

I o WATCH



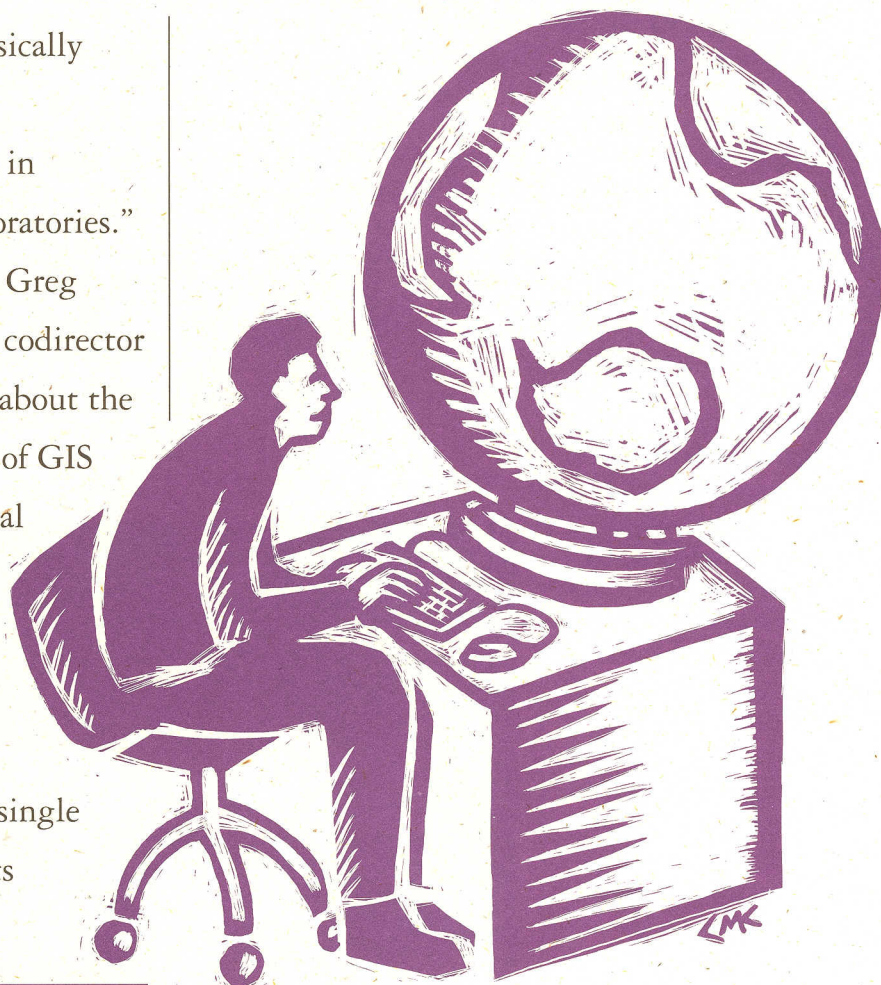
THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

F A L L 2 0 0 0

This issue of *IoWatch* focuses on the use of sophisticated computer technologies to visualize complex environmental features and processes.

When CGRER was first formed, ten years ago, we knew that it would bring together a diversity of researchers with a single common interest: their desire to study human-induced environmental change. We envisioned CGRER as a 'virtual center,' one in which researchers would

than by physically performing experiments in research laboratories." Thus speaks Greg Carmichael, codirector of CGRER, about the Center's use of GIS (Geographical Information System) technology. "GIS has become the single tool that cuts across all of



Visualizing Reality

come together to manipulate and visualize complex data sets in computer laboratories, rather

CGRER's activities. It's a major facilitator of interdisciplinary research among our diverse members."

GIS software programs such as ArcView allow researchers to manipulate extremely large, complicated data sets and, quite literally, to *see* the results in map form — as a cloud of pollution floating across Lake Michigan or a smattering of Native American remains scattered across the landscape. Researchers can input numerical data into

models, massage the data in various ways, and read the results as a picture — of weather masses flowing over the North American continent, or as water droplets carrying grains of sand over the ocean floor. These images present obscure, incomprehensible processes and problems in a straightforward, immediately accessible

manner, proving once again the verity of the adage, "a picture is worth a thousand words."

More and more frequently, today's computer-driven numerical models are coupled with GIS programs that allow output in increasingly sophisticated visual terms. The resulting products are "intelligent maps" that can be overlain one upon another, or viewed from various angles, or queried by the viewer, or animated, or seen in four dimensions: as processes that are changing through space and through time.

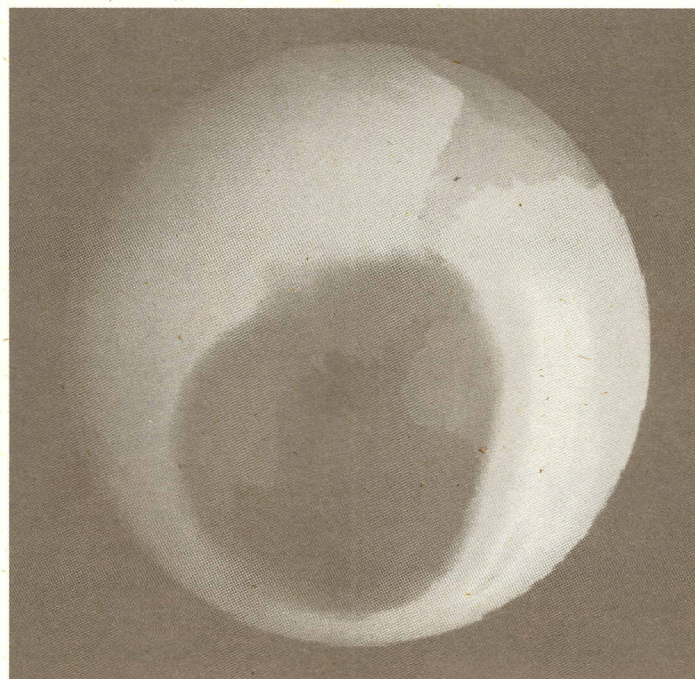
And what are the advantages of doing so? How does GIS enable us to better deal with global change-related problems? For one thing, the productivity and efficiency of researchers is spurred by the speed and ease of analyzing large data sets. Communications among researchers are promoted by the ability to share data sets electronically, just as interdisciplinary collaboration is spurred by the ease of integrating variables – for example overlaying maps of pollutants, industrial producers, groundwater systems, and human population density—all with the tap on the keyboard. Such collaboration is increasingly crucial in dealing with environmental problems whose effects drift across disciplines as well as national boundaries.

