

# Natural Resources Research Institute

1985 - 2005



# NRRI Now

*Reaching higher*

Autumn 2005

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NRRI - poised for the future

A photograph of a man with white hair, wearing a white lab coat, a white hard hat, and safety glasses. He is focused on a task, possibly using a tool to work on a piece of machinery or equipment. The background shows industrial or laboratory equipment, including a large white fan and various pipes and structures.

NRRI Endowed Taconite Chair Iwao Iwasaki, spent hundreds of hours studying the iron nugget process in the new linear hearth, designed and manufactured at NRRI's Coleraine lab.



## NRRI –Then and Now

media. One observation by a member of the press was particularly insightful. She noted that “early on NRRI was quite controversial, but now we don’t seem to hear about NRRI in that light.” The fact is we *were* controversial. In a sense, NRRI was a “square peg in a round hole” in the University of Minnesota system. While the Institute received excellent support from UMD from the outset, that support did not exist in all circles of the University. We were perceived as an immediate threat to the former Minerals Resources Research Center, to the College of Forestry and others. The vision of what NRRI should be was somewhat in the eye of the beholder, as it somewhat still is today.

Provost Robert Heller, an ardent early supporter, was quick to envision NRRI as a state-of-the-art research institute. When speaking at University events, he was quick to point out that NRRI’s research budget would top \$5 million within five years and the Institute would be productive in terms of published papers. Representative Willard Munger’s vision and message was straightforward. Whatever you do, he said, “pay attention to the environment.” Many of his legislative colleagues had a different perspective. One of them, at an early meeting in NRRI’s history, stated it like this: “Lalich,” he said, “never mind the fact that you have not yet hired your scientists and don’t have access to laboratories. Northeastern Minnesota is in a crisis. We need jobs. You have a year.” All of these early visionaries helped to shape NRRI to make it what it is today.

Fast-forwarding a bit, I must say time has been our ally. NRRI has assembled a world-class team of researchers and invested in its

research infrastructure. We have learned what works and what does not from our successes and failures. And, especially important, is the fact that we have developed far-reaching partnerships. In fact, in my mind, NRRI is a model for interfacing a university with its constituents.

NRRI has had time to establish a credible track record based on outstanding applied research and technology development programs. The Institute’s track record includes numerous economic development contributions helping to create and retain jobs in the state and region. We routinely assist companies with product development and process improvement, and we provide business assistance through the NRRI Business Group within the UMD Center for Economic Development. The Institute’s ecosystem studies of lakes, streams, wetlands and uplands contribute to natural resource management protocols.

I am proud to say that, in the race to the future, I honestly believe NRRI is just reaching its stride. With its current portfolio of projects, NRRI is taking the assistance it provides to our region, state and nation to a new level. Further, from the standpoint of infrastructure and programs, we are poised for the future. For example, demand for the services of the Coleraine laboratory and the rapid prototype laboratory continues to increase. NRRI’s virtual team of mathematical modelers and computational chemists, its chemical derivatives laboratory, and its program on environmental indicators for lakes and streams are cutting edge. Thus, from a marketing perspective, demand for NRRI research and development services appears to be getting stronger overall. In short, NRRI’s mission is as relevant today as it was 20 years ago.

**Y**ou may have participated in the symposium at NRRI in September celebrating NRRI’s first 20 years. If not, perhaps the numerous news articles and radio or television features focusing on the occasion caught your attention. In reality, there probably is no one date that perfectly represents NRRI’s 20<sup>th</sup> anniversary. The enabling legislation authorizing the Institute became law

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“The fact is we *were* controversial. In a sense, NRRI was a ‘square peg in a round hole’ in the University of Minnesota system.”

