

Fall 2003

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Recommended Citation

"Fall 2003" (2003). *Perspectives*. Paper 11.
http://opensiuc.lib.siu.edu/orda_pers/11

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PERSPECTIVES

FALL 2003

RESEARCH AND CREATIVE ACTIVITIES

SOUTHERN ILLINOIS UNIVERSITY CARBONDALE



WATER WORK

The Science of Water-Use Forecasting

ALSO: FISH AND THE RAINFOREST + THE MAN WITH A THOUSAND FACES + IT'S A PUZZLE



Scope. SIUC research has it—nationally and even globally—and this issue shows it.

Consider a few items from these pages:

- An analysis of U.S. water-use trends over nearly 50 years, funded by the U.S. Geological Survey, yields statistical models to improve water-demand forecasting here and abroad.

- An SIUC/Texas A&M team publishes the first comprehensive map of the soybean genome, which will aid crop-science research internationally.

- The Australian Defence Science and Technology Organisation, which works collaboratively with U.S. defense agencies, is supporting an SIUC mathematician's research in combinatorics, a field with security-related applications.

- Funding from NASA allows an SIUC geophysicist to study magnetic field variations in the portion of the earth covered by the United States—work that will help both U.S. and foreign scientists studying earthquake hazards.

- Impoverished villagers in the Peruvian Amazon are leading better lives thanks to a joint U.S./Peru aquaculture project that involves research and extension services to rainforest residents.

- Theater students at SIUC will acquire new skills as a result of a trip their scenic-design professor made to Bali to study mask-carving with the experts.

We are learning from the world, and the world is learning from us. It's a dynamic mix.

As we move toward the research benchmarks of *Southern at 150* (SIUC's vision for 2019, its 150th anniversary), we'll continue to bring you news of our projects with national and international import, as well as those focused on our state and region. We hope you enjoy reading the stories we have to tell.

John A. Koropchak
Vice Chancellor for Research and Graduate Dean

Southern Illinois University Carbondale

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*Vice Chancellor for Research
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Perspectives • Fall 2003

Perspectives: Research and Creative Activities at Southern Illinois University Carbondale is published twice a year, in spring and fall, by the Office of the Vice Chancellor for Research/Office of Research Development and Administration.

To be added to our mailing list, obtain back issues, or request permission to reprint material, contact Marilyn Davis, Editor, Office of Research Development and Administration (ORDA), SIUC, Carbondale, IL 62901-4709, (618) 453-4540, mdavis@siu.edu. Back issues also may be found at www.siu.edu/~perspect.

For information about the research program at SIUC, visit www.siu.edu/~ovcr, or contact John A. Koropchak, Vice Chancellor for Research and Graduate Dean, (618) 453-4551, koropcha@siu.edu, or Prudence M. Rice, Director, Office of Research Development and Administration (ORDA), (618) 453-4531, pmrice@siu.edu.

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Photography: Russell Bailey, Steve Buhman, and Jeff Garner, Media & Communication Resources, except where noted. Bottom photo p. 2 courtesy Danielle Crissman. Photo p. 6 courtesy Images of American Political History web site (teachpol.tcnj.edu/amer_pol_hist); in public domain.

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FALL 2003

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SOUTHERN ILLINOIS UNIVERSITY CARBONDALE

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SHOWING THEIR METAL

The History Channel sought out thoroughly modern metalsmiths at SIUC last spring to re-create methods common to smithies before the Industrial Revolution.

"It's not every day that you can say you really saw sparks fly at work," said Matthew Hickey, the television producer who guided the filming for an episode of the cable channel's popular program "Modern Marvels."

"There were sparks everywhere, fires flaring and lots of hammering. That kind of visual excitement makes for very interesting material to work with when you're putting a show together," said Hickey, who flew in from the Los Angeles office of Actuality Productions for the two-day shoot last May.

Actuality Productions created the television series and produces the vast majority of the

documentaries aired under the "Modern Marvels" banner. According to promotional materials, the program delves into the ingenuity, inventions, and creations that show us "where we've been, how we got there and where we are going."

Concrete, silver mines, and casino technology have all taken center stage in earlier shows.

This time, Hickey asked artists at SIUC to re-create authentic, early metalworking techniques that followed the Stone Age and significantly advanced our ability to make weapons, tools, and serving ware. From that foundation, the program goes on to trace the evolution of other metals used today, such as aluminum, "futuristic" alloys

such as Liquidmetal (which has twice the strength of titanium), and shape-memory metals.

The setup at SIUC—which boasts the only full-scale metalsmithing/blacksmithing program at any U.S. college or university—turned out to be picture-perfect, Hickey said.

Faculty members and graduate students in the School of Art and Design fired their forges to 3,000 degrees and simulated metalsmithing methods used from 7000 B.C. through the 1700s.



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Mawdsley's own intricate jewelry and other works in precious metals, which were featured in the Spring 1994 issue of *Perspectives*, are held by the Smithsonian Institution and other museums and exhibited around the world.

Besides Mawdsley, participants in the filming included assistant professor Rick Smith and eight students in the metals program. An Iron Age axe, a stunning raised-copper vessel, and purified iron suitable for spear tips, swords, and knives were among the works they created for the cameras.

"We pride ourselves on the diversity of our [metals] program," Mawdsley said. "Our facilities allow us to work on everything from fine jewelry to functional pieces and all the way to monumental sculptures."

Housed in the SIUC College of Liberal Arts, the metalsmithing/blacksmithing program offers both bachelor's and master's degrees. Find out more about it at www.siu.edu/~artdesn/.

Track the "Modern Marvels" program schedule at www.historychannel.com/modern/ to catch reruns of the episode. 

—Paula Davenport



A ROAD MAP FOR SOYBEANS

Researchers at SIUC and Texas A&M College Station have completed the world's first entire "physical map" detailing the general lay of the soybean's genetic landscape.

Details were announced as part of a multi-author review of legume genomics in the March 2003 issue of *Plant Physiology*, published by the American Society of Plant Biologists.

"The map is now available to the entire research community in an open source code format. Basically, anyone can take everything we have done over the last four years, download it onto a computer, and begin working with it," says SIUC plant biotechnologist David Lightfoot, who heads the joint research team. His A&M colleagues are Chencang Wu and Hongbin Zhang.

A genome consists of a life-form's entire package of chromosomes, genes, and DNA. A map helps researchers find their way around the genome by identifying certain "landmarks"—known genes or bits of DNA, for example—and their relative distances from each other.

"Think of it as a framework that provides places to hang information," Lightfoot says. "Once you can link together all those hanging bits of information (with no gaps), you will have the entire sequence of the genome."

Sequencing plays a key role in genetic research because it [identifies and] pinpoints the exact location of every bit of genetic

material. "Position is important in knowing what a gene does," Lightfoot says.

Making the map available to researchers worldwide should speed up the sequencing process, he adds.

The SIUC team also is planning to work with 10 researchers from other states to use the map in identifying valuable genes in the soybean's makeup.

The National Science Foundation's Plant Genome Program has underwritten the work done so far.

With additional funding, says Lightfoot, "we think we could capture about 80 percent of the genes we're looking for through a combination of further improvement of the physical map and some gene enrichment technologies that would allow us to hook those genes out of the genome and sequence them."

While locating these genes ultimately will help scientists breed a better bean, results also could lead to improvements in lentils, chickpeas, clover, and other members of the legume family. Lightfoot,

one of 26 scientists from around the country who have joined forces to work on legumes, says some members of this group are trying to sequence a fodder crop called barrel medic, while researchers in Japan are focusing on the Japanese version of another fodder crop, birdsfoot trefoil.

"Once we know where the genes go in soybean, we can compare that with where they go in barrel medic and [birdsfoot trefoil]," Lightfoot explains.

"We hope to see that the same genes go together in blocks in all three. If that's the case, we could then predict which genes would be neighbors in all legumes."

From there, it wouldn't take much to pin down what each one does and begin harnessing the most helpful to produce legume "Supercrops."

In some respects, legumes have already achieved star status in the crop world. They play a huge role in feeding the world's peoples and animals, particularly in Third World countries, where they meet as much as two-thirds of human nutritional needs. And because

they can pull nitrogen out of the air, they don't need a lot of chemical fertilizers.

That makes legumes a bargain for poor farmers who can't afford fertilizers and a boon to richer ones whose overuse of farm chemicals can lead to water, soil, and air pollution.

But they could be even better, Lightfoot believes.

"Legumes do wonderfully when it rains, not so good when the water is not there—and everything eats on beans," he says. "Being able to build in resistance to drought, disease, and pests is an important target."

Genetic knowledge of legumes might also lead to improvements in other crops.

"There's a lot of complexity built into these plant mechanisms," Lightfoot says.

"If we can understand enough about how they work, maybe we can transfer that knowledge to other plants." +

For more information, contact Dr. David Lightfoot, Dept. of Plant, Soil, and General Agriculture, at (618) 453-2496 or ga4082@siu.edu.

—K. C. Jaehnig



SIUC will operate a new research field station on a 1,383-acre site restored by the American Land Conservancy and the U.S. Department of Agriculture's Natural Resources Conservation Service.

The American Land Conservancy (ALC), SIUC, and the Illinois Department of Natural Resources dedicated the new Middle Mississippi River Wetland Field Station last June. The station is located in Alexander County, north of Thebes, Ill., in the Mississippi River floodplain.

SIUC's Fisheries and Illinois Aquaculture Center will coordinate interdisciplinary research activities at the site. The goal of the field station is to promote ecologically sound and economically viable uses of large river floodplain wetlands through demonstrations, research, a visitor center, and educational programs. In addition, the site will be open for tourism, hunting, fishing, and other public recreational activities.

The ALC acquired the property in 1997 as part of its efforts to help farmers retire highly flood-prone farmland in the wake of the 1993 Mississippi River flood.