GIS promotes environmental problem-solving in another way: by prompting decision-makers to develop scientifically literate policies. Government officials and policy-makers often are limited in their understanding of complex environmental dilemmas and in the time

they have to educate themselves about change-related issues. GIS addresses both problems. By presenting up-to-date visual images of the evolution and current state of problem situations (such as the graphic below of the ozone hole), GIS allows decision-makers to comprehend (often for the first time) the factual basis of change-related problems and to make informed policy decisions.

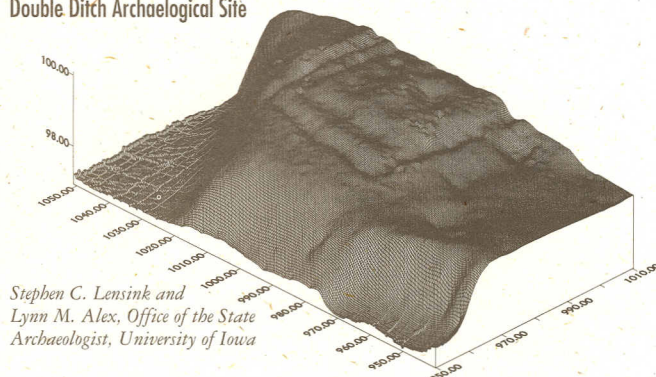
Thus, while GIS remains a mere technological tool, it is leading CGRER's researchers in new directions – and also is encouraging the use of their results in significant ways that were unknown in the past. Some GIS projects are described in Faculty Focus (page 6). Others examples follow:

NASA @ www.nasa.gov



Computer-generated maps bring scientific anomalies into common parlance. The ozone hole, created by the release of CFCs starting in the mid-twentieth century, is an excellent example of this phenomenon. First suspected in 1974, papers proving the break in the protective ozone layer were first published in 1985. Within two years the ozone hole was mapped. Ozone maps graphically displayed a totally new phenomenon to the general public and policy makers, who have followed shifts in the hole's size and position ever since. This recent (September, 2000) map shows the ozone hole to be larger than ever before.

Double Ditch Archaeological Site



Stephen C. Lensink and
Lynn M. Alex, Office of the State
Archaeologist, University of Iowa

GIS Aids Archaeological Digs

Mark Anderson, project archaeologist at the Office of the State Archaeologist (OSA), was the first researcher to use CGRER's GPS (Global Positioning System) equipment (see CGRER's 1997 Annual Report). At that time, this GPS equipment was utilized to site archaeological resources for state highway planners. The GPS unit, carried into the field in a small backpack, was linked to a hand-held

computer that could log not only GPS locations, but also field data such as the depth of a dig or the artifacts found there. Thus a complex but integrated data set can be accumulated with ease in the field and downloaded, back at the office, in GIS-ready mappable files.

Once convinced of its efficacy, Mark has encouraged the use of improved GIS / GPS systems in several complex situations. This last summer, for example, the OSA employed such equipment to establish and mark site boundaries for a joint OSA-UI Department of Anthropology field school for undergraduate and graduate students. The electronic markers had the advantage of being non-destructive to the site, and far faster and easier to establish than the traditional tape and pace systems. Sitings are extremely accurate: current technology permits relocation of sites to within a 0.5 meter accuracy. Also, electronic markers are sure to be there in the future, even if land use or topography have been altered.

Taking the tool one step further, OSA researchers now are using GIS/GPS units in attempts to "see" previously undetected archaeological features and relationships on virtual site maps. Detailed high-resolution typographic

mapping of surface microfeatures, for example, allows detection of subtle features such as ancient lodges and fortification features. And computer manipulation of the 3-dimensional GIS maps allows one to picture a site from a bird's eye view. In the GIS graphic of the "Double Ditch Site," a late Prehistoric village occupied about 800 years ago in today's northwest Iowa, two four-meter-wide ditches that once served as fortifications are clearly visible, as are several lodge depressions. This map shows sufficient detail that it could be used to prepare a detailed plan for site excavation, and to visualize and analyze the size and layout of the site.

GIS Helps Establish Carbon Credits

CGRER codirector Jerry Schnoor and CGRER Research Scientist Richard Ney, along with graduate student Okendra Budhathoki, are attempting to lessen the impact of greenhouse gases by developing scientific accounting methods to support establishment of carbon credits as a commercial commodity. The market for such carbon credits would be created by regulatory or economic incentives that would limit the amount of carbon that can be released by

larger-scale carbon emitters. A carbon emitter could then pay farmers or foresters for removing carbon dioxide emissions from the atmosphere and storing them – say in the soil or in growing plant material (a process called sequestration).