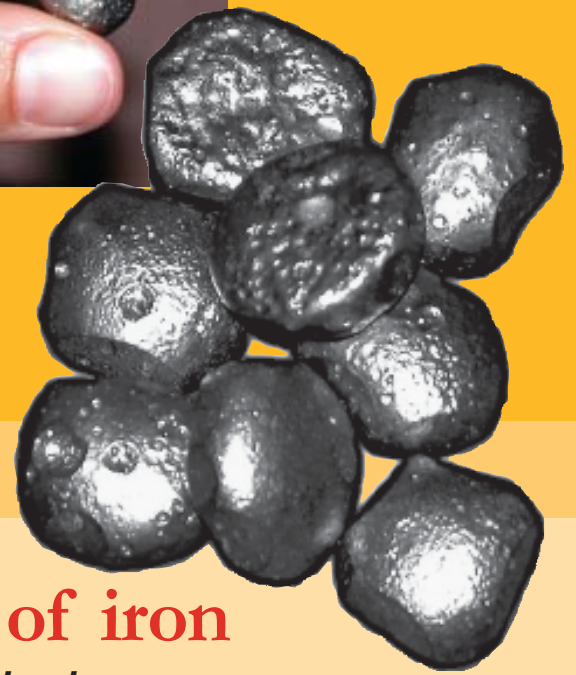
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in 1983. Hiring of staff began shortly thereafter. I came on board as Director on April 1, 1984. Offices in the NRRI building, formerly the SAGE building, became available in the fall of 1985, and labs in the spring of 1986. In any event, the recent celebration turned into an enjoyable occasion and a wonderful series of public relations events. While it was fun to reminisce, it is also useful to reflect. Where has NRRI been? Where is it now? Where is it going? And, perhaps most importantly, what have we learned from our experience that will help us going forward?

During the course of the celebration events, we were well treated by the

2 Growing strong industries ~ 20 years ~ Developing new ideas

# COVER STORY



## Minnesota's next generation of iron

*NRRI receives \$1 million to develop iron nugget technology*

**I**n the steel-making race, mini mills recently nudged ahead of the traditional blast furnace. Electric arc mini mills—now occupying about 52 percent of the steel manufacturing market—require pure iron and scrap steel as feedstock, and NRRI has advanced the state's technical leadership in making reduced iron products using taconite. The trick now is to do it with efficient energy use and low plant emissions.

“Our goal is to diversify the product mix from Minnesota's taconite operations,” said Dave Hendrickson, director of NRRI's Coleraine Minerals Lab. “Our technology will enable the plants to produce iron nuggets for mini mill operations in addition to taconite pellets for blast furnace operations.”

NRRI recently received a grant from the U.S. Department of Energy to further develop its unique patent-pending process and Linear Hearth Furnace for making pure iron nuggets. The Next Generation Metallic Iron Nodule Technology grant, together with matching funds from the University of Minnesota, will first focus on analyzing modifications to the furnace to optimize the production of iron from Minnesota's taconite ore. The second phase will focus on demonstrating the technology in routine production of high quality iron. When completed, energy savings of approximately 30 percent and emission reduction of over 40 percent are anticipated.

NRRI Center Director Donald Fosnacht and NRRI's Endowed Taconite Chair Iwao Iwasaki are co-principal investigators for this project, building on past NRRI research in this area.

“This program, if successful, should greatly enhance our chances to produce high value iron from our ore and help diversify the sources of future revenue from our Iron Range operations,” Fosnacht said. “We know what an effective process should be to routinely make low-cost, high quality iron. This grant will allow us to confirm our ideas and put them in place.”

NRRI is currently making nuggets that are 97 percent pure iron and three percent carbon, which are perfectly suited to the electric arc furnace. Electric mini mills are now able to make many grades of steel, including thin, flat sheets for the automotive industry—a market that had belonged exclusively to the blast furnace-based integrated mills.

“NRRI has been a leader in introducing the iron nugget technology in Minnesota,” said Hendrickson. “This funding will allow us to optimize the process for this vital industry on the Iron Range.”

NRRI researchers Rod Bleifuss, Dave Englund, Dick Kiesel and Andy Lindgren will also actively participate in the program.

# NRRI expertise moves from Great Lakes to 'Great Rivers'

**A**s NRRI scientists begin to wrap up the successful Great Lakes Environmental Indicators project, the great rivers of the United States beg for the same attention. The Environmental Protection Agency awarded NRRI \$840,000 over the next five years to use some of their proven research techniques on river systems.