"There are a number of federal agencies and nonprofit organizations that have an intense interest in the mid-Mississippi region, which is defined as between the mouth of the Missouri River and the mouth of the Ohio River," says Christopher Kohler, director of the fisheries center. "That means Southern Illinois on the Illinois side, so we're perfectly located for any initiatives."

He noted the U.S. Fish and Wildlife Service is establishing a new refuge in the mid-Mississippi corridor. In June 2003, SIUC hosted a mid-Mississippi partnership workshop that included the Fish and Wildlife Service, the U.S. Army Corps of Engineers, the Audubon Society, Ducks Unlimited, and other groups.

"Things are happening in that area, and we have strong programs that are of interest to these groups," Kohler says. "A field station in the midst of that will be a big help to get research under way."

—Tom Woolf

UNDER OUR FEET

An SIUC geophysicist who studies the earth's magnetic and gravitational fields has been awarded a three-year, \$182,000 grant from the National Aeronautics and Space Administration (NASA) for research that may be helpful to understanding both earthquakes and extinctions.

Dhananjay "Tiku" Ravat, an associate professor of geology, will use satellite data to study magnetic field variations in the portion of the earth covered by the United States. These variations relate to temperatures inside the earth, and internal temperatures are a key indicator of the strength or weakness of the country's underlying tectonic plates. Hotter temperatures at shallower depths mean weaker plates.

"This may tell us which areas are most susceptible in the long term to natural hazards such as earthquakes or volcanoes," Ravat says.

Long term means hundreds of millions of years, he stresses.

"We're not talking about tomorrow. But the parameters our students and I will derive regarding temperature and strength of tectonic plates will be directly usable by other researchers studying these hazards during the next decade."

U.S. scientists who use Ravat's results will be able to use more precise parameters in their studies of these natural hazards.

"They have been using average values indirectly derived for their analyses," Ravat says.

"After this, a seismologist who studies earthquakes will be able to take into account more precisely the variability in the strength of the Earth's crust around New Madrid, for example, as opposed to San Francisco." (The earthquakes that took place in the New Madrid, Mo., region in 1811-12 were the strongest in U.S. history.)


Foreign scientists will also benefit, as they can apply the methods Ravat develops to satellite data gathered over their countries.

"This will benefit their understanding of Earth's outer layers and natural hazards in their own regions," Ravat says.

Variations in both the magnetic and gravitational fields of the earth also can help identify areas where huge meteors have smashed into the earth, Ravat says. Time has often altered such sites beyond recognition, so geologists studying the surface cannot find them easily.

"If we could identify these impact sites with satellite-altitude magnetic data, studies of mass extinctions could then be much better correlated with particular impacts," Ravat explains.

"We could figure out their timelines, which would give us a much better idea of how life evolved on earth."

Ravat's research has been funded by NASA since 1994. 

For more information: Dr. Dhananjay Ravat, Dept. of Geology, (618) 453-7352 or ravat@geo.siu.edu.

—K. C. Jaehnig

TALKING ABOUT LOSS

What do you tell a toddler whose beloved dog has died? Far more difficult, how do you comfort a youngster who has lost a grandparent, a friend, a sibling? When are children old enough to attend a funeral—and how can you best help them through the experience?

Such critical issues of communication have been addressed by three SIUC educators in a new book called *Helping Children Live with Death and Loss*, by Dinah Seibert, Judy Drolet, and Joyce Fetro.

The authors know their territory. Seibert, who teaches classes in the College of Applied Sciences and Arts, helped found her local hospice and developed its first volunteer training curriculum. Drolet and Fetro, professors of health education, both have taught courses in death education.

Their book, published by SIU Press, is a comprehensive guide to help parents, caregivers, teachers, clergy, and funeral directors deal with children's questions and feelings on the subject.

Geared towards children who are between 2 and 10, the book is more comprehensive than others with similar themes. Acknowledging that grownups themselves are often not well prepared to handle the issue of death and loss, it begins with a self-assessment for adults, including questionnaires on their beliefs about spirituality, death, and the afterlife.

It's crucial for adults to evaluate their own views on a subject they may never have fully confronted themselves, the authors

believe. Ultimately, the self-assessments will better prepare them to discuss these issues with their children.

Establishing a dialogue is crucial. According to Seibert, Drolet, and Fetro, the most common mistake adults make is avoiding the subject. But silence can do more harm than good.

"When you attempt to shield children from [death], they know something is going on," says Seibert. "So they use their imagination, which is often worse than what is really happening. Children may make conclusions that are more harmful than the ordeal itself. They might think they are not important enough or the topic itself is unimportant."

"People feel they have to be

absolutely comfortable with the subject (in order to address it with children)," says Drolet. "But no one is comfortable, not even the experts."

And at any rate, the authors contend, parents are the true experts on their children.

Following the questionnaires, *Helping Children Live with Death and Loss* gives an overview of how young children learn about death. It covers what they should know about it at various ages, discusses ways of answering children's questions, and presents strategies for responding to a recent loss. It also lists print and online resources on the topic for adults and kids alike.

By emphasizing communication and coping skills, the authors aim to increase adults'

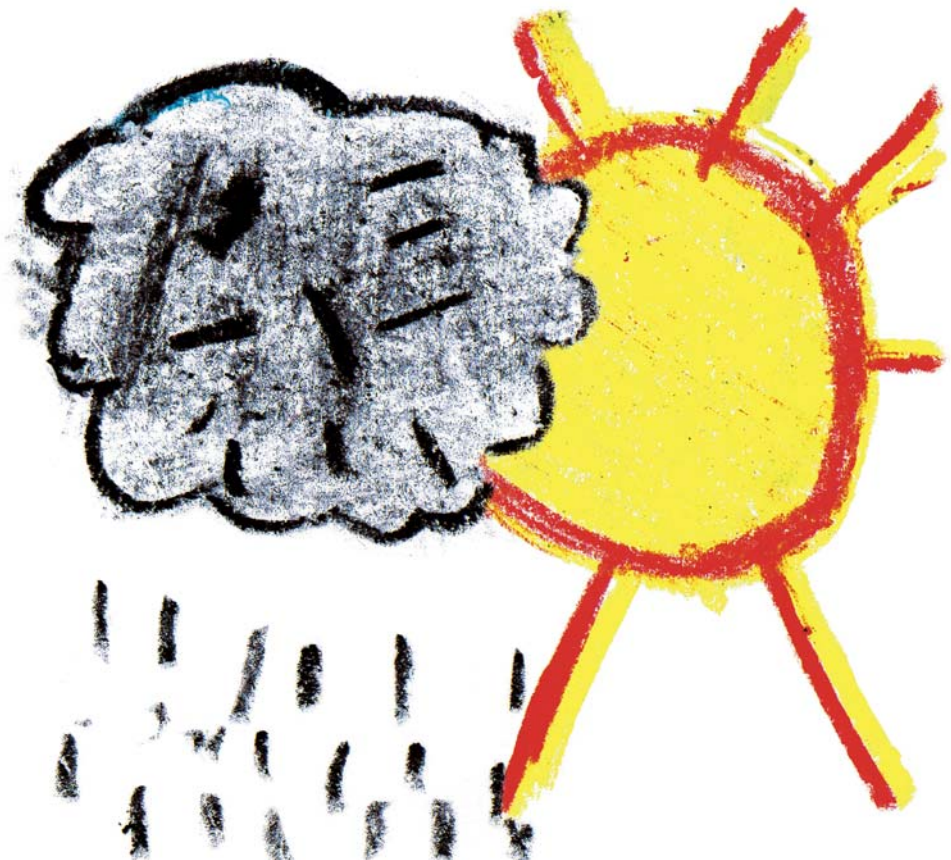
confidence so that they can help children through the grieving process.

Even more important, they want to motivate parents and caregivers to create an atmosphere of openness and support within the family—an atmosphere that will allow children to approach them with any concerns, not just those related to death and loss.

"They need to know that they can come to you," Drolet says. "Adults should be able to say, 'I'm here for you,' and really mean it."

For more information: www.siu.edu/~siupress. ☐

—Jerry Bradley; excerpted with permission from a Southern Illinoian article



THE MARBURY MYTH

John Marshall, chief justice of the United States from 1801 to 1835, is revered as the most influential shaper of the Supreme Court.

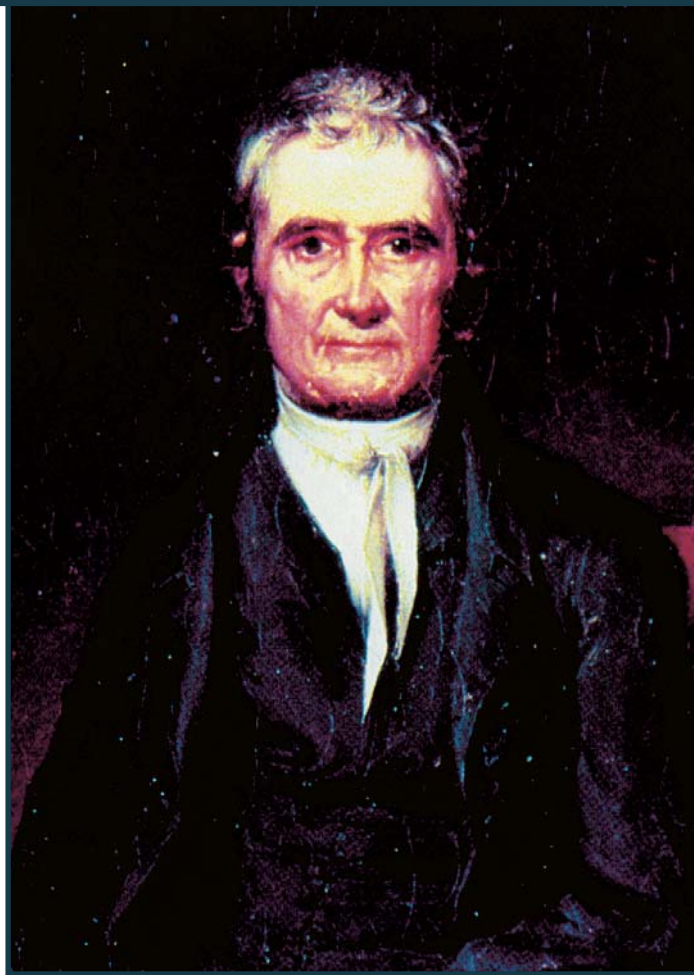
The most famous case of his tenure, *Marbury v. Madison* (1803), established judicial review: the Court's authority to strike down federal laws that it finds unconstitutional.