However, selling carbon credits on the open market will require both quantification and verification: the credit purchaser would require the seller to prove that a given amount of carbon has indeed been removed and stored. And that, in turn, requires valid data showing changes in the amount of carbon stored in the soil (or plant material) of a given region. GIS maps permit complex carbon data, gathered in the field and generated through numerical models, to be expressed in a simple, visual format. The map below for example presents a detailed, high-resolution view of carbon in Iowa's soils. Once numerical models have been executed to predict future conditions, this base map will be modified by CGRER researchers to reflect changes in carbon storage in the soil. Thus GIS maps, combined with complex numerical models that have been calibrated through field studies, may soon be playing a role in reducing the impact of global climate change.

Carbon in Iowa's Soil



1980 U.S.D.A. Soil Conservation Service soil surveys, recompiled in 1996 by the Iowa Department of Natural Resources, Geological Survey Bureau

GIS Enables Analysis of Lake Michigan Pollutants

People who fish in Lake Michigan know that their catches are tainted with an array of pollutants – such as PCBs, mercury, or varied insecticides. But the exact source of these pollutants and their duration in the lake are still subjects of research. Over

Trans-nonachlor over Lake Michigan (dark colors mean higher concentrations)



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the last several years, the Environmental Protection Agency has been performing a multi-million-dollar Mass Balance Study to try to address these questions. UI faculty member Keri Hornbuckle (Civil and Environmental Engineering) along with her graduate students has been tackling the atmospheric aspects of the project, describing pollutants that sink into the lake through rain, gas exchange, or adherence to particulates. EPA provided the data for the analysis, sending the Iowa team 18 months of readings that traced the concentrations of dozens of pollutants across and into Lake Michigan's waters. The volume of data was enormous. Something was needed to reduce the

volumes of numbers into an understandable format. GIS, backed by mathematical models that processed the data, was the tool of choice, crunching the numbers into pictures such as a map that shows gas-phase concentrations of the pesticide *trans-nonachlor* over Lake Michigan. Such maps, which display atmospheric pollutant concentrations and their changes through time, have provided a very useful research tool. The quality of this effort has been reflected the journal *Environmental Science and Technology's* recent publication of project-related papers by Keri's students Sondra Miller and Mark Green.

GIS Displays Data for Hydrological Models

Our future understanding of the global hydrological cycle, as well as its impact on climate and climate change, is likely to result from numerical models of this cycle and its corresponding weather systems. Thus the World Meteorological Organization's World Climate Research Program recently initiated a massive project to support the creation of accurate and useful hydrometeorological models. Researchers at the Iowa Institute of Hydraulic Research (IIHR), in combination with Princeton scientists, are contributing a basic but crucial component of this effort. IIHR research scientists Witold Krajewski and Anton Kruger, along with graduate student Brian Nelson, are constructing a high-quality five-year precipitation data set, with high space and time resolution, presented in under-

Precipitation in the Mississippi River Basin



standable format, for the entire Mississippi River Basin. This data set, once completed, will become a tool for the numerical modelers, who will be able to use it to instantaneously retrieve hourly precipitation information for any 4X4-km site within the basin.

The enormous number of data involved could never be dealt with individually. The Mississippi River Basin is immense, covering two-thirds of the continental U.S. While previous modeling projects have utilized far smaller numbers of raingage data, this project is tapping real-time radar data collected in a 2X2-km grid. This fine resolution promises to produce far more accurate weather maps than ever before. However precipitation maps created in this way require an overwhelming number of data; nearly a million numbers feed into creation of a single map such as the above figure, which displays precipitation across the Mississippi Basin at one instant in time. Thus such GIS maps, which convert large numbers of data into visual displays, are impera-

tive tools for navigating and browsing the data sets while they are being processed and converted into rainfall fields. Later on, once the project has been completed, GIS maps will be employed by modelers to locate specific areas or given storm systems for any specific time, or otherwise preview and select the data that are appropriate for them.

GIS Provides Integrated Assessment for Energy Decisions

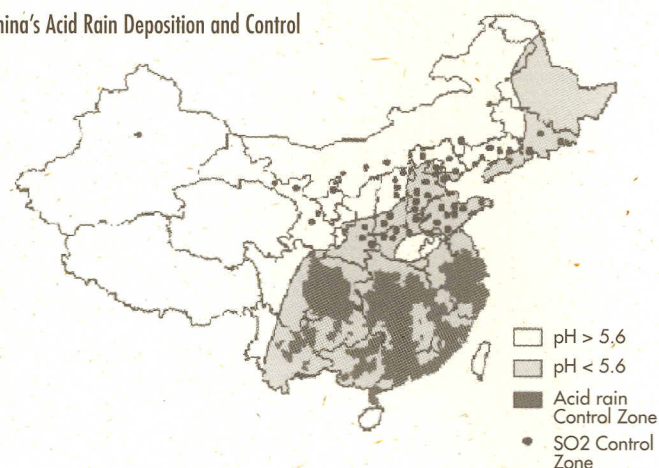
Choosing an energy source and controlling its pollutants is a complex task, especially when financial resources are limited. How can the cost of a given fuel best be matched with its economic use, while simultaneously considering other important contingencies: amounts of pollutant emissions, the cost and efficiency of controlling emissions, and the damage both to ecosystems and to human health if emissions are not limited? Yet significant energy-related decisions, complex as they are, are being made daily by nations hungry for new power sources to feed their development schemes.