The Great Rivers Project will cover the Upper Mississippi, the Ohio and the Missouri rivers and their watersheds. What areas are still pristine? What areas need pollution remediation? How are human activities in the watersheds impacting water quality? Just how healthy are these “great rivers”?

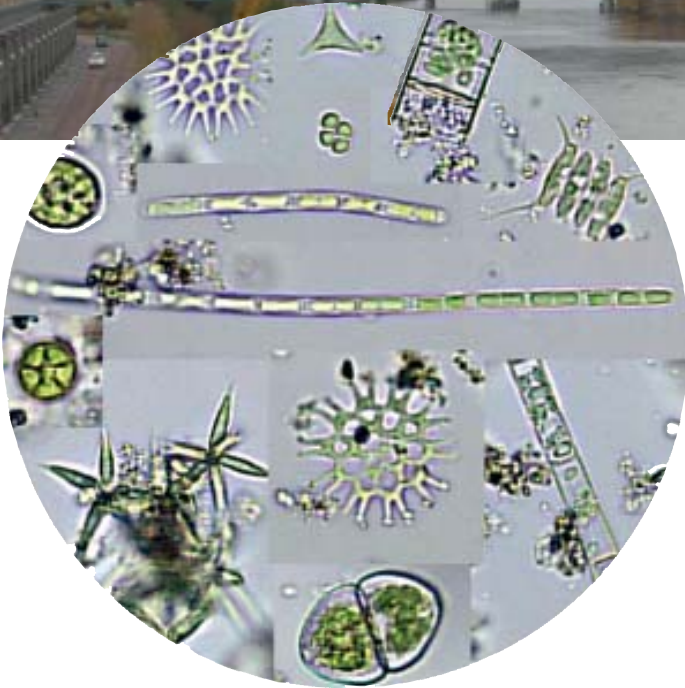
NRRI’s specialists in algae research at the Ely Field Station will tackle a large portion of this comprehensive project. Algae—microbiotic and environmentally sensitive organisms—are remarkable “tools” for monitoring disturbances in river systems. Developing these tools will be the first major task of this project. Other indicators of environmental health, like water chemistry, macroinvertebrates, fish, sediment and vegetation, are currently being developed by collaborating agencies.

Euan Reavie is the lead scientist at the Ely Field Station and charged with execution of NRRI’s portion of the Great Rivers project, in close collaboration with scientists at the EPA’s Health & Environmental Effects Research Laboratory in Duluth.

“The samples have already been gathered,” Reavie explained. “Now, we’ll spend the first two years of the project looking at more than a thousand samples under the microscope. It is excruciatingly detailed work, but it’s important. In the end, we’ll have identified hundreds of species and their ecology.”

As with the GLEI project, the EPA ultimately wants to be able to rank portions of the rivers from “good” to “highly degraded” based on the various indicators developed by the scientists. With clearly defined environmental quality data in hand, the EPA can understand what is truly attainable for remediating the most degraded areas.





## Algae—under the microscope

Full algae populations and diatoms (a highly diverse subgroup of algae) will be studied. Algae are critical to global cycles, such as the absorption of carbon dioxide and replenishment of the planet's oxygen. They are microscopic, single-celled or colonial plants that comprise an indispensable bottom rung of food webs in rivers.

Algae abundance and diversity (more than 20,000 species!) in rivers make them ideal tools for monitoring environmental quality. Each species has its own environmental preference, and so can tell us about a site's condition. Unlike chemical measurements which can fluctuate rapidly over short periods of time, algae can provide a more integrated picture of a site's prevailing condition.

Diatom algae are excellent tools for paleoecology—a discipline that describes the ecological history of an area through sediment analysis. Their sensitive nature makes diatoms respond quickly to environmental stressors. They also have silicate cell walls (i.e. biogenic glass), so their remains can be preserved in sediments for thousands of years. In addition to being an environmental monitoring tool, the diatom algae can help describe the natural condition of the rivers, before Europeans settled the region.

