. The FY2010 GRF expenditure decrease is due to the University-mandated furlough and cash conservation programs. Over these three fiscal years, total annual grant and contract expenditures have increased by almost \$19 million, or 67 percent. Without the addition of ISAS, the increase is about \$17 million or 60 percent. Federal funding brought to Illinois has grown each year, increasing from \$9.7 million in FY2008 to over \$24 million in FY2010, which is a gain of 148 percent. Federal funding now exceeds state appropriations by about \$8 million. In FY2008, for every GRF dollar expended, the Institute brought in an additional \$1.71 in grant and contract funding. That ratio increased to \$2.28 in FY2009 and \$3.16 in FY2010.



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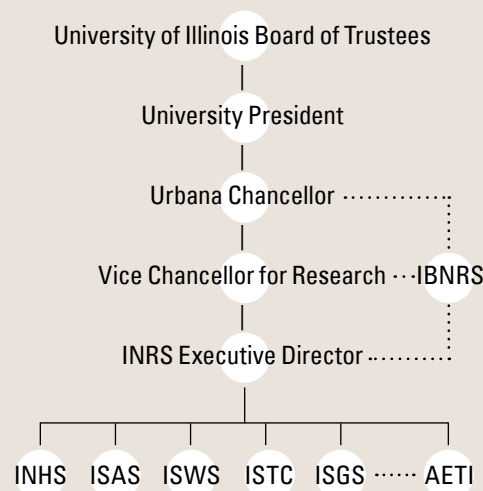
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