Some legal historians have argued that judicial review took the Supreme Court down the wrong path. With *Marbury*, Marshall usurped lawmakers' authority in an unprecedented way for politically motivated reasons, they have charged—and some still view the Marshall court this way.

SIUC political science professor Robert Clinton calls that view "the Marbury Myth." In fact, he says, Marshall was a man of his time, and his leadership built brilliantly upon that of his predecessors.

In a speech Clinton gave in October 2001 at the Supreme Court, to mark the bicentennial of Marshall being appointed as chief justice, he showed how the pre-Marshall court laid the foundation for the Marshall court's achievements.

The printed version of Clinton's speech recently won the Supreme Court Historical Society's annual Hughes-Gossett Award, honoring the best article published in the society's journal in 2002.



▲ **John Marshall, chief justice of the United States from 1801 until his death in 1835, is shown in an 1832 oil painting by William James Hubbard.**

"The Supreme Court Before John Marshall" appeared in Vol. 27, No. 3 of the *Journal of Supreme Court History* (November 2002). Justice Antonin Scalia presented Clinton with his \$1,500 prize this past June in the Court's Great Hall.

"The overall thesis of my article is that the pre-Marshall court had an enormous influence on the Marshall court, that it was of enormous importance in getting the judiciary off the ground in the constitutional arena, but that it

has been essentially forgotten because of the celebrity of the Marshall court," says Clinton, who specializes in political theory and legal and constitutional philosophy and history.

"That's not to say [Marshall] wasn't a great justice," Clinton adds. "He was a more comprehensive legal thinker than the earlier justices, and that's why he was able to pull it together."

As Clinton notes in his article, "Marshall has become an icon, and iconic figures...have the potential to distort our historical vision." One such

distortion, he says, is "the widely held belief that the Marshall court's accomplishments were largely unprecedented."

But judicial review didn't spring forth full-fledged with *Marbury v. Madison*, writes Clinton, who has published a book on the case. The pre-Marshall court tackled constitutional issues in several cases, and its justices "asserted the Court's power to disregard unconstitutional laws."

In fact, they refused to uphold an act of Congress that empowered judges to carry out certain administrative duties, such as granting pensions to Revolutionary War veterans.

If they did not go further, it was probably because most of the cases in the Supreme Court's first decade involved international matters, such as treaties and maritime law.

"The pre-Marshall court was the first in the world to be presented with the terrifying task of figuring out how to work this new Constitution into the framework of existing law—there were never before any written national constitutions, nothing to guide them," Clinton says.

Some of their contemporaries thought the Constitution was nothing more than a charter, a set of guidelines on how to run the fledgling nation, he says.

"It's quite possible that if the pre-Marshall court had not been willing to interpret certain provisions in the small number of cases they had decided by the time Marshall took the bench, everyone would have considered the Constitution in that light."

We can better understand the early Court if we understand the

legal philosophy of its justices, Clinton writes. They subscribed to the longstanding concept of natural law: the notion that the essence of the law existed before it was expressed in written texts such as statutes or constitutions. Their opinions were “efforts to ‘find’ or ‘discover’ the ‘true’ constitutional principle underlying the text.”

In short, the interpretive tradition essential for establishing judicial review was nothing new to the pre-Marshall court. What remained was for Marshall to give it its full expression.

“They began that process, and Marshall followed it up, using the same rules and principles of interpretation that the pre-Marshall court had used,” Clinton says.

“It just happened that Marshall was the man sitting in the chief justice’s seat when the most important cases in the history of the court occurred.”

Among them: *Marbury v. Madison* held that Congress could not enlarge the Supreme Court’s jurisdiction as set forth in the Constitution. *McCulloch v. Maryland* upheld Congress’s right to establish a federal bank. And *Gibbons v. Ogden* described Congress’s commerce power so expansively as to limit the legislative authority of the states.

In these landmark cases and in others, the Marshall court fully asserted the power of the judicial branch of federal government. The rest, as they say, is history. 🇺🇸

For more information: Dr. Robert Lowry Clinton, Dept. of Political Science, (618) 453-3198 or rclinton@siu.edu.

—Marilyn Davis; K. C. Jaehnig

LAYING DOWN THE LAW

If you’re curious about property law, want to know what to expect when you’re selected for a jury, or always wondered just what the heck a tort is, here’s the book for you.

The American Legal System: Foundations, Processes, and Norms (Roxbury Publishing Co., 2003) was written by Albert Melone, professor of political science at SIUC, and Allan Karnes, professor and director of SIUC’s School of Accountancy, to answer questions big and small about U.S. jurisprudence. Intended for students in fields from business to criminal justice and political science, it’s very approachable for general readers too.

“I’ve never been satisfied with the existing texts because they didn’t explore the full scope of the topic,” says Melone, who has taught in this area for years.

“Most textbooks just spell out the legal rules of particular kinds of cases. We tried to cast a wider intellectual net and to bring in contemporary examples—Napster, for instance—to make it more interesting.”

Melone and Karnes wanted students not just to memorize legal terms, but to get an understanding of the full landscape of the law. That means grasping how it reflects our social values, how it fits within the context of protecting civil liberties, how it shapes politics,

and how it affects our personal lives and business affairs.

We should be knowledgeable about it. “After all,” as the authors write, “the law has teeth and it can bite.”

The 800-page book includes an overview of the legal system, discussion of its various judicial processes, chapters dealing with laws that focus on individuals, and chapters dealing with laws that focus on business and government.

Most interesting for readers may be the dozens of edited court opinions in the book. Did the Supreme Court overstep its authority in deciding *Bush v. Gore*? In *Sheppard v. Maxwell*, the case that inspired the TV series *The Fugitive*, why did it reverse Sam Sheppard’s conviction? How did a U.S. court of appeals weigh copyright

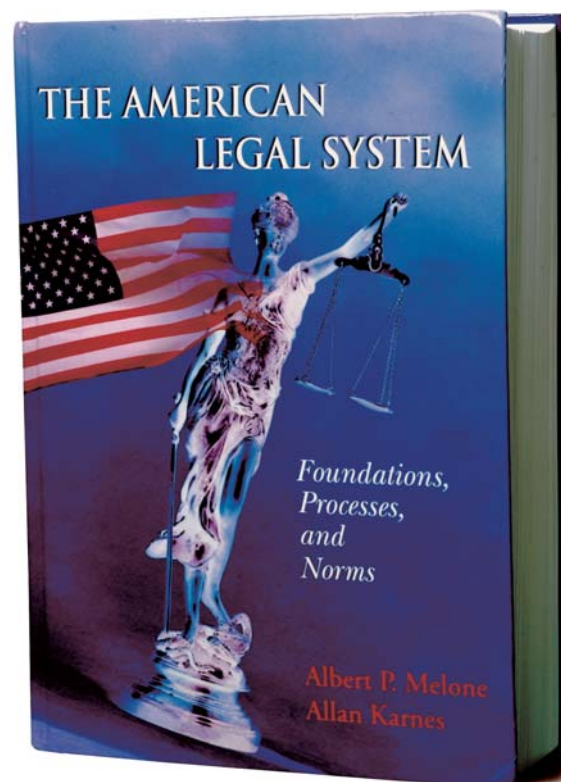
infringement against fair use in *A&M Records v. Napster*? Melone and Karnes comment on these and many other famous cases.

And torts? They’re non-criminal, non-contractual suits in which the plaintiff seeks damages or injunctive relief for injury to her person, property, or legal interests. The infamous McDonald’s hot-coffee lawsuit was a tort case—and the hefty judgment actually wasn’t unreasonable, say the authors.

Why not? Well, you’ll just have to check out the book. 🇺🇸

For more information: Dr. Albert Melone, Dept. of Political Science, (618) 453-3170 or melone@siu.edu; or Dr. Allan Karnes, School of Accountancy, (618) 453-1402 or karnes@cba.siu.edu.

—Marilyn Davis



ALL SHOOK UP

It's been a bumpy ride lately in one of SIUC's engineering labs.

For the past few years, lawn tractors and chassis have been bouncing, jouncing, and jiggling in place on a specialized rig—sometimes continuously for weeks at a time, to simulate a lifetime of use on grassy fields.

This accelerated lifespan testing will improve manufacturing processes for composite materials at John Deere & Co., SIUC's partner in this research, and ultimately at other places too. Since 1997, the John Deere Foundation has contributed funding and equipment for the lab, which also received an initial grant of \$250,000 from the National Science Foundation.

SIUC's Materials Technology Center, which runs the lab, was a natural choice to investigate the durability of composite systems and components. Directed by civil engineering professor Shing-Chung "Max" Yen, MTC has designed and tested composite materials for many years.

The John Deere project has focused on glass/polyester and glass/thermoplastic composites, which the company is using experimentally in some of its products. Besides testing the prototype lawn tractors, graduate and undergraduate students have run durability tests on samples of some five dozen composite formulas.



▲ Some of the students working with Max Yen (center) line a prototype beam for the planned composite bridge on campus.

Traditional fatigue testing with regular loads gave them a framework for understanding each material's behavior under ideal conditions.

Spectrum load testing—applying variable forces in repeated sessions to the point that the material fails—allowed them to better predict durability under real-world conditions.

The data gathered were analyzed and fed into a simulator to project the materials' expected lifespans and how vehicle design and materials manufacturing might be improved.