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Several planktonic algae specimens from the Mississippi River, collected in 2004. Each species has a unique architecture and environmental preference. NRRI scientists use these characteristics to build algae-based tools for inferring environmental quality.

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## NRRI update: Stream restoration efforts begin to flow

Matching the generous donation of UMD alumnus Ron Weber, NRRI received another \$100,000 from an anonymous private donor to help fund the Weber Stream Restoration Initiative.

“This is extremely helpful to our research,” says Jerry Niemi, NRRI Center Director. “When money comes in from private parties, it really underscores how important and necessary this work is.”

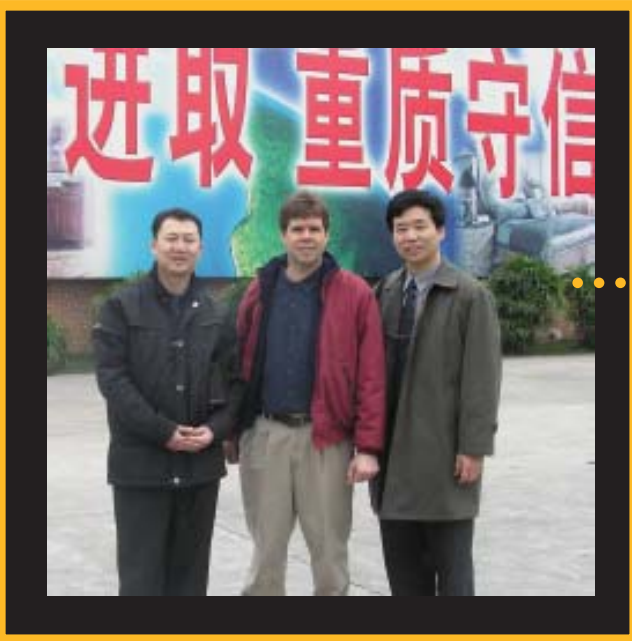
The project kicked off last spring and efforts are beginning to take root. Literally.

NRRI has secured 1,000 trees for planting along the Lester and Amity rivers in Duluth, the areas of primary restoration effort. The tree plantings will incorporate an intensive study to determine both the success of

different species and the effectiveness of weed control and anti-predation techniques to try to reduce browsing mortality by deer.

Field crews also spent the summer examining the streams at both base flow levels and during storm events. Nearly 100 road crossings and other potential problem areas have been examined.

Additional grants are being applied for to expand the Stream Restoration Initiative to watersheds further up Lake Superior's North Shore. The U.S. EPA Great Lakes National Program Office recently approved a \$35,000 grant through the National Fish and Wildlife Foundation, which will complement the Initiative goals by focusing on regional-level geographical analysis of the watersheds.



Above: NRRI's Brian Brashaw (center) relied on help from lumber importer Sunny Cheng (left) and NRRI researcher Xiping Wang to understand the Chinese business culture. Right: Many workers inspect products at a doorskin factory.

*A competitive world offers two possibilities. You can lose. Or, if you want to win, you can change.*

—L. C. Thurow, author of *Economics Explained*.

## Trade mission to China highlights

*Minnesota wood products companies, take note!*



The time had come to face down the competition. Last spring, NRRI forest products researcher Brian Brashaw, journeyed to China with 16 representatives of the regional wood products industry and research facilities. Their mission: to get a better understanding of what it takes to stay competitive in the wood products global marketplace.

China is the toughest competitor in the ring. They don't have the wood supply we do, but wood is easily imported. Their biggest advantage is a low cost workforce that's tough to beat. They also don't have the stringent and costly environmental requirements known to U.S. industry. But Brashaw already knew about China's advantages—this 13-day trip was about discovering opportunities for Minnesota.

Joined by Keith Jacobson, Minnesota Department of Natural Resources Forestry Division (funded 50 percent through NRRI), Brashaw and crew visited flooring and furniture manufacturers and saw a growing number of cabinet manufacturers making high quality items that appeal to the U.S. market.

