



## Crickets signal mercury–selenium research

While the familiar late summer chirping of male crickets typically serves as a mating call to females of the species, at the Energy & Environmental Research Center (EERC) the chatter of those tiny invertebrates signals the EERC’s growing Health Effects Program.

“The crickets are the subjects of a study to determine how selenium and mercury interact within invertebrates,” said Nick Ralston, EERC Research Scientist. The study is one of 15 current EERC projects aimed at shedding new light on mercury’s risk to human and environmental health and the protective role that selenium plays against those risks.

“The effects of mercury in invertebrates are not well studied,” said Carla Ralston, entomologist and coresearcher in the studies. “We considered looking at either crickets or cockroaches, but we didn’t think the latter would be appreciated around here.”

Both Nick Ralston and EERC Research Manager Laura Raymond, who are leading the studies, previously worked at the Grand Forks Human Nutrition Research Center, where they specialized in metals. Their backgrounds complement existing research efforts at the EERC, a leading research center on the emission of mercury and other toxic metals and particulates.

“While other researchers here are finding ways to control emissions, we’re looking at the health implications of exposure to those environmental pollutants,” Raymond said. Their research may ultimately help alleviate fears people have about mercury exposure through fish consumption, the main source of human exposure.

“Unfortunately, there’s a lot of misinformation out there about mercury, and it’s causing people to shy away from eating fish,” Raymond said. “It’s a great concern for nutritionists because fish are a good source of omega 3 fatty acids and selenium, which the body needs.”

The researchers contend that selenium, long known to counteract mercury’s toxic effects, is itself abundant in most fish, offering a protective effect against the accumulated mercury when the fish is consumed. “Laboratory studies have shown that adding tuna to the diet can actually eliminate mercury toxicity effects because of the selenium available in the tuna,” Raymond said.

### Mercury’s threat

That’s not to say that mercury’s threat is not real, the researchers caution. When atmospheric mercury (from natural sources and human-produced emissions) oxidizes, it becomes water-soluble. When it deposits in oceans, lakes, and streams, it is converted through a natural biological process to methylmercury, the toxic form that accumulates in fish.

While ocean fish have more than adequate stores of selenium to counteract the mercury, Nick Ralston said, whale meat contains far more

mercury than selenium, which is why human populations that eat whale meat are at greater risk of harm from mercury exposure. Freshwater fish in lakes and streams where the surrounding soil is deficient in selenium have potential to accumulate higher levels of mercury as well.

Consuming large quantities of mercury can be toxic to the central nervous system in both adults and children, but it is of special concern for pregnant women and their developing fetuses.



Entomologist Carla Ralston evaluates one of 3000 house crickets used in a mercury–selenium study.

*Continued on page 2*

## Mercury–selenium *(Continued from page 1)*

“The placental barrier can stop many toxic elements, but methylmercury is an exception,” Ralston said. “If children in the womb receive high levels of mercury exposure in excess of selenium, it may impact their memory, attention, and language skills.”

The danger comes from mercury’s ability to cross the blood–brain barrier and bind with selenium, creating mercury selenide, an insoluble compound that makes selenium unavailable for use in the body. “Mercury and selenium are soul mates—when they get together, they stay together,” Ralston said.

Selenium is required for the normal function of many systems of the body, particularly the neural and endocrine systems, Raymond said. Selenium is specifically incorporated into proteins that perform numerous biological functions.

Since the late 1960s, it has been known that adding more selenium to the diet has a protective effect against mercury toxicity, Ralston said. “We believe the toxic effects of mercury are caused by mercury’s tendency to ‘steal’ selenium and prevent the formation of these highly important selenoproteins.”

### Selenium’s status

Dietary intake of selenium varies with food sources and typically reflects selenium levels in soils, Ralston said, which vary throughout the world.

“The United States is one of the most selenium-rich nations. Most of this country’s soils are selenium-adequate, yet selenium content can still vary from region to region,” he said. Other areas of the world tend to be low in selenium, Ralston said, including much of Europe. “Because of the generally high selenium content of our soils, North Dakota’s grain products are highly sought by European countries, and some food manufacturers are even seeking patents on their selenium-rich pastas.”

Awareness of selenium’s importance continues to grow. After detecting low blood selenium among its population, Finland began adding selenium to fertilizers. “They increased their soil selenium levels,” Ralston said. “Now they are investigating the health effects that have resulted.”

Raymond said studies have shown that selenium supplementation in lake waters in Sweden “resulted in a 75%–85% reduction in mercury levels in fish over a 3-year period. These studies are ongoing and show promising results.” The EERC researchers hope their chirping crickets will tell them even more about the mercury–selenium interaction that appears so critical to human and environmental health.