Although composites aren't a new material in vehicles, they generally haven't been used for structural components—those that bear the weight and take most of the impact of use. Nor have they been used much in building large structures.

Yen would like to change that. Advanced composite materials offer advantages for bridges and buildings, he says—among them a higher strength-to-weight ratio than reinforced concrete, greater resistance to deterioration, and better performance in earthquake-prone areas.

As a demonstration project, Yen and his students have worked with the engineering firm of Modjeski and Masters to design a pedestrian bridge that will cross Lincoln Drive on SIUC's campus. It will be made of a glass/polyester composite.

Two long, gently curved prototype beams for this bridge are housed in the Engineering Building. They can each bear a quarter-million pounds of weight, Yen says, making them about as strong as steel, but they're much lighter and more wear-resistant.

Lessons from the Deere project helped him with some of the manufacturing specs for these components, as well as with lifespan estimation. He envisions the planned bridge as a "living" laboratory for students to study the durability of structural composites.

Indeed, he would like to shake up the way that engineers monitor the health of such big structures. Over the next two years MTC will develop a bridge-monitoring system using permanent in-place sensors and wireless communications to transmit data on performance and deterioration over a structure's lifetime.

This kind of remote monitoring falls under the heading of "intelligent transportation systems," a hot research field right now. Such monitoring would enable much better planning of repair schedules and improve disaster planning.

"We're very good at designing new things, but not at defining when they're going to need repair," Yen says. "Today we only have rough statistical projections—that a bridge will need repair in 20 years, or 50 years."

He adds, "I want to know how materials and structures change over time. If you can monitor a structure over a lifetime, it will give you data to improve the design for next-generation structures. You may want to design them with new materials or new ideas."

The SIUC project, seeded in 2001 by a grant from the Illinois Department of Commerce and Community Affairs, will be funded by a \$620,000 appropriation from the Federal Highway Administration through the Illinois Department of Transportation.

Laboratory work has already begun, and Yen will soon set up a prototype monitoring system on one of the footbridges crossing Campus Lake. Ultimately, moni-

toring systems will be installed on selected bridges in Southern Illinois.

Faculty and students in chemistry, several engineering departments, and computer science will contribute to different parts of the system, such as developing better sensors, translating sensor behavior into digital signals, and, as Yen says, "correlating the data with what's actually going on in the bridge."

The latter will benefit directly from data analysis programs written in the John Deere Lab. From lawn tractors to bridges is not as big a leap as it seems—at least in some ways.

Look for an update in a future issue of *Perspectives*. 📌

For more information: Dr. Max Yen, Materials Technology Center, (618) 536-7525 or myen@siu.edu.

—Marilyn Davis



▲ **Going nowhere fast:** Accelerated lifespan testing of prototype lawn tractors made of composite materials has been funded by the John Deere Foundation and NSF.

KUDOS

- "Hidden India: The Kerala Spicelands," a 60-minute PBS documentary by radio-TV professor Jan Thompson, won silver awards for best adult education program and best cinematography at the 2003 Chicago International Film and Television Festival. It also won the overall grand prize and a first prize at the National Broadcasting Society's 2003 annual convention. Thompson's work was featured in the Spring 2001 issue of *Perspectives*.

- Patents recently granted to SIUC researchers include "Methods of Treating Clinical Diseases with Isoflavones" (#6,592,910); "Method for Treating or Preventing Prostatic Conditions" (#6,608,111); "Stabilization of Coal Wastes and Coal Combustion Byproducts" (#6,554,888); and "Methods for Improving Learning or Memory by Vagus Nerve Stimulation" (#6,556,868).

Faculty involved are in animal science, food and nutrition, physiology, chemistry, mining engineering, psychology, and neurology. *Perspectives* has featured some of this research in past issues; look for more in the future.

- A \$2 million grant from the U.S. Department of Energy will allow SIUC's Coal Research Center to test improved filters for use in a clean-coal technology called high-temperature pressurized fluidized-bed combustion. Such combustion systems rely on filters to protect equipment by trapping tiny bits of soot or unburned carbon.

SIUC is working on the three-year project with Siemens Westinghouse Corp., which developed the new filters. Testing will be done at the campus's power plant, which uses a fluidized-bed system.

- Studying the effect of prenatal tobacco exposure on the growth and neurobehavioral development of pre-term and full-term infants is the goal of a \$1.78 million grant from the National Institute on Drug Abuse. The five-year project, headed by Kim Espy, associate professor of psychiatry, will also look at genetic differences that may make infants more vulnerable to the effects of prenatal tobacco exposure.

What do Internet security and your child's softball schedule have in common? Combinatorics!

by Marilyn Davis

Have you heard the one about the traveling salesman? As any mathematician can tell you, it's no joke. It goes like this: Given x number of cities that a salesman must visit, what is the shortest circuit he can make?

If just a few cities are involved, this problem is a snap. But with lots of cities in the mix, it becomes a real snarl.

The traveling salesman problem belongs to a branch of mathematics, called combinatorics, that deals with arrangements of finite sets. A set may be composed of numbers or of other objects—cities, people, you name it. What's of interest to mathematicians is the relationship between those things (what they have in common) and the properties of the set itself, regardless of the identity of the objects (such as how many members it has and how many ways they can be combined).

Combinatorial problems crop up all the time in daily life. Take scheduling: Anyone who's ever booked a seat on a commercial flight or played intercollegiate sports has benefited from the solution to a combinatorial headache. But science, engineering, business, and the military rely on combinatorics too.

The Rubik's Cube-like puzzles of combinatorics are math professor Walter Wallis's bread and butter. Wallis, an internationally known expert in this field, has written numerous books on the subject.

One of Wallis's specialties is combinatorial computing. As he explains, combinatorics can help you determine the complexity of a computing problem—for example, whether it will require minutes, months, or years of processing time to arrive at a solution.

"What happens if you make a problem twice as big?" Wallis says. "It may actually take eight times as long to solve. It may take billions of times as long to solve." Combinatorics can help you figure out what kind of ballpark you're in—a playable one, or one that's out of this world.

That's of keen concern not just to scientists, but to cryptographers, who use computers to break codes.

"If you double the complexity of your code and it takes eight times as long for [your enemy] to solve it, all they've got to do is get a better computer," Wallis says.

"But if [doubling it] takes a *billion* times as long to solve it, then you'd feel safe. This idea of complexity comes up in issues like how secure your PIN number is."

One of Wallis's current projects is funded by the Australian Defence Science and Technology Organisation, which works

◀ **Cheonae Kim. Detail. Panel from "100 Days." 1998. Acrylic on canvas.**

closely with U.S. and English defense agencies. (An Australian citizen, Wallis earned his Ph.D. from the University of Sydney but has taught at SIUC since 1985.)

"This research involves intelligent networks, such as the Internet, where the network doesn't just form naturally but forms because there's intelligent input," Wallis says. "We're looking at various properties that would enable better network management. One of the big problems, of course, is bandwidth. You can only send so many messages from one server to another."

Phone companies sell off excess capacity to smaller companies, he says, but during high usage often must buy it back—at much higher prices.

"If you could predict when you're going to have a bandwidth shortage, that would be real nice. Or if you could look at this network and say, 'That looks like someone's starting to hack into our system,' that would be real nice for defense people, or for banks.

"We're looking at the underlying graph properties that seem to indicate interesting patterns of change in networks."

What Wallis means by "graph" has nothing to do with bar graphs. Combinatorial graphs, called *linear graphs*, look like networks, or webs. They're collections of things that are connected.

Linear graphs are made up of points (called "vertices") joined by lines (called "edges"). Each vertex, like the cities on a map, is connected to at least one other, but may be connected to several.

Graph modeling, or graph theory, is a valuable tool for solving problems in all sorts of disciplines. Its strength, says Wallis, is that it ignores extraneous information and zeroes in on a problem's underlying structure.

Epidemiologists can use linear graphs to help understand the spread of a disease like SARS. Engineers use them in designing integrated circuits for computer chips. And Wallis, as part of a team of mathematicians, engineers, experimental psychologists, and computer scientists, is using them in this security-related defense research.

"It's interesting—we started with pure mathematics, and we're ending up publishing stuff in applied engineering journals," he says with a grin.

"The network analysis we're doing also can apply to other social networks such as organizational hierarchies, which have similar properties."

Another area of combinatorics that Wallis is working on—this one outside of graph theory—derives from statistics. Given a certain set of numbers, can you construct an array that meets certain rules?

Here's an example: With a set of 35 numbers, using each number three times, create a table with 7 rows and 15 columns. Any two columns must have one number in common, any two rows must have five numbers in common, and any row/column pair must have three numbers in common.

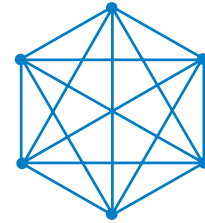
Wallis and a group of colleagues solved that particular problem in 2001—almost four decades after it was first posed. Such row-and-column designs may sound migraine-inducing, but they have important uses in designing complex experiments.

Finally, Wallis is working with graph labeling problems. Labeling involves assigning numbers to a graph's edges, vertices, or both, to see if a graph has certain properties.

For instance, the numbers assigned to each connected pair of vertices might be required to differ by a set amount. That can be done with some graphs but not others. Or each segment of three vertices and two edges might have to add up to the same number (see diagram above).

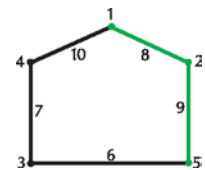
The latter, called "edge magic property," resembles the "magic squares" that you may remember from childhood puzzles. In a magic square, each row of numbers—horizontal, vertical,

Two simple combinatorial graphs:



Traffic moving?

In this "5-regular" graph, every vertex (point) is directly connected to the other five



"Edge magic"

All segments of three vertices and two edges add up to the same sum (25)

and diagonal—adds up to the same sum. Mathematicians are interested in determining which graphs can be labeled so as to have "magic" or other interesting properties.