"Their workmanship is excellent," said Brashaw. "The advantage of low cost labor allows China manufacturers to use less automation and significantly more labor. They're paying about 20 cents per hour, to our \$14 - \$15 an hour."

At a cabinet plant in Foshan, the group noticed many inefficient practices—big batch manufacturing and wasted employee time—but they can afford to do that with the workforce available. The company ships 95 percent or more of their products to the USA which is good news for consumers who want high quality at a low cost, but also means a significant loss of manufacturing jobs in the U.S. North Carolina's furniture industry lost most of their jobs to the competition overseas. The trick will be to stay one step ahead.

"Minnesota has strong wood products companies and I think that's going to continue," said Brashaw. "But Lean Manufacturing or Continuous Improvement programs are a must on the manufacturing floor."



The massive wood market in Dongguan, China, sells wood from all over the world.

## challenges and opportunities

Shipping is a significant local advantage. Products from China take 30 to 60 days, which provides opportunities for the U.S. to be competitive on lead times if they continue to trim the time between order and shipping. Minnesota companies can also nurture their innate *guanxi* (pronounced wan chi)—valuing businesses relationships and being responsive to customer's needs. In China, as in the U.S., it's not what you know but who you know. It's a home team advantage. It was especially helpful to have NRRI wood products researcher Xiping Wang, a native of China, along to make connections. He not only speaks fluent Chinese and English, but speaks the industry lingo as well.

Understanding the competition was one goal of the trip. Making them into a customer was the second goal. The country's explosive building boom and growing middle class is a potential market worth paying attention to. Assistance from the Minnesota Trade Office is readily available for companies who want to explore export possibilities. Specialty products and equipment for the housing industry have good potential in the China market.

"It's easier to keep the jobs we have than try to create new ones," said Brashaw. "There's always competition in business—whether it's down the block or across the ocean. I have a lot of respect for the Chinese. They were very gracious hosts."

For more information about Lean Manufacturing or Continuous Improvement Programs, contact Brian Brashaw at 218-720-4248 or by email [bbrashaw@nrri.umn.edu](mailto:bbrashaw@nrri.umn.edu).

On its way to U.S. markets, the Chinese have developed their niche for mass production cabinets.



### From Brian's travel notebook:

- The Chinese have a wide range of technology and manufacturing expertise. Some "world-class" technology, some secondhand equipment and lots of labor.
- The Chinese government is serious about supporting the wood manufacturing industry. Several (some sources indicate as many as six!) forest product research facilities are housed at Chinese universities (Similar to the USFS Forest Products Lab in Madison, Wisc.).
- Factory workers are typically "migrants" from the Chinese countryside. Companies house and feed workers in dormitories next to the manufacturing facilities. Wages range from 10 to 50 cents an hour, which includes benefits and housing.
- Many wood manufacturing businesses are supplied through huge "wood markets." Many small wood suppliers lease space in a large "wood market."
- Wood handling issues—moisture, stain, re-drying of wood—is commonly done at manufacturing facility.
- Worker safety—we saw no dust abatement equipment or guards on machinery. Workers were observed literally in the "throat" of a veneer slicing machine!

~ 20 years ~ Nurturing natural resources ~ 20 years 7



# A deep look at shallow ponds

Study seeks to  
understand  
challenges facing  
'prairie potholes'

Above: NRRI researchers replicated the prairie potholes in NRRI's back yard. Right: Prairie potholes are teeming with life, and stressed by the development around them.



**R**oughly a million years ago, glaciers carved an amazing and diverse freshwater resource into the Great Plains landscape—the prairie potholes. These scattered pockets of shallow wetlands are alive with plant and animal life. The potholes also play an important role in managing the hydrology of the area—storing excess water during heavy rains and spring snowmelt.