GIS, backed by powerful

numerical models, is now providing integrated energy-related information to decision makers across Asia, thanks to a joint project of CGRER, Argonne National Laboratory, the International Institute for Applied Systems Analysis, the World Bank, and a varied team of Japanese scientists. This project is developing a colorful, enticing software package that can easily be manipulated by policy makers, researchers, planners, and development programs. Exportable on a single CD, the package allows users to explore the merits of alterna-

environmental costs into economic analysis and then choosing the optimal energy decisions. Equally important, the software package enables its users to recognize the deep-seated, complex connections between present actions and future implications. The map below, for example, was used to help convince Chinese leaders about the reality of acid deposition on China's landscape, and aided them in choosing sites where control strategies would yield the most profitable results.

China's Acid Rain Deposition and Control



tive energy and emissions reduction strategies (for example switching fuels, or washing coal to reduce sulfur emissions), by allowing them to enter a variety of energy/fuel/technology options, and then read – in map format – the financial, environmental, and health costs of each new local energy source. These varied “costs” can be played out 10, 20, 30 or more years into the future. Methods for limiting the costs also can be weighed and compared one with another.

This package provides a powerful tool for integrating

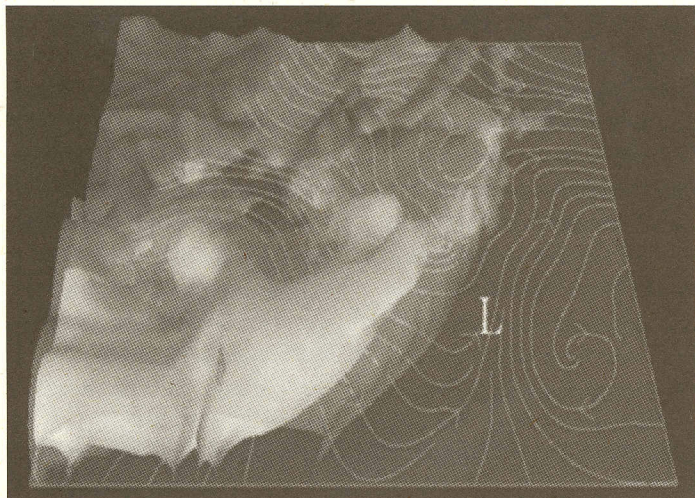
GIS Guides Asian Atmospheric Research

CGRER codirector Greg Carmichael, together with colleagues at the University of Kyushu in Japan, is attempting to determine how growing emissions associated with Asia's expanding energy use are impacting the air quality and climate of the northern hemisphere. Two new experiments conducted by NASA and NSF will explore this important problem, using highly sophisticated research aircraft carrying state-of-the-science chemical and aerosol equip-

ment that will collect data on aerosols and ozone layers high above the eastern half of Asia. During past exploratory missions, the routes of these aircraft were determined by meteorological conditions alone. However a new initiative is now linking numerical models to visual

behind cold fronts and are transported out over the Pacific as these cold fronts move off the continent. While now at the forefront of research activities, such air pollution forecasts will one day become a commonplace planning tool for citizens and policy makers alike.

Forecast, Sulfate Aerosol over Eastern Asia



three-dimensional data sets in order to produce "chemical weather forecasts." These forecasts, communicated as GIS maps, will predict the movement of air pollutants, just like weather forecasters now predict the movement of storm systems. The pollution forecasts will greatly enhance the efficiency and quality of the team's air pollution research. The forecasts, which will extend three to four days into the future, will be used in the field to guide the research aircraft to regions where they can sample air masses with specific pollution characteristics. The above graphic, for example, is a snapshot of a forecasted distribution of sulfate aerosol mass concentration in the East Asia study region. High quantities of sulfate aerosols, arising from coal combustion in eastern China, accumulate

CGRER's Role

For the past decade, CGRER has played a leadership role in the utilization of GIS software. CGRER was one of the first units on campus to employ GIS. CGRER members in the UT's geography and other departments have been actively involved in research on the use of GIS. CGRER was a significant constituent in the UT's application to the University Consortium for Geographic Information Science, an organization striving to review and set national research priorities for GIS and related specialties. Since 1999, CGRER has been one of four contributors to the purchase of a university-wide site license with ESRI, a major GIS software company. This site license ensures that GIS software is available campus-wide to any inter-

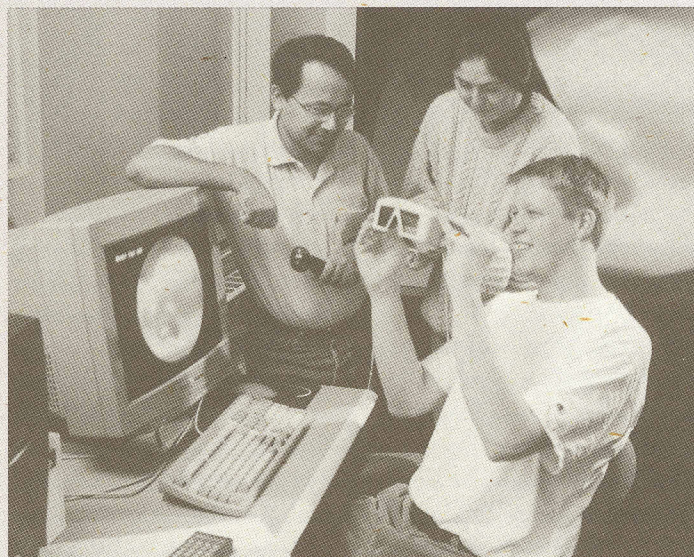
ested user, regardless of discipline. The continued purchase of such a site license will go far to promoting the future use of GIS within the university community. And on November 15, 2000, National GIS Day, CGRER will join other governmental and university GIS users in displaying its GIS projects to interested visitors.