Many of these properties turn out to be useful. Graph labeling, as it happens, has real-world applications in signal processing, radar, and allocation of radio frequencies.

Still, it is the puzzle aspect of this research that Wallis appreciates the most—tackling and solving these thorny theoretical problems.

"If it wasn't fun," he says, "we [mathematicians] wouldn't be doing it." ▣

For more information, contact Dr. Walter Wallis, Dept. of Mathematics, (618) 453-6577 or wdwallis@math.siu.edu.

WATER WORK

**Will the U.S. have enough water in the years to come?
Water-demand forecasting seeks an answer**

by Marilyn Davis

In our bathrooms and laundry rooms, swimming pools and gardens, car washes and amusement parks, we depend on water, even revel in it—and, much of the time, take it for granted.

Not everywhere and not always, of course. Sometimes the tap threatens to run dry. During droughts, communities impose restrictions that put a crimp in our routines, reminding us that water is a finite resource, after all. But human activity, not just nature's, can run us into water trouble:

- The Ogallala aquifer, an underground reservoir that underlies much of the High Plains, is nearly exhausted in many areas due to decades of irrigation.
- So many water districts siphon water from the Colorado River that in some years, the river's delta at the Gulf of California is dry.
- The remaining extent of the Everglades is threatened by the diversion of water for agriculture and urban use. A massive project is now planned to restore some of the region's original hydrology.

Will the United States have enough water to sustain population and economic growth while protecting the environment? Policymakers can't get a good handle on that question without a solid understanding of today's water usage and a reliable way to predict future needs.

"It's a federal priority to create water-use science—a scientific way of estimating and analyzing water usage," says Ben Dziegielewski, professor of geography at SIUC. "We're trying to understand how water is used and what drives demand."

The business of water

Dziegielewski has studied urban water conservation and water-use forecasting for more than two decades. Last year he and SIUC economics professor Subhash Sharma finished a large study of water-use trends in the United States from 1950 to 1995. Funded by the U.S. Geological Survey (USGS) through the Illinois Water Resources Center at the University of Illinois, the study aimed to analyze historical water-use data, then use that information to create statistical models for predicting future water demand.

Since 1950, the USGS has compiled water-use data from the states every five years. This endeavor, called the National Water-Use Information Program, aims to include all surface-water and groundwater withdrawal points—a massive task, since there are more than 2 million nationwide, not counting many rural residential wells.

To make sense of all this data on water withdrawals, the SIUC team had to put it in the context of economic, geographic, and demographic information. Then they modeled the four "sectors" that account for most water use in the United States: irrigation, thermoelectric (power-plant cooling), public supply (essentially, urban use), and industry, in that order.

Industry sounds like it would be a big user, but it accounts for the smallest use among these sectors, due in part to declines in manufacturing over the past 20 to 30 years. Irrigation and thermoelectric account for four-fifths of the water withdrawals in the United States. They are followed by public-supply use, which surpassed industrial use in the 1980s.

Water use climbed 142 percent from 1950 to 1980. Over that time, the U.S. population increased only 77 percent. But 1980 was a watershed year, if you will—the peak year for water use in the nation. After that, water use leveled off and then began to decline. By 1995, it had dropped almost 10 percent from 1980 levels—even though our population grew 16 percent during that time and gross domestic product increased by more than half.

The team's findings show that power plants, irrigation, and industry all were using less water overall in 1995 than in 1980. Some of the drop was due to bad economic news: the decline of industries that are heavy water users, such as steel mills and other manufacturing concerns. But some was due to

◀ **Background: Lake Michigan shoreline at Milwaukee. Space shuttle images in this article courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center.**



◀ **Top: Lake Oahe, S.D., created by damming the Missouri River.**

▼ **Bottom: The dry bed of Owens Lake, in California. The lake's water supply is diverted by aqueduct to Los Angeles.**



water conservation—in particular, more efficient irrigation techniques.

“We are learning to do more with less, and the USGS data bears that out,” says Dziegielewski.

The Jacuzzi culture

The story is different for public use, however, where the demand for water has continued to increase. Domestic use nearly tripled from 1950 to 1995. Population growth was a big part of this jump. But so was higher per-capita use, resulting from a higher standard of living.

Simply put, people who have more money use more water. As people earn more, they can afford not just appliances

like dishwashers, but also swimming pools, hot tubs, Jacuzzis. They put in nice landscaping that has to be watered. Expensive cars get washed more than beaters do. And so it adds up.

Water districts can't do anything about population growth, but they can about per-capita use. “In states where water is a problem, there are aggressive conservation programs to use water more efficiently,” Dziegielewski says.

“If we pursue conservation in a dedicated way, it works,” he adds. “Urban conservation programs that are carefully designed and properly funded are very successful in reducing water usage. Those that are not have mixed results.”

Some conservation measures are voluntary; others, such as the low-flow toilets that are a perennial gripe of humor columnist Dave Barry, can be and have been mandated. But where we really lag behind, says Dziegielewski, is in using water pricing to discourage waste.

It's unlikely that we'll ever see full-value pricing, he says, but price “often isn't used in a market-oriented way.” He adds that, ironically, water in the arid West is considerably cheaper, on average, than water in the East. Yet research, including his own, has shown that higher prices for water do work to decrease usage.

The states vary in how well they're doing to conserve water. Not all have seen declining water usage since 1980. Seventeen states have seen increases, despite the overall nationwide decline. Population growth, higher per-capita water use, and the need for more power plants were the key reasons. In Illinois,

our public water-supply districts are drawing more water than ever.

A handful of states—among them, California, Texas, Illinois, New York, and Florida—exert a huge influence on national trends because of the sheer amount of water they use. Illinois ranks sixth in population, but third in water withdrawals.

What boosts our ranking? We're number one in water withdrawals for power-plant cooling—17 billion gallons a day.

A flood of data

Many of the factors affecting water use are obvious. The complexity lies in identifying them all and determining to what extent they contribute under varying conditions. Forecasters need to know which are most important to take into account.

“We wanted to see what the best predictors of water demand are,” Dziegielewski says. The SIUC research team found that most historical variation in water use could be accounted for by changes in a few factors—what Dziegielewski calls “key explanatory variables.”

For instance, they determined that 69 percent of the growth in per-capita domestic use of water from 1950 to 1995 could be attributed to a higher median family income. “Personal wealth is the major contributor,” Dziegielewski says, “and the percent urban population is also a major contributor. The rural population just doesn't use as much water around a house.”

Statistical modeling using multiple regression allowed Dziegielewski and Sharma to estimate the contributions of the variables they identified. They then fine-tuned the models by “back-casting”—testing them against known water use in 1980 to see how well they would have predicted demand.

To develop the models, Dziegielewski and Sharma needed historical data and projections on everything from weather to demographics to pumping costs for irrigation. Finding and analyzing that data required a small squadron of undergraduate student workers and graduate assistants, as well as the full-time work of

geography staff researcher Thomas Bik (who is also a doctoral student). Besides the USGS data, they relied on data from the U.S. Census Bureau, Department of Labor, Department of Agriculture, Department of Commerce, National Climate Data Center, and other agencies, as well as nonprofit groups such as the American Water Works Association.

To grasp the complexity of the team's task, consider just one water-use sector, thermoelectric. To fully understand what governs water use by power plants, the team had to factor in data on type of plant (coal, nuclear, etc.), capacity, number and capacity of cooling towers at those different types of plants, annual air temperature, cooling degree-days and heating degree-days, details on state water law, and more.

By running statistical analyses, they were able to identify which factors were most important in explaining past water use by this sector. To forecast future use, they also had to factor in economic and demographic trends.

Sharma, a leading econometrician, did a lot of "diagnostic" work on the modeling to make sure the team's estimated values were unbiased—that is, free of statistical errors that would tend to cause under- or overprediction. Based on the backcasting to 1980 data, he and Dziegielewski were able to determine that, across all sectors, their models' overall margin of error was about 20 percent.

"That's not extremely accurate," Dziegielewski says, "but it's good enough to show that the data we collect nationwide can be used to identify variables we can change to be more efficient in water use. And water managers can use the models to refine predictions over time."

A look to the future

What do Dziegielewski and Sharma expect by the year 2040?

Irrigation use, they forecast, will drop by about 18 percent—a big help in conserving water resources. But that will be offset by increases in other areas. Industrial use will rise by about 20 percent and thermoelectric use by about 39

Drop by Drop: Some Fast Water Facts

[1995 data from the U.S. Geological Survey]

Total water withdrawn for use in the United States, per day: **402 billion gallons**

Daily total for Illinois: **20 billion gallons**

Average domestic use, per capita, nationwide: **184 gallons**

State that uses the most water: **California, 46 billion gallons per day**

The smallest state, population-wise, among the nation's top 10 water users:
Idaho, due to irrigation

State whose water use dropped the most from 1960 to 1995:
Pennsylvania, due largely to the decline of the steel industry

State whose water use has increased the most since 1980:
Texas, with increases across all major sectors

State that has reduced water use the most since 1980:
California, thanks largely to better irrigation efficiency

An Alphabet Soup for H₂O

Two major organizations on water resources are headquartered in SIUC's Geography Department.

The International Water Resources Association aims to help nations protect and make better use of water resources by providing information to scientists and policymakers. IWRA, created in 1972 and based at SIUC since 1998, has 1,400 members in 110 countries.

Ben Dziegielewski (see main story) serves as IWRA's executive director; Bruce Hooper, a new associate professor of geography at SIUC, serves as executive editor of its quarterly journal, *Water International*. For information on IWRA, visit www.iwra.siu.edu.

The Universities Council on Water Resources, a consortium of more than 90 universities interested in research, education, and public service related to water, was founded in 1964 and has been administered by SIUC since the mid-1980s. Its executive director is Christopher Lant, chair of the Geography Department.