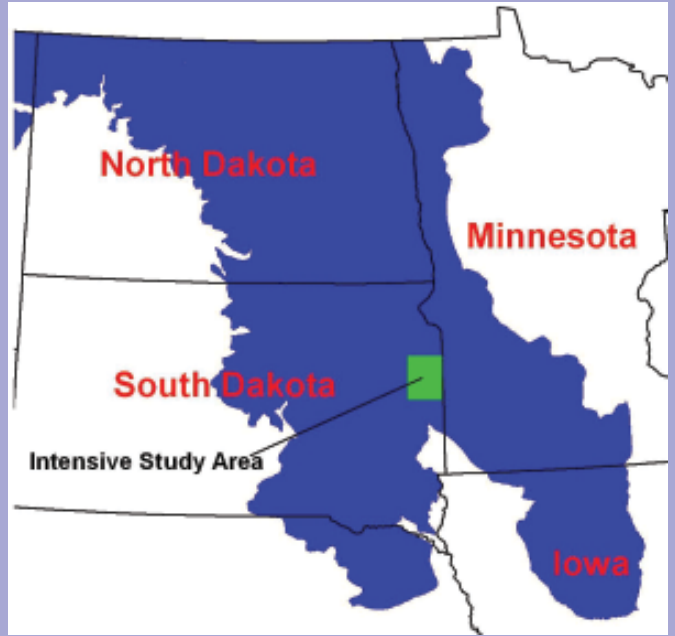
While this already sensitive ecological region faces agricultural development and pollutants, it also faces a new challenge—climate change.

Global climate changes are expected to reduce the amount of precipitation, raise temperatures and increase ultraviolet-B radiation, especially in the northern half of the United States. These stressors join the potholes'

already diminished water quality, declining groundwater resources and an overload of pesticides and nutrients. It is expected that climate change will affect how some potholes function and eliminate others altogether. Some potholes are as much as 10 feet deep and hold water for extended periods, others are shallow and temporary. Over the centuries, wildlife has adapted to their various rhythms.

NRRI Ecotoxicologist Pat Schoff received a grant of \$746,433 from the Environmental Protection Agency to conduct experiments that will help resource managers understand the effect of these stressors on the amphibious life in the potholes.

“When we talk about climate change in the upper Midwest, we’re talking about the region becoming



The glacier-carved prairie pothole region of the Great Plains.



warmer and drier,” said Schoff. “Animals that live in the prairie potholes are used to fluctuating water levels, but we fear that the coming changes will be too dramatic for them to adapt.”

The project design has three levels of experimentation—an extensive portion covering the entire Prairie Pothole Region (see map), a more in-depth, intensive portion that studies a smaller area, and the mesocosm scale, which was recently moved to NRRI’s backyard from Brookings, South Dakota. The experiments replicate the conditions of the prairie potholes in a small, controlled environment. Forty-five tubs are treated with varying levels of atrazine—a common chemical in pesticides—and varying water levels. American Toad eggs are put in the tubs and their life cycle is carefully documented.

“Is there a connection between their metamorphic development and the various stressors the frogs face in these potholes?” Schoff asked. “That’s what we’re really after.”

Under highly stressed situations, amphibians may speed up their development from tadpole to frog, but they tend to form as smaller adults.

“Females put all their energy into reproduction, and an undersized female may be too small to reproduce,” said Schoff. “Ultimately, we’re concerned about their survival in this region.”

Schoff is working in cooperation with NRRI aquatic ecologist Lucinda Johnson, Glenn Guntenspergen with the U.S. Geological Survey and Cathy Johnson with the U.S. Forest Service in West Virginia.

# Experience shapes NRRI Advisory Board

## Board members shape NRRI

From algae research to emergency relief housing... With the wide variety of projects taking place at NRRI on any given day, it's no wonder outsiders are often confused about what the institute is all about. This makes NRRI's Advisory Board more valuable than ever. They're the link to the outside—explaining our role to the community and industry. They're also the link to the inside—sharing information about industry trends or community needs.

The Advisory Board has ridden the rollercoaster of NRRI's progress over the decades—coaching, suggesting, guiding and pushing. Conversations with two retired Advisory Board Chairs, Al France and Jerry Ostroski, and current chair Tom Reagan, reveal insight, support and pride in NRRI's progress over the past 20 years.