Now CGRER is employing a new GIS tool by linking its ImmersaDesk to GIS software. The ImmersaDesk allows researchers to project gridded numerical data sets that are changing through time on a very high resolution

stereoscopic screen. This ImmersaDesk / GIS combination will add another dimension to the visualization of environmental data by allowing researchers to explore environmental data sets using virtual reality tools. It also will magnify the potential for collaborative efforts by enabling multiple researchers or policy makers simultaneously to immerse themselves in a large-screen three-dimensional data set — thus "visualizing reality" in an ever more realistic manner and shaping our environment's future accordingly.

Behind the Scenes:

Jeremie Moen (seated), who manages CGRER's computer facilities, also facilitates the use of GIS at CGRER. With a UI geography degree that emphasized GIS, Jeremie is primed to teach students how to use the lab's mapping software effectively and efficiently. His ability to do so has been enhanced by training classes offered by ESRI, the GIS software company whose products are used across campus. Jeremie also maintains CGRER's GIS capabilities by making necessary hardware purchases and by installing and upgrading GIS software for both Windows and UNIX operating systems. "CGRER views GIS technology as a top priority, and is dedicated to providing facilities and training students in its use," Jeremie states. CGRER's GIS lab is open to all CGRER members and their undergraduate and graduate students, in addition to other students with independent CGRER associations; Jeremie encourages any such students and CGRER members to contact him with GIS-related questions.



As much as computers are refining our ability to visualize reality, they cannot

simulate reality in all its complexity. No one knows this better than CGRER's biologists, who study Earth's ecosystems with their many millions of species and interrelationships. Thus they attempt to unravel the complexities of our natural world by becoming intimately familiar with the "real world" as it has been understood by humans for millennia. They tromp through the grasses and mud of prairies and wetlands to examine, first hand, the flitting of a butterfly, the territorial song of a bird, the bloom of a flower, or the feeding of an insect, all witnessed in the natural environment that these organisms call home.

Their quest begins with finding out exactly what is out there. "As much as we have altered Iowa's natural landscape, we are still finding new native species here," states **Diana Horton**, botany professor at the University of Iowa and curator of its herbarium. Much of her professional life alternates between collecting plant specimens as she examines Iowa's remaining native ecosystems, and developing computer programs that present botanical information

to the general public. "Botanists collected plant specimens in eastern Iowa with flourish around a century ago, and again around 50 years ago," she explains. "But Iowa still harbors many unstudied



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pockets of native species. Surveying these areas and collecting plant specimens provides a necessary floral baseline for global change studies; herbarium specimens provide the permanent physical record of our state's changing natural wealth."

Diana is determined to inform Iowa's public about this natural wealth through a complex web site now nearing completion. The web site will provide (among other things) a Fragile Flora Database — the first searchable database on Iowa's endangered species. "The web site, coupled with continued field reconnaissance, will provide a sound scientific basis for refining Iowa's endangered species list, and it will encourage and aid new

research on endangered species. By enabling anyone to understand where we stand regarding endangered plants, I hope the web site will push change in a positive direction for these declining species." Diana has received a CGRER seed grant to assist with her herbarium efforts (see Seeds, page 9).

Steve Hendrix, ecologist at the UI, also stresses the need for continued inventories of natural areas. "We just don't know details of what's out there yet. We are still working on defining the basics — and this restricts our ability to maintain the state's biodiversity. Biodiversity is a crucially important natural resource that is increasingly threatened by numerous global change issues." Steve's recent projects have focused on the interrelationships of Iowa's fragmented native prairie and prairie-dependent insects. Like Diana, he spends much time in the field visiting numerous locales where he collects data on the abundance and diversity of plants and insects. He then depends on computer-generated Geographical Information System (GIS) maps to correlate the species richness of prairie-dependent

butterflies with the abundance of plants they pollinate and feed upon. "We're trying to figure out how the size and arrangement of our miniscule prairie remnants affect the abundance of prairie plants and insects," he explains. "GIS allows us to map distribution patterns quickly and easily, and manipulate data with ease. This project would be nearly impossible with bulky paper maps." In a related project, Steve employs mark-and-recapture techniques on beetles to examine details of their dispersal capabilities. "I'm finding that prairie plant-eating beetles colonize some prairie remnants even as they become extinct in nearby remnants. They seem to survive as a species by continually dispersing to new sites that provide their required foods." Studies such as this will help Steve and others better understand how to maximize the diversity of Iowa's prairie remnants, and how to site prairie restorations to maximize their biodiversity benefits. Such knowledge will become increasingly important as changing climate and land-use practices continue to stress our remaining natural habitats.



RHYSSALUS LINEATICOLLIS

ISU population geneticist **John Nason** investigates similar matters but from a different vantage. Utilizing his skills with genetic analysis and field botany, he asks questions about gene flow, evolution, and conservation biology, in attempts to discern how changing environments and human disturbance are affecting speciation and biodiversity. For example, he has studied the rate of swamp milkweed's pollen flow within a high-quality Iowa nature preserve, Caylor Prairie, versus nearby prairie remnants. Finding a high rate of pollen exchange among these widely separated prairie remnants, John has concluded that the fragmentation of our once-vast

the fig populations would spark a cascade of extinction of plants and animals both. In another study of how changing environments impact the genetic structure of Sonoran desert plants, John has used genetic markers to trace the range expansion of a columnar cactus species and its dependent moth pollinator. He is now asking whether the moth and cactus, neither of which can reproduce without the other, are undergoing parallel genetic diversification. "None of these projects would exist without my field work," John explains. "Without the ability to observe the natural history of these species in the field, I wouldn't even know what evolutionary or genetic questions to be asking."