The council administers UWIN, the Universities Water Information Network, an online clearinghouse of data on water resources. To tap into the network, visit www.uwin.siu.edu. For information on UCOWR, see www.ucowr.siu.edu.

percent. Meanwhile, domestic use will soar by 61 percent.

Overall, the researchers expect U.S. water use to go up by about a fifth—21 percent—between 1995 and 2040, to 440 billion gallons per day. That's the same amount used nationally in the peak-use year of 1980.

Given a projected population of 377 million by 2040 (a middle-of-the-road estimate), the research team's forecast isn't such bad news. But many water districts will face tough times—including some that have not had supply problems in the past.

Dziegielewski is not an alarmist about water use in the United States, but he acknowledges that some parts of the country will see changes. For example, agriculture in parts of the High Plains, particularly southwestern Kansas and the Texas panhandle, will not be sustainable much

longer at current levels. "The farmers know this, and many are already divesting," Dziegielewski says.

Illinois has a wealth of water resources—major rivers, lakes, and aquifers, along with decent rainfall. Yet we too need to pay attention to water conservation.

Droughts have triggered periodic water-conservation mandates in some Illinois communities. And the Northeastern Illinois Planning Commission predicts that a number of townships in the Chicago metro area will face water shortages by 2020.

There, the problem is that water withdrawals from Lake Michigan are capped, but urban sprawl continues. Communities in the region are increasingly turning to groundwater, including shallow aquifer systems that may

not be able to meet demand sustainably. That is, the rate at which nature replenishes them may not equal the rate at which we deplete them.

Any water-use predictions must weigh many uncertainties about society, the economy, and nature itself. One of the greatest uncertainties is climate change.

Since the SIUC team was looking more at near-term predictions, Dziegielewski says, "we didn't include any scenarios for climate change. But we did include two variables—precipitation and average summer temperature—that really capture the effects of climate on water use. For example, we know that every 1 percent increase in temperature results in a .8 percent increase in water used [by communities]."

"Given unfavorable climate outcomes—meaning less rain and more heat—we would expect up to 20 percent more water demanded for urban use."

Technological advances are another big unknown, but tend to balance out, Dziegielewski says: some increase water use, whereas others decrease it.

Standard of living and population are both projected to increase, and therefore to increase the demand for water. "The good news is that water use has been growing at a slower rate than population," Dziegielewski says. "The conservation ethic is also increasing. Perhaps we can offset demand with [voluntary] conservation measures, although that's hard to push forward."

Thomas Bik, the geography researcher who works with Dziegielewski, notes, "The predictions were based on the assumption that the future will look a lot like the present—or, here is what water use will look like if we keep doing what we're doing in terms of management. There's plenty of room for improving efficiencies in all sectors—especially if pricing starts to drive innovation."

The fact that Illinois is a leader in water-use science can help us in policymaking. Dziegielewski cites the expertise of the Illinois State Water Survey and the Illinois Water Resources Center, as well as a tradition of water resources research in SIUC's Geography

Department stretching back some 30 years.

“Water-use science is a young science, and we’re trying to build it,” he says.

Bringing it all back home

Dziegielewski is now applying what was learned from the USGS study to the Midwest, and Illinois in particular. In one project, he and Bik are developing water-demand predictions for all 102 Illinois counties for 2005 through 2025. They are working with Ken Hlinka of the state water survey, which is funding the research with a grant from the Illinois Department of Natural Resources.

“An increasing number of areas in Illinois, mostly urban areas, will be looking at potential difficulty in providing enough water for economic and population growth,” Dziegielewski says. “We want to identify counties where demand is outpacing supply.”

In 2004, he, Bik, and graduate student Xiaoying Yang will wrap up another study forecasting water needs over the same time period for public-supply use in six Midwestern states, including Illinois. That project is underwritten by the Midwest Technology Assistance Center for Small Public Water Systems with funds from the U.S. Environmental Protection Agency.

The work focuses on infrastructure: will water districts have not only enough available water, but enough treatment capacity to supply customers’ needs down the line? “The idea is to help communities plan better for water supply,” Dziegielewski says.

He and Jack Kiefer, a doctoral student in geography, also recently landed a grant from the Illinois Water Resources Center to take an in-depth look at water rate structures in the state and how they’ve changed over the past 20 years.

Few government agencies gather data on water rates, and no comprehensive study of water prices in Illinois has been done since the late 1960s. Yet most water system managers in the state rank rate-setting as their top concern. (That’s according to a 1999 study by Dziegielewski, Bik, and SIUC agricultural economist Roger Beck.) Price, after all, is one of

- ▲ **Top: Clark Hill Reservoir, Ga.**
- ▶ **Middle: The Columbia River near Hermiston, Ore. The grids of tiny green circles are agricultural fields using center-pivot irrigation.**
- ▼ **Bottom: The Illinois and Mississippi Rivers north of St. Louis (infrared photo showing drainage patterns).**

the few ways that water districts can influence demand for water.

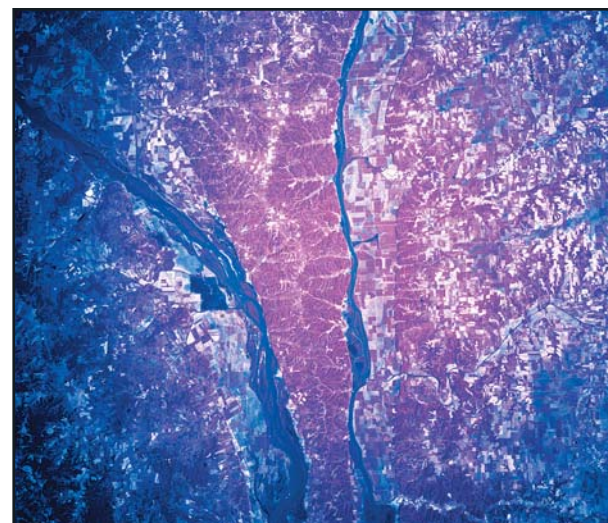
Kiefer and Bik have surveyed some 1,600 water systems in Illinois to see what rate-making structures are in effect (and why), and what factors have driven rate changes. Kiefer is devising ways to measure “acceptability” criteria for rates. Among those criteria: Are rates fair and equitable for customers? Do they encourage conservation? Do they provide stable and sufficient revenue? Are they politically acceptable?

Kiefer will crunch the numbers and analyze them for his dissertation. Findings will be posted on the SIUC Geography Department’s web site. Water utilities will be able to use them to gauge the benefits of alternative price structures. Consumers will be able to use them to see how customer preferences affect water rates—and whether rates are geared to ensuring an adequate supply of water.

“The basis of water management is to look for decision variables that are in our power to change, in order to conserve water,” Dziegielewski says. “Price may be the most important.

“We can send a signal about the true cost of water without overcharging people. We shouldn’t pretend that water is cheap.” ▣

For more information, contact Dr. Ben Dziegielewski, Dept. of Geography, (618) 453-6021 or benedykt@siu.edu.



THE MAN WITH A THOUSAND FACES



Masks entertain us, protect us, sometimes scare the dickens out of us. An SIUC scenic designer enthralled by them went halfway around the world to learn the ancient art of “ukir topeng”—Balinese mask carving.

by Marilyn Davis

A jumble of wooden faces stare blankly from the little makeshift couch in Ron Naversen's office. One has almond-shaped eye sockets and voluptuous cheeks; a second is a devil, complete with horns and ears; a third sports a hinged jaw. There are others, too, all different, along with a bird's beak and a detached, bulbous nose.

Naversen, an associate professor of theater at SIUC, specializes in scenic design. The masks, unpainted and in various stages of completion, are the fruits of a recent trip he made to the Indonesian island of Bali to learn mask carving from a master of the art.

Sitting on his office floor, Naversen braces a partly finished mask between his feet, Balinese-style, and scrapes it gently with a chisel. He explains that he cannot sit for hours in this fashion without taking a break, the way the Balinese artisans can, but that yoga has increased his endurance.

He shows me the tools of the trade: A small, angled hatchet called a *timpas* is used to rough out the mask and make the first cuts to start defining its features. Flat chisels (*pahat*) and rounded gouges (*pengacap*) in various sizes are used to flesh out the brow, cheeks, nose, and chin by creating grooves, ridges, and curves. They're also good for chinking out the openings for eyes and nostrils.

Large and small straight knives (*pamutik*) are employed as finishing tools, to smooth the mask; double-edged, curved knives (*pangot*) are ideal for refining eye sockets, nostrils, and lips and also for hollowing out the inside of the mask. "You want to get the mask as thin as the wood will permit," Naversen says.

That's because these masks play a dominant role in Balinese theater, and they need to be comfortable. They are made, often, for a specific performer, who visits the mask-maker for

◀ **A sea of masks: Ron Naversen with some of those he acquired in Bali.**

Photo by Jeff Garner.

"fittings" as the carving progresses. The mask is custom-designed to rest lightly on the front of the face. "In Western tradition our masks tend to go bigger and higher," Naversen notes.

Life in Bali is replete with ceremonies marking events large and small, public and private. Towns, temples, and well-to-do individuals all sponsor ceremonies, and mask performance (*topeng*, in Balinese) has long been an integral part of them. These highly ritualistic dramas enact the religious stories of Bali's Hindu culture.

"In Bali, theater and religion never separated," Naversen says. "Their plays are about the checks and balances of good and evil fighting with each other."

Masked performers represent deities, kings, warriors, lovers. Performances typically feature music, dance, songs, and spoken interludes. "It's a little like our musical theater," Naversen says. "But they have a lot of mimed performances as well."

A performer's every gesture carries a specific meaning. Balinese audiences "all know these stories and know the masks for each character," says Naversen, but each carver gives his masks unique touches, and performers differ in interpreting the same role. Audience members are connoisseurs of nuance, spotting small but telling variations in mask or performance style.