“Until we understand this relationship better, we are unable to truly assess the impact of mercury exposure. This information will help us identify at-risk populations and guide remediation efforts,” Ralston said.

– Janie Solarski



## Other mercury–selenium studies

EERC researchers are studying the mercury–selenium interaction from many perspectives. In addition to their focus on crickets (main story), the following studies are under way or planned:

- The EERC is investigating the neurotoxic impact of methylmercury on lab rats in a study that dispenses mercury in doses reflecting “real-world” exposure or “normal eating” as opposed to typical lab diets. In addition, the researchers are supplementing the diets of rats affected by mercury exposure with varying amounts of selenium to determine selenium’s potential to reverse mercury’s toxic effects.
- In a follow-up to a mother–child study on the impact of mercury among a fish-eating population in the Seychelles Islands, the researchers are investigating selenium’s role in offsetting mercury’s effects on child development.
- In collaboration with others, the researchers are studying how Zebra mussels in Lake Superior metabolize mercury. Mussels are tremendous filter feeders and accumulators of both mercury and selenium. The research will determine if insoluble mercury selenide bioaccumulates in the shell and soft tissue of mussels.
- The EERC is conducting studies on the abilities of certain grass species and types of water hyacinth to collect and biologically retire mercury. Both plants are considered hyperaccumulators of mercury and selenium, which may form insoluble mercury selenide.
- The EERC and Mayo Clinic are developing an investigation of the impact of selenium in a heart condition responsible for approximately half of all heart transplants.
- The EERC researchers also plan to study the role mercury and selenium may play in autism. The more severely autistic a child is, the less mercury is found in its hair samples, which could point to a selenium metabolism problem.

# Are the fish you eat safe?

In most cases, yes, said EERC Research Scientist Nick Ralston, particularly in regard to ocean fish. “Because selenium levels found in ocean fish like tuna and salmon offer protection from mercury in the fish, ocean fish may be off the hook,” Ralston said, “but the selenium levels in lake fish vary from lake to lake, so until more information is gathered, this question cannot be answered with a simple yes or no.”

The EERC has proposed studies to determine selenium levels in lake fish in North Dakota, Minnesota, and Florida in samples that have already been measured for mercury. “When we know the selenium levels in lake fish, we can more accurately advise consumers and fishing enthusiasts as to which lakes are the safest sources of fish,” he said.

Until then, Ralston said, it is advisable to follow the recommendations issued in state fishing guidelines for lakes and rivers. Most states, including North Dakota and Minnesota, have issued “safe-eating” guidelines based on the sampling of mercury and other possible contaminants in fish. There are specific recommended allowances for the general population, women who are or may become pregnant, and children 15 and younger based on the size of fish caught.

However, the fishing consumption guidelines vary from state to state, and this is most noticeable with connecting bodies of water, like the Red River. For instance, the North Dakota Department of Health advises no more than four meals of walleye a month for the general population, even if the fish are small (17 inches or less), while the Minnesota Department of Health advises only one meal of walleye a month, regardless of size.

The U.S. Food and Drug Administration has developed dietary guidelines that recommend eating up to 12 ounces of fish per week. Ralston says if you’re eating fish, you’re also eating selenium. He said most people receive enough selenium in their diets to protect them from any exposure to mercury through fish consumption. In addition, many vitamin supplements contain the recommended daily allowance of selenium.

“Good sources of selenium include beef, grain products like breads and pastas, white turkey meat, eggs, and rice, as well as tuna and other ocean fish,” Ralston said. “Of 1100 foods the U.S. Department of Agriculture ranked for selenium, 16 of the top 25 were ocean fish.”

– Janie Solarski



## Fish consumption guidelines

### North Dakota

[www.health.state.nd.us/wq/sw/Z7\\_Publications/B\\_2003FishAdvisory.pdf](http://www.health.state.nd.us/wq/sw/Z7_Publications/B_2003FishAdvisory.pdf)

### Minnesota

[www.health.state.mn.us/divs/eh/fish/eating/sitespecific.html](http://www.health.state.mn.us/divs/eh/fish/eating/sitespecific.html)

# Heide seeks to bridge research and business



Although his new job title—Deputy Associate Director for Intellectual Property Management and Technology Commercialization—crowds a business card, Dr. Carsten Heide says his role at the EERC can be summed up in a word: translator.

Heide's mission is to help EERC researchers translate their technical and intellectual endeavors into commercial ventures in the marketplace.