Diane's Iowa research deals with a more immediate question: how to restore a rare insect to a given habitat. In particular, she is working with reintroducing regal fritillaries, beautiful prairie-dependent butterflies that have almost disappeared from Iowa's fragmented landscape. In addition to monitoring Iowa's few small remaining

This hands-on work is giving Diane and her students practical experience with insect restoration that should feed into larger concepts and projects aimed toward restoring and maintaining our native biodiversity. A major question here relates to natural variability. "There are huge variations in nature –

Faculty Focus

prairies has not yet adversely affected the genetic diversity of this plant's populations.

Much of John's fieldwork is completed outside Iowa. He is now studying the effects of habitat fragmentation on gene flow among tropical plants. Tropical forests are becoming increasingly fragmented, but species there seem to be maintaining the ability to exchange pollen among forest patches. John explains that this continued exchange of pollen, and resulting maintenance of biological diversity, is crucial in the tropics (as elsewhere): Strangler figs, for example, may support up to 60% to 80% of the forest's vertebrate biomass during the tropical dry season, and each of the 750-or-so strangler fig species is pollinated by a different wasp species. A collapse of

ISU conservation biologist **Diane Debinski** focuses her efforts on the maintenance and restoration of grassland insect communities. She spends part of her summer field season in Yellowstone National Park where she examines birds, butterflies, and plants, and (using remote sensing and GIS to classify habitats) tests predictions about these organisms' distribution across the landscape. She is using these data to build numerical models of species-habitat relationships. The models, in combination with landscape models of predicted habitat changes accompanying global climate change, will help her predict how the abundance and distribution of species may shift as climatic change impacts their required habitats.

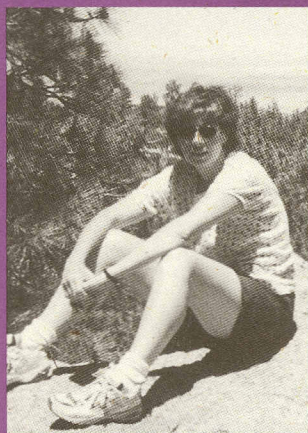


fritillary populations, Diane is planting prairie violets (required food for the fritillary larvae) in restored prairies of the Neal Smith National Wildlife Refuge near Des Moines. This past summer she released the first pregnant fritillaries here, hoping that they will help to found a viable, permanent regal fritillary population.

between seasons, between years – and we need to measure this baseline variability in the field, where it's happening," Diane states. "We can use numerical models all we want, but without such field quantification of natural variability, we cannot differentiate natural variation from human-induced change."

Behind the Scenes:

Jane Frank, CGRER's administrative assistant, has been with the Center since it was formally organized in 1992. Prior to that, she worked in other University of Iowa secretarial positions for over 15 years. As CGRER's administrative assistant, she handles a diversity of day to day operations. She makes payroll appointments, completes all CGRER's billing and accounting activities, facilitates CGRER-related grant proposals, assists with manuscript preparation for CGRER-related journal articles, expedites student activities and accommodations, and dives into any other efforts necessary for CGRER's operation. Jane's friendly smile is the first welcome that most students and researchers receive when they initiate involvement with CGRER. Her cheery, easy going temperament, accommodating nature, and organizational skills are a boon to the Center and all those who walk through its doors. Jane says that she enjoys her position because she performs a variety of duties, works with a diversity of people, and sincerely is concerned about global change issues and CGRER's smooth operation. She invites anyone interested in joining CGRER to contact her.



Steve Heard, insect ecologist at the University of Iowa, studies ecological controls on the generation and maintenance of biological diversity. More specifically, Steve has been examining how competing species of insects survive in a given area by varying the location and size of their egg clutches. He explains that female insects do indeed vary their egg-laying patterns in response to the availability of food for incipient offspring. When larval food plants are common, the female lays but a few eggs on each such plant, ensuring adequate nourishment for each offspring. But sparse food plants result in many eggs laid on each food plant. While larger egg concentrations per plant increase the competition among offspring, that egg-laying pattern also leaves more food plants for other local species with the same eating preferences – and thus safeguards the area's biodiversity. "We have shown this to be true for certain mushroom-breeding flies," Steve claims, "and also for 'generic insects' examined through computer models. Those numerical models have provided new hypotheses that we now are testing by returning to field studies. Models tell you what *can* happen, but you need

fieldwork to tell you what actually *does* happen in a complex natural setting."

Steve's fieldwork also investigates the generation of new insect species and the potential effects of climate change on this process, and he and John Nason have received a CGRER Seed grant to assist with this effort (See "Seeds").

Jim Raich, a terrestrial ecosystem ecologist in ISU's Botany Department, is more concerned with newly planted ecosystems than with native remnants. Jim, along with several other ISU and National Soil Tilth Lab scientists, is attempting to create model riparian buffer strips that will prevent agricultural chemicals from entering surface and ground-water bodies. The research team has been planting varied mixtures of grasses, shrubs, and trees. Once the strips are established, Jim returns to the field to collect soil, roots, and plant materials for carbon and nitrogen analyses. In combination with measurements of plant growth and soil organic matter dynamics, he quantifies carbon and nitrogen cycles within the buffers. Resulting data can be fed into numerical models that analyze the degree to which different plant species are sequestering atmospheric

carbon dioxide, and how well they are capturing nitrogen and keeping it on site. These results can be presented as GIS maps that show the flow of water and associated nutrients through fields into nearby streams. His studies of cool season (C_3) and warm season (C_4) grasses have led to interesting results. The cool-season grasses, which are primarily non-native species, seem to "live fast and die young" as Jim puts it, sequestering nitrogen in goodly quantities but then releasing it equally fast. The more deeply rooted warm-season grasses (natives such as switchgrass), in contrast, appear to be much better nitrogen sinks. Woody plants (trees and shrubs) in the buffers provides the largest potential carbon and nitrogen sinks, while at the same time improving landscape diversity and wildlife habitat.