Most famous for masks in Bali is the village of Mas, where Naversen and four other students were apprentices for several weeks to master woodcarver Ketut Molog. The studios in Mas produce masks, figurines, furniture—even, in a bit of cultural appropriation, totem poles and Scandinavian knick-knacks. "You want something made, they can do it," says Naversen.

Although Naversen had little experience with wood carving before visiting



▲ **On site in Ketut Molog's woodcarving workshop, Naversen begins roughing out a basic mask from a block of pulai wood. The process is called *grounding* or *wasting*.**

Bali, he was already a mask enthusiast. He had collected masks from around the world and had made many masks of plaster, papier-mâché, and modeling clay for theater productions.

In Western culture, mask tradition stems from ancient Greek drama. "That's where we get tragedy and comedy masks," Naversen says. "They used to do plays in huge amphitheaters—5,000 people could sit in the theater at Epidaurus." Large masks conveyed the characters' emotions to the back rows, and miniature built-in megaphones enabled everyone to hear.



◀ Left: A mask of Rangda, the Balinese embodiment of evil. ▲ Above: Tools of the trade. ▶ Right: An actor at a temple ceremony plays Sidha Karya, a benevolent character who closes each *topeng* performance.

In Renaissance drama, masks often designated the stock characters of Italian *commedia dell'arte* plays (where harlequin figures hail from). At Elizabethan masques—lavish musicals written for occasions at court—the noblemen and women in the audience, not just the performers, donned costumes and masks. Recently, Broadway has returned to the mask tradition with such blockbusters as “The Lion King,” which features enormous, breathtaking puppets and masks by avant-garde artist Julie Taymor.

Naversen’s interest in masks, which extends beyond theater to psychology and anthropology, began in early childhood. “My mom would put on this little Halloween tiger mask and chase us around,” he recalls with a grin. “If she’d just put the mask on and growl, it would scare us to death. She’d take off the mask and it would be OK. Put the mask back on, we’d be scared again.” These irrational flip-flops between reassurance and fear fascinated him.

“I’ve done this a lot with my nieces and

nephews, and it’s the same thing,” he says. “When someone puts on a mask, suddenly you’re not sure of that person any more. So I’ve always been interested in masks and their effect, and Halloween always was my favorite holiday. Maybe that’s how I got into theater, I don’t know.”

Something about wearing a mask allows people to do things they wouldn’t ordinarily do and say things they wouldn’t ordinarily say. “There’s a theory that when you put on a mask, the neocortex, which governs reasoning, becomes less active,” Naversen says. That would allow emotion to come to the fore—much like the effects of imbibing alcohol, he notes.

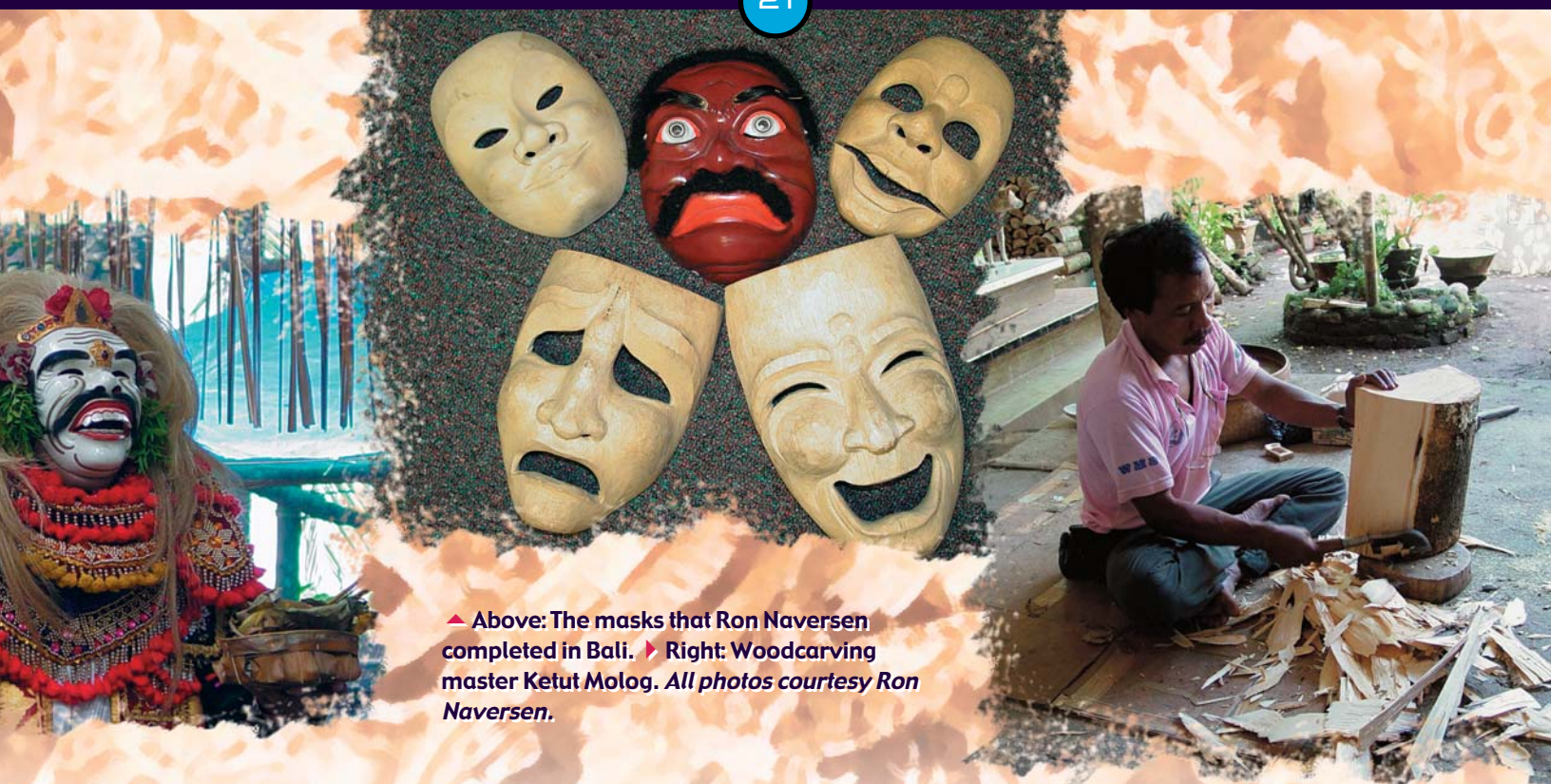
No surprise, then, that many off-stage uses of masks remain theatrical in the broad sense. For instance, in Roman times, during the festival of Saturnalia, people would wear masks and demand treats—the origins of our Halloween. The Italian mask tradition

subsequently became part of Carnival celebrations in Spain, South America, and New Orleans.

In certain African and East European traditions, masks symbolize transformation in puberty rites. Artisans have created death masks of important rulers since the time of the pharaohs. In movies, masks disguise serial killers and superheroes alike.

Other purposes for masks are more prosaic. Their use for hygiene goes back centuries: in the Middle Ages, doctors treating plague victims wore long-nosed masks stuffed with camphor-soaked wadding to fend off the stench of decay. The Inuit people devised leather masks with eye slits that functioned like sunglasses, to cut glare. In sports arenas, deep-sea dives, and military operations, variations on masks provide crucial protection. Masks can offer emotional or spiritual protection, too: they’re sometimes used in counseling to help victims of abuse tell their stories. Shamans may use them to ward off evil spirits.

At a theater conference on masks that Naversen attended in 2001, he kept hearing speakers mention the mask-making tradition of



▲ Above: The masks that Ron Naversen completed in Bali. ▶ Right: Woodcarving master Ketut Molog. All photos courtesy Ron Naversen.

Bali. After some investigation, he discovered that the Dell'Arte International School of Physical Theatre, which focuses on such ancient dramatic traditions as dance, mime, and puppetry, offered mask-carving workshops where neophytes learned the craft from Balinese masters. The next one would be held in spring 2003. Providentially, Naversen was scheduled for a semester sabbatical then.

He signed up. Even the nightclub bombings in Kuta, Bali, in October 2002 didn't dissuade him from making the trip. Once there, he had no concerns about terrorism. "It was a paradise," he says—though one now threatened by economic hard times due to the drop in tourism.

The students began their education by copying masks. "Ketut would carve on one side, and we would carve on the other," says Naversen. "For the first mask I made, Ketut carved about 75 percent of it, and it took about a week, including sanding. By the fourth mask, I carved about 75 percent, and for the last mask I made he would just look at what I was doing and make suggestions."

Naversen documented the entire process,

both in writing and in a video of Ketut producing a mask from start to finish. Carving remains much more laborious for Naversen than for the master. "Ketut could carve a mask within a couple of hours," he says.

In Bali, masks are most often carved from pulai, a creamy, fine-grained wood worked while it is still green and soft. Finished masks are sanded and usually painted, often elaborately—a process that involves applying dozens of thin layers of paint. Sometimes they are embellished with hair, leather, mother-of-pearl, or other additions.

At home, with pulai unavailable, Naversen has branched out to red alder from Oregon and experimented with catalpa wood (too hard, resulting in a cracked mask). Although he has painted and decorated one of his masks, he prefers the look of the unpainted wood.

Naversen plans to pass along his new skill by teaching mask carving in independent study courses. He hopes

enough students will learn so that wooden masks can be made for an upcoming production of "The Green Bird," an 18th-century commedia dell'arte play revived in 1996. He's organizing an interdisciplinary conference on masks and their uses, paired with a museum exhibit, both to be held at SIUC in 2005. And he intends to continue researching the cultural uses of masks.

"In Bali, any mask used in a ritual performance has to be ceremonially cleansed," Naversen says. "Then a spirit is invited to come into the mask, to inhabit it. The performer is felt to be possessed by that spirit during the performance."

It's a notion that, more broadly, may reflect our emotional responses to masks, he thinks. "Our psyche is very stimulated by masks," he says.