France was there in 1983 when the Minnesota Legislature signed the institute into being. At the time, he was president of the Lake Superior Industrial Bureau (now the Iron Mining Association). Minnesota's taconite industry was suffering through a severe economic downturn. The wood products industry was also facing unprecedented global competition.

"The initiative came from Governor Rudy Perpich and Judge Heaney," said France. "We were very much interested in diversification of the economy. We didn't want to rely solely on taconite production. Building an institute that could develop other resource-based industries was very much in our best interests, while also providing help with taconite research."

NRRI has met the mission of strengthening Minnesota's iron ore and taconite industry many times over through the work at its Minerals Research Laboratory situated in the heart of the Iron Range.

"We know more about iron mining than we ever did before, and a lot of that has to do with NRRI research," said Reagan.

Reagan was Congressman Jim Oberstar's chief of staff for 20 years. He joined the NRRI board in the early 1990s.

"A good example is in solving one of the early problems with taconite pellets," Reagan said. "We have a lot of silica in our ore. Through NRRI research, we've now learned that we can get rid of most of that silica. It makes the pellets a lot less expensive and more competitive in world markets. That's been a tremendous advance."

Ostroski, like many Advisory Board Members, is a strong proponent of the idea that, in order to survive into the future, NRRI must develop its own income stream and rely less on state and federal funding. Ostroski has almost 40 years of business experience from various positions at Minnesota Power. In his last few years he ran the company's venture capital entity for emerging technologies.

"It does no good for NRRI to develop a really nice technology—like rapid response housing—and then give it to some entrepreneur who goes off with it, leaving NRRI with nothing long-term," Ostroski said. "NRRI has to have a revenue



Jerry Ostroski, retired Advisory Board Chair

stream of its own so it can continue to do the work it's capable of doing."

Ostroski's advice has been heard and NRRI is working toward licensing a handful of key projects that will strengthen its economic base into the future.

"NRRI, right now, is at a peak higher than I've ever seen it," said Reagan, "in activity, in prospects. The work that's being done is excellent. It stands up to scientific scrutiny. I give Rudy Perpich credit for understanding that if you're going to base your economy on natural resources—mining, timber—you better have a research arm to keep you abreast of what we have to do to keep those industries vital."

France remembers that NRRI's unique role of balancing economic development with environmental research was a hard sell in the beginning. The two seemed incongruous.

"At first, I questioned the emphasis on the environmental programs,"



Al France, retired Advisory Board Chair



Tom Reagan, current Advisory Board Chair

2005

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UMD's School of Business and Economics

France admitted. "We were supposed to provide jobs—but it's been a good mesh and it's important to the overall institute, and industry, to have that environmental work going on."

All three agree that the institute's University connection provides invaluable resources and strength in meeting its outreach mission. But, while NRRI has seen results over its past 20 years, it's really just hitting its stride, and the future is bright. But as Ostroski put it, "Patience is the key."

"The development of new technologies takes somewhere around 10 to 30 years," Ostroski said. "Remember when it seemed like the Internet came along all of a sudden a few years back? It was actually invented in 1969. It took a long, long time to develop it into the tool it is today. NRRI is a great incubator for the development of many new ideas. We just have to be patient."

# NRRI staff look forward

Throughout 2005, NRRI staff marked 20 years of growth in expertise, research programs and responsiveness to the needs of Minnesota. NRRI's unique model for economic development, balanced with environmental

stewardship, plays a vital role for natural resources based industries—and its reach continues to broaden regionally, nationally and even internationally. The horizon for NRRI's next 20 years looks especially exciting.

1985 - 2005



Our best resource – our people! NRRI staff gather in September to celebrate 20 years of results.

## Check us out: [www.nrri.umn.edu](http://www.nrri.umn.edu)

*The Natural Resources Research Institute was established by the Minnesota Legislature in 1983 to foster economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.*

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**Center for Water & the Environment**

Gerald Niemi, director

**Center for Applied Research & Technology Development**

Donald Fosnacht, director

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