As the unraveling of the human genome has taught us, biologists are increasingly able to define life as a precise sequence of molecular reactions. However those reactions can be played out in myriad ways, by organisms with a will of their own. CGRER's biologists depend on computer technology for many things: to spin out maps and understandings of present and future worlds, to model species-habitat relationships, to present their findings to the broader public. However in order to ensure that they are indeed representing reality rather than their own imagination, they will continue to report to the field and study organisms and their environment in their totality.

In August, CGRER awarded seven seed grants for the period 8/1/2000-7/31/2001. The seven projects, which received a combined total of \$120,000, are as follows:

E. Arthur Bettis (UI, Geology) received a \$19,252 grant to help him decipher evolving vegetation communities during the Middle Holocene (8500 to 2000 years before present) across the Midwest's eastern plains and prairies. This period is poorly represented by standard paleoecological indicators such as fossil pollen deposits. Art will measure stable carbon isotope values of soils in alluvial fans from eastern Nebraska to the Mississippi River Valley. These values will reveal the detailed history of fluctuating grassland and savanna community composition during the middle Holocene (ca 6500 to 4000 years before present), the warmest, driest period of the past 10,000 years. Art's results will help us understand the expansion of prairies and retreat of forests during a warm, dry climatic period potentially similar to a climate that could be induced through global warming. Art's study also will provide new data on a period that is poorly understood. By doing so, Art's research will help validate current GCMs (numerical Global Circulation Models) and will support new initiatives to develop smaller scale, more detailed regional climate models that are badly needed to refine our understanding of the effects of future climate change. This project will utilize the Paul

H. Nelson Stable Isotope Laboratory, partially funded by CGRER, and the project's results will be compared to those derived from other CGRER-sponsored efforts (such as paleoclimatic records based on stalagmite examination).

While atmospheric research traditionally has focused on reactions among gases, **Vicki Grassian** (UI, Chemistry and Chemical and Biochemical Engineering) has examined the interactions

Seeds

between trace pollutant gases (such as ozone and sulfur dioxide) and atmospheric particles. Particles are known to alter the chemical balance of the atmosphere by catalyzing reactions among gases—for example, in marine environments, salt particles catalyze reactions that perturb the tropospheric chlorine budget. Vicki has received a \$20,000 seed grant that will allow her to incorporate yet one more factor into her research: photochemistry. She now will be identifying and quantifying reactions between particles and trace gases that are induced by solar radiation. Specifically, Vicki will be using spectroscopic techniques to determine the molecular identity and speed of potentially significant photochemical reactions occurring among gases that are adhering to the surface of atmospheric particles. Once identified, described, and quantified, details of these here-to-fore uninvestigated photochemical reactions will be fed into numerical models concerned with defining the

chemistry of the atmosphere. These models in turn will promote understanding of the fate of environmental contaminants and trace atmospheric gases, factors that are crucial to predicting changes in greenhouse gas emissions and future changes in climate.

Ecologists **Stephen Heard** (UI) and **John Nason** (ISU) received \$18,750 to examine incipient speciation among a gall-moth that feeds on goldenrod plants. Different strains of this moth, although living in the same field, feed off two species of goldenrod that mature at different times. The two moth strains, which also mature at different times and are thus not likely to interbreed, may be on their

way to becoming two distinct species. Steve and John, by comparing the maturation dates and genetically-coded metabolic enzymes of both moth strains at two distant and climatically distinct sites, will examine if this speciation is indeed occurring. By attempting to define a detailed mechanism for speciation and relate it to climate-controlled plant growth, this research addresses a critical concern of global change: will a warming climate provide yet one more attack on Earth's declining biodiversity? If changing climate causes the two goldenrod species to grow at the same time, this would encourage interbreeding of their two dependent strains of moths and elimi-



Behind the Scenes:

CGRER's newsletter author **Connie Mutel** received two awards for her writing efforts this past summer: a citation from the American Association of State and Local History "for publishing and promoting Iowa's environmental and scientific history," and a Staff Excellence Award from the State Board of Regents. Connie has written or edited ten books on a variety of environmental topics including restoration ecology, the natural history of Iowa's Loess Hills and the Rocky Mountains, and environmental health, in addition to numerous articles and book chapters. Her most recent book, *Flowing Through Time*, traces the history of her host institution, the Iowa Institute of Hydraulic Research, where she holds a position as science historian. Connie enjoys working with CGRER because these writing efforts constantly teach her new approaches to confronting varied environmental problems. Currently she is also relishing research for a new book on the environmental history of Johnson County, Iowa, aided in part by CGRER funding.

A draft of *Climate Change Impacts of the United States: The Potential Consequences of Climate Variability*, the first long-term national assessment of the potential consequences of climate change, was posted for review this past summer. The document was prepared by the National Assessment Synthesis Team as a core activity of the U.S. Global Change Research Program. The program, in cooperation with the U.S. Office of Science and Technology Policy, commenced its efforts in 1997 with the intent of engaging a comprehensive planning effort to help prepare the nation for climate change and variability. For more information on this assessment and other Global Change Research Program activities and publications, visit <http://www.nacc/usgcrp.gov/>.

nate their divergence into distinct species. If on the other hand changing climate further diverges goldenrod growth, moth speciation may be hastened. This process could affect numerous other plant-eating insect species, which as a group may number 5 million or more – a full 40% of all animal species.