"Somehow there has to be a spirit in a mask." 🏰

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Fins *for* Forests

by K.C. Jaehnig

How fish are helping to spare the Amazon jungle



Picture a fish that likes nothing better than to root through a flooded forest for fallen fruits and nuts—a healthy, fast-growing fish that will settle for kitchen scraps if that’s all that’s on offer. A fish that does well in captivity and makes mighty good eating—in short, a fish much like a pig, minus the stink and the squeal.

Such fish, members of two tropical species called pacu in the United States, are native to the Peruvian Amazon. They could provide a means not only to feed that

region’s poor but to save its rainforests, too, an SIUC zoologist believes.

“The destruction of the rainforest has been shown to have a tremendous effect on global climate change,” says Christopher Kohler. Director of SIUC’s Fisheries and Illinois Aquaculture Center, he has worked in the Amazon for the last 10 years.

“A lot of that destruction has occurred as a result of agriculture—people have to make a living. But agriculture isn’t a sustainable practice there. Aquaculture is.”

Aquaculture—raising fish for food—has become the main focus of SIUC research and outreach efforts in the Amazon. Working with native fish species, some of them endangered, scientists are devising ways to help Peru’s rainforest residents feed themselves sustainably.

When people in the Amazon clear rainforest acreage for row-crop agriculture or cattle ranching, it’s a losing proposition all around. The soil is too thin and poor to support these activities for more than a few years. Villagers must then move on to clear a new spot, and the cycle of destruction—and poverty—goes on.

◀ **Background, left: Fish pens float on a tributary of the Peruvian Amazon. Fore-ground: Harvesting an aquaculture pond. All photos courtesy SIUC Fisheries Center.**

Small-scale aquaculture offers an eco-friendly way of producing what is really their preferred food: fish. An important part of the diet, fish contributes 60 percent of their protein.

“Since we have been involved with this project, we have gone from a handful of people raising fish to several hundred doing it,” Kohler says. “Although many of them were hunters and gatherers in the past, they have been adapting to this kind of activity readily, and it’s good for the region—it leaves the trees.”

It’s a long way from Southern Illinois to South America, from hybrid striped bass to a fish that can forage on a flooded forest floor. The journey began with a Peruvian student. Luis Campos Baca had come to SIUC from the Universidad Nacional de la Amazonia Peruana, where he taught, to work on a master’s degree. He asked Kohler if the two faculties could join forces to help his homeland.

“My first response was, ‘I’ve never been to the Amazon, I know nothing about the Amazon, and anyway, we could never get any kind of funding for this,’” Kohler recalls.

But in 1993, the U.S. Information Agency, which operated a grant program intended to foster links between American and foreign universities, decided to emphasize conservation, with the Amazon a priority. Kohler learned of the program’s existence three weeks before grant proposals were due.

“We had nothing, but we did have this student,” Kohler says. “He was going back [to Peru], and he promised to get us letters of support.

“The Mississippi and the Amazon are the two largest river systems in this hemisphere. While we didn’t know anything about the Amazon, the Peruvians didn’t know anything about the Mississippi. [I thought] learning about the commonalities and differences might help us all.”

Armed with that proposal, the SIUC team landed a three-year grant.

“We got as many faculty involved as we could, and it worked exactly like USIA wants these projects to work, with friendships and collaborations developing that would keep everything going after the grant ended,” Kohler says.

Peruvian scientists came here to learn about the Mississippi and fisheries management in the United States. Meanwhile, SIUC scientists went south to research the Amazon. Much of their early work, led by SIUC zoologist Brooks Burr and involving a number of graduate students, centered on identifying fish species and collecting research samples.

SIUC now houses specimens of roughly 70 percent of the region’s 800 fish species. The ichthyological research clarified much scientific uncertainty about these species.

“The Amazon River is home to the largest diversity of freshwater fish in the world,” Kohler says. “For people who work with fish, it doesn’t get much better than that.”

As they worked, the SIUC researchers talked with local fishermen and discovered some troubling facts.

“The fishermen were fishing the river fairly intensively but had to go farther and farther to get their catch, and the fish coming in were getting smaller—classic signs of overfishing,” Kohler says.

While sampling continued, researchers began to study the catch and to look at fish populations and came to a conclusion.

“If they were going to continue their consumption of fish, aquaculture would have to make up the difference,” Kohler says.

And then the project got another lucky break. Although USIA support was coming to an end, Oregon State University had been awarded a grant from the U.S. Agency for International Development to put together an aquaculture venture. Its Collaborative Research Support Program linked American researchers with hosts in developing countries. It had no members in South America.

“We’ve been funded through that



▲ **Peruvian fish farmers show off their crop of pacu.**



▲ Peruvian extension workers show would-be fish farmers how to stock fish pens.

program ever since, and ours has become one of their prime sites,” Kohler says.

SIUC scientists and graduate students work with their counterparts at the Universidad Nacional de la Amazonia Peruana and the Instituto de Investigaciones de la Amazonia Peruana. Both are located in Iquitos, in the heart of the rainforest. Fernando Alcantera and Salvador Tello head the Peruvian side of the collaboration, with SIUC researcher William Camargo serving as the chief liaison.

A key task for the team has been to investigate the suitability of native fish species for aquaculture. Much of their early work focused on pacu. These fish “look like a giant piranha, but without the sharp teeth,” Kohler says. In the wild, they play a key role in dispersing seeds through the river ecosystem, but they are being overharvested. By taking the fishing pressure off the wild population, aquaculturists hope to help preserve the ecological balance.

Among other things, the scientists studied water-quality and stocking density requirements for two pacu species, *Colossoma macropomum* and *Piaractus brachyomus*. They experimented with techniques to increase the survival of fish larvae and young

fish, and tried out various feeding regimens of locally available or prepared foods.

As a result of this work, both species can reliably be raised from larvae to two-pounders—big enough to harvest—in just one year. Fred Chu-Koo, a Peruvian doctoral student at SIUC, continues to refine aquaculture techniques for these fish.

The project team began its work with aquaculture ponds, but lately, for villages in floodprone areas or sited on riverbanks, they’re constructing fish pens directly in streams and rivers. Recently they’ve been experimenting with raising a fish called *Arapaima gigas* in these pens. This endangered species, which can grow to 9 feet long in the wild, is one of the most popular food fishes in the Amazon.

“The results are looking surprisingly good (for aquaculture),” Kohler says. “They grow extremely fast—we can get them up to more than 10 pounds in one year.”

The team also is investigating the aquaculture potential of two native catfish species.

The project offers training to prospective fish farmers, who learn everything from how to construct and stock ponds or fish pens, to techniques for breeding and rearing the fish, to knowing when to harvest. It also provides intensive short courses for government and nonprofit agency personnel from Peru and neighboring countries, who then work as aquaculture extension agents. Those outreach activities are spearheaded by Camargo and Sue Kohler, associate director of SIUC’s Office of Economic and Regional Development.

“We try to work with as many individuals as possible to turn them into ‘master aquaculturists,’ somewhat like ‘master gardeners’ here, so that other people can visit and learn from them,” says Chris Kohler.

“We’ve also hired workers who go out to the ‘hinterwaters’ far and wide—places where there are no roads—to spread the word.”

The project stresses sustainability. “Waste is not a problem in the ponds or rivers because it gets broken down—we’re working at a subsistence level, not an industrial level,” Kohler notes. “Farmers might have just one pond or one pen, but it allows them to have an income, produce some of their own food, even use kitchen waste [by feeding it to the fish]. It’s also sustainable because we’re working with native species, so there’s no problem if there are escapes.”

By helping the Peruvians, we also help ourselves—both in the near term and the big picture, Kohler believes.

“Several of the fish species we’re working with have better attributes for aquaculture than species we currently use in this country,” he says. “These are fish we might want to be producing ourselves someday.

“But it’s more than that. Everything is interconnected. Sometimes you don’t know what those connections are until you lose them, but once you lose a species, it’s gone for good. Things that happen in the Amazon will affect all of us. That’s something for mankind to keep in mind.”

For more information, see the Amazon project’s website at us1.coopfish.siu.edulamazonia/index.html.

BEAUTIFUL GEOMETRY



▲ Cheonae Kim. Glass entry wall, 16th District Police Department, Chicago, Ill. 2003.

“My work attempts to elevate the human spirit through line, form, space, and color.

“In my black-and-white series of paintings, I worked with the simplest elements: horizontal and vertical lines. The lines are often combined to make forms, but always on a horizontal and vertical axis. The horizontal line signifies the passive; the vertical line signifies the active. In my more recent paintings, I deal with the effect of color on perceptions of scale, proportion, and space.

“In its structure and repetitiveness, my work has a close association with 20th-century music. Certain forms can suggest certain sounds, and different stripes of color can relate to a certain tonality in music. Repetitiveness in my serial work relates to that in serial music; both contain elements of improvisation and variation within set boundaries.

“A recent development in my work is its application in large-scale public projects funded by percent-for-art programs.”

—Cheonae Kim

Ed.—Cheonae Kim, a visiting instructor of art at SIUC who earned her M.F.A. here in 1986, has exhibited her geometric paintings in New York, Chicago, San Francisco, Los Angeles, and many other locales. Major recent works of hers include “Quarto,” a lobby-sized color painting for the UCLA Hammer Museum, and “100 Days,” an installation of 100 black-and-white paintings at the Milwaukee Art Museum. Commissions for public art projects have expanded her work into glass (above) and tile (an upcoming project in San Francisco).

Kim is represented by Klein Art Works (Chicago), Margaret Thatcher Projects (New York), and several other galleries. In 1993 she was awarded a National Endowment for the Arts grant in painting; this year, she held a prestigious MacDowell Artists Residency in New Hampshire and a studio residency at Loft Nota Bene in Spain. For more of Kim’s work, see p. 10 or www.cheonaekim.com.

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