“Ingenuity must translate into solutions; otherwise, what is the purpose of doing research? At the end of the day, you need to have real-world impact,” he said. “My role is one of bridging the research world with the business world and making them move together. It’s important that one can communicate between those different worlds.”

Heide is responsible for developing collaborative partnerships with industry and government, facilitating the identification and transfer of strategic intellectual property to the EERC Foundation, and pursuing a dynamic commercialization process for EERC and EERC Foundation technologies.

With a Ph.D. in Theoretical Physics from Oxford University in England (1997), Heide is well versed in the technical backbone of the EERC. A native of Kiel, Germany, Heide studied Organic, Inorganic, and Physical Chemistry at the Ludwig Maximilians Universität in 1991, earning a degree in Physics in 1992, and took advanced courses in Theoretical Physics at the State University of St. Petersburg (1994). Heide was a NATO Research Fellow at the Institute of Radio-Engineering Electronics at the Russian Academy of Science in Moscow and a Postdoctoral Research Fellow at New York University’s Department of Physics.

Heide previously worked as a consultant with the Boston Consulting Group in Berlin, an international professional service firm specializing in corporate strategy for Fortune 500 clients. Since 2002, he served as Head of Business Development and Licensing with ipal GmbH, a Berlin intellectual property asset management firm that serves multiple research facilities and universities.

“Ingenuity must translate into solutions; otherwise, what is the purpose of doing research? At the end of the day, you need to have real-world impact.”

“What is so unique about the EERC is that it is the only research institute in the world that takes a true competitive business approach to acquiring research monies,” Heide said. “Through this approach, the EERC leads the way in not only the research and development but also the demonstration and commercialization of technologies. There are many places that invent, but there are very few that innovate—the EERC is one of the few. In many areas, including energy, air, and water, the EERC is tackling problems and offering a full range of solutions.”

In the short term, Heide said, the EERC will seek out more opportunities to leverage its intellectual property, building upon its growing revenue stream (\$29.5 million in contract revenue in FY05).

“Inherently, research is the riskiest business to be in; that is why it’s usually government-subsidized. It requires an investment in time. The goal is to have the research pay for itself so that, in the long term, the EERC is as independent as possible and free to pursue the research having the greatest commercial opportunities,” he said. “Ultimately, that entrepreneurial spirit has a spillover effect, resulting in spin-off businesses throughout the region.”

Heide, who once lived in New York, said he appreciates the freedoms and opportunities the United States offers and enjoys his new home. “North Dakota is quite unique, and I like that adventuring, pioneering aspect of things,” he said. “This is a great place to raise a family. People here are so friendly and so supportive.”

Heide and his wife, Julia, a mathematician with experience in information technology and financial services, have three sons: Alexander, 7; Jakob, 2; and Marc, 9 months.

# Family weathers storm—trees are not so lucky

**G**arrie Etherton and his wife, Annie, felt like trapped animals when they emerged from their rural Larimore home the morning of June 28. The Ethertons had taken refuge in their basement throughout the night when a severe storm with sustained 130-mph winds and driving rain pummeled their home and toppled their trees.

“We went outside when the sun came up. There were trees everywhere around us—it was something else,” said Garrie, an EERC Programmer/Analyst. “I felt like a caged animal. It took 20 minutes just to get past the trees from the house to the road, which is about 150 feet.”

The storm destroyed 90% of the trees in the Ethertons’ 16-acre yard, felled four trees onto their home, and toppled another tree onto their garage, causing nearly \$60,000 in total damage, including broken windows and ruined siding.

“The hardest thing was just getting over the shock of it,” Etherton said. “All of the trees were at least 75 to 100 years old. The largest was a cottonwood 26 feet wide at its roots and maybe 150 feet tall. Its trunk was about 8 or 9 feet across.”



*EERC volunteer Madhavi Marasinghe and Annie Etherton inspect the roots of the largest cottonwood lost during the storm.*

As the extent of the devastation sank in, the task of clearing their land was made less daunting with the help of neighbors and other volunteers, many of whom arrived with chainsaws in hand and one who came with a track hoe.

“One day, about 20 EERC employees came to help. It was raining, but they came anyway. They’re good people,” Garrie said. “The next day, about 30 employees from the (Grand Forks) Police Department, where my wife works, arrived. We had about 60 people helping us altogether. We really want to thank them.”

The majority of tree trunks were cleared off in a week and piled in their backyard. “I was surprised we got so much done so quickly,” said Etherton, who’s now busy clearing the small branches and sticks that litter the yard. “I spend every spare minute I have working on it. It might all be cleaned up about this time next year.”