Diana Horton (UI, Biology) received \$9,245 to boost outreach efforts at the university's herbarium, the repository of 70,000 pressed plant specimens collected in Iowa during the past century-and-a-half. (The herbarium also contains 180,000 specimens collected outside of Iowa.) The Iowa collection constitutes a physical record of our state's thousands of plant species, and as such affords a solid scientific base for studies of changes in the state's flora. The grant is partially funding an assistant who, in addition to perform-

ing routine curatorial duties (such as mounting plants and dealing with inquiries from other researchers), is working on a herbarium web site (see Faculty Focus, page 6). The web site in time will allow researchers the first rapid, easy access to information on the number and location (by county) of Iowa's endangered plants, as provided by records from all of Iowa's major herbaria. It also will allow researchers to compare changes in official listings of these plants through time. Ultimately, the website will provide an interactive, online database for all Iowa plant specimen information.

Sarah Larsen (UI, Chemistry) received \$19,908 to investigate fundamentals of environmental catalysis – the use of chemical compounds to solve environmental problems by increasing the speed of desired chemical reactions. Her work involves the use of inorganic microporous powders called zeolites. Gases flowing through the zeolites' miniscule pores undergo specific chemical reactions. For example nitrogen oxides, waste gases produced by internal combustion engines that lead to ozone pollution and acid rain, can be converted to nitrogen, water, and carbon dioxide through zeolite catalysis. Sarah will be using nuclear magnetic resonance (NMR) techniques to identify the exact reaction process of this conversion and to identify intermediary compounds. Understanding the mechanics of the conversion process could enable the development of better catalysts and thus decrease toxic emissions from automobiles and other such engines.

In a related project, Sarah will examine the zeolite-assisted conversion of cyclohexane to ketones and alcohols, compounds that are important industrial intermediates. Standard conversion is typically highly inefficient, with only a small percentage of the cyclohexanes reaching the desired endpoint. Again using NMR to investigate the reaction process, Sarah hopes to decipher the fundamentals of this conversion mechanism in order to develop improved catalysts, raise the reaction's efficiency, and decrease chemical waste.

Climatologist **Dave McGinnis** (UI, Geography) received a \$18,550 seed grant to investigate correlations between broad atmospheric conditions and local precipitation events. By "characterizing the reasons why it rains," as he puts it, he hopes to develop statistical methods that will help refine information from GCMs, which are used to model large-scale

climatic events, so they can be used to predict small-scale climatic events for the Midwest. His grant involves use of statistical analysis of past climate data to downscale the GCMs and greatly increase their resolution. In particular, Dave is focusing on local, extreme weather events such as multi-inch rainstorms, in hopes that he will contribute to models that can accurately predict whether such extreme events will increase or decrease given various future global climate change scenarios. Dave hopes that his research will be preliminary to a much larger product: the formation of a Midwest Assessment of Regional Climate Impacts center, funded by NOAA (the U.S.'s National Oceanic and Atmospheric Administration). Dave will be collaborating with colleagues at Iowa's two other Regents institutions, the University of Nebraska, the Midwest Climate Center located at the University of Illinois, and



perhaps others, to submit a grant for formation of such a center in the near future. This center, in turn, could feed into formation of a national climate forecasting system, which would forecast climatic conditions on seasonal to annual time scales (just as the U.S. Weather Bureau now forecasts weather 3 to 5 days into the future.)

A related seed grant concerns the possible operation of such a climate-forecast center, specifically evaluating how climatic information could be best transmitted to its users. University of Iowa American Studies professor **Richard Horwitz** and **Dave McGinnis** received \$14,295 from CGRER to help outline the types of products that a climate-forecast center could deliver to the general public, and what language would be best for transmitting these products. The researchers will be interviewing members of Iowa's agricultural community to gain a basic understanding of how these persons presently use climatic information, where they get it from, what information they find most useful and how they use it in decision-making, and how technical climatic information can best be transcribed into the common vernacular. The intent is to develop a "folk climatology" that will improve the researchers' understanding of the transfer of climatic information. As with the former grant, this seed grant is preparatory to a hopeful full-fledged Midwest Assessment of Regional Climate Impacts center.

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IOWA WATCH

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

The University of Iowa's Center for Global and Regional Environmental Research (CGRER) promotes interdisciplinary efforts that focus on the multiple aspects of global environmental change, including its regional effects on natural ecosystems, environments, and resources, and on human health, culture, and social systems. Center membership is composed of interested faculty members at any of Iowa's colleges and universities.

Center goals are promoted by encouraging interdisciplinary research and dialogue among individuals whose disciplines touch upon any of the multifaceted aspects of global change. More specifically, the Center awards seed grants, fosters interdisciplinary courses, provides state-of-the-art research facilities and equipment, and holds seminars and symposia. The Center encourages students to broaden their studies and research through considering the multi-disciplinary aspects of global and regional environmental problems. Through such activities, the Center attempts to assist Iowa's agencies, industries, and citizens as they prepare for accelerated environmental change that may accompany modern technologies.

Housed in the Iowa Advanced Technology Laboratory at the University of Iowa, the Center was established by the State Board of Regents in 1990 and received funding from a public utility trust fund, as mandated by the State of Iowa's Energy Efficiency Act.

IoWatch is published each fall. Comments, questions, and requests for additional copies should be directed to:

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