While he’s not sure exactly how many trees were lost, Etherton said the U.S. Forest Service tallied 186 cords of cottonwood and 210 cords of other trees, including ash, willow, and evergreens.



*Garrie Etherton observes the efforts of EERC employees like Austin Theisen who came to his aid.*

*Continued on page 6*

## Family weathers storm

(Continued from page 5)



EERC volunteers Austin Theisen, Paul Gronhovd, and Andy Palmiscno saw the limbs off of downed trees.

A single cord is a stack of wood 4 ft by 4 ft by 8 ft. A single cord might yield 30 Boston rockers, 12 dining room tables that seat eight, or 7.5 million toothpicks (according to the North Carolina Forestry Association) and could produce the amount of heat equivalent from a ton of coal or 200 gallons of fuel oil.

“In February, we could have one good weenie roast,” Etherton noted.

– Janie Solarski

## On the Move

**2005 National Space & Missile Materials Symposium, Las Vegas, Nevada, June 27–July 1:** John Hurley (EERC) gave a presentation coauthored by John Hamling (EERC) entitled “Castable SiC Composites for Thermal and Debris Shielding.”

**Air & Waste Management Association’s 98th Annual Conference and Exhibition, Minneapolis, Minnesota, June 21–24:** John Pavlish (EERC) served on the “Mercury and Power Generation” panel and gave a presentation entitled “Mercury Control Options for Lignite-Fired Utilities.” Debra Pflughoeft-Hassett (EERC) cochaired the “Mercury Presence in Coal Combustion Byproducts” panel. David Hassett (EERC) served on the “Mercury Presence in Coal Combustion Byproducts” panel and gave a presentation entitled “Release of Mercury from Fly Ash–Carbon Sorbent Mixtures.” Chris Zygarlicke (EERC) presented a paper coauthored by Ye Zhuang and Jeff Thompson (EERC) entitled “Mercury Transformations in Coal Combustion Flue Gas.”

**Power Systems Development Facility Project Review Meeting, Birmingham, Alabama, June 21–22:** Mike Swanson (EERC) gave a presentation entitled “Coal Gasification Testing in a Pilot-Scale Transport Reactor.”

**2005 Alternative Energy Conference: Renewable Energy Use in Transportation, University of Manitoba, Winnipeg, Manitoba, June 20:** Tom Erickson (EERC) gave a conference presentation about the EERC.

**Montana State University, Bozeman, Montana, June 16:** Chris Zygarlicke (EERC) gave a seminar presentation entitled “Agri-Based Energy and Fuels.”

**Teacher Training Course, Headwaters Fort Mandan Visitor Center, Washburn, North Dakota, June 6–7:** Tera Buckley, David Hassett, and Kurt Eylands (EERC) presented a course entitled “Turning Coal into Electricity: What Happens to the By-Products.”

## EERC holds tournament

The team of Earl Battle, Graphics Designer; Jay Gunderson, Research Engineer; Dennis Kyle, Instrument Shop Manager; and Brad Stevens, Research Manager, took first place in the 2005 EERC Golf Tournament July 11.

A total of 48 golfers participated in the event at the Valley Golf Course in East Grand Forks, Minnesota. Golfers purchased \$88 in “Mulligans” or chances to take an extra shot during their game. The money was donated to the North Dakota Association for the Disabled.

## EERC golfers capture title

EERC golfers shined at the UND Employee Golf Tournament, September 12, at the Ray Richards Golf Course. Sheryl Landis, Manager, Contracts and Intellectual Property, and Erin O’Leary, Senior Research Manager, took first place in the women’s division of the tournament, held as part of Staff Recognition Week. Jay Gunderson, Research Engineer, and Dennis Kyle, Manager, Instrument Shop, initially tied with the best score in the men’s division, but lost in a tiebreaker. The event consisted of three holes of scramble, three holes of best score, and three holes of alternating shots.

## Upcoming Events

### November 1–2, 2005

Plains CO<sub>2</sub> Reduction Partnership Phase I Wrap-Up/Phase II Kickoff Meeting, Minneapolis, Minnesota

### November 7, 2005

Senator Dorgan’s Hydrogen Action Summit – Building the Hydrogen Economy: A Global Leadership Role for the Red River Valley Research Corridor, EERC, Grand Forks

### November 8, 2005

Red River Valley Research Corridor Hydrogen Short Course, EERC, Grand Forks

For more information: [www.undeerc.org](http://www.undeerc.org)